

SPECIES ACCOUNT: *Abronia macrocarpa* (Large-fruited sand-verbena)

Species Taxonomic and Listing Information

Listing Status: Endangered; 9/28/1988; Southwest Region (R2) (USFWS, 2016)

Physical Description

This species is a broad-leaved, tap-rooted, herbaceous perennial growing to 20 in (50 cm). The foliage is sticky from glandular hairs. The leaves are usually rounded, and about 0.75-2.0 in (2-5 cm) long and 0.6-1.4 in (1.5-3.5 cm) wide. The magenta flowers are grouped into rounded heads composed of 20-75 individual flowers. These flower heads have bracts at the base that are nearly oval and about 0.25-0.5 in (0.6-1.3 cm) long and 0.13-0.38 inch (0.3-1.0 cm) wide. Each flower has a tube about 0.7-1.3 in (1.8-3.3 cm) long that widens at the top into five nearly divided lobes 0.3-0.4 inch (0.8-1.0 cm) wide. The fruits are 0.3-0.6 inch (0.8-1.6 cm) long and 0.2-0.5 inch (0.5-1.3 cm) wide and papery with five often somewhat twisted wings. The seeds (achenes) are from 0.06-0.19 inch (1.5-4.8 millimeters) long and brown. The species is most easily characterized by its large, thin-walled fruits (anthocarps), which are thinner and more papery than any other species of *Abronia* and among the largest in the genus (USFWS, 1992).

Taxonomy

In the Four-O'clock family (Nyctaginaceae) (NatureServe, 2015). The species' common name has been spelled with and without hyphenation. The Services have chosen to use hyphens, particularly to help clarify the confusion between "sand-verbenas", which are members of the genus *Abronia* and family Nyctaginaceae, and "verbenas", which are members of the genus *Verbena* and family Verbenaceae. Sand-verbenas and verbenas are not closely related (USFWS, 2010).

Historical Range

See Current Range.

Current Range

Known from Leon, Robertson, and Freestone counties in eastern Texas (USFWS, 2010).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect (EPA, 2016)

Breeding Season

Adult: Flowers in March or April and occasionally again in the fall following periods of high rainfall (USFWS, 1992).

Reproduction Narrative

Adult: Species forms rosettes in the fall that overwinter. In spring, plants produce shoot material and bloom. Flowers in March or April and occasionally again in the fall following periods of high rainfall. Plants die back during the hot summer months, and send up new rosettes each fall (USFWS, 1992). Species is moth-pollinated (crepuscular and nocturnal moths); incidental diurnal pollination may be due to bees (genus *Bombus* and *Apis*). Identified moth pollinators include Sphynx moths: black alder or pawpaw sphynx, lettered sphynx and obscure sphynx and the Noctuid moth: large necklace moth (EPA, 2016).

Habitat Type

Adult: Terrestrial (EPA, 2016)

Habitat Vegetation or Surface Water Classification

Adult: Post oak savanna (EPA, 2016)

Geographic or Habitat Restraints or Barriers

Adult: Elevations of 360-450 feet (USFWS, 1992)

Habitat Narrative

Adult: Documented wild populations occur in acid, relatively infertile sandy soils derived from Carrizo Sand, Sparta Sand, and Queen City Sand. Soil composition analyses from 2 sites in Leon and Freestone counties had a range of 90.4-92.8% sand, 4.2-6.2% clay, and 3.0-3.4% silt. Terrain is nearly level to gently sloping at elevations from 360-450 feet (EPA, 2016). Occurs in deep, well-drained sands, sometimes on actively blowing sand dunes, within a post oak-grassland mosaic vegetation type. The species is one of many herbaceous plants that temporarily dominate these bare sands during spring (NatureServe, 2015). Soils are relatively infertile and unstable; water availability is low and unreliable; and temperatures are extreme and variable both diurnally and seasonally (USFWS, 1992).

Dispersal/Migration**Motility/Mobility**

Adult: Abiotic (EPA, 2016)

Dispersal/Migration Narrative

Adult: Dispersed by wind; "Clumped-contagious" distribution (EPA, 2016).

Population Information and Trends**Population Trends:**

Not available.

Species Trends:

Stable (inferred from USFWS, 2010)

Resiliency:

Medium (inferred from USFWS, 2010)

Representation:

Medium (inferred from USFWS, 2010)

Redundancy:

Medium (inferred from USFWS, 2010)

Number of Populations:

9 (USFWS, 2010)

Population Size:

Approximately 90,000 individuals (USFWS, 2010)

Population Narrative:

Nine populations have been documented in Leon, Robertson, and Freestone counties; these include one each in Leon and Robertson counties that were both combined from two previously-recognized populations, based on genetic analyses and field surveys. All known populations are on privately-owned lands that were surveyed with landowner permissions. In addition, three small experimental populations have been successfully established on private land. The total known population has increased from about 35,250 in 1996 to 94,509 in 2008. This increase is due both to the discovery of new populations, and to growth of the known populations resulting from land use changes that are more favorable to conservation of the species (USFWS, 2010)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Habitat could be lost through surface mining; petroleum exploration; highway, power line, and pipeline construction. The conversion of native grasslands to “improved pastures” of introduced grasses is an ongoing threat. Suppression of wildfire and poor rangeland management could lead to increased cover of woody vegetation, which could reduce habitat quality the degree of threat is difficult to assess. Some land uses, including OHV use, mowing, small-scale clearing, herbicide application, and annual wildlife food plots, can directly harm or destroy *A. macrocarpa* individuals, or reduce their reproductive potential (USFWS, 2010).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: All known *A. macrocarpa* populations occur on privately-owned land. Approximately 95 percent of Texas land area is privately owned. It is reasonable to assume that the vast majority, if not all existing *A. macrocarpa* habitat, including sites that have not been documented, occurs on private land. Therefore, the species’ populations and habitats are not subject to Federal or State protection unless there is a Federal nexus, such as provisions of the Clean Water Act or a federally-funded project (USFWS, 2010).

Stressor: Other natural or manmade factors affecting its continued existence (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: Rising temperatures might enable the species to survive further north than at present, but might also reduce the southern limit of the range. Similarly, changes in the frequency and amount of precipitation could favor a shift in geographic range or habitat type. Changes in temperature and rainfall amounts and patterns could alter the species' competitive advantage in the unique micro-habitats it now inhabits. At present, the Services cannot predict how the infinitely complex aggregation of climate change effects will affect the synecology of the species and its habitat (USFWS, 2010).

Recovery**Reclassification Criteria:**

At least 20 healthy, stable populations with a minimum of 600 plants in each should be located or established. A healthy population would be considered to be one with a habitat area of at least 25 acres, demographically stable, and genetically viable. These populations should be distributed throughout the natural, potential geographic range of the species, as determined by recovery research activities (USFWS, 2010).

Delisting Criteria:

The 20 populations described for the reclassification criteria have maintained needed population structure and viability for at least 10 years. In addition, long-term agreements and management plans should be in place that will ensure their continued protection (USFWS, 2010).

Recovery Actions:

- Protect *Abronia macrocarpa* populations from existing and future threats and develop management plans (USFWS, 1992).
- Maintain a reserve germ bank/cultivated population with a responsible agency/Institution (USFWS, 1992).
- Study population biology. Initiate studies to gather information necessary for protective management and restoration. Study cultivation requirements (USFWS, 1992).
- Search/inventory potential habitat (USFWS, 1992).
- Assess restoration feasibility (USFWS, 1992).
- Develop and implement a reintroduction plan, if feasible (USFWS, 1992).
- Develop public concern and support for the preservation and study of *Abronia macrocarpa* (USFWS, 1992).
- Develop a post-recovery monitoring plan (USFWS, 1992).

Conservation Measures and Best Management Practices:

- Revise the recovery plan and recovery criteria to reflect new information on the species' biology, ecology, and range, incorporating the most recent recovery planning guidance (National Marine Fisheries Service 2007). Specifically, the criterion of a minimum viable population area of 10.1 ha (25 ac) is unrealistic, since the known viable wild populations occupy much smaller areas. However, it is important to distinguish between the area requirements of both occupied and unoccupied potential habitat. *Abronia macrocarpa* inhabits sparsely-vegetated, unstable sandy soil formations; anecdotal

observations indicate that the populations respond favorably to occasional light disturbance. Therefore, it is possible that this plant is narrowly adapted to a specific seral stage that continually shifts location as these inland sand dunes form and recede. If this is the case, the area requirement for unoccupied but intact potential habitat will be much greater than the area occupied by the species at any given time; long-term survival would require landscape-scale conservation (USFWS, 2010).

- Increase the minimum viable population size of 600 individuals for the recovery criteria, as this appears to be too small (McGlaughlin et al. 2002, Williamson, pers. com. 2010) (USFWS, 2010).
- Continue to promote public support for conservation and recovery of the species through local schools and news media, non-governmental conservation organizations, and other forms of public outreach (USFWS, 2010).
- Continue periodic monitoring and surveys of the known populations to track demographic trends, and to detect and attempt to alleviate threats to these populations (USFWS, 2010).
- Support conservation of wild populations on private lands through the USFWS Partners for Fish and Wildlife Program and section 6-funded grants, and through cooperative efforts with Natural Resources Conservation Service and other state and federal agencies. Establish a private landowner support group, similar to the group now actively working to conserve Texas snowbells (*Styrax platanifolius* ssp. *texasus*) (USFWS, 2010).
- Continue to search for wild populations. Use GIS technology to identify areas of high potential habitat, and seek landowner permissions to survey those areas (USFWS, 2010).
- Conduct scientific investigation of the species' fire ecology. (USFWS, 2010).
- Continue to develop reintroduction techniques to improve establishment rates in the field and cost effectiveness. Once suitable techniques have been demonstrated through pilot reintroductions, implement a reintroduction program on a scale sufficient to recover the species. (USFWS, 2010).

References

USFWS. 2016. Environmental Conservation Online System (ECOS) – Species Profile. <http://ecos.fws.gov/ecp0/>. Accessed July 2016

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USFWS. 2010. Large-Fruited Sand-Verbena *Abronia macrocarpa* Galloway 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Austin Ecological Services Field Office, Austin, Texas. 42 pp.

SPECIES ACCOUNT: *Abutilon eremitopetalum* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/20/1991; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Abutilon eremitopetalum (Figure 1, from Degener 1933) is a shrub in the mallow family (Malvaceae) with grayish-green, densely hairy, heart-shaped leaves; the leaves are 7 to 12 cm (2.7 to 4.7 in) long. One or two flowers are on stems up to 4 cm (1.6 in) long in the leaf axils. The calyx of the flowers are green, cup-shaped, and about 1.5 cm (0.6 in) long. The petals are shorter than the calyx and are bright green on the upper surface and reddish on the lower surface. The staminal column extends beyond the calyx and is white to yellow, with red style branches tipped with green stigmas. The fruit is a hairy, brown, dry, cylindrical capsule and about 1 cm (0.4 in) long. It is the only *Abutilon* on Lana'i whose flowers have green petals hidden within the calyx (Bates in Wagner et al. 1990). (USFWS, 1994)

Taxonomy

Abutilon eremitopetalum was originally described as *Abutilon cryptopetalum* with type specimen listed as one collected by George C. Munro in 1930 from Maunalei Valley, Lana'i (Caum 1933). The specific epithet refers to, "the very small... petals, which are at all times completely enclosed within the calyx" (Caum 1933). However, unbeknownst to Caum at the time of his original publication, the epithet *Abutilon cryotonetalum* had already been assigned to an Australian species (Degener 1936). Caum renamed the species *Abutilon eremitopetalum* (Caum in Christophersen 1934). In 1932, Otto Degener established the genus *Abortopetalum* (Degener 1932) and in 1936 included this species in that genus as *Abortopetalum eremitopetalum* (Degener 1936). However, Christophersen points out that Degener's *Abortonetalum* does not differ from *Abutilon* in characters of generic rank (Christophersen 1934); the most recent revision of the Hawaiian flora supports Christophersen's conclusion (Bates in Wagner et al. 1990). Therefore, the current designation for this plant is *Abutilon eremitopetalum*. (USFWS, 1994)

Current Range

Endemic to the windward side of the island of Lanai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Abutilon eremitopetalum* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Abutilon eremitopetalum* includes two CHUs in Maui County, Hawaii. Approximately 10,705 ac (4,332 ha) of private land on the Island of Lanai are being designated as critical habitat for *Abutilon eremitopetalum*. (81 FR 17790-18110).

Both Critical Habitat Units are on Lanai and no data is specified except that they are owned by Lanai Resorts, LLC and Castle and Cooke Properties, Inc.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Abutilon eremitopetalum* critical habitat consists of one component (81 FR 17790-18110):

Lowland Dry Ecosystem: Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*. Subcanopy: *Chamaesyce*, *Dodonaea*, *Leptecophylla*, *Osteomeles*, *Psydrax*, *Scaevola*, *Wikstroemia*. Understory: *Alyxia*, *Artemisia*, *Bidens*, *Chenopodium*, *Nephrolepis*, *Peperomia*, *Sicyos*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative

ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

In 2012, the Service revised critical habitat for *Abutilon eremitopetalum*, and the proposed rule identified two critical habitat units on Lānaʻi in the lowland dry ecosystem (10,705 ac, 4,332 ha) (77 FR 34464, July 11, 2012). In the final rule the Service excluded critical habitat for this species on the island of Lānaʻi because, as demonstrated by the ongoing conservation activities by the

private landowner, their commitment to develop the Lānaʻi Natural Resources Plan, and a memorandum of understanding with the Service, exclusion from critical habitat would provide greater long-term benefits to the species than designation of critical habitat (USFWS 2015; 81 FR 17790, March 30, 2016). (USFWS, 2018)

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland, shrubland/chaparral (NatureServe, 2015)

Habitat Narrative

Adult: Abutilon eremitopetalum is found in dry forests and shrublands in gulches. (NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

1 (NatureServe, 2015)

Population Size:

70 observed, estimate of <1000 individuals (NatureServe, 2015)

Population Narrative:

Currently about 70 plants observed, estimate less than 1000 plants. There is 1 current occurrence (between 1982 and 1997) and 2 historical occurrences. (NatureServe, 2015); Only two individuals of Abutilon eremitopetalum remain at Kaheʻa Gulch (PEPP 2013). (USFWS, 2018)

Threats and Stressors

Stressor: Introduced species (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: Threats include alien vegetation and alien animals (deer). (NatureServe, 2015)

Stressor: Climate change (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Climate change destruction or degradation of habitat – Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Abutilon eremitopetalum* is highly vulnerable to the impacts of climate change. Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2014)

Stressor: Ungulates (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Ungulates may be degrading habitat and eating plants. (USFWS, 2014)

Stressor: Fire (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Fire may be a threat to this species. (USFWS, 2014)

Stressor: Small population size (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Extremely limited populations may be a threat to the survival of the species. (USFWS, 2014)

Stressor: Drought degradation of habitat (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Drought is observed to be a threat to the last population of *Abutilon eremitopetalum* on Lānaʻi (PEPP 2011, 2012, 2013). Over the past 100 years, the Hawaiian Islands have experienced an annual decline in precipitation from just over 9 percent, increasing to as much as 15 percent within the last 20 years (US-NSTC 2008; Chu and Chen 2005; Diaz 2005). Drought

affects plants directly by desiccation. The increase in drought frequency and intensity leads to a self-perpetuating cycle of increase in cover of nonnative plants, increase in the number of fires, and an increase of erosion (US-GCRP 2009; Warren 2011). Recent episodes of drought have also driven deer farther into urban and forested areas in search of food, increasing their negative impacts to native vegetation from herbivory and trampling (Waring 1996, in litt; Nishibayashi 2001, in litt.). (USFWS, 2018)

Stressor: Lack of adequate bio-security legislation (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Invasion of the State of Hawai'i by invasive nonnative plant species, and destruction of habitat and competition by nonnative plants are threats to *Abutilon eremitopetalum*. The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, is authorized to prevent the introduction or dissemination of animal and plant pests on all ships, aircraft, and their cargo and baggage arriving in the U.S. and its territories; however, pest species continue to enter the State. In addition, Federal import regulations do not address many species that could be pests in Hawaii (CGAPS 2009; Ikuma et al. 2002). (USFWS, 2018)

Recovery

Reclassification Criteria:

1. A total of five to seven populations are documented on Lanai and at least one other island where they now occur or occurred historically. (USFWS, 1994)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1994)
3. Each of these populations must persist at this level for at least 5 consecutive years before downlisting is considered. (USFWS, 1994)

Delisting Criteria:

1. These taxa may be delisted when a total of 8 to 10 populations of each taxon should be documented on Lanai and at least one other island where they now occur or occurred historically. (USFWS, 1994)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum or 300 mature individuals per population for short-lived perennials. (USFWS, 1994)
3. Each population should persist at this level for at least 5 consecutive years before delisting is considered. (USFWS, 1994)

Recovery Actions:

- Protect habitat of current populations and manage threats. (USFWS, 1994)

- Conduct research essential to conservation of the species. (USFWS, 1994)
- Expand current populations. (USFWS, 1994)
- Establish new populations as needed to reach recovery objectives. (USFWS, 1994)
- Validate and revise recovery objectives. (USFWS, 1994)

Conservation Measures and Best Management Practices:

- Ungulate monitoring and control – Maintain fencing to exclude browsing by deer and mouflon sheep. (USFWS, 2014)
- Invasive plant monitoring and control – Continue control of invasive introduced plant species within the enclosure. (USFWS, 2014)
- Captive propagation for genetic storage and reintroduction: a) continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range and b) evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change. (USFWS, 2014)
- Threats – predator / herbivore research – determine what is eating the seed, and what methods will effectively stop seed predation. (USFWS, 2014)
- Fire monitoring and control - develop and implement a fire management plan at the existing enclosure. (USFWS, 2014)
- Climate change adaptation strategy - research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. (USFWS, 2014)
- Alliance and partnership development - initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2014)

References

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

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SPECIES ACCOUNT: *Abutilon menziesii* (Ko`oloa`ula)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/26/1986; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Abutilon menziesii (Figure 2, from Wagner et al. 1990) is a shrub in the mallow family (Malvaceae) 2-2.5 meters (6.6 to 8.2 feet) tall with coarsely-toothed, silvery, heart-shaped leaves 2-8 centimeters (0.8 to 3.2 inches) long. The flowers are medium red to dark red and about 2 centimeters (0.8 inches) across. The capsules are hairy and five to eight-parted, usually with three seeds per cell. Variation in flower color from pink through red, purple, and even yellow is reported among different populations of *Abutilon menziesii* (National Tropical Botanical Garden 2009a, 2010). (USFWS, 1994; USFWS, 2011)

Taxonomy

Abutilon menziesii was originally described based on two specimens, which were in the British Museum of Natural History, collected by Dr. Archibald Menzies from the “Sandwich Islands” (Seemann 1865-1873). No taxonomic variants of this species have been formally described; however, Hillebrand (1888) recognized a beta-variety with “light flesh-colored” flowers from a specimen collected by Lydgate from Lana’i, and it has been noted that specimens from Lana’i have “densely pubescent calyces, pale corollas, and large mericarps” (Bates in Wagner et al. 1990) Although some Lana’i plants have darker petals, nearly all show vestiges of the light coloration (Robert Hobdy, Maui Division of Forestry and Wildlife, personal communication 1992). (USFWS, 1994)

Current Range

Endemic to the islands of Oahu, Maui, Lanai, and Hawaii. (NatureServe, 2015)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Shrubland/chaparral (NatureServe, 2015)

Habitat Narrative

Adult: *Abutilon menziesii* is found in dry shrublands, including ones that are now dominated by alien plant species. Gulches, plateau lands, and old lava flows. (NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Low (inferred from USFWS, 2011)

Redundancy:

Medium (inferred from USFWS, 2011)

Number of Populations:

9 (NatureServe, 2015)

Population Size:

< 300 (wild individuals) and >100 outplanted (USFWS, 2018)

Population Narrative:

Currently, there are three populations totaling 40 to 60 individuals occurring on Oahu. There are no individuals known currently on the island of Hawaii. There are three populations totaling at least 220 individuals occurring on Maui and two populations totaling several hundred individuals on Lanai. There are 9 current and 3 historical occurrences. (USFWS, 2011); The National Tropical Botanical Garden (NTBG) reported six individuals on Lānaʻi at Naupaka and about 50 individuals at Keone (NTBG 2013a, 2013b). The Plant Extinction Prevention program (PEPP) reported about 50 individuals on Lānaʻi at Paliamano Gulch in 2013, 46 individuals at Puu Māhanalua in 2017, and 40 individuals at Mānele in 2018 (PEPP 2013; PEPP 2017a, 2018). On Maui, there are currently 200 individuals within a fenced exclosure at Puʻu o Kali (PEPP 2011) with an unknown number of individuals outside the fence; at least eight wild individuals at Kalialinui Gulch (Lyon Arboretum 2017; PEPP 2017a). On Oahu, a Habitat Conservation Plan for this species established a Contingency Reserve Area with wild plants (CRA) and three mitigation sites (DOFAW 2016). Twenty wild individuals are at Kapolei (DOFAW 2017). Three (possibly as many as nine) wild individuals were last observed at Lualualei in 2011 (Service 2011; Williams 2011, in litt.). Currently, there are no known wild individuals on Hawaiʻi island. (USFWS, 2018)

Threats and Stressors

Stressor: Invasive plants (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plants that modify the habitat on Maui include *Abutilon grandiflora* (hairy abutilon), *Bidens pilosa* (beggartick), *Cenchrus ciliaris*, *Chloris virgata*

(fingergrass), *Lantana camara* (lantana), *Leucaena leucocephala*, *Melinis repens* (Natal redtop grass), *Prosopis pallida* (mesquite), *Urochloa maxima*, and *Setaria verticillata* (bristly foxtail) (Perlman 2009; Wood 2009). Other threats to the habitat there include fire, Axis deer (*Axis axis*), cattle (*Bos taurus*), and goats (*Capra hircus*) (H. Oppenheimer, pers. comm. 2009; Perlman 2009; Wood 2009). The introduced invasive plant species are also a threat to *Abutilon menziesii* because they compete with the species for water, light, and nutrients. (USFWS, 2011)

Stressor: Fire (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The Puu Mahanalua (Twin peaks) area of Lanai suffered a serious fire in 2009. The habitat is degraded by *Urochloa maxima*, *Leucaena leucocephala*, *Casuarina equisetifolia* (ironwood), *Lantana camara*, and various grasses (Perlman 2009; Wood 2009). (USFWS, 2011)

Stressor: Herbivory (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Deer are reported to chew, trample, and knock down plants of *Abutilon menziesii*. Rats (*Rattus rattus*), mouflon sheep (*Ovis aries*), and insect predators including Hibiscus scale (*Pinnaspis strachani*) and Chinese rose beetle (*Adoretus sinicus*) are also reported to eat or damage these plants (National Tropical Botanical Garden 2010b; Perlman 2009; USFWS 1986; Wood 2009). (USFWS, 2011); Axis deer (*Axis axis*) and mouflon sheep (*Ovis musimon*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil. In addition to areas discussed in the previous 5-year reviews, these ungulates and evidence of their activities have been observed on Lānaʻi at the Keone, Māhāʻulepū, Mānele, and Naupaka occurrences of *Abutilon menziesii* (NTBG Herbarium 2013a, 2013b; PEPP 2012, 2017b). (USFWS, 2018)

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2011) ; change loss or degradation of habitat—Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaiʻi using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Abutilon menziesii* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.564 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2018)

Stressor: Drought degradation of habitat or mortality (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Drought is noted as a threat to the occurrences of *Abutilon menziesii* on Maui (Waikapu), Lānaʻi (Paliamano, Māhāʻulepū, and Mānele), and Hawaiʻi island (Kaʻūpūlehu) (PEPP 2013, 2014, 2017b). Over the past 100 years, the Hawaiian Islands have experienced an annual decline in precipitation from just over 9 percent, to as much as 15 percent within the last 20 years (US-NSTC 2008; Chu and Chen 2005; Diaz 2005). Drought affects plants directly by desiccation (D'Antonio and Vitousek 1992). The increase in drought frequency and intensity leads to a self-perpetuating cycle of increase in cover of nonnative plants, increase in the number of fires, and an increase of erosion (US-GCRP 2009; Warren 2011). Recent episodes of drought have also driven deer farther into urban and forested areas in search of food, increasing their negative impacts to native vegetation from herbivory and trampling (Waring 1996, in litt; Nishibayashi 2001, in litt.). (USFWS, 2018)

Stressor: Human interaction monitoring and management (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Habitat disturbance by human visitation of occurrences at Paliamano on Lānaʻi is noted as a threat to *Abutilon menziesii* (PEPP 2013). (USFWS, 2018)

Stressor: Lack of adequate hunting regulations (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Three of the five known occurrences of *Abutilon menziesii* on Lānaʻi occur in a State Game Management Area. Nonnative feral ungulates pose a major ongoing threat to native species through destruction and modification of habitat, and through direct herbivory or predation. Only some of the occurrences are fenced and habitat destruction and modification, and predation, by axis deer and mouflon sheep are noted as threats to the species. In addition, public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations are at risk (DLNR 2010). (USFWS, 2018)

Stressor: Lack of adequate biosecurity legislation (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Invasion of the State of Hawaiʻi by invasive nonnative plant species, and destruction of habitat and competition by nonnative plants are threats to *Abutilon menziesii*. The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, is authorized to prevent the introduction or dissemination of animal and plant pests on all ships, aircraft, and their cargo and baggage arriving in the U.S. and its territories; however, pest species continue to enter the State. In addition, Federal import regulations do not address many species that could be pests in Hawaiʻi (CGAPS 2009; Ikuma et al. 2002). (USFWS, 2018)

Recovery**Reclassification Criteria:**

1. A total of five to seven populations are documented on Lanai and at least one other island where they now occur or occurred historically. (USFWS, 1994)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1994)
3. Each of these populations must persist at this level for at least 5 consecutive years before downlisting is considered. (USFWS, 1994)

Delisting Criteria:

1. These taxa may be delisted when a total of 8 to 10 populations of each taxon should be documented on Lanai and at least one other island where they now occur or occurred historically. (USFWS, 1994)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum or 300 mature individuals per population for short-lived perennials. (USFWS, 1994)
3. Each population should persist at this level for at least 5 consecutive years before delisting is considered. (USFWS, 1994)

Recovery Actions:

- Protect habitat of current populations and manage threats. (USFWS, 1994)
- Conduct research essential to conservation of the species. (USFWS, 1994)
- Expand current populations. (USFWS, 1994)
- Establish new populations as needed to reach recovery objectives. (USFWS, 1994)
- Validate and revise recovery objectives. (USFWS, 1994)
- Surveys and inventories—Survey for occurrences of *Abutilon menziesii* in historic habitat on Hawai'i island. (USFWS, 2018)
- Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect individuals from the negative impacts of feral ungulates. Protect all occurrences against browsing and habitat disturbances from feral ungulates. (USFWS, 2018)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations; Control invasive nonnative species that compete with the species around all populations. (USFWS, 2018)
- Climate change adaptation strategy—Assess the modeled effects of climate change on this species, and determine future landscape needed for the recovery of the species. (USFWS, 2018)
- Fire monitoring and control—Develop and implement fire prevention management plans. (USFWS, 2018)

- Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock. (USFWS, 2018)
- Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2018)

Conservation Measures and Best Management Practices:

- Continue maintenance of all populations through weed control and fencing. (USFWS, 2011)
- Develop and implement fire management plans for each population. (USFWS, 2011)
- Outplant to augment genetic representation in each Oahu site. (USFWS, 2011)
- Monitor existing populations to track status and historical sites for new recruitment. (USFWS, 2011)
- Collect seeds from those populations not currently well represented. (USFWS, 2011)
- Continue reintroducing individuals into protected suitable habitat within historical range. (USFWS, 2011)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2011)
- Work with Hawaii Division of Forestry and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species on Lanai and Maui. (USFWS, 2011)

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SPECIES ACCOUNT: *Abutilon sandwicense* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/29/1991; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

A perennial shrub up to 6 m tall. Leaves are light green and heart-shaped. Corolla predominantly green, or reddish brown, petals 4-5 cm long, exceeding the calyx; calyx 3-4 cm long; mericarps 17-25 mm long. Flowers vary in color from bright green to reddish brown. (NatureServe, 2015)

Taxonomy

Originally described as *Abortopetalum sandwicense* renamed *Abutilon sandwicense* by Christopherson. (NatureServe, 2015)

Historical Range

Historically, *Abutilon sandwicense* was known from nearly the entire length of the Waianae Mountains, from Makaleha Valley to Nanakuli Valley in Oahu (Bates 1990). (USFWS, 1998)

Current Range

This species is now known from Makaleha Valley east to Palikea Gulch, south to Nanakuli Valley, and Makaha-Waianae Kai Ridge on State, Federal, City/County, and privately owned land (HHP 1997). (USFWS, 1998)

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003 (Revised September 18, 2012), the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Abutilon sandwicense* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes ten critical habitat units (CHUs), in Hawaii (77 FR 57648-57862).

Critical Habitat Designation

The critical habitat designation for *Abutilon sandwicense* includes ten CHUs in Honolulu County, Hawaii (77 FR 57648-57862).

Oahu—Lowland Mesic—Unit 1 consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). This unit is occupied by the plants *Abutilon sandwicense*, *Alectryon macrococcus*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Chamaesyce herbstii*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Cyanea acuminata*, *C. calycina*, *C. grimesiana* ssp. *grimesiana*, *C. grimesiana* ssp. *obatae*, *C. longiflora*, *C. superba*, *Cyrtandra dentata*, *Delissea subcordata*, *Diellia falcata*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Euphorbia haeleeleana*, *Flueggea neowawraea*, *Hesperomannia arborescens*, *H. arbuscula*, *Hibiscus brackenridgei*, *Isodendron laurifolium*, *I. longifolium*, *Kadua degeneri*, *Lobelia niihauensis*, *Melanthera*

tenuifolia, *Melicope makahae*, *M. pallida*, *Neraudia angulata*, *Nototrichium humile*, *Phyllostegia kaalaensis*, *Platydesma cornuta* var. *decurrans*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Schiedea hookeri*, *S. kaalae*, *S. nuttallii*, *S. obovata*, and *Viola chamissoniana* ssp. *chamissoniana*, and includes the mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 4). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Lowland Mesic—Unit 1 is not known to be occupied by the plants *Chamaesyce celastroides* var. *kaenana*, *Cyanea pinnatifida*, *Cyperus pennatififormis*, *Diellia unisora*, *Diplazium molokaiense*, *Eugenia koolauensis*, *Gardenia mannii*, *Gouania meyenii*, *G. vitifolia*, *Kadua coriacea*, *K. parvula*, *Labordia cyrtandrae*, *Melicope saint-johnii*, *Phyllostegia hirsuta*, *P. mollis*, *P. parviflora*, *Plantago princeps*, *Sanicula mariversa*, *Silene perlmanii*, *Solanum sandwicense*, *Stenogyne kanehoana*, *Tetramolopium lepidotum* ssp. *lepidotum*, or *Urera kaalae*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 1 consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. This unit is on State land within the Pahole Natural Area Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). This unit is occupied by the plants *Alectryon macrococcus*, *Cenchrus agrimonoides*, *Chamaesyce herbstii*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Kadua degeneri*, *Plantago princeps* var. *princeps*, and *Schiedea obovata*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 1 is not currently occupied by *Abutilon sandwicense*, *Achyranthes splendens* var. *rotundata*, *Bonamia menziesii*, *Chamaesyce kuwaleana*, *Diellia falcata*, *D. unisora*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Flueggea neowawraea*, *Gouania meyenii*, *G. vitifolia*, *Isodendron laurifolium*, *I. pyriform*, *Kadua parvula*, *Korthalsella degeneri*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *M. saint-johnii*, *Neraudia angulata*, *Nototrichium humile*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Platydesma cornuta* var. *decurrans*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Sanicula mariversa*, *Schiedea hookeri*, *S. trinervis*, *Silene lanceolata*, *S. perlmanii*, *Spermolepis hawaiiensis*, *Tetramolopium filiforme*, *T. lepidotum* ssp. *lepidotum*, or *Viola chamissoniana* ssp. *chamissoniana*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Mesic—Unit 2 consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit is occupied by the plants *Abutilon sandwicense*, *Alectryon macrococcus*, *Cenchrus agrimonoides*, *Chamaesyce herbstii*, *Cyanea calycina*, *C. grimesiana* ssp.

obatae, *Delissea subcordata*, *Diellia falcata*, *Gardenia mannii*, *Phyllostegia hirsuta*, *P. kaalaensis*, *P. mollis*, *Platydesma cornuta* var. *decurrens*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Schiedea hookeri*, *S. kaalae*, *Solanum sandwicense*, *Stenogyne kanehoana*, and *Urera kaalae*, and includes the mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 4). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Lowland Mesic—Unit 2 is not known to be occupied by the plants *Bonamia menziesii*, *Chamaesyce celastroides* var. *kaenana*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Cyanea acuminata*, *C. grimesiana* ssp. *grimesiana*, *C. longiflora*, *C. pinnatifida*, *C. superba*, *Cyperus pennatifolius*, *Cyrtandra dentata*, *Diellia unisora*, *Diplazium molokaiense*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Eugenia koolauensis*, *Euphorbia haeleeleana*, *Flueggea neowawraea*, *Gouania meyenii*, *G. vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Hibiscus brackenridgei*, *Isodendron laurifolium*, *I. longifolium*, *Kadua coriacea*, *K. degeneri*, *K. parvula*, *Labordia cyrtandrae*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *M. pallida*, *M. saint-johnii*, *Neraudia angulata*, *Nototrichium humile*, *Phyllostegia parviflora*, *Plantago princeps*, *Sanicula mariversa*, *Schiedea nuttallii*, *S. obovata*, *Silene perlmannii*, *Tetramolopium lepidotum* ssp. *lepidotum*, or *Viola chamissoniana* ssp. *chamissoniana*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 2 consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. This unit is almost entirely within the Makua Keaau Forest Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). Dry Cliff—Unit 2 is occupied by the plants *Abutilon sandwicense*, *Alectryon macrococcus*, *Dubautia herbstobatae*, *Gouania vitifolia*, *Kadua parvula*, *Lepidium arbuscula*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *Nototrichium humile*, *Peucedanum sandwicense*, *Platydesma cornuta* var. *decurrens*, *Pleomele forbesii*, *Sanicula mariversa*, *Schiedea hookeri*, *Tetramolopium filiforme*, and *Viola chamissoniana* ssp. *chamissoniana*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 2 is not currently occupied by *Achyranthes splendens* var. *rotundata*, *Bonamia menziesii*, *Cenchrus agrimonoides*, *Chamaesyce herbstii*, *C. kuwaleana*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia falcata*, *D. unisora*, *Eragrostis fosbergii*, *Flueggea neowawraea*, *Gouania meyenii*, *Isodendron laurifolium*, *I. pyriforme*, *Kadua degeneri*, *Korthalsella degeneri*, *Lipochaeta lobata* var. *leptophylla*, *Melicope saint-johnii*, *Neraudia angulata*, *Phyllostegia kaalaensis*, *Plantago princeps*, *Pteralyxia macrocarpa*, *Schiedea obovata*, *S. trinervis*, *Silene lanceolata*, *S. perlmannii*, *Spermolepis hawaiiensis*, or *Tetramolopium lepidotum* ssp. *lepidotum*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Mesic—Unit 3 consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit is occupied by the plants *Alectryon macrococcus*, *Cenchrus agrimonoides*, *Delissea subcordata*, *Diellia falcata*, *D. unisora*, *Hesperomannia arbuscula*, *Melicope saint-johnii*, *Phyllostegia mollis*, *P. parviflora*, *Plantago princeps*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Schiedea kaalae*, *Silene perlmannii*, and *Urera kaalae*, and includes the mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Lowland Mesic—Unit 3 is not known to be occupied by the plants *Abutilon sandwicense*, *Bonamia menziesii*, *Chamaesyce celastroides* var. *kaenana*, *C. herbstii*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Cyanea acuminata*, *C. calycina*, *C. grimesiana* ssp. *grimesiana*, *C. grimesiana* ssp. *obatae*, *C. longiflora*, *C. pinnatifida*, *C. superba*, *Cyperus pennatifolius*, *Cyrtandra dentata*, *Diplazium molokaiense*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Eugenia koolauensis*, *Euphorbia haeleeleana*, *Flueggea neowawraea*, *Gardenia mannii*, *Gouania meyenii*, *G. vitifolia*, *Hesperomannia arborescens*, *Hibiscus brackenridgei*, *Isodendron laurifolium*, *I. longifolium*, *Kadua coriacea*, *K. degeneri*, *K. parvula*, *Labordia cyrtandrae*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *M. pallida*, *Neraudia angulata*, *Nototrichium humile*, *Phyllostegia hirsuta*, *P. kaalaensis*, *Platydesma cornuta* var. *decurrens*, *Sanicula marivera*, *Schiedea hookeri*, *S. nuttallii*, *S. obovata*, *Solanum sandwicense*, *Stenogyne kanehoana*, *Tetramolopium lepidotum* ssp. *lepidotum*, or *Viola chamissoniana* ssp. *chamissoniana*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 3 consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. This unit is partially within the Waianae Kai Forest Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). This unit is occupied by the plants *Abutilon sandwicense*, *Alectryon macrococcus*, *Bonamia menziesii*, *Diellia falcata*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Flueggea neowawraea*, *Gouania meyenii*, *Isodendron laurifolium*, *Korthalsella degeneri*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *Neraudia angulata*, *Nototrichium humile*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Schiedea hookeri*, *Silene lanceolata*, *Tetramolopium filiforme*, and *Viola chamissoniana* ssp. *chamissoniana*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 3 is not currently occupied by *Achyranthes splendens* var. *rotundata*, *Cenchrus agrimonoides*, *Chamaesyce herbstii*, *C. kuwaleana*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia unisora*, *Gouania vitifolia*, *Isodendron pyriforme*, *Kadua degeneri*, *K. parvula*, *Melicope saint-johnii*, *Plantago princeps*, *Platydesma cornuta* var.

decurrens, *Sanicula mariversa*, *Schiedea obovata*, *S. trinervis*, *Silene perlmannii*, *Spermolepis hawaiiensis*, or *Tetramolopium lepidotum* ssp. *lepidotum*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 4 consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. This unit is partially within the Waianae Kai Forest Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). This unit is occupied by the plants *Alectryon macrococcus*, *Chamaesyce kuwaleana*, and *Spermolepis hawaiiensis*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 4 is not currently occupied by *Abutilon sandwicense*, *Achyranthes splendens* var. *rotundata*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Chamaesyce herbstii*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia falcata*, *D. unisora*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Flueggea neowawraea*, *Gouania meyenii*, *G. vitifolia*, *Isodendrion laurifolium*, *I. pyriformis*, *Kadua degeneri*, *K. parvula*, *Korthalsella degeneri*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *M. saintjohnii*, *Neraudia angulata*, *Nototrichium humile*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Plantago princeps*, *Platydesma cornuta* var. *decurrens*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Sanicula mariversa*, *Schiedea hookeri*, *S. obovata*, *S. trinervis*, *Silene lanceolata*, *S. perlmannii*, *Tetramolopium filiforme*, *T. lepidotum* ssp. *lepidotum*, or *Viola chamissoniana* ssp. *chamissoniana*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 6 consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). The unit is occupied by the plants *Cenchrus agrimonioides*, *Diellia unisora*, *Flueggea neowawraea*, *Lepidium arbuscula*, *Lobelia niihauensis*, *Melicope saintjohnii*, *Neraudia angulata*, *Plantago princeps*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, and *Tetramolopium lepidotum* ssp. *lepidotum*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 6 is not currently occupied by *Abutilon sandwicense*, *Achyranthes splendens* var. *rotundata*, *Alectryon macrococcus*, *Bonamia menziesii*, *Chamaesyce herbstii*, *C. kuwaleana*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia falcata*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Gouania meyenii*, *G. vitifolia*, *Isodendrion laurifolium*, *I. pyriformis*, *Kadua degeneri*, *K. parvula*, *Korthalsella degeneri*, *Lipochaeta lobata* var. *leptophylla*, *Melanthera tenuifolia*, *Melicope*

makahae, *Nototrichium humile*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Platydesma cornuta* var. *decurrens*, *Sanicula mariversa*, *Schiedea hookeri*, *S. obovata*, *S. trinervis*, *Silene lanceolata*, *S. perlmanii*, *Spermolepis hawaiiensis*, *Tetramolopium filiforme*, or *Viola chamissoniana* ssp. *chamissoniana*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 7a consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4), and is occupied by the plants *Flueggea neowawraea*, *Kadua parvula*, *Melicope saint-johnii*, *Plantago princeps*, *Platydesma cornuta* var. *decurrens*, *Pleomele forbesii*, *Silene perlmanii*, and *Viola chamissoniana* ssp. *chamissoniana*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 7a is not currently occupied by *Abutilon sandwicense*, *Achyranthes splendens* var. *rotundata*, *Alectryon macrococcus*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Chamaesyce herbstii*, *C. kuwaleana*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia falcata*, *D. unisora*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Gouania meyenii*, *G. vitifolia*, *Isodendron laurifolium*, *I. pyrifolium*, *Kadua degeneri*, *Korthalsella degeneri*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *Neraudia angulata*, *Nototrichium humile*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Pteralyxia macrocarpa*, *Sanicula mariversa*, *Schiedea hookeri*, *S. obovata*, *S. trinervis*, *Silene lanceolata*, *Spermolepis hawaiiensis*, *Tetramolopium filiforme*, or *T. lepidotum* ssp. *lepidotum*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Dry Cliff—Unit 7b consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). Although Oahu—Dry Cliff—Unit 7b is not currently occupied by *Abutilon sandwicense*, *Achyranthes splendens* var. *rotundata*, *Alectryon macrococcus*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Chamaesyce herbstii*, *C. kuwaleana*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia falcata*, *D. unisora*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Flueggea neowawraea*, *Gouania meyenii*, *G. vitifolia*, *Isodendron laurifolium*, *I. pyrifolium*, *Kadua degeneri*, *K. parvula*, *Korthalsella degeneri*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *M. saintjohnii*, *Neraudia angulata*, *Nototrichium humile*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Plantago princeps*, *Platydesma cornuta* var. *decurrens*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Sanicula mariversa*, *Schiedea hookeri*, *S. obovata*, *S. trinervis*, *Silene lanceolata*, *S. perlmanii*, *Spermolepis hawaiiensis*, *Tetramolopium*

filiforme, *T. lepidotum* ssp. *lepidotum*, or *Viola chamissoniana* ssp. *chamissoniana*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 8 consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve. A small portion of this area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). This unit is occupied by the plants *Abutilon sandwicense*, *Bonamia menziesii*, *Flueggea neowawraea*, *Lobelia niihauensis*, *Neraudia angulata*, *Nototrichium humile*, and *Pleomele forbesii*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 8 is not currently occupied by *Achyranthes splendens* var. *rotundata*, *Alectryon macrococcus*, *Cenchrus agrimonioides*, *Chamaesyce herbstii*, *C. kuwaleana*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia falcata*, *D. unisora*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Gouania meyenii*, *G. vitifolia*, *Isodendron laurifolium*, *I. pyrifolium*, *Kadua degeneri*, *K. parvula*, *Korthalsella degeneri*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Melanthera tenuifolia*, *Melicope makahae*, *M. saint-johnii*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Plantago princeps*, *Platydesma cornuta* var. *decurrens*, *Pteralyxia macrocarpa*, *Sanicula mariversa*, *Schiedea hookeri*, *S. obovata*, *S. trinervis*, *Silene lanceolata*, *S. perlmanii*, *Spermolepis hawaiiensis*, *Tetramolopium filiforme*, *T. lepidotum* ssp. *lepidotum*, or *Viola chamissoniana* ssp. *chamissoniana*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Abutilon sandwicense* critical habitat consists of two components (Lowland mesic and Dry cliff). Species occurs within the indicated ecosystem in the Waianae Mountain caldera complex. (77 FR 57648-57862):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<914 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Ecosystem: Dry Cliff. Elevation: unrestricted. Annual precipitation: < 75 in (<190 cm). Substrate: >65 degree slope, rocky talus. Canopy: None. Subcanopy: *Antidesma*, *Chamaesyce*, *Diospyros*, *Dodonaea*. Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Schiedea*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not

adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History

Food/Nutrient Resources

Breeding Season

Adult: Year-round but peak flowering occurs April through June (USFWS, 1998)

Reproduction Narrative

Adult: Flowering can be observed at any time of the year, but the peak flowering months are April through June. Fruit capsules develop within six weeks. Although seedlings are often initially abundant, few plants appear to survive to maturity for unknown reasons (USFWS 1995). Reproduction in this species is primarily by seed. Seeds need scarification (physical or mechanical weakening of the seed coat) for germination. (USFWS, 1998; USFWS, 2011; NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs on steep slopes at elevations of 300 to 600 m (1,000 to 2,000 ft). (USFWS, 1998)

Habitat Narrative

Adult: *Abutilon sandwicense* typically grows on steep slopes or gulches in dry to mesic lowland forest at an elevation of 300 to 600 meters (1,000 to 2,000 feet) (USFWS 1995). Associated plants include *Diospyros* spp. (lama), *Pipturus albidus* (mamaki), *Elaeocarpus bifidus* (kalia), *Sapindus oahuensis* (aulu), *Nestegis sandwicensis* (olopua), and *Psydrax odoratum* (alahee) (USFWS 1995). (USFWS, 1998)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Dispersal agents for this species are unknown. (USFWS, 2011)

Population Information and Trends

Population Trends:

Not available.

Resiliency:

Low (inferred from USFWS, 2011)

Redundancy:

Low (inferred from USFWS, 2011)

Number of Populations:

18 (USFWS, 2011)

Population Size:

~300 individuals (USFWS, 2011)

Population Narrative:

In 2008, eight populations still had wild individuals with a total of 100 mature, 158 juveniles, and 50 seedlings counted in both 2008 and 2009. Those populations are located at East Makaleha, Ekahanui, Huliwai, Makaha Makai, Makaha Mauka, North Mikilua, Waianae Kai, and West Makalehu. Halona, Nanakuli, and South Mikilua no longer have extant wild individuals (U. S. Army Garrison 2008; Oahu Army Natural Resource Program 2009). This brings the current total number of mature individuals to 137 in 18 populations. Of these populations, only one population, Makaha Makai, has more than 50 individuals (U.S. Army Garrison 2008). (USFWS, 2011)

Threats and Stressors

Stressor: Invasive species (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Major threats to *Abutilon sandwicense* include invasive introduced plant species including *Ageratina riparia* (spreading mist flower), *Aleurites moluccana* (kukui), *Clidemia hirta* (Koster's curse), *Erigeron karvinskianus* (daisy fleabane), *Ficus microcarpa* (Chinese banyan), *Grevillea robusta* (silk oak), *Hyptis pectinata* (comb hyptis), *Bryophyllum pinnatum* (airplant), *Buddleia asiatica* (dogtail), *Leucaena leucocephala* (haole koa), *Melia azedarach* (pride-of-India), *Melinis minutiflora* (molasses grass), *Montanoa hibiscifolia* (tree daisy), *Oplismenus hirtellus* (basketgrass), *Urochloa maxima* (guinea grass), *Passiflora suberosa* (corky passionflower), *Pimenta dioica* (allspice), *Psidium cattleianum* (strawberry guava), *Psidium guajava* (common guava), *Rivina humilis* (coral berry), *Rubus argutus* (blackberry), *Schinus terebinthifolius* (Christmasberry), *Syzygium cumini* (Java plum), and *Toona ciliata* (Australian red cedar) (Listing Factor A and E) (Perlman 2009; U. S. Army Garrison 2008). (USFWS, 2011)

Stressor: Trampling (USFWS, 2011)

Exposure:**Response:****Consequence:**

Narrative: Major threats to *Abutilon sandwicense* including trampling by ungulates including cattle (*Bos taurus*), pigs (*Sus scrofa*), and goats (*Capra hircus*). (USFWS, 2011)

Stressor: Predation (USFWS, 2011)

Exposure:**Response:****Consequence:**

Narrative: Two serious insect pests damage *Abutilon sandwicense*: black twig borer (*Xylosandrus compactus*) and Chinese rose beetle (*Adoretus sinicus*) (Listing Factor C) (U. S. Army Garrison 2008; Oahu Army Natural Resource Program 2009). Rats (*Rattus* spp.) and slugs (species undetermined) are also predators of this species (Listing Factor C) (Perlman 2009). (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)

Exposure:**Response:****Consequence:**

Narrative: Climate change may also pose a threat to this species (Listing Factors A and E). However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. We anticipate high spatial resolution climate outputs by 2013. (USFWS, 2011)

Recovery**Reclassification Criteria:**

1. A total of five to seven populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)

3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1998)

Recovery Actions:

- Construct enclosures to protect populations against feral ungulates. (USFWS, 1998)
- Control competing alien plant species within enclosures. (USFWS, 1998)
- Survey likely areas for additional populations and implement protective measures if necessary. (USFWS, 1998)
- Implement control methods for the black twig borer, based on further research into methods. (USFWS, 1998)
- Provide protection from fire. (USFWS, 1998)

Conservation Measures and Best Management Practices:

- Continue to collect material for genetic storage and propagation for reintroduction. (USFWS, 2011)
- Fence all populations to exclude feral ungulates. (USFWS, 2011)
- Develop and implement fire management plans. (USFWS, 2011)
- Control invasive plant species. (USFWS, 2011)
- Determine and implement methods to control insect pests. (USFWS, 2011)
- Work with Hawaii Division of Forestry and Wildlife and Hawaii State Parks to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2011)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2011)

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SPECIES ACCOUNT: *Acaena exigua* (Liliwai)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/15/1992; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Acaena exigua is a small perennial rosette herb in the rose family (Rosaceae) with narrow, fern-like, divided leaves and slender flowering stalks 5-15 centimeters (2-5.9 inches) long. It is easily hidden among the other low, tufted bogplants with which it grows. The narrow, oblong leaves are usually 10-25 mm (0.4-1.0 in) long with 6-17 leaflets 1-4 mm (0.04-0.16 in) long and 1-2 mm (0.04-0.08 in) wide. The leaflet on the end is wider (to 3 mm [0.12 in]). The upper surface of the leaves is glossy with conspicuous veins; the lower surface is whitish. The flowers lack petals and are arranged in short, dense spikes 5-10 mm (0.2-0.4 in) long held on slender, sparsely leafy stalks 5-15 cm (2-6 in) tall. The base of the flower is urn-shaped, sometimes with very short spines or bristles, and encloses a single cone-shaped dry fruit (achene) 1 mm (0.04 in) long. (USFWS, 1997)

Taxonomy

Bitter (1910-1911), in a review of the genus *Acaena*, described three varieties of the Hawaiian species (var. *glabriuscula*, var. *subtusstrigulosa*, and var. *glaberrima*). The current taxonomic treatment (Wagner et al. 1990) treats *A. exigua* as a single, variable taxon and does not recognize varieties. The genus *Acaena* is composed of approximately 100 species, centered primarily in the Southern Hemisphere (Wagner et al. 1990). The sole Hawaiian species of the genus *Acaena* is distinguished from other Hawaiian members of the rose family in that it is a small, compact, high-elevation bog species with flowers that lack petals. The specific epithet, *exigua*, means “small, short, poor, scanty,” presumably due to the small size of the species. (USFWS, 1997)

Historical Range

Historically, *Acaena exigua* was known from Puu-kukui on West Maui and from Mount Waialeale on Kauai. (USFWS, 1997)

Current Range

Endemic to mountains of Kauai and West Maui. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Acaena exigua* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Acaena exigua* includes two CHUs in Maui County, Hawaii. Approximately 1,479 ac (599 ha) of federal, private and state land on the Island of Maui (west Maui) are being designated as critical habitat for *Acaena exigua*. (81 FR 17790-18110).

Maui—Montane Wet—Unit 6 (and) *Palmeria dolei*—Unit 15—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 15— Montane Wet This area consists of 1,113 ac (451 ha) of State land, and 286 ac (116 ha) of privately owned land, at the summit and surrounding areas on west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta*, *Calamagrostis hillebrandii*, *Cyanea kunthiana*, *Geranium hillebrandii*, *Myrsine vaccinioides*, and *Sanicula purpurea*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 6 is not known to be occupied by the plants *Acaena exigua*, *Cyrtandra oxybapha*, *Huperzia mannii*, *Phyllostegia bracteata*, or *Platanthera holochila*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 7 (and) *Palmeria dolei*—Unit 16—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 16— Montane Wet This area consists of 80 ac (32 ha) of State land near Hanaula and Pohakea Gulch on the southeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). They are occupied by the plants *Cyrtandra oxybapha* and *Platanthera holochila*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 7 is not known to be occupied by the plants *Acaena exigua*, *Bidens conjuncta*, *Calamagrostis hillebrandii*, *Cyanea kunthiana*, *Geranium hillebrandii*, *Huperzia mannii*, *Myrsine vaccinioides*, *Phyllostegia bracteata*, or *Sanicula purpurea*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Acaena exigua* critical habitat consists of one component (81 FR 17790-18110):

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*. Species- specific physical or biological features: Bogs.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant

species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Small flowers are borne on short spikes. (NatureServe, 2015)

Habitat Type

Adult: Palustrine (inferred from USFWS, 1997)

Habitat Vegetation or Surface Water Classification

Adult: Bogs (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 1,600 and 1,800 meters (USFWS, 1997)

Environmental Specificity

Adult: Medium, with some key requirements

Habitat Narrative

Adult: *Acaena exigua* is known only from montane bogs at elevations of 1,600-1,800 meters (5,250-5,906 feet). This species habitat is characterized by a thick peat substrate overlying an impervious clay substrate, with hummocks of sedges and grasses, stunted trees, and shrubs. Associated native species include the native sedges and grasses *Deschampsia nubigena*, *Dichanthelium cynodon*, *Dichanthelium hillebrandianum*, *Dichanthelium isachnoides*, and *Oreobolus furcatus*, and the native shrubs *Metrosideros polymorpha* and *Vaccinium* sp. Alien species include *Holcus lanatus*, *Juncus planifolius*, *Cyperus halpan*, and *Sacciolepis indica*. (USFWS, 1997)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Resiliency:

Very low (inferred from USFWS, 1997)

Redundancy:

Very low (inferred from USFWS, 1997)

Number of Populations:

Possibly 2 (NatureServe, 2015)

Population Size:

Unknown (NatureServe, 2015)

Adaptability:

Low (inferred from USFWS, 1997)

Population Narrative:

While no occurrences are currently extant in the wild, this species has a history of disappearing only to be rediscovered decades later (USFWS 2009). Since suitable habitat is still existent within its historical range, it is possible it is not truly extinct in the wild (USFWS 2009). Known only from 2 historical records, last collected in 1950's but recently rediscovered. (NatureServe, 2015)

Threats and Stressors

Stressor: Introduced plants (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: Introduced invasive plants such as *Juncus planifolius* (rush), *J. effusus* (Japanese mat rush), *Tibouchina herbacea* (glorybush), *Hypochaeris radicata* (hairy cat's-ear), *Ageratina*

adenophora (Maui mapakani), Ageratina riparia (Hamakua pamakani) and Axonopus fissifolius (narrow-leaved carpetgrass) invade areas disturbed by goats and pigs (USFWS 2009). (NatureServe, 2015)

Stressor: Other threats (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: Other possible threats include loss of pollinators and dispersal agents, disease, inbreeding depression, droughts, and/or rare frost episodes (USFWS 2009). (NatureServe, 2015)

Stressor: Climate change (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Climate change destruction or degradation of habitat – Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Acaena exigua* is highly vulnerable to the impacts of climate change. Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2014)

Stressor: Small population size (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: Because *Acaena exigua*, if it still exists at all, presumably occurs at such low population levels and in such a restricted area a single severe environmental disturbance, such as a prolonged drought, could result in its extinction. In addition, the lack of genetic diversity could depress the reproductive vigor or adaptability of the species. (USFWS, 1997)

Stressor: Human activities (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: Trampling of associated native plant species and introduction (long-distance and regional) of invasive alien plant species in its montane bog habitat are threats to *Acaena exigua* caused by excessive human visitation. (USFWS, 1997)

Stressor: Pigs (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: Though impact from herbivory and rooting by pigs is assumed and often cited, feral pigs have become established at Wainleale (Kauni) only within the past two decades. The other

known habitat, Puu-kukui (West Maui), is pig-free and apparently has always been so. (USFWS, 1997)

Stressor: Introduced species (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: Though undocumented, consumption of vegetative or floral parts of this species by alien slugs and/or rats could have been a factor in the decline of the species and could continue to be a critical limiting factor. Predation by slugs and rats is a concern; specifically, regeneration may be effected by the black rat, European slug, leopard snail, and another unspecified species of slug (USFWS 2009). Species is highly threatened by human impacts, like trampling (USFWS 2009). An alien pathogen such as a disease, fungus or nematode could also be a factor, as could loss of pollinators, or some as-yet-undetected micro-environmental change associated with the species' disappearance. (USFWS, 1997)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1997)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)
2. Each population must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)
3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1997)

Recovery Actions:

- Search for any individuals of this species in the former habitat. (USFWS, 1997)
- If plants are found, initiate research on limiting factors. (USFWS, 1997)
- If plants are found, protect and enhance existing population(s) and create new populations. (USFWS, 1997)

Conservation Measures and Best Management Practices:

- Survey for populations of *Acaena exigua* in areas of potentially suitable habitat. (USFWS, 2014)
- Captive propagation for genetic storage and reintroduction – If the species is rediscovered collect genetic material for ex situ storage and reintroduction. (USFWS, 2014)
- Threats – predator / herbivore research – If the species is rediscovered, research which threats, herbivory by introduced slugs, rodents, or disease. (USFWS, 2014)
- Loss of mutualists – determine if pollinators are lacking, or if other limiting factors affect the survival of this species. (USFWS, 2014)
- Ungulate monitoring and control – Continue ungulate fencing of suitable habitat for *Acaena exigua*. (USFWS, 2014)
- Invasive plant monitoring and control – Eradicate invasive introduced plants and maintain *Acaena exigua* habitat free of invasive introduced plants. (USFWS, 2014)
- Climate change adaptation strategy – Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. (USFWS, 2014)
- Alliance and partnership development – Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2014)

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

Final Rule . 81 FR 17790-18110 (March 30, 2016).

USFWS. 2014. *Acaena exigua* (Iiliwai) 5-Year Review Short Form Summary. Pacific Islands Fish and Wildlife Office (PIFWO), Honolulu, Hawaii

SPECIES ACCOUNT: *Acanthomintha ilicifolia* (San Diego thornmint)

Species Taxonomic and Listing Information

Listing Status: Threatened; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An aromatic annual herb; stems 5-15 cm long. The flowers, which are borne in whorls subtended by leaves and sharp-spined bracts, are tubular and white with pink-tinged lobes. Blooms in April-June (NatureServe, 2015).

Taxonomy

Belongs to the Lamiaceae (mint family) (USFWS, 2009).

Historical Range

See current range/distribution.

Current Range

Only known from coastal San Diego County, California and adjacent Baja California Norte, Mexico (NatureServe, 2015).

Critical Habitat Designated

Yes; 8/26/2008.

Legal Description

On August 26, 2008, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Acanthomintha ilicifolia* (San Diego thornmint) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four critical habitat units (CHUs), in California (73 FR 50454-50496).

Critical Habitat Designation

The critical habitat designation for *Acanthomintha ilicifolia* includes four CHUs (17 sub-units) in San Diego County, California. This species critical habitat encompasses approximately 671 acres (ac) (272 hectares (ha)) (73 FR 50454-50496).

Unit 1: Northern San Diego County: Unit 1 is located in northern San Diego County, California. The area was occupied at the time of listing, is currently occupied, and contains the features essential to the conservation of *Acanthomintha ilicifolia* that may require special management considerations or protection for *A. ilicifolia*. The habitat in Unit 1 is gently sloping and occurs in the north coastal portion of San Diego County. The habitat included in this unit provides for the conservation of populations of this species that are at the lowest elevations where this species is found. These areas represent coastal terrace terrain and, therefore, are edaphically and ecologically distinct from the other units of critical habitat (subunit 1A) (see "Criteria Used to Identify Critical Habitat" section criterion 1). This unit contains some of the most stable populations of *A. ilicifolia* (subunits 1B and 1C) (see "Criteria Used to Identify Critical Habitat" section criterion 3). Below, we present a brief description of subunits designated as critical habitat in this unit. Subunit 1A, Palomar Airport: Subunit 1A is located in Carlsbad, California, northeast of the intersection of Palomar Airport Road and El Camino Real. Subunit 1A consists of

60 ac (24 ha) of land owned by the County of San Diego. Subunit 1A meets our selection criteria because it supports a population on a unique soil type (see “Criteria Used to Identify Critical Habitat” section criterion 1). This is the only area where *A. ilicifolia* is still known to occupy calcareous clay soils. The features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from exotic plant species and unauthorized recreational activities. A portion of the land that meets the definition of critical habitat in this area (2 ac (1 ha)) is covered by the Carlsbad HMP of the San Diego MHCP. We excluded the portion of critical habitat covered by the Carlsbad HMP from critical habitat because we determined the benefits of excluding these lands outweigh the benefits of including these lands in a critical habitat designation. Furthermore, exclusion of these lands will not result in the extinction of this species (see Table 3 and “Exclusions Under Section 4(b)(2) of the Act” section of this final rule for a detailed discussion of this exclusion). Subunit 1B, Southeast Carlsbad: Subunit 1B is located in Carlsbad, California, east of Calle Acervo and west of Paseo Esmerado. All lands within this subunit (57 ac (23 ha)) are covered by the Carlsbad HMP of the San Diego MHCP. We excluded the lands covered by the Carlsbad HMP under the MHCP in this subunit because we determined that the benefits of excluding these lands outweigh the benefits of including these lands in a critical habitat designation. Furthermore, exclusion of these lands will not result in the extinction of this species (see Table 3 and “Exclusions Under Section 4(b)(2) of the Act” section of this final rule for a detailed discussion of this exclusion). Subunit 1C, Manchester: Subunit 1C is located in Encinitas, California, northeast of the intersection of Manchester Avenue and South El Camino Real. Subunit 1C consists of 9 ac (4 ha) of private land. Subunit 1C meets our selection criteria because it supports one of the most stable populations of *Acanthomintha ilicifolia* (criterion 3). The features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from exotic plant species and unauthorized recreational activities. The majority of the land that meets the definition of critical habitat in this area (70 ac (28 ha)) is in the Manchester Avenue Mitigation Bank. The Manchester Avenue Mitigation Bank is owned and managed by the Center for Natural Lands Management (CNLM). There is long-term management in place on this site to conserve several sensitive species, including *Acanthomintha ilicifolia* (Spiegelberg 2005, p. 1). We excluded the portion of critical habitat covered by the Manchester Habitat Conservation Area Management Plan (Spiegelberg 2005) from critical habitat because we determined that the benefits of excluding these lands outweigh the benefits of including these lands in a critical habitat designation; exclusion of these lands will not result in the extinction of this species (see Table 3 and “Exclusions Under Section 4(b)(2) of the Act” section of this final rule for a detailed discussion of this exclusion).

Unit 2: Central San Diego County Unit 2 is located in an east-west line starting in the County of San Diego on private land east of the Sycamore Canyon/Goodan Ranch Preserve (subunit 2D), occurring on Countyowned open space in the Sycamore Canyon/Goodan Ranch Preserve (subunit 2C), occurring on City of San Diego-owned land in Los Pen~asquitos Canyon near the border or the City of San Diego and the City of Poway (subunit 2B), and occurring in Pen~asquitos Canyon Preserve (subunit 2A). The unit was occupied at the time of listing, is currently occupied, and contains the features essential to the conservation of *Acanthomintha ilicifolia* that may require special management considerations or protection for *A. ilicifolia*. This unit contains some of the largest populations of *A. ilicifolia* (subunits 2C and 2D) (criterion 2) and some of the most stable populations of *A. ilicifolia* (subunits 2A and 2B) (criterion 3). All lands that meet the definition of critical habitat in Unit 2 are covered by either the City of San Diego subarea plan (subunits 2A and 2B) or the County of San Diego subarea plan (subunits 2C and 2D) under the San Diego MSCP and

are excluded from the designation. We determined that the benefits of excluding these lands outweigh the benefits of including these lands in the designation and that exclusion of these lands will not result in the extinction of this species (see Table 3 and “Exclusions Under Section 4(b)(2) of the Act” section of this final rule for a detailed discussion of this exclusion).

Unit 3: Viejas Mountain and Poser Mountain: Unit 3 is located in San Diego County, California, on Viejas Mountain and Poser Mountain. The area was occupied at the time of listing, is currently occupied, and contains the features essential to the conservation of *Acanthomintha ilicifolia* that may require special management considerations or protection for *A. ilicifolia*. Unit 3 is divided into six subunits, five of which are designated as critical habitat. Due to the proximity of the occurrences in this area and the fact that the habitat is not fragmented by any manmade barriers, we consider these occurrences to be a single population of *A. ilicifolia*. Unit 3 is designated as critical habitat because it supports one of the largest recorded populations of the species (criterion 2). This population is estimated to have greater than 25,000 plants based on the maximum number of plants observed at the different CNDDDB element occurrences (EO 12, 6,650 plants in 1991 (subunit 3F); EO 50, 5,600 plants in 1994 (subunit 3B); EO 51, 8,300 plants in 2003 (subunit 3C); EO 62, 1,115 plants in 2000 (subunit 3C); EO 73, 8,750 plants in 1997; and EO 74, 2,000 plants in 2000 (subunit 3E)). The habitat in unit 3 is more mountainous than the other units and provides for the conservation of this species at the highest elevations where this species is found. Therefore, this unit is ecologically distinct from the other units of critical habitat and provides for the largest population of *A. ilicifolia* as measured by the area occupied by the species. Below, we present a brief description of subunits designated as critical habitat in this unit.

Subunit 3A, Viejas Mountain: Subunit 3A is located east of Peutz Valley Road on the western flank of Viejas Mountain. All lands that meet the definition of critical habitat in this area (32 ac (13 ha)) are covered by the County of San Diego subarea plan of the San Diego MSCP. We excluded the lands covered by the County of San Diego subarea plan in this subunit because we determined that the benefits of excluding these lands outweigh the benefits of including these lands in a critical habitat designation. Furthermore, exclusion of these lands will not result in the extinction of this species (see Table 3 and “Exclusions Under Section 4(b)(2) of the Act” section of this final rule for a detailed discussion of this exclusion).

Subunit 3B, Viejas Mountain: Subunit 3B is located east of Alpine, California, and north of Interstate 8 on the western slope Viejas Mountain. Subunit 3B consists of 52 ac (21 ha) of land in the Cleveland National Forest (CNF) owned by the U.S. Forest Service (USFS). This subunit was occupied by the species at the time of listing and is currently occupied. Subunit 3B meets our selection criteria because this subunit is part of one of the largest recorded populations of *Acanthomintha ilicifolia* (criterion 2). The features essential to the conservation of the species in this subunit may require special management considerations or protection to address the threat from exotic plant species and recreational activities. The privately owned lands that meet the definition of critical habitat in this area (141 ac (57 ha)) are covered by the County of San Diego subarea plan of the San Diego MSCP. We excluded the lands covered by the County of San Diego subarea plan in this subunit because we determined that the benefits of excluding these lands outweigh the benefits of including these lands in a critical habitat designation and that exclusion of these lands will not result in the extinction of this species (see Table 3 and “Exclusions Under Section 4(b)(2) of the Act” section of this final rule for a detailed discussion of this exclusion).

Subunit 3C, Viejas Mountain: Subunit 3C is located east of Alpine, California, and north of Interstate 8 on southern slope of Viejas Mountain. Subunit 3C consists of 276 ac (112 ha) of land in the CNF owned by the USFS. This subunit was occupied by the species at the time of listing and is currently occupied. Subunit 3C meets our selection criteria because this subunit is part of one of the largest recorded

populations of *Acanthomintha ilicifolia* (criterion 2). The features essential to the conservation of the species in this subunit may require special management considerations or protection to address the threat from exotic plant species and recreational activities. Subunit 3D, Viejas Mountain: Subunit 3D is located east of Alpine, California, and north of Interstate 8 on the eastern slope of Viejas Mountain. Subunit 3D consists of 32 ac (13 ha) of land in the CNF owned by the USFS and 50 ac (20 ha) of private land. This subunit was occupied by the species at the time of listing and is currently occupied. Subunit 3D meets our selection criteria because this subunit is part of one of the largest recorded populations of *Acanthomintha ilicifolia* (criterion 2). The features essential to the conservation of the species in this subunit may require special management considerations or protection to address the threat from exotic plant species and recreational activities. Subunit 3E, Poser Mountain: Subunit 3E is located east of Alpine, California, and north of Interstate 8 on western slope of Poser Mountain. Subunit 3E consists of 34 ac (14 ha) of land in the CNF owned by the USFS. This subunit was occupied by the species at the time of listing and is currently occupied. Subunit 3E meets our selection criteria because this subunit is part of one of the largest recorded populations of *Acanthomintha ilicifolia* (criterion 2). The features essential to the conservation of the species in this subunit may require special management considerations or protection to address the threat from exotic plant species and recreational activities. Subunit 3F, Poser Mountain: Subunit 3F is located east of Alpine, California, and north of Interstate 8 on southern slope of Poser Mountain. Subunit 3F consists of 155 ac (63 ha) of land in the CNF owned by the USFS. This subunit was occupied by the species at the time of listing and is currently occupied. Subunit 3F meets our selection criteria because this subunit is part of one of the largest recorded populations of *Acanthomintha ilicifolia* (criterion 2). The features essential to the conservation of the species in this subunit may require special management considerations or protection to address the threat from exotic plant species and recreational activities.

Unit 4: Southern San Diego County Unit 4 is located in southern San Diego County, California near the City of Jamul. The area was occupied at the time of listing, is currently occupied, and contains the features essential to the conservation of *Acanthomintha ilicifolia* that may require special management considerations or protection. This critical habitat unit contains some of the largest populations of *A. ilicifolia* (subunit 4D) (criterion 2) and some of the most stable populations of *A. ilicifolia* (subunits 4A, 4B, and 4C) (criterion 3). The habitat for *A. ilicifolia* in southern San Diego County is located in proximity to rural residential development and in relatively undeveloped areas. Below, we present a brief description of subunits designated as critical habitat in this unit. Subunits 4A and 4C, McGinty Mountain: Subunits 4A and 4C are located east of Jamul, California, on the southwestern slope of McGinty Mountain. The land designated is part of the San Diego National Wildlife Refuge (SDNWR) and is owned by the Service. We are designating 3 ac (1 ha) of critical habitat in subunits 4A and 4C for *Acanthomintha ilicifolia*. These subunits were occupied by the species at the time of listing and are currently occupied. Subunits 4A and 4C meet our selection criteria because these subunits are part of one of the most stable populations of *A. ilicifolia* (criterion 3). The features essential to the conservation of the species in subunits 4A and 4C may require special management considerations or protection to address the threat from exotic plant species and recreational activities. The non-Federal lands that meet the definition of critical habitat in this area (18 ac (7 ha) in subunit 4A and 27 ac (11 ha) in subunit 4C) are covered by the County of San Diego subarea plan of the San Diego MSCP. We excluded the lands covered by the County of San Diego subarea plan under the MSCP in this subunit because we have determined that the benefits of excluding these lands outweigh the benefits of including these lands in a critical habitat designation and that exclusion of these lands will not result in the

extinction of this species (see Table 3 and “Exclusions Under Section 4(b)(2) of the Act” section of this final rule for a detailed discussion of this exclusion). Subunit 4B, McGinty Mountain: All of the lands in subunit 4B that meet the definition of critical habitat in this area (148 ac (60 ha)) are non-Federal and are covered by the County of San Diego subarea plan of the San Diego MSCP. We excluded the lands covered by the County of San Diego subarea plan under the MSCP in this subunit because we determined that the benefits of excluding these lands outweigh the benefits of including these lands in the critical habitat designation, and that exclusion of these lands will not result in the extinction of this species (see Table 3 and “Exclusions Under Section 4(b)(2) of the Act” section of this final rule for a detailed discussion of this exclusion). Subunit 4D, Hollenbeck Canyon: All of the lands in subunit 4D that meet the definition of critical habitat in this area (84 ac (34 ha)) are non-Federal and are covered by the County of San Diego subarea plan of the San Diego MSCP. We excluded the lands in this subunit because we determined that the benefits of excluding these lands outweigh the benefits of including these lands in a critical habitat designation, and that exclusion of these lands will not result in the extinction of this species (see Table 3 and “Exclusions Under Section 4(b)(2) of the Act” section of this final rule for a detailed discussion of this exclusion). Table 3 below provides approximate areas (ac (ha)) of lands that meet the definition of critical habitat, but are excluded from this final critical habitat designation. Table 3 provides our reason for the exclusion. Also see the “Exclusions Under Section 4(b)(2) of the Act” section of this final rule for detailed discussion of the exclusions listed in Table 3.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Acanthomintha ilicifolia* critical habitat consists of four components (73 FR 50454-50496):

- (i) Within chaparral, grassland, and coastal sage scrub;
- (ii) On gentle slopes ranging from 0 to 25 degrees;
- (iii) Derived from gabbro and soft calcareous sandstone substrates with a loose, crumbly structure and deep fissures (approximately 1 to 2 feet (30 to 60 cm)); and
- (iv) Characterized by a low density of forbs and geophytes, and a low density or absence of shrubs.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the occupied areas contain features that are essential to the conservation of the species and that may require special management considerations or protection. As stated in the final listing rule, threats to *Acanthomintha ilicifolia* include trampling and grazing, the presence of exotic plant species, offroad vehicles (ORVs), mining, and urbanization (63 FR 54938). Through our review of the existing data on *A. ilicifolia*, we conclude that the threats listed in the final listing rule continue to impact this species and its essential physical and biological features. Urban development near *Acanthomintha ilicifolia* populations may alter the habitat characteristics required by this species. The destruction of habitat can change the slope and aspect of a site, making it uninhabitable for *A. ilicifolia* (PCE 1(b)). The close proximity of development to populations of *A. ilicifolia* may affect other aspects of the site. For example, increased water runoff from developments may erode the clay lense

and change the topography of the site (Bauder et al. 1994, p. 23) (PCE 1(b and c)). The introduction of exotic plant species such as *Centaurea melitensis* can drastically change the species present in (PCE 1(a)), and eliminate the open character of, the clay lense habitat (PCE 1(d)). *Centaurea melitensis* has been shown, in field and greenhouse experiments, to negatively effect the biomass (growth) and seed production (reproduction) of *Acanthomintha ilicifolia* (Bauder and Sakrison 1999, p. 16). Populations of *A. ilicifolia* that are close to urbanized areas or in areas that are heavily grazed generally have a high density of exotic plant species (PCE 1(a)). In disturbed soils, *C. melitensis* is a common weed. When this and other exotic plant species become established, they can out-compete *A. ilicifolia* for light, water, nutrients, and space. *Acanthomintha ilicifolia* often grows larger and at a higher density when competition with exotic weeds is reduced (Bauder and Sakrison 1999, pp. 12–16; Vinje 2007, p. 10). The final listing rule (63 FR 54938) discusses the impacts of ORV activity and trampling. In recent years, the impacts associated with the use of mountain bikes have been documented to cause similar impacts (Vinje 2006a, p. 1). Trampling, ORV activity, and mountain bike use in *Acanthomintha ilicifolia* habitat can compact the loose, crumbly soils (PCE 1(c)). Repeated travel over a trail or track degrades the habitat of *A. ilicifolia* in two ways: (1) By displacing soil; and (2) by compacting soil. These activities, in turn, can destroy individual plants and can reduce the amount of water that can percolate into the soil, thus reducing the plant's ability to grow and reproduce. Mining is documented as a threat at two sites known to support *Acanthomintha ilicifolia* (63 FR 54938; Bauder et al. 1994, p. 17). Mining can alter many aspects of *A. ilicifolia* habitat. Heavy machinery can compact or remove clay lenses (PCE 1(c)) or alter the slope of an area (PCE 1(b)). The grading of large areas adjacent to *A. ilicifolia* habitat can make those areas vulnerable to invasion by exotic plant species and lead to the subsequent crowding and shading of *A. ilicifolia* habitat (PCE 1(d)). These impacts may in turn lead to the disruption of the growth and reproduction of *A. ilicifolia*. The protection of habitat for *Acanthomintha ilicifolia* from development is the first measure of protection needed for populations of this species (PCE 1(a)). The control of exotic plant species, the maintenance and enhancement of clay lense habitat, the control of incompatible and often illegal activities such as off-road vehicle use and other unauthorized recreational impacts, and careful oversight of adjacent activities such as mining, will help to ensure the long-term conservation for *A. ilicifolia* and the physical and biological features essential for the conservation of the species.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Self-fertilization, based on closely related species (USFWS, 2009)

Breeding Season

Adult: April - May (USFWS, 2009)

Key Resources Needed for Breeding

Adult: Possibly insect pollinators (USFWS, 2009)

Reproduction Narrative

Adult: This annual species germinates in late winter to early spring and flowers in April and May. Seeds mature in late spring and early summer. Studies show this species has a small seed bank

(Bauder and Sakrison 1999, pp. 25-28, 43-44). The breeding system of *Acanthomintha ilicifolia* has not been studied, but research shows that other members of the genus *Acanthomintha* are self-compatible to varying degrees (Steek 1995, pp. 27-33). A 1996 study identified several insect species that visited the flowers and moved from plant to plant (Bauder and Sakrison 1997, p. 38) (USFWS, 2009).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Coastal sage scrub, grasslands, and chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs < 900 m elevation (NatureServe, 2015)

Habitat Narrative

Adult: Restricted to heavy clay soils in coastal sage scrub, grasslands, and chaparral. Often in open areas, clay depressions, vernal pool habitats; below 900 meters (Hickman 1993; Beauchamp 1986; Munz 1959; Abrams 1951). In Mexico, in rocky or gravelly soil on western slope of the Sierra Juarez, and along the coastal area between Ensenada and Tijuana (Wiggins 1980) (NatureServe, 2015). *Acanthomintha ilicifolia* is restricted to gabbro soils derived from igneous rock, and gray calcareous clay soils derived from soft calcareous sandstone (Oberbauer and Vanderwier 1991, pp. 208-209) (USFWS, 2009).

Dispersal/Migration**Dispersal**

Adult: Low (USFWS, 2009)

Dispersal/Migration Narrative

Adult: *A. ilicifolia* seed is not known to disperse in large quantities or over great distances (USFWS, 2009).

Population Information and Trends**Population Trends:**

Decline of 80-90% (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015)

Redundancy:

High (inferred from USFWS, 2009)

Number of Populations:

55 (USFWS, 2009)

Population Size:

150,000 - 170,000 (USFWS, 2009)

Population Narrative:

This species has experienced a long-term decline of 80-90%. Occupies an estimated 400 acres. Of the 32 extant occurrences in California, 11 are considered major populations that support over 3,000 individuals each. There are thirty-two occurrences extant in United States and at least 9 in Mexico known to have recently had the species. Twenty extirpated/historical in United States (U.S. Fish and Wildlife Service 1998) (NatureServe, 2015). 55 of the 80 historical occurrences are considered to be extant. At the time of listing in 1998, the Service estimated that there were approximately 150,000 to 170,000 *Acanthomintha ilicifolia* individuals (USFWS, 2009).

Threats and Stressors

Stressor: Urbanization (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: At this time, 34 of the 55 extant occurrences (62 percent) are adjacent to development, cutslopes, agricultural fields, golf courses, ornamental landscaping, and fuel modification zones. However, very few occurrences have been extirpated due to habitat loss. The Service considers two occurrences to have been extirpated due to impacts associated with development. Three recent and proposed development projects avoided directly impacting *Acanthomintha ilicifolia* occurrences and resulted in the conservation of these occurrences. Twelve of the 55 extant occurrences are on private lands in areas that have not yet been fully developed. These areas may be vulnerable to impacts associated with development (USFWS, 2009).

Stressor: Recreation (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Presently, several extant occurrences of *Acanthomintha ilicifolia* are in areas potentially impacted by recreational activities. These activities include jogging, hiking, mountain biking, and motorized ORV activity. 55 extant occurrences (42 percent) are in areas where nonmotorized recreation occurs. In several areas, trails run through or adjacent to occurrences of *A. ilicifolia*. Four of the 55 extant occurrences (7 percent) are in areas where unauthorized ORV activity occurs. Recreation occurring at over 40 percent of the extant occurrences is a potential threat to *Acanthomintha ilicifolia* because trail use on wet clay lens soils can cause deep ruts (USFWS, 2009).

Stressor: Nonnative plants (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Currently, the most prominent nonnative species that threaten *Acanthomintha ilicifolia* are *Avena* spp. (wild oats), *Brachypodium distachyon* (purple false brome), *Brassica nigra* (black mustard), *Centaurea melitensis* (yellow star thistle), *Cynara cardunculus* (artichoke thistle),

and *Foeniculum vulgare* (fennel) (Bauder and Sakrison 1997, p. 40). Invasive, nonnative plants impact *A. ilicifolia* by competing for nutrients, light, water, and space. For example, *Centaurea melitensis*, a nonnative thistle, can dry out soils because this plant species takes moisture out of the soil that would have been available to co-occurring native plants (DiTomaso 2001, pp. 3, 12). The biomass and reproductive output of *A. ilicifolia* was reduced in a greenhouse experiment where *A. ilicifolia* was grown with *C. melitensis*, (Bauder and Sakrison 1999, p. 12). In a field experiment at the Hollenbeck Wildlife Area occurrence (Table 1), nonnative species near *A. ilicifolia* plants were removed. Researchers found that there was no increase in the number of *A. ilicifolia* plants, but that the reproductive output of the plants in the treatment area was significantly higher (Lawhead 2006, pp. 1-2). The impacts associated with nonnative plants have the potential to diminish the reproductive output of *Acanthomintha ilicifolia* and occupy space that provides habitat for this species (USFWS, 2009).

Stressor: Small population size (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Most occurrences of *A. ilicifolia* have an average of less than 1,000 plants and could be vulnerable because of their small size. At this time, no genetic analysis has been conducted to determine if inbreeding is a problem for *A. ilicifolia*. Additionally, there has been no research to determine if seeds from smaller occurrences have lower germination rates when compared to larger occurrences. Occurrences with fewer plants are more susceptible to extirpation by threats such as nonnative species competition, trampling, and too frequent fire. Small occurrences output fewer seeds each year; therefore, the ability of these occurrences to withstand the impacts from various threats is decreased. This is a limitation to *Acanthomintha ilicifolia*'s survival because there may not be a persistent seed bank or the species may not be able to recolonize areas of suitable habitat due to dispersal barriers such as intervening development (USFWS 1998a, p. 54950) (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Rainfall and temperature both affect the germination rate and successful reproduction of *Acanthomintha ilicifolia*. Five factors associated with a changing climate may affect the longterm viability of *A. ilicifolia* occurrences in its current habitat configuration: (1) Drier conditions may result in a lower percent germination and smaller population sizes; (2) higher temperatures may inhibit germination (Bauder and Sakrison, p. 32); (3) a shift in the timing of the annual rainfall may favor nonnative species; (4) the timing of pollinator life-cycles may become out-of-sync with timing of flowering *A. ilicifolia*; and (5) drier conditions may result in increased fire frequency, making the ecosystems in which *A. ilicifolia* currently grows more vulnerable to the threats of subsequent erosion and nonnative/native plant invasion. In a changing climate, conditions could change in a way that would allow both native and nonnative plants to invade the habitat where *A. ilicifolia* occurs (USFWS, 2009).

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- Identify opportunities to work with private landowners to encourage conservation actions for *Acanthomintha ilicifolia* on sites that are not conserved. This could be done through the Partners for Fish and Wildlife Program as well as other cooperative programs. Projects could identify and reduce threats, and enhance areas that support *A. ilicifolia* (USFWS, 2009).
- Develop relationships with landowners and managers of conserved lands where *Acanthomintha ilicifolia* occurs to minimize threats associated with urban preserves, such as nonnative plant species (USFWS, 2009).
- Develop a working group for *Acanthomintha ilicifolia* to coordinate monitoring efforts, share effective methods of reducing threats, and gather data on less surveyed occurrences of *A. ilicifolia*. Include land managers, CDFG, USFS, academics, and local governments in this working group (USFWS, 2009).
- Encourage the participation of academic researchers to investigate questions of pollination and seed set, climate change, and fire effects in relationship to *Acanthomintha ilicifolia* (USFWS, 2009).
- Develop restoration projects to benefit *Acanthomintha ilicifolia* in areas that have been impacted by ORV and grazing activity (USFWS, 2009).
- Continue to work with CDFG to strengthen opportunities to conserve *Acanthomintha ilicifolia* through State protections (USFWS, 2009).
- Work with researchers and government agencies in Mexico to evaluate the status of *Acanthomintha ilicifolia* in northwestern Baja California, Mexico (USFWS, 2009).

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SPECIES ACCOUNT: *Acanthomintha obovata* ssp. *duttonii* (San Mateo thornmint)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/18/1985; Pacific Southwest (R8)

Physical Description

An aromatic (strong-scented) annual herb of the mint family (Lamiaceae). The 4 to 20 centimeters (1.6 to 7.9 inches) high plants are typically unbranched, though most populations contain some plants branched from near the base. The plants have squarish stems and opposite leaves. The leaves are 8 to 12 millimeters (0.3 to 0.5 inch) long and are oblong to egg-shaped and may have toothed margins (Jokerst 1991, Hickman 1993). The flowers are white or sometimes tinged with lavender and occur in tight clusters surrounded by almost round prominently spined bracts (California Native Plant Society 1986). Bracts are small leaf- or scale-like structures associated with an inflorescence (Hickman 1993). (USFWS, 1998)

Taxonomy

The taxonomic classification of *Acanthomintha obovata* subsp. *duttonii* has not changed; however it was elevated to species rank by Jokerst (Jokerst 1991, p. 278) since the taxon was listed in 1985. Jokerst treated the taxon as a full species in his treatment for the genus in the Jepson Manual (Jokerst 1993, p. 713). The Service refers to the listed entity as *Acanthomintha* (*obovata*) subsp. *duttonii*; however, will shortly contact the current author(s) of treatments of the genus for the revision of the Jepson Manual (John Miller) and upcoming relevant volume of Flora of North America (USFWS, 2010).

Historical Range

San Mateo County, California. (USFWS, 2010)

Current Range

A single localtion in Edgewood Park in San Mateo County, California. (USFWS, 2010)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, self-pollination (USFWS, 1998)

Lifespan

Adult: 1 year (USFWS, 1998)

Breeding Season

Adult: April - June (USFWS, 2010)

Key Resources Needed for Breeding

Adult: Bee pollinators (USFWS, 1998)

Reproduction Narrative

Adult: Flowers appear from April to June (USFWS, 2010). The species lives less than 1 year and completes its entire life cycle from seed germination to seed production in a single growing season. *Acanthomintha obovata* ssp. *duttonii* is thought to be insect-pollinated (McCarten 1986b, Pavlik and Espeland 1991, Steeck 1995) although no specialized pollinators have been observed (D. Steeck, pers. comm., 1996). Generalist pollinators are likely to include native bees from the families Apidae (bumble bees, honey bees, euglossine bees), Anthophoridae (cuckoo bees, digger bees, carpenter bees), and Megachilidae (leafcutting bees). Although *Acanthomintha obovata* ssp. *duttonii* possesses traits typical of outcrossing plants (open, colorful, nectar-producing flowers), the species also has traits that permit self-pollination and lead to inbreeding. The hand pollination and isolation treatments of Steeck (1995) show that *Acanthomintha obovata* ssp. *duttonii* is self-compatible (capable of self-fertilization) and capable of autogamy (self-pollination in the absence of pollinators). Survival of plants (survivorship) until reproduction was more than 50 percent in each year measured (Pavlik and Espeland 1991, 1993, 1994, Pavlik et al. 1992). Pavlik and Espeland (1994) feel that the observed high fecundity (production of offspring) and survivorship indicate that the potential for continued population growth exists at Edgewood Park (USFWS, 1998).

Habitat Type

Adult: Terrestrial, palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Serpentine grasslands, vernal pools (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs < 300 m elevation (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow (inferred from USFWS, 1998)

Habitat Narrative

Adult: Serpentine grasslands with heavy clay inclusions in the rocky serpentine soil. Reported from grassy slopes, and from shallow depressions and vernal pools at < 300 m elevation (NatureServe, 2015). The specific soil habitat in which *Acanthomintha obovata* ssp. *duttonii* occurs is apparently extremely limited (N. McCarten, in litt., 1998). The deep clay soils appear to have a low calcium/magnesium ratio (due to low levels of calcium along with high levels of magnesium), high percent moisture (with a broad range between field capacity and permanent wilting point), and high cation exchange capacity (McCarten 1986a) (USFWS, 1998).

Dispersal/Migration**Dispersal**

Adult: Low (inferred from USFWS, 1998)

Dispersal/Migration Narrative

Adult: In 1992, the population expanded downslope by approximately 4.4 meters (14.5 feet), perhaps due to nutlets being carried by storm runoff to the unoccupied area (USFWS, 1998).

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Declining (USFWS, 2010)

Resiliency:

V

Number of Populations:

1 (USFWS, 2010)

Population Size:

250 (USFWS, 2010)

Adaptability:

Low (inferred from USFWS, 2010)

Population Narrative:

The area which supported 395 in 2009 only supported 250 in 2010 (C. Niederer pers. comm., July 21, 2010) indicating that the species is continuing to decline. *A. obovata* ssp. *duttonii* plants currently occur in about 0.05 acres (USFWS, 2010).

Threats and Stressors

Stressor: Habitat degradation and curtilment (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Pavlik and Espeland (1998) documented a shift in the plant's distribution downslope at the Edgewood Park occurrence as the result of an intense winter storm that caused soil erosion. *Acanthomintha obovata* ssp. *duttonii* seed moved downslope into an area that had not previously supported the plant. The occurrence is now found within about 10 meters of the lower edge of its potential habitat, with little room to continue dispersing downhill. Many plants are within one meter of the lateral edge of the habitat (Niederer et al., 2010). The occurrence is bound on all sides by barriers of either inappropriate habitat or urban development; to the north and west are woodlands, to the east is a rocky, upland slope and to the south is a road and housing (C. Niederer, pers. comm., July 21, 2010) (USFWS, 2010).

Stressor: Population size (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The species is still represented by a single, small occurrence which is downslope of a development. The low numbers of plants continues to threaten the species with genetic depletion and reduced reproductive potential. Additionally, this occurrence which is small in area and in numbers of plants is readily threatened by stochastic events such as fire, erosion from flooding, herbivory, and disease (USFWS, 2010).

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Climate is predicted to change in California during the 21st century (Field et al. 1999; Cayan et al. 2005). The effects of increased winter flooding and drought conditions in the spring have the potential to adversely affect this species (USFWS, 2010).

Stressor: Competition and moisture (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: Germination trials at the UC Berkeley Botanical Garden, where San Mateo thornmint was successfully grown in different soil types, point to competition (from invasive nonnative plants and thatch) and moisture as the most important factors limiting wild San Mateo thornmint to serpentine vertisol (Niederer et al. 2010). Invasive grasses compete by depleting shallow soil moisture and creating dense thatch that smothers and suppresses seedling recruitment in native plants. Elevated atmospheric nitrogen deposition from increased air pollution exacerbates the invasive grass problem because additions of nitrogen to nutrient-deficient soils, like serpentine, facilitate the invasion of weedy species (Weiss 2006). Nitrogen deposition in nitrogen-limited ecosystems may also affect mycorrhizal communities and increase plant susceptibility to other environmental stressors. (USFWS, 2019)

Stressor: Parasitic plants (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: A serious threat that has arisen in recent years is dodder (*Cuscuta californica*). Dodder is a native parasitic plant that is parasitizing San Mateo thornmint, and other species, at Edgewood Park (Niederer and Weiss 2018). (USFWS, 2019)

Stressor: Seed loss / mortality (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: Seed loss/mortality from falling into deep vertisol cracks (one year estimated to be 24% seed loss; Niederer and Weiss 2018) is likely a natural stressor for serpentine vertisol plants (Niederer et al. 2010, Pavlik and Espeland 1998). However, this reproductive loss may be exacerbated by other threatening conditions such as low production years, drought (more cracking), and heavy rain (more surface seeds wash into cracks and/or into unsuitable habitat). Seed loss may also increase with erosion, altered hydrology, and the effects of climate change

(e.g. weather events, seed bank response to temperature and moisture changes). Significant seed loss could also play a role in creating negative feedback loops in declining populations, which would accelerate population declines, extirpations, and losses in genetic diversity. (USFWS, 2019)

Recovery

Reclassification Criteria:

A/1: A minimum of five populations^{6,7} of San Mateo thornmint are fully protected and managed with the primary intention of preserving the populations in perpetuity. Each protected area should include occupied habitat with adjacent unoccupied habitat and a 150-meter (500-foot) buffer. (USFWS, 2019)

A/2: Management plan(s), approved by the Service, are implemented for the populations described in A/1 and any adjacent areas identified as essential to continued survival. The plans must include provisions for standardized annual monitoring of populations. (USFWS, 2019)

E/1: Each population described in A/1 contains a minimum of 5,000 (but preferably more) individuals each year for a minimum of 20 years. (USFWS, 2019)

E/2: Each population described in A/1 has numbers of individuals that exhibit a stable or increasing trend over a period of 20 years that includes two normal precipitation cycles (or longer if suggested by the results of demographic monitoring). (USFWS, 2019)

E/3: Impacts from competing nonnative species are managed so they do not pose a threat to the persistence of any of the San Mateo thornmint populations described in A/1. (USFWS, 2019)

E/4: Seeds, representative of the breadth of the species' genetic diversity, are stored in at least two Center for Plant Conservation certified facilities and reliable seed germination and propagation techniques are understood. Unless storage techniques and/or research show otherwise, stored seeds are replenished every 10 years¹² in order to ensure seed viability. (USFWS, 2019)

Delisting Criteria:

A/1: A minimum of ten self-sustaining populations of San Mateo thornmint are established on suitable habitat within or near the plant's known historical range, and are fully protected and managed with the primary intention of preserving the populations in perpetuity. Each protected area includes occupied habitat with adjacent unoccupied habitat and a 150-meter (500-foot) buffer, where possible. Additional populations should be protected if indicated by modeling or research. (USFWS, 2019)

A/2: All lands upslope from the populations described in A/1 are protected from incompatible uses. (USFWS, 2019)

A/3: The populations described in A/1 each contain a minimum of 100 square meters (1076 square feet) that are occupied by San Mateo thornmint. (USFWS, 2019)

C/1: Negative effects from dodder infestations to the populations described in A/1 are absent or below a level at which a population viability analysis indicates that dodder is negatively affecting long-term persistence. (USFWS, 2019)

C/2: Long-term management of dodder is both practically and financially sustainable. Financial resources for control of present and potential future dodder infestations are secured. (USFWS, 2019)

E/1: For a minimum of 20 consecutive years that include two normal precipitation cycles, each of the populations described in A/1 exhibits a stable or increasing population trend with a rolling average of at least 50,000 individuals. During low-density years (presumably from natural population fluctuations), the populations described in A/1 must contain a minimum of 6,700 individuals and densities do not fall below 160 per square meter for two or more consecutive years. (USFWS, 2019)

E/3: The populations described in A/1 occupy habitats that sustain a minimum cover of 20% bare ground and a maximum cover of 30% nonnatives (live and thatch). (USFWS, 2019)

E/4: Long-term management to maintain the conditions described in criterion E/3 is both practically and financially sustainable. Active management is not required more frequently than once every 5 years. Financial resources for long-term habitat management are secured. (USFWS, 2019)

Recovery Actions:

- 1. Protect San Mateo thornmint habitat and establish new populations. 1.1. Identify serpentine vertisol and protect potential introduction sites. (Priority 1). 1.2. Develop, or continue the existing, seed increase program. (Priority 1). 1.3. Establish, by seeding, new populations within or near the species' known historical range. Seeding should take place in suitable habitats that also exhibit a range of natural environmental conditions. Numerous sites should be seeded to achieve adequate success rates and determine the range of habitat conditions under which successful establishment can be achieved. (Priority 1). (USFWS, 2019)
- 2. Research San Mateo thornmint life history and conservation strategies. 2.1. Research and develop methods of dodder control that are effective and efficient for San Mateo thornmint populations. (Priority 2). 2.2. Research optimal habitat characteristics, mechanisms of dispersal, and potential impacts from climate change. (Priority 2). 2.3. Study the demography, reproductive biology, and genetic structure of populations. (Priority 3). (USFWS, 2019)
- 3. Monitor and manage San Mateo thornmint populations. 3.1. Implement site-specific management plans for San Mateo thornmint and other native serpentine species. Manage habitat in occupied areas and in surrounding areas that affect, or could affect, conditions in occupied areas (e.g. weedy species invade from adjacent areas). . Best habitat management practices may include complete eradication of nonnative species and restoration of native serpentine plant communities. (Priority 1). 3.2. Implement a standardized annual monitoring program with the power to detect population trends. (Priority 2). 3.3. Store seeds in at least two Center for Plant Conservation certified facilities. Unless storage techniques and/or research show otherwise, replenish seed stock every 10 years to ensure seed viability. (Priority 2). 3.4. Establish a Service-approved monitoring plan to cover a

minimum of 5 years post-delisting. The plan will be ready for implementation at the time of delisting to ensure the ongoing conservation of the species and the continued effectiveness of management actions. Adequate funding must be dedicated in order to implement the delisting management plan. (Priority 3). (USFWS, 2019)

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SPECIES ACCOUNT: *Achyranthes mutica* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Achyranthes mutica, a member of the amaranth family (Amaranthaceae), is a many-branched shrub with stems ranging from 30 to 60 cm (12 to 24 in) long. The opposite leaves, usually 3.2 to 4 cm (1.3 to 1.6 in) long and 1.5 to 2 cm (0.6 to 0.8 in) wide, are inversely egg-shaped to elliptic or inversely lance-shaped. The stalkless flowers are arranged in spikes (flowers directly attached to the main flower axis) that are 0.4 to 1.5 cm (0.2 to 0.6 in) long. The petalless flowers are perfect (containing both female and male parts). The sepals are of unequal length, 3 to 4.2 mm (0.1 to 0.2 in) long, and have sharply pointed tips. This species is distinguished from others in the genus by the shape and size of the sepals and by characteristics of the spike, which is short and congested (Wagner et al. 1990). (USFWS, 1999)

Taxonomy

Achyranthes nelsonii (St. John 1979) is considered to be synonymous with *Achyranthes mutica* by the authors of the current treatment of Hawaiian members of the family (Wagner et al. 1990). (USFWS, 1999)

Historical Range

Known historically from Kauai and Hawaii. (NatureServe, 2015)

Current Range

Currently, this species is known only from Hawaii Island, from the Keawewala Stream area, the south slope of Puu Loa in the Kohala Mountains, and Lanikepu Gulch on private land. (USFWS, 1999)

Critical Habitat Designated

Yes; 7/2/2003.

Legal Description

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Achyranthes mutica* on the island of Hawaii (68 FR 39623 - 39722).

Critical Habitat Designation

The critical habitat designation for *Achyranthes mutica* includes 10 units encompassing 1,491 acres on the island of Hawaii. The units are Hawaii 9—*Achyranthes mutica*—a, b, c, d, e, f, g, h, i, j. Only unit “Hawaii 9—*Achyranthes mutica*—b” currently supports an extant colony of this species.

Hawaii 9—*Achyranthes mutica*—a [63 ha (157 ac)]: This unit contains a portion of Waipahoehoe Gulch in the Kawaihae watershed.

Hawaii 9—*Achyranthes mutica*—b [125 ha (306 ac)]: This unit contains a portion of Keauewai Stream and Kilohana Gulch in the Kawaihae watershed, and is currently occupied by 25 to 50 individuals.

Hawaii 9—*Achyranthes mutica*—c [67 ha (166 ac)]: This unit contains a portion of an unnamed gulch adjacent to Puu Loa in the Kawaihae watershed.

Hawaii 9—*Achyranthes mutica*—d [58 ha (143 ac)]: This unit contains a portion of an unnamed gulch between Hawaii 9—*Achyranthes mutica*—c and Lauhine Gulch in the Kawaihae watershed.

Hawaii 9—*Achyranthes mutica*—e [96 ha (238 ac)]: This unit contains a portion of Lauhine Gulch and a gulch just east of Lauhine Gulch and west of Puu Kawaiwai in the Kawaihae watershed.

Hawaii 9—*Achyranthes mutica*—f [43 ha (105 ac)]: This unit contains a portion of Umipoho Gulch in the Kawaihae watershed.

Hawaii 9—*Achyranthes mutica*—g [37 ha (92 ac)]: This unit contains a portion of Pauahi Gulch, straddling the Kawaihae and the Waikoloa/Waiulaula watersheds.

Hawaii 9—*Achyranthes mutica*—h [51 ha (127 ac)]: This unit contains a portion of Momoualoo Gulch in the Waikoloa/ Waiulaula watershed.

Hawaii 9—*Achyranthes mutica*—i [31 ha (76 ac)]: This unit contains a portion of an unnamed gulch between Puu Kamoia and Puu Lanikepu in the Waikoloa/ Waiulaula watershed.

Hawaii 9—*Achyranthes mutica*—j [33 ha (81 ac)]: This unit contains a portion of Waiaka Gulch in the Waikoloa/Waiulaula watershed. This unit provides the easternmost critical habitat within the species' historical range.

Primary Constituent Elements/Physical or Biological Features

The habitat features contained in these units that are essential for this species include, but are not limited to, lowland dry forest, primarily in gulches but also in remnant stands of forest.

Special Management Considerations or Protections

The Service publishes this final rule acknowledging that we have incomplete information regarding many of the primary biological and physical requirements for these species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species;

monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at an elevation of about 920 meters (USFWS, 1999)

Habitat Narrative

Adult: *Achyranthes mutica* is found in *Acacia koaia* (*koaia*) lowland dry forest at an elevation of about 920 meters (3,030 feet) (USEWS 1996a). Often found in dry forests in gulches. Associated species include *Dodonaea viscosa* (*aalii*), *Myoporum sandwicense* (*naio*), *Nestegis sandwicensis* (*olopua*), *Osteomeles anthyllidifolia* (*ulei*), and *Sophora chrysophylla* (*mamane*) (Hawaiian Plant Conservation Center [HPCC] 1992). (USFWS, 1999)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2015)

Redundancy:

Very low (inferred from USFWS, 2015)

Number of Populations:

2 (USFWS, 2015)

Population Size:

~40 plants (NatureServe, 2015)

Population Narrative:

In 2009, there were two populations containing approximately 40 wild individuals of *Achyranthes mutica* on Hawaii Island (Plant Extinction Prevention Program [PEPP] 2009). In 2015, at Puuloa there were 20 mature and 20 immature wild individuals of *A. mutica* (J. VanDeMark, pers. comm. 2015).

Threats and Stressors

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Climate change destruction or degradation of habitat – Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Achyranthes mutica* is highly vulnerable to the impacts of climate change. Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2015)

Stressor: Habitat degradation by ungulates, competition, and small population size (USFWS, 1999)

Exposure:

Response:

Consequence:

Narrative: The primary threats to *Achyranthes mutica* are habitat degradation and/or destruction by ungulates such as cattle (*Bos taurus*) and feral goats (*Capra hircus*), competition with alien plants, and a risk of extinction from naturally occurring events (such as landslides or hurricanes) and/or reduced reproductive vigor due to the small number of existing individuals and populations (USFWS 1996a). (USFWS, 1999)

Recovery**Reclassification Criteria:**

1. A total of five to seven populations of each taxon should be documented on islands where they now occur or occurred historically. (USFWS, 1999)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with the following minimum numbers of mature individuals per population: 100 for long-lived perennials, 300 for short-lived perennials, and 500 for the annual taxa. (USFWS, 1999)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1999)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on islands where they now occur or occurred historically. (USFWS, 1999)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with the following minimum numbers of mature individuals per population: 100 for long-lived perennials, 300 for short-lived perennials, and 500 for the annual taxa (USFWS, 1999)

3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1999)

Recovery Actions:

- Construct protective fences around the known populations, and initiate removal of cattle and feral goats from its habitat. (USFWS, 1999)
- Control alien plants. (USFWS, 1999)
- Maintain adequate genetic stock. (USFWS, 1999)
- Outplant additional plants in areas of reduced threats. (USFWS, 1999)

Conservation Measures and Best Management Practices:

- Survey geographical and historical range for a current assessment of the species' status. (USFWS, 2015)
- Maintain existing exclosures and monitor for potential incursions and fence third population. (USFWS, 2015)
- Eradicate invasive introduced plants within ungulate exclosures and maintain the exclosures free of invasive plants. (USFWS, 2015)
- Captive propagation for genetic storage and reintroduction. Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change. (USFWS, 2015)
- Continue monitoring all wild and outplanted individuals. (USFWS, 2015)
- Develop and implement a fire management plan for each population. (USFWS, 2015)
- Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. (USFWS, 2015)
- Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2015)

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SPECIES ACCOUNT: *Achyranthes splendens* var. *rotundata* (Round-leaved chaff-flower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/26/1986; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Achyranthes splendens var. *rotundata* is a shrub 1.6 to 6.6 ft (0.5 to 2 m) tall with opposite, broad, elliptic or nearly circular leaves. The leaves are covered with white silky hairs and measure 0.8 to 4.7 in (2 to 12 cm) long and 0.6 to 2.9 in (1.5 to 7.3 cm) wide. Flowers are arranged in 1.2 to 9.8 in (3 to 25 cm) spikes (unbranched clusters of unstalked flowers) which are covered with white hairs, and located at the ends of the stems. Each flower has sepals about 0.3 in (6.5 to 8 mm) long and is subtended by three spine-tipped bracts. The one-seeded, unopening fruit is 0.06 to 0.1 in (1.5 to 3 mm) long. (USFWS, 1994)

Taxonomy

In 1979, Harold St. John divided *A. splendens* into five species, raising var. *rotundata* to specific rank as *A. rotundata* (Hillebr.) St. John (St. John 1979). Subsequently, Warren L. Wagner, Derral R. Herbst, and Seymour H. Sohmer (1990) found the characters used to separate these entities to be taxonomically insignificant and reinstated var. *rotundata* Hillebr. They also included in *A. splendens* var. *rotundata*, *A. manelesiensis* St. John, which is known from a single collection on Lana'i, and *A. reflexa* (Hillebr.) St. John (*A. splendens* var. *reflexa* Hillebr.), which is known from a single collection on Moloka'i. (USFWS, 1994)

Historical Range

Historically found on the 'Ewa coral plain of Oahu, along the western coast from Katena Point to Makua at the northwest tip of the island, and on Lanai and Molokai. (USFWS, 1994)

Current Range

It is currently known from only two small areas on the island of Oahu. (NatureServe, 2015)

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003 (Revised September 18, 2012), the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Achyranthes splendens* var. *rotundata* (Round-leaved chaff-flower) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 17 critical habitat units (CHUs), in Hawaii (77 FR 57648-57862).

Critical Habitat Designation

The critical habitat designation for *Achyranthes splendens* var. *rotundata* includes 17 CHUs in Honolulu County, Hawaii (77 FR 57648-57862).

Oahu—Coastal—Unit 1 consists of 946 ac (383 ha) of State land, 11 ac (4 ha) of Federal land, and 2 ac (1 ha) of privately owned land in the coastal ecosystem along the northwestern coast of

Oahu from Kaena Point east to Kauhao Pali and southeast to Keawaula. This unit is partially within Kaena Point State Park. It is occupied by the plants *Achyranthes splendens* var. *rotundata*, *Chamaesyce celastroides* var. *kaenana*, and *Sesbania tomentosa*, and includes the mixed herbland and shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 4). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Coastal—Unit 1 is not known to be occupied by *Bidens amplexans*, *Centaurium sebaeoides*, *Schiedea kealiae*, or *Vigna o-wahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Dry—Unit 1 consists of 49 ac (20 ha) of State land and 53 ac (22 ha) of privately owned land in the Waianae Mountains, extending from Haili Gulch to Kawaipahai. This unit is occupied by the plants *Bidens amplexans*, *Hibiscus brackenridgei*, *Nototrichium humile*, and *Schiedea kealiae*, and includes the dry forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 4). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Lowland Dry—Unit 1 is not known to be occupied by the plants *Achyranthes splendens* var. *rotundata*, *Bonamia menziesii*, *Chamaesyce celastroides* var. *kaenana*, *Euphorbia haelealeana*, *Gouania meyenii*, *G. vitifolia*, *Isodendron pyriformis*, *Melanthera tenuifolia*, *Neraudia angulata*, *Pleomele forbesii*, *Schiedea hookeri*, or *Spermolepis hawaiiensis*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 1 consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. This unit is on State land within the Pahole Natural Area Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). This unit is occupied by the plants *Alectryon macrococcus*, *Cenchrus agrimonoides*, *Chamaesyce herbsteri*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Kadua degeneri*, *Plantago princeps* var. *princeps*, and *Schiedea obovata*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 1 is not currently occupied by *Abutilon sandwicense*, *Achyranthes splendens* var. *rotundata*, *Bonamia menziesii*, *Chamaesyce kuwaleana*, *Diellia falcata*, *D. unisora*, *Dubautia herbertobatae*, *Eragrostis fosbergii*, *Flueggea neowawraea*, *Gouania meyenii*, *G. vitifolia*, *Isodendron laurifolium*, *I. pyriformis*, *Kadua parvula*, *Korthalsella degeneri*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *M. saint-johnii*, *Neraudia angulata*, *Nototrichium humile*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Platydesma cornuta* var. *decurrens*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Sanicula mariversa*, *Schiedea hookeri*, *S. trinervis*, *Silene lanceolata*, *S. perlmannii*, *Spermolepis hawaiiensis*,

Tetramolopium filiforme, *T. lepidotum* ssp. *lepidotum*, or *Viola chamissoniana* ssp. *chamissoniana*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Dry—Unit 2 consists of 29 ac (12 ha) in the lowland dry ecosystem in the Waianae Mountains, on Federal land within Kaena Point State Park. This unit is occupied by the plants *Bonamia menziesii*, *Melanthera tenuifolia*, *Nototrichium humile*, and *Pleomele forbesii*, and includes the dry forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 4). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Lowland Dry—Unit 2 is not known to be occupied by the plants *Achyranthes splendens* var. *rotundata*, *Bidens amplexans*, *Chamaesyce celastroides* var. *kaenana*, *Euphorbia haelealeana*, *Gouania meyenii*, *G. vitifolia*, *Hibiscus brackenridgei*, *Isodendron pyriformis*, *Neraudia angulata*, *Schiedea hookeri*, *S. kealiae*, or *Spermolepis hawaiiensis*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 2 consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. This unit is almost entirely within the Makua Keaau Forest Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). Dry Cliff—Unit 2 is occupied by the plants *Abutilon sandwicense*, *Alectryon macrococcus*, *Dubautia herbstobatae*, *Gouania vitifolia*, *Kadua parvula*, *Lepidium arbuscula*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *Nototrichium humile*, *Peucedanum sandwicense*, *Platydesma cornuta* var. *decurrens*, *Pleomele forbesii*, *Sanicula maritima*, *Schiedea hookeri*, *Tetramolopium filiforme*, and *Viola chamissoniana* ssp. *chamissoniana*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 2 is not currently occupied by *Achyranthes splendens* var. *rotundata*, *Bonamia menziesii*, *Cenchrus agrimonoides*, *Chamaesyce herbstii*, *C. kuwaleana*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia falcata*, *D. unisora*, *Eragrostis fosbergii*, *Flueggea neowawraea*, *Gouania meyenii*, *Isodendron laurifolium*, *I. pyriformis*, *Kadua degeneri*, *Korthalsella degeneri*, *Lipochaeta lobata* var. *leptophylla*, *Melicope saint-johnii*, *Neraudia angulata*, *Phyllostegia kaalaensis*, *Plantago princeps*, *Pteralyxia macrocarpa*, *Schiedea obovata*, *S. trinervis*, *Silene lanceolata*, *S. perlmanii*, *Spermolepis hawaiiensis*, or *Tetramolopium lepidotum* ssp. *lepidotum*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 3 consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. This unit is partially within the Waianae Kai Forest Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). This unit is occupied by the plants *Abutilon sandwicense*, *Alectryon macrococcus*, *Bonamia menziesii*, *Diellia falcata*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Flueggea neowawraea*, *Gouania meyenii*, *Isodendron laurifolium*, *Korthalsella degeneri*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *Neraudia angulata*, *Nototrichium humile*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Schiedea hookeri*, *Silene lanceolata*, *Tetramolopium filiforme*, and *Viola chamissoniana* ssp. *chamissoniana*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 3 is not currently occupied by *Achyranthes splendens* var. *rotundata*, *Cenchrus agrimonioides*, *Chamaesyce herbstii*, *C. kuwaleana*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia unisora*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua degeneri*, *K. parvula*, *Melicope saint-johnii*, *Plantago princeps*, *Platydesma cornuta* var. *decurrens*, *Sanicula mariversa*, *Schiedea obovata*, *S. trinervis*, *Silene perlmannii*, *Spermolepis hawaiiensis*, or *Tetramolopium lepidotum* ssp. *lepidotum*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 4 consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. This unit is partially within the Waianae Kai Forest Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). This unit is occupied by the plants *Alectryon macrococcus*, *Chamaesyce kuwaleana*, and *Spermolepis hawaiiensis*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 4 is not currently occupied by *Abutilon sandwicense*, *Achyranthes splendens* var. *rotundata*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Chamaesyce herbstii*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia falcata*, *D. unisora*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Flueggea neowawraea*, *Gouania meyenii*, *G. vitifolia*, *Isodendron laurifolium*, *I. pyrifolium*, *Kadua degeneri*, *K. parvula*, *Korthalsella degeneri*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *M. saintjohnii*, *Neraudia angulata*, *Nototrichium humile*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Plantago princeps*, *Platydesma cornuta* var. *decurrens*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Sanicula mariversa*, *Schiedea hookeri*, *S. obovata*, *S. trinervis*, *Silene lanceolata*, *S. perlmannii*, *Tetramolopium filiforme*, *T. lepidotum* ssp. *lepidotum*, or *Viola chamissoniana* ssp. *chamissoniana*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals

or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Dry—Unit 8 consists of 96 ac (40 ha) of privately owned land and 3 ac (1 ha) of State land as part of the old railroad right-of-way in the lowland dry ecosystem, at the Kalaeloa Barber's Point Harbor area. The area was occupied by *Chamaesyce skottsbergii* var. *skottsbergii* at the time the species was listed (see 47 FR 36846, August 24, 1982), although it is not currently known to be occupied by *C. skottsbergii* var. *skottsbergii*. The species was last observed on this site in 1989. However, even though the site is degraded, during two recent field surveys (November 2011 and June 2012), we verified that the area being designated contains the physical and biological features of the lowland dry ecosystem and the coral outcrop substrate that is essential for the conservation of *C. skottsbergii* var. *skottsbergii* (see Tables 4 and 5). Based on the field visits, the boundaries of the unit were revised to remove areas that were modified by construction and excavation activities, and do not contain essential features. This resulted in the reduction of the unit from the 292 ac (118 ha) that were originally proposed to the 99 ac (40 ha) that are included in this final rule. These physical and biological features are essential to the conservation of the species in this location because the conservation of the species requires reestablishment of populations of this species in areas where it once occurred. Based on our evaluation of the conservation needs for *Chamaesyce skottsbergii* var. *skottsbergii*, a plant requiring another individual for pollination (obligate-outcrosser) and living 10 years or less (short-lived perennial), we will need 7 to 8 populations containing a total of 10,000 mature individuals with at least 1,000 mature individuals per population in order to recover the species. The numbers of individuals and numbers of populations calculated for the 4 Lowland Dry units for akoko was based on our analysis (white paper) "Recovery Needs and Strategy for Akoko", June 20, 2012. This analysis incorporated data from the Recovery Plan for *C. skottsbergii* var. *skottsbergii* and *Achyranthes splendens* var. *rotundata* (1993), surveys/species reports from 1979, 1981, 1984, and 2012, the Revised Recovery Objective Guidelines as determined by the Hawaii and Pacific Plants Recovery Coordinating Committee (HPPRCC) 2011, and plant genetics information from Guerrant et al. (2004, pp. 419–441) and Neel and Cummings (2003). Currently, *Chamaesyce skottsbergii* var. *skottsbergii* is found in 2 occurrences in the lowland dry ecosystem on the Ewa Plain in southwestern Oahu, totaling approximately 200 wild individuals and 600 outplanted individuals (Guinther and Withrow 2008, pp. 6, 9–10; Whistler 2008, pp. 7–9; U.S. Navy et al. 2012, pp. 19–20). In our review of areas on the Ewa Plain where the features essential to the conservation of this species are still present, we were only able to find four sites that still had the essential features; were not already modified by construction, development, or excavation activities; were large enough to provide habitat for at least one self-sustaining population; and provided adequate distribution across the historical range of the species. To the extent that portions of this unit may not have been occupied at the time of listing, they are essential to the conservation of the species because, as discussed above, conservation of this species will require establishment of additional populations and this is one of the few suitable locations. Oahu—Lowland Dry—Unit 8 is one of four locations included in this final critical habitat designation that is essential to the conservation of *Chamaesyce skottsbergii* var. *skottsbergii*. It was previously occupied by the species and still contains the features essential to its conservation, such as the unique coral outcrop substrate. Oahu—Lowland Dry—Unit 8 may be able to provide for two separate populations of *C. skottsbergii* var. *skottsbergii*. A designation limited to areas presently occupied by the species would be inadequate to ensure the conservation of the species because the one occupied unit (only Oahu—Lowland Dry—Unit 11, see below, is occupied by wild individuals; Oahu—Lowland Dry—Unit 9 contains outplanted,

propagated individuals) would not provide enough area to support 7 to 8 populations needed for recovery, as determined in the “Recovery Needs and Strategy for *Chamaesyce skottsbergii* var. *skottsbergii* (Ewa Plains akoko)” (Service 2012, entire). There are no other geographic areas that are both undeveloped and contain the species-specific PCE of coral outcrop substrate. Oahu—Lowland Dry—Unit 8 is not known to be occupied by *Bidens amplexans*, one of the plants being listed in this rule as endangered. However, we have determined the lands within this unit are essential for the conservation of this lowland dry species, because they provide the habitat necessary for the reestablishment of wild populations within the historical ranges of the species (see Table 4). Due to their small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Additionally, Oahu—Lowland Dry—Unit 8 was not occupied by the endangered plants *Achyranthes splendens* var. *rotundata*, *Bonamia menziesii*, *Chamaesyce celastroides* var. *kaenana*, *Euphorbia haelealeana*, *Gouania meyenii*, *G. vitifolia*, *Hibiscus brackenridgei*, *Isodendron pyriformis*, *Melanthera tenuifolia*, *Neraudia angulata*, *Nototrichium humile*, *Schiedea hookeri*, *S. kealiae*, or *Spermolepis hawaiiensis* (see 51 FR 10518, March 26, 1986, and 68 FR 35950, June 17, 2003, for previous Federal actions), at the time they were listed, and is not currently known to be occupied by these 14 species. However, we have determined the lands within this unit are essential for the conservation of these lowland dry species, because they provide the habitat necessary for the reestablishment of wild populations within the historical ranges of the species (see Table 4). Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 6 consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). The unit is occupied by the plants *Cenchrus agrimonoides*, *Diellia unisora*, *Flueggea neowawraea*, *Lepidium arbuscula*, *Lobelia niihauensis*, *Melicope saintjohnii*, *Neraudia angulata*, *Plantago princeps*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, and *Tetramolopium lepidotum* ssp. *lepidotum*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 6 is not currently occupied by *Abutilon sandwicense*, *Achyranthes splendens* var. *rotundata*, *Alectryon macrococcus*, *Bonamia menziesii*, *Chamaesyce herbsteri*, *C. kuwaleana*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia falcata*, *Dubautia herbsteri*, *Eragrostis fosbergii*, *Gouania meyenii*, *G. vitifolia*, *Isodendron laurifolium*, *I. pyriformis*, *Kadua degeneri*, *K. parvula*, *Korthalsella degeneri*, *Lipochaeta lobata* var. *leptophylla*, *Melanthera tenuifolia*, *Melicope makahae*, *Nototrichium humile*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Platydesma cornuta* var. *decurrens*, *Sanicula maritima*, *Schiedea hookeri*, *S. obovata*, *S. trinervis*, *Silene lanceolata*, *S. perlmannii*, *Spermolepis hawaiiensis*, *Tetramolopium filiforme*, or *Viola chamissoniana* ssp. *chamissoniana*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Dry—Unit 9 consists of 17 ac (7 ha) of City and County land, 3 ac (1 ha) of privately owned land, 1 ac (0.5 ha) of State land, and 16 ac (6 ha) of Federal (Pearl Harbor NWR) land in the lowland dry ecosystem at Kalaeloa. This unit was not occupied by *Chamaesyce skottsbergii* var. *skottsbergii* at the time the species was listed (see 47 FR 36846, August 24, 1982). As noted in the description of Oahu—Lowland Dry—Unit 8 above, we have determined that for *C. skottsbergii* var. *skottsbergii*, a plant requiring another individual for pollination (obligate-outcrosser) and living 10 years or less (short-lived perennial), we will need 7 to 8 populations containing at least a total of 10,000 mature individuals with at least 1,000 mature individuals per population in order to recover the species HPPRCC 2011; Guerrant et al. 2004, pp. 419–441; Neel and Cummings 2003). Oahu—Lowland Dry—Unit 9 is one of the four locations included in this final critical habitat designation that is essential to the conservation of *C. skottsbergii* var. *skottsbergii*; please see discussion of the importance of these areas on the Ewa Plain, above, in the description of Oahu—Lowland Dry—Unit 8. This unit is currently occupied by recently outplanted individuals of *Chamaesyce skottsbergii* var. *skottsbergii*, and includes the dry forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland dry ecosystem, and the unique PCEs for the species *C. skottsbergii* var. *skottsbergii* (see Tables 4 and 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing populations. Oahu—Lowland Dry—Unit 9 may be able to provide for one separate population of *C. skottsbergii* var. *skottsbergii*. Oahu—Lowland Dry—Unit 9 is not known to be occupied by another plant being listed as endangered in this rule, *Bidens amplexans*. We have determined this area to be essential for the conservation and recovery of both of these lowland dry species because it provides the habitat necessary for the reestablishment of wild populations within the historical ranges of the species (see Table 4). Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. A designation limited to areas presently occupied by the species would be inadequate because the one occupied unit (only Oahu—Lowland Dry—Unit 11, see below, is occupied by wild individuals; Oahu—Lowland Dry—Unit 9 contains outplanted, propagated individuals) would not provide enough area to support 7 to 8 populations needed for recovery, as determined in the “Recovery Needs and Strategy for *Chamaesyce skottsbergii* var. *skottsbergii* (Ewa Plains akoko)” (Service 2012, entire). There are no other geographic areas that are both undeveloped and contain the species-specific PCE of coral outcrop substrate. Additionally, Oahu—Lowland Dry—Unit 9 was not occupied by the endangered plants *Achyranthes splendens* var. *rotundata*, *Bonamia menziesii*, *Chamaesyce celastroides* var. *kaenana*, *Euphorbia haelealeana*, *Gouania meyenii*, *G. vitifolia*, *Hibiscus brackenridgei*, *Isodendron pyriformis*, *Melanthera tenuifolia*, *Neraudia angulata*, *Nototrichium humile*, *Schiedea hookeri*, *S. kealiae*, or *Spermolepis hawaiiensis* (see 51 FR 10518, March 26, 1986 and 68 FR 35950, June 17, 2003), at the time they were listed, and is not currently known to be occupied by these 14 species. We have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species (see Table 4). Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Dry—Unit 10 consists of 43 ac (17 ha) of State land (DHHL) in the lowland dry ecosystem at Kalaeloa. This unit was not occupied by *Chamaesyce skottsbergii* var. *skottsbergii* at the time the species was listed (see 47 FR 36846, August 24, 1982); however, *C. skottsbergii* var. *skottsbergii* was observed in the area in 1998, but has not been re-observed since that time. As noted in the description of Oahu—Lowland Dry—

Unit 8, above, we have determined that *C. skottsbergii* var. *skottsbergii*, a plant requiring another individual for pollination (obligate outcrosser) and living 10 years or less (short-lived perennial), we will need 7 to 8 populations containing a total of 10,000 mature individuals with at least 1,000 mature individuals per population in order to recover the species (HPPRCC 2011; Guerrant et al. 2004, pp. 419–441; Neel and Cummings 2003). Oahu—Lowland Dry—Unit 10 is one of the four locations included in this final critical habitat designation that is essential to the conservation of *C. skottsbergii* var. *skottsbergii*; please see discussion of the importance of these areas on the Ewa Plain, above, in the description of Oahu—Lowland Dry—Unit 8. This unit was previously occupied by *Chamaesyce skottsbergii* var. *skottsbergii* and still contains the features essential to its conservation, such as the unique coral outcrop substrate (see Tables 4 and 5). In the future, Oahu—Lowland Dry—Unit 10 may be able to provide for one separate population of *C. skottsbergii* var. *skottsbergii*. A designation limited to areas presently occupied by the species would be inadequate to ensure the conservation of the species, because the one occupied unit (Oahu—Lowland Dry—Unit 11) would not provide enough area to support 7 to 8 populations needed for recovery, as determined in the “Recovery Needs and Strategy for *Chamaesyce skottsbergii* var. *skottsbergii* (Ewa Plains akoko)” (Service 2012, entire). There are no other geographic areas that are both undeveloped and contain the species-specific PCE of coral outcrop substrate.

Oahu—Dry Cliff—Unit 7a consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4), and is occupied by the plants *Flueggea neowawraea*, *Kadua parvula*, *Melicope saint-johnii*, *Plantago princeps*, *Platydesma cornuta* var. *decurrens*, *Pleomele forbesii*, *Silene perlmannii*, and *Viola chamissoniana* ssp. *chamissoniana*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 7a is not currently occupied by *Abutilon sandwicense*, *Achyranthes splendens* var. *rotundata*, *Alectryon macrococcus*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Chamaesyce herbstii*, *C. kuwaleana*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia falcata*, *D. unisora*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Gouania meyenii*, *G. vitifolia*, *Isodendron laurifolium*, *I. pyriforme*, *Kadua degeneri*, *Korthalsella degeneri*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *Neraudia angulata*, *Nototrichium humile*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Pteralyxia macrocarpa*, *Sanicula mariversa*, *Schiedea hookeri*, *S. obovata*, *S. trinervis*, *Silene lanceolata*, *Spermolepis hawaiiensis*, *Tetramolopium filiforme*, or *T. lepidotum* ssp. *lepidotum*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Dry Cliff—Unit 7b consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). Although Oahu—Dry Cliff—

Unit 7b is not currently occupied by *Abutilon sandwicense*, *Achyranthes splendens* var. *rotundata*, *Alectryon macrococcus*, *Bonamia menziesii*, *Cenchrus agrimonoides*, *Chamaesyce herbstii*, *C. kuwaleana*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia falcata*, *D. unisora*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Flueggea neowawraea*, *Gouania meyenii*, *G. vitifolia*, *Isodendrion laurifolium*, *I. pyrifolium*, *Kadua degeneri*, *K. parvula*, *Korthalsella degeneri*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *M. saintjohnii*, *Neraudia angulata*, *Nototrichium humile*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Plantago princeps*, *Platydesma cornuta* var. *decurrens*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Sanicula mariversa*, *Schiedea hookeri*, *S. obovata*, *S. trinervis*, *Silene lanceolata*, *S. perlmannii*, *Spermolepis hawaiiensis*, *Tetramolopium filiforme*, *T. lepidotum* ssp. *lepidotum*, or *Viola chamissoniana* ssp. *chamissoniana*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Dry—Unit 10 is not known to be occupied by another plant being listed as endangered in this rule, *Bidens amplexans*. However, we have determined this area to be essential for the conservation and recovery of this lowland dry species, because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species (see Table 4). Due to its small numbers of individuals or low population sizes, this species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Additionally, Oahu—Lowland Dry— Unit 10 was not occupied by the endangered plants *Achyranthes splendens* var. *rotundata*, *Bonamia menziesii*, *Chamaesyce celastroides* var. *kaenana*, *Euphorbia haelealeana*, *Gouania meyenii*, *G. vitifolia*, *Hibiscus brackenridgei*, *Isodendrion pyrifolium*, *Melanthera tenuifolia*, *Neraudia angulata*, *Nototrichium humile*, *Schiedea hookeri*, *S. kealiae*, or *Spermolepis hawaiiensis* (see 51 FR 10518, March 26, 1986, and 68 FR 35950, June 17, 2003), at the time they were listed, and is not currently known to be occupied by these 14 species. We have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species (see Table 4). Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. We are aware of the planned development of the Kalaheo Solar One and Two alternative energy facilities (DHHL 2011, in litt.) on lands within, and adjacent to, this unit. The facilities, which are independently owned and operated, are being developed for the purpose of reducing Oahu's dependence on fossil-fuel for power generation. The January 2011 Draft Environmental Assessment prepared for this project states that no Federal funding or Federal authorizations will be required to develop this facility. We are also unaware of any Federal nexus for this project. Accordingly, since a critical habitat designation only triggers a consultation under section 7(a)(2) of the Act for activities that have a Federal nexus, the designation of this unit as critical habitat is not anticipated to have an impact on this project as proposed.

Oahu—Dry Cliff—Unit 8 consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve. A small portion of this area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was

recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). This unit is occupied by the plants *Abutilon sandwicense*, *Bonamia menziesii*, *Flueggea neowawraea*, *Lobelia niihauensis*, *Neraudia angulata*, *Nototrichium humile*, and *Pleomele forbesii*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 8 is not currently occupied by *Achyranthes splendens* var. *rotundata*, *Alectryon macrococcus*, *Cenchrus agrimonioides*, *Chamaesyce herbstii*, *C. kuwaleana*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia falcata*, *D. unisora*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Gouania meyenii*, *G. vitifolia*, *Isodendron laurifolium*, *I. pyriformis*, *Kadua degeneri*, *K. parvula*, *Korthalsella degeneri*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Melanthera tenuifolia*, *Melicope makahae*, *M. saint-johnii*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Plantago princeps*, *Platydesma cornuta* var. *decurrens*, *Pteralyxia macrocarpa*, *Sanicula mariversa*, *Schiedea hookeri*, *S. obovata*, *S. trinervis*, *Silene lanceolata*, *S. perlmannii*, *Spermolepis hawaiiensis*, *Tetramolopium filiforme*, *T. lepidotum* ssp. *lepidotum*, or *Viola chamissoniana* ssp. *chamissoniana*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Dry—Unit 11 consists of 166 ac (67 ha) of federal land (U.S. Navy) in the lowland dry ecosystem at Kalaeloa. The area was occupied by *Chamaesyce skottsbergii* var. *skottsbergii* at the time the species was listed (47 FR 36846, August 24, 1982), and is currently occupied by *C. skottsbergii* var. *skottsbergii*. As noted in the description of Oahu—Lowland Dry—Unit 8, above, we have determined that for *C. skottsbergii* var. *skottsbergii*, a plant requiring another individual for pollination (obligate-outcrosser) and living 10 years or less (short-lived perennial), we will need 7 to 8 populations containing a total of 10,000 mature individuals with at least 1,000 mature individuals per population in order to recover the species (HPPRCC 2011; Guerrant et al. 2004, pp. 419- 441; Neel and Cummings 2003). Oahu— Lowland Dry—Unit 11 is one of the four locations included in this final critical habitat designation that is essential to the conservation of *C. skottsbergii* var. *skottsbergii*; please see discussion of the importance of these areas on the Ewa Plain, above, in the description of Oahu—Lowland Dry—Unit 8. Oahu—Lowland Dry—Unit 11 includes the dry forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland dry ecosystem, as well as unique PCEs for *Chamaesyce skottsbergii* var. *skottsbergii* (see Tables 4 and 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the habitat necessary for the expansion of the existing wild populations. A designation limited to areas presently occupied by the species would be inadequate to ensure the conservation of the species because this occupied unit (only Oahu—Lowland Dry—Unit 11 is occupied by wild individuals; Oahu— Lowland Dry—Unit 9 (see above) contains outplanted, propagated individuals, not wild plants) would not provide enough area to support 7 to 8 populations needed for recovery, as determined in the “Recovery Needs and Strategy for *Chamaesyce skottsbergii* var. *skottsbergii* (Ewa Plains akoko)” (Service 2012, entire). There are no other geographic areas that are both undeveloped and contain the species-specific PCE of coral outcrop substrate. In the future, Lowland Dry—Unit 11 may be able to provide for three or four separate populations of *C. skottsbergii* var. *skottsbergii*. Oahu—Lowland Dry—Unit 11 is not

known to be occupied by another plant being listed as endangered in this rule, *Bidens amplexans*. However, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species (see Table 4). Due to its small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Additionally, Lowland Dry—Unit 11 was not occupied by the endangered plants *Achyranthes splendens* var. *rotundata*, *Bonamia menziesii*, *Chamaesyce celastroides* var. *kaenana*, *Euphorbia haelealeana*, *Gouania meyenii*, *G. vitifolia*, *Hibiscus brackenridgei*, *Isodendron pyriformis*, *Melanthera tenuifolia*, *Neraudia angulata*, *Nototrichum humile*, *Schiedea hookeri*, *S. kealiae*, or *Spermolepis hawaiiensis* (see 51 FR 10518, March 26, 1986, and 68 FR 35950, June 17, 2003) at the time they were listed, and is not currently known to be occupied by these 14 species. We have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species (see Table 4). Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. We are aware and supportive of the efforts underway by State and the Navy, in coordination with the Service, to develop a long-term preservation or conservation plan for *Chamaesyce skottsbergii* var. *skottsbergii* within this unit. These include the development of a State of Hawaii Habitat Conservation Plan and the conditional transfer of some of the Navy lands within this unit to the Hawaii Community Development Authority (HCDA). The State of Hawaii Endangered Species Act already prohibits the take of individual listed plants by the State or any other non-Federal entity, without State review and authorization. If the lands are transferred by the Navy, the deed will require Grantees and successors to enter into a legally binding conservation and management plan approved by the Hawaii Department of Land and Natural Resources, to ensure protection of *C. skottsbergii* var. *skottsbergii* before conveying the property (U.S. Navy 2011, in litt.), based on the species being State and federally listed. The purpose of this agreement is to ensure the use or development of the transferred property does not adversely affect *C. skottsbergii* var. *skottsbergii*, as long as the species remains listed under the Act. If the Navy lands are transferred to HCDA, a portion of the lands may be used to develop a photovoltaic alternative energy project (HCDA 2012, in litt.; HDOFAW 2012, in litt.). The HCDA plans to use a portion of the revenue generated by commercial use of HCDA property to fund the conservation actions required under a conservation management plan (U.S. Navy 2011, in litt.). The Service is committed to working with the Navy and HCDA in the development of this conservation plan, to ensure it will provide for the long-term conservation of the plant and its habitat. Because of this close coordination, and because the deed restriction stipulates that *C. skottsbergii* var. *skottsbergii* will not be adversely affected, we believe the development of the photovoltaic alternative energy project, as proposed, will not be impacted by the designation of critical habitat in this unit, and it is our intent to work with our partners to facilitate this project.

Oahu—Coastal—Unit 13 consists of 19 ac (8 ha) of City and County land, 1 ac (0.5 ha) of State land, and 3 ac (1 ha) of privately owned land in the coastal ecosystem at Kalaeloa. This unit is occupied by the plant *Achyranthes splendens* var. *rotundata*, and includes the mixed herbland and shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 4). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Coastal—

Unit 13 is not known to be occupied by *Bidens amplexans*, *Centaurea sebaeoides*, *Chamaesyce celastroides* var. *kaenana*, *Schiedea kealiae*, *Sesbania tomentosa*, or *Vigna owahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Coastal—Unit 14 consists of 2 ac (1 ha) of City and County of Honolulu land, and 2 ac (1 ha) of Federal land (U.S. Coast Guard) in the coastal ecosystem at Kalaeloa. This unit is occupied by the plant *Achyranthes splendens* var. *rotundata*, and includes the mixed herbland and shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 4). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Coastal—Unit 14 is not known to be occupied by *Bidens amplexans*, *Centaurea sebaeoides*, *Chamaesyce celastroides* var. *kaenana*, *Schiedea kealiae*, *Sesbania tomentosa*, or *Vigna owahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Coastal—Unit 15 consists of 9 ac (4 ha) of State land, 2 ac (1 ha) of privately owned land, and 21 ac (9 ha) of Federal (Pearl Harbor NWR) land at Kalaeloa. This unit is occupied by the plant *Achyranthes splendens* var. *rotundata*, and includes the mixed herbland and shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 4). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Coastal—Unit 15 is not known to be occupied by *Bidens amplexans*, *Centaurea sebaeoides*, *Chamaesyce celastroides* var. *kaenana*, *Schiedea kealiae*, *Sesbania tomentosa*, or *Vigna o-wahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Achyranthes splendens* var. *rotundata* critical habitat consists of three components (Coastal, Lowland dry and Dry cliff). Species occurs within the indicated ecosystem in the Waianae Mountain caldera complex. (77 FR 57648-57862):

Ecosystem: Coastal. Elevation: <980 ft (<300 m). Annual precipitation: <20 in (<50 cm). Substrate: Well-drained, calcareous, talus slopes; dunes; weathered clay soils; ephemeral pools; mudflats. Canopy: *Hibiscus*, *Myoporum*, *Santalum*, *Scaevola*. Subcanopy: *Gossypium*, *Sida*, *Vitex*. Understory: *Eragrostis*, *Jacquemontia*, *Lyceum*, *Nama*, *Sesuvium*, *Sporobolus*, *Vigna*.

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, little weathered lava. Canopy: Diospyros, Myoporum, Pleomele, Santalum, Sapindes. Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Plumbago, Sicyos, Sida, Waltheria.

Ecosystem: Dry Cliff. Elevation: unrestricted. Annual precipitation: < 75 in (<190 cm). Substrate: >65 degree slope, rocky talus. Canopy: None. Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also

required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Reproduction and dispersal method(s) unknown. (NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Bare rock/talus/scree (NatureServe, 2015)

Habitat Narrative

Adult: *Achyranthes splendens* var. *rotundata* occurs in the kiawe forest community as well as in an open shrub community characterized by koa haole, marsh fleabane (*Pluchea x fosbergii*), and the native species, maiapilo (*Capparis sandwichiana*) and naio (*Myoporum sandwicense*). Thickets of koa haole dominate most of these slopes, and the herb layer, when present, consists mostly of buffelgrass (*Cenchrus ciliaris*) and sourgrass (*Digitaria insularis*) (Nagata 1981). Scattered in low elevation, open, dry forest remnants and open thickets, on talus or rocky slopes, and on coralline plains with numerous sinkholes. Rock debris covers more than 50 percent of the surface and the soil layer is thin and well-drained. (USFWS, 1994; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Reproduction and dispersal method(s) unknown. (NatureServe, 2015)

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

7 (NatureServe, 2015)

Population Size:

Less than 2000 plants (NatureServe, 2015)

Population Narrative:

Total population probably less than 2000 plants. There are 7 extant (between 1982 and 1997) and 2 historical occurrences. (NatureServe, 2015)

Threats and Stressors

Stressor: Climate change (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Climate change - Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) funded climate modeling that will help resolve these spatial limitations. High spatial resolution climate outputs are expected to be available sometime in 2013. (USFWS, 2013)

Stressor: Loss of habitat (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Direct human-induced loss of habitat is considered the major cause of the decline of *Chamaesve skottsbergii* var. *skottsbergii* and *Achyranthes splendens* var. *rotundata* on the 'Ewa Plain of O'ahu. The history of direct, human-induced disturbance in this area dates back at least 500 years to the first use of sinkholes for cultivation by native Hawaiians. More intensive disturbances have occurred since the 19th century, when diversified agriculture became widespread throughout the Plain. More recently, urbanization and the establishment of a rock

quarry, military bases, Campbell Industrial Park, and the deep draft harbor have contributed to the virtual extinction of the original ecosystem. Today, approximately 90 percent of the Plain is occupied by residential developments, sugar cane fields, an industrial complex, a deep-draft harbor, military installations and recreational areas. As the need for urban and industrial sites on O'ahu increases, the demand for land in the 'Ewa Plain will also increase. Thus, the continued loss of habitat, albeit completely modified, must still be considered the major threat to both taxa. (USFWS, 1994)

Stressor: Non-native plants (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: In addition to the physical loss of habitat, all populations of *Chamaesyce skottsbergii* var. *skottsbergii* and *Achyranthes splendens* var. *rotundata* have been adversely affected by habitat degradation caused by invading alien shrubs and trees. Today, intact native plant communities are non-existent in the 'Ewa Plain; only remnant individuals remain. Aggressive species such as kiawe, *Pluchea*, Australian saltbush, *Asystasia* and various grasses have altered the natural habitat and are competing with both endangered taxa for space, light, water, and nutrients. Particularly detrimental alien species are: kiawe, which often forms closed-canopied forests; *Pluchea x fosbergii*, which is extremely aggressive; and, grasses and *Asystasia* which can prevent seedling establishment. On Moloka'i, invasion by aggressive weeds is listed by The Nature Conservancy (1991) as a threat to all rare plants on the Hawaiian Home Lands' Ho'olehua parcel (Population 5), and weed control, specifically kiawe removal, is a part of The Nature Conservancy's management program on the Mo'omomi Preserve on Moloka'i (Populations 6 and 7) (TNCH, 1993). Similar encroachment of alien plants occurs in the Ka'ena Point area. (USFWS, 1994)

Stressor: Parasitism by *Cassytha filiformis* (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: The parasitic native vine, *kauna'oa* *pehu* (*Cassytha filiformis*) has been noted as a possible threat to both taxa in the Barber's Point area (AECOS 1981; Nagata 1981). This vine is locally common at Barbers Point where it enshrouds shrubs and smaller trees. Heavy infestations weaken the host plants, leaving them vulnerable to disease-causing organisms and insect predation. (USFWS, 1994)

Stressor: Fire (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Fire must be considered a potential threat for all populations because of the highly localized distribution of both taxa. During long, annual drought periods, vegetation becomes exceptionally dry, particularly in the 'Ewa Plain and in western Moloka'i, and the accumulated litter during these months represents potential fuel for brush fires. In the 'Ewa Plain, residential and industrial development represents an increased threat of fire, although there tends to be a concomitant rise in awareness of such a threat and contingencies for fire are considered in urban planning. (USFWS, 1994)

Stressor: Insect predation (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Potentially damaging insects have been reported on both *Chamaesyce skottsbergii* var. *skottsbergii* and *Achyranthes splendens* var. *rotundata*. An unidentified borer, the croton moth caterpillar (*Aechaea ianata*), and spiralling white fly (*Aleurodicus dispersus*) have been noted on *Chamaesyce skottsbergii* var. *skottsbergii* (AECOS 1981). The croton moth caterpillar is known to denude *Chamaesyce skottsbergii* var. *skottsbergii* of leaves and flowers (AECOS 1981). A severe infestation of white fly is usually debilitating to its host plants (Borrer, et al. 1981). A lack of seed set has been noted on heavily infested plants since the spiralling white fly has become established at Barbers Point (C. Corn, personal communication 1994). An unidentified scale has been noted on *Achyranthes splendens* var. *rotundata* and an unidentified mite seems to be an occasional pest on cultivated specimens (Nagata, unpublished data). Nematodes (*Meloidogyne* spp., *Pratylenchus* spp., *Rotylenchulus reniformis*) are also known to infest cultivated *Achyranthes splendens* var. *rotundata* (Mew 1987). (USFWS, 1994)

Stressor: Destruction by cattle and feral animals (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Threats on western Moloka'i include destruction of native ecosystems by feral animals and cattle (TNCH, 1991; Nagata, unpublished data). Ungulates at the Mo'omomi Preserve are actively controlled, although they remain a threat. At Ka'ena Point, ungulates are not a threat at present, but do represent a potential threat as the range of goats in neighboring areas continues to expand. (USFWS, 1994)

Stressor: Trampling by humans (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: *Chamaesyce skottsbergii* var. *skottsbergii* is a low, rather inconspicuous shrub with brittle stems. It is especially difficult to discern during the dry season when it is dormant and leafless. Plants have been damaged by persons intruding into some of the populations (AECOS 1981). (USFWS, 1994)

Stressor: Runaway disaster (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Populations of *Achyranthes splendens* var. *rotundata* and *Chamaesyce skottsbergii* var. *skottsbergii* occur on either end of one of the runways at NAS Barbers Point. While this location may, in some ways, have protected them by precluding development in these areas, it also leaves them vulnerable to devastation in the case of a runway disaster resulting in fire, a chemical spill or physical destruction of the population. (USFWS, 1994)

Stressor: Over-utilization for commercial use (USFWS, 1994)

Exposure:**Response:****Consequence:**

Narrative: *Achyranthes splendens* var. *rotundata* is an attractive shrub with striking silvery-green leaves and prominent spike-like inflorescences. In the past, its leaves and inflorescences were utilized in lei-making (Nagata 1981). This does not represent a threat if State and Federal laws, which prohibit taking of the plant, are adequately enforced. (USFWS, 1994)

Stressor: Natural disasters (USFWS, 1994)

Exposure:**Response:****Consequence:**

Narrative: The 'Ewa Plain is one of very low relief and inundation by tsunamis is thus a threat. Unusually high tides were recorded at Barbers Point during the tsunamis of 1946 and 1960. Although no damage was reported (Pararas-Carayannis 1977), no structures were located near the coast at that time. (USFWS, 1994)

Stressor: Contamination by ambient pollution or chemical spill (USFWS, 1994)

Exposure:**Response:****Consequence:**

Narrative: Potential chemical spill or contamination of the soil due to ambient pollution are threats to nearly all populations in the Barbers Paine area due to heavy industrial and military activities, and there is a further potential for spread of contamination within the tsunami zone. Indeed, the possibility exists that *Achyranthes* Population #4 was contaminated by heavy metals from baghouse dust escaping from Hawaiian Western Steel (HWS) in the last two decades. The Estate of James Campbell, which is responsible for resolving ecological concerns resulting from HWS operations, agreed in July 1993 to take soil samples within Population 4 to determine the quantity of baghouse dust present. In the event that contamination is found to be significant, mitigation will need to be implemented. Another pollution problem of airborne dust results from rock crushing upwind. This dust coats leaves of *Achyranthes* plants within the Campbell Industrial Park (Population 4) in dry spells (C. Corn, personal communication 1994). (USFWS, 1994)

Recovery**Reclassification Criteria:**

1. There must be at least three self-reproducing populations with a minimum of 500 reproductive plants per population in each of the two geographically distinct regions in which they occur (Ewa Plain and Kaena Point regions). (USFWS, 2009)
2. The population trend should be growing or stable at 500 reproductive individuals and threats should be removed or controlled for at least 10 years prior to downlisting. (USFWS, 2009)
3. Land area for each of these populations should be sufficient to provide a buffer of 30 to 50 meters (100 to 165 feet) around the expanded population. (USFWS, 2009)

Delisting Criteria:

1. All criteria for downlisting should be met as well as the following criteria. (USFWS, 2009)

2. At least three populations of *A. splendens* var. *rotundata* with a minimum of 1,000 reproductive plants each should be re-established within the taxon's historical range on the island(s) of Lanai and/or Molokai to ensure against losses due to a catastrophic event affecting the island of Oahu. (USFWS, 2009)

3. All populations should be stable and self-sustaining, with no human manipulation, for a minimum of 10 years prior to delisting and expected to remain so into the foreseeable future. (USFWS, 2009)

Recovery Actions:

- Protect and manage existing populations. (USFWS, 1994)
- Augment or re-establish populations, if necessary. (USFWS, 1994)
- Validate recovery objectives. (USFWS, 1994)

Conservation Measures and Best Management Practices:

- Continue collection of fruit and plant material for future reintroductions, especially from the recently discovered population at Waianae Kai/Makah. (USFWS, 2009)
- Eradicate invasive introduced plant species within the species' habitat. (USFWS, 2009)
- Establish more populations within suitable habitat in protected sites. (USFWS, 2009)
- Survey geographical and historical range for a thorough current assessment of the species. (USFWS, 2009)
- Determine and implement control methods for scales and ants in the populations. (USFWS, 2009)
- Assess genetic variability within extant populations. (USFWS, 2009)
- Assess the suitability of habitat for reintroducing this species on Lanai and Molokai. (USFWS, 2009)
- Initiate planning and contribute to implementation of ecosystem level restoration and management to benefit this taxon. (USFWS, 2009)
- Study *Achyranthes splendens* var. *rotundata* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, seed banks, specific environmental requirements, limiting factors, and threats. (USFWS, 2009)
- Revise draft recovery plan with current information. (USFWS, 2009)

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SPECIES ACCOUNT: *Acmispon dendroideus* var. *traskiae* (=Lotus d. ssp. *traskiae*) (San Clemente Island lotus (=broom))

Species Taxonomic and Listing Information

Listing Status: Threatened; 9/12/1977; California/Nevada Region (R8) (USFWS, 2015); Proposed Delisting

Physical Description

Lotus dendroideus var. *traskiae* is typically less than 4 feet in height with slender, erect green branches (Munz 1974). Its leaves have 3 to 5 leaflets, each approximately ¼ inch long. *Lotus dendroideus* var. *traskiae* has relatively small, yellow, bisexual flowers that radiate in 1 to 5 flowered groupings from flower stalks that arise from the leaf axils (between the stem and leaf) of terminal shoots (Junak and Wilken 1998). Pistils (female reproductive structures of the flower including an ovary and pollen receiving structure) are initially yellow but with age, turn orange then red (U. S. Fish and Wildlife Service 1984) (USFWS, 2007).

Taxonomy

It is in the legume family (Fabaceae). The Service listed San Clemente Island lotus as *Lotus scoparius* (Nutt.) Ottley subsp. *traskiae* (Abrams) Raven. Since listing, Isely (1978) considered all of the San Clemente Island taxa to be separable from mainland *Lotus scoparius*. Isely (1978) elevated the insular taxa to species rank using the oldest name available (*Lotus dendroideus*) among the three subspecies. The currently recognized name, *Lotus dendroideus* var. *traskiae*, was published by Isely in 1978. This has been recognized in recent floristic (Isely 1993) and systematic treatments (Isely 1998) (USFWS, 2007).

Historical Range

California endemic, Los Angeles Co., San Clemente Island (NatureServe, 2015). The original range and distribution of *Lotus dendroideus* var. *traskiae* on San Clemente Island are speculative because its decline began before thorough botanical studies of the island were completed (USFWS, 2007).

Current Range

Since the 1970s, the distribution of *Lotus dendroideus* var. *traskiae* has been documented, and its range includes north-facing slopes over most of the eastern and western sides of the island (U. S. Fish and Wildlife Service 1984; U. S. Department of the Navy, Southwest Division 2002; Junak and Wilken 1998; Junak 2006) (USFWS, 2007).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, self-fertilization (USFWS, 2007)

Lifespan

Adult: < 5 years (USFWS, 2007)

Breeding Season

Adult: March - May (USFWS, 2007)

Key Resources Needed for Breeding

Adult: Insect pollinators, soil seed bank (USFWS, 2007)

Other Reproductive Information

Adult: Degradation of seed coat required for germination (USFWS, 2007)

Reproduction Narrative

Adult: Flowers are present from March through May, and in several locations, halictid bees, bumblebees, and small beetles have been observed foraging on the flowers (Allan 1999; Junak and Wilken 1998). *Lotus dendroideus* var. *traskiae* has been known to hybridize with the more common, native island lotus, *Lotus argophyllus* var. *adsurgens*, but only in disturbed areas in Wilson Cove (Liston et al. 1990; Allan 1999). A study by Junak and Wilken (1998) found that, on average, a single *Lotus dendroideus* var. *traskiae* individual can produce approximately 36 to 64 flowering shoots, 118 to 144 flowers per shoot, and 4 to 6 seeds per fruit. These data suggest that under ideal conditions, an individual *Lotus dendroideus* var. *traskiae* can produce a high volume of seeds (16,000 or more). Because individual plants have a life span of less than 5 years, it is suspected that populations persist through periodic recruitment from the soil seed bank (M. Wall pers. com. 2006). Like most legumes, *Lotus dendroideus* var. *traskiae* seeds require some sort of scarification or gradual seed coat degradation for germination to take place (M. Wall pers. comm. 2006). Allan's (1999) genetic studies revealed that populations of *Lotus dendroideus* var. *traskiae* were predominantly inbreeding and the taxon was exhibiting an autogamous (self-fertilization) breeding system. Allan (1999) wrote that halictid bees, bumblebees, and small beetles were the primary pollinators for this species and he postulated that differences in pollinator abundance and visitation might account for the high percentage of *Lotus dendroideus* var. *traskiae* populations that are exhibiting inbreeding (USFWS, 2007).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Coastal scrub, valley and foothill grassland (NatureServe, 2015); canyon woodland (USFWS, 2007)

Dependencies on Specific Environmental Elements

Adult: Possibly periodic fire (USFWS, 2007)

Geographic or Habitat Restraints or Barriers

Adult: Occurs < 1,300 ft. elevation (USFWS, 2007)

Spatial Arrangements of the Population

Adult: Semi-colonial (USFWS, 2007)

Habitat Narrative

Adult: Coastal scrub, valley and foothill grassland. Grassland hillsides around coves and dry, sometimes rocky slopes. Associated species are: *Artemisia californica*, *Galvezia*, *Eriopyllum nevinii*, *Castilleja grisea*, *Opuntia littoralis*, *O. prolifera*, *Eriogonum giganteum formosum*, *Dudleya virens*, *Encelia californica*, *Lotus argophyllus ornithopus*, *Calystegia macrostegia*, *Hemizonia clemantina*, and *Stephanomeria virgata* (Unpublished data in TNC files). (NatureServe, 2015). *Lotus dendroideus* var. *traskiae* occurs on north-facing slopes, canyon bottoms, or ridgelines (Junak 2006). It grows somewhat colonially around rock outcrops in grassy areas or along the interface between grassland and maritime sage scrub (Allan 1999; U. S. Department of the Navy, Southwest Division 2002). It occurs below 1,300 feet elevation in well-drained soils, but where more soil moisture is available. Based on vegetation mapping for the San Clemente Island INRMP (U.S. Department of the Navy, Southwest Division 2002), *Lotus dendroideus* var. *traskiae* is associated with two habitats on the island: canyon woodland (696.2 acres) and maritime desert scrub along the northeast escarpment (6,228.2 acres). Based on its growth characteristics, its population increase, and the fire-adaptedness of other plants in the genus, it is likely that *Lotus dendroideus* var. *traskiae* is resilient to, and may benefit from, occasional fire (USFWS, 2007).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Increasing (USFWS, 2012)

Resiliency:

Low (inferred from USFWS, 2007; see current range/distribution)

Representation:

Low (inferred from USFWS, 2007; see reproduction narrative)

Redundancy:

High (inferred from USFWS, 2007)

Number of Populations:

29 (USFWS, 2012)

Population Size:

Up to 7,900 (USFWS, 2007)

Population Narrative:

Since listing and the removal of feral goats and pigs on San Clemente Island, the distribution of *Acemispom dendroideus* var. *traskiae* has expanded from 6 to 29 occurrences (USFWS, 2012). When combined, the 1996/1997 surveys and the 2003/2004 surveys suggest that *Lotus dendroideus* var. *traskiae* can currently be found in over 100 locations and may number as high as 7,900 individuals. This is a significant increase from the original population estimates in 1980 of 9 occurrences and 1,340 individuals (USFWS, 2007).

Threats and Stressors

Stressor: Erosion (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Defoliation from overgrazing on San Clemente Island caused increased erosion over much of the island, especially on steep slopes where denuded soils can be quickly washed away during storm events. Erosion has been identified in the INRMP (U. S. Department of the Navy, Southwest Division 2002) as a threat to the canyon woodland habitat where *Lotus dendroideus* var. *traskiae* occurs. Although more vegetative cover is now present, erosion is still a threat to the recovery of *Lotus dendroideus* var. *traskiae*, especially in areas where it grows in proximity to roads. Except for the main artery, which is paved for 6 of its 20 miles, the island's roads are either unpaved or only partially paved. Because *Lotus dendroideus* var. *traskiae* often grows in proximity to roads, during storm events, run-off can cause scour of root systems and even complete uprooting of the plant (USFWS, 2007).

Stressor: Invasive species (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: A large number of plant taxa have colonized San Clemente Island, and several annual grasses including *Avena barbata*, *Bromus* spp. and *Vulpia myuros*, cover large portions of San Clemente Island (U. S. Department of the Navy, Southwest Division 2002). These nonnative grasses may compete with *Lotus dendroideus* var. *traskiae* for space or other resources such as light, water, and nutrients. Non-native plant species can also alter ecological processes such as nutrient cycling or the prevalence of fire (Brooks 1999) that otherwise could affect the persistence of this species. As stated above, non-native annual grasses were found associated with *Lotus dendroideus* var. *traskiae* in 69 percent of its locations in 1996 and 1997, and percent cover of these species was over 40 percent in *Lotus dendroideus* var. *traskiae* habitats. Another non-native species, *Carpobrotus edulis* (ice-plant), also appears to be hindering the recovery of *Lotus dendroideus* var. *traskiae* (Allan 1999). This invasive species occupies large areas of Wilson Cove where it may be outcompeting native species such as *Lotus dendroideus* var. *traskiae* for space, nutrients, and water (Allan 1999) (USFWS, 2007).

Stressor: Fire (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: The relationship between fire and the ecology of *Lotus dendroideus* var. *traskiae* has not been studied. Although fire may aid the dispersal of *Lotus dendroideus* var. *traskiae*

individuals (U. S. Department of the Navy, Southwest Division 2002), the most beneficial fire intervals and intensities are unknown. According to the species account provided in the INRMP, members of the genus *Lotus* “seed prolifically following fire” and “some regeneration after fire has been observed in this species” (U. S. Department of the Navy, Southwest Division 2002). Because this species is short-lived and relies on its seed bank for recruitment, fire may create openings in the vegetation where *Lotus dendroideus* var. *traskiae* seedlings can become established. However, in areas that burn on a more frequent basis the seed bank may become depleted if individuals burn before they produce seeds (USFWS, 2007).

Stressor: Military training activities (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: As the last range in the eastern Pacific Basin where many training operations are performed prior to troop deployments, portions of the island receive intensive use, especially the area known as the Shore Bombardment Area (SHOBA) (U. S. Department of the Navy, Southwest Division 2002). Because of the elevated risk of fire associated with these training activities, live and non-live munitions fire is targeted towards two delineated Impact Areas within SHOBA where training disturbances and repeated fires are concentrated. Strip burning and fire retardant are used to maintain fuel breaks around these impact areas and to limit the spread of fires. Because of the dangers associated with unexploded ordinance, however, it is not safe to implement certain measures to combat fire in and around the Impact Areas, including the use of helicopters from any altitude to make water drops. Instead, fires are controlled by back-burning and holding the fire along a road, fuel break, or other fuel treated area (U.S. Department of the Navy, Southwest Division 2002). Much of the remainder of SHOBA serves a buffer function where there is less intensive use and fire suppression can be used to protect sensitive resources, such as *Lotus dendroideus* var. *traskiae*. As of 2004, 20 occurrences and approximately 300 *Lotus dendroideus* var. *traskiae* individuals were documented in this buffer zone (Junak 2006) (USFWS, 2007).

Stressor: Access to SHOBA (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Because SHOBA is used for ship-to-shore bombardment, access to this area is often restricted for non-military personnel. Because of the frequency of training, access to SHOBA can be restricted for long periods of time, and there may only be brief intervals when biological work can be done (K. O'Connor pers. comm. 2006). This can undermine the effectiveness of invasive species control programs that often rely on treatments during a particular time in an organism's life cycle (e.g., spraying herbicide prior to seed set by invasive non-native grasses). Safety concerns relative to the presence of unexploded ordinance within SHOBA have recently prompted the Navy to review access policies (K. O'Connor pers. comm. 2006). During the winter/spring of 2005 and 2006, all access for civilian personnel was withheld for one to two months. Currently, the Navy is considering adopting a new set of policies to address access to SHOBA. It is anticipated that access to the Impact Areas will be granted only when an explosive ordinance device escort can be present (K. O'Connor pers. comm. 2006). Restricted access to certain portions of SHOBA could impair the ability of biologists to implement erosion control

measures or to detect and combat new invasive species prior to their becoming established and posing a threat to native species (USFWS, 2007).

Stressor: Hybridization with *Lotus adsurgens* var. *argenteus* (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Liston et al. (1990) offered the following three hypotheses for the paucity of hybrid individuals. First, hybrids may be selected against and/or have reduced fitness, or be sterile. If this were the case, then hybridization would not be a threat to the genetic integrity of *Lotus dendroideus* var. *traskiae*. Conversely, if the hybrids are recent in origin (within the last 20 years), and because the species are woody perennials, few hybrid individuals would be expected. If this is the correct scenario, then the genetic integrity of the largest-known (at the time of publication) population of *Lotus dendroideus* var. *traskiae* might be at risk by introgressive hybridization. Lastly, the presence of only four hybrids might be an artifact of the genetic testing method that was used. Liston et al. (1990) stated that there should be further investigation of these hypotheses before management recommendations are made. Although hybridization has only been documented at Wilson Cove, Allan (1999) states that it is “particularly disconcerting in that it may lead to a loss of genetic diversity through genetic assimilation of the smaller population (*Lotus dendroideus* var. *traskiae*) by the larger one (*Lotus adsurgens* var. *argenteus*).” Alternately, genetic diversity of *Lotus dendroideus* var. *traskiae* could be reduced due to outbreeding depression in that the hybrids may have reduced fitness (USFWS, 2007).

Recovery

Reclassification Criteria:

Not available

Delisting Criteria:

When sufficient habitat has been restored on San Clemente Island to support viable, self-sustaining populations and when management and use of habitat is such that survivability of the populations is assured. Quantitative goals on San Clemente, Santa Barbara, and San Nicolas Islands will be determined when additional information, as outlined in the plan, becomes available (USFWS, 1984).

Recovery Actions:

- Protect existing populations by removal of feral animals and by fencing and signing; protect restored/rehabilitated habitat by erosion control, prevent the introduction of additional feral animals, remove existing feral animals (USFWS, 1984).

Conservation Measures and Best Management Practices:

- Develop a systematic survey protocol for *Acemispom dendroideus* var. *traskiae* on San Clemente Island. These surveys should include confirmation of existing locations at greater regularity to better determine accurate population status and trend for the species. Additionally, these protocols should include the standardization of information collected such as habitat conditions, habitat type, number of plants, date collected, etc. (USFWS, 2012).
- Conduct studies to investigate hybridization of *Acemispom dendroideus* var. *traskiae* with related species and the extent of this hybridization on island (USFWS, 2012).

- Conduct studies to determine the fire tolerance and preferred fire regime of *Acmispon dendroideus* var. *traskiae* (USFWS, 2012).
- Work with the Navy to better estimate fire frequency in areas occupied by *A. d.* var. *traskiae* on San Clemente Island (USFWS, 2012).

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SPECIES ACCOUNT: *Aconitum noveboracense* (Northern wild monkshood)

Species Taxonomic and Listing Information

Listing Status: Threatened; 05/27/1978; Great Lakes-Big Rivers Region (R3) (USFWS, 2016)

Physical Description

Species of the genus *Aconitum* have showy, zygomorphic flowers that are adapted for pollination by bumblebees, and it is from this hood-shaped flower that the genus derives its common name. Besides the diagnostic flower shape, monkshoods in general are perennial herbs arising from short tuberous roots, with basal and cauline leaves that are palmately cleft or dissected, and with usually blue to whitish flowers that are borne in a terminal raceme or panicle. (USFWS, 1983). The northern wild monkshood is an erect to reclining or climbing perennial herb with stems up to 2.5 m long. Small clusters of pale to dark blue or white flowers bloom in July and August. (NatureServe, 2015)

Taxonomy

The genus *Aconitum*, known generally worldwide as monkshood, is a highly specialized and widely distributed group of species in the Ranunculaceae, the crowfoot or buttercup family. *Aconitum noveboracense* was described as a species by Harvard botanist Asa Gray in 1886 from material collected by F. V. Coville in Chenango County, New York. Early collections of northern monkshood from native habitats before and after 1886 in New York, Ohio, Wisconsin and Iowa were often mis-identified as *Aconitum napellus* L. (the common European monkshood) or *Aconitum uncinatum* L. (the mainly Appalachian species ranging as far north as southern Pennsylvania). (USFWS, 1983)

Historical Range

This species ranges over nearly half the continent, from northeastern Iowa and southwestern Wisconsin to northeastern Ohio and the Catskill Mountains of New York. (USFWS, 1983)

Current Range

This species is restricted to 20 currently extant sites in three distinct regions: in and adjacent to the unglaciated (Wisconsin epoch) portion of Iowa and Wisconsin, the northeastern Ohio glaciated area and the Catskill Mountains of New York (glaciated area). (USFWS, 1983)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual and vegetative (NatureServe, 2015)

Breeding Season

Adult: Flowers from June until August (NatureServe, 2015)

Reproduction Narrative

Adult: The showy, zygomorphic flowers are adapted for pollination by bumblebees; seeds are probably dispersed by water. In sexual reproduction, the northern monkshood produces flowers from June until August and produces 30-45 seeds from each flower. In vegetative reproduction, 'daughter' ramets or stems can grow out of parent tubers and this is the main form of vegetative reproduction; bulbils may be formed in some populations at the leaf axes. These bulbils can produce tubers and apical meristems. This species over winters as a tuber (Mabry et al. 2009). (NatureServe, 2015)

Habitat Type

Adult: Algific talus slopes (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Bare rock cliff bases (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Moist cold air flow (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (inferred from USFWS, 1978)

Environmental Specificity

Adult: Very narrow; key requirements scarce. (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: This species occurs in a unique habitat, algific talus slopes, which is characterized by north-facing, carbonate talus slopes where cold air and moisture pours out of ice filled caves. These caves maintain a below freezing temperature throughout the year and yield surrounding soil temperatures of 15C or less (Nekola 1999). It occurs in shaded or partially shaded cliffs and talus slopes in Ohio, Iowa, and Wisconsin, and at high-elevation headwaters and in crevices along streams in New York. There seems to be no rock substrate favored by the species overall. The most significant common habitat factor appears to be the cold soil environment associated with these cliff, talus slope, and spring/headwater stream situations. In most of the habitats occupied by northern wild monkshood there is either active and continuous cold air drainage or cold ground water flowage out of the nearby bedrock. The year-round soil temperatures average from 11 to 18 degrees Celsius. Local distribution of the species is also closely associated with areas where ground water or subterranean air is emanating, which contributes to a local microclimate with high relative humidity. (NatureServe, 2015)

Dispersal/Migration

Dispersal

Adult: Low (inferred from NatureServe, 2015)

Dispersal/Migration Narrative

Adult: Dispersal of the species is very limited by lack of environments with cold flowing air. (NatureServe, 2015)

Population Information and Trends**Population Trends:**

Variable (NatureServe, 2015)

Species Trends:

Variable to declining (NatureServe, 2015)

Population Growth Rate:

Variable, but generally slow (inferred from NatureServe, 2015)

Number of Populations:

81 - 300 (NatureServe, 2015)

Population Size:

2500 - 10,000 individuals (NatureServe, 2015)

Adaptability:

Very sensitive to disturbance (NatureServe, 2015)

Population Narrative:

The monkshood is very sensitive to disturbance, generally slow-growing and not very viable when transplanted. The largest populations are found in Iowa (one population is estimated at 10,000 individuals); population sizes are smaller in Wisconsin, ranging from 65 to 1,000 individuals; two small populations (ca. 100 individuals) are found in Ohio; in New York population sizes range from < 10 to ca. 1,000 individuals. (Hanowski, 1983 (updated 1986)). There are 84 sites known in Iowa, 19 in Wisconsin, 3 in Ohio and 11 in New York. There may only be two sites of this species left in Ohio. In 2006 the habitat of one of the sites was dramatically altered and only one plant was found, this being a large decline from the nearly 100 plants found at this site in the late 1980s (Ohio Natural Heritage Program 2007). The species may decline in one year and recover in another year, probably as related to drought. (NatureServe, 2015)

Threats and Stressors

Stressor: Dams and reservoirs (USFWS, 1983)

Exposure:

Response:

Consequence:

Narrative: The proximity of monkshood cliffs to water courses has sometimes put monkshood close to dams and their resultant reservoirs. In certain cases, the pre-existing condition of the reservoir basin as monkshood habitat is not known, so it is speculative to guess whether the reservoir did in fact inundate monkshood. However, the occurrence of reservoirs downstream from monkshood habitats does curtail seed dispersal via flowing water. Such is the case in one New York habitat (Peekamoose), and was historically the case in two Wisconsin sites (Loddes Mill Bluff and Parfreys Glen) where mill ponds (now defunct) may have impacted the monkshood population nearby. (USFWS, 1983)

Stressor: Road and powerline construction and maintenance (USFWS, 1983)

Exposure:

Response:

Consequence:

Narrative: On a number of occasions, road construction and maintenance activities have been implicated in threatening northern monkshood populations. Excessive use of deicing agents in winter and herbicides in summer are potential problems for one site in Iowa (Elkader), one site in New York (Peekamoose), and possibly one site in Ohio (Akron). Road construction impacts on a small northern monkshood population were avoided during a state highway upgrading in 1978-79 near Elkader, Iowa. By a short narrowing of the paved shoulder in a road-cut containing this species, the rather anomalous habitat was spared. The only other northern monkshood population which may be affected by existing road maintenance activities is at the Peekamoose, New York, site where the roadside ravine habitat has been infringed upon in places by the placement of riprap in the right-of-way to stabilize the roadbed. Unless this practice is continued in other places along the stream and right-of-way, the habitat damage has been done already and no further infringement is expected. - Iowa, has been crossed by two power line corridors which have destroyed habitat by clearing and maintenance activities. The main threat from in-place corridors is further habitat degradation from maintenance activities, especially herbicide drift from aerially dispersed weed retardants. (USFWS, 1983)

Stressor: Logging operations (Read and Hale, 1983)

Exposure:

Response:

Consequence:

Narrative: All northern monkshood habitats are in wooded situations, and some of these sites may be subject to periodic logging operations. Destruction of the habitat may not be due only to logging machinery and skidding of logs, but also to modification of requisite light conditions caused by the removal of shade trees. Logging is difficult to accomplish in certain habitats due to steepness of slopes and inaccessibility, but woodland spring and streamside populations in New York's Catskill Mountains have been subject to logging in the past. Recent logging of canopy trees on one slope of the Chase Creek, Wisconsin, site has skirted the edge of the algal slope containing a major monkshood population. Certain habitats in Iowa and Wisconsin are subject not only to logging for commercial harvest, but they may be cleared of trees by girdling, cutting, and burning to create pasture on the otherwise non-productive farmland. (USFWS, 1983)

Stressor: Quarrying operations (USFWS, 1983)

Exposure:

Response:

Consequence:

Narrative: The association of northern monkshood with cliffs and talus slopes sometimes makes the species susceptible to damage from quarrying. Such has been the case in the past at the Loddes Mill Bluff (Wisconsin) and Elkader (Iowa) locations. It is difficult to assess how much of the original populations were affected by the quarrying (if any), but their close proximity to the quarries indicates that there may have been impacts. (USFWS, 1983)

Stressor: Grazing and browsing (USFWS, 1983)

Exposure:

Response:

Consequence:

Narrative: Browsing by a number of animals, most commonly cattle and white-tailed deer, has been a problem at a number of sites, most notably at the Maquoketa and Pine Creek (Iowa) locations (accessible to cattle), Coon Valley and Chase Creek (Wisconsin) populations (cattle grazing), and the Akron (Ohio) site (white-tailed deer browsing). Before Federal acquisition, much of the Kickapoo River Valley (Wisconsin) population was accessible to cattle grazing. The major threats to a northern monkshood population caused by grazing animals are weakening of the plants by loss of their photosynthetic organs, loss of reproductive potential when flowers or fruits are consumed, and trampling of the plants, especially when grazing animals are at high density and the site is used as a pathway, resting place, or wallow. (USFWS, 1983)

Stressor: Developments (USFWS, 1983)

Exposure:

Response:

Consequence:

Narrative: Two types of developments have been noted to affect existing northern monkshood populations. Foot trail developments have affected or have the potential for affecting populations at Parfreys Glen (Wisconsin) and Beaverbrook (New York). At the former site, over 10,000 visitors pass through the scenic glen each year, creating a muddy path at the base of the cliff where northern monkshood occurs. No northern monkshood reproduction can be expected to take place at the cliff base due to the amount of foot traffic. At the Beaverbrook, New York, site a state trail crosses within a few meters of the monkshood population, and should this trail be redirected or expanded from its present course, a portion of the population could be adversely affected. Low density foot traffic occurs at the base of other cliffs containing northern monkshood (Bixby Park, Iowa; Nelson, Ohio; Akron, Ohio; Loddes Mill Bluff, Wisconsin; some of the Kickapoo, Wisconsin cliffs) but the level of traffic on these volunteer trails does not pose a threat to the species presently. The other type of development having negative impact implications for northern monkshood is residential and urban development. Since most of the known populations of the species are in rural locations, urban/residential development poses a problem in only a few cases. The Akron, Ohio, site is in an urban setting and the small Nelson, Ohio, population is within a few hundred meters of suburban houses. It is reported, too, that the Chenango County, New York, site(s) is in a developed area, a factor which may have contributed to its presumed extirpation. While such developments may not be directly placed on northern monkshood locations, the probability of various harmful activities increases with increased human presence, be it higher coincidental visitation, vandalism, or accidents. Also, higher land costs, taxes, and complex ownership patterns make preservation more difficult to accomplish in suburban and urban environments. (USFWS, 1983)

Stressor: Scientific overcollection and visitation (USFWS, 1983)

Exposure:**Response:****Consequence:**

Narrative: Over the course of several generations, scientific curiosity about a rare species may contribute to its demise, caused by too many people visiting the site (sometimes resulting in habitat degradation) and overcollecting (resulting in population depletion). This problem is suggested in the case of northern monkshood by the collection of plants from the small Parfreys Glen (Wisconsin) population on at least nine independent occasions in less than 45 years. Collectors often gather more than one plant so that duplicates can be distributed to the herbarium collections at various institutions. Together with collections housed in herbaria not seen in the preparation of this recovery report, total scientific collections from the Parfreys Glen site may account for a significant portion of the population remaining today in the glen. Scientific collecting was also mentioned as a threat to the Akron, Ohio, population by its property manager. He cited the time a few years ago when he led a professional botanist to the site, only to have him collect 25 specimens for comparative intra-population variation studies back in his lab. The property manager is now very wary of leading other biologists to the site. The high scientific and public interest in endangered and threatened species also poses a threat to the species' welfare in some instances. With even a small number of visitations to certain northern monkshood sites each year, trampling of plants and surrounding vegetation, compaction of soil, and destruction of vulnerable spring seeps can become a problem. This has been true with habitats visited periodically in the course of these studies, and foot damage to a steep-slope habitat was noted at one other northern monkshood site in Iowa where the ecology of another rare cliff plant was being studied. The small number of northern monkshood populations, the fragile nature of many of their habitats, and the large number of people who would like to study, collect, photograph, or simply observe this rare plant make it susceptible to being "loved to death." (USFWS, 1983)

Stressor: Natural catastrophes (USFWS, 1983)

Exposure:**Response:****Consequence:**

Narrative: There are a number of natural events and factors which can adversely affect a population of monkshood. Such factors which were observed over the last six years with northern monkshood are drought, flooding, cliff failure, disease, and predation. With the exception of cliff failure, northern monkshood populations seem to be able to rebound from these events, with only limited mortality or more often only a weakening or death of the present year's growth. Unless a particular monkshood population is subjected to a single or combination of damaging events over a sustained period of years, it is unlikely that any northern monkshood population will be lost due to the natural catastrophes to which the species was subjected periodically in its evolution. Failure of the cliff face on which or over which the northern monkshood occurs is the one natural event which could almost totally eliminate a known population. All but three plants at the Nelson, Ohio, site are located in a small patch no larger than nine square feet in area, and are located at the base of a slightly overhanging cliff. Nearby, cliff failure has taken place, resulting in a rubble pile at the base of the cliff. Should failure occur in the cliff face above this small monkshood population, it would probably be lost. (USFWS, 1983)

Stressor: Invasive plants (NatureServe, 2015)

Exposure:

Response:**Consequence:**

Narrative: Garlic mustard (*Alliaria petiolate*), and invasive plant, may invade and outcompete the monkshood. (NatureServe, 2015)

Recovery**Reclassification Criteria:**

Not applicable.

Delisting Criteria:

Not defined. (USFWS, 1983)

Recovery Actions:

- Secure some level of protection for all known habitats. This may be accomplished by a variety of means, such as fee acquisition, easement, preserve designation, or simple landowner contact. The lead agency and type of preferable protective measure must be considered for site-by-site conditions, such as degree of threat, ability for adequate management by acquiring agency, need for controlled access, etc. (USFWS, 1983)
- Continue research on the propagation of northern monkshood under greenhouse and garden conditions. The goal of this research should be the production under controlled conditions of northern monkshood from seed to the survival of first generation plants through seed production. This would supply a demand for seed by horticulturists and the establishment of experimental colonies on which to develop management techniques, and enhance life history knowledge. (USFWS, 1983)
- Taxonomic studies are needed to solve the dispute over the specific validity of *noveboracense*. (USFWS, 1983)
- Conduct life history research on northern monkshood in native habitats to determine such factors as breeding (pollination) systems, dispersal mechanisms, predation, juvenile mortality, adult longevity, and habitat requisites. (USFWS, 1983)
- Initiate northern monkshood population monitoring effort in each state, with the goal of an early warning system to indicate population declines, threats, and land use or ownership changes. (USFWS, 1983)
- Resolve La Farge Reservoir Flood Control Project issue in Wisconsin. The completion of this flood control project along the Kickapoo River, in any one of its several alternatives, poses the single largest threat to northern monkshood numbers anywhere. The project was halted in 1977 due to the projection of poor water quality in its conservation reservoir, lack of flood control for an adequate distance downstream, and impacts to the scenic valley and its biota. Despite these problems, the projects may be reactivated unless it is deauthorized by Congress. It would be prudent to have the issue of the La Farge Reservoir resolved. (USFWS, 1983)
- Revise New York Endangered Species Law to include protection of northern monkshood. (USFWS, 1983)
- Complete field surveys for additional northern monkshood habitats. It is probable that all northern monkshood locations have not yet been found. State surveys to search for additional northern Monkshood populations should be initiated or completed. Exhaustive searches should also be made of old, as yet unverified sites. (USFWS, 1983)

- Pursue acquisition of properties that are found to be available on a willing-seller basis. The goal of this activity is to prepare an acquisition plan for all properties found to be available as a result of landowner contacts. (USFWS, 1983)
- Pursue land-use zoning and/or nature preserve designation where appropriate to the enhancement of habitat protection. The goal of this task is an analysis of zoning or designation categories that would be compatible with a particular population's preservation. Evaluation of zoning should be especially stressed on state, city and federal properties where master planning can often put sensitive areas into protective categories without divulging the identity of the specific resource being protected. (USFWS, 1983)
- Initiate an educational effort with the scientific community, requesting their cooperation in not collecting or conducting student field trips at northern monkshood populations. The goal of this activity is to heighten the scientific community's awareness of the damaging results of overcollecting and trampling, and how they can participate in recovery activities. (USFWS, 1983)
- Implement most important management activities. (USFWS, 1983)
- Conduct a research program to develop tissue culture techniques for the propagation of northern monkshood. This activity is not recommended at this time because northern monkshood population levels are not critically low enough to warrant such research. The creation of genetic clones is not conducive to maintenance of genetic diversity now existing in out-crossing, native populations. Research aimed at growth of northern monkshood through seeds--which most plants produce copious numbers-- should have a higher research priority, however, if population size drops to a critical level tissue culture would be the last chance for survival. (USFWS, 1983)
- Strengthening protection laws for plant species at the state and federal level. It may be argued that legislative protection for endangered species has reached a plateau, based on several years of experience with existing laws. Constitutional restraints, regularity backlash, and enforcement limitations may have determined the limits of further legislative initiatives toward protection of endangered and threatened plants. The present level of recognition of endangered resource conservation may be adequate to be effective for plants in most cases. The one exception for the need of further legislation is in the state of New York, where northern monkshood (as well as other biologically endangered and threatened state species) should be added to the statutorily protected list of plants. (USFWS, 1983)

Conservation Measures and Best Management Practices:

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References

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Fort Snelling, MN. 81 pp. https://ecos.fws.gov/docs/recovery_plan/830923.pdf

USFWS. 1978. Determination that 11 Plant Taxa are Endangered Species and 2 Plant Taxa are Threatened Species

Final Rule. 43 FR 17910 - 17916 (April 26, 1978).

SPECIES ACCOUNT: *Aeschynomene virginica* (Sensitive joint-vetch)

Species Taxonomic and Listing Information

Commonly-used Acronym: SJV

Listing Status: Threatened; 5/20/1992; Northeast Region (R5) (USFWS, 2016)

Physical Description

A robust annual legume that typically attains a height of 1.0-2.0 m in a single growing season, although it may grow as tall as 2.4 m. The stems are single, sometimes branching near the top, with stiff or bristly hairs. The leaves are even-pinnate, 2.0-12.0 cm long, with entire, gland-dotted leaflets. Each leaf consists of 30-56 leaflets. Leaflets are 0.8-2.5 cm long and 0.2-0.4 cm wide. The leaves fold slightly when touched. Pedicels are 3.0-8.0 mm long, bearing toothed bractlets about 4.0 mm long and 2.0-3.0 mm wide immediately below the flowers. The yellow, irregular, legume-type flowers are 1.0-1.5 cm across, streaked with red, and grow in racemes 2.0-6.0 cm long. The flowers have uniformly shaped anthers. The fruit is a loment with 4-10 one-seeded segments, the lowest 5.0-7.0 mm wide, turning dark brown when ripe. Fruits are 3.0-7.0 cm long, on a stipe 10.0-25.0 mm in length, and shallowly scalloped along one side (USFWS, 1995).

Taxonomy

In the pea family, Fabaceae (USFWS, 1995)

Historical Range

Tidal marshes of New Jersey, Pennsylvania, Delaware, Maryland, and Virginia, and ditches and agricultural fields in North Carolina (USFWS, 2013).

Current Range

Current range includes New Jersey, Maryland, Virginia, North Carolina. Delaware and Pennsylvania occurrences have not been observed since the 1800s (USFWS, 2013).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect (EPA, 2016)

Breeding Season

Adult: Germination begins late May to early June; flowers from July to September; fruits are produced simultaneously from July to late October (NatureServe, 2015).

Key Resources Needed for Breeding

Adult: Small bumblebees, some self-pollination (EPA, 2016)

Reproduction Narrative

Adult: Germination begins late May - early June. Plants begin flowering in July, continuing through September; fruits are produced simultaneously from July to late October. Limited pollinator observations of the small bumblebees have been made on the plants. Establishment of seedlings may be restricted by deposition of flotsam on the river bank and dense stands of perennial species such as *Peltandra virginica* and *Pontederia cordata*. However, most of the *Aeschynomene* zone is composed of annual species which die back, presumably leaving many available germination sites. Plants have been known from a site in NJ for at least 9 years, so as long as conditions remain the same, the species seems to maintain itself adequately (NatureServe, 2015). Some self-pollination is possible (EPA, 2016).

Habitat Type

Adult: Wetland (EPA, 2016)

Habitat Vegetation or Surface Water Classification

Adult: Fresh to slightly brackish tidal river shores and estuarine-river marsh borders (NatureServe, 2015)

Habitat Narrative

Adult: Majority are found in natural tidal marsh habitats, but also a few documented cases of a pocket marsh wetland, edge of a moist soybean field, and a mowed grassy strip between a manmade drainage channel and dirt road (EPA, 2016). Usually grows within 2 m of low water mark on raised banks in peaty, sandy or gravelly substrates. Salinity of one site in New Jersey ranges from 0.7 to 0.8 ppt with an average pH of 4.4. In North Carolina, *A. virginica* has been found in a few ditches and wet fields, but these are not considered stable populations. Associated species include *Zizania aquatica*, *Peltandra virginica*, *Pontederia cordata*, *Bidens laevis*, *Polygonum arifolium*, *P. sagittatum*, and *Leersia oryzoides* (NatureServe, 2015).

Dispersal/Migration**Motility/Mobility**

Adult: Abiotic (EPA, 2016)

Dispersal/Migration Narrative

Adult: Abiotic dispersal, possibly floating on water (EPA, 2016). Fruits disseminate as individual articles and have been observed to float; length of floatability is unknown. Plants consistently reappear (observed in NJ & MD) in the same place indicating limited dispersal, or at least some seed remaining in place as a seed bank (NatureServe, 2015).

Population Information and Trends**Population Trends:**

Decline of 50-70% (NatureServe, 2015)

Species Trends:

Decline of 10-30% (NatureServe, 2015)

Resiliency:

Medium (inferred from NatureServe, 2015)

Representation:

Medium (inferred from NatureServe, 2015)

Redundancy:

Medium (inferred from NatureServe, 2015)

Number of Populations:

Approximately 20 (NatureServe, 2015)

Population Size:

Approximately 7000 individuals (NatureServe, 2015)

Adaptability:

Sensitive to water pollution and marsh drainage; difficulty in controlling headwater pollution (NatureServe, 2015)

Population Narrative:

Species shows considerable annual fluctuations in population numbers. Over 3 years one population varied from approximately 50 to 2,000 individuals. Long-term trend is a decline of 50-70%; short-term trend is a decline of 10 - 30%. Many populations are no longer extant, or have not been relocated recently. New Jersey: 2,000 +/- 50; Maryland: several hundred individuals; Virginia: ca. 5,000 plants; North Carolina; all populations unstable in ditches. About twenty recently documented occurrences. New Jersey: 2 occurrences; Maryland: 5 occurrences; Virginia: 12 occurrences; North Carolina: 1 marginal occurrence (NatureServe, 2015).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 1995)

Exposure:

Response:

Consequence:

Narrative: *Aeschynomene virginica* is susceptible to population and habitat destruction or degradation from a wide variety of anthropogenic sources, including: sedimentation, competition from exotic plant species, dams, dredging and filling activities, boating activities, shoreline stabilization and structural development, road and bridge construction, commercial and residential development, water withdrawal projects, changes in water quality, agricultural practices, introduced pest species, mining, timber harvest, over-visitation to sensitive joint-vetch sites, declines in muskrat populations, sea level changes (possibly in conjunction with natural cycles), plant collection (USFWS, 1995).

Stressor: Natural disturbances (USFWS, 1995)

Exposure:

Response:

Consequence:

Narrative: Natural threats are often identified with disturbances, such as wave and ice action associated with severe storm events, competition, channel migration, sea level rise, and natural sedimentation processes. Healthy metapopulations of the sensitive joint-vetch are adapted to these stresses, and in some cases dependent upon them over time. Certain subpopulations may be locally extirpated, but others are able to establish and reproduce in newly opened habitat patches if seed viability and mobility are good and the frequency of disturbance events allows for biotic responses. Small populations are more vulnerable to these stresses than larger populations, especially if the disturbance event occurs during the growing season and plants are unable to compensate for high mortality rates within a particular year class. Severe hurricanes along the mid-Atlantic coast have the potential to temporarily or permanently destroy *A. virginica* habitat (USFWS, 1995).

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

1. The sensitive joint-vetch and the ecosystems upon which it depends are adequately protected within the following six watersheds: Manokin Creek in Maryland; Manumuskin River in New Jersey; and Rappahannock, Pamunkey, Mattaponi, and Chickahominy Rivers in Virginia (USFWS, 1995).
2. Annual monitoring over a 10-year period shows that the populations in these six river systems are stable or expanding (USFWS, 1995).
3. Life history and ecological requirements of the species are understood sufficiently to allow for effective protection, monitoring, and, as needed, management (USFWS, 1995).

Recovery Actions:

- Maintain the integrity of the tidal wetland systems upon which the sensitive joint-vetch depends (USFWS, 1995)
- Protect extant sensitive joint-vetch populations and sites (USFWS, 1995).
- Survey for additional populations (USFWS, 1995).
- Establish monitoring priorities, develop reliable monitoring techniques, and monitor populations accordingly (USFWS, 1995).
- Determine the ecological and distributional characteristics and requirements of the sensitive joint-vetch (USFWS, 1995).
- Develop an informational brochure on the importance of the sensitive joint-vetch and the tidal wetlands upon which it depends (USFWS, 1995).

Conservation Measures and Best Management Practices:

- More consistent monitoring of all of the Virginia occurrences is needed to confirm the population trends in the portion of its range that has the greatest number of extant occurrences/subpopulations. This monitoring can also serve to detect current threats and identify areas where management actions such as *Phragmites* control may be needed in Virginia (USFWS, 2013).

- A review of the monitoring methodologies being used across the range of this species should be conducted with the purpose of increasing standardization. Monitoring protocols likely vary across the species range. Although long-standing monitoring programs may not want to abandon established methodology for fear of making their year-to-year data less comparable, a review could highlight where changes might be made and lead to increased standardization and therefore more comparable data rangewide (USFWS, 2013).
- Conduct genetic research to ensure that seeds representing the genetic diversity of SJV are in the collection of the National Center for Genetic Resources Preservation (Formerly National Seed Storage Laboratory) in Fort Collins, Colorado (USFWS, 2013).
- Investigations should continue into the effects of invasive plants such as *Murdannia keisak* and the introduced insect species, tobacco budworm (*Heliothis virescens*) and corn earworm (*Helicoverpa zea*) on SJV (USFWS, 2013).
- The role of muskrats in creating and maintaining SJV habitat needs to be investigated (USFWS, 2013).
- Consideration should be given to what role proactive measures such as habitat management, seed additions, and introductions in upstream habitat should play in a long term management strategy for SJV in light of dwindling populations in parts of its range, the serious threat from sea level rise, and questions about the ability of this species to migrate to upstream habitat. Recent publications mention the use of vegetation management and seed additions for the conservation and management of SJV or recommend directing research efforts to introducing the species into new upstream sites. Guidelines should be developed in case more aggressive management strategies are warranted (USFWS, 2013).
- Surveys should be conducted in potential habitat throughout the range of the species (USFWS, 2013).
- Revise the recovery plan to update information and to consider the incorporation of the James River Basin in the Recovery Criteria (USFWS, 2013).

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SPECIES ACCOUNT: *Agalinis acuta* (Sandplain gerardia)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/7/1988; Northeast Region (R5) (USFWS, 2016)

Physical Description

The sandplain gerardia is an annual light-green herb from 4 to 8 inches (1 to 2 decimeters) and occasionally up to 16 inches (four decimeters) tall. The stem is weakly angular and has few branches. The leaves are opposite, linear, and up to 1 inch (2.5 centimeters) long. The pink-purple, bell-shaped flowers appear from late August through September, are 0.4—0.5 inches (1 to 1.3 centimeters) long, and have two yellow lines and red or purple spots in the corolla throat. The corolla lobes are slightly notched at the tip. (USFWS, 1988)

Taxonomy

The sandplain gerardia is in the snapdragon family (Scrophulariaceae). (USFWS, 1988) In a 2019 document, the Service summarized more than 10 years of research and associated discourse regarding the phylogenetic studies that inform the Service's consideration of the taxonomic status of *A. acuta*. Based on a detailed review of all the available scientific and commercial information, it was concluded that "the taxonomic entity known as *A. acuta* is not a distinct species (Neel and Pettengill 2009; Pettengill 2010; Pettengill and Neel 2011; Hays pers. comm. 2018a, 2018b). The Service therefore concurs with the taxonomic revision recommended by Pettengill and Neel (2011) and the FNA synonymizing *A. acuta* under *A. decemloba*." (USFWS, 2019)

Historical Range

See current range/distribution.

Current Range

In 2017, known populations were present in the states of Connecticut, Rhode Island, Massachusetts, Maryland, and New York. (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect (EPA, 2016)

Lifespan

Adult: < 1 year (inferred from USFWS, 1989)

Dependency on Other Individuals or Species

Adult: Insects for pollination (EPA, 2016)

Breeding Season

Adult: Flowers from mid-August to mid-October (USFWS, 1989)

Reproduction Narrative

Adult: Flowers from mid-August to mid-October; insect-pollinated. Life span is less than 1 year (USFWS, 1989; EPA, 2016).

Habitat Type

Adult: Terrestrial (USFWS, 1989)

Habitat Vegetation or Surface Water Classification

Adult: Dry, sandy, poor-nutrient soils of sparsely vegetated sandplain environments and serpentine barrens (USFWS, 1989)

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Habitat Narrative

Adult: This species typically occurs on dry, sandy, poor-nutrient soils of sparsely vegetated sandplain environments and serpentine barrens, whose harshness may eliminate potentially competitive species (USFWS, 1989). It is dependent on periodic disturbance that maintains an open habitat. The soils are nutrient-poor, usually acidic, and excessively drained. An underlying factor common to all sites is the lack of competition from other species - a factor imposed by conditions that include extremely nutrient-poor, and sometimes minerally toxic, soils and regular or sporadic disturbance. Fire has played a role in maintaining open habitat at a number of *Agalinis acuta* sites (NatureServe, 2015).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Dispersal is possibly by wind or small animals (USFWS, 1989). If wind dispersed, seeds are not likely to travel far. Some dispersal may occur through ingestion by small animals such as meadow voles or cottontail rabbits (NatureServe, 2015).

Population Information and Trends**Population Trends:**

Not available.

Species Trends:

Increase of > 10% (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

22 - 23 (NatureServe, 2015)

Population Size:

100,000 - 1,000,000 individuals (NatureServe, 2015)

Population Narrative:

While there are about 6 sites with reasonably large, stable, well managed populations, few have good viability/integrity. "Large" represents a population that has maintained an average of 3000+ individuals over the past 5 years. Many populations are still very small or occur on marginal habitat such as small expanses of grassland surrounded by development or unsuitably dense vegetation (NatureServe, 2015).

Threats and Stressors

Stressor: Habitat destruction or modification, or absence of disturbance within habitat (USFWS, 1989)

Exposure:

Response:

Consequence:

Narrative: The most significant threat to *A. acuta* is the direct loss or degradation of its habitat. Residential, commercial, and recreational development has encroached on the species community. Shopping malls, condominiums and expanding highway systems have taken the place of much of the species natural habitat. Agricultural development and sand and gravel mining have destroyed large amounts of potential habitat (USFWS, 1989). The loss of grazing animals and the suppression of fires have allowed woody vegetation to claim many of its historical sites (NatureServe, 2015).

Stressor: Other factors with the potential to affect the species (USFWS, 1989)

Exposure:

Response:

Consequence:

Narrative: Due to the relatively small population size of extant occurrences, It is likely that other factors may have the potential to affect the species. Natural disasters, reproductive failures and other influences on growth, reproduction and distribution have the potential to eliminate a site, if the effects are dramatic enough to prevent the plants from fully recovering (USFWS, 1989).

Recovery**Reclassification Criteria:**

1. There are 20 stable, wild populations located throughout the species historic range to ensure against any unpredictable events that could lead to reproductive failure and subsequent population decline. In order to be deemed "stable," a population must maintain a 5-year running geometric average population size of at least 100 individuals. The geometric average is

considered a better indicator of the stability of a population that exhibits wide year-to-year size fluctuations than is the arithmetic average (USFWS, 1989).

2. At least 15 of these populations are located on protected sites. Protection may be accomplished through: 1) ownership by government agency or a private organization that considers maintenance of the *A. acuta* population to be the predominating management objective for the site; or, 2) a deeded easement or covenant that effectively commits present and future landowners to implementing any management activities needed to perpetuate the population. This high level of landowner commitment to site protection is necessary because of the species apparent need for active habitat manipulation to counteract the effects of removing natural sources of disturbance from the plants environment (USFWS, 1989).

3. There must be a proven technology for: 1) propagating the species in a cultivated setting; or, 2) storing seed in a seed bank and successfully sowing then on a wild site (USFWS, 1989).

Delisting Criteria:

Not available.

Recovery Actions:

- Protect known populations (USFWS, 1989).
- Investigate species and habitat characteristics necessary to maintain and establish populations throughout the range of the species (USFWS, 1989).
- Formulate and implement measures to maintain existing sites and locate, establish and maintain new sites (USFWS, 1989).
- Develop technology for cultivating plants and provide for long-term seed storage (USFWS, 1989).
- Periodically review progress towards species recovery and modify elements as appropriate (USFWS, 1989).

Conservation Measures and Best Management Practices:

- Not available.

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SPECIES ACCOUNT: *Alectryon macrococcus* (Mahoe)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/15/1992; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Alectryon macrococcus is a tree in the soapberry family (Sapindaceae) consisting of two varieties, *macrococcus* and *auwahiensis*. Both reach heights of 3-11 m (10-36 ft), with reddish-brown branches and net-veined paper- or leather-like leaves 20-55 cm (8-22 in) long, with one to five pairs of sometimes asymmetrical egg-shaped leaflets 10-28 cm (4-11 in) long by 4-12 cm (1.6-4.7 in) wide. The upper surface of the leaf is glossy and smooth. The underside of the leaf has dense brown hairs, only when young in *Alectryon macrococcus* var. *macrococcus*, and whether young or mature (persistent) in *Alectryon macrococcus* var. *auwahiensis* (Linney 1987). Flower clusters up to 30 cm (12 in) long consist of cup-shaped, small flowers 1.5-2.5 mm (0.06-0.1 in) long with unequal lobes on short, individual stalks. The flowers have no petals and sometimes lack female parts. Fruits consist of one or two nearly spherical parts, the second of two often abortive; the inside of the seed coat is irregularly scarlet. The hard seeds are 5-10 mm (0.2-0.4 in) long and glossypale brown with irregular projections, and have a smooth, scarlet fleshy coating with an irregular sinus on one side. (USFWS, 1997)

Taxonomy

Alectryon macrococcus was described by L. Radlkofer (1890) based on Hillebrand's specimens and the information in Hillebrand (1888). St. John and Frederick (1949) described *Alectryon mahoe* for Oahu specimens based on leaf shape, pubescence on lower leaflet surfaces, and details of flower structure. Linney (1987) included the Oahu population with *Alectryon macrococcus* var. *macrococcus* but recognized East Maui plants as a new variety, var. *auwahiensis*, based on the persistent pubescence on lower leaflet surfaces. This treatment of a single Hawaiian species with two varieties, var. *macrococcus* and var. *auwahiensis*, was adopted by Wagner et al. (1990). The specific epithet *macrococcus* has been used by some botanists (St. John and Frederick 1949; St. John 1973) in accordance with Gaertner's original neuter designation of the genus; however, Radlkofer's (1890) revision of the genus treated the genus as masculine and renamed all existing specific epithets to agree with the masculine gender at that time. (USFWS, 1997)

Current Range

Alectryon is endemic to the Hawaiian Islands, with two recognized varieties, var. *macrococcus* and var. *auwahiensis*. *Alectryon macrococcus* var. *macrococcus* is known from a number of sites on Kauai, Oahu, Molokai, and West Maui, while *A. macrococcus* var. *auwahiensis* is only known from East Maui. (USFWS, 2010)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On June 17, 2003 (Revised September 18, 2012), the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Alectryon macrococcus* (Mahoe) under the Endangered Species

Act of 1973, as amended (Act). The critical habitat designation includes 12 critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

On September 18, 2012, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Alectryon macrococcus* (Mahoe) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 15 critical habitat units (CHUs), in Hawaii (77 FR 57648-57862).

On February 27, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Alectryon macrococcus* (Mahoe) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in Hawaii (68 FR 9116-9479).

Critical Habitat Designation

The critical habitat designation for *Alectryon macrococcus* var. *auwahiensis* and var. *macrococcus* includes 12 CHUs in Maui County (81 FR 17790-18110).

Molokai—Lowland Mesic—Unit 1 (and) *Palmeria dolei*—Unit 37—Lowland Mesic (and) *Pseudonestor xanthophrys*—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Ctenitis squamigera*, *Cyanea dunbariae*, *C. mannii*, *C. profuga*, *Cyperus fauriei*, *Cyrtandra filipes*, *Gouania hillebrandii*, *Labordia triflora*, *Neraudia sericea*, *Santalum haleakalae* var. *lanaiense*, *Schiedea lydgatei*, *S. sarmentosa*, *Silene alexandri*, *S. lanceolata*, *Spermolepis hawaiiensis*, and *Zanthoxylum hawaiiense*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Mesic—Unit 1 is not known to be occupied by *Asplenium dielirectum*, *Bonamia menziesii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea procera*, *C. solanacea*, *Diplazium molokaiense*, *Festuca molokaiensis*, *Flueggea neowawraea*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Melicope mucronulata*, *M. munroi*, *M. reflexa*, *Phyllostegia haliakalae*, *P. mannii*, *P. pilosa*, *Sesbania tomentosa*, *Stenogyne bifida*, or *Vigna o-wahuensis*, or the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 1 consists of 11,465 ac (4,640 ha) of State land, 2,069 ac (837 ha) of federally owned land, and 3 ac (1 ha) of privately owned land, from Kanaio to Kahualau Gulch on the southern slopes of east Maui. This unit is occupied by the plants *Bonamia menziesii*, *Cenchrus agrimonoides*, *Flueggea neowawraea*, *Melicope adscendens*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 1 is not known to be occupied by *Alectryon macrococcus*, *Bidens micrantha* ssp. *kalealaha*, *Canavalia*

pubescens, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Sesbania tomentosa*, *Solanum incompletum*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 2 consists of 1,851 ac (749 ha) of State land at Keokea on the southern slopes of east Maui. This unit is occupied by the plants *Bonamia menziesii*, *Canavalia pubescens*, and *Hibiscus brackenridgei*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 2 is not known to be occupied by *Alectryon macrococcus*, *Bidens micrantha* ssp. *kalealaha*, *Cenchrus agrimonoides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Mesic—Unit 1 (and) *Palmeria dolei*—Unit 42—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 42—Montane Mesic This area consists of 257 ac (104 ha) of State land, and 559 ac (226 ha) of privately owned land from Kamiloloa to Makolelau in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Bidens wiebkkei*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Montane Mesic—Unit 1 is not known to be occupied by *Asplenium dielerectum*, *Cyanea dunbariae*, *C. mannii*, *C. procera*, *C. solanacea*, *Cyperus fauriei*, *Kadua laxiflora*, *Melicope mucronulata*, *Neraudia sericea*, *Plantago princeps*, or *Stenogyne bifida*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 2 (and) *Palmeria dolei*—Unit 3—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 3—Lowland Wet (and) *Newcombia cumingi*—Unit 1—Lowland Wet This area consists of 65 ac (26 ha) of State land at Moomoku, on the northwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy,

subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. Although Maui—Lowland Wet—Unit 2 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), or by the Newcomb's tree snail (*Newcombia cumingi*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 5 (and) *Palmeria dolei*—Unit 6—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 6— Lowland Wet This area consists of 30 ac (12 ha) of State land at Iao Valley on the eastern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 5 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 6 (and) *Palmeria dolei*—Unit 7—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 7— Lowland Wet This area consists of 136 ac (55 ha) of State land at Honokowai and Wahikuli valleys on the western slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 6 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, or by the forest

birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 7 (and) *Palmeria dolei*—Unit 8—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 8— Lowland Wet This area consists of 898 ac (364 ha) of State land at Olowalu Valley, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Alectryon macrococcus*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 7 is not currently occupied by the plants *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 8 (and) *Palmeria dolei*—Unit 9—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 9— Lowland Wet This area consists of 230 ac (93 ha) of State land at upper Ukumehame Gulch, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 8 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Dry—Unit 1 consists of 2,962 ac (1,199 ha) of State land, and 563 ac (228 ha) of federally owned land (Haleakala National Park), from Kanaio to Naholoku and Kaupo Gap along

the southern slopes of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane dry ecosystem (see Table 5). Although Maui—Montane Dry—Unit 1 is not known to be occupied by the plants *Alectryon macrococcus*, *Geranium arboreum*, *Melicope knudsenii*, *M. mucronulata*, *Santalum haleakalae* var. *lanaiense*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these montane dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 6 (and) *Palmeria dolei*—Unit 35—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 35—Wet Cliff This area consists of 1,858 ac (752 ha) of State land, and 253 ac (102 ha) of privately owned land, at the summit ridges of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plants *Alectryon macrococcus*, *B. conjuncta*, *Ctenitis squamigera*, *Cyrtandra munroi*, *Remya mauiensis*, and *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 6 is not known to be occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Bonamia menziesii*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyriformis*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, or *Tetramolopium capillare*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 8 consists of 337 ac (137 ha) of State land along Kahakuloa ridge on the north side of west Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff—Unit 8 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyriformis*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat designation for *Alectryon macrococcus* includes 15 CHUs in Honolulu County, Hawaii (77 FR 57648-57862).

Oahu—Lowland Mesic—Unit 1 consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). This unit is occupied by the plants *Abutilon sandwicense*, *Alectryon macrococcus*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Chamaesyce herbstii*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Cyanea acuminata*, *C. calycina*, *C. grimesiana* ssp. *grimesiana*, *C. grimesiana* ssp. *obatae*, *C. longiflora*, *C. superba*, *Cyrtandra dentata*, *Delissea subcordata*, *Diellia falcata*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Euphorbia haeleeleana*, *Flueggea neowawraea*, *Hesperomannia arborescens*, *H. arbuscula*, *Hibiscus brackenridgei*, *Isodendron laurifolium*, *I. longifolium*, *Kadua degeneri*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *M. pallida*, *Neraudia angulata*, *Nototrichium humile*, *Phyllostegia kaalaensis*, *Platydesma cornuta* var. *decurrans*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Schiedea hookeri*, *S. kaalae*, *S. nuttallii*, *S. obovata*, and *Viola chamissoniana* ssp. *chamissoniana*, and includes the mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 4). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Lowland Mesic—Unit 1 is not known to be occupied by the plants *Chamaesyce celastroides* var. *kaenana*, *Cyanea pinnatifida*, *Cyperus pennatifidus*, *Diellia unisora*, *Diplazium molokaiense*, *Eugenia koolauensis*, *Gardenia mannii*, *Gouania meyenii*, *G. vitifolia*, *Kadua coriacea*, *K. parvula*, *Labordia cyrtandrae*, *Melicope saint-johnii*, *Phyllostegia hirsuta*, *P. mollis*, *P. parviflora*, *Plantago princeps*, *Sanicula mariversa*, *Silene perlmannii*, *Solanum sandwicense*, *Stenogyne kanehoana*, *Tetramolopium lepidotum* ssp. *lepidotum*, or *Urera kaalae*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

18 ac (7 ha) of City and County of Honolulu land, 352 ac (142 ha) of State land, and less than 1 ac (less than one ha) of privately-owned land in the montane wet ecosystem at the summit of the Waianae Mountains at Kaala, and partially within the Mokuleia Forest Reserve and the Kaala Natural Area Reserve. This unit is occupied by the plants *Cyanea acuminata*, *C. calycina*, *Labordia cyrtandrae*, *Melicope christophersenii*, and *Schiedea trinervis*, and includes the wet forest and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 4). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Montane Wet—Unit 1 is not known to be occupied by the plants *Alectryon macrococcus*, *Lobelia oahuensis*, or *Phyllostegia hirsuta*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 1 consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. This unit is on State land within the Pahole Natural Area Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). This unit is occupied by the plants *Alectryon macrococcus*, *Cenchrus agrimonoides*, *Chamaesyce herbstii*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Kadua degeneri*, *Plantago princeps* var. *princeps*, and *Schiedea obovata*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 1 is not currently occupied by *Abutilon sandwicense*, *Achyranthes splendens* var. *rotundata*, *Bonamia menziesii*, *Chamaesyce kuwaleana*, *Diellia falcata*, *D. unisora*, *Dubautia herbtsobatae*, *Eragrostis fosbergii*, *Flueggea neowawraea*, *Gouania meyenii*, *G. vitifolia*, *Isodendron laurifolium*, *I. pyriformis*, *Kadua parvula*, *Korthalsella degeneri*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *M. saint-johnii*, *Neraudia angulata*, *Nototrichium humile*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Platydesma cornuta* var. *decurrens*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Sanicula mariversa*, *Schiedea hookeri*, *S. trinervis*, *Silene lanceolata*, *S. perlmannii*, *Spermolepis hawaiiensis*, *Tetramolopium filiforme*, *T. lepidotum* ssp. *lepidotum*, or *Viola chamissoniana* ssp. *chamissoniana*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Mesic—Unit 2 consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit is occupied by the plants *Abutilon sandwicense*, *Alectryon macrococcus*, *Cenchrus agrimonoides*, *Chamaesyce herbstii*, *Cyanea calycina*, *C. grimesiana* ssp. *obatae*, *Delissea subcordata*, *Diellia falcata*, *Gardenia mannii*, *Phyllostegia hirsuta*, *P. kaalaensis*, *P. mollis*, *Platydesma cornuta* var. *decurrens*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Schiedea hookeri*, *S. kaalae*, *Solanum sandwicense*, *Stenogyne kanehoana*, and *Urera kaalae*, and includes the mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 4). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Lowland Mesic—Unit 2 is not known to be occupied by the plants *Bonamia menziesii*, *Chamaesyce celastroides* var. *kaenana*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Cyanea acuminata*, *C. grimesiana* ssp. *grimesiana*, *C. longiflora*, *C. pinnatifida*, *C. superba*, *Cyperus pennatifolius*, *Cyrtandra dentata*, *Diellia unisora*, *Diplazium molokaiense*, *Dubautia herbtsobatae*, *Eragrostis fosbergii*, *Eugenia koolauensis*, *Euphorbia haeleeleana*, *Flueggea neowawraea*, *Gouania meyenii*, *G. vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Hibiscus brackenridgei*, *Isodendron laurifolium*, *I. longifolium*, *Kadua coriacea*, *K. degeneri*, *K. parvula*, *Labordia cyrtandrae*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *M. pallida*, *M. saint-johnii*, *Neraudia angulata*, *Nototrichium humile*, *Phyllostegia parviflora*, *Plantago princeps*, *Sanicula mariversa*, *Schiedea nuttallii*, *S. obovata*, *Silene perlmannii*, *Tetramolopium lepidotum* ssp. *lepidotum*, or *Viola chamissoniana* ssp. *chamissoniana*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it

provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 2 consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. This unit is almost entirely within the Makua Keaau Forest Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). Dry Cliff—Unit 2 is occupied by the plants *Abutilon sandwicense*, *Alectryon macrococcus*, *Dubautia herbstobatae*, *Gouania vitifolia*, *Kadua parvula*, *Lepidium arbuscula*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *Nototrichium humile*, *Peucedanum sandwicense*, *Platydesma cornuta* var. *decurrans*, *Pleomele forbesii*, *Sanicula marivera*, *Schiedea hookeri*, *Tetramolopium filiforme*, and *Viola chamissoniana* ssp. *chamissoniana*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 2 is not currently occupied by *Achyranthes splendens* var. *rotundata*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Chamaesyce herbstii*, *C. kuwaleana*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia falcata*, *D. unisora*, *Eragrostis fosbergii*, *Flueggea neowawraea*, *Gouania meyenii*, *Isodendrion laurifolium*, *I. pyriformis*, *Kadua degeneri*, *Korthalsella degeneri*, *Lipochaeta lobata* var. *leptophylla*, *Melicope saint-johnii*, *Neraudia angulata*, *Phyllostegia kaalaensis*, *Plantago princeps*, *Pteralyxia macrocarpa*, *Schiedea obovata*, *S. trinervis*, *Silene lanceolata*, *S. perlmanii*, *Spermolepis hawaiiensis*, or *Tetramolopium lepidotum* ssp. *lepidotum*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Mesic—Unit 3 consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit is occupied by the plants *Alectryon macrococcus*, *Cenchrus agrimonioides*, *Delissea subcordata*, *Diellia falcata*, *D. unisora*, *Hesperomannia arbuscula*, *Melicope saint-johnii*, *Phyllostegia mollis*, *P. parviflora*, *Plantago princeps*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Schiedea kaalae*, *Silene perlmanii*, and *Urera kaalae*, and includes the mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Lowland Mesic—Unit 3 is not known to be occupied by the plants *Abutilon sandwicense*, *Bonamia menziesii*, *Chamaesyce celastroides* var. *kaenana*, *C. herbstii*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Cyanea acuminata*, *C. calycina*, *C. grimesiana* ssp. *grimesiana*, *C. grimesiana* ssp. *obatae*, *C. longiflora*, *C. pinnatifida*, *C. superba*, *Cyperus pennatifolius*, *Cyrtandra dentata*, *Diplazium molokaiense*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Eugenia koolauensis*, *Euphorbia haeleeleana*, *Flueggea neowawraea*, *Gardenia mannii*, *Gouania meyenii*, *G. vitifolia*, *Hesperomannia arborescens*, *Hibiscus brackenridgei*, *Isodendrion laurifolium*, *I.*

longifolium, *Kadua coriacea*, *K. degeneri*, *K. parvula*, *Labordia cyrtandrae*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *M. pallida*, *Neraudia angulata*, *Nototrichium humile*, *Phyllostegia hirsuta*, *P. kaalaensis*, *Platydesma cornuta* var. *decurrens*, *Sanicula mariversa*, *Schiedea hookeri*, *S. nuttallii*, *S. obovata*, *Solanum sandwicense*, *Stenogyne kanehoana*, *Tetramolopium lepidotum* ssp. *lepidotum*, or *Viola chamissoniana* ssp. *chamissoniana*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 3 consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. This unit is partially within the Waianae Kai Forest Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). This unit is occupied by the plants *Abutilon sandwicense*, *Alectryon macrococcus*, *Bonamia menziesii*, *Diellia falcata*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Flueggea neowawraea*, *Gouania meyenii*, *Isodendron laurifolium*, *Korthalsella degeneri*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *Neraudia angulata*, *Nototrichium humile*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Schiedea hookeri*, *Silene lanceolata*, *Tetramolopium filiforme*, and *Viola chamissoniana* ssp. *chamissoniana*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 3 is not currently occupied by *Achyranthes splendens* var. *rotundata*, *Cenchrus agrimonoides*, *Chamaesyce herbstii*, *C. kuwaleana*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia unisora*, *Gouania vitifolia*, *Isodendron pyriforme*, *Kadua degeneri*, *K. parvula*, *Melicope saint-johnii*, *Plantago princeps*, *Platydesma cornuta* var. *decurrens*, *Sanicula mariversa*, *Schiedea obovata*, *S. trinervis*, *Silene perlmanii*, *Spermolepis hawaiiensis*, or *Tetramolopium lepidotum* ssp. *lepidotum*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Mesic—Unit 4 consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. This unit includes the lowland mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 4). Although Oahu—Lowland Mesic—Unit 4 is not known to be occupied by the plants *Alectryon macrococcus*, *Bonamia menziesii*, *Chamaesyce celastroides* var. *kaenana*, *Ctenitis squamigera*, *Cyanea acuminata*, *C. calycina*, *C. crispa*, *C. grimesiana* ssp. *grimesiana*, *C. lanceolata*, *C. longiflora*, *C. truncata*, *Cyrtandra dentata*, *C. polyantha*, *Delissea subcordata*, *Diellia erecta*, *D. falcata*, *Eugenia koolauensis*, *Gardenia mannii*, *Hesperomannia arborescens*, *Isodendron laurifolium*, *I. longifolium*, *Kadua coriacea*, *Labordia cyrtandrae*, *Lobelia monostachya*, *Melicope*

lydgatei, *M. saint-johnii*, *Phyllostegia hirsuta*, *P. mollis*, *P. parviflora*, *Plantago princeps*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Schiedea kaalae*, *S. nuttallii*, *Solanum sandwicense*, *Tetraplasandra gymnocarpa*, or *T. lydgatei*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 4 consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. This unit is partially within the Waianae Kai Forest Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). This unit is occupied by the plants *Alectryon macrococcus*, *Chamaesyce kuwaleana*, and *Spermolepis hawaiiensis*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 4 is not currently occupied by *Abutilon sandwicense*, *Achyranthes splendens* var. *rotundata*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Chamaesyce herbstii*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia falcata*, *D. unisora*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Flueggea neowawraea*, *Gouania meyenii*, *G. vitifolia*, *Isodendron laurifolium*, *I. pyriform*, *Kadua degeneri*, *K. parvula*, *Korthalsella degeneri*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *M. saintjohnii*, *Neraudia angulata*, *Nototrichium humile*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Plantago princeps*, *Platydesma cornuta* var. *decurrens*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Sanicula mariversa*, *Schiedea hookeri*, *S. obovata*, *S. trinervis*, *Silene lanceolata*, *S. perlmanii*, *Tetramolopium filiforme*, *T. lepidotum* ssp. *lepidotum*, or *Viola chamissoniana* ssp. *chamissoniana*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Mesic—Unit 5 consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. This unit includes the mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 4). Although Oahu—Lowland Mesic—Unit 5 is not known to be occupied by the plants *Alectryon macrococcus*, *Bonamia menziesii*, *Chamaesyce celastroides* var. *kaenana*, *Ctenitis squamigera*, *Cyanea acuminata*, *C. calycina*, *C. crispa*, *C. grimesiana* ssp. *grimesiana*, *C. lanceolata*, *C. longiflora*, *C. truncata*, *Cyrtandra dentata*, *C. polyantha*, *Delissea subcordata*, *Diellia erecta*, *D. falcata*, *Eugenia koolauensis*, *Gardenia mannii*, *Hesperomannia arborescens*, *Isodendron laurifolium*, *I. longifolium*, *Kadua coriacea*, *Labordia cyrtandrae*, *Lobelia monostachya*, *Melicope lydgatei*, *M. saint-johnii*, *Phyllostegia hirsuta*, *P. mollis*, *P. parviflora*, *Plantago princeps*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Schiedea kaalae*, *S. nuttallii*, *Solanum sandwicense*, *Tetraplasandra gymnocarpa*, or *T. lydgatei*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations

within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 6 consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). The unit is occupied by the plants *Cenchrus agrimonioides*, *Diellia unisora*, *Flueggea neowawraea*, *Lepidium arbuscula*, *Lobelia niihauensis*, *Melicope saintjohnii*, *Neraudia angulata*, *Plantago princeps*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, and *Tetramolopium lepidotum* ssp. *lepidotum*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 6 is not currently occupied by *Abutilon sandwicense*, *Achyranthes splendens* var. *rotundata*, *Alectryon macrococcus*, *Bonamia menziesii*, *Chamaesyce herbstii*, *C. kuwaleana*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia falcata*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Gouania meyenii*, *G. vitifolia*, *Isodendron laurifolium*, *I. pyrifolium*, *Kadua degeneri*, *K. parvula*, *Korthalsella degeneri*, *Lipochaeta lobata* var. *leptophylla*, *Melanthera tenuifolia*, *Melicope makahae*, *Nototrichium humile*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Platydesma cornuta* var. *decurrens*, *Sanicula mariversa*, *Schiedea hookeri*, *S. obovata*, *S. trinervis*, *Silene lanceolata*, *S. perlmanii*, *Spermolepis hawaiiensis*, *Tetramolopium filiforme*, or *Viola chamissoniana* ssp. *chamissoniana*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Mesic—Unit 6 (and) Oceanic Hawaiian Damselfly—Unit 1— Lowland Mesic This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. This area is occupied by the plants *Cyanea acuminata*, *C. crispa*, *C. truncata*, *Gardenia mannii*, *Pteralyxia macrocarpa*, and *Schiedea kaalae*; and the invertebrate, the oceanic Hawaiian damselfly. This area includes the lowland mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem, as well as unique PCEs for the damselfly (see Tables 4 and 5). Because the streams and upland foraging and cover areas required by the oceanic Hawaiian damselfly are dispersed in the lowland mesic ecosystem, the lowland mesic ecosystem's physical or biological features are essential to the damselfly because they provide for the proper ecological functioning of this ecosystem. This area also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although this area is not known to be occupied by the plants *Alectryon macrococcus*, *Bonamia menziesii*, *Chamaesyce celastroides* var. *kaenana*, *Ctenitis squamigera*, *Cyanea calycina*, *C. grimesiana* ssp. *grimesiana*, *C. lanceolata*, *C. longiflora*, *Cyrtandra dentata*, *C. polyantha*, *Delissea subcordata*, *Diellia erecta*, *D. falcata*, *Eugenia koolauensis*, *Hesperomannia arborescens*, *Isodendron laurifolium*, *I. longifolium*, *Kadua coriacea*, *Labordia cyrtandrae*, *Lobelia monostachya*, *Melicope*

lydgatei, *M. saint-johnii*, *Phyllostegia hirsuta*, *P. mollis*, *P. parviflora*, *Plantago princeps*, *Pleomele forbesii*, *Schiedea nuttallii*, *Solanum sandwicense*, *Tetraplasandra gymnocarpa*, or *T. lydgatei*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 7a consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4), and is occupied by the plants *Flueggea neowawraea*, *Kadua parvula*, *Melicope saint-johnii*, *Plantago princeps*, *Platydesma cornuta* var. *decurrens*, *Pleomele forbesii*, *Silene perlmannii*, and *Viola chamissoniana* ssp. *chamissoniana*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 7a is not currently occupied by *Abutilon sandwicense*, *Achyranthes splendens* var. *rotundata*, *Alectryon macrococcus*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Chamaesyce herbstii*, *C. kuwaleana*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia falcata*, *D. unisora*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Gouania meyenii*, *G. vitifolia*, *Isodendron laurifolium*, *I. pyrifolium*, *Kadua degeneri*, *Korthalsella degeneri*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *Neraudia angulata*, *Nototrichium humile*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Pteralyxia macrocarpa*, *Sanicula mariversa*, *Schiedea hookeri*, *S. obovata*, *S. trinervis*, *Silene lanceolata*, *Spermolepis hawaiiensis*, *Tetramolopium filiforme*, or *T. lepidotum* ssp. *lepidotum*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Dry Cliff—Unit 7b consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). Although Oahu—Dry Cliff—Unit 7b is not currently occupied by *Abutilon sandwicense*, *Achyranthes splendens* var. *rotundata*, *Alectryon macrococcus*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Chamaesyce herbstii*, *C. kuwaleana*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia falcata*, *D. unisora*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Flueggea neowawraea*, *Gouania meyenii*, *G. vitifolia*, *Isodendron laurifolium*, *I. pyrifolium*, *Kadua degeneri*, *K. parvula*, *Korthalsella degeneri*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *M. saintjohnii*, *Neraudia angulata*, *Nototrichium humile*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Plantago princeps*, *Platydesma cornuta* var. *decurrens*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Sanicula mariversa*, *Schiedea hookeri*, *S. obovata*, *S. trinervis*, *Silene lanceolata*, *S. perlmannii*, *Spermolepis hawaiiensis*, *Tetramolopium filiforme*, *T. lepidotum* ssp. *lepidotum*, or *Viola chamissoniana* ssp. *chamissoniana*, we have

determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Mesic—Unit 7 consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge. This unit is occupied by the plants *Bonamia menziesii*, *Cyanea acuminata*, *C. grimesiana* ssp. *grimesiana*, *C. lanceolata*, *Cyrtandra polyantha*, *Diellia erecta*, *Lobelia monostachya*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, and *Tetraplasandra lydgatei*, and includes the mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 4). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Lowland Mesic—Unit 7 is not known to be occupied by the plants *Alectryon macrococcus*, *Chamaesyce celastroides* var. *kaenana*, *Ctenitis squamigera*, *Cyanea calycina*, *C. crispa*, *C. longiflora*, *C. truncata*, *Cyrtandra dentata*, *Delissea subcordata*, *Diellia falcata*, *Eugenia koolauensis*, *Gardenia mannii*, *Hesperomannia arborescens*, *Isodendron laurifolium*, *I. longifolium*, *Kadua coriacea*, *Labordia cyrtandrae*, *Melicope lydgatei*, *M. saint-johnii*, *Phyllostegia hirsuta*, *P. mollis*, *P. parviflora*, *Plantago princeps*, *Schiedea kaalae*, *S. nuttallii*, *Solanum sandwicense*, or *Tetraplasandra gymnocarpa*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 8 consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve. A small portion of this area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). This unit is occupied by the plants *Abutilon sandwicense*, *Bonamia menziesii*, *Flueggea neowawraea*, *Lobelia niihauensis*, *Neraudia angulata*, *Nototrichium humile*, and *Pleomele forbesii*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 8 is not currently occupied by *Achyranthes splendens* var. *rotundata*, *Alectryon macrococcus*, *Cenchrus agrimonioides*, *Chamaesyce herbstii*, *C. kuwaleana*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia falcata*, *D. unisora*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Gouania meyenii*, *G. vitifolia*, *Isodendron laurifolium*, *I. pyrifolium*, *Kadua degeneri*, *K. parvula*, *Korthalsella degeneri*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Melanthera tenuifolia*, *Melicope makahae*, *M. saint-johnii*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Plantago princeps*, *Platydesma cornuta* var. *decurrens*, *Pteralyxia macrocarpa*, *Sanicula mariversa*, *Schiedea hookeri*, *S. obovata*, *S. trinervis*, *Silene lanceolata*, *S. perlmanii*, *Spermolepis hawaiiensis*, *Tetramolopium filiforme*, *T. lepidotum* ssp. *lepidotum*, or *Viola chamissoniana* ssp. *chamissoniana*, we have determined this area to be

essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

The critical habitat designation for *Alectryon macrococcus* includes two CHUs in Kauai County, Hawaii (68 FR 9116-9479).

Kauai 11—*Alectryon macrococcus*—a This unit is critical habitat for *Alectryon macrococcus* and is 382 ha (943 ac) on State land (Alakai Wilderness Preserve). This unit contains portions of Kawaiiki and Kipalau Valleys. This unit provides habitat for one population of 100 mature, reproducing individuals of the longlived perennial *Alectryon macrococcus* and is currently occupied with between 123 and 133 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. It provides habitat for the westernmost range of the species. The habitat features contained in this unit that are essential for this species include, but are not limited to, dry slopes or gulches in *Diospyros* spp.-*Metrosideros polymorpha* lowland mesic forest, *Metrosideros polymorpha* mixed mesic forest, or *Diospyros* spp. mixed mesic forest. This unit provides for one population within this multiisland species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations on the island from being destroyed by one naturally occurring catastrophic event.

Kauai 11—*Alectryon macrococcus*—b This unit is critical habitat for *Alectryon macrococcus* and is 90 ha (222 ac) on State land (Na Pali Coast State Park) and is completely within the back of Kalalau Valley. The habitat features contained in this unit that are essential for this species include, but are not limited to, dry slopes or gulches in *Diospyros* spp.-*Metrosideros polymorpha* lowland mesic forest, *Metrosideros polymorpha* mixed mesic forest, or *Diospyros* spp. mixed mesic forest. This unit provides habitat for one population of 100 mature, reproducing individuals of the long-lived perennial *Alectryon macrococcus* and is currently occupied with between 35 and 40 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. It provides habitat for the westernmost range of the species. Critical habitat on this island provides for a recovery population within the historical range of this multiisland species. Kauai 11—*Alsinidendron lychnoides*—a This unit is critical habitat for *Alsinidendron lychnoides* and is 994 ha (2,457 ac) on State (Alakai Wilderness Preserve, Halelea Forest Reserve, Hono o Na Pali NAR, and Na Pali Coast State Park) and private land. This unit contains portions of the Alakai Trail and Alealau, Hono o Na Pali, Keanapuka, Moaalele, Pihea, Pohakea, and Waiahuakua Summits. This unit provides habitat for six populations of 100 mature, reproducing individuals of the long-lived perennial *Alsinidendron lychnoides* and is currently occupied with three plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep riparian clay or silty soil banks in montane wet forests, and is the area most likely to contain a viable seed bank on this side of the island. This unit is geographically separated

from the other two units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Alectryon macrococcus* critical habitat consists of five components (lowland dry, montane mesic and montane dry ecosystems in east Maui for var. *auwahiensis* and lowland mesic (Molokai), lowland wet (west Maui), montane mesic (east Maui and Molokai) and wet cliff (west Maui) for var. *macrococcus*). Species- specific physical or biological features: elevation >1,200 ft (>370 m) (81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*. Subcanopy: *Chamaesyce*, *Dodonaea*, *Leptecophylla*, *Osteomeles*, *Psydrax*, *Scaevola*, *Wikstroemia*. Understory: *Alyxia*, *Artemisia*, *Bidens*, *Chenopodium*, *Nephrolepis*, *Peperomia*, *Sicyos*.

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Ecosystem: Lowland Wet. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: *Acacia*, *Ilex*, *Metrosideros*, *Myrsine*, *Nestegis*, *Nothocestrum*, *Pisonia*, *Pittosporum*, *Psychotria*, *Sophora*, *Zanthoxylum*. Subcanopy: *Alyxia*, *Charpentiera*, *Coprosma*, *Dodonaea*, *Kadua*, *Labordia*, *Leptecophylla*, *Phyllostegia*, *Vaccinium*. Understory: Ferns, *Carex*, *Peperomia*.

Ecosystem: Montane Dry. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Dry cinder or ash soils, loamy volcanic sands, blocky lava, rock outcroppings. Canopy: *Acacia*, *Metrosideros*, *Myoporum*, *Santalum*, *Sophora*. Subcanopy: *Chamaesyce*, *Coprosma*, *Dodonaea*, *Dubautia*, *Leptecophylla*, *Osteomeles*, *Wikstroemia*. Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Vaccinium*.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. Understory: Bryophytes, Ferns, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Alectryon macrococcus* critical habitat consists of three components (Lowland mesic, Montane wet and Dry cliff). Species occurs within the

indicated ecosystem in the Waianae Mountain caldera complex (Lowland mesic, Montane wet and Dry cliff). Species is known historically (last observed > 20 yrs ago) from indicated ecosystem in the Koolau Mountain caldera complex (Lowland mesic) (77 FR 57648-57862):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<914 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Ecosystem: Montane Wet. Elevation: 3,300–6,600 ft (1,000-2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: Acacia, Charpentiera, Cheirodendron, Metrosideros. Subcanopy: Broussaia, Cibotium, Eurya, Ilex, Myrsine. Understory: Ferns, Carex, Coprosma, Leptecophylla, Oreobolus, Rhynchospora, Vaccinium.

Ecosystem: Dry Cliff. Elevation: unrestricted. Annual precipitation: < 75 in (<190 cm). Substrate: >65 degree slope, rocky talus. Canopy: None. Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Alectryon macrococcus* critical habitat consists of two components (68 FR 9116-9479):

(i) Dry slopes or gulches in *Diospyros* spp.-*Metrosideros polymorpha* lowland mesic forest, *Metrosideros polymorpha* mixed mesic forest, or *Diospyros* spp. mixed mesic forest, and containing one or more of the following native plant species: *Acacia koa*, *Alyxia oliviformis*, *Antidesma* spp., *Bobea timonioides*, *Caesalpinia kavaense*, *Canavalia* spp., *Carex meyenii*, *Carex wahuensis*, *Doodia kunthiana*, *Hibiscus waimeae*, *Kokia kauaiensis*, *Melicope knudsenii*, *Microlepidia strigosa*, *Munroidendron racemosum*, *Myrsine lanaiensis*, *Nesoluma polynesianum*, *Nestegis sandwicensis*, *Pisonia* spp., *Pleomele aurea*, *Pouteria sandwicensis*, *Psychotria* spp., *Psydrax odorata*, *Pteralyxia kauaiensis*, *Rauvolfia sandwicensis*, *Streblus pendulinus*, *Tetraplasandra* spp., *Xylosma* spp., or *Zanthoxylum* spp.; and

(ii) Elevations between 343 and 954 m (1,126 and 3,129 ft).

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight

plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet

Cliff—Units 6 and 7; and MolokaiMontane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent

habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds.

Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species and therefore are not included in the critical habitat designations.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (NatureServe, 2015)

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Mean annual rainfall is 80-220 cm (USFWS, 1997)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 360 and 1,070 meters (USFWS, 1997)

Habitat Narrative

Adult: The habitat of *Alectryon macrococcus* is dryland forest on slopes or in gulches, once widespread on leeward exposures of all the Hawaiian Islands, but now almost completely eliminated. Both varieties of *Alectryon macrococcus* typically grow on dry slopes or in gulches, within dry to mesic lowland forests at elevations of 360-1,070 meters (1,180-3,510 feet). Mean annual rainfall is roughly 80-200 cm (2.6-6.6 feet) in this habitat. Most rainfall comes in the winter, whereas summers are hot and dry. Associated native plants include *Metrosideros polymorpha*, *Aleurites moluccana*, *Diospyros sandwicensis*, *Nestegis sandwicensis*, *Psychotria*, *Pisonia*, *Xylosma*, *Streblus*, *Hibiscus*, *Antidesma*, *Pleomele*, *Acacia*, *Melicope knudsenii*, *Hibiscus waimeae*, *Pleralyxia*, *Zanthoxylum*, *Doodia*, *Blechnum*, *Kokia kavatensis*, *Bobea timontoides* (USFWS 1992a; Hawaii Plant Conservation Center (HPCC) 1994). (USFWS, 1997)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Low (inferred from USFWS, 1997)

Redundancy:

Low (inferred from USFWS, 1997)

Number of Populations:

37 (var. *macrococcus*) and 1 (var. *auwahiensis*) (NatureServe, 2015)

Population Size:

500-1000 (var. *macrococcus*) and 1-10 (var. *auwahiensis*) plants (NatureServe, 2015)

Population Narrative:

Total population estimates for *Alectryon macrococcus* var. *macrococcus* are from 500-1000 plants and 1-10 plants for *A. m.* var. *auwahiensis*. There are 37 populations of *A. m.* var. *macrococcus* and 1 population of *A. m.* var. *auwahiensis*. (NatureServe, 2015)

Threats and Stressors

Stressor: Competition with alien plant species (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: The alien plants *Melinis minutiflora* (molasses grass), *Pennisetum clandestinum* (kikuyu grass), and *Schinus terebinthifolius* (Christmas berry) pose threats to *Alectryon macrococcus* reproduction because of competition with seedlings for light, space, and water. Christmas berry is now replacing the native vegetation of much of the southern Waianae Mountains and threatens to occupy the range of all Oahu populations of *Alectryon macrococcus* var. *macrococcus*. Most populations of *Alectryon macrococcus* var. *macrococcus* on Oahu and Molokai are immediately threatened by molasses grass. Kikuyu grass forms a thick mat that displaces reproduction of native plant taxa at Auwahi on East Maui. The West Maui individuals of *Alectryon macrococcus* var. *macrococcus* are immediately threatened by competition with strawberry guava (*Psidium cattleianum*). (USFWS, 1997)

Stressor: Black twig borer (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: The black twig borer has been cited as an immediate threat to the extant populations of both recognized varieties of *Alectryon macrococcus* (J. Lau, TNCH, personal communication 1990). This pest burrows into the branches and introduces a pathogenic fungus, pruning the host severely, often killing branches or whole plants. The Waimea Canyon populations of *Alectryon macrococcus* var. *macrococcus*, most populations on Oahu, and the single population of *Alectryon macrococcus* var. *auwahiensis* suffers severe defoliation and reduced vigor due to infestations of this alien insect. Most populations of this species probably sustain some damage from the borer. (USFWS, 1997)

Stressor: Seed predation by alien rodents (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: Predation on fruits and flowers by rodents, both black rats (*Rattus rattus*) and less often house mice (*Mus musculus*), threatens *Alectryon macrococcus*. Evidence of rat predation has been seen on both varieties of *Alectryon macrococcus*. Seed predation by black rats has inhibited reproduction of this species for many years. Virtually all *Alectryon* seeds lying beneath the canopies of trees in Auwahi and Kanaio districts on Maui are destroyed by black rats (Medeiros, Loope, and Holt 1986). (USFWS, 1997)

Stressor: Alien ungulates (USFWS, 1997)

Exposure:**Response:****Consequence:**

Narrative: Herbivory, trampling, and soil erosion caused by goats are immediate threats to *Alectryon macrococcus* var. *macrococcus*. Currently, goats contribute to the substantial decline of all four populations of this taxon in Waimea Canyon on Kauai. Goats on State lands in this area are managed for recreational hunting. In the Waianae Mountains of Oahu, encroaching urbanization and hunting pressure tend to restrict goats to the drier upper slopes (Tomich 1986), where *Alectryon macrococcus* occurs. Over half of the Oahu populations of *Alectryon macrococcus* var. *macrococcus* are affected by increasing numbers of goats in scattered locations along the Waianae Mountains, especially in Makua and Nakaleha. On Molokai, all five localities of *Alectryon macrococcus* var. *macrococcus* are restricted to a 7.5 square kilometer (4.7 square mile) area that is immediately threatened by goats (USFWS 1992a). Both recognized varieties of *Alectryon macrococcus* are threatened by habitat degradation by feral pigs and have sustained loss of individual plants or habitat as the result of feral pig activity. Present throughout the Waianae Mountains of Oahu in low numbers, feral pigs pose a significant threat to the scattered populations of *Alectryon macrococcus* var. *macrococcus*. Herbivory, trampling, and habitat degradation by cattle also threaten the species, particularly *Alectryon macrococcus* var. *auwahiensis*. The sole remaining habitat for this variety is on a cattle ranch consisting of private and State-leased lands. Although all individuals of *Alectryon macrococcus* var. *auwahiensis* are protected from ungulates with small woven-wire exclosures, these must be rigorously maintained. Cattle trample seedlings and damage mature plants by browsing (USFWS 1992a). (USFWS, 1997)

Stressor: Wildland fire (USFWS, 1997)

Exposure:**Response:****Consequence:**

Narrative: Fire is a threat to some populations of *Alectryon macrococcus* var. *macrococcus*. Unintentionally ignited fires have resulted from ordinance training practices in Makua Military Reservation on Oahu. Although most fires have been contained within 0.01 hectares (0.02 acres), a single 120 hectare (300 acre) fire in July 1989 spread upslope and came to within 0.3 kilometers (0.2 miles) of a population of *Alectryon macrococcus* var. *macrococcus*, also threatening seven other populations in the area. Fires are also a potential threat to Waimea Canyon, Kauai, and less likely, but possibly, to west and east Maui populations (USFWS 1992a). (USFWS, 1997)

Stressor: Small population size (USFWS, 1997)

Exposure:**Response:****Consequence:**

Narrative: Due to the very small remaining number of individuals of *Alectryon macrococcus* var. *auwahiensis* and their limited distribution, a single natural or human-caused environmental disturbance could easily be catastrophic. Given the limited size and scattered distribution of populations and individuals of both *Alectryon macrococcus* var. *macrococcus* and *A. macrococcus* var. *auwahiensis*, gene pool limitations may depress reproductive vigor and adaptability. (USFWS, 1997)

Stressor: Seed predation and loss of pollinators (USFWS, 1997)

Exposure:**Response:****Consequence:**

Narrative: Possible threats to both varieties include seed predation by insects (probably the endemic microlepidopteran *Prays* cf. *fulvocanella* Walsingham [Yponomeutidae]) and loss of pollinators. (USFWS, 1997)

Stressor: Climate change (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: Climate change - Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC funded climate modeling that will help resolve these spatial limitations. High spatial resolution climate outputs are expected to be available sometime in 2013. (USFWS, 2013)

Recovery**Reclassification Criteria:**

1. A total of five to seven populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1997)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)
2. Each population must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)
3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1997)

Recovery Actions:

- Identify target populations for manipulative management. (USFWS, 1997)
- Survey known populations to determine effect of black twig borer and rodents. (USFWS, 1997)
- Initiate an emergency program. (USFWS, 1997)

- Establish outplanted populations in “safe” (through fencing where necessary) habitat and institute weed control as necessary at these sites. (USFWS, 1997)

Conservation Measures and Best Management Practices:

- Continue surveys for female individuals. (USFWS, 2013)
- Captive propagation for genetic storage and reintroduction - Continue collection of seeds and propagation for reintroduction, using hand pollination of flowers to increase seed set, where possible. (USFWS, 2013)
- Population biology research. Consider crossing isolated male trees with isolated female trees, even if in distant populations. Continue research to find the best seed storage methods and to identify and control other seed predator insects. (USFWS, 2013)
- Continue research on methods to control the black twig borer. (USFWS, 2013)
- Continue ungulate fencing of suitable *Alectryon micrococcus* habitat. (USFWS, 2013)
- Continue removal of invasive introduced plant species and maintain *Alectryon macrococcus* habitat free of invasive introduced plants. (USFWS, 2013)
- Continue control of rats at wild *Alectryon macrococcus* populations. (USFWS, 2013)
- Initiate planning and contribute to implementation of ecosystem level restoration and management to benefit this taxon. (USFWS, 2013)

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SPECIES ACCOUNT: *Amaranthus brownii* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 08/21/1996; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Amnanthus brownii, a member of the amaranth family (Amaranthaceae), is an annual herb with leafy upright or ascending stems, 30 to 90 cm (1 to 3 ft) long. The slightly hairy, alternate leaves are long and narrow, 4 to 7 cm (1.6 to 2.8 in) long, 1.5 to 4 mm (0.06 to 0.16 in) wide, and more or less folded in half lengthwise. Flowers are either male or female, and both sexes are found on the same plant. The green flowers are subtended (embraced) by two oval, bristle-tipped bracts about 1 mm (0.04 in) long and 0.7 mm (0.03 in) wide. Each flower has three bristle-tipped sepals which are lance-shaped and 1.3 mm (0.05 in) long by 0.8 mm (0.03 in) wide in male flowers and spatula shaped and 0.8 to 1 mm (0.03 to 0.04 in) long by 0.2 to 0.5 mm (0.01 to 0.02 in) wide in female flowers. Male flowers have three stamens; female flowers have two stigmas. The flattened, oval fruit, which does not split open at maturity, is 0.8 to 1 mm (0.03 to 0.04 in) long and 0.6 to 0.8 mm (0.02 to 0.03 in) wide and contains one shiny, lens-shaped, reddish black seed. This species can be distinguished from other Hawaiian members of the genus by its spineless leaf axils, its linear leaves, and its fruit which does not split open when mature (Wagner et al. 1990). (USFWS, 1998)

Taxonomy

Amnanthus brownii is the only member of this genus found in the Hawaiian Islands and is endemic to Nihoa. (USFWS, 1998)

Current Range

This species is only found on Nihoa in the Northwestern Hawaiian Islands. (NatureServe, 2015)

Critical Habitat Designated

Yes; 5/22/2003.

Legal Description

On May 22, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Amaranthus brownii* on the island of Nihoa, Hawaii.

Critical Habitat Designation

The critical habitat designation for *Amaranthus brownii* includes one unit totaling 171 acres on Nihoa. The unit is Nihoa 1—*Amaranthus brownii*.

Nihoa 1—*Amaranthus brownii*: This unit is critical habitat for *Amaranthus brownii* and is 69 ha (171 ac) on federally owned land. It includes the entire island, which is part of the HINWR. The unit is currently unoccupied but provides habitat that is essential to the conservation of up to 500 reproducing individuals of this annual species endemic to Nihoa. The area designated as critical habitat is considered to be the most likely to contain a viable seed bank of *Amaranthus brownii*. The habitat features contained in this unit that are essential for this species include, but are not limited to, shallow soil and rocky outcrops in fully exposed locations that contain one or

more of the following associated native plant species: *Chenopodium oahuense*, *Eragrostis variabilis*, *Ipomoea indica*, *Ipomoea pes-caprae* ssp. *brasiliensis*, *Panicum torridum*, *Scaevola sericea*, *Schiedea verticillata*, *Sicyos pachycarpus*, *Sida fallax*, and *Solanum nelsonii*. This critical habitat unit is essential to the conservation of the species because it supports habitat for the re-establishment of populations of this endemic species.

Primary Constituent Elements/Physical or Biological Features

On Nihoa, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

- (1) Shallow soil in fully exposed locations on rocky outcrops and containing one or more of the following associated native plant species: *Chenopodium oahuense*, *Eragrostis variabilis*, *Ipomoea indica*, *Ipomoea pes-caprae* ssp. *brasiliensis*, *Panicum torridum*, *Scaevola sericea*, *Schiedea verticillata*, *Sicyos pachycarpus*, *Sida fallax*, or *Solanum nelsonii*; and
- (2) Elevations between 30 and 242 m (100 and 800 ft).

Special Management Considerations or Protections

Within the critical habitat boundaries, section 7 consultation is generally necessary, and adverse modification could occur only if the primary constituent elements are affected. Therefore, not all activities within critical habitat would trigger an adverse modification conclusion. In addition, existing manmade features and structures within boundaries of the mapped unit do not contain one or more of the primary constituent elements and would be excluded under the terms of this proposed regulation. Federal actions limited to those areas would not trigger a section 7 consultation unless they affect the species or primary constituent elements in adjacent critical habitat.

The following management actions are ranked in order of importance: (1) Nonnative plant control; (2) Rodent control; (3) Invertebrate pest control; (4) Fire control; (5) Maintenance of genetic material of the endangered plant species; (6) Propagation, reintroduction, and/or augmentation of existing populations into areas deemed essential for the recovery of the species; (7) Ongoing management of the wild, outplanted, and augmented populations; (8) Maintenance of natural pollinators and pollinating systems, when known; (9) Habitat management and restoration in areas deemed essential for the recovery of the species; (10) Monitoring of the wild, outplanted, and augmented populations; (11) Rare plant surveys; and (12) Control of human activities/ access.

Life History**Food/Nutrient Resources****Lifespan**

Adult: 1 year (USFWS, 1998)

Reproduction Narrative

Adult: *Amaranthus brownii* is an herbaceous annual with a growing season that extends from December to June or July. (USFWS, 1998)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Shrubland/chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 30 and 242 meters (USFWS, 1998)

Habitat Narrative

Adult: *Amaranthus brownii* typically grows in shallow soil on rocky outcrops in dry shrublands. It is found in fully exposed locations at elevations between 30 and 242 meters (100 and 800 feet). Associated native plant taxa include *Schiedea verticillata*, *Chenopodium oahuense*, *Ipomoea pes-caprae* ssp. *brasiliensis*, *Ipomoea indica*, *Sida fallax*, *Solanum nelsonii*, *Sicyos pachycarpus*, *Eragrostis variabilis*, and *Panicum torridum*. (USFWS, 1998; NatureServe, 2015)

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2010)

Redundancy:

Very low (inferred from USFWS, 2010)

Number of Populations:

Unknown (USFWS, 2017)

Population Size:

Unknown (USFWS, 2017)

Population Narrative:

In 1983, the 2 known colonies were about 0.25 miles apart, near Miller's Peak and in Middle Valley, and totaled about 35 plants (Conant 1985). At the time of listing in 1996, no individuals had been observed since 1983, as all surveys were conducted in the dry summer months when *A. brownii* is difficult to distinguish from other desiccated herbaceous plants. Currently, less than 50 plants observed, estimate less than 100 plants. No extant occurrences observed (between 1982 and 1997) and 2 historical occurrences (1981). (USFWS, 2012; NatureServe, 2015); This species was not observed in previous surveys, including the most recent survey from June 4–9, 2015 (Bruegmann 2015, in litt.). Previous surveys were conducted between August and October, the dry season. The 2015 survey was conducted in June and included intense searching throughout all previously known population sites. *Amaranthus brownii* only germinates and grows in the wet season (December through February); however, ocean conditions are not conducive to visiting Nihoa Island during the wet season. Two surveys, in

1980 and 1981, were conducted over a similar time frame as the 2015 survey. During these surveys, plants were observed to be vegetative, budding and flowering, bearing immature and mature fruit, or dead. If possible, additional surveys should be conducted towards the end or immediately following a wet season. (USFWS, 2017)

Threats and Stressors

Stressor: Invasive plant species (USFWS, 1998; USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Pigweed, an alien species, is widespread on Nihoa and grows in habitat similar to *Amaranthus brownii*. Pigweed may pose a threat by outcompeting *Amaranthus* for space, moisture, and nutrients. Other alien plant and insect species on the island may be posing threats as well. Tangalin (2006) also noted *Tetragonia tetragonoides* (New Zealand spinach) as an invasive species competing with *A. brownii* and recommended the removal of this species from the vicinity of Needle Rock. (USFWS, 1998; USFWS, 2012)

Stressor: Small population size (USFWS, 1998)

Exposure:

Response:

Consequence:

Narrative: Due to the small numbers of populations and individuals, and its limited distribution, this species is threatened by stochastic extinction and/or reduced reproductive vigor. (USFWS, 1998)

Stressor: Alien species (USFWS, 1998)

Exposure:

Response:

Consequence:

Narrative: Fire, introduction of rats, and other human disturbances also pose potential threats. (USFWS, 1998)

Stressor: Human disturbances (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: At the time the Service listed *Amaranthus brownii*, we identified historical disturbance of habitat by Polynesian settlement of Nihoa as a possible explanation for a reduction in its total numbers. Currently, the only legal visitors to the island include Service personnel or permitted scientific researchers who are aware of the fragile nature of Nihoa's environment and are required to follow strict conservation guidelines while on the island. There has been no evidence of trespassing over a 20-year period of nearly annual visits by U.S. Fish and Wildlife Service Refuges staff (Beth Flint, pers. comm. 2006). Although there is the potential for unauthorized landings and subsequent habitat disturbances, the difficulty in landing and accessing the island makes this an unlikely possibility. (USFWS, 2007)

Stressor: Substrate changes (USFWS, 2007)

Exposure:**Response:****Consequence:**

Narrative: An additional threat to this species includes substrate changes (such as erosion, rock slides, and landslides) to its rocky outcrop habitat. (USFWS, 2007)

Stressor: Insect damage (USFWS, 2007)

Exposure:**Response:****Consequence:**

Narrative: Perhaps the greatest current threat to the native biota of Nihoa is predation by the nonnative grasshopper *Schistocerca nitens*, which has caused widespread defoliation of the island's vegetation over the last few years (Factor C) (Wegmann, in litt. 2002; Gilmartin 2005). The grasshopper was first recorded on Nihoa in the early 1980s, but it was not until 2002 and again in 2004 that vegetation on Nihoa was denuded by it. Botanist Steve Perlman visited Nihoa in 2004 for the purpose of surveying for rare plant species and did not observe any individuals of *A. brownii*. The high population level of the alien grasshopper had resulted in the widespread defoliation of the vegetation on the island, thereby increasing the difficulty in detecting any *A. brownii* that may have been present (Steve Perlman, National Tropical Botanical Garden, pers. comm. 2006). (USFWS, 2007)

Recovery**Reclassification Criteria:**

1. A total of at least five colonies of each taxon should exist on Nihoa and successful propagation and outplanting ex situ must be underway for each taxon. (USFWS, 1998)
2. Each of these colonies must be stable, secure, and naturally reproducing with a preliminary target of a minimum number of 500 mature individuals per colony (USFWS, 1998)
3. Each colony should be stable or increasing for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:

1. Establishment of one to three additional colonies on an island other than Nihoa. (USFWS, 1998)
2. Should establishment of one to three colonies of any or all of these taxa on an island other than Nihoa occur, delisting may be considered when there are a minimum of 500 mature individuals. (USFWS, 1998)
3. If the establishment of any or all of these taxa on a second island proves unfeasible, delisting may be considered if the downlisting objectives have been met and the colonies persist at target levels for a minimum of 10 years. (USFWS, 1998)

Recovery Actions:

- Immediate recovery actions should include a winter expedition to monitor and map remaining populations and to collect seeds and/or cuttings to establish ex situ populations. (USFWS, 1998)
- Increasing the numbers and locations of this species on Nihoa will be critical to its ultimate survival and recovery. Considerable work will need to be done to identify, prepare, protect, and monitor sites for establishing new wild populations, particularly if the sites are outside of the historic range. (USFWS, 1998)

Conservation Measures and Best Management Practices:

- Conduct surveys for *Amaranthus brownii* late in the wet season, when there is a better chance of observing sprouting individuals. (USFWS, 2012)
- If the species is rediscovered, secure vegetative material or fruit for ex situ cultivation and genetic storage. (USFWS, 2012)
- If ex situ cultivation is successful, consider establishing new populations in suitable habitat on other islands in the Northwestern Hawaiian Islands, preferably on the adjacent Necker Island. (USFWS, 2012)
- Continue to control invasive plant species that compete with the species around all populations, especially *Portulaca oleracea* and *Tetragonia tetragonioides*. (USFWS, 2012)
- Continue to monitor the threat of nonnative grasshoppers (*Schistocerca nitens*) to the species. (USFWS, 2012)
- Invertebrate control research: conduct research to collect data that will facilitate in the suppression of the grasshopper on Nihoa. Also, develop a list of possible control measures for nonnative grasshoppers. (USFWS, 2012)

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SPECIES ACCOUNT: *Amaranthus pumilus* (Seabeach amaranth)

Species Taxonomic and Listing Information

Listing Status: Threatened; 4/7/1993; Southeast Region (R4) (USFWS, 2015)

Physical Description

An annual herb with reddish-colored, prostrate, highly branched stems that form clumps, often reaching 30 cm in diameter. Leaves are spinach-green, clustered towards the tips of the stems. Flowers and fruits are inconspicuous. (NatureServe, 2015)

Historical Range

Formerly occurred from vicinity of Charleston, SC north to islands south of Cape Cod, MA. Actual area formerly occupied was quite small; occurring only in a narrow band of suitable habitat. (NatureServe, 2015)

Current Range

Extant from vicinity of Cape Hatteras, NC, to vicinity of Cape Romain, SC, and at scattered sites on Long Island, NY, and in coastal Delaware, Maryland, Virginia, and New Jersey. (NatureServe, 2015) Populations in the latter four states were not known at the time of listing, but were subsequently rediscovered. (USFWS, 2007)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Annual seed production (USFWS, 1996)

Lifespan

Adult: Less than one year (USFWS, 1996)

Breeding Season

Adult: April to January (USFWS, 1996)

Other Reproductive Information

Adult: Probably wind pollinated (USFWS, 1996)

Reproduction Narrative

Adult: Flowering of the Seabeach Amaranth begins as soon as plants have reached sufficient size, typically commencing in July and continuing until their death in late fall or early winter. Seed production begins in July or August and reaches a peak in most years in September; also continuing until the plant dies. Seeds are regularly produced by nearly all adult plants; fertility is assumed to be high (Baskin and Baskin 1994). The relative roles of the fresh seed crop and banked seeds from previous years are unknown in seabeach amaranth. Weather events

(including rainfall, hurricanes, and temperature extremes) and predation by webworms can significantly reduce the length of the reproductive season. Based on morphology of the flower and inflorescence, seabeach amaranth is probably wind-pollinated, as are most species of amaranth. It is clear that seabeach amaranth is capable of self-pollination, and it is likely that self-pollination plays a large, probably dominant, role in seed production. Seeds may survive many years buried in the sand; they germinate when brought near the surface by severe storms. The seabeach amaranth is a classic example of a fugitive species--"an inferior competitor which is always excluded locally under interspecific competition, but which persists in newly disturbed habitats by virtue of its high dispersal ability; a species of temporary habitats" (Lincoln et al. 1982). (USFWS, 1996)

Habitat Type

Adult: Terrestrial (USFWS, 1996)

Habitat Vegetation or Surface Water Classification

Adult: Sparsely vegetated sand (USFWS, 1996)

Dependencies on Specific Environmental Elements

Adult: Requires tidal overwash (USFWS, 1996)

Geographic or Habitat Restraints or Barriers

Adult: Occurs 8 inches to 5 feet above mean high tide. (USFWS, 1996)

Spatial Arrangements of the Population

Adult: Sparse (USFWS, 2007)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 1996)

Habitat Narrative

Adult: The species occurs on barrier islands, mainly on coastal overwash flats at the accreting ends of the islands and lower foredunes and on ocean beaches above mean high tide (occasionally on sound-side beaches). It is intolerant of competition, not occurring on well-vegetated sites. According to Weakley and Bucher (1991), this species appears to need extensive, dynamic, natural areas of barrier island beaches and inlets, especially with fresh sand. Within this dynamic landscape, this amaranth functions as a fugitive species, occupying suitable habitat as it becomes available. (NatureServe, 2015)

Dispersal/Migration**Motility/Mobility**

Adult: Moderate for seeds (USFWS, 2007)

Dispersal

Adult: Moderate for seeds (USFWS, 2007)

Dispersal/Migration Narrative

Adult: Seabeach amaranth produce numerous seeds. Seeds are blown along the surface of the sand to reach new habitat within an island. They also float in water. In addition to being washed inland by waves, the seeds can withstand the conditions necessary to move among islands. It is also likely that they have the ability to persist as seed banks in inlets and possibly offshore (Strand 2002). (USFWS, 2007)

Additional Life History Information

Adult: Seeds may survive many years buried in the sand; they germinate when brought near the surface by severe storms. (USFWS, 2007)

Population Information and Trends**Population Trends:**

Declining (USFWS, 2007)

Species Trends:

Declining (USFWS, 2007)

Resiliency:

Low (NatureServe, 2015)

Representation:

Vulnerable (NatureServe, 2015)

Redundancy:

Vulnerable (NatureServe, 2015)

Number of Populations:

21 - 300 (NatureServe, 2015)

Population Size:

5948 (3-year average from 2013-2015; USFWS, 2018)

Adaptability:

Low (inferred from USFWS, 2007)

Population Narrative:

Given the fugitive nature of the species and the constantly changing environment where it occurs, it is difficult to make determinations about population size or trends based on limited data from annual surveys which had only been conducted for the last ten years (as of 2007). Northern populations are generally seen as declining, but southern populations fluctuate significantly, which is consistent with its occurrence in a geologically dynamic landscape. Total seabeach amaranth numbers reported in 2005 range-wide surveys were the lowest since 1999. Annual census data indicate up to 100,000 individuals, with up to 300 populations. However, in many cases, groups of existing mapped sites should be lumped to represent single, dynamic populations. Once the occurrences are re-mapped in this fashion, the range-wide number may be on the order of 30-50. (USFWS, 2007; NatureServe, 2015); USFWS provided detailed Census Data on the Seabeach amaranth in the addendum to the 2007 5-year review (USFWS, 2018).

Threats and Stressors

Stressor: Beach hardening (sea walls, jetties, rip-rap, etc) (USFWS, 1996)

Exposure:

Response:

Consequence:

Narrative: The primary threat to the seabeach amaranth is from beach-hardening (sea walls, riprap, etc.) that prevents sand accretion. Dune fencing was thought to be a significant threat. Seabeach amaranth often occurs around sand fencing on newly created dunes. It doesn't appear that sand fencing is detrimental to the species, but the dune stabilization that they facilitate encourages other vegetation to colonize these areas and effectively reduces habitat for seabeach amaranth. (USFWS, 2007)

Stressor: Development (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Development of barrier islands, especially by hotels and condominiums, threatens the seabeach amaranth by removing potential habitat, by stabilizing beaches, and by introducing non-native competing vegetation. Beach nourishment projects and beach raking are also associated with development. (USFWS, 2007)

Stressor: Pedestrians (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Pedestrian impacts are most common on beaches in resort towns and especially in close proximity to large hotels and condominiums. In populated areas, there is often an increase in human traffic on the sand. Beach chairs and umbrellas are frequently set up in the upper beach area near the edge of the dunes and informal sand volleyball courts are delineated on the upper beach. (USFWS, 2007)

Stressor: Off-road vehicles (USFWS, 1996)

Exposure:

Response:

Consequence:

Narrative: While seabeach amaranth populations are somewhat tolerant of ORV use from December until May, the brittle, fleshy stems are easily broken, and growing plants (May to December) do not generally survive a single pass by a truck tire. Thus, even minor beach traffic directly across the plants during the growing season is detrimental, causing mortality and reduced seed production. It appears that vehicles are most harmful to seabeach amaranth on beaches that are less accessible to pedestrians. Often, little to no seabeach amaranth is found in areas that receive high ORV use. (USFWS, 1996; USFWS, 2007)

Stressor: Beach raking. (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: On many beaches, especially those used recreationally, vehicles are regularly driven along the beach pulling various types of rakes in order to collect trash, seaweed, marsh grasses and other things that are considered undesirable to human beach visitors. This activity increases the potential of running over, or pulling up seabeach amaranth plants. Little vegetation occurs in the areas where beach raking occurs (Steve Sinkevich, USFWS, Long Island Field Office, pers. comm., 2006). (USFWS, 2007)

Stressor: Herbivory by webworms (USFWS, 1996)

Exposure:

Response:

Consequence:

Narrative: At least 4 species of webworms, along with other larval insects are known to feed on seabeach amaranth, as well as other plant species. The insect threat is variable from year to year and is more important in southern seabeach amaranth populations. In addition, deer, feral horses, nutria, rabbits, and songbirds have been observed feeding on the seabeach amaranth. While impacts from predation are localized, poorly understood and mostly based on observations, it is generally believed that vertebrate predators may negatively affect seabeach amaranth growth and reproduction, while invertebrates do not. (USFWS, 2007)

Stressor: Climate change (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: According to NOAA's Tides and Currents web page, the mid Atlantic coast is currently experiencing a rise in mean sea level of 0 to 2 feet per century. Given that Seabeach amaranth grows at very low elevations and is often the species found growing closest to the ocean, even a minor rise in sea level could be detrimental to existing populations. (USFWS, 2018)

Stressor: Disease or predation (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: At the time of the listing, webworms were the only known predator of seabeach amaranth. Since that time, several species of animals have been identified as feeding on seabeach amaranth. While impacts from predation and disease on seabeach amaranth plants are localized, poorly understood, and mostly based on observations, it is generally believed that vertebrate predators may negatively affect seabeach amaranth growth and reproduction, while invertebrates do not. (USFWS, 2018)

Recovery**Delisting Criteria:**

Delisting will be considered when a minimum of 75 percent of the sites with suitable habitat within at least six of the nine historically occupied States are occupied by seabeach amaranth populations for 10 consecutive years. (USFWS, 1996)

Recovery Actions:

- Survey suitable habitat for additional populations. (USFWS, 1996)
- Monitor and protect existing populations including enforcement of laws protecting the species and/or its habitat. (USFWS, 1996; USFWS, 2015)
- Determine habitat protection priorities. (USFWS, 1996)
- Determine and implement the management necessary for long-term reproduction, establishment, maintenance, and vigor. (USFWS, 1996)
- Conduct research on the biology of the species including long-term demographic studies and determining the effects of past and ongoing habitat disturbance. (USFWS, 1996; USFWS, 2015)
- Develop techniques and reestablish populations in suitable habitat within the species' historic range. (USFWS, 1996)
- Develop a cultivated source of plants and provide for long-term seed storage. (USFWS, 1996)
- Establish new populations or rehabilitate marginal populations to the point where they are self-sustaining. (USFWS, 1996)
- Investigate and conduct necessary management activities at all key sites, and annually assess the success of recovery efforts. (USFWS, 1996; USFWS, 2015)
- Prepare articles for popular and scientific publications; prepare and distribute news releases and informational brochures. (USFWS, 2015)

Conservation Measures and Best Management Practices:

- Revise or clarify sections of the Recovery Plan to determine when the recovery criteria have been met. The recovery plan does not define some terms used and other recovery criteria need to be clarified. Recovery criteria in future amendments or revisions need to include additional threats in the listing package that were not included in the 1996 Recovery Plan. (USFWS, 2007)
- Define what constitutes "Likely to Adversely Affect" and "Jeopardy" for this species in order to improve consistency in USFWS consultations. (USFWS, 2007)
- Develop a list of list of conservation measures that Service biologists can use in formal consultations that address impacts to seabeach amaranth. (USFWS, 2007)
- Develop survey protocols, continue annual range-wide monitoring, and submit annual survey data to the lead recovery biologist for analysis. (USFWS, 2007)
- Develop management recommendations in accordance with USFWS policy. (USFWS, 2007)
- Develop guidelines for restoration, augmentation and transplantation. (USFWS, 2007)
- Discuss potential impacts of ORV use and beach raking with local governments. (USFWS, 2007)
- Ensure that seed collections and herbarium specimens represent a variety of populations from throughout the species range. (USFWS, 2007)
- Work with academic institutions to address the additional research needs. (USFWS, 2007)
- Work with partners to revise the photo identification cards, produce interpretive signs for beach access sites, encourage media coverage, and maintain an up-to-date web site. (USFWS, 2007)

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SPECIES ACCOUNT: *Ambrosia cheiranthifolia* (South Texas ambrosia)

Species Taxonomic and Listing Information

Listing Status: Endangered; 9/23/1994; Southwest Region (R2)

Physical Description

an herbaceous, ashy blue-gray, rhizomatous perennial in the Asteraceae Family (sunflowers) (Figure 4). Stems of the plant stand erect and are approximately 10–60 cm (3.9– 23.6 in) tall. The number of individuals at any site is difficult to count due to rhizomatous growth habits that produce multiple stems from plants that are growing in closely-spaced colonies, thus inhibiting accurate stem number counts. The leaves are usually opposite at the base, and alternate above. The leaves are mostly oblanceolate or oblong-lanceolate, 2–7 cm (0.8–2.8 in) long, depending on the area of placement and the age of the stem, with the blade narrowing gradually at the base. Most leaves are unlobed and entire, although the lower and larger leaves of juvenile plants may be undulate or shallowly-pinnate. Both sides of the leaves appear whitened due to a fine and short appressed pubescence, giving the leaf an ashy, blue-gray color. The inflorescence is usually unbranched and composed of separate, inconspicuous male and female flowers. The male flowers occur in a terminal raceme 5–10 cm (2–4 in) long, composed of 10–12 small, light yellow, saucer-shaped flowers that are about 4 mm (0.16 in) broad with 4–6 acute, triangular lobes. The female flowers are in small clusters in the axils of the leaves. The fruit is an achene, somewhat angled and long with a stout beak. The fruit has 4- 5 blunt spines spread across the surface (Poole et al. 2007). (USFWS, 2018)

Taxonomy

In the Asteraceae (sunflower) family. The first ambrosia collection on record was taken by Luis Berlandier in 1835 in San Fernando, Tamaulipas, Mexico (USFWS 1993). In 1859, Asa Gray named the plant *Ambrosia cheiranthifolia* (Payne 1964). In 1932, the first collection of *Ambrosia cheiranthifolia* in the United States was taken from an area near Barreda (now Russelltown) in Cameron County, Texas, by Robert Runyon (Turner 1983). (USFWS, 2018)

Historical Range

Nueces County, Texas, on the north; as far south as San Fernando in Tamaulipas, Mexico, a distance of approximately 322 kilometers (USFWS, 2018).

Current Range

In Texas, north-central Kleberg County through north-central Nueces County. (USFWS, 2018)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Abiotic, Insect (EPA, 2016)

Breeding Season

Adult: Flowers and fruits in late summer and fall (EPA, 2016)

Key Resources Needed for Breeding

Adult: Wind and possibly insects for pollination (USFWS, 2010)

Reproduction Narrative

Adult: More often than not ambrosia is seen reproducing vegetatively by rhizomatous regrowth in the upper portion of the soil. As a result, a single individual may be represented by several-tohundreds of stems, depending on the age of the plant (Turner 1983). The most current scientific information suggests that ambrosia patches represent several separate individual members of a larger metapopulation, as is thought to be the case on NASK. In 2010, Overath began work on NASK ambrosia to answer a number of genetics-related questions including variation within patches (whether dominated by one or a few clones) and relatedness among patches; as well as analysis of the genotypes within patches. Overath (pers. comm. 2012) found little genetic variation among ambrosia samples collected and compared to 13 genetic markers, implying that all the separate patches on NASK are likely part of one larger population (or metapopulation). Small patches of ambrosia may be part of the same clone, but larger patches are not composed of single clones (Overath 2013b). However, these genetic studies also suggested that some NASK ambrosia patches (2013b) were reproducing sexually or that they had in the relatively recent past. Overath's genetic studies to determine the reproductive mode at other sites, including the St. James Cemetery (Nueces County), are incomplete at this time. (USFWS, 2018)

Habitat Type

Adult: Terrestrial (USFWS, 2018)

Habitat Vegetation or Surface Water Classification

Adult: Coastal grasslands and shrublands (USFWS, 2018)

Geographic or Habitat Restraints or Barriers

Adult: Low elevations; 26 to 66 ft

Habitat Narrative

Adult: This plant grows in the Gulf coastal grasslands of southern Texas, and is found in grassland and mesquite shrubland habitat on various soils. It is associated with sites where native short-grass prairie species persist, and also on moderately disturbed sites such as cemeteries, right-of-ways, roadsides, parkfields, and eroded areas along creeks. Typically grows on well-drained, heavy soils associated with subtropical woodland communities. Found in various soils, both heavy clays to lighter-textured sandy loams, mostly of the Beaumont and Victoria Clay series (EPA, 2016).

Dispersal/Migration**Motility/Mobility**

Adult: Insect, Bird, Mammal (EPA, 2016)

Dispersal/Migration Narrative

Adult: Thought to be dispersed by wind (USFWS, 2010). Burred seeds suggest dispersal by animals (birds or mammals) (EPA, 2016).

Population Information and Trends

Population Trends:

Not available.

Species Trends:

Not available.

Number of Populations:

7 (USFWS, 2019)

Population Size:

Uncertain (USFWS, 2019)

Population Narrative:

As of 2014, there are seven extant, or presumed extant, ambrosia populations from north-central Kleberg County through north-central Nueces County. One site occurs on state land, on both the north and southbound ROWs of US Hwy 77. The largest population occurs on Federal land at the Naval Air Station Kingsville (NASK). There are two sites on city or county-owned lands; the Bishop City Park and the Nueces County Park in Robstown. Two sites are located on private land, including a large population at the St. James Cemetery in Bishop and a small group of plants on a lot in Kingsville (General Cavazos Boulevard). Additionally, a National Guard training area formerly leased from a private landowner, known as the KRTA, has several sites (Table 9). These KRTA populations became inaccessible and thus unverifiable after the lease expired in the mid-1990s. Observations using Google Earth show the habitat still exists and the ambrosia is assumed to be extant. All of these separate KRTA occurrences are less than 1.0 kilometer (km) (3, 280 feet (ft)) apart and may therefore be a single metapopulation. The same is true for the occurrences in the St. James Cemetery, Bishop City Park, and the US Hwy 77 ROW, as well as the separate patches of ambrosia on NASK (see paragraph below). If the ambrosia is sexually reproducing, the close proximity between occurrences allows for the genetic exchange between each occurrence, or sub-population, and may mean that these sub-populations constitute at least 3 different metapopulations based on these distances. The population at Robstown and the one in Kingsville would be considered separate populations. (USFWS, 2018)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Invasion of short-grass prairie by non-native grasses, conversion of native prairie to row crops and improved pasture, development in urban and rural areas, and restricted geographic distribution and abundance are historic, as well as ongoing, habitat-related threats (USFWS, 2010).

Stressor: Limited genetic diversity (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The current limited geographic distribution of *A. cheiranthifolia* may be expected to result in lower genetic diversity due to a lack of gene exchange through pollen, seed, or ramets between different sub-populations and populations. The existence of the species in fragmented, unconnected habitat patches can lead to restrictions in genetic variability, reducing the species' ability to overcome environmental stresses, especially during stochastic events or in response to climate change, and thereby render the populations vulnerable to extirpation and extinction (USFWS, 2010).

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Projected climate changes across the South Texas plains and the southern coastal region include higher temperatures, more frequent and prolonged droughts, and intensified rainfall events (Intergovernmental Panel on Climate Change 2007). These climatic conditions can cause or exacerbate direct stress to vegetation communities and individual plant species by decreasing water availability, altering temperature regimes to which the species has adapted, and subjecting the plants to flooding and potentially increased erosion from more severe storms (USFWS, 2010).

Stressor: Drainage improvements (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Since most of the plants are located near or along drainage corridors and in close proximity to one another, improvements or diversion of water could perhaps impact the species. These improvements could cause an increase/decrease in water amounts reaching natural drainages, cause a channelizing of natural drainage routes, and cause habitat fragmentation to an existing population or otherwise potential sites of *A. cheiranthifolia* (USFWS, 2010).

Stressor: Effects of pesticide drift (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Remaining areas of the native coastal prairie habitat of *A. cheiranthifolia* populations are surrounded by agricultural fields, pastures, and urban development, from which aerial drift of pesticides has potential to harm or kill individuals of the species. Insecticides could be considered a potential threat because they can directly or indirectly kill pollinators of *A. cheiranthifolia* (USFWS, 2010).

Recovery

Reclassification Criteria:

Downlisting Criteria 1: A recommended minimum of nine populations are necessary for downlisting and should have at least 7,500-15,000 mature stems per population. Each population should be stable or increasing over the next 20 years. The extant populations (seven total), as well as any that may be restored, augmented, or created, should be maintained with at least one natural population located in each of the drainage systems (Oso, Chililpitin Creek-San Fernando, Alazan Bay-Baffin Bay, and Santa Getrudis Creek basins) where the species is known to naturally occur to ensure genetic representation. (USFWS, 2018)

Downlisting Criteria 2: Each ambrosia site should be managed for and support high quality shortgrass prairie habitat. High quality shortgrass prairie habitat has these characteristics: 1) occurs in unplowed, relatively undisturbed soils; 2) has a high diversity and high vegetative cover of native grasses and forbs; 3) has a low vegetative cover of introduced grasses; and, 4) has a low vegetative cover of woody species (i.e. native brush). High quality shortgrass prairie habitat should contain species commonly associated with ambrosia (see Table 7 of 2018 Recovery Plan). Although ideal high quality shortgrass prairie habitat would be located in unplowed/undisturbed habitat areas, this scenario means only remnant pieces of land in Nueces County which has been largely converted to cropland, and is restricted in Kleberg County to areas that can be accessed for plant surveys. As a consequence, existing patches of shortgrass prairie may need intensive restoration or habitat may need to be created on areas that are currently devoid of vegetation due to previous land use. Unplowed/undisturbed habitats should be sought out and restored as a priority before attempting creation of new habitat amidst disturbed shortgrass prairie. Prolific and aggressive nonnative grasses and woody species should not constitute more than small patches within each high quality shortgrass prairie site and these undesirable species should not be spreading throughout the site or inhibiting growth and reproduction of ambrosia. Each ambrosia site should be managed and monitored appropriately to ensure the maintenance and restoration of high quality shortgrass prairie habitat and to minimize and control threats over a period of 20 years. (USFWS, 2018)

Delisting Criteria:

Delisting Criteria 1: A minimum of 15 populations are necessary for delisting and should have at least 7,500-15,000 mature stems per population. Delisting may be possible if each of these populations remains stable or increasing over a period of 40 years. All extant populations, as well as any that are restored or created in the future, should remain secure. Also, a minimum of one natural population or genetically distinct population is extant within each drainage system (Oso, Chililpitin Creek-San Fernando, Alazan BayBaffin Bay, and Santa Getrudis Creek basins). (USFWS, 2018)

Delisting Criteria 2: At least seven of the populations that meet the delisting MVP minimum will be protected long-term (protection in perpetuity being optimum) via fee title acquisitions, conservation easements, or conservation agreements. These agreements will be between the USFWS, TPWD, or conservation organizations and landowners or land managers controlling areas with suitable habitat who carry out active management under USFWS-approved monitoring and management plans. See Downlisting Criteria 1 for a description of high-quality habitat. (USFWS, 2018)

Recovery Actions:

- 1. Habitat protection and management of all known population sites of South Texas Ambrosia in the United States. - Establish positive working relationships with landowners

- and land managers of all known sites. Maintain contact with all landowners or land managers each year. Educate landowners about the extreme rarity and significance of both the ecosystem and species on their property. Encourage the long-term stewardship of the shortgrass prairie at these sites through technical assistance to landowners; also potentially through long-term leases, conservation easements, and conservation agreements. - Cooperate with landowners and land managers to develop and implement management plans that address landowner and species goals. With willing landowners, determine short- and long-term land use goals and their effects on South Texas Ambrosia. With all cooperating landowners, develop and implement management plans that are beneficial to the species as well as acceptable to landowners and land managers. Develop a monitoring program that is reviewed by the USFWS and other interested parties, with voluntary landowner assistance, to evaluate the effects of management practices on the species and ensure consistent and reliable monitoring of plant populations and management. - Enforce applicable laws and regulations. Work with regulatory agencies (DOD– NASK, TXDOT, TPWD, USDANRCS, and through internal USFWS coordination) to ensure that existing regulations are used to provide adequate protection of current habitat. (USFWS, 2018)
- 2. Monitor South Texas Ambrosia on an annual basis. - Develop a monitoring plan for ambrosia. Monitoring plan will include population assessment and abundance measures to ascertain plant abundance and spread. Monitoring plan will include measurements of habitat conditions, ecological integrity, and conservation status of sites. - Use the approved monitoring plans to annually monitor ambrosia, its habitat, management actions, and threats at extant sites. - Monitor species and biotic communities and assess ecological integrity and conservation status of historic sites. (USFWS, 2018)
 - 3. Initiate studies to gather biological information needed for effective management and recovery of ambrosia. - Determine specific habitat requirements (specifically limiting factors). Study soils and underlying geology. Determine the plant community structure for South Texas Ambrosia. Study community dynamics/ecology. - Study population dynamics. Analyze the demographic structure of all populations. Characterize phenology and assess the most vulnerable stages of life cycle. Determine the primary means of reproduction in the wild. Study pollination biology and determine effective pollination requirements and effective pollinators. Study seed production and dispersal. Study seedling recruitment. Study population genetics to determine the genetic diversity within and among populations. (USFWS, 2018)
 - 4. Survey for additional populations of ambrosia. As more information about the habitat and biology of the species becomes available, determining areas capable of supporting the species may be more predictable. Models, maps, and other tools will be developed showing the vegetative and edaphic characteristics of occupied sites. This information will help to determine where coastal shortgrass prairie habitats currently might remain intact and/or where the species could be located. These potential areas are a high priority to survey and engage in stewardship efforts. These surveys should be performed to locate existing and new populations and for use as potential reintroduction sites in Texas. (USFWS, 2018) (USFWS, 2018)
 - 5. Cooperatively work with landowners and land managers to restore additional shortgrass prairie sites located in one or more of the drainage areas from which ambrosia is known to co-occur. (USFWS, 2018) (USFWS, 2018)
 - 6. Establish seed or propagule banks and ex-situ (botanical garden, refugium, research institute, etc.) populations for the species. These banks and ex-situ populations will be

established using approved reintroduction plans for South Texas Ambrosia (see Recovery Action 7 below). (USFWS, 2018)

- 7. Conduct a reintroduction program on public and private lands where there are willing partners. Evaluate and document the success of different cultivation techniques, site preparation, and other management techniques based on research, and assess any additional information necessary to attempt reintroduction. If reintroduction is feasible, a USFWS-approved Propagation and Reintroduction plan should be developed and implemented for ambrosia. This should provide for all phases of reintroduction, including site selection, site preparation, monitoring, and short- and long-term management strategies, particularly the effective management (eradication and prevention) of nonnative, invasive grass species. Reintroduced populations for South Texas Ambrosia should not be considered successful until they are established, reproductively active, self-perpetuating, and demonstrated to be demographically and genetically viable. (USFWS, 2018)
- 8. Develop an education and outreach program. Develop any necessary educational or outreach materials. Provide educational and outreach materials to landowners and land managers. Provide educational and outreach materials to interested parties including agencies, engineering and consulting firms, developers, utilities, county road associations, and others.
- 9. Conduct Population Viability Analyses (PVA) and update the existing MVPs for the species based on current biological and ecological information. . Investigate South Texas Ambrosia' population genetics to ensure long-term persistence. Develop traditional MVP estimates for South Texas Ambrosia. Reassess the MVP size when new information is made available. (USFWS, 2018)
- 10. Review and track recovery. Maintain the STXPRT to help review the status of South Texas Ambrosia and assess the effectiveness of the management plans and other recovery tasks. Revise the Recovery Plan as appropriate. Develop a post-delisting monitoring plan when appropriate. (USFWS, 2018)

Conservation Measures and Best Management Practices:

- The continued loss of habitat from invasive grasses exceeds impacts from all other currently known threats to *A. cheiranthifolia* in the extant populations in Nueces and Kleberg Counties. Evaluation of best management practices, including prescribed burns, grazing, and mowing, that will favor *A. cheiranthifolia* in these existing population sites is among the highest of priorities. Determining the best methods of controlling invasive plants, particularly introduced grasses, within *A. cheiranthifolia* populations is a critical need (USFWS, 2010).
- Further investigation of reproductive biology in wild populations is needed to ascertain if *A. cheiranthifolia* is reproducing sexually as well as vegetatively. Research is needed to describe pollination ecology and pollinator species of the plant. A thorough genetic analysis of *A. cheiranthifolia*, including a determination of the relatedness of subpopulations and populations, is needed to clarify the genetic diversity that exists within the species. New information collected on the genetics, pollinators, and dispersal of the species may help in understanding maximum or minimum distances between populations that would allow for transfer of genetic material (USFWS, 2010).
- Additional surveys for new populations of *A. cheiranthifolia* are needed in potential habitat areas in both counties, where permission to access land can be attained. Building good relationships with private landowners is a prerequisite to conducting these surveys. The Service, TPWD, and other partners should develop presentations and materials to share with landowners and their

representatives that provide reassurance that threatened and endangered plants will not restrict land uses (USFWS, 2010).

- Soil analyses should be conducted at all known population sites. Soil analysis will help to elucidate the substrate that supports shortgrass prairie in the Texas Coastal Bend region. This would aid in focusing *A. cheiranthifolia* surveys as well as providing information needed to more fully understand habitat requirements for the shortgrass prairie species, including *A. cheiranthifolia*. A reintroduction plan for *A. cheiranthifolia* should be developed that identifies potential sites for both restoration and pilot introduction efforts (USFWS, 2010).
- Annual monitoring of existing populations should be undertaken to monitor status and trends and to evaluate condition of the plants and the habitat (USFWS, 2010).

References

USFWS. 2018. Texas Coastal Bend Shortgrass Prairie Multi-Species Recovery Plan: Including Slender Rush-Pea (*Hoffmannseggia tenella*) and South Texas Ambrosia (*Ambrosia cheiranthifolia*). U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 130 pp. August 23, 2018.

USFWS. 2018. Texas Coastal Bend Shortgrass Prairie Multi-Species Recovery Plan: Including Slender Rush-Pea (*Hoffmannseggia tenella*) and South Texas Ambrosia (*Ambrosia cheiranthifolia*). U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 130 pp. August 23, 2018.

USFWS. 2010. South Texas Ambrosia (*Ambrosia cheiranthifolia*) 5-year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Corpus Christi Ecological Services Field Office Corpus Christi, Texas. 34 pp.

USFWS. 2010. South Texas Ambrosia (*Ambrosia cheiranthifolia*)

5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Corpus Christi, Texas. 34 pp. December 20, 2010. https://ecos.fws.gov/docs/five_year_review/doc3601.pdf

SPECIES ACCOUNT: *Ambrosia pumila* (San Diego ambrosia)

Species Taxonomic and Listing Information

Listing Status: Endangered; 7/2/2002; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

Ambrosia pumila is a clonal herbaceous perennial plant. Individual stems are generally 5 to 30 centimeters (cm) (2 to 12 inches (in)) tall, but may grow to 50 cm (20 in), and are densely covered with short hairs. The leaves are two to four times pinnately divided into many small segments and are covered with short, soft, gray-white, appressed (lying flat on surface) hairs. The species has separate male and female flowers on the same plant (monoecious). Male flowers have no petals, are yellow to translucent, and are borne in clusters on terminal flower stalks. Female flowers have no petals, are yellowish-white, and occur in clusters in the axils of the leaves below the male flower clusters (Nuttall 1840, pp. 344–345; Gray 1882, p. 217; Munz 1935, p. 544; Keck 1959, p. 1103; Ferris 1960, p. 148; Munz 1974, p. 112; Beauchamp 1986, p. 94; Payne 1993, p. 194) (USFWS, 2010).

Taxonomy

Ambrosia is a genus of 35 to 50 wind pollinated species of annuals and perennials in the Asteraceae (sunflower) family. The perennial taxa range from woody shrubs to herbaceous rhizomatous (possessing underground stems) taxa (USFWS, 1999).

Historical Range

Only known from southern San Diego County (Lake Hodges to the border) in the United States and from northern Baja California, Mexico (to Colonet acc. to Oberbauer or to El Arco acc. to Wiggins, or to 23 km south of Parador Catarina acc. to CNDD), California. Also in Riverside County, California (Fish and Wildlife Service 1999) (NatureServe, 2015).

Current Range

Occurs in southern California from northwestern Riverside County, south through western San Diego County, to northwestern Baja California, Mexico (USFWS, 2010).

Critical Habitat Designated

Yes; 11/30/2010.

Legal Description

On November 30, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Ambrosia pumila* (San Diego ambrosia) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six critical habitat units (CHUs), in California (75 FR 74546-74604).

Critical Habitat Designation

The critical habitat designation for *Ambrosia pumila* includes six CHUs (including 12 sub-units) in Riverside and San Diego Counties, California. This species critical habitat encompasses approximately 783 acres (ac) (317 hectares (ha)) (75 FR 74546-74604).

Unit 1: Santa Ana River Watershed: Unit 1 is located in western Riverside County and consists of two subunits totaling approximately, 26 ac (11 ha) of State or local government-owned land, and 85 ac (35 ha) of private land for a total of approximately 112 ac (45 ha) (values do not sum due to rounding). Subunit 1A: Alberhill Subunit 1A is located near Alberhill, north of Lake Elsinore and just west of Interstate Highway 15 in Riverside County, California. This subunit is near the northern base of Alberhill Mountain, and near the intersection of Lake Street and Temescal Canyon Road. Subunit 1A consists of approximately 23 ac (10 ha) of County-owned land, and 18 ac (7 ha) of privately owned land for a total of approximately 41 ac (17 ha). The approximately 23 ac (10 ha) of Countyowned land in Subunit 1A are conserved and currently managed by the Western Riverside County Regional Conservation Authority; transfer of ownership by the County of Riverside to the Western Riverside County Regional Conservation Authority is planned for the near future. This conserved area is not yet receiving active management. This subunit was occupied at the time of listing and remains occupied and, like all other extant occurrences, we also believe this subunit is essential to the conservation of this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Subunit 1A contains the physical and biological features essential to the conservation of *Ambrosia pumila*, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and potentially periodic flooding presumed necessary for the plant's persistence (PCE 1); and coastal sage scrub vegetation, which allows adequate sunlight and airflow for *A. pumila* (PCE 2). The PCEs in this subunit require special management considerations or protection to address threats from nonnative plant species in situations where nonnative species are outcompeting *A. pumila* for resources, and from human encroachment and development. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to *A. pumila* habitat and potential management considerations. Subunit 1B: Nichols Road Subunit 1B is located about 2.1 mi (3.5 km) southeast of Subunit 1A (Alberhill), on the north and south sides of Nichols Road, in Riverside County, California. This subunit is near the southeastern base of Alberhill Mountain, just west of Durant Road and Temescal Creek. Subunit 1B consists of approximately 3 ac (1 ha) of State or local government-owned land, and 67 ac (27 ha) of privately owned land for a total of approximately 70 ac (29 ha) (values do not sum due to rounding). No lands in Subunit 1B are conserved or managed for biological resources. This subunit was occupied at the time of listing and remains occupied, and is essential to the conservation of this species because this subunit (along with Subunit 1A) represents the northernmost occurrences of this species, which is geographically situated to potentially assist this species expand its range northward. Like all other extant occurrences, this subunit is also essential to the conservation of this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). However, due to impacts from unauthorized grading and disking, and a permitted road realignment project, *Ambrosia pumila* within this subunit may be in imminent danger of extirpation. Subunit 1B contains physical and biological features that are essential to the conservation of *A. pumila*, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and periodic flooding presumed necessary for the plant's persistence (PCE 1), and ruderal habitat type, which allows adequate sunlight and airflow for *A. pumila* (PCE 2). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species in situations where nonnative species are outcompeting *A. pumila* for resources, and from activities (grading, construction, human encroachment) that occur in the area. Please see the Special Management Considerations or

Protection section of this rule for a discussion of the threats to *A. pumila* habitat and potential management considerations.

Unit 3: Santa Margarita River Watershed: Unit 3 is located in western Riverside County and consists of two subunits totaling approximately, 8 ac (3 ha) of State or local government-owned land, and 69 ac (28 ha) of private land for a total of 77 ac (31 ha). **Subunit 3A: Santa Gertrudis Creek** Subunit 3A is located about 1 mile (1.6 km) southwest of Unit 2, along the San Diego Aqueduct, south of the intersection of Chandler and Suzi Roads and north of Santa Gertrudis Creek in Riverside County. Subunit 3A consists of approximately 8 ac (3 ha) of Stateowned land and 25 ac (10 ha) of privately owned land for a total of approximately 33 ac (13 ha). No lands in Subunit 3A are conserved or managed for biological resources. This unit was occupied at the time of listing and remains occupied, and like all other extant occurrences, is essential to the conservation of this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Subunit 3A contains physical and biological features that are essential to the conservation of *Ambrosia pumila*, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and periodic flooding presumed necessary for the plant's persistence (PCE 1), and ruderal habitat type, which allows adequate sunlight and airflow for *A. pumila* (PCE 2). The physical and biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats from nonnative plant species in situations where nonnative species are outcompeting *A. pumila* for resources, human encroachment, and utility maintenance activities. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to *A. pumila* habitat and potential management considerations. **Subunit 3B: Murrieta Creek** Subunit 3B is located in the City of Temecula in southwestern Riverside County, California. This subunit is near the western end of 1st Street, just west of Murrieta Creek. Subunit 3B consists of approximately 44 ac (18 ha) of privately owned land. No lands in Subunit 3B are conserved or managed for biological resources. This subunit meets the definition of critical habitat for this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Subunit 3B contains physical and biological features that are essential to the conservation of *Ambrosia pumila*, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and periodic flooding presumed necessary for the plant's persistence (PCE 1), and nonnative grassland habitat type, which allows adequate sunlight and airflow for *A. pumila* (PCE 2). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species in situations where nonnative species are outcompeting *A. pumila* for resources, from human foot and vehicle traffic that may occur in the area, and from development. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to *A. pumila* habitat and potential management considerations.

Unit 4: San Luis Rey River Watershed: Unit 4 is located in northwestern San Diego County and consists of four subunits of approximately 17 ac (7 ha) of State or local government-owned land and approximately 74 ac (30 ha) of privately owned land, for a total of approximately 91 ac (37 ha). **Subunit 4A: Calle de la Vuelta** Subunit 4A is located near junction of State Route 76 and Calle de la Vuelta in unincorporated San Diego County. Subunit 4A consists of approximately 0.8 ac (0.3 ha) of State or local government-owned land and 14 ac (6 ha) of privately owned land, for a

total of approximately 15 ac (6 ha). No lands in Subunit 4A are conserved or managed for biological resources. This subunit was occupied at the time of listing and, like all other extant occurrences, we also believe this subunit is essential to the conservation of this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Subunit 4A contains physical and biological features that are essential to the conservation of *Ambrosia pumila*, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and periodic flooding presumed necessary for the plant's persistence (PCE 1), and ruderal vegetation, which allows adequate sunlight and airflow for *A. pumila* (PCE 2). The PCEs in this subunit may require special management considerations or protection to address threats from nonnative plant species in situations where nonnative species are outcompeting *A. pumila* for resources, human encroachment, road maintenance activities, and future widening of State Route 76. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to *A. pumila* habitat and potential management considerations.

Subunit 4B: Olive Hill Road Subunit 4B is located on the west side of State Route 76, south of Olive Hill Road in unincorporated San Diego County. Subunit 4B consists of approximately 16 ac (6 ha) of State or local government-owned land and approximately 8 ac (3 ha) of privately owned land, for a total of approximately 23 ac (9 ha) (values do not sum due to rounding). No lands in Subunit 4B are conserved (a portion of Subunit 4B is within the Groves mitigation preserve, managed by the California Department of Transportation (Caltrans); this area has not yet been conserved). The occurrence in this subunit was erroneously considered extirpated at the time of listing, but has since been found to be extant. Like all other extant occurrences, we also believe this subunit is essential to the conservation of this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Subunit 4B contains physical and biological features that are essential to the conservation of *Ambrosia pumila*, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and flooding presumed necessary for the plant's persistence (PCE 1), and grassland vegetation which allow adequate sunlight and airflow for *A. pumila* (PCE 2). The PCEs in this subunit may require special management considerations or protection to address threats from nonnative plant species in situations where nonnative species are outcompeting *A. pumila* for resources, human encroachment, road maintenance activities, and future widening of State Route 76. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to *A. pumila* habitat and potential management considerations.

Subunit 4C: Jeffries Ranch Subunit 4C is located approximately 0.7 mi (1 km) southwest of Bonsall Bridge, adjacent to the south side of State Route 76 in the City of Oceanside, San Diego County. Subunit 4C consists of approximately 0.1 ac (0.05 ha) of State or local government-owned land and approximately 33 ac (13 ha) of privately owned land for a total of approximately 33 ac (13 ha). No lands in Subunit 4C are conserved. This subunit was occupied at the time of listing and, like all other extant occurrences, we believe this subunit is essential to the conservation of this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Subunit 4C contains physical and biological features that are essential to the conservation of *Ambrosia pumila*, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and periodic flooding presumed necessary for the plant's persistence (PCE 1), and nonnative grassland vegetation, which allows adequate sunlight and airflow for *A. pumila* (PCE 2). The PCEs in this subunit may require special management considerations or protection to address threats from nonnative plant species in situations where

nonnative species are outcompeting *A. pumila* for resources, human encroachment, road and utility maintenance activities, future widening of State Route 76, and potential development. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to *A. pumila* habitat and potential management considerations. Subunit 4D: Gird/Monserate Hill Subunit 4D is located in the Fallbrook area of northern San Diego County, California. This subunit is adjacent to the north side of State Route 76, almost equidistant from Gird Road (to the west) and Monserate Hill Road (to the east). Subunit 4D consists of 0.7 ac (0.3 ha) of State-owned land and 20 ac (8 ha) of privately owned land, for a total of 21 ac (9 ha) (values do not sum due to rounding). No lands in Subunit 4D are conserved or managed for biological resources. This subunit was occupied at the time of listing and, like all other extant occurrences, we believe this subunit is also essential to the conservation of this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Subunit 4D contains physical and biological features that are essential to the conservation of *A. pumila*, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and periodic flooding presumed necessary for the plant's persistence (PCE 1); and nonnative grassland vegetation, which allows adequate sunlight and airflow for *A. pumila* (PCE 2). The PCEs in this subunit may require special management considerations or protection to address threats from nonnative plant species in situations where nonnative species are outcompeting *A. pumila* for resources, from human encroachment that may occur in the area, and from development and road maintenance. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to *A. pumila* habitat and potential management considerations.

Unit 5: San Dieguito River Watershed— Lake Hodges: Unit 5 is located in central San Diego County and consists of two subunits comprised of approximately 129 ac (52 ha) of State or local government-owned land and approximately 121 ac (49 ha) of privately owned land, for a total of approximately 249 ac (101 ha) (values do not sum due to rounding). This total does not include a portion of Subunit 5B (52 ac (21 ha)) that we have excluded from this designation under section 4(b)(2) of the Act (see the Exclusions under Section 4(b)(2) of the Act section of this rule). Subunit 5A: Lake Hodges East (Via Rancho Pkwy) Subunit 5A is located on the west side of Interstate 15, just north of Lake Hodges and south of Via Rancho Parkway in San Diego County. Subunit 5A consists of approximately 16 ac (6 ha) of State or local government owned land and approximately 5 ac (2 ha) of privately owned land, for a total of approximately 21 ac (9 ha) (values do not sum due to rounding). No lands in Subunit 5A are conserved or managed for biological resources. This subunit was occupied at the time of listing and, like all other extant occurrences, we also believe this subunit is essential to the conservation of this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Subunit 5A contains physical and biological features that are essential to the conservation of *Ambrosia pumila*, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and periodic flooding presumed necessary for the plant's persistence (PCE 1), and nonnative grassland vegetation, which allows adequate sunlight and airflow for *A. pumila* (PCE 2). The PCEs in this unit may require special management considerations or protection to address threats from nonnative plant species in situations where nonnative species are outcompeting *A. pumila* for resources, human encroachment, utility maintenance activities, and potential development. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to *A. pumila* habitat and potential management

considerations. Subunit 5B: Lake Hodges West—Crosby Estates Subunit 5B is located just west of Lake Hodges in the western portion of central San Diego County, California. This subunit is on and adjacent to the west side of the Crosby National Golf Club. Subunit 5B consists of approximately 113 ac (46 ha) of State or local government owned land, 115 ac (47 ha) of privately owned land for a total of approximately 228 ac (92 ha) (values do not sum due to rounding). This subunit meets the definition of critical habitat for this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Subunit 5B contains physical and biological features that are essential to the conservation of *Ambrosia pumila*, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and periodic flooding presumed necessary for the plant's persistence (PCE 1), and nonnative grassland habitat type, which allows adequate sunlight and airflow for *A. pumila* (PCE 2). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species in situations where nonnative species are outcompeting *A. pumila* for resources, from human encroachment that may occur in the area, and from golf course maintenance. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to *A. pumila* habitat and potential management considerations.

Unit 6: San Diego River Watershed— Mission Trails Regional Park: Unit 6 is located in Mission Trails Regional Park in the City of San Diego. Unit 6 consists of approximately 6 ac (3 ha) of State or local government owned land, and approximately 32 ac (13 ha) of privately owned land, for a total of 38 ac (15 ha) (values do not sum due to rounding). This total does not include a portion of Unit 6 (160 ac (65ha)) that we have excluded from this designation under section 4(b)(2) of the Act (see the Exclusions under Section 4(b)(2) of the Act section of this rule). This unit was occupied at the time of listing and remains occupied, and like all other extant occurrences, is essential to the conservation of this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Unit 6 contains physical and biological features that are essential to the conservation of *A. pumila*, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and periodic flooding presumed necessary for the plant's persistence (PCE 1), and nonnative grassland habitat type, which allows adequate sunlight and airflow for *A. pumila* (PCE 2). The physical and biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats from nonnative plant species in situations where nonnative species are outcompeting *A. pumila* for resources, and human encroachment. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to *A. pumila* habitat and potential management considerations.

Unit 7: Sweetwater River Watershed: Unit 7 is located in southwestern San Diego County and consists of three subunits containing approximately 146 ac (60 ha) of federally owned land (San Diego National Wildlife Refuge), approximately 13 ac (5 ha) of State or local government owned land, and approximately 57 ac (23 ha) of privately owned land, for a total of approximately 215 ac (87 ha) (values do not sum due to rounding). Subunit 7A: Jamul Road Subunit 7A is located southeast of the City of El Cajon at and near junction of Jamul Road and Steele Canyon Road, on the north and south sides of Jamul Road. Subunit 7A consists of approximately 3 ac (1 ha) of State or local government owned land, and approximately 36 ac (15 ha) of privately owned land, for a total of approximately 39 ac (16 ha). No lands in Subunit 7A are conserved or managed for

biological resources. This subunit was occupied at the time of listing and remains occupied. This subunit, like all other extant occurrences, is essential to the conservation of this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Subunit 7A contains physical and biological features that are essential to the conservation of *A. pumila*, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and periodic flooding presumed necessary for the plant's persistence (PCE 1), and nonnative grassland habitat type, which allows adequate sunlight and airflow for *A. pumila* (PCE 2). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species in situations where nonnative species are outcompeting *A. pumila* for resources, alterations of site hydrology, and offhighway vehicle use. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to *A. pumila* habitat and potential management considerations.

Subunit 7B: San Diego National Wildlife Refuge (SDNWR) Subunit 7B is located on the San Diego National Wildlife Refuge, south of Sweetwater River between Rancho San Diego Golf Course and the hills to the south, and on the north and south sides of a dirt trail adjoining the end of Par Four Drive in unincorporated San Diego County. Subunit 7B consists of approximately 118 ac (48 ha) of Federal land owned and managed by the Service, and approximately 15 ac (6 ha) of privately owned land, for a total of approximately 133 ac (54 ha). No private lands in Subunit 7B are conserved or managed for biological resources. This subunit was occupied at the time of listing and, like all other extant occurrences, we also believe this subunit is essential to the conservation of this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329 see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Subunit 7B contains physical and biological features that are essential to the conservation of *A. pumila*, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and periodic flooding presumed necessary for the plant's persistence (PCE 1), and nonnative grassland vegetation, which allows adequate sunlight and airflow for *A. pumila* (PCE 2). The PCEs in this subunit may require continued management and protection on federally owned lands to address threats from nonnative plant species in situations where nonnative species are outcompeting *A. pumila* for resources, and human encroachment. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to *A. pumila* habitat and potential management considerations.

Subunit 7C: Steele Canyon Bridge Subunit 7C is located mainly on the east side of State Route 94 on a slope between a concrete-lined ditch and a fence adjacent and parallel to State Route 94, approximately 0.7 mi (1.1 km) southeast of Subunit 7B, in unincorporated San Diego County. A small portion of the subunit is located on the opposite side of State Route 94 just south of Steele Canyon Bridge in a split-rail enclosure. Subunit 7C consists of approximately 28 ac (11 ha) of federally owned land managed by the Service, approximately 10 ac (4 ha) of State or local government owned land, and approximately 6 ac (2 ha) of privately owned land, for a total of approximately 44 ac (18 ha) (values do not sum due to rounding). No private or state/local government owned lands in Subunit 7C are conserved or managed for biological resources. This subunit was occupied at the time of listing and, like all other extant occurrences, we also believe this subunit is essential to the conservation of this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Subunit 7C contains physical and biological features that are essential to the conservation of *Ambrosia pumila*, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and flooding presumed necessary for the

plant's persistence (PCE 1), and nonnative grassland vegetation, which allows adequate sunlight and airflow for *A. pumila* (PCE 2). The PCEs in this subunit may require continued management and protection on federally owned lands to address threats from nonnative plant species in situations where nonnative species are outcompeting *A. pumila* for resources, and human encroachment. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to *A. pumila* habitat and potential management considerations.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Ambrosia pumila* critical habitat consists of two components (75 FR 74546-74604):

(i) PCE 1—Sandy loam or clay soils (regardless of disturbance status), including (but not limited to) the Placentia (sandy loam), Diablo (clay), and Ramona (sandy loam) soil series that occur on or near (up to several hundred meters from but not directly adjacent to) a river, creek, or other drainage, or within the watershed of a vernal pool, and that occur on an upper terrace (flat or gently sloping areas of 0 to 42 percent slopes are typical for terraces on which *Ambrosia pumila* occurrences are found).

(ii) PCE 2—Grassland or ruderal habitat types, or openings within coastal sage scrub, on the soil types and topography described in PCE 1, that provide adequate sunlight, and airflow for wind pollination.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the occupied areas contain the physical and biological features that are essential to the conservation of the species, and whether these features may require special management considerations or protection. The area designated as critical habitat will require some level of management to address the current and future threats to the physical and biological features essential to the conservation of the species. In all units, special management will be required to ensure that the habitat is able to provide for the growth and reproduction of the species. Records indicate that *Ambrosia pumila* historically was known from over 50 locations in San Diego and Riverside counties, but the number of extant occurrences has been dramatically reduced because much of the species' habitat has been impacted by human activities (Burrascano and Hogan 1997, p. 7; Dudek 2000, p. 17; CNDDB 2010). A detailed discussion of threats to *A. pumila* and its habitat can be found in the final listing rule (67 FR 44372, July 2, 2002). The features essential to the conservation of *A. pumila* require special management considerations or protection to reduce the following threats, among others:

- Habitat destruction caused by urban development, including highway and utility corridor construction and maintenance, highway expansion, and development of recreational facilities (such as golf courses and campgrounds). These activities can destroy the PCEs by removing or compacting soil, making habitat unsuitable for *Ambrosia pumila*.
- Soil compaction caused by the creation and use of trails by hikers, horses, and vehicles. *Ambrosia pumila* appears to be tolerant to some level of disturbance caused by trail creation and use; it is often found in the disturbed areas along margins of dirt trails. However, it is found less often in trailways, implying that although the appropriate soil type might be present, soil compaction can alter soil physical characteristics such that the soil can no longer support plant growth (PCE 1).
- Habitat alteration caused by invasion of nonnative plant species that may, if present in large enough numbers,

change the plant assemblage or cover density to the extent that *Ambrosia pumila* plants can no longer receive adequate sunlight and airflow (PCE 2). • Alteration of hydrological and floodplain dynamics, such as channelization and water diversions, (an additional threat not discussed in the listing rule), which can change the frequency of flooding in occupied areas or eliminate natural periodic flooding presumed necessary for the plant's longterm persistence (PCE 1). Special management considerations or protection are required within critical habitat areas to address these threats. Management activities that could ameliorate these threats include fencing *Ambrosia pumila* occurrences and providing signage to discourage encroachment by hikers, horses, and offroad vehicle users; control of nonnative plants using methods shown to be effective (for examples, see CNLM 2008); guiding the design of development projects to avoid impacts to *A. pumila* habitat; and restoring and maintaining natural hydrology and floodplain dynamics of waterways associated with *A. pumila* occurrences where feasible. These management activities will help protect the PCEs for the species by reducing soil compaction (PCE 1), lowering the density of nonnative plants thereby maintaining the appropriate community structure (PCE 2), and maintain periodic flooding of *A. pumila* habitat where possible (PCE 1).

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Vegetative, presumed self-pollination, sexual (USFWS, 2010)

Lifespan

Adult: Unknown - presumed long-lived (USFWS, 2010)

Breeding Season

Adult: May - October (USFWS, 2010)

Key Resources Needed for Breeding

Adult: Winter rains, presumed wind-pollinated (USFWS, 2010)

Reproduction Narrative

Adult: *Ambrosia pumila* spreads vegetatively by means of slender, branched, underground root-like rhizomes from which new aboveground stems (aerial stems or ramets) arise each year (Nuttall 1840, p. 344; Munz 1974, p. 112; Payne 1993, p. 194). Aerial stems of *Ambrosia pumila* sprout from their underground rhizomes in early spring after winter rains, and flower between May and October (Keck 1959, p. 1103). However, aerial stems have been observed sprouting under dry conditions in late fall (A. Folarin, USFWS, 2008, pers. obs.). *Ambrosia pumila* is presumed to be wind-pollinated because most other species of *Ambrosia* are wind pollinated, and because biological pollinators have not been observed visiting *A. pumila* flowers (Johnson et al. 1999, p. 4; Dudek 2000, p. 16; Dudek 2003, p. P-331). Alternatively, pollinator(s) of *A. pumila* may have been extirpated (Dudek 2003, p. P-331). The species is presumed to be capable of self-pollination and of being self-fertile (i.e., self-compatible, where pollen from an individual plant can fertilize an ovule on the same plant, resulting in production of viable seed), because other species of *Ambrosia* are capable of self-pollination (Payne 1976, pp. 171–172). *Ambrosia pumila* is thought to have limited sexual reproductive output due to low production of viable seed

(Johnson et al. 1999, pp. 1–5; Dudek 2000, pp. 16–17; Dudek 2003, pp. P-331–P-332). Low seed production in this species is inferred by the lack of fertile fruits on all but a few preserved *A. pumila* museum specimens (G. Wallace, USFWS, 1999, pers. obs.), and field observers have found seed production in *A. pumila* to be low (Dudek 2000, p. 17; Dudek 2003, p. P-332). The longevity of individual plants is also unknown, although plants with clonal growth patterns tend to be long-lived (Watkinson and White 1985, pp. 44–45; Tanner 2001, p. 1980) (USFWS, 2010).

Habitat Type

Adult: Terrestrial (NatureServe, 2015); riparian (USFWS, 2010)

Habitat Vegetation or Surface Water Classification

Adult: Coastal scrub, grasslands, open floodplains (NatureServe, 2015); vernal pool (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at ~600 ft. or ~1,600 ft. elevation (USFWS, 2010)

Spatial Arrangements of the Population

Adult: Colonial (USFWS, 2010)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from USFWS, 2010)

Habitat Narrative

Adult: Coastal scrub, grasslands, open floodplains and low valley bottoms below 150 m. Persists where disturbance has been superficial (NatureServe, 2015). The species is found primarily on upper terraces of rivers and drainages; however, several patches of the plant occur within the watershed of a large vernal (ephemeral) pool at the Barry Jones (Skunk Hollow) Wetland Mitigation Bank in Riverside County. It is generally found at or below elevations of 487 meters (m) (1,600 feet (ft.)) in Riverside County, and 183 m (600 ft.) in San Diego County (CNDDDB 2010). Because of the clonal nature of *Ambrosia pumila*'s growth, it is not possible to directly determine the number of genetically distinct plants (genets) present in an area simply by counting stems (McGlaughlin and Friar 2007, p. 320). The species is found primarily on sandy loam or clay soils (Johnson et al. 1999, p. 1; Dudek 2000, p. 18; CNDDDB 2010; USDA 2008). The species may also be found in ruderal habitat types (disturbed communities containing a mixture of native and nonnative grasses and forbs) such as fire fuel breaks and edges of dirt roadways (Beauchamp 1986, p. 94; Payne 1993, p. 194; CNDDDB 2010), however nonnative plants can out-compete *A. pumila* plants for resources in some situations. *Ambrosia pumila* consistently occurs in areas near waterways such as upper terraces of rivers or other water bodies. These areas do not necessarily provide high levels of soil moisture, and *A. pumila* is adapted to dry conditions (Keck 1959, p. 1103; Munz 1974, p. 112; Dudek 2000, Appendix A; CNLM 2008, p. 18) (USFWS, 2010).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: The dispersal strategy of *Ambrosia pumila* is unknown. *Ambrosia pumila* seeds lack structures that facilitate dispersal by wind or passing animals (Nuttall 1840, p. 344; Payne 1993,

p. 194). The species may depend on periodic flooding of nearby waterways for dispersal of seeds and rhizomes that can produce new aerial stems (Dudek 2003, p. P- 332) (USFWS, 2010).

Population Information and Trends

Population Trends:

Not available

Resiliency:

Low (inferred from USFWS, 2010; see current range/distribution)

Representation:

Low (inferred from USFWS, 1999)

Redundancy:

Moderate (inferred from USFWS, 2010)

Number of Populations:

16 (USFWS, 2010)

Population Size:

Unknown (USFWS, 2010)

Adaptability:

Low (inferred from USFWS, 2010)

Population Narrative:

Reduced sexual reproduction may negatively impact the ability of the species to adapt to rapid environmental change or environmental change over the long term, which is especially deleterious to a rare species with disjunct occurrences such as *A. pumila* (Dudek 2000, p. 17; Dudek 2003, p. P-332). There are 16 extant native occurrences. Because of the clonal nature of *Ambrosia pumila*'s growth, it is not possible to directly determine the number of genetically distinct plants (genets) present in an area simply by counting stems (McGlaughlin and Friar 2007, p. 320). Number of stems/patches visible each year may vary due to environmental factors (e.g., rainfall or temperature), and reliable, precise stem counts are not often available for occurrences (USFWS, 2010). Payne (1976) notes that self-pollination and self-fertility contribute strong inbreeding, as does seed longevity (USFWS, 1999).

Threats and Stressors

Stressor: Development (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Habitat loss associated with development is the result of destruction and modification of *Ambrosia pumila* habitat (associated soils and plant community) due to filling, grading, discing, construction, landscaping, and other activities. Urban development has displaced habitat supporting one occurrence of *A. pumila* since the species was listed in 2002, and will soon

displace habitat supporting another. Of the 16 currently known extant occurrences of *A. pumila*, 7 are conserved or partially conserved. The remaining 9 of 16 occurrences are not conserved and are more vulnerable to habitat loss from urban development (USFWS, 2010).

Stressor: Nonnative plants (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Nonnative plants continue to encroach upon *Ambrosia pumila* populations and pose a significant threat to the species throughout its range (CNDDDB 2010; CNLM 2009, p. 3; Folarin, 2008, 2009, pers. obs.). Since listing, no research has been done to clarify the specific effects of nonnative plants on *A. pumila*. A recent study by CNLM demonstrated that reduction of nonnatives increases percent cover of *A. pumila* (CNLM 2008, p. 5; 2009, pp. 8 - 9) (USFWS, 2010).

Stressor: Fuel modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Weed abatement, fire suppression, and landscaping practices (including mowing, discing, and plowing) are fuel modification activities that were recognized as a threat to several occurrences of *Ambrosia pumila* in the listing rule. Mowing *A. pumila* plants, if done in midsummer to early fall, can remove flowering portions of the aerial stems, thus decreasing or preventing seed output. Mowing stems at other times may reduce the vegetative vigor of the plants. Discing, grading, or plowing occupied areas can break apart stems and rhizomes and leave rhizomes vulnerable to desiccation, potentially killing plants. Grading can also remove stems and rhizomes from a site completely (USFWS, 2010).

Stressor: Recreation (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Human encroachment into *Ambrosia pumila* habitat on foot, bicycles, or horses can result in trampling of *A. pumila* stems along often-used trails (Dudek 2000, p. 20). Trampling and soil compaction were identified in the listing rule as a significant threat to *A. pumila*, affecting the species through direct destruction of stems and affecting its habitat by reducing percolation of water into the soil. The effects of soil compaction on *A. pumila* are not known (USFWS, 2010).

Stressor: Fragmentation (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Most occurrences of *Ambrosia pumila* are patchy in nature, composed of a few to numerous smaller groups of aerial stems (McGlaughlin and Friars 2007, p. 319). While some of this patchiness may be inherent to the growth habit of the species, many occurrences are also fragmented by development activities, competition by nonnative plants, and human encroachment (CNDDDB 2010). The creation and continued use of paths through occurrences of *A. pumila* has been a major source of fragmentation. Fragmentation of *Ambrosia pumila*

occurrences could diminish the efficacy of wind pollination or biological pollinators by increasing the between-population distances (USFWS, 2010).

Stressor: Altered hydrology (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: *Ambrosia pumila* occurrences are almost always found on the upper terraces of rivers/streams or near the margins of vernal pools, where under natural conditions they would likely be subjected to inundation during large-scale flooding events (McGlaughlin and Friars 2007, p. 320). If *A. pumila* is dependent on these periodic flooding events for some aspect of its life history (e.g., seed germination, dispersal) or control of competing plants, altering the flooding regimes of associated waterways or vernal pools could have a significant impact on the species. However, since the Service is unsure if or to what degree *A. pumila* is dependent upon periodic flooding or other aspects of its proximity to waterways, it is unknown to what degree altering the hydrology of adjacent waterways would impact the species (USFWS, 2010).

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Since listing, it has become apparent that there is potential for threats to biota from ongoing accelerated climate change (IPCC 2007). The impacts of local climatic shifts on populations of native and nonnative plants that compete with *Ambrosia pumila* and the interaction of these shifts with other ongoing threats are as yet unmeasured. Habitat conditions altered as a result of climate change impacts could favor invasive nonnative plants, which could then out-compete *A. pumila* for resources. Climatic change could also impact hydrological systems on which the species may depend. While the Service recognizes that climate change is an important issue with potential effects to listed species and their habitats, the Service lacks adequate information at this time to make accurate predictions regarding its effects to particular species and habitats, including *A. pumila* (USFWS, 2010).

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan

Delisting Criteria:

Not available - this species does not have a recovery plan

Recovery Actions:

- Not available - this species does not have a recovery plan

Conservation Measures and Best Management Practices:

- Identify opportunities through the Service's Partners for Fish and Wildlife Program to seek habitat restoration and enhancement opportunities (USFWS, 2010).
- Work with partners to implement nonnative plant control methods such as those demonstrated effective by CNLM's 2008 study (USFWS, 2010).

- Work within the Service and with outside researchers to design studies aimed at gaining insight into sensitive aspects of the biology and life history of *Ambrosia pumila* (USFWS, 2010).
- Conduct field surveys to verify persistence of occurrences that are in question and accurately map extant occurrences (USFWS, 2010).
- Determine whether a program to propagate *Ambrosia pumila* in greenhouses and outplant the resulting plants in unoccupied areas would be biologically sound and feasible (USFWS, 2010).

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SPECIES ACCOUNT: *Amorpha crenulata* (Crenulate lead-plant)

Species Taxonomic and Listing Information

Listing Status: Endangered; 08/19/1985; Southeast Region (R4)

Physical Description

The crenulate lead-plant is a rhizomatous, perennial, deciduous shrub that grows to 1.5 m in height. The branches are red/purple, and contain 25 to 33 leaflets borne on leaves that are 0 to 15 centimeter (cm) long, with petioles 1 cm long or less. The crenulate leaflets are gray and green above, paler and glandular dotted below, and 5 to 11 cm long. The racemes are terminal, 15 to 20 cm long, solitary, or in clusters of two to three. The 8 millimeter (mm)-long flowers are held in loose clusters. The calyx is dark green or purplish, 3.2 to 4.0 mm long with the upper half glandular dotted. The showy white standard flower is 5.2 mm long and 4.2 mm wide with long exerted stamens. The fruit is 6 to 11 mm long, laterally compressed, and glandular dotted on the upper two-thirds. The seeds produced in the fruit are 5 mm long and compressed. (USFWS, 1999)

Taxonomy

The crenulate lead-plant was described by Rydberg in 1919, citing his type specimen as J.K. Small and Percy Wilson #1898, May 9, 1904, In hammocks, between Coconut Grove and Cutler (New York Botanical Garden herbarium). Small (1933) followed this treatment. Isley (1986, 1990) argues that *A. crenulata* is an isolated variant of *A. herbacea*, distinguished only by the presence of crenulate leaf margins. He published the new combination as *A. herbacea* Walt. var. *crenulata* (Rydberg) Isley (Isley 1986). Synonyms: *Amorpha crenulata* Rydberg, *A. herbacea* auct. non. Walt. (USFWS, 1999)

Historical Range

The historical range of *Amorpha crenulata* encompasses only a 20 square-mile (52 km²) area from Coral Gables to Kendall (Service 1999) within Miami-Dade County, Florida. (USFWS, 2019)

Current Range

The current range of *Amorpha crenulata* encompasses only a 20 square-mile (52 km²) area from Coral Gables to Kendall (Service 1999) within Miami-Dade County. (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Little is known of the life history of crenulate lead-plant. In two years of life history monitoring of one population, no seedlings were observed. Plants showed little to no growth and flowered primarily following human disturbance. Crenulate lead-plant is semi-deciduous, about 70 percent of plants losing most or all leaves between December and February. Pollinators or dispensers have not been observed (DERM 1993). New sprouts, when observed,

have been identified as primarily adventitious roots (DOT 1997). In addition, the viability of germplasm is not known (DOT 1997). This species is relatively easy to cultivate, indicating that the lack of reproduction in the wild may not be due to a lack of viable seeds (A. Herndon, personal communication 1998). (USFWS, 1999)

Habitat Type

Adult: Pine rocklands

Habitat Narrative

Adult: The crenulate lead-plant occurs in plant communities that were historically associated with seasonally hydrated soils and frequent burning, including wet pinelands, transverse glades, and hammock edges. It can be found growing in poorly-drained Opalocka sands within pine rocklands or in wet prairies with Opalocka-rock outcrop complex soils. It requires open sun to partial shade. The type specimen (Small and Wilson #1898) cites the habitat as "In hammocks." No recent collections have been seen from within hardwood hammocks. Many of Small's specimen labels were pre-printed with habitat data and some species were collected and labeled as occurring in hammocks that were actually collected in habitats outside hammocks. It may be that crenulate lead-plant was never collected in hammocks. (USFWS, 1999)

Dispersal/Migration***Population Information and Trends*****Number of Populations:**

5 populations (USFWS, 2019)

Population Size:

~ 650 individuals (USFWS, 2019)

Population Narrative:

The current and historical range of *Amorpha crenulata* encompasses only a 20 square-mile (52 km²) area from Coral Gables to Kendall (Service 1999) within Miami-Dade County. Two of the four known historical *A. crenulata* populations (Matheson Hammock and Coral Pines Parks) are extirpated. Five *A. crenulata* populations, including three that are reintroduced, remain. The total population size of *A. crenulata* is approximately 649 individuals (Possley, Fairchild Tropical Botanic Gardens [FTBG], pers. comm. 2017a; Lange, FTBG, pers. comm. 2017; Lange et al. 2018). (USFWS, 2019)

Threats and Stressors

Stressor: Habitat loss and fragmentation

Exposure:

Response:

Consequence:

Narrative: The pine rockland community of south Florida is critically imperiled globally (FNAI 2010b). In Miami-Dade County, development and agriculture have reduced pine rockland habitat by 90 percent. Continued habitat loss (Factor A) and fragmentation threaten the existence of this species, and less than 1 percent of the original acreage of pine rockland habitat remains outside

of Everglades National Park (Herndon 1998). Populations on private sites remain threatened with destruction or habitat modification due to improper or lack of management (Factors A and E). (USFWS, 2019)

Stressor: Inadequacy of existing regulatory mechanisms

Exposure:

Response:

Consequence:

Narrative: Currently, regulatory mechanisms (Factor D) provide limited protections for this species. The Florida Department of Agriculture and Consumer Services designated these species as endangered under Chapter 5B-40, Florida Administrative Code. This law regulates the taking, transport, and sale of listed plants. This law does not prohibit private property owners from destroying listed plants, nor does it require them to manage habitats to maintain populations. The Natural Forest Communities (NFC) program was established by Miami-Dade County to encourage but not require private landowners to protect forested lands by making it necessary to apply for a permit with the County prior to working in designated NFCs (i.e., pinelands, hammocks). (USFWS, 2019)

Stressor: Inadequate fire management

Exposure:

Response:

Consequence:

Narrative: Fire suppression continues to affect *Amorpha crenulata* (Factor E). Historically, frequent (approximately twice per decade), lightning-induced fires were a vital component in maintaining native vegetation and ecosystem functioning within south Florida pine rocklands. A period of just 10 years without fire may result in a marked decrease in the number of herbaceous species due to the effects of shading and litter accumulation (FNAI 2010b). The majority of extant populations of this species is affected by some degree of inadequate fire management, with the primary threat being shading by hardwoods (Bradley and Gann 1999; Bradley and Gann 2005). (USFWS, 2019)

Stressor: Nonnative invasive plants

Exposure:

Response:

Consequence:

Narrative: Invasion by exotic plant species continue to affect *Amorpha crenulata* (Factor E). Nonnative invasive plants compete with native plants for space, light, water, and nutrients, and make habitat conditions unsuitable for this species, which prefers open conditions (Factor E). Bradley and Gann (1999) indicated that the control of nonnative plants is one of the most important conservation actions for the pine rockland species and a critical part of habitat maintenance. Nonnative plants have significantly affected pine rocklands and negatively impacted all occurrences of this species to some degree (Bradley and Gann 1999; Bradley 2006; Bradley and Saha 2009; Bradley and van der Heiden 2013). (USFWS, 2019)

Recovery

Reclassification Criteria:

Not developed (USFWS, 1999; USFWS, 2010)

Delisting Criteria:

1. Existing natural populations achieve and maintain a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (addresses Factors A and E) (USFWS, 2019)
2. A network of 5 new populations are either discovered or reintroduced that exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (addresses Factors A and E) (USFWS, 2019)
3. All populations (criteria 1 and 2) are protected by a conservation mechanism. (addresses Factors A, D, and E) (USFWS, 2019)
4. Threats have been reduced or eliminated to the degree that this species will remain viable for the foreseeable future. (addresses Factors A, D, and E) (USFWS, 2019)

Recovery Actions:

- Conduct surveys to determine distribution of crenulate lead-plants. Crenulate lead-plants on county-owned pine rockland sites have been thoroughly surveyed in Miami-Dade County. However, other populations may be noted during pine rockland purchase and restoration program implementation. Fire may eliminate litter concealing listed species, or enable seeds in the seed bank to germinate. For that reason, pine rocklands that did not contain listed species when unmanaged should be resurveyed after fire events. (USFWS, 1999)
- Protect and enhance existing populations. It is imperative for the stabilization of crenulate leadplants that additional populations not be lost. The existing populations should be mapped, including obtaining GPS coordinates and developing GIS coverage. Herbarium voucher specimens should be collected and archived for all populations. (USFWS, 1999)
- Collect biological information important to species recovery. Additional information on the ecology and life history of pine rockland plants needs to be collected. Determine size and viability of all populations. Known populations of the listed pine rockland plants should be evaluated. Population viability needs to be investigated and determined for each listed plant species. (USFWS, 1999)
- Develop standardized monitoring. Standardized monitoring based upon the protocols developed by FNAI should be used for pine rockland species in order to determine the effect of management actions on these species and make the data compatible to existing databases. (USFWS, 1999)
- Continue to provide public information about pine rocklands and their unique flora. Public support will increase the chances of recovery for pine rockland species. Informational and educational materials have been produced. DERM and Miami-Dade County Parks and Recreation Department's Natural Areas Management have developed flyers, displays, newsletters, and press releases, and have held workshops with the general public. Organizations best able to carry out information and education programs include Metropolitan Miami-Dade County Parks and Recreation Department, the Florida Native Plant Society, Everglades National Park, and Miami-Dade County DERM. Support of local press coverage should continue. DERM has developed a web page that will also aid in disseminating information about this endangered plant community to the public. (USFWS, 1999)

- Habitat-Level Recovery Actions: Develop a GIS database on all listed pine rockland species and their habitats, and distribute the database to researchers, land managers, and conservationists. Continue to protect and prevent degradation of pine rockland plant habitat. Restore areas to suitable habitat. Monitor habitat and ecological processes. Continue implementation of the fire education program and modify as necessary any fire management education program that has been developed. (USFWS, 1999)

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SPECIES ACCOUNT: *Amphianthus pusillus* (Little amphianthus)

Species Taxonomic and Listing Information

Listing Status: Threatened; 2/5/1988; Southeast Region (R4) (USFWS, 2015)

Physical Description

A diminutive aquatic annual with both floating and submerged leaves. The floating leaves are 4-8 mm long and are attached to the submerged plant base by thread-like stems. Flowers are tiny, white to pale purple, and are produced among the floating and the submerged leaves. This is an ephemeral species - it completes its entire life cycle in as little as 3-4 weeks in the spring. (NatureServe, 2015)

Taxonomy

A monotypic genus of uncertain placement within the family. Highly distinct, no close relatives. (NatureServe, 2015)

Historical Range

The range of the *Amphianthus* has not changed although suitable habitat within the range has diminished. (USFWS, 2008)

Current Range

Granite outcrop areas of Piedmont Alabama, Georgia, and South Carolina. (NatureServe, 2015)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual (NatureServe, 2015)

Lifespan

Adult: 3-4 weeks to several months (USFWS, 2008)

Breeding Season

Adult: February to March, possibly later (USFWS, 2008)

Key Resources Needed for Breeding

Adult: Light and moisture (USFWS, 2008)

Reproduction Narrative

Adult: *Amphianthus pusillus* is an annual plant with a short life cycle of as little as 3-4 weeks (Garris 1980, Kral 1983, Rayner 1986), but may be longer depending upon when rains start and how quickly its pools dry out in spring. Germination may occur in as little as four days and seems to be dependent only on the presence of light and of sufficient standing water or soil

saturation in its habitat. In some areas, a second germination may occur after summer rains. It has a high reproductive capacity, and a substantial seedbank. It appears to be self-pollinated. The seeds can remain viable in the soil for several years (Pennell 1935, Lunsford 1939). (USFWS, 2008) The plants grow slowly through the winter months; flower buds form early and are clearly visible by early February; flowering generally peaks in mid-March. During this period, if sufficient water and sunshine are present, the plants continue to produce more flowers, both submersed and floating. The plants continue to grow as long as the soil remains moist. By mid-April in most years, most pools are experiencing dry periods between heavy rains. At this time, the plants are totally exposed and the process of fruit maturation continues. In the pools holding water for the longest periods, the plants become relatively large, with 10-15 or more flowers or fruits. Eventually, these dry up also, and by late May or June, all the seeds have been shed, the plants have desiccated and are disintegrating, and there is little if any sign that *Amphianthus* ever existed (Lunsford 1939, McVaugh and Pyron 1937, Garriss 1980, personal observations). Seeds of floating flowers are shed into the water of the pool, and those of the basal flowers and capsules which are totally exposed at maturation are shed onto the soil surface. (NatureServe, 2015)

Habitat Type

Adult: Pools on granite outcrops (USFWS, 2008)

Habitat Vegetation or Surface Water Classification

Adult: Temporary pools (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Isolated pools (USFWS, 2008)

Site Fidelity

Adult: High (USFWS, 2008)

Habitat Narrative

Adult: *Amphianthus pusillus* is totally confined to vernal pools on granite outcrops of the southeastern Piedmont. Optimal habitat has been described as a shallow, flat-bottomed pool almost invariably surrounded by a rock rim several centimeters in height (Garriss 1980). These pools tend to be best developed in flatter outcrop areas, such as the flattened crests of dome-shaped outcrops or the extensive flat to gently rolling outcrops (Lester 1938 in Lunsford 1939, Garriss 1980). Water depths in the pools at the time of flowering range from 0-10 cm. In the pools which hold less water, or hold water for shorter periods after a rain, deeper soil is required. The number of occupied pools may vary in an area probably due to environmental factors being inconsistent from year to year. Biotic associates of *Amphianthus* are generally few and of low coverage within the population habitat. *Isoetes piedmontana* is the most consistently associated species. (NatureServe, 2015)

Dispersal/Migration**Dispersal**

Adult: Low (NatureServe, 2015)

Dispersal/Migration Narrative

Adult: Several species of birds and mammals are known to use the granite outcrops. Tracks have been found on the soils in drying ponds, and it is likely that seeds are dispersed by animals in this manner. It is possible that seeds could overflow in heavy rains and disperse to the other pools, but this is not very likely because there is generally little or no connections between the pools. (NatureServe, 2015)

Population Information and Trends

Population Trends:

Declining (USFWS, 2008)

Species Trends:

Declining (USFWS, 2008)

Number of Populations:

77 (20 = extirpated; 3 = Alabama; 51 = Georgia; 3 = South Carolina; USFWS, 2019)

Population Size:

10,000 to >1,000,000 individuals (NatureServe, 2015)

Adaptability:

Low (USFWS, 2008)

Population Narrative:

Because this annual plant has a high reproductive capacity and a substantial seedbank, it may exist in large numbers and high densities when water is in its pool habitat. But plants die when the pools desiccate in the spring, usually March-May. The number of populations is therefore more relevant than numbers of individuals. That population number is declining due to loss of outcrop pools and the inability of the plant to adapt to other habitats. (USFWS, 2008); Cumulatively, between the three states, there has been 77 populations of little amphianthus. Twenty known populations of amphianthus have been documented as extirpated. Of the non-extirpated populations, three occur in Alabama, 51 occur in Georgia, and three occur in South Carolina. Forty-six populations are currently considered extant and 11 populations are in an unknown condition. Fifteen of the extant populations occur on protected lands (e.g. state, county, and private conservation lands). Two additional populations were introduced into a single pool on each protected site outside of the known historic range of the species (Cobb and Jackson Counties, Georgia). Of the known populations, 24 are listed in poor condition because of either low pool redundancy (the population consists of less than three pools) and/or populations occur at outcrops where there still is active quarrying. The populations in Alabama consist of some occupied pools with a limited number of plants, which could indicate the potential of the species being extirpated in that state in the near future (Frings and Davenport 2017). Nine new populations have been discovered in Georgia since the last 5-year review (USFWS 2008), but five of those populations are already classified as poor condition. Nine of the past extant populations have declined in status and three have been classified as extirpated since the last 5-year review (USFWS 2008). Seed bank sources may provide some adaptive capabilities of amphianthus to respond to poor reproductive years, but as the number of plants decline in individual pools the seed bank also declines making population recovery more unlikely (Boyd and Bartig 1992). (USFWS, 2019)

Threats and Stressors

Stressor: Quarrying (USFWS, 1993)

Exposure:

Response:

Consequence:

Narrative: By far, the greatest threat to these species is the destruction of habitat due to quarrying activities. Of the 16 documented local extinctions of the listed species, eleven can be attributed to this cause. Amphianthus may have been extirpated at up to four additional sites now being quarried. The numerous exposures of granites and gneisses in the Piedmont, particularly in Georgia, have been quarried extensively since the Civil War (Watson 1902, 1910), and an unknown number of undocumented populations of the listed species were doubtless unknowingly destroyed. There are many more abandoned quarries than active ones. Most of the abandoned quarries are small, and may have areas of intact outcrop habitat, sometimes supporting the listed species. (USFWS, 1993) Quarrying companies own 17.4% of the outcrops investigated for Amphianthus in Georgia (Garris 1980). (NatureServe, 2015)

Stressor: Farm animals (USFWS, 1993)

Exposure:

Response:

Consequence:

Narrative: Habitat supporting these species has been degraded through conversion to pasture. Excessive animal wastes have resulted in eutrophication of pools, promoting excessive algal growth, which competes with these species for dissolved carbon dioxide and light. Addition of matter to the habitat increases soil depth, with concomitant reduction in potential water depth. Increased soil depth and organic matter may benefit these species in the short term, but soon result in the invasion of more aggressive native and exotic species. (USFWS, 1993) Cattle using the pools for water may trample Amphianthus. (NatureServe, 2015)

Stressor: Dumping (USFWS, 1993)

Exposure:

Response:

Consequence:

Narrative: Because granitic outcrops are regarded by the uninformed as worthless, they are frequently subjected to dumping of waste materials. This leads, in some cases, to destruction of the microhabitat through covering over or filling in of pools, or through eutrophication. (USFWS, 1993)

Stressor: Vehicular traffic (USFWS, 1993)

Exposure:

Response:

Consequence:

Narrative: Vehicular traffic is a serious problem at many of the extant sites. This can be due to recreational traffic, such as off-road vehicles, motorbikes, or even automobiles in some cases. Even more destructive are the heavy vehicles used in logging operations. At one outcrop explosives were stored in tractor-trailers on the outcrop. As part of the site preparation, many depressions, including all Amphianthus pools, were filled with concrete to provide a smoother

surface. Potentially serious disturbance can result from vehicular traffic, often motorbikes, through the pools. These crush the plants, loosen the soil, and probably hasten erosion of the pool rims.

Stressor: Recreational impacts (USFWS, 1993)

Exposure:

Response:

Consequence:

Narrative: Many sites exhibit signs of recreational overuse or abuse. Although those sites that are publicly owned are protected from quarrying, they are subjected to excess foot traffic, littering, or vandalism, such as spray painting. Rearrangement of stones within a pool has caused serious declines of *Amphianthus*.

Stressor: Other environmental factors (USFWS, 1993)

Exposure:

Response:

Consequence:

Narrative: In some cases, other environmental factors may have led to the decline of certain populations. As these species require high light intensities (Lammers 1958), excessive tree growth is suspected to be a problem at a few sites, due to shading. A few pools appear to be moving toward a later stage of succession due to excessive soil accumulation. *Amphianthus* is sometimes killed by freezes but, being an annual, can recover population size readily. The effects of widespread environmental changes, such as acid rain and possible global warming, are unclear.

Stressor: Inadequacy of existing regulation (USFWS, 1993)

Exposure:

Response:

Consequence:

Narrative: The Georgia Wildflower Preservation Act has not had a significant effect upon retarding habitat loss, the primary threat. Recreational overuse of publicly owned sites is not always addressed by current ordinances. Existing ordinances against littering, spray-painting, fire-building, off-road vehicles, etc., have proved difficult to enforce, and not fully effective.

Stressor: Fire ants (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Invasive fire ants have been hypothesized to be an additional threat (Malcolm Hodges, pers. comm. March 2006). Fire ants have become well established on some outcrops and their impact is unclear. Fire ants may impact insects that play a role as pollinators or in seed dispersal. (USFWS, 2008)

Recovery

Delisting Criteria:

1. Twenty (20) populations exhibit a stable or increasing trend, evidenced by natural recruitment. (USFWS, 2019)

2. All 20 populations occur on lands protected via a conservation mechanism (addressed listing Factor A and D). (USFWS, 2019)

3. All 20 populations consist of at least 3 occupied pools at least 2.4 m² (26 ft²) in size (addresses listing factor E). (USFWS, 2019)

4. At least 2 populations occur in Alabama and 2 populations occur in South Carolina. (USFWS, 2019)

Recovery Actions:

- Protect existing populations on publicly owned land, and secure plants on private property through negotiated management agreements or through land acquisition. (USFWS, 1993)
- Preserve genetic stock and conduct germination experiments on *Amphianthus*. Research is needed to determine this species' germination requirements. (USFWS, 1993)
- Monitor populations to determine trends and developing threats. All *Amphianthus* populations in Alabama and South Carolina should be assessed yearly, as well as at least the best Georgia sites.
- Searches should be made for additional populations. These species have been searched for extensively. However, a few outcrops remain to be explored at the optimal time of year (January through March). (USFWS, 1993)
- Reestablish populations and augment populations at protected locations, if deemed necessary. This requires that the microhabitat of the listed species be present or that similar microhabitat occurs which can be modified or maintained by addition or removal of soil. (USFWS, 1993); Through partnerships with state, non-government, and other sources, populations at Heggie's Rock, Greensboro South, Bradley Mountain, Arabia Mountain, and Stone Mountain have all been modified through pool creation and/or pool modification. Artificial deepening of existing pools or artificially created pools should target the minimum pool size identified in the recovery criteria for the species. Pool creation should target areas at the highest elevation (top of the watershed) of the outcrop and minimize impacts to surrounding landscape. Because of the natural geology of the sites, site choice should also assess likelihood of exfoliation fissures beneath the surface. When intersected, these fissures result in the failure of the pool to hold water. Coordination with the Service in determining locations, size, depth, and source populations should occur. (USFWS, 2019)
- Use management techniques to maintain and/or enhance populations. Maintenance of populations chiefly requires protection from disturbance, i.e., whether certain natural or experimental such actions as manipulation of soil depth or the cutting of nearby trees will benefit the particular microhabitats. (USFWS, 1993)
- Educate the public about the value and fragility of these species and their habitat. Granite outcrops support the most distinctive natural community in the Piedmont. Relatively undisturbed outcrops can provide an all-too-rare primeval experience as well as serving to educate the public on geological, ecological, and evolutionary processes. (USFWS, 1993)

Conservation Measures and Best Management Practices:

- Protect and/or enhance each of these listed plants as well as other community associates of the granite outcrop. (USFWS, 2008)

- At outcrops with conservation potential, contact the land owners to seek conservation easements or fee simple acquisition. (USFWS, 2008)
- Contact private landowners to request their cooperation in plant conservation. (USFWS, 2008)
- Status surveys need to be completed for these species in all three States. (USFWS, 2008)

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SPECIES ACCOUNT: *Amsinckia grandiflora* (Large-flowered fiddleneck)

Species Taxonomic and Listing Information

Listing Status: Endangered; 6/7/1985; Pacific Southwest (R8)

Physical Description

An annual dicot herb. Flowers are red-orange, 14-20mm. Fruit is smooth and shiny. (NatureServe, 2015). This annual species has bright, red-orange, trumpet-shaped flowers arranged in a fiddleneck-shaped inflorescence. Its bright green foliage is covered with coarse, stiff hairs (USFWS, 2009).

Taxonomy

Amsinckia grandiflora (large-flowered fiddleneck) is an herbaceous plant in the Boraginaceae (borage family) (USFWS, 2009).

Historical Range

Historically, *A. grandiflora* ranged from northern Contra Costa County, California, at the San Joaquin River Delta, south to Corral Hollow and adjacent areas in San Joaquin County (USFWS, 2009). The full range encompasses about 550 square miles, though much of that is either extirpated or poor introduction sites today (NatureServe, 2015).

Current Range

Currently, *A. grandiflora* is only found in two reintroduced locations, one at Site 300 in southwestern San Joaquin County and the second at Lougher Ridge in Contra Costa County (USFWS, 2009).

Critical Habitat Designated

Yes; 6/7/1985.

Legal Description

On May 8, 1985, the Service designated critical habitat (effective June 7, 1985) for *Amsinckia grandiflora* (large-flowered fiddleneck) (50 FR 19374 - 19378).

Critical Habitat Designation

The critical habitat designation for *Amsinckia grandiflora* includes one area of approximately 180 acres in San Joaquin County, California (50 FR 19374 – 19378). (USFWS, 1985)

California. San Joaquin County, Mount Diablo Meridian, T3S R4E Section 28 W1/2 NW1/4 and W1/2 SW1/4.

Primary Constituent Elements/Physical or Biological Features

This area includes the following known primary constituent elements (50 FR 19374 – 19378). (USFWS, 1985)

A steep, west- and south-facing slope with light textured but stable soils.

Special Management Considerations or Protections

Any activity that would result in a disturbance of the soil or the hydrological regime where the large-flowered fiddleneck occurs would probably adversely modify the critical habitat. Also, any activity that may increase the frequency of grass fires in the area may adversely affect the population and modify the critical habitat. Construction activities, such as high explosives and controlled burns, could have an adverse impact on the large-flowered fiddleneck and its habitat unless they are undertaken carefully. (USFWS, 1985)

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Self-fertilization, vegetative (USFWS, 2009)

Lifespan

Adult: < 1 year (USFWS, 2009)

Dependency on Other Individuals or Species

Adult: Possibly *A. edwardsii* (USFWS, 1997)

Breeding Season

Adult: Spring (USFWS, 2009)

Key Resources Needed for Breeding

Adult: Fall/winter rain (USFWS, 2009)

Reproduction Narrative

Adult: This species has a low reproductive potential and a primitive reproductive system (NatureServe, 2015). *Amsinckia grandiflora* is an herbaceous annual that germinates with the onset of fall or early winter rain, grows vegetatively throughout the winter, flowers in the early spring, sets seeds and dies prior to the summer drought. Pollination studies by Carlsen (1996) and Carlsen et al. (2002) indicate that *A. grandiflora* is not completely self-incompatible and, under greenhouse conditions, this species' nutlet output can approach that of *A. tessellata*, a common, self-compatible, homostylous species. Pollinators are needed for *A. grandiflora* to produce seeds (Carlsen et al. 2002) (USFWS, 2009). Bees, primarily *Anthophora edwardsii* (a solitary wood-boring bee in the family Megachilidae), were the most consistent visitors to *A. grandiflora*. However, there is no direct evidence of actual pollination by *Anthophora* (USFWS, 1997).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Coastal grasslands (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Habitat Narrative

Adult: Occupies inner coast range grasslands on steep slopes and sandy soil. The environmental specificity is very narrow; it is only known from a very narrow distribution (NatureServe, 2015).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Unavailable (USFWS, 2019)

Species Trends:

Stable (NatureServe, 2015)

Number of Populations:

2 extant natural populations; 9 extant introduced populations (USFWS, 2019)

Population Size:

~2500 or greater (natural and introduced sites) (USFWS, 2019)

Population Narrative:

At the time of listing, there was only one known population, which consisted of fewer than 50 plants. This population was located in southwestern San Joaquin County, California, at the Lawrence Livermore National Laboratory at the Droptower site at Site 300. In 2017, there were no plants at this site. There are two introduced populations adjacent to the Droptower site with a combined population of 132 plants in 2017 (Carlsen and Paterson 2018). The Draney Canyon site at the Lawrence Livermore National Laboratory at Site 300 was not visited in 2017 (Carlsen and Paterson 2018). There were 84 plants in the Carnegie Canyon site (formerly called the Etchelet site) in 2017 on Contra Costa Water District property (Carlsen and Paterson 2018), and a combined 2,559 plants at ten introduction sites in three counties in 2017 (Schweitzer, pers. comm. 2018). (USFWS, 2019)

Threats and Stressors

Stressor: Invasive species (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: At the time of listing, the primary threat to *Amsinckia grandiflora* was the invasion of aggressive *Amsinckia* species and weedy nonnatives into the grassland habitat. This is still an ongoing threat (USFWS, 2009).

Stressor: Grazing (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: At the time of listing it was thought that grazing may have been responsible, in part, for the extirpation of some populations of this species. The introduction of grazing animals to the Livermore area was thought to have degraded the native grasslands that once existed there. Since listing, a combination of either the change in the intensity of grazing or the change from cattle grazing to sheep grazing is thought to have possibly extirpated the natural population located at Carnegie Canyon (T. Carlsen, Lawrence Livermore National Laboratory, pers. comm. 2008). No plants were seen at this site in 2003 (T. Carlsen, pers. comm. 2008) (USFWS, 2009).

Stressor: Reproductive biology (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: At the time of listing, the relatively primitive reproductive system of *Amsinckia grandiflora* was thought to put the species at a competitive disadvantage with its congeners and with nonnative plants. This factor continues to threaten *A. grandiflora*. Additionally, because of the small number of populations and their small sizes, stochastic (chance) extinction also threatens this species (USFWS, 2009).

Stressor: Small population size (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Small population size increases the susceptibility of a population to extirpation from random demographic, environmental and/or genetic events (Shaffer 1981, 1987; Primack 2006; Groom et al. 2006). In this 5-year review populations of 200 growing plants (not counting ungerminated seeds) or less are considered to be small, in keeping with Menges' (1992) calculation that populations of this size are especially vulnerable to even moderate levels of environmental uncertainty. The combination of few populations, small range, and restricted habitat renders *Amsinckia grandiflora* susceptible to extinction or extirpation from a significant portion of its range due to random events, such as flood, drought, disease, or other factors (Shaffer 1981, 1987; Groom et al. 2006). Small populations may also be subject to increased genetic drift and inbreeding (Menges 1991; Ellstrand and Elam 1993). Populations that are continually small in size are particularly susceptible to adverse genetic changes due to drift. However, drift may also cause genetic changes with populations that occasionally fluctuate to small sizes (e.g., undergo population bottlenecks). Increased homozygosity resulting from genetic drift and inbreeding may lead to a loss of fitness (ability of individuals to survive and reproduce) in small populations. In addition, reduced genetic variation in small populations may make any species less able to successfully adapt to future environmental changes (Ellstrand and Elam 1993) (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Climate is predicted to change in California during the 21st century (Field et al. 1999; Cayan et al. 2005). Even modest changes in warming could result in a reduction of the spring snowpack, earlier snowmelt, and more runoff in winter with less runoff in spring and summer,

more winter flooding, and drier summer soils (Field et al. 1999; Cayan et al. 2005). The predicted impacts on California's ecosystems projected with a high certainty include higher sea level; decreased suitable habitat for many terrestrial species as climate change intensifies human impacts; and increased competition among urban, agricultural, and natural ecosystem uses (Field et al. 1999). Although the specific effects of climate change on *Amsinckia grandiflora* are unknown, the effects of increased winter flooding and drought conditions in the spring have the potential to adversely affect this species (USFWS, 2009).

Recovery

Reclassification Criteria:

1. A minimum of six management areas are secured and protected from the threats that caused listing initially, including urbanization, agricultural conversion, competition with invasive vegetation, and livestock overgrazing. (USFWS, 2019)
2. Sufficient information has been obtained to ensure the perpetuation of suitable habitat, and appropriate management, based on this information, is being implemented at each management area in perpetuity. (USFWS, 2019)
3. Each management area has an average of 3,000 individuals over two precipitation cycles or 10 years, whichever is longer, with sufficient acreage of suitable habitat to support an expanded population and provide an appropriate buffer. (USFWS, 2019)
4. The six management areas concurrently demonstrate self-maintenance without intensive management intervention (e.g. hand-pollination, seed collection, off-site propagation) needed to prevent population decline for two precipitation cycles or 10 years, whichever is longer. (USFWS, 2019)

Delisting Criteria:

A/1: A minimum of 12 management areas that encompass sufficient acreage with suitable habitat characteristics and an appropriate buffer area to conduct site specific management actions have been protected in perpetuity. Twelve areas will provide sufficient redundancy for the species to withstand potential catastrophic events. (USFWS, 2019)

C/1: Predation pressure by granivores and herbivores is at a level that does not result in a declining population trend for any of the management areas over four precipitation cycles or 20 years, whichever is longer. (USFWS, 2019)

E/1: Each management area has an average of 16,000 individuals over four precipitation cycles or 20 years, whichever is longer. (USFWS, 2019)

E/2: The twelve management areas concurrently demonstrate self-maintenance without intensive management intervention (e.g. hand-pollination, seed collection, off-site propagation) needed to prevent population decline for four precipitation cycles or 20 years, whichever is longer. (USFWS, 2019)

Recovery Actions:

- Conserve the genetic diversity of *Amsinckia grandiflora*. As added insurance against extinction, seeds shall be collected from all natural populations. This seed will be available to use for augmentation or reintroduction, if remaining natural populations decline or are extirpated. It is important to ensure that the collected seeds are representative of the entire range of the species' genetic variability, as indicated in Pavlik 1996. Because of the small number of natural populations known at this time, it is very important that propagules be taken in such a way that the donor plants or populations are not reduced. Possible impacts of seed collection or removal of plants from natural populations must be closely monitored to detect any effect harvest may have on source populations. (USFWS, 1997)
- Secure and protect the habitat for at least six management areas within the historical range. To meet the downlisting criteria, at least six management areas need to be established. At least two of these management areas shall comprise natural populations. Habitat also needs to be surveyed for reintroduction sites. If new populations are discovered and confirmed as *A. grandiflora*, the areas where they occur should be protected and enhanced by appropriate means. (USFWS, 1997)
- Contact Landowners. To downlist to threatened status, at least six viable management areas must be protected by perpetual administrative agreements with the landowners on whose land *A. grandiflora* or essential habitat for *A. grandiflora* is found. Landowner contact constitutes the first step in this process.
- Establish six management areas and maintain or enhance populations of *Amsinckia grandiflora* that may occur within any area. Despite much ongoing habitat work, *Amsinckia grandiflora* management areas have not yet been designated. Until sites are selected, as many of the natural and reintroduced sites as possible shall be protected. Once the sites have been selected, management areas need to be established. Establishing management areas will include delineating boundaries of each area and securing and protecting habitat within the boundaries. At least two management areas shall contain natural populations. (USFWS, 1997)
- Characterize habitat and management requirements. An understanding of the population trends of each site, and interactions of key community members, including pollinators and dispersal vectors, is necessary to refine management plans and to revise management techniques. Many aspects of the basic life history and ecology of *Amsinckia grandiflora* are not known. Factors that would be the most important for increasing the population size of each natural population need to be determined. Information gained from appropriate studies is needed to establish recovery goals, and to effectively and efficiently manage and protect natural and reintroduced populations of the species and its habitat. (USFWS, 1997)
- Develop and implement site-specific management plan for each management area. Management plans, which direct actions essential for preserving the populations as long as active management is deemed necessary, should be individually tailored to each management area. Because management actions, including habitat protection, monitoring, and population reintroduction are ongoing, these plans have, in practice, been partially completed. However, they should be written down, for the benefit of future managers and researchers, and to promote future management consistency. (USFWS, 1997)
- Reintroduce populations into management areas. Downlisting and recovery of *Amsinckia grandiflora* require that additional populations be established and maintained. The interim goal, for downlisting, is to have at least six management areas with 1,500 reproductive plants each. To accomplish this goal, unless new populations are discovered, *A. grandiflora* must have success in reintroductions on four management areas. The potential sites must

be identified and tested for suitability as reintroduction sites. Specific establishment test sites must be selected, secured, and managed. (USFWS, 1997)

- Determine delisting criteria . Information gathered needs to be analyzed to establish delisting criteria. Genetic factors also need to be studied to determine if they are limiting

Conservation Measures and Best Management Practices:

- Secure the Carnegie Canyon population. The Carnegie Canyon population should be secured from a willing seller by fee title for the benefit of several listed species (USFWS, 2009).
- Conduct a management study whose first objective is the establishment of 6 to 10 acres of thriving *Amsinckia grandiflora* populations with the ultimate objective of determining what factors enable and prevent sufficient recruitment to sustain the populations. This study would be done in a completely controlled and intensively managed basis. *Amsinckia grandiflora* has been grown successfully in greenhouses, but we do not know why it is not thriving in the wild. Such a study would provide the information needed for recovery, while maintaining the seed stocks and as much genetic variability and adaptability as is needed to implement recovery. The expanded scale would also allow the study of more extensive techniques and the study of more kinds of management techniques simultaneously (USFWS, 2009).
- Maintain seed bank to have viable seeds for restoration (USFWS, 2009).
- Determine causes for the extirpations of the natural and reintroduced occurrences and remedy the decline of *Amsinckia grandiflora* (USFWS, 2009).
- Conduct a study to help determine the effect of grazing and other vegetation management on *Amsinckia grandiflora* populations and the restoration of perennial grasslands (USFWS, 2009).
- Conduct surveys to try to locate additional natural occurrences of *Amsinckia grandiflora* (USWS, 2009).

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SPECIES ACCOUNT: *Amsonia kearneyana* (Kearney's blue-star)

Species Taxonomic and Listing Information

Listing Status: Endangered; 1/19/1989; Southwest Region (R2) (USFWS, 2016)

Physical Description

A perennial herb; the root crown produces many erect, rarely branching, pubescent stems. Leaves are alternate, lance-shaped, 0.4 - 0.7 inch (11 - 17 mm) long, 0.1-0.3 inch (3 - 8 mm) wide, soft, and bright green with short petioles. Mature plants are about 2.3 feet (0.7 m) high and 3.0 feet (0.9 m) across. The pale blue flowers are 1.2 - 3.9 inches (12 - 15 mm) long. The fruits are follicles 1.2 - 3.9 inches (3 - 10 cm) long and are usually paired, a characteristic of the dogbane family. The follicles are terminal and extend above the foliage. Seeds are corky cylinders 0.1 - 0.2 inch (3 - 4 mm) wide and 0.3 - 0.4 inch (8 - 11 mm) long with tapered ends (USFWS, 1993).

Taxonomy

In the dogbane family (Apocynaceae) (USFWS, 1993)

Historical Range

See Current Range

Current Range

Known from the Baboquivan Mountains in Pima County, Arizona (USFWS, 1993).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect, Bird (EPA, 2016)

Breeding Season

Adult: Flower clusters form in April; fruits from June to July (USFWS, 1993).

Key Resources Needed for Breeding

Adult: Insects and hummingbirds for pollination (EPA, 2016)

Reproduction Narrative

Adult: Flower clusters form in April; fruits from June to July. Butterflies, beetles, and hummingbirds have been observed feeding on flowers (USFWS, 1993). Pollinators may include butterflies, bee flies, mordellid beetles, hawkmoths, moths, and broad-tailed hummingbirds. It is suspected that moths may be the primary pollinator, although a number of generalist pollinators may be effective. It is possible that other plant species in the vicinity of *A. kearneyana* plants such as beargrass (*Nolina microcarpa*) in the steep slope habitat or

doctorbush (*Plumbago scandens*) in the canyon bottom habitat may contribute to successful pollination for the species (EPA, 2016).

Habitat Type

Adult: Terrestrial (USFWS, 2013)

Habitat Vegetation or Surface Water Classification

Adult: Open unconsolidated slopes and intermittent stream beds (USFWS 2013)

Geographic or Habitat Restraints or Barriers

Adult: 3,600-6,000 ft elevation (EPA, 2016)

Environmental Specificity

Adult: Moderate. Generalist or community with some key requirements scarce (NatureServe, 2015)

Habitat Narrative

Adult: There are two distinct habitats: open woodland on unconsolidated slopes of over 20 degrees, and canyon bottoms in full sun to partial shade. While once thought to only occupy canyon bottoms, it is now known that this is secondary habitat for the species, with most subpopulations being located on steep, dry, and open woodland-dominated slopes. Soil types are unknown; elevation range is 3,600-6,000 ft (EPA, 2016). Occurs in two disturbance-prone environments: Open unconsolidated slopes and intermittent stream beds (USFWS, 2013).

Dispersal/Migration**Motility/Mobility**

Adult: Abiotic (EPA, 2016)

Dispersal/Migration Narrative

Adult: The corky seeds float in water (EPA, 2016). The nature of the seeds and the riparian habitat suggest that floodwater associated with storms that occur mostly from July to September disperse the seeds (USFWS, 1993).

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Species Trends:

Decline of 10-30% (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Population Growth Rate:

Unknown (NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Adaptability:

Low (inferred from NatureServe, 2015)

Population Narrative:

From a very isolated area in Arizona and Sonora, Mexico. Unknown 8 individuals from one population in Arizona - formerly 25 (5/93 Recovery Plan). In fall 1988 and winter 1989, 181 individuals were transplanted to another canyon in the same mountain range. A flood removed most of the individuals except for 33 in the summer of 1990. Another planting was made in the winter of 1992 (FWS, in AGFD 2012). Abundance of this plant is considered low (Laurenzi and Spence, 2012). Occupies a few canyons in the Baboquivari Mountains. Formerly known only from (probable) type locality in Arizona, on west-facing drainage. Occupies a few canyons in the Baboquivari Mountains. Discovered about 1996 nearby in Sonora, Mexico (NatureServe, 2015).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Kearney's blue star and its habitat is susceptible to damage from livestock grazing, wildfire, flooding, and foot traffic resulting from border activity at the U.S.-Mexico border (USFWS, 2013).

Stressor: Other natural or manmade factors affecting its continued existence (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Low numbers, few populations, and apparently insufficient reproduction and climate change are threats to the species. *Amsonia kearneyana* has a very restricted geographic range with a small number of known subpopulations ranging in size from a single plant to roughly 130 individuals (Donovan 1998; Service 2012). Additionally, seedlings are rare in both wild subpopulations and in the transplant population (USFWS, 2013).

Stressor: Predation (USFWS, 1993)

Exposure:

Response:

Consequence:

Narrative: Due to predation by some insect on the plants at Brown Canyon, Reichenbacher et.al. (1991) noted that all of the follicles produced by 31 Kearney's blue star plants had to be collected prematurely. The predator, in this case, was never identified. Thus, it appears Kearney's blue star may be subject to intense periodic predation by several insects (USFWS, 1993).

Recovery**Reclassification Criteria:**

1. Establish or maintain 10 self-sustaining native populations of Kearney's blue star within the known or inferred historic range of the species. Each population must contain at least 200 reproducing individuals and show recruitment that equals or exceeds mortality. The populations should be geographically distinct and represent the geographic range and genetic variability of the species. Of the ten natural populations needed to ensure the long-term survival of the species, at least seven must be natural populations and up to three may be reintroduced populations. The downlisting criteria will not be met if fewer than seven natural populations are found (USFWS, 1993).

2. Insure long-term protection of the populations from human threats on Indian, private, and public lands. Because most of the potential habitat for Kearney's blue star occurs on the Tohono O'odham Nation (TON), the Tribe will need to take the lead in implementing the recovery plan and any additional protective measures on the Reservation. The FWS must provide the Tribe the technical advice needed to carry out recovery actions and seek the funding necessary to support the Tribe in their recovery efforts (USFWS, 1993).

Delisting Criteria:

Not available.

Recovery Actions:

- Identify and protect natural and introduced populations. Develop a conservation strategy for Kearney's blue star and the associated ecosystem on the Tohono O'odham Reservation. The FWS will coordinate and provide technical assistance for recovery activities on private and public lands. Enforce existing rules and regulations of the Endangered Species Act, the Arizona Native Plant Law, and any other applicable law or local ordinance (USFWS, 1993).
- Assess the status of natural, reintroduced, and ex situ populations. Monitor threats. Collect demographic data to determine population status and viability (USFWS, 1993).
- Conduct research and observe the populations to describe the species' habitat requirements. and modify management as appropriate. Define associated plant species. Describe the physical environment. Use information obtained to map the inferred historic range of the species. Conduct grazing impact studies and determine watershed conditions and trends. Study insect seed predation. Examine the pollination ecology and reproductive biology (USFWS, 1993).
- Survey for new populations. Inventory all lands in Arizona and Mexico believed capable of supporting Kearney's blue star (USFWS, 1993).
- Establish a sufficient number of reintroduced populations to meet the downlisting criteria. The reintroduction of populations should not be used to substitute for effective management of natural populations or habitat. Techniques learned in the ex situ conservation program should be employed in establishing populations. Reintroduced

populations should be managed and monitored the same as natural populations (USFWS, 1993).

- Establish an ex situ conservation program. Establish a botanical garden population and a seed bank. Establish and monitor ex situ populations to maintain a conservation pool (USFWS, 1993).
- Develop and implement a public awareness program. Scientific information, including results of field and greenhouse research, monitoring data, trip reports, agency reports, and scientific literature should be readily available to all parties interested in the management and survival of Kearney's blue star (USFWS, 1993).

Conservation Measures and Best Management Practices:

- The 1993 Recovery Plan should be updated with recovery criteria that reflect current threats to *A. kearneyana*. Updated objective, measurable criteria for downlisting and delisting should be established (USFWS, 2013).
- Studies should be conducted to evaluate impacts of climate and long-term drought on this species. Studies should focus on site specific climate changes such as precipitation, snowfall, and temperature that influence flower and seed production, and seed germination (USFWS, 2013).
- Studies should be conducted to evaluate the impacts of fire of varying severity on this species. Comparisons to non-burned subpopulations on Tohono O'odham lands would be very helpful (USFWS, 2013).
- Studies should be conducted to evaluate the pollination ecology of *A. kearneyana* and evaluate if pollinators are connecting all subpopulations, thereby maintaining genetic diversity (USFWS, 2013).
- Establish monitoring within several subpopulations that allows comparison of data over time and across various disturbance regimes (USFWS, 2013).
- Studies specific to genetics or trends in genetic variation should be completed (USFWS, 2013).

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SPECIES ACCOUNT: *Apios priceana* (Price's potato-bean)

Species Taxonomic and Listing Information

Listing Status: Threatened; 2/5/1990; Southeast Region (R4)

Physical Description

A twining, herbaceous, perennial vine that grows from a stout, thick, roundish tuber often 18 centimeters (cm) or 7.2 inches (in.) in diameter (Figure 1). The stem is round in cross section, somewhat twisted and slightly ridged. It is finely hairy early in its growth, but later becomes smooth and glabrous. Leaves of the main stem are 20 to 30 cm (8 to 12 in.) long, alternate, and pinnately compound with 7 (5 to 9) leaflets. The leaflets are 4 to 10 cm (1.6 to 4.0 in.) long and half as wide, ovate and obtuse or rounded at the base and on 3 to 5 millimeter (mm) (0.1 to 0.2 in.) hairy stalks. The upper leaflet surface is smooth at maturity, and the lower surface is pale, slightly hairy, and veiny. Leaves and leaflets of branches are smaller than those of the main stem. Racemes are 5 to 15 cm (2 to 6 in.) long, dense with flowers (50 to 70) and are usually in clusters of two and three in the axils of the leaves. Pedicels (flower stalks) are thin and 3 to 5 mm (0.1 to 0.2 in.) long; the bracts (small leaves at base of flowers) are longer than the pedicels and are ovate with a slender, tapering tip. The greenish-white or brownish pink flowers are 1 cm long (0.4 in.) and tinged with magenta at the apex. The standard (large, upper petal) is bi-auriculate (ear-shaped appendages) at the base with a fleshy beak-like apex, the wings (lateral petals) are shorter and narrowly oblong but rounded at the base, and the keel (bottom, ridged petals) are fleshy and curved upward. Pods are 12 to 15 cm (5 to 6 in.) long, 1 cm (0.4 in.) wide, and tapering at both ends. There are usually 4 to 10 seeds per pod. Seeds are 7 to 8 mm (0.3 in.) long and separated in the pod by a silvery white endocarp. The roots of *A. priceana* produce nodules 2 to 3.5 mm (0.1 in.) in diameter (Robinson 1898; Kral 1980; Woods 1988; Isely 1990; L. McCook, Missouri Botanical Garden, personal communication, 1992). (USFWS, 1993)

Taxonomy

A member of the pea family (Fabaceae). The genus *Apios* was described by Cornut in 1633; however, Linnaeus called the genus *Glycine* in 1753. In 1905, at the botanical congress in Vienna, *Apios* was conserved over *Glycine* (pro parte). The genus consists of three Asian species and two North American species (Woods 1988). Common names for *Apios oriceana* include Price's potato-bean, Sadie Price's potato-bean, potato-bean, and Price's ground nut. Type specimens are in the Gray Herbarium, Cambridge, Massachusetts. (USFWS, 1993). Woods (2005) revised the taxonomy of the North American species of *Apios* (Fabaceae). In doing so, he maintained recognition of Price's potato-bean as *Apios priceana* Robinson, as originally published. A phylogenetic analysis indicated that the genus *Apios* originated in Southeast Asia, and that the North American species (*A. americana* and *A. priceana*) are more closely related to one another than to any of the Asian species (Li et al. 2014) (USFWS, 2016).

Historical Range

At time of Recovery Plan, found in 22 counties in five states: Alabama, Illinois, Kentucky, Mississippi, and Tennessee. Originally found in 1896 by Sadie Price in open woods near Bowling Green in Warren County, Kentucky. (USFWS, 1993)

Current Range

Mississippi (Clay, Oktibbeha and Lee counties); Alabama (Madison, Autauga and Marshall counties); Kentucky (Lyon, Livingston and Trigg counties); Tennessee (Marion, Montgomery and Williamson counties) (NatureServe, 2015). The species is considered extirpated from the State of Illinois (Ebinger et al. 2010) (USFWS, 2016).

Critical Habitat Designated

Yes;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual: primarily cross-pollination, self-pollination possible (USFWS, 2016)

Dependency on Other Individuals or Species

Adult: A butterfly (*Eudamus tityrus*), honey and bumble bees (NatureServe, 2015); *Bombus* spp. (USFWS, 2016)

Breeding Season

Adult: June through September (NatureServe, 2015)

Reproduction Narrative

Adult: Flowers of *A. priceana* bloom from June through August, possibly as late as September (Kral 1983, Mahler 1970). Legumes mature in August to September (Kral 1983). Early reports by the discoverer of the species, Sadie Price, suggested that it does not frequently set fruit (Robinson 1898). Flowers of *A. priceana* bloom from June through August, possibly as late as September (Kral 1983, Mahler 1970). Legumes mature in August to September (Kral 1983). Early reports by the discoverer of the species, Sadie Price, suggested that it does not frequently set fruit (Robinson 1898). Potential pollinators include a butterfly (*Eudamus tityrus*), honey and bumble bees (Robinson 1898). Apparently the bees find the nectaries very difficult to access. *Apios priceana* can be readily germinated by scarification of the seed coat through chipping (Seabrook 1973) or acid (Walter et al. 1986). Plants can grow 5-6 feet during the first summer, but do not flower. Flowering is apparently initiated only in plants that have over-wintered (Baskin pers. comm.). Tubers of *A. priceana* apparently require vernalization for growth (Bowden pers. comm.). Plants die back to the tuber in the mid-summer (NatureServe, 2015). *Apios priceana* plants produce very few seeds (Robinson 1898, Chester and Holt 1990). This low level of sexual reproduction may result in small population sizes and little dispersal of the species to new sites. It also is likely to result in low genetic diversity within populations (USFWS, 1993). During 2013, 10,752 flower buds were initiated, from which 2,550 flowers were produced, resulting in 97 mature fruits bearing a total of 234 seeds. Reproductive output was lower during 2010, when a sample of five plants that generated 4,299 flower buds ultimately produced only 7 mature fruits, yielding a total of 51 seeds. Results of a field-based study of the species' breeding system indicated that *A. priceana* is not self-compatible (Boyd 2014). However, production of viable seeds by a lone plant at Missouri Botanical Garden indicates that selfcompatibility is possible (M. Albrecht pers. comm. 2008). At least four species of medium (~1-1.5 cm length; *Bombus pennsylvanicus*, *Bombus* sp.) to large bees (>1.5 cm; *Bombus*

bimaculatus, *Megachile sculpturalis*) were relatively efficient pollinators in the breeding system study (Boyd 2014) (USFWS, 2016).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Palustrine: forested wetland, riparian; Terrestrial: Cliff, Forest - Mixed, Forest/Woodland, Woodland - Mixed (NatureServe, 2015)

Environmental Specificity

Adult: Broad (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Open, rocky, wooded slopes and floodplain edges. Sites are usually under mixed hardwoods or in associated forest clearings, often where bluffs or ravine slopes meet creek or river bottoms. Soils are well-drained and loamy, formed on alluvium or over calcareous boulders. Several populations extend onto road or powerline rights-of-way. Price's potato-bean is an inhabitant of open, mixed-oak forests, forest edges and clearings on river bottoms and ravines, being unable to tolerate deep shade (USFWS 1989, Kral 1983). The species occurs on well-drained loams on old alluvium or over calcareous boulders (Kral 1983). According to the Missouri Botanical Garden, *A. priceana* prefers acidic, water retentive soils, requires no soil additives, can withstand winter temperatures below 5 degrees Celsius, shows no intolerance to supplemental feedings, and possesses no apparent pests (Bowden pers. comm.) (NatureServe, 2015).

Dispersal/Migration**Dispersal**

Adult: Low (NatureServe, 2015)

Dispersal/Migration Narrative

Adult: Unlike its close relative, *Apios americana*, which produces numerous tubers, *A. priceana* produces only one. This fact may serve to severely limit natural dispersal of the species. Since *A. priceana* has just the single tuber, it is unable to be dispersed effectively along rivers by spring freshets as is *A. americana* (Seabrook and Dionne 1976) (NatureServe, 2015).

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Stable (USFWS, 2016)

Number of Populations:

59 (USFWS, 2016)

Adaptability:

Relatively resistant (NatureServe, 2015)

Population Narrative:

Relatively resistant. *Apios priceana* has been collected from Alabama, Mississippi, Kentucky, Tennessee and Illinois (Norquist 1990, USFWS 1989, Medley 1980). The single Illinois site has been destroyed (Medley 1980) and the species is no longer considered extant in the state (Karnes pers. comm.). *Apios priceana* is known from 50-100 extant element occurrences throughout its range (NatureServe central databases July 2013). However, the degree of overlap between some element occurrences in the central database is unknown. 13 to 40 of these occurrences have good viability/integrity. The species has experienced a short-term decline of 10 - 50% (NatureServe, 2015). Many new populations of *Apios priceana* have been discovered since the species' recovery plan (USFWS 1993) was published. Of the 25 populations included in the recovery plan, 20 are still extant, and available data indicate that population sizes have remained stable in those locations. Twenty-three populations are located on public lands or privately owned conservation lands. However, populations are small at most locations. Based on data in unpublished reports and data from Natural Heritage Programs in Alabama, Kentucky, Mississippi, and Tennessee, there are now 59 known extant populations, distributed among 26 counties in four states (USFWS, 2016).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 1993)

Exposure:

Response:

Consequence:

Narrative: Logging may threaten *A. priceana* populations. Selective removal of trees that shade plants can enhance growth and reproduction of *A. priceana* by increasing levels of light; however, clearcutting or heavy logging can eliminate populations (U.S. Fish and Wildlife Service 1989). It is unclear whether clearcutting will result in permanent destruction of populations. Populations of *A. priceana* are found in secondary-growth forest suggesting that the species may recover after heavy logging (Kral 1983). Landowners who do not know that the species is on their land or who are not interested in its continued survival may make land management decisions that are harmful to the species. The location of 11 populations on rights-of-way (road edges, powerlines, etc.) is also a potential threat to the species. Maintenance of these areas by herbicides, mowing, and clearing of trees could damage or extirpate these populations (U.S. Fish and Wildlife Service 1989, Chester and Holt 1990). Clearing trees may be harmful if the debris is piled on top of the populations. Widening of a road adjacent to an *A. priceana* population could easily wipe out an entire population. Mining for limestone is a potential threat to *A. priceana* populations found over limestone bedrock (Kral 1983). Grazing and trampling of plants by cattle can cause severe damage. The erosion of soil that results from heavy grazing and trampling also can harm the species (Medley 1980) (USFWS, 1993).

Stressor: Low reproductive potential (USFWS, 1993)

Exposure:

Response:**Consequence:**

Narrative: *Apios priceana* plants produce very few seeds (Robinson 1898, Chester and Holt 1990). This low level of sexual reproduction may result in small population sizes and little dispersal of the species to new sites. It also is likely to result in low genetic diversity within populations. It is not known whether *A. priceana* reproduces vegetatively; 1993).

Stressor: Pests and pathogens (USFWS, 1993; 2016)

Exposure:**Response:****Consequence:**

Narrative: A variety of pests are reported to damage *A. priceana* plants, including spider mites (D. Wright, Missouri Botanical Garden, personal communication, 1991), a powdery mildew virus, and root-knot nematodes (Blackmon and Reynolds 1986). An unidentified insect has been observed to damage the flowers and fruits of *A. priceana* (E. Chester, personal communication, 1991). These pests may have a significant effect on *A. priceana* (USFWS, 1993). The bean leaf beetle (*Certoma trifurcate*) was observed eating leaves and flower buds, causing the formation of holes in the leaves and interrupting development of flowers and fruits. A second species of beetle, *Chalepus scapularis*, was collected from an *A. priceana* plant, but its feeding behavior was not observed. The extent to which these observations of insect herbivory indicate a threat to *A. priceana* is not known, but monitoring efforts for the species should include assessments of the extent of insect herbivory when observed and collection of specimens to identify potentially threatening species (USFWS, 2016).

Stressor: Invasive species (USFWS, 1993)

Exposure:**Response:****Consequence:**

Narrative: An introduced, invasive plant, *Coronilla varia* (crown vetch), is threatening to outcompete one Kentucky population (Chester and Holt 1990). Other exotics, *Ligustrum sinense* and *Rosa multiflora*, are reported to be competing with populations in Mississippi (M. Morris, University of Florida, personal communication, 1992) (USFWS, 1993).

Stressor: Climate change (USFWS, 2016)

Exposure:**Response:****Consequence:**

Narrative: Davenport (2007) included *A. priceana* in an analysis of potential effects of climate change on Alabama's plant life. The analysis was based on best professional judgment of how various habitat types and associated species would respond to climate changes that models predict Alabama will experience. Davenport (2007) concluded that "species demanding shady ravines and stream banks will constrict in distribution", including the hardwood forests inhabited by *A. priceana*. (USFWS, 2016).

Recovery**Reclassification Criteria:**

Not applicable.

Delisting Criteria:

1. When there are at least 25 geographically distinct, self-sustaining, protected populations and they have been maintained for 10 years. A population will be considered self-sustaining if the population size is stable and there is evidence of successful reproduction. Protected populations will have appropriate legal protection and appropriate management. (USFWS, 1993).

Recovery Actions:

- Protect known populations. Twenty-one of the 25 known populations of *A. priceana* are on privately-owned land; the remaining four populations are on federally-owned land. One of the privately-owned populations is owned by The Nature Conservancy and is adequately protected. Four of the privately-owned populations are Registered Natural Areas. The remaining 16 privately-owned populations are unprotected. Legal protection of these areas is necessary to provide long-term security and prevent land use that is harmful to the species. Management plans should be developed for all populations that are protected, particularly those owned by the Federal government and conservation organizations. Management plans should be developed for the remaining populations once some sort of protection is achieved. Without this protection, *A. priceana* habitat will continue to be destroyed, and the species may become extinct. (USFWS, 1993)
- Investigate effects of potential management techniques. Potential management techniques for *A. priceana* should be tested to determine their effectiveness. Because there are few populations of *A. priceana* and population sizes are small, it is essential that work begins to enhance growth and reproduction of plants and to reestablish populations (if found necessary). Without this active management, the species is likely to become extinct. The selection of populations used for these experiments should be based on their need for this type of management and the size and vigor of the population. The experimental treatment should be applied within replicated plots. The number and size of the plots should be determined by the size of the population and the density of the plants. An equal number of unmanipulated plots should be established as controls. (USFWS, 1993)
- Search for new populations. The search for new populations of *A. priceana* must continue. The most accurate information on the number and distribution of populations is necessary to make appropriate decisions about management of the species. (USFWS, 1993)
- Study biology of *Apios priceana*. An increased understanding of the biology of *A. priceana* is necessary to develop appropriate management practices for the species. (USFWS, 1993)
- Maintain plants and seeds ex situ. Plant material should be preserved in artificial conditions in case catastrophes destroy all or most populations of the species. This stored material also could be used to establish new populations if natural populations become depleted. The Center for Plant Conservation (Center) has extensive experience in this area and should be involved in the planning and implementation of these tasks. (USFWS, 1993)
- Provide public information. Priority should be given to providing landowners with information about the species. *Apios priceana* is already on display at the Missouri Botanical Garden (a member botanical garden of the Center for Plant Conservation) and is used to educate the public about rare plants and conservation needs. The artificial population at Land Between the Lakes should be maintained and similarly used to educate the public. Providing the public with information about the species could also encourage amateur and professional naturalists to search for new *A. priceana* populations. (USFWS, 1993)

Conservation Measures and Best Management Practices:

- Apios priceana plants are being grown artificially in several locations. These plants will provide seeds and tubers for further studies of the species. Seeds from these plants also may be used in the future to reestablish extirpated populations (USFWS, 1993).
- Work is also being done to protect several naturally occurring populations of A. priceana. Four populations are Registered Natural Areas. Although this is not legally binding protection, it does indicate that the owners of the property are showing an active interest in the survival of the species. A population in Tennessee has been purchased by The Nature Conservancy (USFWS, 1993).
- Four populations are on federally-owned land. These populations are legally protected by the Endangered Species Act. Two populations in Kentucky are on land owned by the Tennessee Valley Authority within an area designated as a Conservation Education Center (Table 1, number 7 and number 8) (U.S. Fish and Wildlife Service 1990). TVA has shown active involvement in the protection of the species. Two populations in Alabama are owned by the U.S. Army Corps of Engineers (U.S. Fish and Wildlife Service 1990) (USFWS, 1993).
- Searches for new populations of A. priceana were carried out in Tennessee and Illinois during the 1990 growing season. The search in Tennessee resulted in the discovery of four new occurrences of the species (Tennessee Department of Conservation 1991). The Illinois search did not result in the discovery of new sites or the relocation of the two populations previously known from the State (Hutchinson 1990). A search for the species in Tennessee in 1991 resulted in the discovery of five new populations (Tennessee Department of Conservation 1991) (USFWS, 1993).
- Continue efforts to work with local governments and highway officials to reduce threats associated with roadside maintenance, including establishing cooperative agreements when possible (USFWS, 2016).
- Continue management at LBL and Sauta Cave NWR to reduce canopy cover and invasive species encroachment and promote flowering, seed production, and population growth. Encourage similar management efforts at other protected sites (USFWS, 2016).
- Work with Natural Heritage Programs, NPS, USFS, and others to establish consistent range wide monitoring program (USFWS, 2016).
- Work cooperatively with Redstone Arsenal, Alabama, to manage and monitor population on Department of Defense lands (USFWS, 2016).
- Work cooperatively with ADCNR to manage and monitor population at Old Cahawba Forever Wild Tract in Alabama (USFWS, 2016).
- Work cooperatively with NPS to develop conservation strategies for populations at Fort Donelson National Battlefield, in Tennessee, and Natchez Trace Parkway, in Mississippi (USFWS, 2016).
- Work with landowners of protected sites to develop conservation agreements that establish biological goals for A. priceana, identify management strategies to achieve those goals, and include a monitoring plan for measuring effectiveness of conservation efforts as relates to the species' status (USFWS, 2016).
- Ensure that ex situ accession information and propagation protocols are maintained and curated in the Center for Plant Conservation National Collection of Endangered Plants centralized database (USFWS, 2016).
- Conduct experimental studies that examine the species' habitat needs in order to develop management protocols that bolster population size and fitness. While it has been assumed that A. priceana will respond favorably to opening forest canopies, current monitoring protocols are not adequately designed to compare population responses across light gradients. Future work should include design of experiments to examine the response of natural or experimental populations to fire, canopy thinning, and other management tools. Greenhouse studies to explore effects of varying

levels of shade, soil moisture, and soil fertility could also improve understanding of factors that regulate growth of *A. priceana* individuals and populations (USFWS, 2016).

References

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USFWS. 1993. Recovery Plan for *Apios priceana*. U.S. Fish and Wildlife Service, Jackson, Mississippi. 43 pp. https://ecos.fws.gov/docs/recovery_plan/930210.pdf

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

USFWS. 1993. Recovery Plan for *Apios priceana*. U.S. Fish and Wildlife Service, Jackson, Mississippi. 43 pp. https://ecos.fws.gov/docs/recovery_plan/930210.pdf .

SPECIES ACCOUNT: *Arabis georgiana* (Georgia rockcress)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/14/2014; Southeast Region (R4) (USFWS, 2015)

Physical Description

A slender, erect biennial, with white flowers produced on a leafy stem to 9 dm in height. Leaves disposed at the base and along the stem, are alternate, lanceolate to narrowly elliptic, 1-5 cm long, and slightly clasp the stem. The flowers are produced in a terminal inflorescence that is sometimes loosely branched; 4-merous with petals 6-9 mm long. The fruit is an erect pod roughly 1 mm wide and 5-7 cm long. Flowering season: late March to early May. (NatureServe, 2015)

Taxonomy

Georgia rockcress was first collected in 1841, by Boykin from the vicinity of the Chattahoochee River in Georgia. Several other collections of this species were made in the late 1800s; however, Harper was the first to document its distinctiveness, after seeing it in fruit in 1901, on the bank of the Chattahoochee River in Stewart County, Georgia. Harper later described it as a distinct species in 1903 (Allison 1995, p. 4). Georgia rockcress was maintained as a distinct species (*Arabis georgiana*) in Hopkins's 1937 monograph of *Arabis* in the eastern United States (Allison 1995, p. 3) (USFWS, 2013).

Historical Range

Georgia rockcress is known from the Lower Gulf Coastal Plain, Upper Gulf Coastal Plain, Red Hills, Black Belt, Piedmont, and the Ridge and Valley Physiographic Provinces (Schotz 2010, p. 6; Allison 1995, p. 6) (USFWS, 2014).

Current Range

Despite fairly extensive searches, this species is currently known from fewer than 25 populations in Alabama and western Georgia. (NatureServe, 2015)

Critical Habitat Designated

Yes; 9/12/2014.

Legal Description

On September 12, 2014, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Arabis georgiana* (Georgia rockcress) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 17 critical habitat units (CHUs), in Alabama and Georgia (79 FR 54635-54667).

Critical Habitat Designation

The critical habitat designation for *Arabis georgiana* includes 17 CHUs in Gordon, Floyd, Harris, Muscogee, and Clay Counties Georgia and Bibb, Dallas, Elmore, Monroe, Sumter, and Wilcox Counties, Alabama. This species critical habitat encompasses approximately 732 acres (ac) (297 hectares (ha)) (79 FR 54635-54667).

Unit 1. Fort Tombebee, Sumter County, Alabama: The 6-ha (14-ac) Fort Tombebee unit is approximately 0.5 kilometers (km) (0.3 miles (mi)) northeast of the city of Epes, Alabama, and is owned by the University of West Alabama. This Georgia rockcress occurrence inhabits the crest and steep slopes of a deeply incised stream bank overlooking a small intermittent creek approximately 91 m (300 ft) upstream from its confluence with the Tombigbee River. Livestock grazing was observed during a visit made in May 2010, in a portion of the site where the species was previously observed; it is conceivable that livestock may have further impacted the occurrence. Only four plants were found in 2010 (Schotz 2010, p. 51). The physical or biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats associated with road crossings, development and potentially grazing.

Unit 2. Marshalls Bluff, Monroe County, Alabama: The 11-ha (27-ac) Marshall Bluff unit is a privately owned tract 9.6 km (6 mi) southwest of Perdue Hill, Alabama, on the eastern bank of the Alabama River on a high bluff (Marshalls Bluff) overlooking the Alabama River. An abandoned quarry exists approximately 150 m (500 ft) distant to the east, and while the quarry may have destroyed bluff habitat, the quarry currently poses no threat to the occurrence, and there are no plans to expand the quarry (Schotz 2010, p. 22). More than 400 plants were found in 2010. The physical or biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats associated with mining.

Unit 3. Prairie Bluff, Wilcox County, Alabama: Privately owned, the 13-ha (32-ac) Prairie Bluff unit is located along the banks of the Millers Ferry (William “Bill” Dannelly) Reservoir, approximately 1.6 km (1 mi) north of the Lee Long Bridge on State Route 28. Georgia rockcress is scattered along the bluffs and ravines associated with the Alabama River. Nonnative species, most notably *Ligustrum sinense* (Chinese privet) and *Lonicera japonica* (Japanese honeysuckle), threaten this site (Allison 1999, p. 2; Schotz 2010, pp. 54–55). More than 500 plants were found in this unit in 2010; however, some habitat was likely inundated by the reservoir. This site is slated for residential development with lakeside lots, and the infestation of nonnatives will likely become worse. The physical or biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats associated with roads, development, hydropower, and nonnative species.

Unit 4. Portland Landing River Slopes, Dallas County, Alabama: Privately owned, the 12-ha (31-ac) Portland Landing River Slopes unit is located 18 km (11.5 mi) south of Orrville, Alabama, on the south side of the Alabama River at Portland Landing. This occurrence of Georgia rockcress is restricted to the unstable, highly erodible, sandy soils along the bank of the Alabama River. Nonnatives, most notably *Melia azedarach* (Chinaberry or bead-tree), Japanese honeysuckle, and *Pueraria montana* var. *lobata* (kudzu), are present, and although not severe, these nonnatives will persist without active management (Schotz 2010, p. 40). In 2010, 498 Georgia rockcress plants were recorded (Schotz 2010, p. 40). The physical or biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats associated with timber harvest, hydropower, and nonnative species.

Unit 5. Durant Bend, Dallas County, Alabama: Privately owned, the 12-ha (28-ac) Durant Bend unit occurs 16 km (10 mi.) east of Selma in a sharp bend on the Alabama River. Fewer than 50 plants were reported in sandy alluvium along the Alabama River under a partially open to filtered

canopy in 2010 (Schotz 2010, p. 37). While the majority of plants occur in forested conditions, a small number of plants were observed in relatively open and exposed soils of actively eroding sections of the riverbank. Nonnatives, including Chinese privet and Japanese honeysuckle, are present but not severe. Timber harvesting has recently taken place approximately 46 m (150 ft) north of the site, but it currently has not impacted species' viability or habitat integrity (Schotz 2010, p. 37). The physical or biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats associated with timber harvest and nonnative species.

Unit 6. Murphys Bluff Bridge Cahaba River, Bibb County, Alabama: Privately owned, the 11-ha (26-ac) Murphys Bluff Bridge Cahaba River unit is 11.4 km (7 mi) southwest of Centreville, Alabama, and located along the west bank of the Cahaba River downstream (southwest) of the Murphy Road Bridge. Chinese privet, Japanese honeysuckle, and other nonnatives are present, but are relatively sparse. Infestation of nonnative plants could worsen. Timber harvesting has been observed nearby and may pose a potential concern (Schotz 2010, p. 22). Sixteen Georgia rockcress plants were found at this location during the 2010 survey. The physical or biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats associated with road crossings and nonnative species.

Unit 7A. Creekside Glades, Bibb County, Alabama: Privately owned, the 11-ha (26-ac) Creekside Glades subunit is located 9.6 km (6 mi) north-northeast of Centreville, Alabama, along the banks of Little Schultz Creek. Georgia rockcress occurs in association with a small dolomite glades complex on either side of Little Schultz Creek. The plants (mostly rosettes, i.e., non-reproductive) predominantly occur in the ecotone of the glades and the encompassing woodland, in association with a mix of shrubs and low-growing trees. A smaller number of individuals (mostly mature) can be found in the glades and surrounding woodlands (Allison 1999, p. 2; Schotz 2010, p. 30). This subunit contained 42 plants in 2010. A utility line right-of-way passes through this subunit, and while there is no canopy on the right-of-way, it provides essential supporting habitat such that the right-of-way has not been excluded from critical habitat. The physical or biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats associated with development and utility right-ofway maintenance. Unit 7B. Little Schulz Creek, Bibb County, Alabama Privately owned, the 12-ha (28-ac) Little Schulz Creek subunit is located 8.9 km (5.5 mi) north-northeast of Centreville, Alabama. In 2010, 29 plants occurred on limestone outcrops along the west bank of the Cahaba River. The site is characterized as a bouldery limestone woodland situated along a low bluff overlooking the Cahaba River. Georgia rockcress inhabits shallow soils associated with the bluff, occurring under an open to lightly shaded canopy (Schotz 2010, p. 32). This subunit consisted of 29 plants in 2010. The physical or biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats associated with development and utility right-ofway maintenance.

Unit 8A. Cottingham Creek Bluff and Unit 8B. Pratts Ferry, Bibb County, Alabama: Privately owned, the Cottingham Creek Bluff subunit is located on the east side of the Cahaba River, upstream of Pratts Ferry Bridge, 10 km (6.2 mi) northeast of Centreville, Alabama. The Pratts Ferry subunit is located on the west side of the Cahaba River, downstream of Pratts Ferry Bridge, 10 km (6.2 mi) northeast of Centreville, Alabama. A small portion (26 percent (5.88 ha (14.5 ac)) of the Cottingham Creek Bluff subunit is owned by The Nature Conservancy (TNC). A small

number of plants are confined to an abandoned limestone quarry several hundred feet back from the southeastern side of the river's edge. Chinese privet and Japanese honeysuckle impact this site, particularly in the vicinity of the abandoned quarry. Nonnatives could become worse. Timber harvesting is of potential concern in an area adjacent to the population on the west side of the Cahaba River, which was selectively logged in the 1990s (Allison 1999, p. 3; Schotz 2010, pp. 34–35). Subunit 8A is 22 ha (55 ac), and subunit 8B is 11 ha (28 ac). In 2010, these two subunits together contained 299 Georgia rockcress plants. The physical or biological features essential to the conservation of the species in these subunits may require special management considerations or protection to address threats associated with road crossings, timber harvest, and nonnative species.

Unit 9A. Fern Glade, Bibb County Alabama: The 14-ha (34-ac) Fern Glade subunit is centered near the confluence of the Little Cahaba River and Sixmile Creek approximately 14.2 km (8.9 mi) northeast of Centreville, Alabama. Twelve percent of the Fern Glade subunit (4.2 ha (1.7 ac)) is owned by TNC, and 79 percent (10.9 ha (27 ac)) of this subunit is part of the Cahaba National Wildlife Refuge. A moderate incursion of invasive Chinese privet and Japanese honeysuckle occurs at this site. Nonnatives will likely become worse (Allison 1999, p. 3; Schotz 2010, p. 26). A small glade on the north side of the Little Cahaba River had 81 Georgia rockcress plants in 2010. The physical or biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats associated with timber harvest and nonnative species. Unit 9B. Sixmile Creek, Bibb County, Alabama Privately owned, the Sixmile Creek subunit is located 13.7 km (8.5 mi) northeast of Centreville, 0.8 km (0.5 mi) upstream on Sixmile Creek from its confluence with the Little Cahaba River. The majority of this subunit (96.6 percent or 8.2 ha (20.3 ac)) was acquired by TNC in 2013. This population of Georgia rockcress is on the west side of Sixmile Creek. In a relatively isolated site, Georgia rockcress occupies the upper slope and summit of a steep forested bluff overlooking Sixmile Creek. This 13-ha (31-ac) subunit had 59 Georgia rockcress plants in 2010. The physical or biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats associated with timber harvest and nonnative species.

Unit 10A. Browns Dam Glade North and Unit 10B. Browns Dam Glade South, Bibb County, Alabama: Privately owned, the Browns Dam Glade subunits are located 15.8 km (9.8 mi) northeast of Centreville, Alabama, on both sides of the Little Cahaba River. Subunit 10A is on the north side of the river, and subunit 10B is in a sharp bend on the south side of the River. More than 96 percent of subunit 10A (13.7 ha (33.8 ac)) and all of subunit 10B are owned by TNC. A combination of open woodland and dolomitic glades characterize the site. An infestation of nonnatives, most notably Chinese privet, occurs at this unit. This site serves as a primitive recreation area for local residents, resulting in some trash disposal and the construction of fire pits (Allison 1999, p. 5; Schotz 2010, pp. 24–25). Subunits 10A and 10B are 14 ha (35 ac) and 15 ha (37 ac), respectively. A complex of dolomitic glades and associated woodlands along both sides of the Little Cahaba River contained 71 Georgia rockcress plants in 2010. The physical or biological features essential to the conservation of the species in these subunits may require special management considerations or protection to address threats associated with nonnative species.

Unit 11. McGuire Ford/Limestone Park, Bibb County, Alabama: Privately owned, the McGuire Ford/ Limestone Park unit is located 18.7 km (11.6 mi) northeast of Centreville, Alabama, on the

southeast side of the Little Cahaba River. A small number of plants occupy shallow soils of low, rocky limestone outcrops along the Little Cahaba River under a lightly shaded canopy of eastern red cedar, chinquapin oak, white ash, Southern sugar maple, and redbud, among others (Allison 1999, p. 5; Schotz 2010, p. 20). This 6-ha (15-ac) unit contained 50 Georgia rockcress plants during the 2010 survey. The physical or biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats associated with roads, development, and maintenance of a pasture.

Unit 12. Fort Toulouse State Park, Elmore County, Alabama: State-owned, the Fort Toulouse State Park unit is located 16 km (10 mi) north of Montgomery, Alabama, on the south side of the Coosa River. Georgia rockcress is widely scattered along the bluffs overlooking the Coosa River, primarily occupying mesic, sandy soils of upper slopes and crest. Japanese honeysuckle is beginning to severely impact many areas of the site (Allison 1999, p. 2; Schotz 2010, p. 42). This 7-ha (17-ac) unit contained 47 Georgia rockcress plants during the 2010 survey. The physical or biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats associated with maintenance of a recreational field and nonnative species.

Unit 13. Fort Gaines Bluff, Clay County, Georgia: Privately owned, the Fort Gaines Bluff unit is located 1.5 km (0.9 mi) south of Fort Gaines, Georgia, on the Chattahoochee River. This high, steep, eroding river bank has sandy loam soils and an intact hardwood overstory. Japanese honeysuckle has become severe over much of area (Allison 1995, pp. 18–29; Moffett 2007, p. 9). This 17-ha (43-ac) unit contained 84 Georgia rockcress plants in 2010. The physical or biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats associated with timber harvest and nonnative species.

Unit 14A. Goat Rock North and Unit 14B. Goat Rock South, Harris and Muscogee Counties, Georgia: Privately owned, the Goat Rock Dam is 18.5 km (11.5 mi) north of Columbus Georgia. The Goat Rock North subunit is immediately north of Goat Rock Dam on the banks of Goat Rock impoundment, while the Goat Rock South subunit is immediately downstream of Goat Rock Dam along the high bluffs overlooking the Chattahoochee River. All of Goat Rock North subunit and the majority of the Goat Rock South subunit are owned by a corporation that supports conservation efforts for Georgia rockcress. The corporately owned property is provided modest protection in the shoreline management plan, which was developed during Federal Energy Regulatory Commission (FERC) licensing (FERC 2004, pp. 29–30). However, the southernmost portion of the Goat Rock South subunit is privately owned. This high rocky bluff is mostly covered by a mature canopy of trees. A narrow portion of this habitat has a transmission line passing over the top where all woody species have been removed; however, Georgia rockcress plants are scattered in the transmission line right-of-way. This area contains PCEs 1 and 2; therefore, it is included in the final designation. Nonnative species, including Chinese privet and Japanese honeysuckle, have severely impacted this site (Allison 1995, pp. 24–27; Moffett 2007, pp. 6–9). Conservation actions here have included invasive species/woody competition removal (both manually and chemically) to benefit existing Georgia rockcress plants, and prescribed burning to open up new adjacent sites for outplanting enhancement. The Chattahoochee Nature Center (CNC) outplanted approximately 300 Georgia rockcress plants of the Goat Rock genotype at this site in 2008. The local office of TNC has also expressed interest in possibly including this site in their long-range ecosystem planning (Elmore 2010, pp. 1–3). Subunits 14A and 14B are 7 ha (19

ac) and 24 ha (59 ac), respectively, and contain two or more of the PCEs throughout the subunits. In 2007, approximately 1,000 Georgia rockcress plants were found scattered across these subunits. The physical or biological features essential to the conservation of the species in these subunits may require special management considerations or protection to address threats associated with hydropower, utility line maintenance, and nonnative species.

Unit 15. Blacks Bluff Preserve, Floyd County, Georgia: Privately owned, the 37-ha (92-ac) Blacks Bluff Preserve unit is located 6.5 km (4.0 mi) southwest of Rome, Georgia, on the Coosa River. Blacks Bluff is in private ownership with a conservation easement on the property. There were 27 Georgia rockcress plants reported on this site in 1995; however, the presence of nonnative species has since extirpated all Georgia rockcress from this site. The Georgia Plant Conservation Alliance (GPCA) and TNC agreed to bolster the existing population with plants grown from seed collected at the two nearby (Ridge and Valley physiographic province) populations, Whitmore Bluff, and Resaca Bluffs. The CNC collected seed and grew 35 plants from Whitmore Bluff and 65 plants from Resaca Bluffs. In 2008, 100 Georgia rockcress plants were planted in this unit, with 84 Georgia rockcress surveyed on this site in 2011 (Goldstrohm 2011, p. 1). This steep bluff with limestone ledges and boulders has a mature deciduous canopy. Multiple sources of disturbance, including an abandoned quarry, have impacted this site and resulted in the establishment of many nonnative species, including Japanese honeysuckle and Nepalese browntop (Allison 1995, pp. 19–20; Moffett 2007, pp. 5–9; Elmore 2010, pp. 1–3). The physical or biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats associated with roads, mining, and nonnative species.

Unit 16. Whitmore Bluff, Floyd County, Georgia: Privately owned, the Whitmore Bluff unit is located 6.5 km (4 mi) northeast of Rome, Georgia, on the east bank of the Oostanaula River. This steep bluff with limestone boulders has a mature canopy with *Ulmus alata* (winged elm), *Quercus montana* (chestnut oak), and *Fraxinus americana* (white ash), and an understory including *Hydrangea arborescens* (wild hydrangea), *Toxicodendron radicans* (poison ivy), and *Sedum ternatum* (woodland stonecrop). Japanese honeysuckle has severely impacted this site (Allison 1995, p. 21; Moffett 2007, pp. 6–9; Elmore 2010, pp. 1–3). This 17-ha (43-ac) unit contained 63 Georgia rockcress plants in 1995, but only 12 in 2010. The physical or biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats associated with timber harvest and nonnative species.

Unit 17. Resaca Bluffs, Gordon County, Georgia: Privately owned, the Resaca Bluffs unit is located 0.8 km (0.5 mi) southwest of Resaca, Georgia, immediately east of I-75 along the northern bank of the Oostanaula River. This unit includes a rocky limestone bluff with a mature canopy, including eastern red cedar, *Quercus nigra* (water oak), *Quercus velutina* (black oak), winged elm, white ash, southern sugar maple, and redbud. Nonnative species, including Chinese privet and Japanese honeysuckle, have severely impacted this site (Allison 1995, pp. 22–23; Moffett 2007, pp. 5–9; Elmore 2010, pp. 1–3). This 5-ha (13-ac) unit contained 51 plants in 1995, and 42 in 2010. The physical or biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats associated with road crossings, development, and nonnative species.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Arabis georgiana* critical habitat consists of four components (79 FR 54635-54667):

(i) Large river bluffs with steep and/ or shallow soils that are subject to localized disturbances that limit the accumulation of leaf litter and competition within the Lower Gulf Coastal Plain, Upper Gulf Coastal Plain, Red Hills, Black Belt, Piedmont, and Ridge and Valley Physiographic Provinces of Georgia and Alabama.

(ii) Well-drained soils that are buffered or circumneutral generally within regions underlain or otherwise influenced by granite, sandstone, or limestone.

(iii) A mature, mixed-level canopy with spatial heterogeneity, providing mottled shade and often including species such as *Juniperus virginiana* (eastern red cedar), *Ostrya virginiana* (American hophornbeam), *Quercus muehlenbergii* (chinquapin oak), *Fraxinus americana* (white ash), *Acer barbatum* (southern sugar maple), and *Cercis canadensis* (eastern redbud) with a rich diversity of grasses and forbs characterizing the herb layer.

(iv) Intact habitat that is fully functional (i.e., with mature canopy and discrete disturbances) and buffered by surrounding habitat to impede the invasion of competitors.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographic area occupied by the species at the time of listing contain features which are essential to the conservation of the species and which may require special management considerations or protection. A fully functioning bluff habitat (i.e., with mature canopy and discrete disturbances) is required to provide the features essential to the conservation of this species and may require special management considerations or protection to reduce the following threats: Land-clearing activities that alter the canopy, including silvicultural management, building of utility lines, structures, roads, or bridges; construction of reservoirs that inundate habitat; mining activities; or introduction of invasive species that compete directly with Georgia rockcress. Large-scale disturbances, such as fire or soil-disturbing activities, should be minimized. A mature canopy with spatial heterogeneity should be maintained to impede invasive species while providing an opportunity for localized disturbances as canopy-gap dynamics develop. Invasive species should be eliminated from the critical habitat units. A mature canopy on the bluffs and a surrounding buffer area will help to exclude nonnatives.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 2013)

Dependency on Other Individuals or Species

Adult: Pollinators (inferred from USFWS, 2013)

Breeding Season

Adult: March - April

Reproduction Narrative

Adult: Flowering occurs from March to April, with fruiting beginning in May and into early July (Allison 1995, p. 4; Patrick et al. 1995, pp. 17–18; Chafin 2007, pp. 47–48; Schotz 2010, p. 3) (USFWS, 2013).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Palustrine: herbaceous wetland, riparian; Terrestrial: bare rock/talus/scree, barrens, cliff, mixed forest (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: High to moderate light conditions (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Heavy shade, acidic soils (NatureServe, 2015)

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Shallow soil accumulations on rocky bluffs, ecotones of gently sloping rock outcrops, outcrops along rivers, and sandy loam along eroding riverbanks. It is occasionally found in adjacent mesic woods but it will not persist in heavily shaded conditions. Requires high to moderate light conditions, occurs on soils which are circumneutral to slightly basic (Norquist 2000). Ketona Glades and other locations in Bibb County, AL (Allison and Stevens 2001). The environmental specificity is narrow as this species is a specialist with key requirements common (NatureServe, 2015). This species requires large river bluffs with steep slopes and/ or shallow soils that are subject to localized disturbances (USFWS, 2014).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Species Trends:

10 - 30% decline (NatureServe, 2015)

Resiliency:

Moderate (inferred from USFWS, 2013)

Representation:

Low (inferred from USFWS, 2013)

Redundancy:

Moderate (inferred from NatureServe, 2015)

Population Growth Rate:

Unknown (NatureServe, 2015)

Number of Populations:

18 (USFWS, 2013)

Population Size:

~ 5,000 plants (USFWS, 2013)

Adaptability:

Low (inferred from USFWS, 2013)

Population Narrative:

No studies have been conducted on population dynamics and reproduction biology. However, based on field inspections, recruitment appears low. Most occurrences are small, containing only a few plants. This species has experienced a short-term decline of 10 - 30%; although many occurrences have remained relatively stable over the past 10-20 years, some have decreased in size primarily as a result of invasive species, logging, and succession. (NatureServe, 2015). Currently, 18 populations are documented to occur across Alabama and Georgia. Georgia rockcress is rare throughout its range. Moffett (2007, p. 8) found approximately 2,140 plants from all known sites in Georgia. Moffett (2007, pp. 1–2) indicated that the overall status of the three populations in the Ridge and Valley ecoregion (Floyd and Gordon Counties, Georgia) was poor, as these populations tended to be small, and declining in size and vigor. Schotz (2010, p. 8) documented fewer than 3,000 plants from all known sites in Alabama. Only the Goat Rock Dam and Fort Benning populations are sufficiently large (greater than 1,000 individuals) to preclude a genetic bottleneck (Schotz 2010, pp. 13–57; Moffett 2007, p. 8) (USFWS, 2013).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Currently, habitat degradation, more than its outright destruction, is the most serious threat to this species' continued existence. Most of the Coastal Plain rivers surveyed by Allison (1995, p. 11) were considered unsuitable for Georgia rockcress because their banks had been disturbed to the point where there was no remaining vegetative buffer. Recent habitat degradation (i.e., vegetation denuded and replaced by hard-packed, exposed mineral soil) has

occurred at several Georgia sites in association with residential development and campsites atop the bluffs (Moffett 2007, pp. 3–4). Disturbance associated with timber harvesting, road building, and grazing in areas where the plant exists has created favorable conditions for the invasion of nonnative weeds in this species' habitat (Factor E) (Schotz 2010, p. 10). Timber operations that remove the forest canopy promote early successional species and result in the decline of Georgia rockcress (Schotz 2010, p. 10). Encroachment of development in the form of bridges, roads, houses, commercial buildings, or utility lines allowing for the introduction of nonnative species (Factor E) also result in the decline of Georgia rockcress (Schotz 2010, pp. 9–10; Moffett 2007, pp. 2–7; Alison 1995, pp. 7–18). Quarrying destroys the bluff habitat by removing the canopy and soil. Rock bluffs along rivers have also been favored sites for hydropower dam construction. Historically, suitable habitat was destroyed or degraded due to quarrying, residential development, timber harvesting, road building, recreation, and hydropower dam construction. Severe impacts continue to occur across the range of this species, from quarrying, residential development, timber harvesting, road building, recreation, and hydropower dam construction, and one or more of these activities pose ongoing threats to all known populations (USFWS, 2013)

Stressor: Small population size (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Given the extremely small size of Georgia rockcress populations, projects that destroy even a small amount of habitat can have a serious impact on this species, including existing genetic diversity of the species. Given the extremely small number of total plants (fewer than 5,000 in a given year; 12 of the 18 populations have fewer than 50 plants (Schotz 2010, p. iii; Elmore 2010, pp. 1–4; Moffett 2007, pp. 2–7; Alison 1999, pp. 1–5; Alison 1995, pp. 7–18)), and that the species is distributed as disjunct populations across five physiographic provinces (Schotz 2010, pp. 9–10; Moffett 2007, pp. 2–7; Alison 1995, pp. 7–18) in three major river systems, each population is important to the conservation of genetics for the species (Garcia 2012, pp. 30–36). Any threats that remove or further deteriorate populations can also have a detrimental effect on the existing genetic diversity of the species (USFWS, 2013)

Stressor: Climate change (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Climate change will be a particular challenge for biodiversity because the interaction of additional stressors associated with climate change and current stressors may push species beyond their ability to survive (Lovejoy 2005, pp. 325–326). The synergistic implications of climate change and habitat fragmentation are the most threatening facet of climate change for biodiversity (Hannah and Lovejoy 2005, p. 4). Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, pp. 1–3; Hayhoe et al. 2004, p. 12422; Cayan et al. 2005, p. 6; Intergovernmental Panel on Climate Change (IPCC) 2007, p. 1181). Climate change may lead to increased frequency and duration of severe storms and droughts (Golladay et al. 2004, p. 504; McLaughlin et al. 2002, p. 6074; Cook et al. 2004, p. 1015).). While severe drought would be expected to have an effect on the plant community, including the mature canopy and canopy gap dynamic, and increased storm intensity could accelerate erosion-related disturbances, the information currently available on the effects of

global climate change and increasing temperatures does not make sufficiently precise estimates of the location and magnitude of the effects. In addition, we are not currently aware of any climate change information specific to the habitat of the Georgia rockcress that would indicate which areas may become important to the species in the future (USFWS, 2013).

Stressor: Nonnative species (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: The primary threat to extant populations of Georgia rockcress is the ongoing invasion of nonnative species due to the degradation of its habitat. Encroachment from timber management and development in the form of bridges, roads, houses, commercial buildings, or utility lines allowing for the introduction of nonnative species has resulted in the decline of Georgia rockcress (Schotz 2010, pp. 9–10; Moffett 2007, pp. 2–7; Alison 1995, pp. Human-induced disturbance (quarrying, residential development, timber harvesting, road building, recreation and hydropower dam construction) has fragmented river bluff habitats and created conditions so that these bluff habitats are receptive to invasion of nonnative species (Honu and Gibson 2006, pp. 263–264). Disturbance of 17 of the 18 known sites occupied by this species has provided opportunities for the invasion of aggressive, nonnative weeds, especially *Lonicera japonica* (Japanese honeysuckle).

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- Not available - this species does not have a recovery plan.

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SPECIES ACCOUNT: *Arabis hoffmannii* (Hoffmann's rock-cress)

Species Taxonomic and Listing Information

Listing Status: Endangered; 7/31/1997; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial herb with slender stems, 5-7 dm tall, bearing white to lavender flowers at the tips (NatureServe, 2015).

Taxonomy

Hoffmann's rock-cress (*Arabis* [*Boechera*] *hoffmannii*) is a short-lived, perennial herb in the mustard (*Brassicaceae*) family. *Arabis* [*Boechera*] *hoffmannii* was formerly known as *Arabis hoffmannii* until recent taxonomic revisions placed it in the genus *Boechera* (USFWS, 2011).

Historical Range

It is endemic to Santa Rosa, Santa Cruz, and Anacapa Islands in the Channel Islands National Park located off the coast of southern California, although it has not been seen on Anacapa Island since 1941 (USFWS, 2011).

Current Range

Currently, the species is known from Santa Cruz Island and Santa Rosa Island (NatureServe, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Vegetative, possibly self-fertilization (USFWS, 2011)

Lifespan

Adult: Up to 5 years (USFWS, 2011)

Breeding Season

Adult: February - April (NatureServe, 2015).

Reproduction Narrative

Adult: The plant is believed to be monocarpic (bearing fruit only once, then dying); however, the plant has been observed to live for up to 5 years if two or more vegetative and reproductive rosettes are present on the plant (Wilken 2006). Hoffmann's rockcress can produce tens to hundreds of slightly curved fruits (siliques) borne on long stalks with thousands of seeds. Hoffmann's rock-cress does not appear to be dependent upon pollinators for seed set, and individual plants may produce as many as 3,000 to 4,000 seeds. The small sizes of natural populations indicate that establishment success of new plants is low despite the large number

of seeds produced per plant. Results from demographic monitoring suggest that approximately 10 to 15 percent of Hoffmann's rock-cress plants within a population flower each year (McEachern and Chess 2006). In studies conducted on plants germinated at SBBG, it was found that plants can reproduce as early as 2 years after germination. Hoffmann's rock-cress was found to be self-compatible and can produce more than 30 fruits per plant and 3,000 to 4,000 seeds per plant. It is unknown at this time whether or not the breeding system is autogamous (self-fertilizing). However, high proportions of fruit set and many seeds per fruit under insect-free conditions suggest that Hoffmann's rock-cress does not need pollinators to set seed. If the plants are self-fertilizing, a very low level of genetic variability would be expected. Overall seed germination rates ranged from 59 to 89 percent and most seeds germinated within 9 to 14 days of planting (Wilken 2006) (USFWS, 2011). Blooms February-April (NatureServe, 2015).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliff, coastal bluff scrub, chaparral, coastal scrub (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at 60 - 390 m elevation, restricted to CA channel islands (NatureServe, 2015); may be intolerant of high cover of annual species (USFWS, 2011)

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Habitat Narrative

Adult: Grows on cliffs and ledges of loose volcanic rock, coastal bluff scrub, chaparral, coastal scrub / rocky, and volcanic areas, at elevations between 60 and 395 m (California Native Plant Society 2001). The environmental specificity is narrow; it is only known from a few sites on California's Channel Islands (NatureServe, 2015). Surviving plants tend to be found in the shade of shrubs where the cover of annual species is low, suggesting that Hoffmann's rock-cress cannot tolerate competition with a high cover of annual species (Service 2000) (USFWS, 2011).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Decline of 30-50% (NatureServe, 2015)

Species Trends:

Increasing (USFWS, 2011)

Resiliency:

Low (inferred from NatureServe, 2015)

Representation:

Low (inferred from USFWS, 2011; see reproduction narrative)

Redundancy:

Low (inferred from USFWS, 2011)

Number of Populations:

10 (USFWS, 2011)

Population Size:

~244 (NatureServe, 2015)

Population Narrative:

This species has experienced a long-term decline of 30-50%. CNDDDB knows of 244 individuals as of 2005. The known occurrences occupy approximately 140 acres (NatureServe, 2015). Since the last 5-year review was prepared, the number of known populations has increased from 6 to 10 (USFWS, 2011).

Threats and Stressors

Stressor: Ungulates (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: While the threat of rooting from feral pig populations is gone, subsequent trampling by elk and deer of potential seed germination sites adds to the already low establishment success of new plants compounding the effects and vulnerability of small population size. On Santa Rosa Island, nonnative sheep and cattle have been absent since 1999; deer and elk have remained, though in reduced numbers (Rutherford and Chaney 1999). It is estimated that no more than 60 nonnative ungulates are present on the island at this time and plans to remove the deer and elk are underway with a projected removal deadline of the end of 2011 (K. Niessen, C. Cory, and P. Power, TNC and NPS, pers. comm. 2011; Environmental Defense Center (EDC) 1998; K. Faulkner, NPS, in litt. 2011). In summary, trampling and grazing by remaining deer and elk continues to be the biggest threat to all Santa Rosa Island populations of Hoffmann's rock-creep (Rodriguez and Niessen, pers. comm. 2011). For populations on Santa Cruz Island, residual habitat degradation from nonnative ungulates and competition with nonnative annual plants are the biggest threats (USFWS, 2011).

Stressor: Small population size (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The species is threatened by stochastic extinction due to small population size and limited distribution, which remains a threat since the time of listing. Small population size makes it difficult for the species to persist while sustaining the impacts of soil loss, shrub canopy loss, and competition with nonnative annual plants; while impacts from deer and elk populations have been reduced, they still remain a concern on Santa Rosa Island (USFWS, 2011).

Stressor: Nonnative plants (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The disruption of native habitats and displacement of native species by alien plants, particularly fennel (*Foeniculum vulgare*) and nonnative grasses, among others, were considered major threats at the time of listing. Currently, once-continuous canopies of chaparral, coastal scrub, and island woodland are still either fragmented or missing from large areas on Santa Cruz Island (McEachern and Chess 2006). Coastal sage and coastal bluff scrub plant communities, canyon live oak stands in the Central Valley, and Bishop pine woodland of the Sierra Blanca Ridge have been replaced by nonnative annual grasses, perennial stands of fennel, or barren landscapes (USFWS, 2011).

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Recently, the potential impacts of climate change on the flora of California were discussed by Loarie et al. (2008). Based on modeling, they predicted that species' distributions will shift in response to climate change and that the species will "move" to higher elevations and northward, depending on the ability of each species to do so. In the case of smaller island ecosystems, such as the Channel Islands, opportunities to move to higher elevations or further north are limited. We lack adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors such as limited geographical distribution, will affect federally listed species; however, small-ranged species such as Hoffmann's rock-creep are more vulnerable to extinction due to these changing conditions (Loarie et al. 2008) (USFWS, 2011).

Recovery

Reclassification Criteria:

1. Discover or establish 10 populations per island (Santa Rosa and Santa Cruz) (USFWS, 2011).
2. Maintain populations as stable or increasing with evidence of natural recruitment for a period of 15 years that includes the normal precipitation cycle (USFWS, 2011).

Delisting Criteria:

Demonstrate no decline after downlisting for 10 years (USFWS, 2011).

Recovery Actions:

- Support and intensify active control programs where herbivory or habitat alteration by alien animals exists (USFWS, 2000).
- Develop and implement a plan to achieve the goals and standards of the Conservation Strategy. The Conservation Strategy is a draft strategy for conservation of island resources prepared by biologists from the National Park Service, U.S. Fish and Wildlife Service, and the U.S. Geological Survey, Biological Resources Division. This Strategy is essentially a primer or

guide that provides the basis for the recovery of the species in this recovery plan and should be referred to as a supporting document (USFWS, 2000).

- Restore habitats and control competitive weeds for long-term management of the listed species and their habitats (USFWS, 2000).
- Conduct thorough surveys for all species in the recovery plan (USFWS, 2000).
- Conduct research that aids in the conservation and recovery of the species in the recovery plan (USFWS, 2000).
- Store seeds at facilities certified by the Center for Plant Conservation and develop successful seed germination and propagation techniques (USFWS, 2000).
- Develop successful outplanting techniques (USFWS, 2000).

Conservation Measures and Best Management Practices:

- Seek additional funding to continue field surveys and monitoring, demographic monitoring, outplantings, population viability analyses and further investigations into recovery prescriptions (USFWS, 2011).
- Continue nonnative vegetation removal on Santa Cruz Island (USFWS, 2011).
- Implement nonnative vegetation removal, particularly nonnative grasses, on Santa Rosa Island (USFWS, 2011).

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U.S. Fish and Wildlife Service. 2000. Thirteen Plant Taxa from the Northern Channel Islands Recovery Plan. Portland, Oregon. 94 pp.

SPECIES ACCOUNT: *Arabis macdonaldiana* (McDonald's rock-cress)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/28/1978; Pacific Southwest (R8)

Physical Description

A perennial species having relatively large, conspicuous lavender to purplish flowers and a rosette, usually flattened, of obovate to broadly oblanceolate leaves from which the flowering stems arise (Rollins 1973). Seeds are winged at the distal end and have trichomes (hairs) on the leaves which are simple. *Arabis mcdonaldiana* is glabrous (without hairs) except for a few marginal trichomes on the basal leaves; is less than 1.5 decimeters high, and has truncate petals. (USFWS, 1990)

Taxonomy

Arabis mcdonaldiana was first described by Alice Eastwood (1903). In her original description, Eastwood (1903) employed the spelling used in this recovery plan, naming the species in honor of Captain James M. McDonald. Critchfield (1977) altered the spelling to "*macdonaldiana*" following Recommendation 73C.4 of the International Code of Botanical Nomenclature (Latest edition: Stafleu 1978). Critchfield considered the Eastwood spelling to be an orthographic error. Since, however, the spelling change is based on a recommendation of the Code, not a rule, and because it is unclear whether this recommendation applies to previously published names, the original spelling "*mcdonaldiana*" is retained. (USFWS, 1990) Genetics research summarized in the USFWS 2013 Five-Year Review reported that Harbaugh-Reynaud and Vorobik sampled 42 specimens within the purple-flowered *Arabis* group. Their results indicated that *Arabis macdonaldiana* is represented by two distinct lineages: (1) Red Mountain, Mendocino County, California; and (2) Siskiyou and Del Norte counties, California, and Curry and Josephine counties, Oregon. In their summary report of the 2012 research, Harbaugh-Reynaud and Vorobik recommended that *Arabis macdonaldiana* specimens from Red Mountain retain the name *Arabis macdonaldiana*, while the other lineage be revised to be a distinct species (yet to be named), or a subspecies of *Arabis aculeolata*. Furthermore, Harbaugh-Reynaud and Vorobik determined that *Arabis macdonaldiana* on Red Mountain is clearly distinct from any other taxon (Harbaugh-Reynaud and Vorobik 2012). Therefore, although there has been much confusion and uncertainty related to the taxonomy genetics of the purple-flowered *Arabis* group, the most recent genetic work indicates that *Arabis macdonaldiana* on Red Mountain is distinct from any other taxon. (USFWS, 2013)

Historical Range

At the time it was listed, *Arabis macdonaldiana* was considered to be restricted to a single population at Red Mountain, Mendocino County. However, in 1993, the taxonomic treatment of the species was revised to include populations of purple-flowered rock-cress located near the Oregon border. Since 1993, the species was thought to occur in Mendocino, Del Norte, and the very western portion of Siskiyou counties in California, and the very southern portion of Curry County in Oregon (USFWS, 2013).

Current Range

Recent genetic work indicates that *Arabis macdonaldiana* is confined to Red Mountain, Mendocino County, California (USFWS, 2013).

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Vegetative (USFWS, 2013; see habitat narrative)

Breeding Season

Adult: April - May (USFWS, 2013)

Reproduction Narrative

Adult: Flowering typically occurs between April and May (USFWS, 2013).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Barrens, forest, shrubland (NatureServe, 2015); open scrub (USFWS, 2013)

Dependencies on Specific Environmental Elements

Adult: Periodic fire (USFWS, 2013)

Geographic or Habitat Restraints or Barriers

Adult: Occurs ~1,200 m elevation (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 2013)

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Habitat Narrative

Adult: Occurs in rocky serpentine areas or reddish soils derived from serpentinite, in dry open woods or brushy steep slopes or ledges; usually at elevations of about 1200 m. The environmental specificity is narrow; it is known from 2 or 3 specific areas on serpentine on the north coast of California and in Oregon (NatureServe, 2015). *Arabis macdonaldiana* occurs in soils derived from ultramafic parent material, containing high levels of heavy metals and low levels of nutrients. Its habitat ranges from barren gravel slopes to open scrub and pine woodlands. *Arabis macdonaldiana* is highly rhizomatous and clonal, making the determination of an individual difficult. Fire is an important factor affecting vegetation patterns in general across the Klamath Bioregion, including the Red Mountain area where *Arabis macdonaldiana* occurs, and appears particularly important in maintaining many open habitats (Skinner et al. 2006; U.S. Forest Service [USFS] 1995; Baad 2002) (USFWS, 2013).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Decline of 30-50% (NatureServe, 2015)

Species Trends:

10 - 30% decline (NatureServe, 2015)

Number of Populations:

34 (NatureServe, 2015)

Population Size:

> 10,000 (USFWS, 2013); 17,500 (NatureServe, 2015)

Population Narrative:

This species has experienced a long-term decline of 30-50%. The total number of known plants is about 17,500. CNDDDB currently has 29 EO's, 9 of which are historic. 10 additional field forms remain unprocessed. California has 29 occurrences, 4 of which are historic. Oregon has 10 occurrences but one is historic. The short term trend is estimated to be slightly declining (10 - 30%) due to mining activities (NatureServe, 2015). Taken together, population survey data suggest the overall population size probably exceeds 10,000 plants (USFWS, 2013).

Threats and Stressors

Stressor: Mining (USFWS, 2013; USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: Mining continues to pose a threat to *Arabis macdonaldiana* at Red Mountain, because the entire distribution of *Arabis macdonaldiana* continues to be held under unpatented lode and/or placer mining claims. However, the degree of threat is less than when the species was listed, due to Red Mountain Wilderness designation, which has reduced the vulnerability of *Arabis macdonaldiana* to impacts from new mining claims. Any mining operation on Red Mountain would most likely be an open-face bench type that would involve removal and processing of the mineral-bearing ore containing nickel, chromium, and cobalt (Service 1984). All vegetation and habitat for *Arabis macdonaldiana* would be removed in the affected area. Although the operations plan would require restoration of the affected areas, plant species composition would undoubtedly be altered. There is no evidence in the literature indicating *Arabis macdonaldiana* is able to recolonize disturbed soils. Regardless of existing mining claims, *Arabis macdonaldiana* habitat and serpentine soils in general contain an attractive source of heavy metals, particularly nickel, subject to technological improvements and market fluctuations. Therefore, future pressure to open these lands to mining is possible (USFWS, 2013). The 2019 Amended Recovery Plan reported that new information regarding threats has been obtained that

suggest the threat of mining has been greatly reduced, but not entirely eliminated based on the expiration of several previously valid mining claims near the populations. Several of the mining claims in the Red Mountain Unit of the South Fork Eel River Wilderness Area (Red Mountain Wilderness) have been forfeited. These forfeited claims cannot be relocated, which reduces the threat of mining in the area. However, there are areas occupied by McDonald's rock-cress outside of the Red Mountain Wilderness that are still open for mineral entry. (USFWS, 2019)

Stressor: Fire suppression (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: A potential threat not identified when the species was listed, and not yet well characterized, is the progressive encroachment into *Arabis macdonaldiana* habitat by woody species in the absence of fire. Fire suppression efforts can cause adverse effects on *Arabis macdonaldiana* as a result of fire breaks constructed with heavy equipment or hand crews. Fire breaks are often placed along ridge lines, potential suitable habitat for *Arabis macdonaldiana*. The heavy equipment generally scrapes a layer of earth, eliminating all vegetation and permanently altering the soils. Fire suppression would also maintain existing scrub and forested habitat, allowing progressive encroachment on the species. At the same time, fire control measures could be beneficial by reducing fire intensity in situations where *Arabis macdonaldiana* is vulnerable to incineration. Without fire to periodically restore early successional conditions and an open canopy, *Arabis macdonaldiana* would likely decline in a portion of its range (USFWS, 2013).

Stressor: Genetic diversity (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: The genetic implications of habitat fragmentation, genetic isolation and declining effective population size are threats common to rare species (Saunders et al. 1991; Meffe and Carroll 1997). At Red Mountain, small breeding populations and the potential loss of genetic diversity from inbreeding and/or random genetic drift could be a problem, given the limited population size and limited range of the species, particularly if the decline observed at Red Mountain continues in future years (USFWS, 2013).

Stressor: Climate change (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Global climate change likely constitutes a new threat for the species. Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999; Cayan et al. 2005; IPCC 2007). However, predictions of climatic conditions for smaller subregions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. *Arabis macdonaldiana* at Red Mountain may not have access to environmental heterogeneity, due in part to its more limited extent (USFWS, 2013).

Recovery**Reclassification Criteria:**

1. At least ten viable subpopulations are protected and managed to assure their continued existence. Subpopulations include at least 1,000 reproductive individuals (have flowered at least once or are capable of flowering), and a population structure indicating stable or increasing reproductive plant numbers. Subpopulations are polygons or clusters of individuals that are separated by >100 meters. (USFWS, 2019)
2. The ten viable subpopulations must be distributed between both soil types that currently support McDonald's rock-cress (Littlered and Hiltebiden/Dann soils), with at least two viable subpopulations in each of the two soil types from which the species is currently known to occur. For the purposes of this plan, a subpopulation includes at least 1,000 reproductive individuals, and a population structure indicating stable or increasing reproductive plant numbers. (USFWS, 2019)

Delisting Criteria:

1. Over a 20-year survey period, monitoring demonstrates a stable or increasing trend in abundance and distribution over the entire Red Mountain population (or across the minimum ten subpopulations). During a minimum of 80 percent of the survey period (i.e., 16 years), an estimated population of 10,000 reproductive individuals will remain extant across all subpopulations. Monitoring will demonstrate a minimum average patch occupancy rate (number of subpopulations with occupied habitat divided by total number of subpopulations) of 60 percent. (USFWS, 2019)
2. At least 10 subpopulations of 1,000 or more reproductive individuals should be protected and managed in perpetuity to reduce or eliminate threats to the species, or perpetual endowments are secured for management necessary to maintain the continued existence of the species. Agreements for the protection and appropriate management of the self-sustaining subpopulations should be in place. Perpetual protection on public land will be assured via management plans. Formal stewardship agreements (e.g., conservation easements or similar instruments) should be in place to ensure perpetual long-term, species-appropriate management on privately owned land. (USFWS, 2019)
3. Lands in public ownership (federal lands) should consider land use allocations compatible with managing habitats to maintain or enhance McDonald's rock-cress occupied habitat. Habitat management plans (HMPs) should be developed and implemented that include restoration opportunities, use restrictions, and/or management actions for the conservation of sensitive, threatened, and endangered plants and wildlife resources. Approved HMPs should include a minimum of a 100-meter (300-foot) surface disturbance buffer around occupied McDonald's rock-cress habitat, and would prioritize avoidance of occupied habitat and assist in connectivity for pollination between subpopulations. (USFWS, 2019)
4. An ex situ collection of plant material is established in a Center for Plant Conservation-affiliated botanic garden. A soil seedbank would typically provide a strategy for a species to regenerate populations in the face of stochastic events as well as natural senescence; however, this species is known to be susceptible to high rates of seed predation. (USFWS, 2019)

5. A monitoring plan to cover a minimum of 10 years post-delisting of McDonald's rockcress has been approved by the Pacific Southwest Regional Director and is ready to be implemented at the time of delisting. (USFWS, 2019)

Recovery Actions:

- Enforce laws and regulations that may affect conservation of the species. To accomplish the primary objective of this recovery plan it is necessary for the appropriate Federal and State agencies to rigorously enforce all laws and regulations which may affect conservation of *Arabis mcdonaldiana*. Foremost among these laws and regulations is the Endangered Species Act of 1973, as amended, and its associated regulations. Other relevant laws and regulations include the California Native Plant Protection Act, applicable to those areas within the range of *A. mcdonaldiana* that are privately owned; the Federal Land Policy and Management Act, under which the Bureau administers lands under its jurisdiction; the National Environmental Policy Act and California Environmental Quality Act; the Wilderness Act and Bureau regulations and policies applying to lands under wilderness review for those applicable portions of the species' range; the Bureau regulations governing the surface management of Federal lands under the U.S. Mining Laws; the State of California Surface Mining and Reclamation Act of 1975; the Clean Water Act of 1977 as it applies to the regulation of surface disturbing activities such as mining which pollute waterways; and the Clean Air Act as applicable to air pollution associated with the processing of minerals. (USFWS, 1990).
- Protect essential habitat. Sufficient habitat must be protected to insure the well-being of *Arabis mcdonaldiana*. This will require identification and precise mapping of the essential habitat as well as determining and selecting the appropriate means to do so. Much of the opportunity to protect *A. mcdonaldiana* will depend upon the authority of the State and Bureau to regulate surface mining. (USFWS, 1990).
- Monitor agency compliance with the recovery plan. To assure that all aspects of the recovery program are proceeding in an effective and timely manner, a compliance monitoring effort should be initiated. (USFWS, 1990).
- Enhance public awareness of *Arabis mcdonaldiana* recovery effort through informational and educational programs. Although an awareness program does not contribute direct benefits to the recovery effort, it can provide important long-term benefits. Audio-visual programs, a small brochure on the unique resources of Red Mountain, and a pamphlet on *Arabis mcdonaldiana* could help foster respect for the values addressed in this plan. In addition, scientific study of the soils, vegetation, and fauna of Red Mountain should be encouraged. Additional studies could provide as yet unknown benefits to future generations. (USFWS, 1990).

Conservation Measures and Best Management Practices:

- A field study of *A. mcdonaldiana* should be conducted to determine the degree to which shrub and tree encroachment may be impacting the population (USFWS, 2013).
- A field study of *A. mcdonaldiana* should be conducted to determine the continued presence of *Arabis mcdonaldiana* in previously mapped habitat polygons, or other locations at Red Mountain (USFWS, 2013).
- A field study of *A. mcdonaldiana* should be conducted to determine the cause for the observed decline in *Arabis mcdonaldiana* in the vicinity of the study sites used by Baad (2002) (USFWS, 2013).

References

USFWS. 2013. *Arabis macdonaldiana* (McDonald's rock-creep), 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Arcata Fish and Wildlife Office. 26 pp. May 13, 2013. https://ecos.fws.gov/docs/five_year_review/doc4151.pdf

USFWS. 1990. McDonald's rock-creep (*Arabis macdonaldiana* Eastwood), Recovery Plan. U.S. Fish and Wildlife Service, Portland, Oregon. 40 pp. https://ecos.fws.gov/docs/recovery_plan/840228.pdf

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

USFWS. 2013. *Arabis macdonaldiana* (McDonald's rock-creep), 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Arcata Fish and Wildlife Office. 26 pp. May 13, 2013.

USFWS. 2019. Amendment to Recovery Plan for *Arabis macdonaldiana* (McDonald's rock-creep). U.S. Fish and Wildlife Service, Sacramento, California. 11 pp. December 10, 2019.

USFWS. 2019. Amendment to Recovery Plan for *Arabis macdonaldiana* (McDonald's rock-creep). U.S. Fish and Wildlife Service, Sacramento, California. 11 pp. December 10, 2019.

SPECIES ACCOUNT: *Arabis perstellata* (Braun's rock-cress)

Species Taxonomic and Listing Information

Listing Status: Endangered; 2/2/1995; Southeast Region (R4)

Physical Description

Braun's rockcress is distinguished from other members of the genus *Arabis* by the white stellate (star-shaped) hairs on stems and leaves that give the plant a grayish appearance. These stellate hairs are mixed with simple hairs on the upper surface of the leaves. Braun's rockcress is a perennial, while most other *Arabis* species are biennials. The stem, which can reach 80 centimeters (cm) or 31.5 inches in length (but is usually much smaller), is branched at the base and can be decumbent or partially erect. The mostly lanceolate stem leaves are auriculate at the base where they clasp the stem. Leaf size (2 to 5 cm) becomes reduced on the upper stem, and the shape may become more ovate. Small white to lavender flowers are produced in a terminal raceme and are barely emergent beyond the sepals. The fruit is a round, elongate, and densely hairy silique. Flowers are produced from late March to early May; fruits mature from mid-May to early June. (USFWS, 1997)

Taxonomy

The genus *Arabis* has undergone major taxonomic revision due to recent molecular phylogenetic studies. Based on the results of this research, the majority of species within the Genus *Arabis* have been transferred to the genus *Boechera*. This includes Braun's Rockcress (formerly *Arabis perstellata*, now *Boechera perstellata*) (Al-Shehbaz 2003, 2010; Alexander et al. 2013; ITIS 2018). (USFWS, 2018)

Historical Range

See Current Range information.

Current Range

Franklin, Henry, and Owen Counties in Kentucky; Davidson, Rutherford, and Wilson Counties in Tennessee. (USFWS, 2018)

Critical Habitat Designated

Yes; 7/6/2004.

Legal Description

On June 3, 2004, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective July 6, 2004) for *Arabis perstellata* (Braun's rock-cress) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 22 critical habitat units (CHUs) in Tennessee and Kentucky (69 FR 31460-31496).

Critical Habitat Designation

The critical habitat designation for *Arabis perstellata* includes 22 CHUs in Rutherford and Wilson Counties, Tennessee; and Franklin, Owen and Henry Counties, Kentucky. These units encompass approximately 648 hectares (ha) (1,600 acres (ac)) of upland habitat. Kentucky has approximately 328 ha (810 ac) and Tennessee has approximately 320 ha (790 ac) designated as critical habitat for *Arabis perstellata*. Brief description and the promulgated description of each critical habitat

unit is provided below; maps depicting the CHU location are available in the Final Rule (69 FR 31460-31496). (USFWS, 2004)

Unit 1. Sky View Drive in Franklin County, Kentucky. Unit 1 is located on the west side of the City of Frankfort. It occurs along U.S. 127 and Skyview Drive on the slopes of the first large ravine system due west of the confluence of Benson Creek and the Kentucky River. It contains approximately 22 ha (54 ac). Promulgated Unit 1 description: Sky View Drive, Franklin County, Kentucky. From USGS 1:24,000 quadrangle map Frankfort West, Kentucky; land bounded by the following Kentucky State Plane North / NAD83 (Feet) coordinates: 1453158.08, 257013.95; 1455318.02, 258193.89; 1455537.40, 256159.34. (USFWS, 2004)

Unit 2. Benson Valley Woods in Franklin County, Kentucky. Unit 2 is located west of the City of Frankfort. The unit lies southeast of Benson Valley Road on the south side of Benson Creek. It contains approximately 37 ha (91 ac). Promulgated Unit 2 description: Benson Valley Woods, Franklin County, Kentucky. From USGS 1:24,000 quadrangle map Frankfort East, Kentucky; land bounded by the following Kentucky State Plane North / NAD83 (Feet) coordinates: 1450864.02, 256869.46; 1453925.25, 260160.79; 1454705.56, 258980.31; 1451054.09, 256519.32. (USFWS, 2004)

Unit 3. Red Bridge Ridge in Franklin County, Kentucky. Unit 3 is located west of Kentucky (KY) Highway 1005, at the confluence of South Benson and Benson Creeks. The site is privately owned. It is approximately 6 ha (15 ac) in size. Promulgated Unit 3 description: Red Bridge Road, Franklin County, Kentucky. From USGS 1:24,000 quadrangle Frankfort West, Kentucky; land bounded by the following Kentucky State Plane North / NAD83 (Feet) coordinates: 1442614.00, 258863.10; 1443144.60, 258502.62; 1441670.26, 257801.90; 1441581.15, 258012.52. (USFWS, 2004)

Unit 4. Tributary to South Benson Creek in Franklin County, Kentucky. This unit is located northeast of the City of Frankfort. It occurs along the southeast side of South Benson Creek and the north and south slopes of an unnamed tributary. The site is 10 ha (25 ac) in size. Promulgated Unit 4 description: Tributary to South Benson Creek, Franklin County, Kentucky. From USGS 1:24,000 quadrangle map Frankfort West, Kentucky; land bounded by the following Kentucky State Plane North / NAD83 (Feet) coordinates: 1443620.37, 253609.15; 1444037.01, 253294.00; 1442925.97, 252129.54; 1442210.20, 252471.40. (USFWS, 2004)

Unit 5. Davis Branch in Franklin County, Kentucky. This unit occurs along the east side of Harvieland Drive and Davis Branch. This unit contains approximately 3 ha (7 ac). Promulgated Unit 5 description: Davis Branch, Franklin County, Kentucky. From USGS 1:24,000 quadrangle map Polsgrove, Kentucky; land bounded by the following Kentucky State Plane North / NAD83 (Feet) coordinates: 1450167.05, 277739.69; 1450767.00, 277750.87; 1450761.41, 277314.88; 1450202.46, 277180.73. (USFWS, 2004)

Unit 6. Onans Bend in Franklin County, Kentucky. Unit 6 occurs north of Onans Bend Road and east of KY Highway 12. The unit lies along the banks of an unnamed stream near its mouth with the west bank of the Kentucky River. This unit contains approximately 12 ha (30 ac). Promulgated Unit 6 description: Onans Bend, Franklin County, Kentucky. From USGS 1:24,000 quadrangle map Polsgrove, Kentucky; land bounded by the following Kentucky State Plane North

/ NAD83 (Feet) coordinates: 1458610.26, 289401.40; 1459066.14, 289401.50; 1459484.82, 288182.67; 1458210.30, 287759.68; 1458191.76, 288155.34. (USFWS, 2004)

Unit 7. Shadrock Ferry Road in Franklin County, Kentucky. This unit is located along the north side of Shadrock Ferry Road (KY Highway 898). This unit is approximately 15 ha (37 ac) in size.

Promulgated Unit 7 description: Shadrock Ferry Road, Franklin County, Kentucky. From USGS 1:24,000 quadrangle Switzer, Kentucky; land bounded by the following Kentucky State Plane North / NAD83 (Feet) coordinates: 1461695.27, 280422.79; 1462823.09, 280986.70; 1463880.43, 280256.18; 1463463.90, 279506.43. (USFWS, 2004)

Unit 8. Hoover Site in Franklin County, Kentucky. This unit lies northwest of the City of Frankfort, along the west side of the Kentucky River on slopes bordering two unnamed tributaries. Plants are widely scattered in small groups along the Kentucky River bluff from river kilometer (km) 98.6 to 101.7 (river mile 61.3 to 63.2). This unit contains approximately 83 ha (205 ac). Promulgated Unit 8 description: Hoover Site, Franklin County, Kentucky. From USGS 1:24,000 quadrangle Frankfort West, Kentucky; land bounded by the following Kentucky State Plane North / NAD83 (Feet) coordinates: 1479208.72, 296984.32; 1480548.19, 297074.83; 1480548.19, 296260.28; 1479407.83, 295690.11; 1479177.04, 295694.63. (USFWS, 2004)

Unit 9. Longs Ravine Site in Franklin County, Kentucky. Unit 9 is located north of the City of Frankfort and Lewis Ferry Road. This unit lies east of the Kentucky River in a large ravine and along the steep slopes above the river. Promulgated Unit 9 description: Longs Ravine Site, Franklin County, Kentucky. From USGS 1:24,000 quadrangle Frankfort West, Kentucky; land bounded by the following Kentucky State Plane North / NAD83 (Feet) coordinates: 1457404.81, 269596.23; 1457959.89, 270126.46; 1460205.09, 268958.30; 1459003.79, 267607.86. (USFWS, 2004)

Unit 10. Strohmeiers Hill in Franklin County, Kentucky. This unit is located south of the Town of Swallowfield and adjacent to Strohmeier Road and U.S. 127. It occurs on steep slopes on the south side of Elkhorn Creek and on the east bank of the Kentucky River, south of the confluence with Elkhorn Creek. The site is approximately 20 ha (49 ac) in size. Promulgated Unit 10 description: Strohmeiers Hills, Franklin County, Kentucky. From USGS 1:24,000 quadrangle Switzer, Kentucky; land bounded by the following Kentucky State Plane North / NAD83 (Feet) coordinates: 1467733.92, 298729.06; 1468218.13, 298978.50; 1468695.00, 297144.38; 1469854.17, 296131.94; 1469568.53, 295848.76; 1468658.32, 296498.77; 1468247.47, 297181.06; 1468056.72, 297936.72; 1467763.26, 296704.19; 1467440.46, 297415.83. (USFWS, 2004)

Unit 11. U.S. 127 in Franklin County, Kentucky. Unit 11 is located along the east side of U.S. 127 in a ravine just southeast of Elkhorn Creek. This unit is approximately 11 ha (27 ac) in size.

Promulgated Unit 11 description: U.S. 127, Franklin County, Kentucky. From USGS 1:24,000 quadrangle Switzer, Kentucky; land bounded by the following Kentucky State Plane North / NAD83 (Feet) coordinates: 1469164.24, 295115.19; 1469939.07, 295511.62; 1470629.82, 294466.49; 1469662.78, 294058.06. (USFWS, 2004)

Unit 12. Camp Pleasant Branch Woods in Franklin County, Kentucky. Unit 12 is located along the south side of Camp Pleasant Road (KY Highway 1707). This site contains approximately 14 ha (35 ac). Promulgated Unit 12 description: Camp Pleasant Branch Woods, Franklin County, Kentucky.

From USGS 1:24,000 quadrangle Switzer, Kentucky; land bounded by the following Kentucky State Plane North / NAD83 (Feet) coordinates: 1453446.71, 269919.75; 1454641.35, 269410.27; 1453921.05, 266476.39; 1452392.62, 264561.46; 1451250.69, 265879.07. (USFWS, 2004)

Unit 13. Saufley in Franklin County, Kentucky. Unit 13 occurs west of the KY Highway 1900 bridge over Elkhorn Creek on the hillside above the creek. The land ownership for this unit is private. The site is approximately 8 ha (20 ac) in size. Promulgated Unit 13 description: Saufley, Franklin County, Kentucky. From USGS 1:24,000 quadrangle Switzer, Kentucky; land bounded by the following Kentucky State Plane North / NAD83 (Feet) coordinates: 1476234.26, 281055.05; 1476538.92, 281115.98; 1476924.83, 280171.52; 1477848.97, 279612.98; 1476538.92, 279887.17. (USFWS, 2004)

Unit 14. Clements Bluff in Owen County, Kentucky. This unit is located in a ravine facing the Kentucky River along the east side of KY Highway 355. The site is owned by the State of Kentucky and is part of the Kentucky River Wildlife Management Area. This unit is approximately 11 ha (27 ac) in size. Promulgated Unit 14 description: Clements Bluff, Owen County, Kentucky. From USGS 1:24,000 quadrangle Gratz, Kentucky; land bounded by the following Kentucky State Plane North / NAD83 (Feet) coordinates: 1451615.01, 349295.36; 1452022.39, 349505.61; 1452910.30, 347908.24; 1452180.35, 347473.85. (USFWS, 2004)

Unit 15. Monterey U.S. 127 in Owen County, Kentucky. Unit 15 is located 1.6 km (1 mile) north of the City of Monterey, just north of the junction of U.S. 127 and KY Highway 355. This unit is approximately 12 ha (30 ac) in size. Promulgated Unit 15 description: Monterey U.S. 127, Owen County, Kentucky. From USGS 1:24,000 quadrangle Monterey, Kentucky; land bounded by the following Kentucky State Plane North / NAD83 (Feet) coordinates: 1462791.17, 342357.03; 1463347.35, 341639.38; 1462109.41, 340778.21; 1461660.88, 341370.27. (USFWS, 2004)

Unit 16. Craddock Bottom in Owen County, Kentucky. This unit is located south of the City of Monterey. It occurs along the west side of Old Frankfort Pike on the westfacing slope just east of Craddock Bottom. The site contains approximately 23 ha (57 ac). Promulgated Unit 16 description: Craddock Bottom, Owen County, Kentucky. From USGS 1:24,000 quadrangles Frankfort East and West, Kentucky; land bounded by the following Kentucky State Plane North / NAD83 (Feet) coordinates: 1463039.86, 332602.65; 1463575.00, 332555.43; 1464377.71, 331784.20; 1464377.71, 329218.68; 1463748.13, 329202.94; 1463716.65, 330918.53. (USFWS, 2004)

Unit 17. Backbone North in Franklin County, Kentucky. Unit 17 is located north of KY Highway 1900. It occurs in an old river oxbow west of the existing Elkhorn Creek. The unit size is approximately 11 ha (27 ac). Promulgated Unit 17 description: Backbone North, Franklin County, Kentucky. From USGS 1:24,000 quadrangle Frankfort East, Kentucky; land bounded by the following Kentucky State Plane North / NAD83 (Feet) coordinates: 1470487.13, 273240.06; 1471988.00, 273697.42; 1472199.59, 273279.29; 1471168.97, 272953.00; 1470516.94, 272031.81; 1470339.01, 272116.74. (USFWS, 2004)

Unit 18. Scales Mountain in Rutherford County, Tennessee. This unit is located west of the City of Murfreesboro on Scales Mountain, 1.6 km (1 mile) south of Highway 96. This unit is 103 ha (255 ac) in size and consist of three knobs. Promulgated Unit 18 description: Scales Mountain, Rutherford County, Tennessee. From USGS 1:24,000 quadrangle Rockvale, Tennessee; land

bounded by the following Tennessee State Plane / NAD83 (Feet) coordinates (E,N): 1797871.97, 548892.57; 1800101.59, 549457.83; 1800070.19, 547856.27; 1797934.77, 547071.19. (USFWS, 2004)

Unit 19. Sophie Hill in Rutherford County, Tennessee. Unit 19 is located west of the City of Murfreesboro on Sophie and Townsel Hills which lies between Newman and Coleman Hill Roads. The unit is approximately 53 ha (132 ac) in size and consists of two hills. Promulgated Unit 19 description: Sophie Hill, Rutherford County, Tennessee. (i) From USGS 1:24,000 quadrangle Rockvale, Tennessee; land bounded by the following Tennessee State Plane / NAD83 (Feet) coordinates (E,N): 1804270.37, 539691.44; 1805958.29, 539809.20; 1806076.05, 538867.10; 1804427.38, 538631.58. (USFWS, 2004)

Unit 20. Indian Mountain in Rutherford County, Tennessee. Unit 20 is located west of the City of Murfreesboro on Indian Mountain between Highway 96 and Coleman Hill Road. The unit size is approximately 87 ha (214 ac) and consists of three knobs. Promulgated Unit 20 description: Indian Mountain, Rutherford County, Tennessee. (i) From USGS 1:24,000 quadrangle Rockvale, Tennessee; land bounded by the following Tennessee State Plane / NAD83 (Feet) coordinates (E,N): 1800305.71, 546168.35; 1802111.40, 546443.12; 1802543.19, 544794.46; 1800423.48, 544676.69. (USFWS, 2004)

Unit 21. Grandfather Knob in Wilson County, Tennessee This unit is located 1.8 km (1.1 miles) west of Cainesville between State Route 266 (Cainesville Road) and Spain Hill Road. The unit is 43 ha (106 ac) in size. Promulgated Unit 21 description: Grandfather Knob, Wilson County, Tennessee. From USGS 1:24,000 quadrangle Lascassas, Tennessee; land bounded by the following Tennessee State Plane / NAD83 (Feet) coordinates (E,N): 1888463.64, 602182.29; 1890759.35, 602182.29; 1890842.07, 601189.55; 1889518.42, 599969.31; 1888877.28, 599638.40; 188670.46, 599638.40; 1888401.59, 600300.23. (USFWS, 2004)

Unit 22. Versailles Knob in Rutherford County, Tennessee Unit 22 is located 1.3 km (0.8 mile) south of Versailles between Versailles Road and Bowles Road. The unit size is approximately 34 ha (83 ac). Promulgated Unit 22 description: Versailles Knob, Rutherford County, Tennessee. From USGS 1:24,000 quadrangle Rover, Tennessee; land bounded by the following Tennessee State Plane / NAD83 (Feet) coordinates (E,N): 1806361.65, 504515.38; 1808616.22, 505711.83; 1809308.27, 504327.51; 1808517.23, 503872.66; 1807034.03, 503477.14. (USFWS, 2004)

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Arabis perstellata* critical habitat consists of four components (69 FR 31460-31496):

- (i) Relatively undisturbed, closed canopy mesophytic and sub-xeric forest with large, mature trees (such as sugar maple (*Acer saccharum*), chinquapin oak (*Quercus muhlenbergii*), hackberry (*Celtus occidentalis*), or Ohio buckeye (*Aesculus glabra*)), and
- (ii) Open forest floors with little herbaceous cover and leaf litter accumulation with natural disturbance to allow for *Arabis perstellata* germination and seedling germination, and
- (iii) Areas with few introduced weed species such as *Alliaria petiolata* or *Lonicera maackii*, and

(iv) Rock outcrops on moderate to steep calcareous slopes defined by: (A) Ordovician limestone, in particular the Grier, Tanglewood, and Macedonia Bed Members of the Lexington Limestone in Kentucky and the Lebanon, Carters, Leipers, and Catheys, and Bigby-Cannon Limestones in Tennessee; and (B) Limestone soils such as the Fairmont Rock outcrop complexes in Kentucky and the Mimosa Rock outcrop complexes in Tennessee.

Special Management Considerations or Protections

We have determined that the critical habitat units may require special management or protection, largely because no long-term protection or management plans exist for any of the units and due to the existing threats to this plant. Absent special management or protection, these 22 units are susceptible to existing threats and activities such as the ones listed in the "Effects of Critical Habitat" section, which could result in degradation and disappearance of the populations and their habitat.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: *Arabis perstellata* is facing potential inbreeding problems because of low population numbers (Rollins 1993).; (NatureServe, 2015)

Habitat Type

Adult: Wooded slopes (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Habitat Narrative

Adult: Typically found on mesic, shady, steep, north-facing wooded slopes, however, no exposure is 'preferred' in Kentucky, above streams or in ravines that lead into streams. The soils at these sites are derived from limestones, which often outcrop. The plants often occur either in sheltered areas, such as around the bases of larger trees, or in areas where there is little competition, such as in places regularly scoured by talus movement or erosion. It can also occur in areas of disturbance such as animal trails and roadcuts. It should be sought on shady forested limestone slopes with wild ginger (*Asarum canadense*), in forests dominated by sugar maple (*Acer saccharum*), chinquapin oak (*Quercus muehlenbergii*), blue ash (*Fraxinus quadrangulata*), Ohio buckeye (*Aesculus glabra*), and Kentucky coffeetree (*Gymnocladus dioica*). (NatureServe, 2015)

Dispersal/Migration

Population Information and Trends

Population Trends:

Stable or increasing (23%); declining (31%); Unknown trend (46%) (USFWS, 2018)

Number of Populations:

46 (40 in Kentucky); 6 in Tennessee)(USFWS, 2018)

Population Size:

2500 - 10,000 individuals (NatureServe, 2015)

Adaptability:

Persistent and fairly resilient if habitat integrity maintained. (NatureServe, 2015)

Population Narrative:

Based on current monitoring and distributional data compiled by the Office of Kentucky Nature Preserves (KNP) (formerly KSNPC) and TDEC, Braun's Rockcress is represented by a total of 54 extant occurrences (46 individual populations) in Kentucky and Tennessee (Table 3; Appendix C, Tables 6-7 and Figures 1-5). Of this total, 40 occurrences (40 populations) are located in Kentucky, and 12 occurrences (6 populations) are located in Tennessee. Since completion of the first review, the number of extant occurrences (populations) decreased in Kentucky and remained constant for Tennessee. Within Kentucky, the number of occurrences (populations) decreased due to the loss of five occurrences (ranks changed from D to X or D to F), the 2016 discovery of a new population, and the inclusion of one occurrence erroneously omitted during the first review (KSNPC 2005; T. Littlefield, pers. comm., 2018). Within Tennessee, two C-ranked occurrences were discovered in Smith County, while three other occurrences (8, 16, and 17) were combined as a single occurrence. Based on these results, the number of Tennessee occurrences remained constant, while the number of populations increased by one. Currently, 17.3% of extant occurrences are A-ranked (9 of 52), 15.4% are B-ranked, 34.6% are C-ranked, and 32.7% are D-ranked. Within Tennessee, all extant occurrences are monitored by TDEC every three to five years, including comprehensive surveys in 2008, 2011, 2015, and 2018 (TDEC 2009, 2011, 2015; D. Lincicome, pers. comm., 2018). Over the past 10 years, two additional occurrences have been discovered by TDEC in Smith County (TN EO 20, 21) (TDEC, 2009, 2011, 2015). These occurrences represented new county records for the species in Tennessee. Based on the last 15 years of monitoring data in Kentucky and Tennessee, 12 of 52 extant occurrences (23.1%) are considered to be stable or increasing, 18 (30.8%) are considered to be declining, and 24 (46.2%) are of unknown trend or status (Table 4). Most occurrences with unknown trend status have not been monitored in several years. Within Kentucky, the majority of these occurrences are historic or near historic sites that were last visited in the 1990s. Nearly all these sites were of D quality with associated habitats of low diversity caused by disturbances from logging, grazing, or invasive plants. Because KNP's efforts over the past 20 years have focused on monitoring, management, and protection of higher quality sites, no efforts have been made to resurvey these populations. In 2019-2020, KNP is planning to conduct a full status survey for the species (Littlefield 2018b). Forest community quality and viability will also be assessed. Within Tennessee, the six occurrences with unknown status were not visited during the most recent survey effort (2018) because access had not been granted by landowners. (USFWS, 2018)

Threats and Stressors

Stressor: Destruction and deterioration of habitat (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: The recovery plan (USFWS 1997) and subsequent critical habitat rule (69 FR 31460) listed the primary threats to the species as alteration or loss of habitat through development (primarily home and road construction), competition with native and exotic weedy species, grazing and trampling, and timber harvesting . These threats still exist. (USFWS, 2016)

Stressor: Invasive plants (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Invasive plants continue to affect all Kentucky populations, and the magnitude and scope of these threats increase every year without active management (Appendix C, Table 6). Garlic Mustard (*Alliaria petiolata*) and Bush Honeysuckle (*Lonicera maackii*) have the greatest impact on Braun's Rockcress populations, followed by Chickweed (*Stellaria media*), Winter Creeper (*Euonymus fortunei*), and Privet (*Ligustrum* sp.). Bush Honeysuckle appears to be reducing overall wildflower numbers across the species' range in Kentucky and may be causing erosion of Braun's Rockcress habitats on lower slopes (D. White, pers. comm., 2018). Tennessee populations have less competition from invasive species in part due to topography. The Tennessee populations occur on isolated knobs in contrast to the Kentucky populations existing along steep slopes of the Kentucky River and its tributaries. Despite these conditions, Garlic Mustard was noted as a threat to two of Tennessee's historic/extirpated sites (TN EO 1 and 4), and monitoring of new infestations is critical to the viability of TN populations (TDEC 2018) (Appendix C, Table 7). The two main clusters of Braun's Rockcress occurrences in Tennessee are located on opposite sides of an extensive urban corridor, with virtually no habitat connectivity. This differs from the higher connectivity of Kentucky occurrences along the Kentucky River corridor in a largely rural area. (USFWS, 2018)

Stressor: Lack of adequate existing regulatory mechanisms (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: The inadequacy of exiting regulatory mechanisms also represents a threat to the species. Most populations occur on private property and are vulnerable to landowner activities that might result in some kind of habitat disturbance. Within Kentucky, the species' endangered status is only a KSNPC designation that carries no legal protection (KSNPC 2005). (USFWS, 2016)

Stressor: Loss of ash trees (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Dramatic impacts have been observed over the past six years in the forest canopy of Franklin, Henry, and Owen counties, Kentucky due to the spread of the Emerald Ash Borer (*Agrilus planipennis*) and its impact on White Ash (*Fraxinus americana*) and Green Ash (*Fraxinus pennsylvannica*). At least two Braun's Rockcress sites have been logged by landowners as a result of the impending ash decline (KY EO 16 and 24), and the majority of Braun's Rockcress sites in KY have experienced some canopy loss and increased disturbance from ash tree death. The loss of ash trees has resulted in open canopy conditions, allowing for rapid colonization by invasives such as Garlic Mustard (Littlefield, 2018b). (USFWS, 2018)

Stressor: Erosion due to large rainfall events (USFWS,2018)

Exposure:

Response:

Consequence:

Narrative: Over the past 10 years, erosion caused by large rainfall events has impacted at least three populations in Tennessee (TN EOs 8, 16, 17) and at least one population in Kentucky (KY EO 51A/B) (TDEC, 2009, 2011, 2015; Littlefield 2009-2017). Significant rainfall events in 2010 contributed to extensive erosion at several Braun's Rockcress sites. Documented population declines were noted at four sites in Tennessee and Kentucky (TDEC, 2009, 2011, 2015; Littlefield 2009-2017; NOAA 2010). (USFWS, 2018)

Stressor: Herbivory (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Whitetail Deer herbivory of Braun's Rockcress has been noted at a few sites (KY EO 51, 13) over the past five years in Kentucky, but it does not appear to be a significant threat. Because Whitetail Deer in particular seem to play a role in Braun's Rockcress seed dispersal, occurrences are often associated with deer trails and rock outcrops and along the base of large trees on steep slopes. Anecdotal evidence suggests that as Whitetail Deer move along these steep forested slopes, passing through Braun's Rockcress populations, seeds are trapped (with soil) on deer hooves and distributed passively along trails. If not for these modes of seed dispersal, Braun's Rockcress plants would only recolonize downslope by means of gravity and would get concentrated on lower slopes and rock outcrops above creeks, eventually disappearing when most seeds would fall into unsuitable habitat along the creek (Littlefield 2018). (USFWS, 2018)

Recovery

Reclassification Criteria:

When 10 geographically distinct self-sustaining populations consisting of 50 plants or more each are protected within a significant portion of the species' range in Kentucky and Tennessee. At least half of these should be populations of 100 plants or more. It must also be demonstrated that these populations are stable or increasing through 5 years of monitoring. Protection can be achieved through ownership by government or private actions. It can also include legal dedication or the placement of conservation easements on private land. Site registry may be used to protect up to three of the sites; it is expected that this form of protection will be preferred for lower-quality sites. All protected sites must have management plans or agreements in place that ensure the long-term maintenance of *Arabis perstellata* habitat. (USFWS, 1997)

Delisting Criteria:

When 20 geographically distinct self-sustaining populations, also consisting of 50 or more plants each, are protected in Kentucky and Tennessee and it has been demonstrated that they are stable or increasing after another 5 years of monitoring following reclassification to Threatened. Registry agreements may be used for up to six of these sites. (USFWS, 1997)

Recovery Actions:

- 1. Develop a site protection plan for all sites rangewide. (USFWS, 1997)

- 2. Conduct inventories in an effort to locate new populations. An inventory conducted in Kentucky in 1996 (KSNPC 1996a) increased the number of known sites, and several of these were some of the highest-quality sites discovered to date. Additional surveys are particularly warranted in Tennessee and, to a lesser degree, in Kentucky. (USFWS, 1997)
- 3. Determine the demographic trends. Develop a census technique that will detect general demographic trends in the population numbers. Criteria to be used in the census must evaluate population viability and identify threats at each site. For instance, size classes should be used in conjunction with population counts to determine whether population numbers are changing and whether demographic shifts are occurring. The census technique can also be used to determine whether more intensive monitoring may be needed at a site. An effort should be made to include as many representative populations as feasible. (USFWS, 1997)
- 4. Determine whether populations are self-sustaining and determine the population attributes needed to attain viability. Aspects of the life history that are to be specifically addressed in these studies are: (1) age class distribution relative to population stability; (2) minimum viable population size; (3) the role of seedling establishment in population stability; (4) pollination and self-fertilization; (5) seed dispersal; and (6) longevity of seeds under natural conditions. (USFWS, 1997)
- 5. Determine optimal habitat conditions. Environmental factors affect population success. A description of the optimal conditions for the species is needed in evaluating management applications and evaluating sites for protection. Studies should specifically address the following: (1) the role of disturbance (as a natural factor and as a threat); (2) competition, and (3) moisture relations in seed germination and establishment and adult plant growth. (USFWS, 1997)
- 6. Develop and implement a site management strategy for the species. (USFWS, 1997)
- 7. Secure and store viable seeds. This aspect of recovery has been accomplished by the Center for Plant Conservation. (USFWS, 1997)
- 8. Develop materials to inform the public about the status of the species and the recovery plan objectives. Public support for the conservation of Braun's rockcress could greatly encourage landowner assistance in conservation efforts. However, informational material should not identify the plant's precise locations in order to discourage vandalism to, or collection of, wild populations. Informational materials should stress pragmatic reasons for species conservation as well as intellectual, aesthetic, or moral considerations. Background information about the pharmacological, agricultural, or economic properties of the species, its congeners, or other plant family relatives will help address the questions frequently posed by laypersons. (USFWS, 1997)
- 9. Annually assess the success of recovery efforts for the species. The timely review of new information and the evaluation of ongoing programs are essential to ensure that full recovery occurs as rapidly and efficiently as possible. Monitoring information may reveal new problems or require shifts in the allocation of resources to monitoring, research, and management projects. Population performance should be compared to preestablished targets, and more rigorous or frequent monitoring programs should be implemented if populations decline below the preestablished thresholds. Pilot and full-scale management projects should also be reviewed to ensure their continuing effectiveness. (USFWS, 1997)

Conservation Measures and Best Management Practices:

- Complete a full status survey of Braun's Rockcress in Kentucky, including evaluations of associated forest quality (2019-2020). (USFWS, 2018)
- Increase survey efforts for new populations in high quality habitat with more mature forest. (USFWS, 2018)
- Conduct studies on garlic mustard management. (USFWS, 2018)
- Increase seed banking efforts. (USFWS, 2018)
- Increase augmentation and introductions to high quality sites containing less invasive plants. (USFWS, 2018)
- Work cooperatively with the Kentucky Department of Fish and Wildlife Resources (KDFWR) and Office of Kentucky Nature Preserves (KNP) to develop management plans and conservation agreements for populations occurring on KDFWR owned properties (e.g., state wildlife management areas). (USFWS, 2018)

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SPECIES ACCOUNT: *Arabis serotina* (Shale barren rock cress)

Species Taxonomic and Listing Information

Listing Status: Endangered; 7/13/1989; Northeast Region (R5) (USFWS, 2016)

Physical Description

A facultative biennial herb characterized in its nonreproductive stage by an inconspicuous basal rosette of lobed leaves. Average rosette size ranged from 1.6—3.5 cm. In its reproductive stage, the basal leaves shrivel as the slender stem grows, or “bolts,” and the inflorescence develops (USFWS, 1991).

Taxonomy

A member of the mustard family, Brassicaceae. There has been some debate over the taxonomy of the species: *A. serotina* is not mentioned in some floras and is treated as synonymous with *Arabis laevigata* var. *burkii* in others (USFWS, 1991).

Historical Range

First observed in Virginia; extent of historical range is not reported (USFWS, 1991).

Current Range

Ten counties in Virginia and West Virginia (USFWS, 1991).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect (EPA, 2016)

Breeding Season

Adult: Flowers from mid-July through September (USFWS, 1991); the fruiting period usually occurs in early to mid-September (EPA, 2016).

Key Resources Needed for Breeding

Adult: Flower flies and butterflies for pollination (EPA, 2016); possibly bees (NatureServe, 2015).

Reproduction Narrative

Adult: Flowers from mid-July through September (USFWS, 1991); the fruiting period usually occurs in early to mid-September (EPA, 2016). Pollinated by insects (flower flies and butterflies, possibly bees (EPA, 2016); NatureServe, 2015).

Habitat Type

Adult: Terrestrial (USFWS, 1991)

Habitat Vegetation or Surface Water Classification

Adult: Shale barrens of the Ridge and Valley Province of the Appalachian Highlands (USFWS, 1991)

Geographic or Habitat Restraints or Barriers

Adult: Elevation from 400 to 600 m (NatureServe, 2015)

Habitat Narrative

Adult: Habitat is shale barrens of the Ridge and Valley Province of the Appalachian Highlands (USFWS, 1991), occurring only on sparsely-vegetated xeric, south or west-facing shale slopes (barrens) at elevations from 400 to 600 meters (NatureServe, 2015). Populations are known from both the shale openings and shale woodlands adjacent to the shale openings. The term "shale barren" is a general reference to certain mid-Appalachian slopes that possess the following features: 1) southern exposures, 2) slopes of 20-70 degrees and 3) a covering of lithologically hard and weather-resistant shale or siltstone fragments (NatureServe, 2015).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Dispersal pathway is unknown (EPA, 2016).

Population Information and Trends**Population Trends:**

Decline of 50-70% (NatureServe, 2015)

Species Trends:

Decline of 30-50% (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

56 (NatureServe, 2015)

Population Size:

Most recent survey: 3854 individuals (NatureServe, 2015)

Population Narrative:

Populations fluctuate dramatically but most are of very low numbers (typically <50 individuals). The most recent counts from all sites total 3854 plants altogether. Area of occupancy is estimated to be approximately 220 square km, determined using a 4 km square grid cell size.

Approximately 56 occurrences are believed extant, 34 in Virginia and 22 in West Virginia. Approximately 11 occurrences are believed to have excellent or good viability, with 4 additional occurrence believed to have good or fair viability. Long-term decline is 50 - 70%; short-term decline is 30 - 50% (NatureServe, 2015).

Threats and Stressors

Stressor: Habitat degradation or modification (USFWS, 1991)

Exposure:

Response:

Consequence:

Narrative: Road, dam, and railroad construction have resulted in the partial destruction and disturbance of shale barrens containing *A. serotina* (USFWS, 1991).

Stressor: Drought (USFWS, 1991)

Exposure:

Response:

Consequence:

Narrative: Increased reproductive failure was observed among populations in one West Virginia valley that suffered a severe drought in 1987. Additional West Virginia data from 1988 and 1989 - years of drought and normal rainfall, respectively -- suggested significant negative effects from drought on reproduction in the *A. serotina* populations studied, including dead terminal and lateral shoot tips and decreased fruit production (USFWS, 1991).

Stressor: Herbivory (USFWS, 1991)

Exposure:

Response:

Consequence:

Narrative: Herbivory by deer has been suggested by some investigators as a significant threat to *A. serotina*, although the data are mainly circumstantial. Most grazing activity appears to occur in spring, when (if a plant is not otherwise stressed) loss of the terminal bud could increase branching and, possibly, flower and seed production; this makes it difficult to ascertain the degree of threat grazing represents (USFWS, 1991).

Stressor: Other factors that can affect species populations (USFWS, 1991)

Exposure:

Response:

Consequence:

Narrative: Since most of the 34 extant populations consist of less than 100 plants (many with fewer than ten individuals), this rare species may be particularly vulnerable to local extirpation. In general, any other threat that acts on the species is more likely to destroy a small population than a large one. These small populations may also be susceptible to catastrophic loss by a stochastic event causing reproductive failure such as a tree falling or seed dispersal into an unsuitable habitat (USFWS, 1991).

Stressor: Insects and insect-control measures (USFWS, 1991)

Exposure:

Response:

Consequence:

Narrative: There has been some concern about possible impacts on *A. serotina* from gypsy moth (*Lymantria dispar*) infestation. Escaping in New England, the gypsy moth has moved south, defoliating large forest tracts and causing substantial mortality of trees in some forest types. The moth has entered the northern portion of *A. serotina*'s range and may cover the entire range in the next one to four years. Of more immediate concern are the possible effects on *A. serotina* caused by treatments to control gypsy moths, which may cause high mortality in certain non-target organisms. These organisms include pollinators of *A. serotina* such as two rare butterflies (*Pvrcrus wyandot* and *Euchloe olympia*), which inhabit shale barrens and adjacent woodlands (USFWS, 1991).

Stressor: Overcollection (USFWS, 1991)

Exposure:

Response:

Consequence:

Narrative: Overcollection of this species by botanists may also pose a threat to some populations of *A. serotina*, particularly at the more accessible shale barrens (USFWS, 1991).

Recovery**Reclassification Criteria:**

1. Twenty demonstrably self-maintaining populations are distributed throughout the species' range (USFWS, 1991).
2. The habitat of these 20 populations is permanently protected (USFWS, 1991).
3. Seeds are stored to prevent extinction in case of disastrous loss of natural populations (USFWS, 1991).

Delisting Criteria:

1. Twenty demonstrably self-maintaining populations are distributed throughout the species' range (USFWS, 1991).
2. The habitat of these 20 populations is permanently protected (USFWS, 1991).
3. Seeds are stored to prevent extinction in case of disastrous loss of natural populations (USFWS, 1991).
4. Fifteen additional self-maintaining populations and their habitat are permanently protected (USFWS, 1991).

Recovery Actions:

- Seek protection of all extant populations, and secure permanent protection for demonstrably self-maintaining populations and their habitat (USFWS, 1991).
- Monitor extant populations and their habitat on a regular basis (USFWS, 1991).
- Search for additional populations (USFWS, 1991).
- Study life history, ecological, and population parameters and establish guidelines for determining what constitutes a self-maintaining population (USFWS, 1991).

- Store seeds off-site in case of loss of extant populations (USFWS, 1991).
- As needed, manage populations for the maintenance of each population and its habitat (USFWS, 1991).

Conservation Measures and Best Management Practices:

- Not available.

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SPECIES ACCOUNT: *Arctomecon humilis* (Dwarf Bear-poppy)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/06/1979; Mountain-Prairie Region (Region 6) (USFWS, 2015)

Physical Description

perennial herb with long taproots, woody caudices, and tufts of basal leaves. Short leafy peduncles are only 12-15 cm tall. Due to the short leafy stems, the white flowers appear to float above the cluster of leaves, accentuating the plant's low stature. The flower of *A. humilis* usually has 4 petals. The genus name is based on the bear paw-like appearance of the shaggy villous leaves while the leaves of are only slightly lannate with deeply 3-toothed leaves at the apex. The abundant white flowers that bloom mid-April through May are showy next to the red soils in which the plant grows. (USFWS, 2015; NatureServe, 2015)

Taxonomy

While three species of bear-poppy share common morphological features, the combination of features is distinctive in each one. The dwarf bear-poppy exhibits similar stamen and pistil structure to *A. merriamii* and the racemose inflorescence of *A. californica* rather than the solitary inflorescence of *A. merriamii*. The clustered pure white flowers of the dwarf bear-poppy and the bright yellow-flowered *A. californica* make them quite attractive in their arid environment. The dwarf bear-poppy is characterized by several unique features including stature, leaf morphology, and floral parts. Its short leafy peduncles are only 12-15 cm tall. Both other species have tall naked peduncles: *A. merriamii*, 20-35 cm, and *A. californica*, up to 60 cm. Due to the short leafy stems, the white flowers appear to float above the clusters of leaves, accentuating the plant's low stature. Although each species may have from 4-6 petals, the dwarf bear-poppy usually have 4 petals (Atwood 1977). (USFWS, 1985); Dwarf bear-poppy (*Arctomecon humilis* Coville), is one of three species in the genus *Arctomecon* of the poppy (*Papaveraceae*) family. The other two species are *A. californica* and *A. merriamii*. The dwarf bear-poppy is the only *Arctomecon* species found in Utah. There are no taxonomic issues with its status as a distinct and clear species (Nelson and Welsh 1993, Welsh et al. 2003). (USFWS, 2016)

Current Range

Endemic to the Dixie Corridor; extant in Washington Co., Utah on the eastern edge of the Mohave desert. (USFWS, 1985); Dwarf bear-poppy is restricted to approximately 9,000 acres (3,642 ha) of habitat in the vicinity of St. George in Washington County, Utah (see Figure 2). The elevation range the species occupies is 823 to 1,006 m (2,700 to 3,300 ft). Approximately 30 percent of the habitat is located on state, private or municipally administered lands; the remaining 70 percent occurs on federal lands managed by the Bureau of Land Management (BLM) (see Table 1) (BLM 2008, Nelson 1989). (USFWS, 2016)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Dwarf bear-poppy reproduces sexually by seeds. The species has a mixed mating system and is thus capable of producing seeds through self-fertilization or crosspollination by pollinators (Tepedino et al. 2014). However, the highest number of seeds and fruits are produced when flowers are cross-pollinated (Tepedino et al. 2014). (USFWS, 2016)

Breeding Season

Adult: Seedling recruitment is episodic and occurs en masse when rainfall is sufficient during the late winter and spring. (USFWS, 2016); Mid-April through May (NatureServe, 2015)

Key Resources Needed for Breeding

Adult: Seeds are primarily dispersed by wind and animals, mainly ants and rodents, which are also seed predators (Harper and Van Buren 2004; Farrall and Mull 2012; Mull 2012). Seeds are dispersed before they are mature and they need several years to complete development before they germinate (Nelson 1989b; Allphin et al. 1998; Allphin pers. comm. 2014). (USFWS, 2016)

Reproduction Narrative

Adult: The abundant white flowers that bloom mid-April through May are showy next to the red soils in which the plant grows. Seeds are dispersed by ants. (NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Desert (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 700 and 1402 m. (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (Natureserve, 2015)

Dependency on Other Individuals or Species for Habitat

Adult: The dwarf bear-poppy grows sympatrically with the Moenkopi endemic *Eriogonum thompsonae* var. *albiflorum*. (USFWS, 1985)

Habitat Narrative

Adult: Dwarf bear-poppy habitat is sparsely vegetated, and consists of highly weathered rounded hill and dome formations. Roughly half of the soil surface is bare of vegetation, and the majority of the living cover in the habitat is biological soil crust¹ (Nelson 1989a; Nelson and Harper 1991; Simpson 2014). Associated native plants include shadscale (*Atriplex confertifolia*), Torrey's ephedra (*Ephedra torreyana*), nodding buckwheat (*Eriogonum cernuum*), desert trumpet (*E. inflatum*), desert pepperweed (*Lepidium fremontii*) and burrobrush (*Ambrosia salsola*). Invasive species include red brome (*Bromus rubens*), cheatgrass (*Bromus tectorum*), barb-wire Russian thistle (*Salsola paulsenii*), and African mustard (*Malcomia africana*) (Harper and Van Buren 2004; Simpson 2014). (USFWS, 2016); Dwarf bear-poppy is found on gypsiferous clay soils derived from the Moenkopi Formation, sometimes on cryptogamic crust. Occurs on

rolling low hills and ridge tops, often on barren, open sites in warm desert shrub communities. Found at elevations between 700 and 1402 m. The dwarf bear-poppy grows sympatrically with the Moenkopi endemic *Eriogonum thompsonae* var. *albiflorum*. (USFWS, 1985; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seeds are dispersed by ants. (NatureServe, 2015)

Population Information and Trends

Population Trends:

A Population Viability Analysis (PVA) for the species indicates a downward population trend within the past 21 years (Meyer et al. 2015) (USFWS, 2016); Short-term trends indicate a decline of 10 to 30% (NatureServe, 2015)

Resiliency:

Low (inferred from USFWS, 1985)

Redundancy:

Low (inferred from USFWS, 1985)

Number of Populations:

8 (USFWS, 2016)

Population Narrative:

Because of its restricted habitat, it probably never was common. Population numbers fluctuate widely from year to year, based on precipitation, and a large seed bank with long lived seeds is a requirement for the maintenance of this species (Harper and Van Buren 2004). Short-term population trends indicate a decline of 10 to 30%. (NatureServe, 2015)

Threats and Stressors

Stressor: Recreation (including OHV use, hiking, mountain biking, horseback riding, unauthorized recreational use, and vandalism) (USFWS, 2016)

Exposure:

Response:

Consequence: damage and mortality of individuals, destruction and fragmentation of habitat, soil compaction and erosion, destruction of biocrusts, and degradation of vegetative community (Harper et al. 1998; Brooks and Lair 2005; Ouren et al. 2007; Roth 2012). (USFWS, 2016)

Narrative: While OHV use in the habitat has declined significantly since 1999, the impact to the habitat and the species continues into the future. Old OHV trails continue to be used by non-motorized users and the majority of this use is unauthorized. Since enforcement is sporadic, we do not have good reporting of the current level of unauthorized recreational use in the majority of the populations. We anticipate the level of recreational use will increase in poppy habitat with an increase in local population growth, with smaller buffers between residential development and poppy habitat, and with fewer options for recreation as open space is developed in and

immediately surrounding the St. George city limits. Therefore, we designated the threat level from recreation as high for dwarf bear poppy. (USFWS, 2016)

Stressor: Land development (including residential and industrial development, utility projects, and road development) (USFWS, 2016)

Exposure:

Response:

Consequence: Potential impacts to dwarf bear-poppy from land development include mortality of individuals, habitat loss, degradation and fragmentation, increased soil erosion, increased dust generation, reductions in pollinator populations, reductions in plant reproductive potential, reductions in seed bank quantity and quality, and increasing invasive plant occurrences (Brock and Green 2003). (USFWS, 2016)

Narrative: Land development was considered a threat to dwarf bear-poppy at the time of listing (USFWS 1979). All known populations occur in Washington County, UT, in and around the city of St. George, which is currently one of the fastest growing metro areas in the country (U.S. Census Bureau 2000, 2010, 2014). Projections indicate that the population of Washington County will likely increase by 243 percent by the year 2050 from recorded 2010 levels (Utah Foundation 2014). To date approximately 50 percent of the dwarf bear-poppy's historic habitat has been lost to urbanization and degradation from off-road vehicles (Harper and Van Buren pers. comm. 2004). Currently, the poppy no longer occurs on private lands in Washington County except for habitat protected by The Nature Conservancy (TNC) (TNC 2015). Roughly 22 percent of known poppy habitat remains under state ownership by Utah School and Institutional Trust Lands Administration (SITLA). The loss of poppy habitat is highly likely in the next twenty years on the majority of State lands. A priority for recovery is the protection of poppy habitat on State and private lands. Protection options include land exchanges between the BLM and the State of Utah, land acquisition by TNC, a conservation agreement with the State of Utah, or additional protections afforded by the State of Utah and private landowners. Due to the high exposure and intensity of development in and around dwarf bearpoppy habitat, the continued and increasing levels of development in Washington County and around St. George, and the severity of the direct and indirect impacts to the species resulting from development, we assign development a high threat level for dwarf bear-poppy. (USFWS, 2016)

Stressor: Livestock Grazing (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: We determine that livestock grazing is a potential threat to dwarf bear-poppy because we do not have evidence of a population level impact to the species. We will continue to assess the potential of livestock grazing to pose a threat to the species. Regular monitoring of livestock grazing in poppy habitat is recommended and research on the direct and indirect impact of livestock grazing to the species is needed. (USFWS, 2016)

Stressor: Invasive Species (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Invasive plants can exclude native plants and alter pollinator behaviors (D'Antonio and Vitousek 1992; DiTomaso 2009; Mooney and Cleland 2001; Levine et al. 2003; Traveset and

Richardson 2006). Red brome, an invasive annual grass, was the only non-native plant specifically noted in the species' habitat from the earliest plant community assessment (Nelson and Harper 1991). We determine invasive species are a potential threat to dwarf bear-poppy because they are present at a low level in the habitat and we do not have evidence of a population level impact to the species. We will continue to assess the potential of invasive species to pose a threat to the species. Regular monitoring of invasive species in poppy habitat is recommended and research on the direct and indirect impact of invasive species to the species is needed.

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: In the absence of the Act's protection, we believe the existing regulatory mechanisms would not provide dwarf bear-poppy with adequate protection from threats. Under the Act's protection, a review of Federal actions potentially impacting the species can be performed. Because the species occurs on Federal land, threats to the species can be addressed by regulatory mechanisms, and some threats (development, recreation) have been addressed. Enforcement of unauthorized recreation is not being addressed on Federal land, but that is not a result of lacking regulatory mechanisms. A newly identified threat to the species, the loss of specialist pollinators, is also not being addressed on Federal land but we need more information about this threat in order to identify adequate regulatory mechanisms. There are no regulatory mechanisms on State and private lands to protect the species from these threats. We assign an overall threat level of high because development and recreation are high threats to the species and are not adequately being addressed by existing State regulatory mechanisms. (USFWS, 2016)

Stressor: Loss of Pollinators and Pollinator Diversity (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: In summary, we have evidence that primary pollinators of dwarf bear-poppy no longer occur within the species' range and that the pollinator assemblage has simplified to generalist pollinators that can only be relied upon to provide adequate pollination services in areas of high plant density. The species' new primary pollinator, the honey bee, is in decline and may not be a reliable pollinator in the future. We also have documented impacts to reproduction that are likely due in part to pollinator limitation. We anticipate the level of development and habitat fragmentation to increase in poppy habitat with an increase in local population growth and it already appears that the species' important specialist pollinators are not able to tolerate and adapt to the current level of development and habitat fragmentation within the species' range. Given these considerations and the critical importance of seed production for the dwarf bear-poppy, we now determine the loss of specialist pollinators is a threat to the species now and in the foreseeable future, and we assign a high threat level. We strongly encourage the synergistic feedback of this threat and other stressors be evaluated and mitigated to prevent extinction (see Brooks et al. 2008 on synergies among extinction drivers).

Recovery

Reclassification Criteria:

Reclassification criteria are not available.

Delisting Criteria:

Delisting criteria are not available.

Recovery Actions:

- 1. Protect occupied and suitable habitat from urban development. (USFWS, 2016)
- 2. Protect occupied and suitable habitat from degradation and additional fragmentation. (USFWS, 2016)
- 3. Support and monitor pollinators in occupied and suitable habitat as well as in adjacent habitat. (USFWS, 2016)
- 4. Perform research on suitable microsites for seedling establishment. (USFWS, 2016)
- 5. Perform propagation research using seeds and plant tissue. (USFWS, 2016)
- 6. Perform a comprehensive census of the medium and large dwarf bear-poppy populations (Red Bluff, Warner Ridge, Webb Hill, White Dome, and Beehive Dome). (USFWS, 2016)
- 7. Update the Recovery Plan. (USFWS, 2016)
- 8. Conduct Census and Monitoring Studies:Comprehensively census all known populations on a regular basis in order to produce an accurate picture of population number and distribution to adequately characterize the species' status. In addition to the populations identified in #6, above: a) Locate and survey the Warner Valley Springs population on foot. b) Survey the Shinob Kibe population on foot. c) Based on census results, develop and implement a range-wide monitoring plan to determine population trends and select monitoring plot locations to regularly monitor recruitment, plant reproduction, and pollinator assemblage. Evaluate population breeding system. d) Monitor crust recovery of land scars periodically. BLM and TNC assistance with this action is essential. e) Regularly monitor and assess recreational use within plant populations. BLM, TNC, and State assistance with this action is essential. (USFWS, 2016)
- 9. Abate Heavy Land Use:a) Identify with GIS all land scars and degradation of habitat within populations and evaluate every 5 years. BLM and State assistance with this action is essential. b) Utilize technical expertise (USGS Las Vegas and Moab or universities) for habitat restoration, trail planning, and assessment of vehicular routes including mountain bikes trails in dwarf bear-poppy habitat. c) Assess and if necessary remove or redirect activities that negatively impact dwarf bear-poppy habitat. d) The Service should be a cooperator on the Washington County Comprehensive Travel and Transportation Management Plan. e) Update ACEC management prescriptions at Red Bluff and Warner Ridge/Fort Pierce to reflect current levels of impact on dwarf bear-poppy: Provide regular, adequate, and responsive monitoring and management at ACECs; Update Implementation Schedule of needed activities; Update ACEC Activity Plans. f) Provide ACEC management protections for the remaining dwarf bear-poppy populations on BLM lands. g) Provide consistent, scientifically based, range-wide management plans for the species. h) Engage and educate recreational user groups that are creating heavy use impacts. (USFWS, 2016)
- 10. Provide Adequate Law Enforcement to address unauthorized recreation use: a) Support law enforcement officials in promoting compliance with off-highway vehicle laws (and regulations) and effective deterrents of abuses of public land. b) Increase patrol of BLM lands to reduce non-compliant land use. c) Seek support and help from the Cities of St. George, Santa Clara, and Washington to manage use within poppy habitat. d) Prioritize and schedule regular land use patrol at high use areas (suggested Red Bluff near Bloomington,

Red Bluff near Boomer Hill, Webb Hills at Brigham Road, White Dome at River Run Road, and North Warner Ridge). (USFWS, 2016)

- 11. Conduct Research to Better Understand Species and Species Response to Stressors and Threats: a) Repeat Population Viability modeling using new census and monitoring data on a regular basis. b) Evaluate the synergistic effect or feedback of multiple threats and stressors on the landscape and design a mitigation strategy to prevent extinction. c) Evaluate and implement a human-assisted gene flow pilot study. d) Evaluate and implement a pollinator rearing or transplant pilot study. (USFWS, 2016)
- 12. Coordinate with State, County, City Officials and Developers: a) Coordinate advance planning of development and infrastructure to avoid, minimize, and mitigate impacts to dwarf bear-poppy habitat. Conservation measures include permanent habitat protections with pollinator buffers to offset impacts, and seed and soil salvage operations to preserve the seedbank and genetic diversity when habitat is lost. b) Evaluate, address and offset habitat impacts from increased land use due to easier access provided by highways. (USFWS, 2016)

Conservation Measures and Best Management Practices:

- Conservation measures are not available.

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SPECIES ACCOUNT: *Arctostaphylos confertiflora* (Santa Rosa Island manzanita)

Species Taxonomic and Listing Information

Listing Status: Endangered; 7/31/1997; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

aperennial shrub in the heath (Ericaceae) family that grows 0.1 to 2.0 meters (4 inches to 6.5 feet) high, sometimes reaching as high as 6 meters (20 feet) (Wells 1993; Parker and Vassey in titt. 1998) (Figure 7). Santa Rosa Island manzanita occurs in prostrate and upright forms, the former most likely due to climatic influences and herbivory (McMinn 1951). The plant has smooth, dark red-purple bark and densely hairy-glandular branchlets and flower stalks. The leaves are light green, round-ovate with cupped margins. The flowers occur in dense clusters that mature into flattened reddish-brown fruits (McMinn 1951). Another manzanita on Santa Rosa Island, *Arctostaphylos tomentosa*, has three subspecies. These are differentiated from *A. confertiflora* and each other by variously having long, stiff hairs or no glandularity (*A. t. ssp. crustacea* - long, nonglandular hairs; *A. t. ssp. insuticola* - pubescent, nonglandular hairs; *A. t. ssp. subcordata* - long, glandular hairs) (USFWS, 2000).

Taxonomy

Belongs to the heath family (Ericaceae) (USFWS, 2014). Santa Rosa Island manzanita was described as *Arctostaphylos confertiflora* by Eastwood in 1934 from a collection made by Hoffmann 4 years earlier "in a sheltered dell south of Black Mountain" on Santa Rosa Island (Eastwood 1934). Munz (1958) published the new combination *Arctostaphylos subcordata* var. *confertiflora*. However, in subsequent treatments of the genus, Wells (1968, 1993) has continued to use the original taxonomy (USFWS, 2000).

Historical Range

See current range.

Current Range

Known from three areas on Santa Rosa Island; the north-east side of Black Mountain (less than 300 plants) combined with the Torrey Pine vicinity (less than 100 plants), the canyons on the south-east side of the island (less than 1,000 plants), and in the vicinity of South Point (approximately 200 plants) (USFWS, 2000).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Possibly sexual and self-pollination, based on closely related species (USFWS, 2014)

Lifespan

Adult: 100+ years (USFWS, 2014)

Key Resources Needed for Breeding

Adult: Fire; insect pollinators, based on closely related species (USFWS, 2014)

Reproduction Narrative

Adult: It has lost this ability to resprout and, as such, reproduce only by seed (obligate seeder) (Tyler and Odion 1996). Obligate seeders produce seeds annually, and a small proportion of the seeds may germinate each year. Dormant seeds are long-lived and accumulate in leaf litter and soil over time creating a long-term seed bank. Often in chaparral, the trigger is a fire; although the Service does not know the exact germination triggers for *A. confertiflora*, there is no reason to think it is different for this species of *Arctostaphylos*. Pollination and seed production in *Arctostaphylos confertiflora* are not well understood. Researchers studying *A. pringlei* (a closely related obligate seeder) observed that the species was pollinated by solitary bees, bumblebees (*Bombus* spp.), and syrphid flies (family *Syrphidae*); and the heaviest visitation was from honey bees (*Apis* spp.). They also observed successful self-pollination in *A. pringlei* (Fulton and Carpenter 1979). *Arctostaphylos confertiflora* is a long-lived perennial (individuals of the species may live 100 years or longer (Schreiner et al. 2006; D. Rodriguez, NPS, in litt. 2013)). Recruitment has been nearly zero at all three population locations for as long as monitoring has occurred (USFWS, 2014).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Chaparral, mixed woodland, pine woodland (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Scattered (NatureServe, 2015)

Habitat Narrative

Adult: Scattered on sedimentary substrates (shales, volcanoclastic sediments, and sandstone) in chaparral, mixed woodland, and pine woodland communities. Extant plants are mostly on very steep slopes (NatureServe, 2015). *Arctostaphylos confertiflora* occurs as a component of mixed chaparral, mixed woodland, and island pine (*Pinus torreyana*, *P. muricata*) woodland vegetation types (Service 2000) (USFWS, 2014).

Dispersal/Migration**Dependency on Other Individuals or Species for Dispersal**

Adult: Possibly *U. l. santarosae* (inferred from USFWS, 2014)

Dispersal/Migration Narrative

Adult: The NPS has observed the Santa Rosa Island fox (*Urocyon littoralis santarosae*) consuming *Arctostaphylos confertiflora* seeds, although the seeds appear to pass through the fox digestive system intact (Rodriguez, in litt. 2007). Seed viability testing was conducted on seeds contained

in island fox scat; results indicate that there was no loss of viability in these seeds compared to the viability of undigested seeds (Ransom Seed Lab 2007) (USFWS, 2014).

Population Information and Trends

Population Trends:

Unknown (USFWS, 2014)

Resiliency:

Low (inferred from USFWS, 2014)

Redundancy:

Low (inferred from USFWS, 2014)

Number of Populations:

3 (USFWS, 2014)

Population Size:

6,500 - 8,500 (USFWS, 2014)

Adaptability:

Low (inferred from USFWS, 2014)

Population Narrative:

It is found in only three populations. It is not possible to determine population trends (based on recruitment and mortality rates) at this time for *Arctostaphylos confertiflora*. There are 6,500 to 8,500 individuals on Santa Rosa Island (USFWS, 2014).

Threats and Stressors

Stressor: Erosion (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: The listing rule for *Arctostaphylos confertiflora* identified soil loss (via erosion) and habitat alteration by non-native mammal species as Factor A threats to the species. All non-native ungulates excepting a few deer were removed from Santa Rosa Island in 2011 (Rodriguez pers. comm. 2012), and direct habitat destruction and curtailment by these animals is no longer a threat. However, because the ungulates were removed only recently, their impacts on *A. confertiflora* have not yet been reversed. Remaining indirect effects of ungulates on *A. confertiflora* habitat include edge effects from game trails, as well as wind and water erosion continuing to affect the seed bank, seed bed, and leaf litter. Although small increases in litter cover have occurred in some areas since monitoring started in 2001 (Schreiner et al. 2006), the ground underneath arborescent *A. confertiflora* individuals is exposed and accumulated leaf litter tends to be removed by wind (Rodriguez pers. comm. 2012) (USFWS, 2014).

Stressor: Insect damage (USFWS, 2014)

Exposure:

Response:**Consequence:**

Narrative: The 2007 5-year review reported insect damage to individuals of *Arctostaphylos confertiflora* in all three populations. Damage included fruit and seed predation (Rodriguez, pers. comm. 2006a, 2012) and leaf damage (Dale-Cesmat, in litt. 2005; Rodriguez, pers. comm. 2006b, 2012). The NPS correlated apparently higher levels of “die-back” with insect damage at Black Mountain (Rodriguez, in litt. 2006c). In late 2007, the NPS and USGS observed defoliation of *A. confertiflora* individuals by tussock moth caterpillars. In the following spring, at least seven individuals appeared to have died as a result (McEachern and Rodriguez 2008). The individual plants killed by the moths were already stressed by other factors, and it is likely that healthy *A. confertiflora* would be resilient to defoliation by tussock moths (Rodriguez pers. comm. 2012). Tussock moths appear on *A. confertiflora* in an irregular, multi-annual cycle. The Service is uncertain regarding the extent to which insect damage represents a threat to the species; however, tussock moths can rapidly defoliate plants (Brubaker 1978, Harrison and Maron 1995) and could pose a threat to species such as *A. confertiflora* that have a restricted range and low reproductive success (USFWS, 2014).

Stressor: Low reproductive success (USFWS, 2014)

Exposure:**Response:****Consequence:**

Narrative: In some locations, the past browsing pressure resulted in plants that never had the opportunity to fruit, flower, and produce seed. In other locations, plants had become arborescent through browsing of the lower portions of the plant; in this case, even if the plants produced seed, the increased erosion under and around stands did not provide suitable conditions for seed retention and germination. These effects compromised the seed bank and reduced the quality of germination sites. The Ransom Seed Lab (2007) found that the germination rate during standard lab testing was zero. These results are not uncommon for *Arctostaphylos* species (Rodriguez pers. comm. 2012), because members of this genus typically require a specific trigger (such as scarification from a fire event) to break seed dormancy and allow germination to occur (USFWS, 2014).

Stressor: Stochastic events (USFWS, 2014)

Exposure:**Response:****Consequence:**

Narrative: Although the extant populations of *Arctostaphylos confertiflora* are not particularly small, there are only three. Rarity, including a small number of populations, makes a species vulnerable to stochastic events. *Arctostaphylos confertiflora* is a long-lived species and there are 6,500 to 8,500 individuals on Santa Rosa Island. Therefore, most natural stochastic events are unlikely to extirpate all three populations. One exception is fire. Although the species is an obligate seeder and likely requires fire for large-scale germination, mature plants of this species do not regenerate when damaged by fire as do burl-forming species of *Arctostaphylos*. In addition, the species’ depleted seed bank may preclude large-scale germination required to replace destroyed mature plants. Therefore, a large enough fire could extirpate one or more of the three known *A. confertiflora* populations (USFWS, 2014).

Stressor: Climate change (USFWS, 2014)

Exposure:**Response:****Consequence:**

Narrative: Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, increased summer continental drying, and increased fire frequency (Field et al. 1999; Cayan et al. 2005; Westerling et al. 2006; IPCC 2007). Increased fire frequency could have positive or negative impacts on *Arctostaphylos confertiflora*. Recently, Loarie et al. (2008) modeled the potential impacts of climate change on the flora of California. They predicted that species' distributions will shift in response to climate-driven habitat changes. Specifically, they predicted that, in general, species will shift northward and to higher elevations, and may experience a reduction in the extent of available habitat. Species will redistribute with shifting habitat, depending on the ability of each species to do so. Species diversity will also shift with a general trend of diversity increasing towards the coast and northwards, with these areas becoming de facto future refugia. Given the narrow geographic range of *A. confertiflora*, the species will have limited ability to disperse in response to climate change (USFWS, 2014).

Recovery**Reclassification Criteria:**

Maintain three stable or increasing populations on Santa Rosa Island with evidence of natural recruitment for a 30-year period including the normal precipitation cycle (USFWS, 2000).

Delisting Criteria:

No decline in populations for 10 years after downlisting (USFWS, 2000).

Recovery Actions:

- Support and intensify active control programs where herbivory or habitat alteration by alien animals exists (USFWS, 2000).
- Develop and implement a plan to achieve the goals and standards of the Conservation Strategy. The Conservation Strategy is a draft strategy for conservation of island resources prepared by biologists from the National Park Service, U.S. Fish and Wildlife Service, and the U.S. Geological Survey, Biological Resources Division. This Strategy is essentially a primer or guide that provides the basis for the recovery of the species in this recovery plan and should be referred to as a supporting document (USFWS, 2000).
- Restore habitats and control competitive weeds for long-term management of the listed species and their habitats (USFWS, 2000).
- Conduct thorough surveys for all species in the recovery plan (USFWS, 2000).
- Conduct research that aids in the conservation and recovery of the species in the recovery plan (USFWS, 2000).
- Store seeds at facilities certified by the Center for Plant Conservation and develop successful seed germination and propagation techniques (USFWS, 2000).
- Develop successful outplanting techniques (USFWS, 2000).

Conservation Measures and Best Management Practices:

- The Service recommends that the NPS conduct a threats assessment for insect damage to *Arctostaphylos confertiflora*. If the assessment indicates insect damage is a concern, the NPS could

consider a trial insect control program and additional monitoring to track the extent of insect damage (USFWS, 2014).

- *Arctostaphylos confertiflora* seeds may require episodic disturbances to stimulate seed germination. These conditions are critical for the establishment and survival of new generations and recovery of the species. Additional research should be done to identify germination cues using methods that are more appropriate for fire-adapted seeds. Once germination cues are better understood, the NPS could explore ways to enhance these conditions in the field through activities such as controlled burns and erosion control (USFWS, 2014).
- Because this species is an obligate seeder and regeneration is sporadic without the presence of disturbance such as fire, an important measure of recovery is the size and viability of the seed bank. The seed bank should be monitored at regular intervals (such as every 3 years) by surveying the amount of seeds in the soil seed bank and conducting seed viability analysis on the seed samples collected during the surveys (USFWS, 2014).

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U.S. Fish and Wildlife Service Ventura Fish and Wildlife Office Ventura, California

SPECIES ACCOUNT: *Arctostaphylos franciscana* (Franciscan manzanita)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/5/2012; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

Arctostaphylos franciscana is a low evergreen shrub with horizontal or upward curving stems that may reach 0.6 to 0.9 meters (m) (2 to 3 feet (ft.)) in height when mature (Chasse et al. 2009, p. 5). Its leaves are about 1.5 to 2 centimeters (cm) (0.6 to 0.8 inches (in)) long, are isofacial (have the same type of surface on both sides), and are oblanceolate (longer than they are wide and wider towards the tip) (Eastwood 1905, p. 201; Chasse et al. 2009, p. 39). Its mahogany brown fruits are about 6 to 8 millimeters (mm) (0.24 to 0.32 in) wide, while its white to pink, urn-shaped flowers measure about 5 to 7 mm (0.2 to 0.28 in) long (Wallace 1993, p. 552; Service 2003, p. 57) (USFWS, 2013).

Taxonomy

Belongs in the heath family (Ericaceae) (USFWS, 2013).

Historical Range

Arctostaphylos franciscana is considered to be endemic to the San Francisco peninsula. Prior to 1947, *Arctostaphylos franciscana* was known from three locations on the San Francisco peninsula: the Masonic and Laurel Hill Cemeteries in San Francisco's Richmond district, and Mount Davidson in the south-central part of San Francisco (Service 2003, pp. 16, 62, 95; Chasse et al. 2009, p. 4) (USFWS, 2013).

Current Range

Restricted to a single site in San Francisco, California (NatureServe, 2015). The current range of the species consists of this single wild plant in the San Francisco Presidio (USFWS, 2013).

Critical Habitat Designated

Yes; 12/20/2013.

Legal Description

On December 20, 2013, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Arctostaphylos franciscana* (San Francisco manzanita) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes thirteen critical habitat units (CHUs), in Colorado (78 FR 77289-77325).

Critical Habitat Designation

The critical habitat designation for *Arctostaphylos franciscana* includes thirteen CHUs in San Francisco County, California. This species critical habitat encompasses approximately 230.2 acres (ac) (93.1 hectares (ha)) (78 FR 77289-77325).

Unit 1: Fort Point: Unit 1 consists of 7.7 ac (3.1 ha) and is located within the Presidio east of the Golden Gate Bridge and north of Doyle Dr. along Long Ave. and Marine Dr. This unit is currently unoccupied. The unit is within an area that experiences summer fog, and contains serpentine and Franciscan Complex bedrock outcrops, soils derived from these formations, and

native maritime chaparral habitat. The unit represents one of the northern-most areas identified for the species. We have determined that the area is essential for the conservation of the species, because it provides one of multiple independent sites for *Arctostaphylos franciscana* and contains some of the last remaining appropriate habitat within the area.

Unit 2: Fort Point Rock: Unit 2 consists of 21.6 ac (8.7 ha) and is located within the Presidio west of the Golden Gate Bridge and west of Lincoln Blvd. The unit extends from the Toll Plaza south to Kobbe Ave. This unit is currently occupied, although it was not occupied at the time of listing. The unit is within an area that experiences summer fog, and contains serpentine and Franciscan Complex bedrock outcrops, soils derived from these formations, and native maritime chaparral habitat along the coastal bluffs. The unit represents one of the northern-most areas identified for the species. We have determined that the area is essential for the conservation of the species, because it provides one of multiple independent sites for *Arctostaphylos franciscana* and contains some of the last remaining appropriate habitat within the area.

Unit 3: World War II Memorial: Unit 3 consists of a total of 1.9 ac (0.8 ha). The unit is located within the Presidio at the intersection of Lincoln Blvd. and Kobbe Ave. The unit is comprised of two subunits. Subunit 3A (0.8 ac (0.3 ha)) is located west of Lincoln Blvd., and subunit 3B (1.1 ac (0.5 ha)) is located east of Lincoln Blvd. This unit is currently unoccupied. The unit is along the coastal bluffs within an area that experiences summer fog, and contains serpentine and Franciscan Complex bedrock outcrops, soils derived from these formations, and native maritime chaparral habitat. We have determined that the area is essential for the conservation of the species, because it provides for one of multiple independent sites for *Arctostaphylos franciscana* and contains some of the last remaining appropriate habitat within the area.

Unit 4: Immigrant Point: Unit 4 consists of a total of 1.5 ac (0.6 ha). The unit is located within the Presidio along Washington Blvd. east of Lincoln Blvd. and north of Compton Rd. The unit is comprised of two subunits. Subunit 4A (0.4 ac (0.2 ha)) is located west of Washington Blvd., and subunit 4B (1.1 ac (0.4 ha)) is located east of Washington Blvd. This unit is currently unoccupied. The unit is located along the coastal bluffs within an area that experiences summer fog, and contains serpentine and Franciscan Complex bedrock outcrops, soils derived from these formations, and native maritime chaparral habitat. We have determined that the area is essential for the conservation of the species, because it provides for one of multiple independent sites for *Arctostaphylos franciscana* and contains some of the last remaining appropriate habitat within the area.

Unit 5: Inspiration Point: Unit 5 consists of a total of 13.9 ac (5.7 ha). The unit is within the Presidio and is located north of Pacific Ave. and east of Arguello Blvd. The unit is comprised of two subunits, which are adjacent to each other. Subunit 5A (11.8 ac (4.8 ha)) and subunit 5B (2.1 ac (0.9 ha)) are located east of Arguello Blvd., but the two areas are separated by an access road. This unit is currently occupied and was occupied at the time of listing. The unit contains the physical or biological features essential to the conservation of the species. The unit is within an area that experiences summer fog, and is located on sloping terrain containing serpentine and Franciscan Complex bedrock outcrops, soils derived from these formations, and native maritime chaparral habitat. The physical and biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats from habitat loss, degradation, or alteration due to development or other human activities; competition from nonnative plants; small population size and curtailment of

the species' range; and various other human-induced factors such as soil compaction, potential overutilization, disease, or vandalism from visitor use. Please see the Special Management Considerations or Protection section of this final rule for a discussion of the threats to *Arctostaphylos franciscana* habitat and potential management considerations.

Unit 6: Corona Heights: Unit 6 consists of 5.2 ac (2.1 ha) and is located northwest of Castro and 17th Streets adjacent to Roosevelt and Museum Way. This unit is currently unoccupied. The unit is within an area that experiences summer fog, and is located on sloping terrain that contains Franciscan Complex (greenstone) bedrock outcrops of chert or volcanic materials, soils derived from these formations, and open grassland habitat. The unit represents one of several areas identified for the species within the Mount Davidson area. The units in this area would assist in establishing populations of *Arctostaphylos franciscana* outside the Presidio. As a result, we have determined that the area is essential for the conservation of the species, because it provides for one of multiple independent sites for *A. franciscana* and contains some of the last remaining appropriate habitat within the area.

Unit 7: Twin Peaks: Unit 7 consists of 43.8 ac (17.7 ha) along the hilltop of Twin Peaks along Twin Peaks Blvd. west of Market St. This unit is currently unoccupied. The unit is within an area that experiences summer fog; is located on sloping terrain; and contains Franciscan Complex (greenstone) bedrock outcrops of chert or volcanic materials, soils derived from these formations, and open grassland habitat. The unit represents one of several areas identified for the species within the Mount Davidson area. The units in this area would assist in establishing populations of *Arctostaphylos franciscana* outside the Presidio. As a result, we have determined that the area is essential for the conservation of the species, because it provides for one of multiple independent sites for *A. franciscana* and contains some of the last remaining appropriate habitat within the area.

Unit 8: Mount Davidson: Unit 8 consists of 7.1 ac (2.9 ha) and is located on the eastern slope of Mount Davidson near Myra Way and Molimo Dr. This unit is currently unoccupied. The unit is within an area that experiences summer fog, and is located on sloping terrain containing Franciscan Complex (greenstone) bedrock outcrops of chert and sedimentary materials, soils derived from these formations, and open grassland habitat. Mount Davidson is the only known site still remaining that was previously occupied by the species. The reestablishment of populations of *Arctostaphylos franciscana* at this and surrounding units would assist in establishing multiple populations of *A. franciscana* outside the Presidio. As a result, we have determined that the area is essential for the conservation of the species, because it provides for one of multiple independent sites for *A. franciscana* and contains the last remaining historic occurrence for the species.

Unit 9: Diamond Heights: Unit 9 consists of a total of 34.3 ac (13.9 ha) and is located near Diamond Heights Blvd. south of Turquoise Way, and O'Shaughnessy Blvd. This unit is comprised of three subunits. Subunit 9A (19.1 ac (7.7 ha)) is located near Diamond Heights Blvd. south of Turquoise Way. Subunit 9B (3.9 ac (1.6 ha)) is located east of O'Shaughnessy Blvd., and subunit 9C (11.3 ac (4.6 ha)) is located west of O'Shaughnessy Blvd. Unit 9 is currently unoccupied. The unit is within an area that experiences summer fog; is located on sloping terrain; and contains Franciscan Complex (greenstone) bedrock outcrops of chert, volcanic, and sedimentary materials, as well as soils derived from these formations and open grassland habitat. The unit represents one of several areas identified for the species within the Mount Davidson area.

Mount Davidson is the only site still remaining that was known to be previously occupied by the species. The units in this area would assist in establishing populations of *Arctostaphylos franciscana* outside the Presidio. The additional subunits provide additional rock outcrop areas within the matrix of natural land. As a result, we have determined that the area is essential for the conservation of the species, because it provides for one of multiple independent sites for *A. franciscana* and contains some of the last remaining appropriate habitat within the area.

Unit 10: Bernal Heights: We have determined that the area we proposed at Bernal Heights (14.9 ac (6.0 ha)), which is not occupied at the time of listing, is highly degraded and does not meet our criteria for designating areas as critical habitat. As a result, we have determined that this unit is not essential for the conservation of the species, and we are not including Unit 10 in the critical habitat designation.

Unit 11: Bayview Park: Unit 11 consists of 42.5 ac (17.1 ha) and is located at Bayview Park west of Candlestick Park and east of U.S. Highway 101. This unit is currently unoccupied. This unit is considered outside the range of the species but still within the same Franciscan fault zone as historic populations. The unit is within an area that experiences summer fog; is located on sloping terrain; and contains Franciscan Complex (greenstone) bedrock outcrops of chert, volcanic, and sedimentary materials, as well as soils derived from these formations and open grassland habitat. The unit represents one site identified for the species outside the Presidio and Mount Davidson area. Due to the rapid development of the San Francisco peninsula and limited historical information on plant location and distribution, it is difficult to determine the exact range of the species. Given the amount of remaining habitat available with the appropriate characteristics, we looked at all areas within San Francisco that met our criteria as potential habitat. Including this unit would assist in establishing an additional population of *Arctostaphylos franciscana* outside the Presidio and Mount Davidson areas. As a result, we have determined that the area is essential for the conservation of the species, because it provides for one of multiple independent sites for *A. franciscana* and contains some of the last remaining appropriate habitat for the species within the area.

Unit 12: McLaren Park East: Unit 12 consists of a total of 25.0 ac (10.1 ha) and is located at McLaren Park south of Mansell St. near Visitacion Ave. This unit is comprised of two subunits. Subunit 12A (13.4 ac (5.4 ha)) is located south of Mansell St. and west of Visitacion Ave. Subunit 12B (11.6 ac (4.7 ha)) is located south of Mansell St. and east of Visitacion Ave. This unit is currently unoccupied. The unit is within an area that experiences summer fog and is located on sloping terrain. It contains Franciscan Complex (greenstone) bedrock and serpentine outcrops, soils derived from these formations, and open grassland habitat. This unit will assist in establishing an additional population of *Arctostaphylos franciscana* outside the Presidio and Mount Davidson areas. This unit and Unit 13 (McLaren Park West) are located roughly midway between the remaining appropriate habitat at Diamond Heights and Bayview Park and thereby provide increased connectivity between these units. As a result, we have determined that the area is essential for the conservation of the species, because it provides for one of multiple independent sites for *A. franciscana*, contains some of the last remaining appropriate habitat within the area, and provides connectivity between Unit 9 (Diamond Heights) and Unit 11 (Bayview Park).

Unit 13: McLaren Park West: Unit 13 consists of 25.7 ac (10.4 ha) and is located at McLaren Park between Geneva Ave. and Sunnydale Ave. This unit is currently unoccupied. The unit is

within an area that experiences summer fog; is located on sloping terrain; and contains Franciscan Complex (greenstone) bedrock outcrops of volcanic materials, soils derived from these formations, and open grassland habitat. This unit will assist in establishing additional populations of *Arctostaphylos franciscana* outside the Presidio and Mount Davidson areas. This unit and Unit 12 (McLaren Park East) are located roughly midway between remaining appropriate habitat at Diamond Heights and Bayview Park. As a result, we have determined that the area is essential for the conservation of the species, because it provides for one of multiple independent sites for *A. franciscana*, contains some of the last remaining appropriate habitat within the area, and provides connectivity between Unit 9 (Diamond Heights) and Unit 11 (Bayview Park).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Arctostaphylos franciscana* critical habitat consists of four components (78 FR 77289-77325):

- (i) Areas on or near bedrock outcrops often associated with ridges of serpentine or greenstone, mixed Franciscan rocks, or soils derived from these parent materials.
- (ii) Areas having soils originating from parent materials identified in paragraph (2)(i) of this entry that are thin, have limited nutrient content or availability, or have large concentrations of heavy metals.
- (iii) Areas within a vegetation community consisting of a mosaic of coastal scrub, serpentine maritime chaparral, or serpentine grassland as characterized as having a vegetation structure that is open, barren, or sparse with minimal overstory or understory of trees, shrubs, or plants, and that contain and exhibit a healthy fungal mycorrhizae component.
- (iv) Areas that are influenced by summer fog, which limits daily and seasonal temperature ranges, provides moisture to limit drought stress, and increases humidity.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features which are essential to the conservation of the species and which may require special management considerations or protection. The features essential to the conservation of this species may require special management considerations or protection to reduce the direct and indirect effects associated with the following threats: Habitat loss and degradation from development or human activities; competition from nonnative plants; small population size; and soil compaction, overutilization, disease introduction, or vandalism from visitor use. Please refer to the final listing rule published on September 5, 2012, in the Federal Register (77 FR 54434) for a complete description of these threats. Special management to protect the features essential to the conservation of the species from the effects identified above may include (but are not limited to) actively managing appropriate open space areas, limiting disturbances to and within suitable habitats, and evaluating the need for and potentially conducting restoration or revegetation of areas inhabited by *Arctostaphylos franciscana*.

Life History

Food/Nutrient Resources**Reproductive Strategy**

Adult: Sexual (capable of hybridization), vegetative (propagation of cuttings), possibly self-pollination (USFWS, 2013)

Dependency on Other Individuals or Species

Adult: Bombus spp. (USFWS, 2013)

Key Resources Needed for Breeding

Adult: Fire, insect pollinators, soil mycorrhizal fungi community (USFWS, 2013)

Reproduction Narrative

Adult: In the wild, *Arctostaphylos franciscana* is an obligate-seeding species (it reproduces primarily from seed rather than from burls) (Vasey 2010, p. 1). *Arctostaphylos* (manzanita) species are members of the chaparral plant community, which have a variety of triggers for seed germination including heat, smoke, and light (Keeley 1987, p. 434). *Arctostaphylos* species have germinated after being exposed to charate (ground charred wood) (Keeley 1987, pp. 435, 440) which suggests that fire or conditions that simulate fire stimulate germination of the seeds. The establishment of successful populations of *A. franciscana* may require the presence of a pollinator community (primarily bumblebees (*Bombus* spp.) but also other insects), a fruit dispersal community (primarily rodents), and a mutually beneficial soil mycorrhizal fungi community (Parker 2011, p. 1). *Arctostaphylos franciscana* may be capable of self-pollination. The successful propagation of over 300 cuttings from the wild plant has reduced the threat of loss of the genetic information of the wild plant. Hybridization between diploid species of manzanita is well recognized (Chasse et al. 2009, p. 5) (USFWS, 2013).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Serpentine outcrops (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Summer fog (USFWS, 2013)

Habitat Narrative

Adult: Serpentine outcrops, probably in association with *Arctostaphylos hookeri* ssp. *ravenii*. (NatureServe, 2015). It historically occurred in areas with serpentine soils, bedrock outcrops, greenstone, and mixed Franciscan rock, typically growing in mixed populations with *A. montana* ssp. *ravenii* (Service 2003, pp. 95, 96; Chasse et al. 2009, p. 6). The Doyle Drive *A. franciscana* site consisted of disturbed soil over serpentinite (Chasse et al. 2009, p. 3). Summer fog is one of the primary habitat requirements for *Arctostaphylos franciscana* (Vasey 2010, p. 1) (USFWS, 2013). Serpentine soil restricts the growth of many plants due to its high nickel and magnesium concentrations, and thus tends to support unique plant communities because relatively few plant species can tolerate such soil conditions (Brooks 1987, pp. 19, 53; Service 2003, p. 16). These conditions generally result in semibarren soil and a lack of competing plants,

which benefits serpentine-tolerant plants such as Franciscan manzanita (Bakker 1984, p. 79). (USFWS, 2019b).

Dispersal/Migration

Dispersal

Adult: Low to high, depending on mammal movement (inferred from USFWS, 2013)

Dispersal/Migration Narrative

Adult: The seeds of *Arctostaphylos* are dispersed primarily by rodents that consume the fruits, but also by other mammals, including coyotes (*Canis latrans*) and foxes (T. Parker 2011, pers. comm.; Vasey 2011, p. 1). Animals such as coyotes and foxes eat the *Arctostaphylos* fruit and may travel long distances before depositing their scat. Any undigested fruit left in the scat can then be harvested by rodents and either eaten or buried (USFWS, 2013).

Population Information and Trends

Population Trends:

Presumed extirpated until rediscovery in 2009 (NatureServe, 2015)

Species Trends:

Stable (inferred from NatureServe, 2015)

Resiliency:

Very low (USFWS, 2013)

Representation:

Very low (USFWS, 2013)

Redundancy:

Very low (USFWS, 2013)

Number of Populations:

1 (USFWS, 2013)

Population Size:

1 (USFWS, 2013)

Adaptability:

Very low (inferred from USFWS, 2013)

Additional Population-level Information:

As stated in the final rule to list the species as endangered, there is a single wild Franciscan manzanita plant, and the Franciscan manzanita plants that exist in cultivation fall into three categories: (1) cuttings and rooted specimens collected from the Laurel Hill Cemetery and transplanted to various managed botanical gardens in San Francisco, Berkeley, and Claremont prior to 1947; (2) specimens currently propagated in greenhouses from cuttings and layers taken from the wild plant in 2010; and (3) specimens, some of which may be of unknown origin, sold

in the nursery trade or transplanted into home gardens. We consider the single wild plant and plants identified in (1) and (2) above to be the listed entity under the Act. The Franciscan manzanita plants found in botanical gardens, in particular, may represent from one to six genetically distinct plants other than the single wild plant (Chasse et al. 2009, p. 7; Chasse 2011a, p. 1; Chasse 2011b, p. 1; Vasey 2011b, pp. 2, 3), and cuttings from those plants may contribute genetic material to efforts to expand the number of wild plants. We concluded that the third category of plants, those cultivated for private or commercial uses, would not aid in the conservation or recovery of the species in the wild because some cultivated plants may be hybrids and bred for landscape (ornamental) use and thus offer minimal contribution to conservation. Therefore, Franciscan manzanita plants in this third category are not considered to be listed and are not considered in the assessment of the species status. (USFWS, 2019b).

Population Narrative:

Previously believed extinct in the wild, a single wild plant was discovered in 2009. "The plant's location was directly in the footprint of a roadway improvement project designed to upgrade the seismic and structural integrity of the south access to the Golden Gate Bridge" (Caltrans et al. 2009, Chasse et al. 2009, cited by USFWS 2011). In January 2010, the plant was moved successfully to a new site and monitoring reports indicate the plant is doing well (Yam 2010, Young 2010, cited by USFWS 2011). "The plant is considered to be wild because it has been moved to an undeveloped area of the Presidio that is managed as natural habitat. Although the plant is currently receiving care associated with its transplantation, it is not receiving the level of protection, water, and nutrients that plants in a botanical garden may receive." (USFWS 2011) (NatureServe, 2015). The species consists of a single wild plant (USFWS, 2013).

Threats and Stressors

Stressor: Habitat loss and modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: All areas of habitat originally known to be occupied by *Arctostaphylos franciscana* have been lost to urban development or to habitat conversion through the introduction of nonnative plant species (Chasse et al. 2009, pp. 4, 7; Chasse 2011c, p. 1). The loss of the plant's native serpentine chaparral habitat to development and the curtailment of its range restrict the species' current and future ability to naturally reproduce and expand its range. The threats of possible development and change in management of the habitat may further limit the species' propagation and expansion, and could potentially threaten the only remaining wild plant. Additionally, nitrogen deposition from automobile exhaust may modify habitat by increasing soil nutrients and increasing nonnative grass cover (Weiss and Luth 2003, p. 1), thus posing a threat to remnant habitat that might otherwise be suitable for *Arctostaphylos franciscana*. The entire northern San Francisco peninsula, with the exception of the Presidio and Golden Gate Park, has been urbanized, and four major highways (Highways 1, 101, 280, and 480) and other urban roadways dissect the peninsula (USFWS, 2013).

Stressor: Collection (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Overutilization of *Arctostaphylos franciscana* is possible due to its popularity for landscape use, as evidenced by the use of cultivars of this species in the commercial nursery trade. *Arctostaphylos franciscana* is specifically recommended for use in erosion control on steep slopes (Theodore Payne Foundation 2009, p. 1; Sierra Club 2011, p. 1). The attention and media coverage generated by the discovery of a species thought to be extirpated from the wild may result in efforts by the public to visit the plant and possibly collect cuttings or seed. Although nursery-grown *A. franciscana* are available to residents for use in private gardens, collection of the wild plant is a threat to the species, and the Service expects it may be a threat in the future, particularly if the location of the plant becomes known to the public (USFWS, 2013).

Stressor: Disease (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: A fungal infection called twig blight, usually caused by *Botryosphaeria* species in *Arctostaphylos*, is a potential concern for the *Arctostaphylos franciscana*, particularly during wet years (Service 2003, p. 69). Twig blight was observed in the wild plant during the winter of 2009–2010, but subsided during the dry summer months (Chasse 2010, p. 2). These pathogens could threaten *A. franciscana* because the wild population is limited to a single plant and infection by this group of fungi is one of the major factors leading to the decline of older *Arctostaphylos* sp. plants (Swiecki 2011, p. 1). *Arctostaphylos franciscana* is also threatened by various pathogens in the genus *Phytophthora*. An oak tree infected with sudden oak death disease was discovered on the Presidio in 2010 (Fimrite 2011). *Phytophthora ramorum*, the pathogen that causes sudden oak death, has so far been observed to cause only a foliar blight in species of *Arctostaphylos*, rather than the lethal bark cankers that occur on members of the black oak group (Swiecki 2012, p. 1). However, a related species, *P. cinnamomi*, has killed plants of another *Arctostaphylos* species, *A. pallida* (pallid manzanita), in the Oakland Hills of the East San Francisco Bay region and is expected to be a serious threat to *A. franciscana* (USFWS, 2013).

Stressor: Predation (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: After being transplanted, the wild plant became severely infested with the larvae of a native leaf roller moth (*Argyrotaenia franciscana*) (Estelle 2010, p. 1) which feeds on and pupates within rolled-up manzanita leaves. The moth has not been known to kill plants and does not appear to be a serious threat at this time; however, the moth species was found to have five overlapping generations in a year (Estelle 2010, p. 1). Damage to *Arctostaphylos franciscana* branches by California voles has been observed by Presidio Trust staff (Chasse 2011c, p. 2). Some branch dieback of *A. franciscana* has been attributed to gnawing by voles and other rodents (Chasse 2011c, p. 2) (USFWS, 2013).

Stressor: Climate change (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Summer fog is important to upland coastal vegetation and partly determines the distribution of coastal species (Johnstone and Dawson 2010, p. 4533). Besides serpentine soil and

cool air temperatures, (Parker 2010c, p. 1), summer fog is one of the primary habitat requirements for *Arctostaphylos franciscana* (Vasey 2010, p. 1). Reduced soil moisture from loss of summer fog may result in a reduction of seed germination and seedling survival. Additionally, the ability of *A. franciscana* to track future climate changes by establishing new plants in new habitat may be limited because of its association with serpentine and greenstone bedrock outcrops (Service 2003, pp. 95, 96) and because remaining soils derived from serpentine and greenstone bedrock on the peninsula are limited in area and largely fragmented (Chasse 2010, p. 1) (USFWS, 2013).

Stressor: Fire suppression (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: The fire return interval for the general area of *Arctostaphylos franciscana* is currently approximately 100 to 125 years (T. Parker pers. comm., 2011, Vasey 2011, p. 1). If fire continues to be excluded from these areas and the fire return interval greatly exceeds the natural return interval, the loss of fire over time may result in the loss of the mature plant and individual outplanted seedlings due to competition by plants, including nonnative plants, which could encroach upon the manzanita (USFWS, 2013).

Stressor: Trampling and vandalism (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Trampling by visitors could impact the wild plant, and its offspring, or any herbarium-raised plants that are restored to the wild, if they are placed in areas subject to regular foot traffic. The translocated wild plant has been planted in an active native plant management area that receives heavy public use; however, it is protected by a cable and post fence from public access and is monitored (Chasse et al. 2009, pp. 20–28). Trampling has also been found to cause considerable damage to mycorrhizal fungi in seedling roots (Waltert et al. 2002, p. 1). Most *Arctostaphylos* species form strong symbiotic associations with soil mycorrhizal fungi, which facilitate the uptake of water and nutrients (Chasse 2009, p. 12). Damage from trampling will not only impact the wild plant by reducing its ability to take up water and nutrients, but will also reduce the ability of any seedlings germinating near the wild plant to survive. The location of the *Arctostaphylos franciscana* plant within the Presidio is near common-use trails and an area that is available for rent for private and public events. Threats to *A. franciscana* include damage from vandalism and interested visitors (USFWS, 2013).

Stressor: Low genetic diversity (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Reduced genetic variation may result in the plant's offspring not being able to adapt to changes in habitat such as decrease in fog and increase in temperature or loss of pollinators. *Arctostaphylos franciscana* may be capable of self-pollination. In general, self-pollination results in a decrease in genetic variation in the offspring of a plant (Allendorf and Luikart, 2007, p. 123); therefore, a loss of genetic variation is expected if *A. franciscana* is dependent on self-pollination to produce seed (USFWS, 2013).

Stressor: Small population size (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Chance events constitute a serious threat to the species. Because the known population of *Arctostaphylos franciscana* in the wild is currently limited to a single plant, the species is extremely vulnerable to stochastic events—normal but damaging environmental perturbations and catastrophes such as droughts, storm damage, and fires, from which large, wide-ranging populations can generally recover, but which may lead to extirpation of small, isolated populations (Gilpin and Soule 1986, pp. 25–31). The wild plant is also threatened by the Allee effect, which is a decline in population growth rate due to declining plant density (Akçakaya et al. 1999, p. 86). For the wild plant, the Allee effect may result from a lack of other available *Arctostaphylos franciscana* plants with which to cross-pollinate and produce viable seed (USFWS, 2013).

Stressor: Hybridization (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: The cultivars of *Arctostaphylos franciscana* used in the commercial nursery trade are likely descended from some of the last wild *A. franciscana* plants known to exist in the 1940s. Since hybridization between diploid species of manzanita is well recognized (Chasse et al. 2009, p. 5), there is a good chance that many of these commercially available specimens have resulted from hybridization. Because of the threat of cross-pollination from hybrids or other species (Allendorf et al. 2001, pp. 613, 618–621), any propagation or reintroduction programs for *A. franciscana* must account for subsequent contamination and swamping of the *A. franciscana* gene pool (USFWS, 2013).

Stressor: Invasive native and non-native plants (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative:

Stressor: Water Stress, particularly to transplants (USFWS, 2019b)

Exposure:

Response:

Consequence:

Narrative: Currently, the plant appears to be unable to survive the dry summer months without regular irrigation. The cause of the water stress is not known but may be from a combination of factors including low rainfall during the last three years, possible root damage during excavation and transplanting in 2010, possible root damage from California vole (*Microtus californicus*) herbivory or from disease, or unsuitable soil at the transplant site. (USFWS, 2019b).

Stressor: Stochastic events (USFWS, 2019b)

Exposure:

Response:

Consequence:

Narrative: Because the known population of Franciscan manzanita in the wild is currently limited to a single plant, the species is extremely vulnerable to stochastic events—normal but damaging environmental perturbations and catastrophes such as droughts, storm damage, disease outbreaks, and fires, from which large, wide-ranging populations can generally recover, but which may lead to extirpation of small, isolated populations (Gilpin and Soule 1986, pp. 25–31). The majority of the remaining habitat associated with Franciscan manzanita occurs within rock outcrops on hilltops or slopes surrounded by development or along coastal cliffs. These areas, because of their limited size and proximity to developed areas, are more likely to experience inadvertent fire or environmental degradation (altered hydrologic regime; increased introduction of nonnative, invasive plants; and increased spread of disease). The nature of the habitat associated with Franciscan manzanita may also increase the effects of drought. These habitats generally do not have the water-holding capacity of deeper soiled, level habitats and may be more susceptible to landslides or erosion during excessively wet precipitation events. As a result, we consider stochastic events to be of significant threat for this species. (USFWS, 2019b).

Stressor: Cumulative Impacts (USFWS, 2019b).

Exposure:

Response:

Consequence:

Narrative:

Recovery**Reclassification Criteria:**

Downlisting Criterion A/1: At least three populations of mature Franciscan manzanita plants are established in suitable habitat within the historical range of the species using clones from the wild plant. All populations must exhibit signs of natural recruitment. For the purpose of recovery, a mature plant is defined as being 25 years of age or greater. (USFWS, 2019).

A/2: Additional populations of mature Franciscan manzanita plants are established in suitable habitat within the historical range of the species using clones of other genotypes located in botanical gardens. The source of the plants to be used is plants collected from Laurel Hill Cemetery in San Francisco and transplanted to botanical gardens in San Francisco. All populations must exhibit signs of natural recruitment. (USFWS, 2019).

A/3: Each population under A/1 and A/2 above should be comprised of at least 50-100 plants. (USFWS, 2019).

A/4: A multi-agency management team is established to develop and implement site-specific monitoring and management plans for Franciscan manzanita. Implementation of habitat management plans is expected to also ameliorate threats described under Factors B and E, such as altered fire regime, wildfire fuel reduction treatments, changes in environmental conditions resulting from climate change, vandalism, trampling, or removal of plant material by people visiting the Presidio, and water stress, thus resulting in improved habitat conditions for Franciscan manzanita. (USFWS, 2019).

B/1: No damage is observed during routine monitoring of the outplantings or the wild plant due to trampling, vandalism, and removal of cuttings or seeds in the pursuit of commercial, recreational, or scientific utilization. Appropriate removal of cuttings or seeds in accordance with a management plan approved by USFWS is allowed and should not be considered non-attainment of this criterion. (USFWS, 2019).

C/1: Negative effects to the cuttings, outplantings, and the wild plant from infestation by *Phytophthora* sp., *Botryosphaeria* sp. (twig blight), and other diseases must fall below a level at which a population viability analysis indicates that the diseases are negatively affecting long-term persistence. (USFWS, 2019).

E/1: Land managers, including the Presidio Trust, Golden Gate National Recreation Area, and the City and County of San Francisco, are committed, via the 2009 Memorandum of Understanding and the 2009 Conservation Plan to provide long-term vegetation control that will conserve resident Franciscan manzanita. Specifically, they will ensure that competing native and non-native vegetation is controlled to a level whereby the Franciscan manzanita plants are not shaded and their vigor is not negatively affected. Attainment of this criterion may require revision to the existing Memorandum of Understanding and the Conservation Plan. (USFWS, 2019).

E/2 Outcrossing (cross pollination) between wild plants and other genetically distinct individuals is accomplished. Planting of mixed groups will be performed within the historical range of the species and will include wild plants and other genetically distinct individuals planted in locations that are permanently protected and managed. (USFWS, 2019).

E/3 Planting methods have resulted in an increasing trend in the number of mature Franciscan manzanita over a 25-year period⁴ such that criterion A/3 (50-100 plants per population) is achieved. (USFWS, 2019).

E/4 Seed, representative of the breadth of the species' genetic diversity, is stored in a minimum of two Center for Plant Conservation-approved seed storage facilities. From each genet (seedling or clone), 1,500 seeds should be collected and banked, as long as seed collection does not result in adverse impacts to the wild plant or the established outplantings. This seed will be used for growing additional plants if the wild plant fails to survive, as well as for long-term conservation storage. (USFWS, 2019).

Delisting Criteria:

Establishment of several self-sustaining populations throughout its historical range, the San Francisco peninsula, in areas that contain appropriate habitat (USFWS, 2013).

Recovery Actions:

- Monitoring the wild plant in Spring of each year (2013-2024); continuing control of invasive vegetation around the plant; and collecting and storing seed in at least two locations (USFWS, 2013).
- Outplanting clones. Planting sites should be examined for pathogen infection prior to plant installation. Appropriate planting areas will be determined by *Arctostaphylos franciscana* experts in conjunction with GGNRA, Presidio Trust, and Golden Gate Parks Conservancy using the selection criteria developed for transplanting the wild plant as described in the

- Conservation Plan (Chasse et al. 2009, p. 18). As noted in the Conservation Plan (Chasse et al. 2009, p. 32), plants used for reintroduction of the wild plant and other genotypes of the species should be as close in lineage to the plants of origin as possible. Plants that have been grown in captivity for several generations may have been selected for different conditions than the outplanting site and, therefore, are unsuitable. Cuttings should be taken only from the wild plant or from clones of the original genotypes that are in botanical gardens (USFWS, 2013).
- Collecting pollen if distances between the wild plant and outplanted plants exceed pollinator range. Pollen will be used for long-term storage or immediate crosspollination (USFWS, 2013).
 - Protecting the wild plant and outplanted plants from threats including fire, vandalism, insect damage, and disease. Determine appropriate management (USFWS, 2013).
 - Updating and revising the Conservation Plan (USFWS, 2013).
 - 1. Establish new populations of Franciscan manzanita within the historic range of the species. (USFWS, 2019c) 1.1 Identify appropriate planting sites within the historic range of the species on the San Francisco peninsula. (Priority 1) Sites should be selected to include a gradient of factors including fog influence, slope, exposure, and soil moisture to maximize success. This gradient should be present among the various selected sites, but could also be present within a single site. Other factors that should be evaluated are included in the 2009 Conservation Plan (Chasse et al. 2009). Sites should have soils similar to historical sites, i.e. serpentine, greenstone, or chert. Soils should be nutrient poor (similar to historical sites) and have available water for irrigation during the first 5 years to ensure plant establishment through periods of drought. (USFWS, 2019c) Outplantings should not be placed in areas where cross pollination with ornamental manzanita cultivars is likely to occur, thus creating hybrid seed¹. Also, selecting sites isolated enough from other taxa that may harbor *Phytophthora* or other potential pathogens should be a priority. 1.2 Plant at least six populations of Franciscan manzanita within the historical range of the species from cuttings or layers taken from the wild plant. (Priority 1) Plants should be planted in areas where their eventual growth to 2 to 3 meters in diameter does not impact any rare species². Plants should be planted no closer than 3 m (10 ft) apart to avoid overlap of the plants³. (USFWS, 2019c). 1.3 Establish at least three populations of genetically distinct individuals in addition to the populations of clones of the wild plant. (Priority 1) Each population should consist of three representatives of each known genotype⁴. Sources of cuttings and layers should be plants currently in botanic gardens that were transplanted from Laurel Hill Cemetery in the 1940s and likely represent individuals that are genetically distinct from the wild plant. See Criterion A/3 for target population size. (USFWS, 2019c) 1.4 Ensure that all planting sites and cuttings or layers from the wild plant are free from infestation by *Phytophthora* sp. and other diseases at the time they are outplanted and that they are tested periodically for infestation thereafter. (Priority 1) Clean technique should be followed for growing plants in nurseries and for handling cuttings (Presidio Trust, in prep). Also, additional cuttings collected from the wild plant should be taken using the technique described in the 2009 Conservation Plan (Chasse et al 2009). (USFWS, 2019c). 1.5 Clones and seedlings should be planted within or adjacent to existing serpentine chaparral communities to facilitate pollination by insects and seed dispersal by mammals. (Priority 2) If serpentine chaparral community is not present, appropriate species [e.g., coast blue blossom (*Ceanothus thyrsiflorus*), coyote brush (*Baccharis pilularis*), toyon (*Heteromeles arbutifolia*), woolly sunflower (*Eriophyllum confertiflorum*), sticky monkeyflower (*Diplacus aurantiacus*), coast

- buckwheat (*Eriogonum latifolium*), and yarrow (*Achillea millefolium*)] should be planted. (USFWS, 2019c).
- 2. Protect, monitor, and manage outplanted populations and the wild plant. (USFWS, 2019c)
 - 2.1 Conduct quarterly demographic monitoring and watering for the cuttings and the wild plant, as needed. For new cuttings, monitoring and watering (if needed) should occur monthly or more often until cuttings are established. (Priority 1) (USFWS, 2019c).
 - 2.2 Conduct quarterly monitoring of invasive plants that compete with the cuttings and the wild plant for sunlight, water, and nutrients. (Priority 1) Hand removal of invasive plants should be conducted. Herbicide foliar spray should not be applied within 30 m (100 ft) of any Franciscan manzanita plant. Cut and paint methods of herbicide application should not be used within 3 m (10 ft) of any Franciscan manzanita plant to avoid damaging the plants. (USFWS, 2019c).
 - 2.3 Conduct quarterly monitoring for mammals and mammal trapping around the cuttings and the wild plant. (Priority 1) (USFWS, 2019c).
 - 2.4 Collect and accession Franciscan manzanita seed. (Priority 1) Seed should be collected according to guidelines established by Center for Plant Conservation (1991). Collect seed from the wild plant and its clones at multiple year intervals and store in at least two locations, including the USDA National Center for Genetic Resources Preservation in Fort Collins, CO. The locations should be approved by the U.S. Fish and Wildlife Service, National Park Service, and Presidio Trust. The seed will be used to propagate new plants if the wild plant(s) fails to survive, as well as for long-term conservation storage. Seed storage facilities must be affiliates of the Center for Plant Conservation. Eventually a goal of 1,500 stored seeds from each genet (seedling or clone) should be reached as long as seed collection does not result in adverse impacts to the wild plant or the established outplantings. (USFWS, 2019c).
 - 2.5 Collect pollen from the wild plant. (Priority 2) If the distance between plantings of genetically distinct individuals and the wild plant exceeds pollinator flight range, thereby limiting cross pollination, pollen should be collected either for immediate pollination or stored for long-term conservation use. Pollen should be stored at facilities with sufficient capability to maintain viability of the pollen. (USFWS, 2019c).
 - 2.6 Map all Franciscan manzanita plants and make available to all partners in Franciscan manzanita recovery. (Priority 3) A map should be created showing locations and origin of all Franciscan manzanita outplantings, including all cuttings, clones, and the wild plant so as to improve coordination between recovery partners on strategic habitat management and genetic management. This map should include those plantings performed at botanic gardens and universities and colleges, such as the University of California at Santa Cruz and University of San Francisco. (USFWS, 2019c).
 - 2.7 Record all data related to propagation, transplanting, watering, and plant death. (Priority 2) All data relative to collection of seeds and cuttings, accession of seeds, techniques of collection and propagation of seed and cuttings, and irrigation, should be recorded and made available to parties involved in establishment or management of Franciscan manzanita populations. Data should be used to adaptively modify management practices, as warranted. (USFWS, 2019c).
 - 3. Conduct research to determine the full range of the species and to guide outplanting and management efforts and establishment of a supportive chaparral community. (USFWS, 2019c).
 - 3.1 Conduct reconnaissance surveys to determine full range of species and additional opportunities for reintroduction. (USFWS, 2019c).
 - 3.1.1 Determine whether Franciscan manzanita is present in Marin or San Mateo Counties. (Priority 2) These Counties may provide the closest suitable habitat and similar climate conditions as those found in San Francisco County. (USFWS, 2019c).
 - 3.1.2 Determine whether suitable habitat for outplanting is present in Marin or San Mateo Counties. (Priority 2) These Counties may

provide the closest suitable habitat and similar climate conditions as those found in San Francisco County. (USFWS, 2019c). 3.2 Conduct genetic research. (USFWS, 2019c). 3.2.1 Determine genotypic variation between the wild plant and those in botanic gardens which originate from plants removed from Laurel Hill Cemetery in the 1940s. (Priority 1) (USFWS, 2019c). 3.2.2 Seedlings germinated from seeds of wild plants should undergo genetic analysis to determine the degree of heterozygosity (i.e., whether the seedlings are recombined offspring of the one plant or have unique characters from another plant) and to test for possible hybridization. This should be done 1 to 5 years after germination when the seedlings have reached sufficient size. (Priority 1) (USFWS, 2019c). 3.2.3 Determine the genotype of any newly discovered populations, including, in the future, rates of outcrossing and inbreeding. (Priority 2) (USFWS, 2019c). 3.2.4 Conduct research on the success of tissue culture if propagation material is limited or is infected with disease. (Priority 3) (USFWS, 2019c). 3.3 Research pollinator species diversity and long-term abundance trends at the wild plant and site of any introductions to determine if loss of pollinators threatens Franciscan manzanita. (Priority 2) (USFWS, 2019c). 3.4 Determine appropriate plant species to use in establishing a serpentine chaparral plant community for local restoration projects that will support native pollinators of Franciscan manzanita. Species should be selected that are found naturally on the San Francisco peninsula and provide a year-round source of pollen and nectar for pollinators known to visit the Franciscan manzanita. Taxa with high susceptibility to infection by *Phytophthora* species should be avoided. (Priority 3) (USFWS, 2019c). 3.5 Determine whether fungal associates (mycorrhizae) of the wild plant are necessary or beneficial for outplanting Franciscan manzanita plants and if found to be beneficial, incorporate during outplanting the addition of mycorrhizal species from close serpentine relatives, such as Raven's manzanita (*A. montana* subsp. *montana*). To avoid pathogen concerns, this should be done without the transfer of soil. (Priority 2) (USFWS, 2019c). 3.6 Conduct research into additional methods to discourage predators, such as California voles, from damaging Franciscan manzanita plants. (Priority 2) (USFWS, 2019c).

Conservation Measures and Best Management Practices:

- The single wild *Arctostaphylos franciscana* plant has been removed from its original location along Doyle Drive and transplanted to a secure, monitored location on the San Francisco Presidio. Critical habitat has been proposed (77 FR 54517), but has not been finalized at the time this document was completed (USFWS, 2013).
- Cuttings were taken by Golden Gate National Parks Conservancy from the wild plant and distributed among several botanical nurseries and one commercial nursery to generate plants for starting new populations. By distributing the cuttings to multiple nurseries, the risk of loss of all the cuttings to disease or other causes was lessened. Currently, over 300 rooted cuttings are available to be transplanted (USFWS, 2013).
- A study to develop a seed germination protocol for *Arctostaphylos franciscana* using a surrogate species, *A. montana* (Mount Tamalpais manzanita), is ongoing at the Golden Gate National Parks Conservancy Nursery in San Francisco. Seeds have been collected from the wild plant and germination will be attempted using the protocol (USFWS, 2013).
- A study to identify the primary pollinators of *A. franciscana* is being conducted at the Presidio by a Presidio Trust volunteer. Photographs of pollinators visiting the wild plant have been taken and will be identified. An infestation of the wild plant by leaf roller moths was discovered during regular monitoring by Presidio Trust staff and the moth larvae removed. Damage to the plant from California voles was also noted and the voles trapped and removed by Presidio Trust staff (USFWS, 2013).

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SPECIES ACCOUNT: *Arctostaphylos glandulosa* ssp. *crassifolia* (Del Mar manzanita)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/7/1996; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial burl-forming shrub; plant height ranges from 1 to 1.2 meters (3.3 to 4 feet) tall. It has thick, leathery leaves that are dark grey-green and a characteristic smooth red bark. It has clusters of urn-shaped flowers (white to pink). The twigs and young stems characteristically lack glandular hairs, but rather are either densely covered with short fine hairs or have scattered longer hairs. The leaves are dark grey-green, sometimes with a reddish margin. The flowers are small, urn-shaped, white to pink in color, and appear between late winter and early spring. Compared to other subspecies, the globose fruits are small and markedly depressed and the twigs lack glandular hairs. The fruits of *A. glandulosa* produce an average of six seeds embedded in a hard resinous endocarp surrounded by a pulpy pericarp (USFWS, 2010).

Taxonomy

A member of the Ericaceae (heath family). In a recent taxonomic treatment for the species *A. glandulosa*, a new, narrower distribution for *A. g.* subsp. *crassifolia* was proposed. Based on morphologic traits, researchers restricted the distribution to within 3, or possibly 6 miles (mi) (5 to 10 kilometers (km)) from the coast, from Encinitas in San Diego County, south to Baja California (Keeley et al. 2007, p. 57). Carlsbad was not included in this distribution because the research suggests that while some of the plants in Carlsbad are *A. g.* subsp. *crassifolia*, many are a different subspecies (*A. g.* subsp. *glandulosa*) and that these northern populations comprise a mixture of the two subspecies (Keeley et al. 2007, p. 57). Based on this new treatment, surveys for *A. g.* subsp. *crassifolia* by land managers at the Rancho La Costa Habitat Conservation Area in Carlsbad, yielded nine individuals in a population previously thought to be over 1000. The majority of the plants at this site are now considered *A. g.* subsp. *glandulosa* (CNLM, unpubl. data 2009) (USFWS, 2010). Also known as Eastwood's Manzanita (NatureServe, 2015).

Historical Range

Historically, *Arctostaphylos glandulosa* subsp. *crassifolia* was believed to be restricted to sandstone terraces and bluffs along the immediate coast in San Diego County, California, from Carlsbad south to Torrey Pines State Reserve (USFWS, 2010).

Current Range

Endemic to San Diego County, California and northwestern Baja California, Mexico (USFWS, 2010).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Vegetative, sexual (USFWS, 2010)

Breeding Season

Adult: December - April (NatureServe, 2015)

Key Resources Needed for Breeding

Adult: Insect pollinators, fire (USFWS, 2010)

Reproduction Narrative

Adult: Blooms December-April (NatureServe, 2015). The fruits of *A. glandulosa* produce an average of six seeds. The flowers of *Arctostaphylos glandulosa* are self-incompatible and are visited by flies, bees, and bee-flies (Keeley 1977, p. 821; Moldenke 1976, pp. 318-353). *Arctostaphylos glandulosa* seeds are dependent on fire to germinate. Typically, seedlings are only established in the first year after a fire (Keeley 1991, p. 96). *Arctostaphylos glandulosa* subsp. *crassifolia* plants are woody shrubs, which, when mature, can regenerate from burls (lignotubers) and from seeds. The burl at the base of the stem is covered with undeveloped branch buds. Typically, these buds will sprout after the stems are removed or damaged by fire or other means. Occasionally some of these buds will sprout in the absence of fire (Keeley 1992a, p. 1196) (USFWS, 2010).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Maritime chaparral (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Coastal fog (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: Occurs < 100 m elevation (NatureServe, 2015); canopy-forming vegetation - shade intolerant; generally occurs within 5 mi of the coast (USFWS, 2010)

Spatial Arrangements of the Population

Adult: Linear (inferred from USFWS, 2010)

Habitat Narrative

Adult: Sandstone terraces and bluffs at < 100 m elevation in low, fairly open southern maritime chaparral communities. (NatureServe, 2015). *A. glandulosa* is shade intolerant and can be replaced by taller stature species (Howard 1992, p. 5). Southern maritime chaparral can be described as a chamise-black sage chaparral that includes rare species such as *A. g.* subsp. *crassifolia* and is associated with coastal fog from Carlsbad south to Point Loma. It occurs on weathered sandstone soils including the Carlsbad series, Cesterton series, and Corralitos sandy loam. It can also be found on loamy alluvium, rough broken land, and terrace escarpments. Southern maritime chaparral is typically found within 5 mi (8 km) of the coast (USFWS, 2010).

Dispersal/Migration**Dispersal**

Adult: Low to moderate (USFWS, 2010)

Dispersal/Migration Narrative

Adult: There does not appear to be any specialized seed dispersal mechanism and the fruits generally fall close to the parent plant in late summer where they may be consumed by rodents (Keeley 1977, pp. 821-826). Some are eaten by foxes or coyotes and may be transported some distance away (Keeley 1977, p. 826; J. Keeley, U.S. Geological Survey, pers. comm. 2009) (USFWS, 2010).

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Low (inferred from NatureServe, 2015; see current range/distribution)

Redundancy:

High (inferred from USFWS, 2010)

Number of Populations:

50 (USFWS, 2010)

Population Narrative:

At listing there were 17 occurrences distributed from Carlsbad south to Torrey Pines State Reserve and east to Rancho Santa Fe, just south of the San Dieguito River, southwest of Lake Hodges. Currently, there are 50 known occurrences of *A. g. subsp. crassifolia* in the United States that are considered to be extant or presumed extant (USFWS, 2010).

Threats and Stressors

Stressor: Development (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: According to the listing rule, the majority of extant populations had been greatly reduced and significantly fragmented due to urban and agricultural development mostly prior to listing (USFWS 1996, p. 52378). The majority of these populations were distributed in highly fragmented habitat along the margins of residential development. At listing, four of the six largest populations were threatened by proposed or approved development projects. Since listing, completion of these projects resulted in an additional 35 percent being eliminated through direct impacts and 20 percent through indirect impacts to these four populations. In addition, several of the smaller populations were impacted by development (USFWS 1996, pp. 52377- 52378). Impacts of development are rangewide (USFWS, 2010).

Stressor: Fire management (USFWS, 2010).

Exposure:

Response:

Consequence:

Narrative: Fuel modification activities can result in the damaging or removal of plants and their habitats. In addition, these activities can increase the fragmentation of habitat and increase the rate and extent of introduction of nonnative species which could in turn increase both erosion and fire frequency, all of which pose threats to *A. g. subsp. crassifolia* (see discussion of nonnatives and altered fire regime below) (Longcore 2003, p. 116). Fire history data shows that the majority of *Arctostaphylos glandulosa subsp. crassifolia* occurrences (mainly located directly adjacent to residential development) have not burned in the last 100 years. Fire suppression activities may have prevented these areas from burning given their proximity to residential development, however, their proximity to residential development also puts them more at risk to be subjected to fire. Given this last assumption, the Service believes that fire suppression activities alone in the order of 100 years may not pose a threat to the habitat of *A. g. subsp. crassifolia*. However, more information is needed to determine what, if any, the impacts are of fire suppression in cycles greater than 100 years. Fires that occur too frequently may threaten the species because if resprouting plants are burned again before they are able to adequately replenish stores in the burls or sufficient seeds for their seed bank leaving the long term persistence of the plants in doubt. When fires are too frequent, nonnatives (especially grasses) can invade frequently burned areas and outcompete natives. In addition, they can modify the environment in their favor by creating a mass of highly flammable fuels which not only can extend the length of the fire season, but alter the types of fires that occur (USFWS, 2010).

Stressor: Invasive species (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Some invasive nonnative plants can become well established locally and may have profound impacts to the habitat. For example, land managers at the Rancho La Costa Habitat Conservation Area (EO 1) in the City of Carlsbad have noted a nonnative grass, *Ehrharta calycina*, as a serious problem for the reserve (Appendix 1). This grass is invasive, can cover the ground like a mat, and potentially increase the flammability of the area (J. Vinje, CNLM, pers. comm. 2009). According to the California Invasive Plant Inventory, *Ehrharta calycina* is considered to have a severe ecological impact on plant and animal communities and are considered to be severely invasive (Cal-IPC 2006, pp. 3-11). Another example is the presence of a woodland *Eucalyptus* spp. at San Dieguito County Park (EO 17). The canopy is relatively open over the *Arctostaphylos glandulosa subsp. crassifolia* occurrence but there is a layer of dead, high oil content leaves augmented by park personnel who spread additional leaf litter and wood chips from maintenance operations in the area (Luciani, pers. obs. 2009). If, and when a fire starts at this site, it will likely be intense enough to kill at least some of the burls. In addition, *Eucalyptus* spp. can have an allelopathic effect on other plants from the compounds found in its bark and leaf litter. These compounds have been shown to inhibit germination, seedling length, vigor, and nitrogen fixation of certain plant species (Sasikumar et al. 2001, pp. 135-137). Currently, nonnative species likely continue to be a threat to *A. g. subsp. crassifolia* and its habitat at most occurrences (USFWS, 2010).

Stressor: Residential development

Exposure:**Response:****Consequence:**

Narrative: Most *A. g. subsp. crassifolia* occurrences are directly adjacent to residential development. Use of these lands, whether or not public access is allowed, has proven to be problematic. For example, unwanted public use of lands supporting *A. g. subsp. crassifolia* have resulted in trail creation, disposal of green waste, dumping of trash, vandalism, and itinerant encampments on the Kelly Ranch and Rancho La Costa Preserves in the City of Carlsbad (CNLM 2008a, p. 22; CNML 2008b, p. 28). The Service has no evidence of direct impacts to *A. g. subsp. glandulosa* or its habitat; however, these activities generally lead to habitat degradation (USFWS, 2010).

Stressor: Small population size (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: Some of the occurrences of *Arctostaphylos glandulosa subsp. crassifolia* are potentially threatened by having a small population size. The listing rule estimated a 50 percent decline in the number of stands and individuals since 1982. In addition, the rule stated that over 75 percent of the remaining individuals occurred at 6 of the 25 locations. Four of those populations have been further reduced by development. At one occurrence (the portion of EO 1 at the Rancho La Costa Habitat Conservation Area) there are only nine individuals of *A. g. subsp. crassifolia*. A commonly accepted principal in conservation biology is that small populations have higher probabilities of extinction than larger populations. Populations with small numbers of individuals are more susceptible to genetic drift, losing variation more readily making them more prone to local extinction. In addition, species whose numbers have been significantly reduced due to habitat destruction may be more susceptible to genetic stresses imposed by small population size (Barrett and Kohn 1991, p. 7). Other factors that can make small populations more susceptible to extinctions than large populations are demographic stochasticity and naturally occurring events such as wildfires, floods, droughts, and disease (Shaffer 1981, p. 131). Because the majority of *A. g. subsp. crassifolia* occurrences are small, it is reasonable to consider these smaller populations at risk due to these effects of small population size (USFWS, 2010).

Stressor: Military training (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: Since listing, populations of *A. g. subsp. crassifolia* have been found on MCAS Miramar (EO 47, 50, 51, 52, 54, 55, and MCAS Miramar training areas). Potential threats to the plant on MCAS Miramar range from ground training activities including foot traffic, motor vehicle operations, combat engineering support operations, temporary encampments, and fixed or rotary wing aviation operations (MCAS Miramar 2006, p. 2-6). Impacts from these training activities can result in trampling and destruction of seedlings and plants. However, threats associated with these training activities are thought to be minimal and potentially offset by management considerations described in MCAS Miramar's INRMP (USFWS, 2010).

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:**Consequence:**

Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, p. 1; Cayan et al. 2006, pp. 1, 7-8; IPCC 2007, pp. 8-9). However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. One study has predicted that 5 to 10 percent of California's native plant species would no longer find suitable habitat within the state, and thus be vulnerable to extinction, if average temperatures warmed 5 to 6° F (2.7 to 3.3° C) (Morse et al. 1995, p. 393). Whether or not this would include *Arctostaphylos glandulosa* subsp. *crassifolia* is unknown (USFWS, 2010).

Recovery**Reclassification Criteria:**

Not available - this species does not have a final recovery plan.

Delisting Criteria:

Not available - this species does not have a final recovery plan.

Recovery Actions:

- Not available - this species does not have a final recovery plan.

Conservation Measures and Best Management Practices:

- Determine subspecific identity and densities of plants at occurrences peripheral to the core coastal portion of the range (USFWS, 2010).
- Assess the reproductive output of *Arctostaphylos glandulosa* subsp. *crassifolia* occurrences, including seed production and viability (USFWS, 2010).
- Determine causes and likely remedies for apparent low rate of establishment of new plants. This should include establishing the role of fire in the species biology and exploration of an acceptable alternative (USFWS, 2010).
- Evaluate the status of *Arctostaphylos glandulosa* subsp. *crassifolia* in Mexico (USFWS, 2010).

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5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Carlsbad Fish and Wildlife Office Carlsbad, California.

SPECIES ACCOUNT: *Arctostaphylos hookeri* var. *ravenii* (Presidio Manzanita)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/29/1979; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

Prostrate, shrub, dicot, Ericaceae (NatureServe, 2015). The plant's leathery, evergreen, round-elliptic to elliptic leaves are 1 to 2 centimeters (cm) (0.4 to 0.8 inches (in)) long, 1 to 1.5 cm (0.4 to 0.6 in) wide, and are isofacial (have the same type of surface and color on both sides) (Wells 1993, p. 552; Parker and Frey 2010, p. 6). The flowers are urn-shaped, with five-lobed white corollas 4 to 5 millimeters (mm) (0.25 in) long (Wells 1993, p. 552; Parker and Frey 2010, p. 9) (USFWS, 2012). The small, round fruit (a drupe) is 4 to 5 mm (0.16 to 0.20 in) in diameter with a dry, smooth surface (Parker and Frey 2010). (USFWS, 2019).

Taxonomy

USFWS list of Endangered and Threatened Wildlife and Plants (October 1996) lists *Arctostaphylos hookeri* var. *ravenii*. The second edition of The Jepson Manual (Baldwin et al. 2012) treats what have been accepted as *Arctostaphylos hookeri* ssp. *montana* and ssp. *ravenii* as subspecies of the separate species, *A. montana* (NatureServe, 2015).

Historical Range

Historically from San Francisco area; type from the Presidio in S.F. (NatureServe, 2015). All historic localities are recorded from the San Francisco peninsula; however, with the exception of the remaining Presidio occurrence, all other localities were extirpated before this plant was rediscovered in 1950 (California Natural Diversity Database (CNDDB 2011)) (USFWS, 2012).

Current Range

Single specimen persists at the Presidio, California (NatureServe, 2015).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Self-pollination, vegetative (clones) (USFWS, 2012); sexual (USFWS, 2003)

Breeding Season

Adult: February - March (USFWS, 2012)

Key Resources Needed for Breeding

Adult: Fire/disturbance (USFWS, 2012)

Reproduction Narrative

Adult: Flowers appear from February to March (California Native Plant Society (CNPS 2001, p. 77)) depending on rainfall and temperature patterns (Parker and Frey 2010, p. 9). The species is an obligate seeder and reproduces only from seeds that germinate following a fire or other disturbance (Parker and Frey 2010, p. 3). *Arctostaphylos montana* ssp. *ravenii* is capable of self-pollination (USFWS, 2012). Fruits contain 2 to 10 seeds. Raven's manzanita has been reported to be an obligate outcrosser (M. Parker, pers. comm. cited in McCarten 1986), a cross-fertilizing species unable to produce significant amounts of viable seed from self-pollination. There have been no reports of natural seedling establishment around the remnant wild Raven's manzanita or elsewhere since it was rediscovered in 1952. The absence of seedlings may be due to a lack of viable seed, seed predation, or lack of sufficient seedling microsites in the undisturbed vegetation around the single natural plant, or possibly other factors (USFWS, 2003).

Habitat Type

Adult: Terrestrial (USFWS, 2012)

Habitat Vegetation or Surface Water Classification

Adult: Maritime chaparral-coastal prairie (USFWS, 2012)

Dependencies on Specific Environmental Elements

Adult: Coastal fog (USFWS, 2012)

Geographic or Habitat Restraints or Barriers

Adult: Excessive competition/shading from other vegetation (USFWS, 2003)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 2003)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from USFWS, 2003)

Habitat Narrative

Adult: It is found in a maritime chaparral-coastal prairie community (Parker and Frey 2010, p. 14) which is influenced by summer coastal fog, humidity, and cool temperatures. It is found on serpentine soil. All *Arctostaphylos* species, including *A. montana* ssp. *ravenii*, are dependent on a mutualistic relationship with mycorrhizal fungi in the soil for nutrition in poor soils such as serpentine soils (Parker and Frey, 2010, p. 16). (USFWS, 2012). Generally, available data suggest that Raven's manzanita is a slow-growing, stress-tolerant evergreen shrub that is able to grow on serpentine soils with sparse competing vegetation, but like many manzanitas (Gottlieb 1968, Kruckeberg 1977), is relatively intolerant of competition (especially shading from shrub or tree canopies). It appears to have been locally abundant (Behr 1892) in relatively isolated, localized open serpentine outcrop colonies. (USFWS, 2003). It is found in a maritime chaparral-coastal prairie community (Parker and Frey 2010) which is influenced by summer coastal fog, humidity, and cool temperatures. (USFWS, 2019).

Dispersal/Migration**Dispersal**

Adult: Low to moderate (inferred from USFWS, 2012)

Dispersal/Migration Narrative

Adult: The seeds of *Arctostaphylos* species are dispersed primarily by mammals, including coyotes, foxes, and rodents (T. Parker pers. comm., 2011). Animals such as coyotes and foxes eat the *Arctostaphylos* fruit and may travel long distances before depositing their scat (USFWS, 2012).

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Very low (inferred from USFWS, 2012)

Representation:

Very low (inferred from USFWS, 2012)

Redundancy:

Very low (inferred from USFWS, 2012)

Number of Populations:

1 (USFWS, 2012)

Population Size:

1 (USFWS, 2012)

Adaptability:

Very low (inferred from USFWS, 2012)

Population Narrative:

The species is restricted to a single clonal colony. The population consists of one wild plant augmented by identical daughter clones (USFWS, 2012).

Threats and Stressors

Stressor: Competition (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Current threats from nonnative species are mostly from herbaceous plants such as the urban weed, *Oxalis pes-caprae* (Bermuda buttercup) (M. Chassé, in litt., July 5, 2011, p. 2). Introduced plants may also impact the habitat of *A. montana* ssp. *ravenii* by modifying the generally depauperate serpentine soils through nutrient enrichment and modifying the available soil moisture (Parker and Frey 2010, 16). Either of these changes could lead to the conversion of the plant community toward more competitive species and make the site less suitable to *A. montana* ssp. *ravenii* (Parker and Frey 2010, 16). Several native plants are having negative

impacts on the original wild plant and daughter clones. For example, areas of *Arctostaphylos montana* ssp. *ravenii* that are shaded by the leaves of *Chlorogalum pomeridianum* (soap-plant), have experienced dieback (Parker and Frey 2010, p. 26). Other native species that have caused dieback of *A. montana* ssp. *ravenii*, apparently from shading, include *Grindelia hirsutula* ssp. *maritima* (gumweed) and *Baccharis pilularis* (coyote brush). *Ceanothus thyrsiflorus* (blue blossom) is encroaching on many of the clones (M. Chassé, in litt., July 5, 2011, p. 2). Some invasive plant species can modify the composition of the soil microbial community to their advantage when they invade new soils (Callaway et al. 2004, p. 731); therefore, invasion by nonnative plants could impact *Arctostaphylos montana* ssp. *ravenii* by shifting the community composition of the mycorrhizal fungi away from those that benefit *A. montana* ssp. *ravenii* to those that benefit the invading species (Parker and Frey 2010, p. 16 (USFWS, 2012).

Stressor: Collection or vandalism (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Since the time of listing, no collection of cuttings or clones of the plant or vandalism of the plant has been observed (S. Estelle, in litt., October 4, 2011, p. 2; M. Chassé in litt., July 5, 2011, p. 2). The locations of the wild plant and its clones have not been revealed to the public by NPS in order to protect the plant from vandalism. No damage to the plant has been observed to date; however, trampling or the taking of cuttings could occur if the identification and location of the plants become known (USFWS, 2012).

Stressor: Disease (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Twig blight, a fungus that causes tissue death in leaves, has infected *Arctostaphylos montana* ssp. *ravenii* in years of frequent and late rains. A slow dieback of branches, especially on the original wild plant and the daughter clones surrounding it, has occurred over the past decade (M. Chassé, in litt., July 5, 2011, p. 2). The introduced soil-borne pathogen, *Phytophthora cinnamomi*, has long been known as a worldwide threat to commercial and ornamental plants. *P. cinnamomi* is a fungus-like organism most closely related to diatoms and kelp (Kingdom Stramenopilia) rather than to the true fungi (Kingdom Fungi or Eumycota). *Phytophthora cinnamomi* has been the cause of the decline and death of rare *Arctostaphylos* species, including *A. pallida* (pallid manzanita) in the Oakland Hills of the East San Francisco Bay region, and *A. myrtifolia* (lone manzanita) near Lone in the Sierra Nevada foothills, and of other woody native species in the San Francisco Bay area (Swiecki et al. in press, pp. 3 to 5). This organism causes root decay but can also kill above-ground portions of some plants (Swiecki et al. in press, p. 3). This pathogen poses a threat in the foreseeable future to *A. montana* ssp. *ravenii* through the potential for infestation by the public and by staff who work with the plant (USFWS, 2012).

Stressor: Loss of pollinators (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: The final listing rule notes that members of the genus *Arctostaphylos* are pollinated by large bees (e.g., *Bombus* (bumblebees) and *Anthophora* (mining bees)) and that native insect

populations have been seriously reduced in San Francisco. The final rule also notes that it is important to the recovery of *Arctostaphylos montana* ssp. *ravenii* to maintain healthy populations of pollinators in a natural state in the vicinity of the plant (USFWS, 2012).

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Although the specific effects of climate change on *Arctostaphylos montana* ssp. *ravenii* are unknown, the effects of increased winter flooding and drought conditions in the spring have the potential to adversely affect this species. In addition, it is not known how climate change will influence ocean currents and in turn affect the frequency of coastal summer fog which is an important element of the species' maritime chaparral habitat (USFWS, 2012).

Stressor: Seed predator removal (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Parker (2010, p. 1) found that 70 percent of the fruits buried by rodents were located deeper than 2 centimeters (cm) (0.78 in), which is the maximum soil depth at which seeds are typically killed by wildfire. This activity inadvertently protects the soil seedbank from destruction by wildfire. A small mammal eradication program in the Presidio could have long-term negative effects on *A. montana* ssp. *ravenii* by removing this protection from wildfire. Currently, however, there is no gopher control program in the immediate area around the original *A. montana* ssp. *ravenii* plant although gopher control does happen in irrigated turf areas nearby (M. Frey and S. Estelle, in litt., 2011, p. 2) (USFWS, 2012).

Stressor: Loss of genetic diversity (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: *Arctostaphylos montana* ssp. *ravenii* is capable of self-pollination. In general, self-pollination results in a decrease in genetic variation in the offspring of a plant (Allendorf and Luikart, 2007, p. 123); therefore, a loss of genetic variation is expected if *A. montana* ssp. *ravenii* is dependent on self-pollination to produce seed (USFWS, 2012).

Stressor: Small population size (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Because the known population of *Arctostaphylos montana* ssp. *ravenii* in the wild is currently limited to a single wild plant and its clones, the species is extremely vulnerable to stochastic events—normal but damaging environmental perturbations and catastrophes such as droughts, storm damage, and fires, from which large, wide-ranging populations can generally recover, but which may lead to extirpation of small, isolated populations (Gilpin and Soule 1986, pp. 25–31). The wild plant is also threatened by the Allee effect, which is a decline in population growth rate due to declining plant density (Akçakaya et al. 1999, p. 86). For the wild plant, the

Allee effect may result from a lack of other available *Arctostaphylos montana* ssp. *ravenii* plants with which to cross-pollinate and produce viable seed (USFWS, 2012).

Recovery

Reclassification Criteria:

1. The site of the original wild plant and all daughter clones established in the Presidio must be dedicated to permanent habitat protection, maintained, and protected in perpetuity (principally by removing nonnative vegetation). The original and daughter clones must exhibit significant net growth over a 10-year period, while the number of daughter clones must increase (USFWS, 2012). This remains a downlisting recovery criteria in 2019. (USFWS, 2019).
2. Multiple nursery populations of propagated *Arctostaphylos montana* ssp. *ravenii* must be established within the Golden Gate Natural Recreation Area (GGNRA) and at two or more botanical gardens that are committed to conservation of this species. Nursery populations must consist of both clones and seedling-grown plants. Seedling-grown plants must be derived at least from self-pollinated inbred lines (highest priority), but may include separate experimental breeding lines composed of recurrent backcrosses of selected *Arctostaphylos montana* (Tamalpais manzanita) individuals (and possibly *A. franciscana* or other *Arctostaphylos* taxa) on *A. montana* ssp. *ravenii* if production of inbred lines is not feasible, and if the strategy is recommended by a scientific review panel of manzanita experts, plant conservation geneticists, and others. The panel should develop a genetic management plan in cooperation with the Service before any hybridization. Genetic management of the species should be subject to expert peer review. Artificially bred stock should be maintained in both permanent outdoor collections for unrestricted growth (and future potential propagation stock), and in container-grown collections available for outplanting at restoration sites. The total cultivated population size must be maintained at 50 or more daughter clones (of original Presidio plant) at all times, with a goal of 50 seedling plants (preferably inbred, at least initially) that have at least two clonal replicates each (total 200 plants) (USFWS, 2012). This remains a downlisting recovery criteria in 2019. (USFWS, 2019).
3. At least five additional colonies, each comprising at least five daughter clones (with a goal of at least five inbred seedling-grown plants), must be established on relatively stable, exposed serpentine outcrops within or above the Presidio bluffs or in suitable inland outcrop areas, in areas where pre-existing vegetation is sparse, particularly on steep slopes. New colonies must exhibit net growth 5 years after transplanting with intensive maintenance (USFWS, 2012). This remains a downlisting recovery criteria in 2019. (USFWS, 2019).
4. Studies must be conducted to clarify the taxonomic relationships between *Arctostaphylos montana* ssp. *ravenii* and Monterey County species *Arctostaphylos hookeri* ssp. *hearstiorum* and ssp. *hookeri*, *A. montana* (Tamalpais manzanita), *A. uva-ursi* (bearberry), and *A. franciscana*, and other relevant taxa. The breeding systems of these taxa including comparisons of fruit set and seed viability resulting from within-species crosses and self-pollination, should also be studied. An especially high priority is to experimentally determine the level of self-compatibility (level of viable seed production resulting from self-pollination) in the one remaining wild *A. montana* ssp. *ravenii* (USFWS, 2012). This remains a downlisting recovery criteria in 2019. (USFWS, 2019).

5. At least five spontaneously reproducing variable populations are established in reserves on bedrock outcrops outside the Presidio in San Francisco, at least three of which must be on serpentine outcrops (USFWS, 2012). This remains a downlisting recovery criteria in 2019. (USFWS, 2019).

6. At least two sexually reproduced generations are established within the Presidio (USFWS, 2012). This remains a downlisting recovery criteria in 2019. (USFWS, 2019).

7. At all sites, population size and individual clone size increase over a period of 30 years (USFWS, 2012). This remains a downlisting recovery criteria in 2019. (USFWS, 2019).

8. If feasible, at least one generation of spontaneously established inbred (not experimental hybrid backcross) seedlings of *Arctostaphylos montana* ssp. *ravenii* must grow to reproductive maturity in at least one colony out of five new Presidio bluff subpopulations within 30 years after establishment. Over 50 percent of plants within all five colonies must exhibit progressive and significant net growth over 20 years (USFWS, 2012).

9. At least five mixed populations (*A. montana* ssp. *ravenii* and *A. franciscana*) consisting of original clones and cloned seedlings (preferably inbred lines, if they are feasible and found to be suitable for reintroduction to novel reintroduction sites) must be established at separate interior San Francisco serpentine outcrop sites. Over 50 percent of founder plants at each new population must exhibit net growth in size over a 10-year period. At least one generation of spontaneously recruited seedlings of *A. montana* ssp. *ravenii* must establish within 25 years in at least one interior site. Significant recurrent production of viable seed must be in evidence at all five sites. All reintroduction sites must be permanently maintained to prevent reinvasion by competing nonnative vegetation, degeneration from recreational misuse, or unforeseen threats that require adaptive management (USFWS, 2012).

10. Horticultural propagation of *Arctostaphylos montana* ssp. *ravenii* (also interim recovery criteria) must be dedicated in perpetuity at no fewer than four botanical gardens in California. Multiple independent garden collections in different California coastal regions reduce the chance that region-wide catastrophic events (e.g., virulent new pathogens, extreme rainfall) could cause general loss from cultivation. Propagation and cultivation of *A. montana* ssp. *ravenii* for other specific educational, scientific or outreach efforts in support of recovery actions recommended in this plan may be needed on a case-by-case basis for recovery implementation, but such propagation and cultivation are not treated as recovery criteria (USFWS, 2012).

Delisting Criteria:

Delisting Criterion A/1: Establishment and Protection of New Presidio Populations.

Establishment of five new populations¹ of Raven's manzanita in the Presidio. The new populations must be established on relatively stable, exposed serpentine or greenstone outcrops within or above the Presidio bluffs or in suitable inland outcrop areas, in areas where pre-existing vegetation is sparse, particularly on steep slopes. (USFWS, 2019).

A/2 Establishment and Protection of New Interior Populations. At least five mixed populations¹ of Raven's and Franciscan manzanita consisting of original clones and cloned seedlings (preferably inbred lines, if they are feasible and found to be suitable for reintroduction to novel reintroduction sites) must be established at separate interior San Francisco serpentine or

greenstone outcrop sites². All reintroduction sites must be permanently protected, and the perpetuation of suitable habitat must be ensured. (USFWS, 2019).

C/1 Effects of pathogens. Negative effects to the populations from infestation by *Phytophthora* spp., *Botryosphaeria* spp., and other pathogens are below a level at which a population viability analysis indicates that the pathogens are negatively affecting long-term persistence. (USFWS, 2019).

E/1 Reproduction and Growth in the New Presidio Bluff Populations. Each new population from A/1 will consist of at least 50 plants. Over 50 percent of the plants within all five populations must exhibit progressive and significant net growth (see Appendix IV) until maturity. All populations must exhibit signs of natural recruitment. For the purpose of recovery, a mature plant is defined as being 25 years of age or greater. (USFWS, 2019).

E/2 Reproduction and Growth in the New Interior Populations. Each new population from A/2 will consist of at least 50 plants. Over 50 percent of the founder plants at each new population must exhibit net growth in size over a 10-year period. All populations must exhibit signs of natural recruitment, and the significant recurrent production of viable seed must be evident. For the purpose of recovery, a mature plant is defined as being 25 years of age or greater. (USFWS, 2019).

E/3 Permanent Reserve Cultivated Populations in Botanical Gardens. Horticultural propagation of Raven's manzanita (also Downlisting Criteria 2) must be dedicated in perpetuity in at least one botanical garden in no fewer than two California coastal regions. (USFWS, 2019).

Recovery Actions:

- Protect and restore a series of ecological urban wildland reserves (USFWS, 2003).
- Promote population increases of target species within urban wildland reserves and reintroduce target species to restored habitat (USFWS, 2003).
- Long-term removal (local eradication) or suppression of invasive, nonnative vegetation within and around all reserves and subsequent reestablishment of native communities compatible with endangered species within the ecological reserves (USFWS, 2003).

Conservation Measures and Best Management Practices:

- Increase the number of potentially different genetic *A. montana* ssp. *ravenii* individuals using seed from the seedbank beneath the wild plant (USFWS, 2012).
- Understand the phenology and pollinator ecology for the community that contains *A. montana* ssp. *Ravenii* (USFWS, 2012).
- Develop techniques to ensure outplanting success (USFWS, 2012).

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5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Sacramento Fish and Wildlife Office Sacramento, California.

SPECIES ACCOUNT: *Arctostaphylos morroensis* (Morro manzanita)

Species Taxonomic and Listing Information

Listing Status: Threatened; 1/17/1995; Pacific Southwest (R8)

Physical Description

This shrub reaches a height of 1.5 to 4.0 meters (5 to 13 feet) and has crowded oblong to ovate grey-green to olive-green leaves, 2.5 to 4.0 centimeters (1 to 1.5 inches) long, with petioles 2 to 6 millimeters (0.08 to 0.20 inch) long. The white to pinkish flowers are 5 to 8 millimeters (0.2 to 0.3 inch) long, and form orange-brown fruits 8 to 13 millimeters (0.3 to 0.5 inch) in diameter with 8 to 10 stones per fruit that are fused but separable. The bark of the trunk is a shaggy grey to brown; the leaf blades range from wedge-shaped (cuneate) to rounded or nearly straight (truncate) at the base, with the lower surface paler and usually somewhat tomentose (short woolly hairs). Occasional specimens have small projecting lobes at bases of the leaf blades and a short leafstalk or none at all (USFWS, 1998).

Taxonomy

Member of the heath (Ericaceae) family. Morro manzanita (*Arctostaphylos morroensis*) (Figure 3) was first described by Albert E. Wieslander and Beryl O. Schreiber in 1939 (Wieslander and Schreiber 1939) based on a specimen collected in Hazard Canyon, south of Morro Bay, which is now within the boundaries of Montaña de Oro State Park. The species has continued to be recognized by McMinn (1939), Abrams (1944), Munz (1959), Hoover (1970), and Wells (1993) (USFWS, 1998).

Historical Range

Endemic to San Luis Obispo County, California. The distribution of *A. morroensis* is correlated with the distribution of Baywood fine sands. Based on the distribution of these sands, the historical distribution of *A. morroensis* is estimated to have comprised between 2,000 and 2,700 acres (809 and 1,092 hectares (ha)) (USFWS, 2013).

Current Range

Arctostaphylos morroensis ranges from the northeast side of Morro Bay to the southern end of Montaña de Oro State Park, a distance of less than 10 miles (16.1 kilometers) (USFWS, 2013).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 2013)

Lifespan

Adult: 47+ years (USFWS, 1998)

Dependency on Other Individuals or Species

Adult: *Bombus vosnesenskii* (USFWS, 2013)

Breeding Season

Adult: Winter (USFWS, 2013)

Key Resources Needed for Breeding

Adult: Insect pollinators, > 40 year fire intervals (USFWS, 2013)

Reproduction Narrative

Adult: *Arctostaphylos morroensis* flowers in the winter, with fruit maturation and seed dispersal occurring in the fall. Unlike other species of manzanita, *A. morroensis* is an obligate seeder, lacking a woody burl from which it can resprout post-fire. Fruits contain 8 to 10 seeds each. Although it is unknown whether the flowers are self-compatible, extensive research revealed that pollination is required for reproduction. In 1998 and 1999, Tyler and Odion found that bumblebees (*Bombus vosnesenskii*) are the dominant pollinators, though anthophorid bees (*Anthophora urbana*), several bee flies (*Bombylius* spp.), and syrphid flies (family Syrphidae) are also known pollinators. The authors also noted surprisingly low pollinator activity for both years surveyed (Tyler et al. 1998 and 2000). Only 10 percent of flowers examined in 1998 produced fruits. For *Arctostaphylos morroensis* and other obligate-seeding species of manzanita, maintenance and regeneration are dependent upon mass germination triggered by fire (Tyler and Odion 1996). Fire breaks seed dormancy and also creates open areas where seedlings can germinate and individuals establish. Due to very low seed viability in *Arctostaphylos morroensis*, in combination with high seed mortality in response to fire, Tyler and Odion (1996) suggest that stands burned at cycles greater than 40 years would have sufficient time to accumulate an adequate seed bank (USFWS, 2013). Morro manzanita is a long-lived shrub; studies of stand age based on trunk ring counts and aerial photos of previous disturbance events, including fire and possibly clearing, indicate that the youngest intact stands are some of those south of Highland Drive, which are about 37 years old. Stands west of Pecho Drive are about 47 years old. The remainder are older than 47 years, with stands in the Elfin forest estimated to be the oldest (Tyler and Odion 1996) (USFWS, 1998).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Coastal dune scrub, maritime chaparral, coast live oak woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Periodic fire (USFWS, 2013; see reproduction narrative)

Geographic or Habitat Restraints or Barriers

Adult: Occurs < 200 m elevation (NatureServe, 2015); closed-canopy (USFWS, 2013)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2013)

Habitat Narrative

Adult: Inhabits soils derived from ancient sand dunes. Found in nearly pure stands on steep slopes, especially on north exposures. On low-moderate slopes, found in association with coastal dune scrub, maritime chaparral, and coast live oak woodland communities; < 200 m elevation. (NatureServe, 2015). Development of climax, closed-canopy chaparral stands has an adverse effect on populations of *A. morroensis* by precluding expansion into otherwise suitable habitat. *Arctostaphylos morroensis* is primarily found on Baywood fine sand soils (ancient wind-blown beach sands), though small stands have also been documented on Santa Lucia shaley clay loam (Soil Conservation Service 1958, McGraw 2005) (USFWS, 2013).

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 2013)

Dispersal/Migration Narrative

Adult: Birds and large mammals (coyote (*Canis latrans*) and mule deer (*Odocoileus hemionus*)) are thought to aid *Arctostaphylos morroensis* in seed dispersal (Keeley and Hays 1976). This secondary dispersal (which occurs after the parent plant initially sets seed) is limited, however, as evidenced by 90 percent fewer seeds present in soil cores 5 feet (1.5 meters) away from *A. morroensis* compared to samples taken from beneath the canopy (Tyler and Odion 1996) (USFWS, 2013).

Population Information and Trends

Population Trends:

Not available

Species Trends:

Stable (inferred from USFWS, 2013)

Resiliency:

Very low (inferred from USFWS, 2013; see current range/distribution)

Representation:

Low (inferred from USFWS, 2013)

Redundancy:

Moderate (inferred from NatureServe, 2015)

Number of Populations:

18 (NatureServe, 2015); Unknown (USFWS, 2013)

Population Size:

Currently unknown; previously 86,500 - 153,000 (USFWS, 2013)

Adaptability:

Low (inferred from USFWS, 2013)

Population Narrative:

It is unknown precisely how many populations occur across the range of the species. LSA estimated approximately 153,000 *Arctostaphylos morroensis* plants occurred across the species' range at the time of listing. McGuire and Morey produced a lower estimate than LSA (using a 15-foot diameter per individual), estimating that the total species population would be closer to 86,500 individuals (McGuire and Morey 1992). An accurate estimate of *Arctostaphylos morroensis* abundance throughout its range was unavailable at the time of the 5 year review. Tyler and Odion (1996) hypothesized that the low viability may be due to inbreeding as a consequence of small effective population sizes. The current status of *Arctostaphylos morroensis* is not markedly different than what was summarized in the final listing rule published in 1994, the final recovery plan completed in 1998, or the most recent 5-year review, released in 2008 (USFWS, 2013). There are 18 occurrences (NatureServe, 2015)

Threats and Stressors

Stressor: Habitat destruction and alteration (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Areas of habitat with high cover of *Arctostaphylos morroensis* are still at risk on private lands that could be developed in the future. For example, in 2010, a privately owned parcel containing this species in Cabrillo Estates was developed for a private residence. The spread of nonnative species, particularly veldt grass, has altered the composition of the plant communities associated with *Arctostaphylos morroensis* habitat. This in turn is likely altering the fire cycle, potentially increasing the frequency of fires, and decreasing the viability of existing seed banks. the acquisition of lands reduces the threat of destruction of habitat from development. However, the continued spread of nonnative species throughout *Arctostaphylos morroensis*' range and the fire cycle needs particular to the species (discussed below in Factor E) necessitate land management that is not currently in place; alteration of habitat from nonnative species is increasing (USFWS, 2013).

Stressor: Altered fire cycles (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Land managers have not planned any prescribed burns for *Arctostaphylos morroensis* habitat. The U.S. Army Corps of Engineers burned and cleared shrubs in Montaña de Oro State Park in 1958; however, the Service has no knowledge or evidence of prior burns (Odion and Tyler 2003). Montaña de Oro State Park performs controlled burns as needed and when possible, but burning *A. morroensis* habitat is inhibited by the nature of the landscape. The fuel requirements, steepness of the slopes, limited accessibility, and proximity to residential areas make a prescribed burn for *A. morroensis* difficult to perform (V. Cicero, California State Parks, in litt. 2012)). The most recent wildfire within the State Park occurred in 1997, but did not burn *A. morroensis* stands. Wildfires for this maritime chaparral habitat are estimated to occur about every 50 to 200 years (Cicero in litt. 2012). For these reasons, the limited ability to manage fire cycles hinders efforts to reduce the threat of altered fire cycles to *A. morroensis* (USFWS, 2013).

Stressor: Invasive species (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: The nonnative veldt grass (*Ehrharta calycina*) has spread to the Los Osos and Morro Bay region. This species has not only invaded disturbed areas, such as vacant lots, road cuts, and utility corridors, but is becoming naturalized in native plant communities, including conserved lands owned and/or managed by the CDFW and CDPR for *Arctostaphylos morroensis* (J. Vanderwier, U.S. Fish and Wildlife Service, pers. obs., 2006). Members and volunteers associated with Small Wilderness Area Preservation use manual removal to fight veldt grass in the Elfin Forest and continue to make progress (Sarafian 2011). Although veldt grass more likely competes for resources with herbaceous species than with established perennials, its presence may also increase the frequency and risk of fire that would negatively affect *A. morroensis* by reducing the abundance and viability of its seed bank. Veldt grass is not currently invading established *A. morroensis* stands in Montaña de Oro State Park, although it may prevent recruitment in areas where it has already invaded the habitat (Cicero in litt. 2012). In the final listing rule, the Service recognized that stands of *Arctostaphylos morroensis* in Montaña de Oro State Park were being overtopped by spreading eucalyptus (*Eucalyptus* spp.) planted in the early 1900s. The Service noted that *A. morroensis* is not able to survive such encroachment due to reduction in available soil moisture, increased shading, and the effects of growth-inhibiting terpenes that are released from eucalyptus (California Invasive Plant Council 2006-2011). Although the general plan for Montaña de Oro State Park calls for the removal of exotic species, including eucalyptus, this program has only been partially implemented. In past years, eucalyptus removal efforts generally focused on removing seedlings from outside the bounds of the original groves and not specifically from habitat that supports *A. morroensis* (Service 1998). Recently, efforts to control eucalyptus have been undertaken and have been successful in preventing further recruitment. However, fluctuations in the park's budget in coming years may hinder these efforts; therefore, the Service still considers competition with eucalyptus to be a threat (Cicero in litt. 2012). Other invasives not mentioned at the time of listing, including narrow-leafed iceplant (*Conicosia pugioniformis*), are encroaching upon Elfin Forest populations of *Arctostaphylos morroensis*. Bridal creeper (*Asparagus asparagoides*) is also posing a threat in the Elfin Forest (USFWS, 2013).

Stressor: Climate change (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, Intergovernmental Panel on Climate Change 2007). *Arctostaphylos morroensis*' small and isolated range increases its vulnerability to random fluctuations in annual weather patterns and environmental disturbances such as those that may result from climate change. Recently, Loarie et al. (2008) discussed the potential impacts of climate change on the flora of California. Based on climate modeling, they predicted that species' distributions will shift in response to climate change and that species will "move" to higher elevations and northward, depending on the ability of each species to do so. Broadly, indirect ecological impacts caused by fog and variation in humidity could alter pollinator activity, soil moisture, and phenology of the species. In general, the scientific community lacks adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors such as limited geographical distribution, will affect federally

listed species. Small-ranged species, such as *A. morroensis*, are more vulnerable to extinction due to these changing conditions (Loarie et al. 2008) (USFWS, 2013).

Recovery

Reclassification Criteria:

Not applicable.

Delisting Criteria:

1. Ninety percent of existing acreage supporting high (75-100 percent) and medium (25-75 percent) cover of Morro manzanita and 85-90 percent of low (1-24 percent) cover supporting Morro manzanita are secured from human-induced threats in preserves in the Northeast Los Osos, South Los Osos and West Pecho Conservation Planning Areas with no greater fragmentation by roads, residences, or other areas of human use than currently exists. (USFWS, 1998)
2. Evidence that the acreage and approximate cover classes of Morro manzanita in preserves can be maintained over time and that preserves are not made unmanageable by small size, proximity to urban development, or fragmentation. (USFWS, 1998)
3. Site-specific management plans have been successfully implemented for the preserves. Because habitat in the Conservation Planning Areas must remain unfragmented to recover this species, habitat attrition must be restricted to isolated or remnant patches of Morro manzanita that are unlikely to be viable over the long term. Highest priority for securing sites should be given to stands where Morro manzanita is the dominant in terms of cover, where large blocks of occupied habitat are still present, and where Morro manzanita habitat can be secured that abuts other protected lands, as in the South Los Osos Conservation Planning Area. (USFWS, 1998)

Recovery Actions:

- Secure populations and habitat on unprotected lands. Methods for securing lands include in-fee purchase, gifts of easement or fee interest by the property owner, deed restrictions (provided restrictions cannot be changed privately without the knowledge of Federal, State and County agencies), acquisition of property rights (e.g., development rights) or permanent conservation easements. (USFWS, 1998)
- Manage secured lands to control or eliminate other known threats. Although habitat alteration through development is currently the most substantial and irreversible threat facing all of the species in this plan, the management of lands secured from development will remain a formidable task, made more so in those cases where the secured habitats are adjacent to high density residential and urban development. (USFWS, 1998)
- Evaluate potential threats and conduct management-oriented research. Conduct habitat-oriented research for Morro Bay species. Conduct species-specific research. Evaluate research results and use in future management. (USFWS, 1998)
- Determine population dynamics and effects of recovery efforts. Studies should be conducted to learn the number and size of successful self sustaining populations for the species to establish criteria for its reclassification. (USFWS, 1998)

- Develop and implement an education/information program. The benefits of protecting native species and their habitats and maintaining native biological communities should be explained clearly to all concerned parties. (USFWS, 1998)
- Reevaluate recovery criteria and revise recovery plan based on expanded knowledge from research, monitoring, and management. The scientific validity of the recovery criteria and recovery plan should be reviewed and revised as more information becomes available. The criterion of maintaining sufficient numbers of populations or conservation areas should be assessed, and the success or failure of management actions should be evaluated. (USFWS, 1998)
- Recommendation from 2013 5-Year Review: 1. Additional lands with high densities of *Arctostaphylos morroensis* should be secured from the threat of development in Northeast Los Osos, West Pecho, and South Los Osos conservation planning areas. (USFWS, 2013)
- Recommendation from 2013 5-Year Review: 2. All secured lands should be managed to ensure ecosystem function. Active management is needed to maintain and enhance populations of *Arctostaphylos morroensis*; therefore, the development and implementation of management plans that identify specific actions for the species are critical to its recovery. At a minimum, these plans need to address: (a) regeneration requirements for the species; and (b) an assessment of the extent of the threat of competition from nonnative invasive plant species. The Service should work with CDPR, CDFW, and other relevant partners to encourage the development and implementation of these management plans. (USFWS, 2013)
- Recommendation from 2013 5-Year Review: 3. Ensure that management actions are implemented and ongoing by securing and using funding sources. Engage partners (State Parks and/or the County of San Luis Obispo) in an effort to work with them toward the common goal of securing the long-term persistence of *Arctostaphylos morroensis*.

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SPECIES ACCOUNT: *Arctostaphylos myrtifolia* (lone manzanita)

Species Taxonomic and Listing Information

Listing Status: Threatened: listed in 1999 (64 FR 28403)

Physical Description

lone manzanita is an evergreen shrub of the heath family (Ericaceae). Reaching a height of generally less than about 4 feet (1.2 meters) and commonly only 2 feet (0.6 meter) tall, plants appear low and spreading. Its bark is red, smooth, and waxy. Olive-green leaves are small 1/4 to 1/2 inch (0.6 to 1.3 centimeters), oval in shape, pointed at the tip, and often pointed at the base as well. The white to pinkish urn-shaped flowers are also small, averaging 1/8 inch (0.3 centimeters) across, and appear from January to February. Its small, rounded, greenish fruits are 1/8 inch (0.3 centimeters) long and 1/16 inch (0.15 centimeter) wide. This manzanita species lacks a basal burl (a basal burl is a swelling at the junction of roots and stems that allows many chaparral shrub species to sprout from the base, and vegetatively regenerate after a fire). After a fire, lone manzanita must regenerate from seed. lone manzanita can be distinguished from other species in the same genus by its smaller stature and the color of its leaves (NatureServe 2014; USFWS 2009; USFWS 2010).

Historical Range

lone manzanita occurs throughout all of its presumed historical range in Amador County, though many populations have been reduced in size due to mining, road construction, development, and diseases. The distribution of lone manzanita was believed to extend as far east as the Town of San Andreas in Calaveras County. However, efforts to locate and identify the San Andreas populations of lone manzanita have not been successful. Because of the discontinuous nature of the lone Formation on which it grows, lone manzanita was always patchily distributed with other chaparral and oak forest types (USFWS 2010; NatureServe 2014).

Current Range

lone manzanita occurs in about 100 individual stands, which cover a total of about 1,000 acres (4 square kilometers). It is narrowly endemic to a habitat found only in the central Sierra Nevada foothills of California. At the time of listing, lone manzanita was known from 17 occurrences covering approximately 1,000 acres (4 square kilometers); currently, the Calflora Occurrence Database (Calflora 2014) contains 94 records for lone manzanita from Amador and Calaveras Counties, and the CNDDDB (2014) recognizes 15 occurrences for this species. Most of the occurrences are on private lands. One occurrence on U.S. Bureau of Land Management (BLM) land is within the lone Manzanita Area of Critical Environmental Concern. Two additional occurrences are partially on BLM lands. Four small, pure (containing only lone manzanita) populations and several smaller, mixed populations also occur on the State-owned Apricum Hill Ecological Reserve managed, by the California Department of Fish and Wildlife (USFWS 2010; CNDDDB 2014; NatureServe 2014).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources**Food Source**

Adult: sunlight

Food/Nutrient Narrative

Adult: This species is a plant that acquires its energy from sunlight via photosynthesis.

Reproductive Strategy

Adult: Flowering plant

Lifespan

Adult: unknown

Dependency on Other Individuals or Species

Adult: unknown

Breeding Season

Adult: January and February (Calflora 2014; CNPS 2014).

Key Resources Needed for Breeding

Adult: unknown

Reproduction Narrative

Adult: Flowering occurs from mid-January to early March and fruits are fully developed by late spring or early summer (Gankin and Major 1964, p. 796). *Arctostaphylos myrtifolia* is an obligate seeder that can be killed by fire and therefore depends entirely on seeds stored in the soil or dispersed to the site for stand regeneration (Gankin and Major 1964, p. 795).

Habitat Type

Adult: barrens, shrubland/chaparral

Dependencies on Specific Environmental Elements

Adult: 190 to 1,900 feet (60 to 580 meters) (CNPS 2014) with soils that are highly acidic, and high levels of aluminum

Geographic or Habitat Restraints or Barriers

Adult: restricted to lone Formation

Spatial Arrangements of the Population

Adult: clumped according to suitable resources

Environmental Specificity

Adult: special habitat requirements, but not special feeding requirements

Tolerance Ranges/Thresholds

Adult: low

Site Fidelity

Adult: high; plants do not move once they become established

Habitat Narrative

Adult: lone manzanita occurs on outcrops of the lone Formation (a remnant Eocene, hard white sandstone formation) in an area of about 22,500 acres (91 square kilometers) in Amador County. A few separate populations occur in Calaveras County. The populations range in elevation from 190 to 1,900 feet (60 to 580 meters) (CNPS 2014), with the largest populations occurring at elevations between 295 and 900 feet (90 and 275 meters) (USFWS 2009; USFWS 2010). lone manzanita is mostly confined to the unusual soils of the lone formation. These soils are highly acidic, and contain high levels of aluminum. This soil environment is extremely hostile to the growth of most plants (aluminum in high concentrations can be toxic to plants). Organic matter and nutrient availability is low. lone manzanita only occupies sites where the extreme conditions described above persist. It commonly grows in pure stands; at the edge of these stands, there may be a transition zone where lone manzanita and whiteleaf manzanita coexist. It also occurs in transitional zones with surrounding taller chaparral types, but it does not persist if it is shaded (USFWS 2009; USFWS 2010; NatureServe 2014). Some manzanita species have basal burls that can resprout after a fire burns the canopy; lone manzanita does not have a burl. It is an obligate seeder that can be killed by fire. It depends entirely on seeds stored in the soil or dispersed to the site; seed germination may be promoted by periodic fire (USFWS 2010).

Dispersal/Migration**Motility/Mobility**

Adult: not mobile

Dispersal

Adult: unknown

Dependency on Other Individuals or Species for Dispersal

Adult: unknown

Dispersal/Migration Narrative

Adult: There is not much information available regarding the dispersal of this species

Population Information and Trends**Population Trends:**

Unknown

Species Trends:

Declining

Resiliency:

low

Representation:

low

Redundancy:

low

Population Growth Rate:

unknown

Number of Populations:

17

Population Size:

unknown, but likely greater than 100 individuals

Minimum Viable Population Size:

unknown

Resistance to Disease:

low

Adaptability:

low

Population Narrative:

Current status and number of individuals is unknown. At the time of listing *Arctostaphylos myrtifolia* was known from 17 occurrences covering approximately 404.7 ha (1,000 ac) Individuals occur in stands, with approximately 100 stands documented as still existing. Populations exist in a narrow geographic range that contains the required soil conditions; they occur primarily on private or non-Federal lands. The amount of lone manzanita habitat lost to mining and has not been quantified, because information regarding the total acreage of land newly disturbed by mining operations is proprietary. However, the loss is believed to be significant. Populations are restricted to a very limited habitat, with much of that population suffering from disease. The ability of populations to recover is limited by poor health and reduction of habitat. There are only about 100 stands, with an unknown number of individuals in a limited area of habitat. A significant portion of those populations are suffering from disease. Populations are restricted to habitat in the lone Formation soil conditions. Loss of habitat due to mining and other development removes potential area for regrowth.

Threats and Stressors**Stressor:** Mining**Exposure:****Response:****Consequence:**

Narrative: Nearly all populations of this species occur on private or non-Federal land. The primary threat facing this species is the ongoing and threatened destruction and modification of its habitat by mining for silica sand, clay, lignite, common sand and gravel; and reclamation of mined lands involving establishment of vegetation with which this species cannot co-exist. A lesser degree of threat is posed by commercial or residential development, clearing for

agriculture and fire protection, and continued erosion due to previous fireline construction and driver training for California Department of Forestry and Fire Protection (CDFFP) employees. Commercial and residential development also threatens the habitat of *Arctostaphylos myrtifolia*. In 1993, a 43 ha (106 ac) parcel in the city of Lone reported to have *A. myrtifolia* was cleared, presumably to facilitate future development (Randy L. Johnsen, Lone City Administrator, in litt. 1994). The Amador County master plan has zoned an area in the northern Lone chaparral near Carbondale for industrial uses. Its habitat occurs in areas that contain valuable minerals. Clay mining began in the Lone area around 1860. Since that time, the Lone area has produced about a third of the fire clay in California (Chapman and Bishop 1975). Lignite, a low-grade coal, also has been mined in the Lone area since the early 1860s, initially for fuel, but more recently for wax used for industrial purposes. Chapman and Bishop (1975) reported the Lone lignites were the only lignites used commercially in the United States in the production of a specialized wax (montan wax). Quartz sand used in making glass containers, and laterite used for making cement also are commercially mined in the Lone area (Chapman and Bishop 1975). Common sands and gravels are also mined for various uses. Mining of all of these deposits has resulted in the direct removal of habitat for this plant species (Wood and Parker 1988; V. Thomas Parker, Professor of Biology, San Francisco State University, in litt. 1994; M. Wood, in litt. 1994). Strip mining of silica for glass and clay for ceramics and industrial filters has extirpated (caused extinction of) populations of *A. myrtifolia* north and south of Highway 88 (Roof 1982). mining results in conversion of former habitat to rangeland, pasture, and other agricultural uses; landowners do not restore the original plant community that was lost when the area was mined. Additionally, once the area is mined, the specialized substrate required by the plants may no longer be present. This type of disturbance permanently precludes restoration of habitat suitable for *Arctostaphylos myrtifolia*. To a lesser extent, land conversion to grazing and agriculture also has degraded or destroyed the habitat for these plants (Wood and Parker 1988; V.T. Parker, in litt. 1994; M. Wood, in litt. 1994). Both activities continue to pose threats to its habitat.

Stressor: Disease

Exposure:

Response:

Consequence:

Narrative: Recent studies by Swiecki and Bernhardt (2003, pp. 1–49) and Swiecki et al. (2005, pp. 1–38) determined that at least three different diseases are affecting the health of *Arctostaphylos myrtifolia* in the Lone area. First, a branch canker disease caused by a species of *Fusicoccum* that had previously been identified, and two newly identified pathogens, *Phytophthora cinnamomi* and *P. cambivora*. Progressive dieback associated with *Fusicoccum* spp. cankers likely contributes to and may sometimes cause the death of *A. myrtifolia* plants. *Phytophthora* spp. were found to cause contiguous patches of mortality in stands of *A. myrtifolia* due to root and crown rot (Swiecki and Bernhardt 2003, p. 4; Swiecki et al. 2005, p. 22). While mortality associated with *Phytophthora* spp. appears to have been noted since the 1980's, Swiecki and Bernhardt (2003, p. 41) believe it was at least partially confused with the branch canker disease because both diseases can occur together in the same area. However, mortality associated with *Fusicoccum* spp. tends to be patchily distributed within a stand and mortality caused by *Phytophthora* spp. is continuous. Swiecki and Bernhardt (2003, pp. 41–43) determined that two species of *Fusicoccum* affect *Arctostaphylos myrtifolia* plants by killing off branch tips or infecting larger diameter stems where the infection may expand and girdle the stem. The girdling of the stem may result in the death of large portions of the plant or the plant in its entirety. Swiecki and Bernhardt (2003, p. 41) observed that stem cankers associated with *Fusicoccum* spp. may expand slowly during the

months from March to October; however, if the die-back associated with *Fusicoccum* spp. exceeds new growth, individual plants may eventually be killed. Although advancement of the disease appears to be reduced during the drier months, stem canker severity, and subsequent dieback, appears to be related to plant water stress (Swiecki and Bernhardt 2003, p. 43). *Arctostaphylos myrtifolia* is highly susceptible to the pathogen *Phytophthora cinnamomi*. The *P. cinnamomi* pathogen was first identified as affecting *A. myrtifolia* by Swiecki and Bernhardt (2003, p. 5). *Phytophthora cinnamomi* is considered to be a serious pathogen of agricultural crops and native plant communities. In California, it is known to infect avocado trees, orchard trees, ornamental plants and Christmas tree farms (Swiecki and Bernhardt 2003, p. 44). More recently *P. cinnamomi* was identified to be partially responsible for mortality in *Quercus agrifolia* (coast live oak) (Garbelotto et al. 2006, p. 1). *Phytophthora cinnamomi* is a disease that causes root and crown rot and is responsible for killing off large patches of *A. myrtifolia* in the lone area. Once infected by this pathogen, the root system of the plant begins to decay until the loss of roots and/or water-conducting tissues causes the plant to desiccate (Swiecki and Bernhardt 2003, p. 43). Additionally, *P. cinnamomi* can also infect the leaves and stems of the plant, providing the same symptoms as *Fusicoccum* infections, making it difficult to determine which disease is affecting a particular plant (Swiecki and Bernhardt 2003, p. 45). Introduction of *Phytophthora cinnamomi* into *Arctostaphylos myrtifolia* habitat represents longterm, if not permanent, destruction of habitat due to its long persistence in the soil (Swiecki and Bernhardt 2003, p. 43). *Phytophthora cinnamomi* can persist in the environment in the absence of susceptible hosts. This pathogen survives in the soil in infected roots, or as long-lived resident spores (Swiecki and Bernhardt 2003, p. 44). There is no known cure or prevention for this *A. myrtifolia* disease (Swiecki and Bernhardt 2003, pp. 45–47). Swiecki and Bernhardt (2003, pp. 26–27) found that *A. myrtifolia* regeneration within an older portion of a mortality center was killed off by *P. cinnamomi*, while Swiecki et al. (2005, p. 25) discovered healthy *A. myrtifolia* regeneration in other older portions of mortality centers. However, subsequent investigation in 2009 discovered regeneration in these mortality centers displayed extreme dieback, or complete mortality (Karuzas, in litt. 2009, p. 1). Swiecki et al. (2005, p. 330) further noted that although reductions in pathogen populations may occur over time, it is unclear what period of time is needed to allow successful reestablishment of *A. myrtifolia*. The pathogenic activity of *Phytophthora cinnamomi* is favored by free moisture and under wet conditions, multiple infection cycles are likely to occur. *Phytophthora cinnamomi* is primarily spread to new areas through the movement of infested soil by humans, particularly through the use of vehicles (Swiecki and Bernhardt 2003, p. 45). Once the disease has been introduced into an area, the movement of the pathogen is facilitated by water flow. Swiecki et al. (2005, p. 33) noted that the local spread of *P. cinnamomi* occurs during the wet season at a cross slope and upslope rate of approximately 0.25 m (0.8 ft) per year. Down slope spread has been calculated at 2 m (6.5 ft) per year, presumably due to transport via flowing water, and under stagnant stream conditions *P. cinnamomi* has been located 10 m (33 ft) from disease-associated mortality centers (Swiecki et al. 2005, p. 34). While it is more likely for *P. cinnamomi* infected soil to be spread over larger distances during the wet season, movement of infected soils can readily occur during dry months as the result of mining operations and excavation (Swiecki et al. 2005, p. 35). An investigation of the distribution of the *Phytophthora cinnamomi* pathogen throughout the range of *Arctostaphylos myrtifolia* found that *P. cinnamomi* infection is widespread throughout the lone and Buena Vista area, with a second disease center in the Carbondale area (Swiecki et al. 2005, pp. 1–38). Of the populations located in and around lone and Buena Vista, over 50 percent have been killed by disease or are at risk of being infected (Swiecki, in litt. 2008, p. 1). DNA microsatellite analysis of *P. cinnamomi* isolates from Apricum Hill Preserve identified four

genetically distinct variants, suggesting multiple introductions of the pathogen at this location. Additionally, two of the four genotypes have been identified elsewhere in California (Swiecki et al. 2005, pp. 28–29). Investigation of the *A. myrtifolia* mortality on BLM land in the Carbondale area resulted in the discovery of a second soil-borne Phytophthora species, *P. cambivora* (Swiecki et al. 2005, p. 36). While it is not known what effect *P. cambivora* has on *A. myrtifolia*, *P. cambivora* is closely related to *P. cinnamomi* and is also an aggressive root pathogen (Swiecki et al. 2005, p. 36). *Phytophthora cinnamomi* is currently considered to be the greatest threat to *Arctostaphylos myrtifolia*. As of 2005, *P. cinnamomi* was documented as occurring in two of the five large *A. myrtifolia* populations. However, because *P. cinnamomi* is causing mortality in a number of native forests and chaparral communities in northern California (Swiecki, in litt. 2008, p. 2), and contaminated soil is readily transported on vehicles and in nursery stock, it is likely that *P. cinnamomi* will spread throughout the range of *A. myrtifolia* in the foreseeable future.

Stressor: Inadequate regulations

Exposure:

Response:

Consequence:

Narrative: Regulatory mechanisms thought to be inadequate to protect *Arctostaphylos myrtifolia* included: (1) the CEQA; (2) the SMARA; and (3) local regulations (see five year review for more information).

Recovery

Reclassification Criteria:

Not available

Delisting Criteria:

Not available

Recovery Actions:

- Currently there is no approved final or draft recovery plan for *Eriogonum apricum* (inclusive of vars. *apricum* and *prostratum*) or *Arctostaphylos myrtifolia*, therefore a high priority action should be finalizing a recovery plan for these species. Disease is currently the greatest threat to *A. myrtifolia*, and as such, a high priority should be placed on identification of the current extent of this pathogen within the range of *A. myrtifolia* and implementing measures to restrict the movement of infested soil and plant materials from areas affected by *Phytophthora cinnamomi*. Additional emphasis should be placed on conducting research into how to eliminate this disease from the ecosystem and identify other methods to prevent disease transmission. As part of this effort, the symptomatology, etiology, and impact of *P. cambivora* on *A. myrtifolia* and other species should be studied. Additionally, priority should be placed on identifying the status of *E. apricum* populations and obtaining an accurate representation of the area occupied by this species and the availability of habitat for restoration purposes. These tasks would aid us in better understanding the threats facing these species and to develop methods to help reduce the threats.

References

FEMA species account

five year review

Nature Serve

five year review 2010

final listing rule

SPECIES ACCOUNT: *Arctostaphylos pallida* (Pallid manzanita)

Species Taxonomic and Listing Information

Listing Status: Threatened

Physical Description

Pallid manzanita is an upright, evergreen shrub, usually 1.5 to 13 feet (2 to 4 meters) tall, but occasionally much taller. The bark on the main branches is gray to reddish. The leaf blades are 0.75 to 1 inch (2.5 to 4.5 centimeters), and a pale, dull-green color. Flowers are white and urn-shaped, 0.23 to 0.27 inch (6 to 7 millimeters) long, in dense clusters (USFWS 2014; Jepson 2013). Additional detail from 2015b: *Arctostaphylos pallida* is an upright, evergreen, non-burl-forming, obligate-seeding shrub. It grows up to 4 meters (13 feet) in height, with rough, gray, or reddish bark. The twigs (terminal branches) are bristly and canescent (covered with whitish fine hairs). The pale green leaves surround the stem and are attached by a petiole less than 2 millimeters (0.08 inch). The leaves are closely imbricated (overlap), and are cordate (heart-shaped) and glabrous (hairless). The leaf blade is 2.5 to 4.5 centimeters (1.0 to 1.8 inches) long, 2 to 3 centimeters (0.8 to 1.2 inches) wide, ovate or oblong-ovate, glaucous (covered with a whitish waxy covering), dull, and smooth (Wells 1993). The inflorescences (cluster of flowers) are dense, 3 to 5 per branch; the bracts (leaflike organ subtending an inflorescence) are 5 to 9 millimeters (0.2 to 0.35 inch), widely lanceolate (narrow and tapering at both ends), and acute (sharply pointed) (Wells 1993). The flowers are white, rose, or white-rose in color, urn-shaped, and 6 to 7 millimeters (0.2 to 0.3 inch) long; and flowering occurs from December to March. Fruits are 8 to 10 millimeters (0.3 to 0.4 inch), globe-shaped, and sticky (Wells 1993). (USFWS, 2015b).

Taxonomy

Arctostaphylos pallida was first described by Eastwood (1933), based on a specimen collected by W. W. Carruth in 1902 from the "East Oakland Hills." Prior to Eastwood (1933), the specimen was included in *Arctostaphylos andersonii*. Jepson (1922; 1939) did not recognize *A. pallida* as a separate species and continued to include it in *Arctostaphylos andersonii*. McMinn (1939) published the combination *A. andersonii* var. *pallida*, apparently agreeing with J. E. Adams' conclusions (first presented in his 1935 dissertation at the University of California at Berkeley) that the Oakland specimen was distinct but related to *A. andersonii*. This combination was not published until several years later (Adams 1940). In their floristic treatment of California, Munz and Keck (1959) followed McMinn's treatment. Wells (1969) recognized *A. pallida* as a species separate from *A. andersonii* and retained this treatment in the Jepson Manual (Wells 1993). The phylogenetic analysis and relationships outlined in Boykin et al. (2005) do not support *A. pallida* as being a variety of *A. andersonii*. Although Parker et al. (2012) revised the taxonomy of several *Arctostaphylos* species for the second edition of the Jepson Manual; no taxonomic revisions were made to *A. pallida*. *Arctostaphylos pallida* is recognized as a full species (Parker et al. 2012).

Historical Range

Pallid manzanita has a historical range in the Contra Costa Hills in the northern Diablo Range in Alameda and Contra Costa counties, California (NatureServe 2014). It was collected on the summit of East Oakland Hills in January of 1902. A second population, which was believed to have been reported in the 1940s or 1950s, was on Sobrante Ridge in Contra Costa County (USFWS 2014). Added in 2015: Based on a personal communication with the late James Roof,

the founding director of East Bay Regional Parks District's (EBRPD) Tilden Regional Park Botanical Garden (Tilden Park; Amme et al. (1987) noted that Mr. Roof planted several dozen *A. pallida*, in the period between 1939-1940, along Shasta Road and Golf Course Drive in Tilden Park. (USFWS, 2015b).

Current Range

There are 13 documented occurrences where pallid Manzanita currently exists. All extant, naturally occurring populations are in two geographic regions: Huckleberry Ridge in Alameda County, and Sobrante Ridge in Contra Costa County. There are likely dormant seed banks of pallid manzanita in the range of the species, as indicated by the presence of germinated seeds at several sites in Joaquin Miller Park following soil disturbance and/or burning (USFWS 2014). The largest concentration of pallid manzanita occurs on Huckleberry Ridge, with many stands distributed across connected and adjacent ridge tops. The largest stands by number and size occur along the boundary between East Bay Regional Park District's (EBRPD) Huckleberry Botanic Regional Preserve, and private properties to the west, primarily on northeast-facing slopes and extending southwest over the top of the ridge into the urban development of Skyline Boulevard. The second-largest concentration of pallid manzanita occurs at Sobrante Ridge in EBRPD's Sobrante Ridge Ecological Preserve. A 2004 survey indicated the population existed within 1.33 acres at Sobrante Ridge. There also exists a small, naturalized population at Tilden Park that is divided into two stands. One is scattered along the roadside of Wildcat Canyon Road, and the other is along the Selby Trail north of Shasta Road (CNPS 2014, USFWS 2014).

Critical Habitat Designated

Yes;

Life History**Food/Nutrient Resources****Food Source**

Adult: sunlight

Competition

Adult: yes (see threats section)

Food/Nutrient Narrative

Adult: This species acquires its energy from sunlight via photosynthesis.

Reproductive Strategy

Adult: diploid, obligate seeding; also capable of reproducing vegetatively by layering

Dependency on Other Individuals or Species

Adult: Depends on bees for pollination; seed caching by seed predators may be important for surviving fires

Key Resources Needed for Breeding

Adult: fire

Reproduction Narrative

Adult: *Arctostaphylos pallida* is diploid, obligate seeding, and shade-intolerant (Amme and Havlik 1987). Bees and other insects in the superfamily Apoidea, in particular European honeybees (*Apis mellifera*), appear to be important pollinators (Amme and Havlik 1987, B. Solvesky, Service, pers. obs. 2010). Two basic life history patterns are found among species within the genus *Arctostaphylos* with respect to wildfire; *Arctostaphylos* plants either survive wildfire and resprout from a basal burl (sprouter) or *Arctostaphylos* plants are killed by fire and regenerate from seeds stored in the soil (obligate seeder). Obligate seeding *Arctostaphylos* species, like *A. pallida*, may require 5 to 25 years before substantial seed crops are produced (Keeley 1986). Seeds typically suffer high rates of predation (Kelly and Parker 1990); however, seed caching by seed predators may be an important mechanism by which seeds are buried to a sufficient depth at which they may survive high-intensity wildfires. Parker (2010) found that while overall seedling density declined with fire intensity, the proportion of seedlings emerging from rodent caches increased. Seeds that are not depredated on are slowly added to the soil seed bank, eventually reaching depths at which they can survive fire (Parker 2007). Obligate seeding *Arctostaphylos* species tend to have fire-dependent seedling recruitment; and mature stands tend to be even-aged, exhibiting little to no regeneration during fire-free intervals (Safford and Harrison 2004). Mechanical disturbance may be an alternative to fire under certain conditions. The regeneration of seedlings at stands where vegetation management activities disturbed the soil and increased light levels, in the absence of fire, indicates fire is not required for seed germination to occur. However, based on the large number of seedlings that occur at Huckleberry Preserve as the result of a pile burn, compared to other stands with seedlings where fire has not occurred, fire is likely a more effective means of stimulating germination. In addition to being an obligate seeder, *A. pallida* can reproduce vegetatively by layering. Layering occurs when branches become partially or fully buried in soil or litter and produce roots. Some extensive clones of *A. pallida* have developed in this manner within the Sobrante Ridge population (Amme and Havlik 1987). The understory of mature *Arctostaphylos pallida* stands and chaparral vegetation in general is typically free of vegetation, including regeneration. The cause of the lack of vegetation beneath chaparral species has been attributed to allelopathy (inhibitory biochemical interactions between plants), small mammal herbivory, and/or fire dependant seed banks. Keeley and Keeley (1989) concluded that in nature, a substantial proportion of the seed pool of some chaparral species is unlikely to germinate in the absence of fire and that dormancy mechanisms minimize seed germination during periods of low-survival probability. However, they also note that a portion of the seed pool is potentially capable of germinating in the absence of fire. A study comparing the regeneration and recolonization of obligate-seeding to sprouting *Arctostaphylos* after fire found that the seedlings of obligate seeders did not compete well against sprouters post-fire; thus, seedlings are adapted to openings in chaparral after fire (Keeley and Zelder 1978). Based on this observation, Keeley and Zelder (1978) hypothesized that longer fire-free periods favor obligate seeders by creating more and larger openings in chaparral post-fire, because: (1) longer fire-free periods result in higher fuel loads and more intense fires, thereby reducing the number of sprouters that survive fire; and (2) long fire-free periods allow for increased stem-exclusion, thereby reducing the density of potential sprouters after a fire. In support of this hypothesis, Odion and Davis (2000) found that chaparral with dense canopy cover prior to fire tended to be barren after fire, where heating was relatively high, except for the occasional obligate seeding *Arctostaphylos* and obligate seeding *Ceanothus*. The authors also noted that obligate seeders tended to have deeply buried seeds, allowing them to withstand prolonged soil heating. A study of the effects of prescribed fire on *A. morroensis* (Morro manzanita), a closely related species to *A. pallida* (Boykin et al. 2005) and a federally

endangered obligate-seeding species from Morro Bay, California, found that *A. morroensis* may require considerably longer than 40 years between fires to establish a deeply buried seed bank with enough viable seed to adequately compensate for mortality and prevent population decrease or local extinction (Odion and Tyler 2002). However, it is not clear how long it takes to produce a persistent soil seed bank in which seeds are buried deep enough to withstand fire (Parker 2007).

Habitat Type

Adult: maritime chaparral vegetation type and appears to be co-dominant with other woody shrubs and shrub-form trees

Dependencies on Specific Environmental Elements

Adult: cool air temperatures that experience maritime fog

Geographic or Habitat Restraints or Barriers

Adult: likely restricted to the northwestern extremity of the Diablo Range (see Misc. Section)

Spatial Arrangements of the Population

Adult: clumped according to suitable resources

Environmental Specificity

Adult: Narrow; special habitat requirements

Tolerance Ranges/Thresholds

Adult: shade intolerant

Site Fidelity

Adult: very high

Habitat Narrative

Adult: The primary soil series *Arctostaphylos pallida* occurs on, including the large stands and satellite stands along Huckleberry Ridge and portions of Sobrante Ridge and Tilden Park, is Millsholm loam (NRCS 2013). The Millsholm soil series consists of shallow, well-drained soils that formed in material weathered from sandstone, mudstone, and shale. In addition to Millsholm loam, *A. pallida* occurs on other shallow well-drained soils series, rock formations, and soil complexes with parent materials that include shale, schist, greenstone, sandstone, silty clay loam, or conglomerate. The Huckleberry Preserve and the Sobrante Ridge stands grow on soil composed of Middle Miocene cherts and shales of the Monterey Group (Amme and Havlik 1987). These soils are thin, well drained at the surface, and deficient in many essential plant nutrients. However, the fractured and bedded rocks below hold water that is accessible to deep roots. Satellite stands along Skyline Boulevard occur on Pinehurst Shale and the Joaquin Miller Formation; both substrates are mixtures of shale, sandstone, and minor conglomerate. The stand along Exeter Drive occurs on soft sandstone. *Arctostaphylos pallida* appears to only grow on these soils in areas that experience maritime summer fog, and have not been found on the same substrates where summer air and soil temperatures are higher (Johnson 1983). *Arctostaphylos pallida* is a component of the maritime chaparral vegetation type and appears to be co-dominant with other woody shrubs and shrub-form trees, including *A. crustacea* subsp. *crustacea* (brittle leaf manzanita), *Vaccinium ovatum* (California huckleberry), *Chrysolepis*

chrysophylla var. minor (golden chinquapin), and several shrub-form *Quercus* species. Maritime chaparral represents a plant community of special concern because of the high density of narrowly distributed endemic species, its patchy distribution, and its association with forest edges or odd soils (Parker 2007). *Arctostaphylos pallida* is shade intolerant and will slowly die when shaded by larger trees and shrubs. However, based on the results of vegetation management activities conducted in the mid-1980s at Huckleberry Preserve, Chabot, and Big Trees Trail and in the mid-2000s at Redwood Regional Park and Big Trees Trail, *A. pallida* responds positively to activities that reduce light competition and disturb the soil. Four vegetation types exist on Sobrante Ridge: maritime chaparral, oak woodland, coastal scrub, and grassland (Amme and Havlik 1987). The area outside of the shale soil formation is dominated by open park-like coast live oak woodland, interspersed with grassland and coastal scrub; while the area within the shale soil formation is dominated by maritime chaparral, including *A. pallida* and *A. crustacea* subsp. *crustacea*. Within the approximately 3.6-hectare (9-acre) shale soil formation, primarily along the edges, are *A. crustacea* subsp. *crustacea*; within the center of the formation is the largest concentration of *A. pallida*, occurring on both east- and southwest-facing slopes. There are two vegetation types within the Huckleberry Preserve stand: maritime chaparral and oak/California bay laurel (*Quercus* species/*Umbellularia californica*) woodland. As is the case at Sobrante Ridge, the most barren soils at Huckleberry Preserve are occupied by the largest concentrations of *Arctostaphylos pallida*. Unlike the large stand at Huckleberry Preserve and the Sobrante Ridge, the soils of the satellite stands of the Huckleberry Ridge population are more developed and less nutrient deficient, capable of supporting redwood and coast live oak vegetation types. As such, the *A. pallida* at these sites occur mainly on roadcuts and within forest gaps.

Dispersal/Migration**Motility/Mobility**

Adult: not mobile

Dispersal

Adult: only the seeds can disperse

Dispersal/Migration Narrative

Adult: There is not a lot of available dispersal information on this species.

Population Information and Trends**Population Trends:**

some declining and some with unknown status

Species Trends:

unknown

Resiliency:

low

Representation:

low

Redundancy:

low

Population Growth Rate:

unknown

Number of Populations:

6 to 10

Population Size:

The species is endemic to the San Francisco East Bay, and currently consists of two naturally occurring populations and an outplanted population, totaling 1,353 mature plants. (USFWS, 2015).

Minimum Viable Population Size:

unknown

Resistance to Disease:

low

Adaptability:

low

Population Narrative:

The largest concentration of *Arctostaphylos pallida* occur on Huckleberry Ridge in Alameda County, with many satellite stands scattered across connected and adjacent ridge tops. The total Huckleberry Ridge population (all *A. pallida* found south of California State Route 24) consists of 879 mature plants and 337 seedlings (Table 1). The largest stands and largest concentration of stands occur along the boundary that separates EBRPD's Huckleberry Botanic Regional Preserve (Huckleberry Preserve) from private properties to the west, primarily on northeast-facing slopes, extending southwest over the top of the ridge onto private property within the urban development along Skyline Boulevard. An assessment conducted in the mid-1980's estimated that the number of mature *A. pallida* plants within the Huckleberry Preserve area was 2,400 to 2,700 plants (Amme et al. 1987). A census of all *A. pallida* occurring on EBRPD lands was conducted in 2004 by EBRPD biologists, during which each individual plant's location and canopy radius was mapped. Based on these results, there were 747 mature plants with a canopy cover that occupied 2.01 acres (0.81 hectare). Of these 747 mature plants, 325 occur within Huckleberry Preserve, 326 within the yards of several private homes adjacent to Huckleberry Preserve, and 96 on property owned by a tennis club which is also adjacent to Huckleberry Preserve. The extent to which the number of plants in the Huckleberry Preserve area has decreased since the estimate from the mid-1980s is not known, since Amme et al. (1987) likely overestimated the number of plants at this site in 1985 and signs of a die-off of this magnitude are not apparent (W. Legard, EBRPD, 2010 pers. com.). Based on the distribution of *Arctostaphylos pallida* that occurs along Ascot, Exeter, and Manzanita Drives, within the suburban development southwest of large stands that occur at Huckleberry Preserve and on private properties adjacent to the Huckleberry Preserve, it is likely these scattered plants represent what was once a much larger stand or a group of stands that, prior to suburban

development in the early 1970's, would have been connected to the large concentration of stands at Huckleberry Preserve. According to Kanz (2004), the suburban development that occurred in this area in the early 1970's resulted in the loss of as many as half of the *A. pallida* plants found along Huckleberry Ridge. The Huckleberry Ridge satellite stands occur along the ridge tops connected and adjacent to Huckleberry Ridge, on properties managed by EBRPD, including Robert Sibley Volcanic Regional Preserve and Redwood Regional Park; at Joaquin Miller Park, which is owned by the City of Oakland; on privately owned properties along Ascot Drive, Manzanita Drive, and Exeter Drive in the City of Oakland; and above Pinehurst Road on lands owned by East Bay Municipal Utility District (EBMUD). Of the Huckleberry Ridge satellite stands occurring on public lands, two of the larger stands are found at Joaquin Miller Park and are referred to as "Chabot" and "Big Trees Trail." According to M. Matarrese (City of Oakland, pers. comm. 2011), both of these stands are naturally occurring; unlike the Manzanita Flat stand that also occurred at Joaquin Miller Park, which is believed to have been established as a result of soil containing *Arctostaphylos pallida* seed being transported to the site from homebuilding activities on Manzanita Drive in the 1970's. The Manzanita Flat stand has since been extirpated through City of Oakland goat grazing activities for the purpose of reducing fire fuel loads. The Chabot stand occurs along the western side of the Chabot Space and Science Center (Science Center). In 1985, prior to the construction of the Science Center, City of Oakland personnel cut *Eucalyptus* species and *Pinus radiata* (Monterey pine) at the site, followed by burning the limbs and other vegetation debris (M. Matarrese, City of Oakland, pers. comm. 2011). Seemingly, these activities stimulated germination of a dormant viable soil seed bank of *Arctostaphylos pallida*, as the species was not known from the site prior to vegetation removal and burning. The number of plants at the site declined from 21 in 1994 to 10 in 2006, and the condition of many of the remaining plants continue to decline due to shading from surrounding vegetation. Of all of the Huckleberry Ridge satellite stands of *Arctostaphylos pallida*, the Big Trees Trail has the largest number of mature plants. Prior to 1988, *A. pallida* plants were not known to occur at Big Trees Trail (M. Matarrese, City of Oakland, pers. comm. 2011). In 1988, the City of Oakland removed a large *Pinus radiata* that had fallen onto a wooden storage building. It is believed that the logging equipment used to remove the fallen pine disturbed an *A. pallida* seed bank, scarifying seed coats and increasing light levels, resulting in regeneration. Between 1989 and 2006, 14 of the 61 plants died. Since 2006, the stand has continued to decline due to shading by *Pinus radiata*, *Hesperocyparis macrocarpa* (Monterey cypress), and *Arbutus menziesii* (Pacific madrone) and pruning and plant removal for road-side vegetation management conducted by the City of Oakland. The non-native water mold pathogen *Phytophthora cinnamomi* has been confirmed infecting the largest stand of *Arctostaphylos pallida* plants at Huckleberry Preserve (Swiecki et al. 2011) and Big Trees Trail (Phytosphere Research 2010). The extent of the infestation at these sites is not known at this time. *Phytophthora cinnamomi* causes a root and crown rot of *A. pallida* and many other native and introduced woody species. When *A. pallida* plants become infected with *P. cinnamomi*, they do not exhibit the slow branch die-back over multiple years that is typical of a decline from shading or native fungal pathogens; rather, the plant dies within several months. Based on a site visit in August 2013, dozens of plants at Big Trees Trails have died or appear to be infected and many *Arbutus menziesii* (Pacific madrone) at the site, which are also susceptible to *P. cinnamomi*, appear to be infected (B. Solvesky, Service, pers. obs. 2013). The second largest population of *Arctostaphylos pallida* occurs at Sobrante Ridge (454 mature plants), within EBRPD's Sobrante Ridge Ecological Preserve. This population is the most isolated from all other stands, occurring 8 kilometers (5 miles) north of the out-planted population at Tilden Park and 15 kilometers (9.5 miles) north of the Huckleberry Ridge population. Kanz (2004) noted that shading of the site by native trees is gradually

increasing and that numerous plants along the trail have been pruned as part of trail maintenance. A status survey in the mid-1980s indicated the Sobrante Ridge population had an estimated 1,700 to 2,000 plants (Amme et al. 1987). However, a 2004 survey by EBRPD biologists indicated there were 454 plants with a canopy cover that occupied 1.33 acres (0.54 hectare) at Sobrante Ridge. According to W. Legard (EBRPD, pers. comm. 2010), Amme et al. (1987) likely overestimated the number of plants at this site, because signs of a population die-off of this magnitude are not apparent. The small naturalized population of 20 *Arctostaphylos pallida* plants at Tilden Park can be divided into two small stands, one scattered along the roadside of Wildcat Canyon Road and the other along the Selby Trail north of Shasta Road. It is not known how many plants were planted in 1939 or 1940, or if there has been any regeneration at the site. A 1981 account of the Shasta Road stand indicated there were less than 50 plants; however, the accuracy of the 1981 estimate is unclear so we are unable to determine if the 2004 survey result of 12 plants indicates there has been significant decline. Amme and Havlak (1987) and Kanz (2004) have attributed mortality or declines to: 1) removal for wildfire fuel reduction purposes (Manzanita Drive); 2) herbicide use below Pacific Gas and Electric (PG&E) powerlines (Manzanita Drive); 3) shading by native plant species, including *Arbutus menziesii* (Pacific madrone), *Quercus* species (oak species) and *Sequoia sempervirens* (coast redwood) (Huckleberry Preserve, Redwood Park, Chab

Threats and Stressors

Stressor: Disease

Exposure:

Response:

Consequence:

Narrative: Recently, *Phytophthora cinnamomi* has been confirmed infecting and killing *A. pallida* plants at Huckleberry Preserve and the Big Trees Trail stands. In contrast to the unidentified fungal pathogen, *A. pallida* infected with *P. cinnamomi* die within several months of signs of infection and do not experience branch or stem dieback while maintaining healthy branches and meristems. To our knowledge, the extent of the infestation within stands of *A. pallida* has not been quantified and the potential for widespread population decline is still unknown. The pathogenic activity of *Phytophthora cinnamomi* is favored by free moisture, and under wet conditions multiple infection cycles are likely to occur. *Phytophthora cinnamomi* is primarily spread to new areas through the movement of infested soil by humans, particularly on vehicle tires, but also on shoes, tools and equipment that become contaminated with infested soil (Swiecki and Bernhardt 2003). In addition, *P. cinnamomi* has been isolated from container stock purchased from several native plant nurseries, suggesting nursery stock used for restoration projects or planted within the Wildland Urban-Interface (WUI) can provide a vector for this disease (Swiecki et al. 2011). In addition, a high percentage of woody plant materials from commercial nurseries are infested with various root-rotting *Phytophthora* species, including *P. cinnamomi*. This not only increases the likelihood that remnant plants in landscapes will be killed by this pathogen, but further increases the risk to stands in the vicinity of landscaped parcels, especially where landscaped parcels are located upslope of *A. pallida* stands (e.g., Manzanita Drive area) (T. Swiecki pers. comm. 2012). Human transport of contaminated soil is the primary vector for introducing *Phytophthora cinnamomi* into new areas. Most *Arctostaphylos pallida* stands occur along ridge tops, adjacent to unpaved maintenance roads and trails, increasing the likelihood contaminated soils will be spread throughout the East Bay Hills on shoes, bicycles, and vehicles. Once *Phytophthora cinnamomi* has been introduced into an area, its movement is

facilitated by water flow, especially downhill. Swiecki et al. (2005) noted that the local spread of *P. cinnamomi* in *A. myrtifolia* occurs during the wet season at a cross-slope and upslope rate of approximately 0.25 meter (0.8 foot) per year. Down slope spread has been calculated at 2 meters (6.5 feet) per year, presumably due to transport via flowing water (Swiecki et al. 2005). Over a longer time interval, Swiecki and Bernhardt (2012) have documented that *P. cinnamomi* has spread at average rates about 1 meter (3.3 feet) per year in relatively level sites within *A. myrtifolia* stands. Introduction of *Phytophthora cinnamomi* into *Arctostaphylos pallida* habitat represents a long-term and substantial threat. *Phytophthora cinnamomi* can persist in the environment in the absence of susceptible hosts, surviving in the soil in infected roots, or as long-lived resident spores (Swiecki and Bernhardt 2003). There is no known cure for plants that have been infected. Prevention of this disease depends on the exclusion of the pathogen from areas that contain host plants.

Stressor: Fire frequency

Exposure:

Response:

Consequence:

Narrative: A lack of frequent small fires to stimulate regeneration and reduce fuel loads within stands of chaparral represented one of the greatest threats to the species. There has been considerable debate about the effects of decades of fire suppression on chaparral ecosystems (Moritz 2003). One side of the debate argues that fire suppression has increased fuel loads which lead to fewer, but larger wildfires. This theory is supported by studies contrasting shrubland fire regimes north and south of the U.S.-Mexican border (Minnich 1983, 1995, 2001), suggesting that the pattern of frequent small fires south of the boarder is a model of what fire regimes were like north of the boarder prior to fire suppression policy. Based on this assumption, proponents of this theory suggested that California-shrubland WUI management should de-emphasize fire suppression and reestablish an age mosaic of shrublands to return the landscape to a condition in which fire size is constrained by discontinuities in fuels due to smaller, more frequent fires. In contrast, others contend that relatively large stand-replacing crown fires are a natural part of these ecosystems and that urban expansion into these ecosystems has increased the rate of fire incidence through human ignition sources, resulting in more destructive (that is, expensive due to loss of human structures) fires. This is supported by research that has shown that frequency and area burned have not declined as a result of fire suppression (Keeley 1999), extremely large, stand replacing crown fires in California shrubland ecosystems predate fire suppression policy (Keeley and Fotheringham 2001, Keeley and Zedler 2009); over the last 130 years there has been no significant change in the incidence of large fires greater than 10,000 hectares (24,710 acres); fire suppression has not reduced the area burned (Conrad and Weise 1998, Keeley et al. 1999); large extensive fires are not dependent on stand age (Keeley et al. 1999, Moritz 2003); and when wildfires occur under severe fire conditions they burn through all but the youngest age-class of chaparral and coastal scrub (Keeley et al. 1999, Keeley 2002). Keeley and Fotheringham (2001) question the use of current fire regimes south of the border as a model of what fire regimes were like north of the border prior to fire suppression for the following reasons: (1) fire frequency from human ignition sources is five times greater south of the boarder; (2) most fires in northern Baja California, Mexico are driven by on-shore northwestern breezes, which have a different capacity for fire spread than fires driven by föhn winds; (3) areas south of the border tend to receive less precipitation and soils tend to be less fertile, both of which affect fuel production; (4) much of the chaparral-dominated landscape south of the boarder is a plateau, lacking topographic heterogeneity, which affects the rate of fire spread and increases solar evaporation

and reduced fuel production; and (5) few, if any, contiguous chaparral stands south of the boarder reach the sizes of those north of boarder. In a study of relative frequency of human-caused and lightning-caused fires in the coast range east of San Francisco Bay, Keeley (2005) found that most years were without any lightning-ignited fires: in Contra Costa County 86 percent of the years had no lightning-ignited fires and in Alameda County the figure was 74 percent. Wildfire in Alameda and Contra Costa counties is most often human caused; thus, the fire return interval is likely no longer within the evolutionary bounds of the species. Odion and Tyler's (2002) study of *Arctostaphylos morroensis* indicates that a fire return interval of 40 years or less would likely result in the extirpation of the species, and other studies on obligate seeding *Arctostaphylos* similarly found that long fire-free intervals (with an interval greater than one fire every 100 years) likely do not represent a significant threat (Keeley and Zelder 1978, Odion and Davis 2000). Consequently, a relatively short fire-return interval, one that depletes the soil seed bank before it can be replenished, is likely a greater threat to *A. pallida* than a relatively long fire-return interval. Still, because fire is essential to the natural regeneration of *Arctostaphylos pallida* and regeneration can be difficult in the absence of fire, fire suppression remains a threat. The Huckleberry Preserve site has likely not experienced a stand-replacing fire for more than 80 years and would benefit from fire or other management activities that stimulated regeneration and reduced competition with native and non-native species. The Sobrante Ridge site likely experienced a stand-replacing fire 30 to 40 years ago (Service 1998) and appears to be healthy and vigorous. EBRPD does not typically conduct broadcast burning in the WUI due to the threat of fire escape and liability; however, EBRPD is proposing to burn slash piles at Huckleberry Preserve as part of their Wildfire Hazard Reduction and Resource Management Plan (LSA Associates, Inc. 2009) (WHRRMP). The limited opportunities to use fire to stimulate regeneration of *A. pallida* represents a threat to the species, because the effectiveness of mechanical soil disturbance to stimulate regeneration has not been proven to provide adequate regeneration.

Stressor: Goat grazing

Exposure:

Response:

Consequence:

Narrative: Both EBRPD and the City of Oakland have used domestic goat (*Capra aegagrus*) grazing as a tool to reduce fuel loads and wildfire hazard within the WUI of the East Bay Hills. Due to the relatively indiscriminant food selection preferences of the domestic goat, this practice poses a serious, yet easily avoidable, threat to *Arctostaphylos pallida*. According to Kanz (2004) goat grazing by the City of Oakland is responsible for the extirpation of the Manzanita Flat stand and has caused damage to *A. pallida* plants at the Big Trees Trail site. The WHRRMP specifically excludes the use of goat grazing near stands of *A. pallida*. Goat grazing is a minor threat in areas other than City of Oakland properties, but is a significant threat to *A. pallida* occurring on City of Oakland properties.

Stressor: Succession and invasive species

Exposure:

Response:

Consequence:

Narrative: Succession of maritime chaparral to oak/California bay laurel (*Quercus* species/*Umbellularia californica*) woodland and shading by non-native invasive species such as *Eucalyptus* species and *Pinus radiata* were cited as significant threats to *Arctostaphylos pallida* at the time of listing and continue to represent one of the most significant threats to the species.

Mosaics of grassland, oak woodland, coastal scrub, and chaparral, in some locations, have been reported to correlate with geological substrate (Cole 1980, Davis et al. 1988) and soil characteristics (Harrison et al. 1971). However, Callaway and Davis (1993) found each of these vegetation types represented abundantly on most soil depths, slope aspects, and all geological substrates. Cyclical changes between chaparral, oak woodland, grassland, and coastal scrub do occur. However, the interactions between variables responsible for vegetation type conversion and the rate of conversion are complex and site-specific. Callaway and Davis (1993) found that transition rates varied with substrate and topographic position, indicating fire, grazing, and the physical environment interacted to determine direction and rate of conversion. Variation in transition on different substrates suggests that only portions of the vegetation on the landscape may be dynamic, with some patches in certain combinations of environment and disturbance that change rapidly, and other patches that remain static as edaphic or topographic climax communities. As a broad generalization, in the absence of disturbance and on sites with environmental factors that allow for transition from one vegetation type to another, grasslands tend to transition to coastal scrub, coastal scrub to chaparral or oak woodland, chaparral to oak woodland, and oak woodland to grassland (Callaway and Davis 1993). *Arctostaphylos pallida* is highly shade intolerant and the invasion of tree-form plant species creates shade that causes *A. pallida* shrubs to slowly die over several years if management action is not taken. All of the stands of *A. pallida*, to some degree, show signs of succession to oak/ California bay laurel woodland and/or are being shaded by non-native trees. The Huckleberry Preserve stands and all of the satellite stands of the Huckleberry Ridge population are in severe decline due to shading via native species and non-native invasive species. For example, the Chabot stand will likely be extirpated within a decade if action is not taken that addresses this issue. Shading lowers seed production, reduces vegetative growth, causes branch dieback and ultimately results in plant death. However, *A. pallida* stands that experience 100 percent mortality will likely have a viable, although declining, seed bank for many decades.

Stressor: Nitrogen Deposition

Exposure:

Response:

Consequence:

Narrative: Atmospheric nitrogen deposition is a complex process by which reactive chemical species of nitrogen (N), nitrogen oxides (NOX), ammonia (NH₃), and their reaction products are deposited onto surfaces and enter ecosystems as N-fertilizer. As a consequence of anthropogenic inputs, the global nitrogen cycle has been significantly altered over the past century (Weiss 2006). The added N has been shown to allow nutrient-deficient soils, such as serpentine, to be invaded by both native and non-native species that require added nutrients to survive (Weiss 2006). Although it has been posited that the succession of maritime chaparral to oak/bay (*Quercus* species/*Umbellularia californica*) woodland in the East San Francisco Bay is due to fire exclusion or is a natural process, it is also possible N-deposition has created conditions that have allowed vegetation-type conversion, from maritime chaparral to oak-bay woodland, to occur on the nutrient deficient soils that are typical of *Arctostaphylos pallida*.

Stressor: Hybridization

Exposure:

Response:

Consequence:

Narrative: Hybridization between *Arctostaphylos pallida* and other *Arctostaphylos* species was cited as a threat at the time of listing and continues to threaten the species today. Hybridization is known to occur naturally between *A. pallida* and *A. crustacea*. However, several species of *Arctostaphylos* not known to co-occur with *A. pallida* have been used for landscaping on private lands within the urban development adjacent to Huckleberry Preserve and threaten nearby *A. pallida* individuals through pollen swamping and hybridization leading to genetic assimilation. While most *Arctostaphylos* are diploid, about 30 percent are tetraploid. Differences in ploidy level are not a complete barrier to hybridization, and several diploid-tetraploid crosses have been observed in the field (e.g., *A. crustacea* X *A. pallida*) (Wahlert et al. 2006). From examination of populations of co-occurring diploid *Arctostaphylos* species in the field, in which the co-occurring *Arctostaphylos* species are from different genetic clades as defined in Boykin et al. (2005), there is very little or no hybridization (V.T. Parker and M.C. Vasey, unpublished data). However, *A. glauca*, *A. pajaroensis* and *A. pallida* are from the same genetic clade (Boykin et al. 2005) and are all diploid (Parker et al. 2012). Furthermore, hybrids have been observed between *A. pallida* and *A. glauca* (bigberry manzanita) and hybridization may be occurring in areas where residents have planted *A. pajaroensis* (Pajaro manzanita). This calls into question the genetic integrity of the seed bank within the City of Oakland residential development along Huckleberry Ridge and, to some extent, within the adjacent Huckleberry Preserve stands. If the seed bank in this area, including that of the Huckleberry Preserve stands, has been genetically compromised through hybridization with non-native *Arctostaphylos* species, regeneration in the area could result in a hybrid swarm and a blurring of the genetic integrity of all future stands of *A. pallida* in the area. At this time, the extent to which hybridization has occurred and the extent to which hybridization threatens *A. pallida* is not known.

Stressor: Landscaping

Exposure:

Response:

Consequence:

Narrative: *Arctostaphylos pallida* plants that occur within the yards of private residences (less than 57 plants) in City of Oakland residential neighborhoods are highly susceptible to mortality from landscaping activities. The majority of these plants will likely be lost in the foreseeable future due to these activities and a lack of regeneration. In addition, the genetic integrity of the soil seed bank is questionable due to hybridization with non-native *Arctostaphylos* species (see Factor D, Hybridization above). Due to the susceptibility of these plants to mortality from landscaping and home improvement projects, and ongoing hybridization with non-native *Arctostaphylos* species, these plants and the associated seed bank will not contribute to meeting any of the recovery criteria for this species.

Stressor: Herbicide Use

Exposure:

Response:

Consequence:

Narrative: At the time of listing, herbicide use for the purpose of controlling roadside vegetation in the residential development adjacent Huckleberry Preserve was cited as a threat to *Arctostaphylos pallida*. Kanz (2004) indicated that *A. pallida* plants below the Pacific Gas and Electric Company power lines, between Manzanita Drive and Skyline Boulevard, exhibited evidence of herbicide use. Herbicide use continues to be a minor threat to *A. pallida*, particularly within the urban development and associated *A. pallida* stands adjacent to Huckleberry Preserve.

Stressor: Small Population Size and Stochasticity

Exposure:

Response:

Consequence:

Narrative: Because *Arctostaphylos pallida* exists as three populations with only two large stands and several small satellite stands, inbreeding depression and stochastic events represent significant threats to the species. Inbreeding depression can result in reduced fitness, which, coupled with small population size may result in a higher susceptibility to stochastic events, such as excessive rain, drought, and landslides, that further increase the likelihood of loss of genetic variability. Stochastic events, such as prolonged rainy periods, can also increase susceptibility to other threats, such as fungal pathogens and *Phytophthora cinnamomi*.

Stressor: Climate Change

Exposure:

Response:

Consequence:

Narrative: Effects to this species as a result of climate change are unclear. A trend of warming in the mountains of western North America is expected to decrease snowpack, hasten spring runoff, and reduce summer stream flows, and increased summer heat may increase the frequency and intensity of wildfires (IPCC 2007). While it appears reasonable to assume that the species may be affected, we lack sufficient certainty on knowing how and to what degree climate change will affect the species, the extent of average temperature increases in California/Nevada, or potential changes to the level of threat posed by drought, fire, etc. The most recent literature on climate change includes predictions of hydrological changes, higher temperatures, and expansion of drought areas, resulting in a northward and/or upward elevation shift in range for many species (IPCC 2007). A modeling study by Loarie et al. (2008) provides an evaluation of potential trends to California's floristic communities under climate change scenarios. In general, large numbers of plant species will tend to move to higher elevations, towards the coast, or northwards. The models suggest that climate change has the potential to break up local floras, resulting in new species combinations, with new patterns of competition and biotic interactions (Loarie et al. 2008). Based on these models, *Arctostaphylos pallida* plants would likely be unable to shift their range naturally because of their dependence on specific soil types and a maritime climate and due to the presumably low dispersal potential of the species. Climate change may also affect summer fog frequency and have a substantial impact on *Arctostaphylos pallida*, which is dependent on a fog-influenced maritime climate. According to M. Vasey (personal communication 2010), coastal endemic *Arctostaphylos* species are more vulnerable to summer drought stress than interior species, and if the frequency of coastal fog declines, the hydrologic regime of coastal *Arctostaphylos* species will likely become more challenging as they are not well-adapted to water stress. In addition, summer fog increases plant, soil, and atmospheric moisture, which decreases fire hazard and decreases the threat of too-frequent fire. Based on observational (Bakun 1990, Lebassi et al. 2009) and modeling studies (Diffenbaugh et al. 2004, Snyder et al. 2003) climate change may intensify upwelling, an important process in fog production off the coast of California, suggesting increases in fog in response to increased carbon emissions. However, Johnstone and Dawson (2010) found empirical evidence for moderate fog reductions since 1951, with interannual and multidecadal variations governed largely by ocean-atmosphere circulation and temperature anomalies.

Recovery**Reclassification Criteria:**

Not applicable

Delisting Criteria:

To delist *Arctostaphylos pallida*, threats to the species habitat must be reduced. This will be accomplished when the following has occurred: The 6,700 mature *Arctostaphylos pallida* plants counted toward recovery in delisting criterion E/2 are protected from incompatible uses through long-term conservation agreements with landowners. To delist *A. pallida*, the threat of disease must be controlled or eliminated. This will be accomplished when the following have occurred: Tools or treatments have been developed and are effectively being utilized that have stopped the spread of *Phytophthora cinnamomi* and any individual mortality. Treatments have been developed that allow *Arctostaphylos pallida* plants infected with *Phytophthora cinnamomi* to produce viable seed during or after treatment in quantities similar to uninfected healthy *A. pallida* plants. A *Phytophthora cinnamomi* monitoring plan has been developed and implemented for all *Arctostaphylos pallida* stands and areas within watersheds of stands, to determine if stands are infected, the extent of infection, and to identify potential sources of future infection. Other natural or manmade factors believed to affect the continued existence of *Arctostaphylos pallida* include: fire frequency, wildfire fuel reduction treatments, succession and non-native invasive species, and small population size and stochasticity. To delist *A. pallida*, these threats must be reduced. This will have been accomplished when the following have occurred: There are at least three separate populations of mature *Arctostaphylos pallida* plants: at least one population south of California State Route 24 (SR24) and at least two populations north of SR24, each with at least 1,700 genetically pure mature *A. pallida* plants.¹ For the purpose of recovery, a population is considered to be separate as long as it is more than 3.0 kilometers (1.9 miles) from the nearest *A. pallida* stand, and a mature plant is defined as being 25 years of age or greater. There are at least 6,700 genetically pure mature *Arctostaphylos pallida* plants. Competing native and non-native vegetation is controlled to a level whereby *Arctostaphylos pallida* vigor is not negatively affected and landowners have committed to provide long-term vegetation control that will conserve resident *A. pallida*. Stand regeneration methods (mechanical or fire) result in an increasing trend in the number of mature *Arctostaphylos pallida* over a 25-year period. Seed, representative of the breadth of the species' genetic diversity, is stored at a seed storage facility.

Recovery Actions:

- In 2009, as part of a Low Effect Habitat Conservation Plan for EBMUD lands in the San Francisco East Bay, a large *Pinus radiata* that shaded the Pinehurst Road stand was removed. Prior to the removal of this tree, the stand had declined from 25 to 11 mature *Arctostaphylos pallida* plants. Apparently, the increased light not only invigorated the plants that had been shaded, but the mild disturbance to the site, caused by horse logging activities, stimulated a portion of the soil seed bank and over 52 *A. pallida* seedlings germinated. EBMUD continues to survey the Pinehurst Road stand on an annual basis.
- In the summers of 2004 and 2005, approximately 500 square feet (152 square meters) were cleared by EBRPD at Huckleberry Preserve, leaving only *Arctostaphylos pallida* plants. Cut material and dead wood were placed into piles. In late February and early March of 2007, the piles were burned. In 2008, 176 seedlings had sprouted within the burned area.

- The Big Trees Trail stand is likely to have sustained greater mortality if not for vegetation management activities conducted by a local volunteer watershed restoration organization, the Friends of Sausal Creek (FOSC). The FOSC conducts surveys of the site and occasionally removes both native and non-native plants that shade *Arctostaphylos pallida* plants. The management of the Big Trees Trail stand was included in the Chabot management plan to allow for a memorandum of understanding between FOSC and CDFG to permit FOSC to conduct restoration activities at both sites. A small number of *A. pallida* seeds have again germinated at the Big Trees Trail site in the absence of fire. Seed germination is likely due to soil disturbance caused by vegetation removal activities that scarified the seed coats.
- A 1995 Environmental Impact Report (EIR) prepared for the construction of the Science Center in Oakland California required that an *A. pallida* management plan be created and implemented. The plan was finalized in September 2009, and proposes to restore habitat and maintain a minimum of 21 plants at the site (Nomad Ecology 2009). According to the management plan, restoration activities were to begin in October 2009; however, the *A. pallida* at the Science Center have continued to decline and management activities did not begin until 2013.
- Recovery Strategy: Because *Arctostaphylos pallida* is an obligate-seeding species naturally occurring as even-aged stands with a long-lived soil seed bank, the primary management goal, at the stand level, should be to maximize seed production and to ensure the soil seed bank is adequate to replace all mature plants within a stand in the event of fire. At this time, the most significant long-term threats to seed production and stand regeneration, and in effect, the continued existence of the species, are: 1) the fungal pathogen *Phytophthora cinnamomi* which directly kills *A. pallida* plants and results in perpetual soil contamination; 2) competition, via succession, with native and non-native vegetation for light and space; 3) an altered fire regime that may prematurely deplete soil seed banks; 4) fire fuels management; and 5) small population and stand sizes that increase the likelihood stochastic events will extirpate a stand or population. In addition to ensuring habitat loss does not occur as a result of development, these threats can be minimized or ameliorated through the implementation of management plans that include and prioritize the control of *P. cinnamomi* at the stand level, *P. cinnamomi* spread abatement at the landscape level, management of competing native and non-native vegetation, perpetual stand regeneration, maintenance of genetic diversity, stand expansion, establishment of additional stands, and compatible fuel reduction treatments and methods.

Conservation Measures and Best Management Practices:

- Phosphite (neutralized phosphorous acid), is a biodegradable systemic fungicide that, in part, potentiates plant defense mechanisms so that there is a more rapid and robust response to the pathogen. Phosphite stresses *Phytophthora cinnamomi*, causing it to release chemical signals that trigger the natural defense mechanisms of the host plant, thereby reducing the ability of *P. cinnamomi* to colonize and reproduce within the host (Suddaby and Liew 2008). Phosphite can be applied as a low volume aerial spray, high volume foliar spray, or by trunk injection of individual plants. The dosage of phosphite required to protect individual plant species is not universal. Applications that are too high for a particular plant species will have side-effects, such as leaf burning and a reduction in pollen viability, however, these effects may be temporary (Suddaby and Liew 2008). The efficacy of phosphite is not permanent and reapplication is required. The appropriate treatment regime (including an understanding of season, dose, application type, frequency, etc.) for *Arctostaphylos pallida* is not known at this time, but treatment frequency could be as often as once every 2 years. Low volume aerial application rates in Western Australia have

ranged from 12 to 24 kilograms per hectare (11 to 21 pounds per acre) with disease control anticipated for approximately 2 years post-spray (Barrett et al. 2001). A study is currently underway to assess the efficacy of phosphite for limiting the spread of root disease caused by *P. cinnamomi* in native *A. myrtifolia* stands (Swiecki and Bernhardt, 2012).

- EBRPD's Wildfire Hazard Reduction and Resource Management Plan: According to EBRPD's Wildfire Hazard Reduction and Resource Management Plan (WHRRMP) the maritime chaparral vegetation type represents an extreme wildfire hazard. To reduce the hazard, the WHRRMP aims to focus mechanical fuel treatment efforts on key locations, including almost all stands of *Arctostaphylos pallida*. To minimize the effects of the WHRRMP, the Service is working with the Federal Emergency Management Agency and EBRPD to complete a long-term *A. pallida* management plan. Although the WHRRMP threatens *A. pallida*, the WHRRMP includes the removal of both native and non-native vegetation that grows within and adjacent to stands of *A. pallida* to reduce wildfire hazard. Shading by native and non-native species poses a significant threat to the existence of *A. pallida* (see Factor E section on Succession and Non-native Invasive Species); thus, the WHRRMP, if implemented in conjunction with an *A. pallida* management plan, may benefit the species.

References

draft Recovery Plan

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U.S. Fish and Wildlife Service. 2015b. Recovery plan for *Arctostaphylos pallida* (pallid manzanita). U.S. Fish and Wildlife Service, Pacific Southwest Region, Sacramento, California. vi, 39 pp.

draft recovery plan

Natureserve

SPECIES ACCOUNT: *Arenaria paludicola* (Marsh Sandwort)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/3/1993; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A herbaceous green perennial often supported by surrounding vegetation, with angled or grooved stems, which are glabrous (without hair) except at the nodes (points of leaf attachment) (Figure 1, Figure 3). The trailing stems often root at the nodes, and can be up to 1 meter (3 feet) long. The opposite leaves of the plant are lanceolate (lance-shaped) and narrowly acute (sharp-pointed), with a solitary mid-vein. The species blooms from May to August. At Oso Flaco Lake, it was flowering with some green fruit in early June (John Chesnut, in litt. 1998). Flowers are small, white, and borne singly on long stalks arising from the leaf axils (point of leaf attachment to the stem); capsules (fruits) contain 15 to 20 seeds. The solitary axillary flower and smooth, angled stem distinguish this species from others in the genus. Hitchcock (1964) speculated that this plant was “very seldom collected, possibly because it is mistaken for sterile plants of *Galium aparine*,” a common species. As reported by Bonilla (1992, in litt. 1998) from Zempoala Lakes in the state of Morelos in central Mexico, this species is an annual, flowering April to September and producing seeds from June to October. (USFWS, 1998)

Taxonomy

Marsh sandwort (*Arenariapaludicola*) is a dicotyledonous plant belonging to the pink family (Caryophyllaceae). Pertinent synonyms for the scientific name are *Minuartia paludicola* House; *Alsinopsis paludicola* A. Heller; *Arenariapalustris* S. Watson not of Gay 1845; and *Alsine palustre* Kellogg. The species first was described as *Alsine palustre* by Albert Kellogg in 1863, from specimens collected by Bolander near Fort Point (now within Golden Gate National Recreation Area), San Francisco, California. The plant was then “very abundant in swamps” in the area (Kellogg 1863). In 1876, Sereno Watson reassigned the species to the genus *Arenaria*. The resulting name, *Arenaria palustris*, inadvertently duplicated the name that Gay had published earlier, in 1845, for another species. This duplication of names was corrected by B.L. Robinson (1894), who substituted the currently used scientific name, *Arenaria paludicola*. (USFWS, 1998)

Historical Range

Historically collected by botanists from scattered locations near the Pacific coast in southern and central California and Washington. California locations were recorded in 1899 in San Francisco and San Bernardino counties, in 1947 in Santa Cruz and San Luis Obispo counties, and in 1950 and 1964 in San Luis Obispo County. The southern range limit is given as Los Angeles County by Hitchcock (1964), and as the Santa Ana River (Orange County) by Hartman (1993). In a sequence of regional floras starting with Abrams and Ferris (1944), and continuing through Mason (1957), Munz and Keck (1968), Hoover (1970), Munz (1974), Smith (1976), and Hartman (1993), the earlier floras report the species as widespread within its historical range. Later floras report it as more localized and restricted, becoming “occasional,” “scarce” in swamps and marshes, and most recently, “rare.” (USFWS, 1998)

Current Range

In California, in San Luis Obispo County. One extant wild population at Oso Flaco Lake; one introduced population at Sweet Springs Marsh on the southern edge of Morro Bay. (USFWS, 2008)

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual, vegetative (USFWS, 2008)

Breeding Season

Adult: May - August (USFWS, 2008)

Reproduction Narrative

Adult: It generally blooms from May to August. This plant can also reproduce asexually. It can produce adventitious roots on the trailing stems that come in contact with suitable conditions (USFWS, 2008).

Habitat Type

Adult: Wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Freshwater marshes (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 0 - 450 m elevation (NatureServe, 2015); possibly shade (USFWS, 1998)

Habitat Narrative

Adult: Inhabits freshwater marshes from close to sea level to 450 m elevation. Plants have been found in areas with shallow standing water and with no standing water. Substrates are saturated, acidic, organic bog soils. Sensitive to disturbance; specialized habitat and wetlands are vanishing (NatureServe, 2015). Shady or filtered light conditions may inhibit the growth of *Arenaria paludicola* (USFWS, 1998).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Declining (most populations extirpated) (USFWS, 2008)

Species Trends:

Declining (USFWS, 2008)

Number of Populations:

1 (USFWS, 2008)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Sensitive to disturbance; specialized habitat and wetlands are vanishing. One U.S. occurrence with fewer than 10 plants, the other with more than 85 (Recovery Plan, 1998) (NatureServe, 2015). *Arenaria paludicola* has one known, remaining wild population. This population is declining. At the time of listing, *Arenaria paludicola* was considered to have been extirpated from eight other populations along the Pacific coast ranging from Washington to southern California. The 2008 5-Year Review stated: 'there is only one known, extant wild population, at Oso Flaco Lake, and one, extant, introduced population, at Sweet Springs Marsh on the southern edge of Morro Bay.' (USFWS, 2008).

Threats and Stressors

Stressor: Habitat destruction and degradation (USFWS, 2008).

Exposure:

Response:

Consequence:

Narrative: There continues to be both a loss and degradation of habitat due to development/urbanization and a conversion of marsh habitat due to the collateral, but indirect, effects from development/urbanization. Some of this habitat loss occurs in watersheds that are classified as impaired by the Regional Water Quality Control Board for excessive amounts of nitrogen and other nutrients (California State Water Resources Control Board 2006a). The vegetation in these watersheds exhibits excessive growth that is consistent with biostimulation and eutrophication (a state in which the total nitrogen is >1.5 milligrams/liter and/or the total phosphorus is >0.075 milligrams/liter within an aquatic system) (California State Water Resources Control Board 2006a, California State Water Resources Control Board 2006b, Central Coast Ambient Monitoring Program 2002, Dodds et. al. 1998) (USFWS, 2008).

Stressor: Herbivory (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Herbivory has been documented in some locations. While this plant may be able to withstand some herbivory, herbivory may cause a reduction in its reproductive success due to the loss of flowers and the correlated reduction in the production of seeds. The extent of this threat is not known, but the herbivory of even a few flowers may have a significant effect on the long-term survival of *Arenaria paludicola* because there are so few individuals and only one known population remaining in the wild (USFWS, 2008).

Stressor: Small population size (USFWS, 2008)

Exposure:**Response:****Consequence:**

Narrative: Small populations are threatened by inbreeding depression (Ellstrand and Elam 1993). Small populations can have significantly lower germination rates than larger populations of the same species due to high levels of homozygosity (Menges 1991). An increase in urban development has reduced the range of this species considerably. Increasing development in the area will likely increase threats from stochastic events. Indirect effects from urbanization in the watershed include changes in hydrology, changes in vegetation, and an increase in nonnative species. The effects of competition with nonnative species is most problematic immediately adjacent to urban areas and in habitat that has been isolated or fragmented by development (Alberts et al. 1993). These factors may not be enough to threaten the survival of *A. paludicola* independently, but taking into account its limited range, the cumulative and synergistic effects of all of these factors combined could be a threat to the survival and recovery of *A. paludicola* (USFWS, 2008).

Recovery**Reclassification Criteria:**

1. When new plants are established so that there are at least 5 populations of at least 500 individuals each (USFWS, 1998)
2. When some of the populations occur in permanently protected habitats within the Black Lake Canyon and the dune lakes area (USFWS, 1998)
3. When some of the populations are in other areas of suitable habitat with the species' historical range in the United States (USFWS, 1998)
4. When the populations remain viable for at least 5 years. Viable populations are defined as those that are showing natural reproduction and either stable or increasing in size over time, without artificial augmentation (USFWS, 1998)

Delisting Criteria:

1. If threats are reduced or eliminated so that protected populations are capable of persisting without significant human intervention or perpetual endowments are secured for management necessary to maintain the continued existence of the species. The most outstanding management needs currently are: a) controlling competition with nonnative species, and b) managing water conditions, particularly flow and salinity, that the species depends on. (USFWS, 2019)
2. If protected populations are established across the species ecological settings (in addition to Black Lake Canyon and the Dune Lakes area), including San Mateo Creek in San Onofre State Park in Orange County or comparable site(s) in that region; the San Antonio Creek drainage on Vandenberg Air Force Base in Santa Barbara County or comparable site(s) in that region; and wetlands in Golden Gate National Recreation Area in San Francisco County or comparable site(s) in that region. (USFWS, 2019)

3) the populations remain viable for at least 10 years. Because this species has narrow microhabitat conditions that it will tolerate, particularly with respect to soil moisture and salinity, and in light of fluctuations that can occur with climatic conditions, local groundwater table levels, and saltwater intrusion events, the persistence of populations with these varying conditions over time needs to be confirmed. (USFWS, 2019)

Recovery Actions:

- 1. Protect, maintain, and enhance species habitats. The most important immediate objective in the recovery plan for Marsh sandwort is the protection of its habitat. - Coordinate among agencies involved in recovery activities. - Define and maintain the sensitive Resource Area boundary and restrictions at Black Lake Canyon. - Establish protection agreements. - Acquire key land parcels and conservation easements. Enhance existing habitat at Black Lake Canyon. - Continue to protect, maintain, and enhance habitat in the Dune Lakes area. - Communicate species and habitat protection information to all concerned parties. (USFWS, 1998)
- 2. Document and monitor population and habitat characteristics. - Conduct plant surveys. - Protect newly discovered populations. - Monitor all populations and habitats. (USFWS, 1998)
- 3. Conduct research on the ecology and biology of the species. - Identify potential impacts of conducting research. - Determine population characteristics and life history of the species. - evaluate species' tolerances. - Investigate the effects of genetic diversity. (USFWS, 1998)
- 4. Augment existing populations. In addition to protecting existing and newly discovered habitats of Marsh sandwort, monitoring these populations and their habitats, and conducting research on the biology and ecology of the species, attempts should be made to augment existing populations. (USFWS, 1998)
- 5. Establish new populations. Because Marsh sandwort currently has very restricted distribution in California, establishment of new populations within the historic range of the species at potentially suitable sites other than at historic sites should be attempted. If new populations are successfully established, it will reduce the likelihood that a catastrophic event could result in the extinction of the species with its current restricted distribution. (USFWS, 1998)
- 6. Evaluate Progress and Update Management and Recovery Guidelines. Results of all recovery activities should be evaluated and incorporated into updated management and recovery guidelines for the species. All relevant information should be distributed. (USFWS, 1998)

Conservation Measures and Best Management Practices:

- Work with the California Department of Parks and Recreation and other stakeholders to implement site-specific management activities in the immediate future to alleviate threats and prevent the loss of the last, known remaining wild population (at Oso Flaco Lake) (USFWS, 2008).
- Work with others to establish several new populations in the near future to reduce the risk of extinction to *Arenaria paludicola* and maintain ex situ stock at two or more institutions (USFWS, 2008).
- Assemble a scientific recovery implementation team to assist us in determining a scientifically sound plan to reintroduce and introduce *Arenaria paludicola* to sites within its historical range in California (USFWS, 2008).

- Work with the Regional Water Quality Control Board to determine nutrient levels in the watersheds which have supported *Arenaria paludicola* in the recent past (particularly Black Lake Canyon and Oso Flaco), and work with local landowners and stakeholders to alleviate (and remove) any threats to *A. paludicola* that are associated with water quality (USFWS, 2008).
- Conduct a genetic analysis to determine the extent of variation within and between *Arenaria paludicola* populations to help determine an appropriate recovery and reintroduction strategy (USFWS, 2008).
- Survey historical *Arenaria paludicola* sites for potential extant occurrences and to identify suitable sites for reintroductions and survey areas in southern and central California and near Tacoma in Washington State for potential new *A. paludicola* occurrences and to identify suitable sites for introductions (USFWS, 2008).
- Modify downlisting criterion number 4 (“[T]he [introduced] populations remain viable for at least 5 years”) to viable onsite reproduction for more than one generation (i.e., a second, or “f2” generation) has been confirmed (USFWS, 2008).

References

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NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

USFWS. 2019. Amendment 1. Recovery Plan for Marsh Sandwort (*Arenaria paludicola*) and Gambel’s Watercress (*Rorippa gambelii*). U.S. Fish and Wildlife Service, Ventura, California. 13 pp. September 13, 2019. Link

SPECIES ACCOUNT: *Arenaria ursina* (Bear Valley sandwort)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/14/1998; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

This species is a low, tufted perennial herb with stems from 2 to 6 inches (in) (5 to 15 centimeters (cm)) long. The leaves are opposite and 0.16 to 0.5 in (0.41 to 1.3 cm) long. The flowers are white, five-parted and arranged in open cymes 1.5-6 in (3.8-15 cm) high. The petals are 0.16 to 0.2 in (0.41 to 0.51 cm) long, and the sepals are up to 0.16 in (0.41 cm) long (63 FR 49006). Bear Valley sandwort is distinguished from other members of the genus within its range by its glabrous, filiform, nerveless leaves that are less than 0.08 in (0.2 cm) wide and its rounded 0.12 to 0.16 in (0.3 to 0.41 cm) long sepals (63 FR 49006). (USFWS, 2008)

Taxonomy

Member of the pink family (Caryophyllaceae). The Service made a technical correction to the List of Endangered and Threatened Plants at 50 CFR 17.12(h) to reflect acceptance of the change in scientific name for Bear Valley sandwort to *Eremogone ursina* (B.L. Rob.) Ikonn. (Ikonnikov 1973, p. 140) from *Arenaria ursina* B.L. Rob. (Robinson 1894, p. 294). Recent phylogenetic analysis of three chloroplast gene regions has confirmed the polyphyletic nature of *Arenaria*, and supports recognition of *Eremogone* as a separate genus (Harbaugh et al. 2010, p. 195) (USFWS, 2015).

Historical Range

Eremogone ursina was known from pebble plain complexes in the vicinity of Big Bear and Baldwin lakes in San Bernadino County, California. (USFWS, 2015)

Current Range

Eremogone ursina was known from pebble plain complexes in the vicinity of Big Bear and Baldwin lakes in San Bernadino County, California. (USFWS, 2015)

Critical Habitat Designated

Yes; 1/25/2008.

Legal Description

On December 26, 2007, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective January 25, 2008) for *Arenaria ursina* (Bear Valley sandwort) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation for this species includes 17 critical habitat units (CHUs) in California (72 FR 73092-73178).

Critical Habitat Designation

The critical habitat designation for *Arenaria ursina* includes 17 CHUs in San Bernardino County, California. Approximately 1,412 ac (571 ha) of Federal and private land are being designated as critical habitat for *A. ursina* (72 FR 73092-73178). Units are grouped by pebble plain complexes (e.g., Arrastre/Union Flat) as identified in the USFS's 2002 Management Guide. Detailed coordinates and maps are provided in the Final Rule.

Units ARUR 1 and ARUR 2, Arrastre/Union Flat, San Bernardino County, California. ARUR 1 contains 69 ac (28 ha); ARUR 2 contains 229 ac (93 ha). The landowner is the U.S. Forest Service. ARUR 1 is USFS Pebble Plain Number 100; ARUR 2 is USFS Pebble Plain Number 87.

Units ARUR 3 and ARUR 4, Big Bear Lake, San Bernardino County, California. ARUR 3 contains 21 ac (9 ha); ARUR 4 contains 6 ac (2 ha); the landowner is the U.S. Forest Service. ARUR 3 is USFS Pebble Plain Number 248; ARUR 4 is USFS Pebble Plain Number 254.

Unit ARUR 5, Broom Flat, San Bernardino County, California. ARUR 5 contains 326 ac (132 ha). The landowners are the U.S. Forest Service (255 ac) and a private landowner (71 ac). ARUR 5 is USFS Pebble Plain Numbers 285 and 309.

Unit ARUR 6 and ARUR 7, Fawnskin, San Bernardino County, California. ARUR 6 contains 15 ac (6 ha); ARUR 7 contains 24 ac (10 ha). The landowner is the U.S. Forest Service. ARUR 6 is USFS Pebble Plain Number 301; ARUR 7 is USFS Pebble Plain Number 302.

Units ARUR 8, ARUR 9, and ARUR 12, Gold Mountain and North Baldwin Lake, San Bernardino County, California. ARUR 8 contains 62 ac (25ha); ARUR 9 contains 43 ac (17 ha); ARUR 12 contains 320 ac (129 ha). The landowner is the U.S. Forest Service. ARUR 8 is USFS Pebble Plain Number 188; ARUR 9 is USFS Pebble Plain Number 192; ARUR 12 is USFS Pebble Plain Number 128.

Units ARUR 10 and ARUR 11, Holcomb Valley, San Bernardino County, California. ARUR 10 contains 28 ac (11 ha); ARUR 11 contains 44 ac (18 ha). The ARUR 10 landowners are the U.S. Forest Service (22 ac) and a private landowner (6 ac). ARUR 11 is owned by the U.S. Forest Service. ARUR 10 is USFS Pebble Plain Numbers 98 and 109; ARUR 11 is USFS Pebble Plain Number 153.

Units ARUR 13 and ARUR 14, Sawmill, San Bernardino County, California. ARUR 13 contains 36 ac (15 ha); ARUR 14 contains 5 ac (2 ha). The ARUR 13 landowners are the U.S. Forest Service (15 ac) and a private landowner (21 ac). ARUR 13 is USFS Pebble Plain Number 236; ARUR 14 is USFS Pebble Plain Number 224.

Unit ARUR 15, South Baldwin Ridge/Erwin Lake, San Bernardino County, California. ARUR 15 contains 23 ac (9 ha). The landowner is the U.S. Forest Service. ARUR 15 is USFS Pebble Plain Number 212.

Units ARUR 16 and ARUR 17, Sugarloaf Ridge, San Bernardino County, California. ARUR 16 contains 127 ac (51 ha); ARUR 17 contains 34 ac (14 ha). The landowner is the U.S. Forest Service. ARUR 16 is USFS Pebble Plain Number 294; ARUR 17 is USFS Pebble Plain Number 289.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of critical habitat for *Arenaria ursina* are the habitat components that provide (72 FR 73092-73178):

- (i) Pebble plains in dry meadow-like openings within upper montane coniferous forest, pinyon-juniper woodlands, or Great Basin sagebrush in the San Bernardino Mountains of San Bernardino

County, California; at elevations between 5,900 to 9,800 ft (1,830 to 2,990 m) that provide space for individual and population growth, reproduction and dispersal.

(ii) Seasonally wet clay, or sandy clay soils, generally containing quartzite pebbles, subject to natural hydrological processes that include water hydrating the soil and freezing in winter and drying in summer causing lifting and churning of included pebbles, that provide space for individual and population growth, reproduction and dispersal, adequate water, air, minerals, and other nutritional or physiological requirements to the species.

Special Management Considerations or Protections

Critical habitat does not include manmade structures (such as buildings, aqueducts, airports, roads, and other paved areas) and the land on which they are located existing on the effective date of this rule and not containing one or more of the primary constituent elements.

Threats to listed pebble plains plants throughout their range include land development, off-highway vehicle (OHV) use off of designated routes, road maintenance activities, ground disturbance that affects surface hydrology, mining activities, recreational activities, and nonnative plant species (63 FR 49006; September 14, 1998). Pebble plain habitat is also threatened by vegetation and fuels management, hazard tree removal, and wildfire suppression activities (Eliason 2006). However, of the above threats, land development remains the primary cause of habitat loss on private lands; while on Federal lands, OHV use off of designated routes has historically been, and continues to be, the most significant threat to pebble plains habitat. Increasing residential populations adjacent to pebble plains habitat on private and Federal lands has also resulted in degradation of habitat, as dispersed recreation and unauthorized OHV use increases (Eliason 2006). Also, while forest system road use and maintenance, mining activities, and dispersed recreation continue to have adverse ongoing effects to pebble plain habitat and the species it supports, the magnitude and severity of effects caused by these activities are relatively small compared to the effects of unauthorized motorized vehicle use (Eliason 2006). The primary constituent elements for the listed pebble plains plants may require special management considerations or protection to minimize impacts associated with, (1) vehicle use and road maintenance; (2) recreational activities; and (3) the presence of nonnative species (63 FR 49006, September 14, 1998; USFS 2002, p. 17; USFS 2005, pp. 207, 249, 293).

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (outcrossing), self-pollination (USFWS, 2015)

Breeding Season

Adult: May - June (USFWS, 2015)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 2015)

Reproduction Narrative

Adult: Plants flower between May and June. *Eremogone ursina* produces seeds by selfing (self-pollinating) and entomophilous (insect-mediated) outcrossing (O'Brien 1979, p. 80). Small syrphid flies, sphecids wasps, and bees appear to be the primary insect pollinators for this species (O'Brien 1979, p. 82; Freas and Murphy 1990, p. 6). O'Brien (1980, p. 217) observed that *E. ursina* flowers with their open cup morphology were heavily visited by insects, in contrast to pebble plain plants with specialized flower morphology. Additionally, this species was dependent on insects for maximum seed set, as bagged individuals had approximately half of the seed production of those that were not bagged (O'Brien 1980, p. 214). (USFWS, 2015).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Pinyon and juniper woodland (NatureServe, 2015); pebble plain (USFWS, 2007)

Dependencies on Specific Environmental Elements

Adult: Surface water flow (USFWS, 2015); freeze-thaw cycles (USFWS, 2007)

Geographic or Habitat Restraints or Barriers

Adult: 1800 - 2300 m elevation (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015 and USFWS, 2007)

Habitat Narrative

Adult: Grows on pebble plains and dry slopes in pinyon and juniper woodland. Pebble plains: dense clay soils, usually covered with a cobble pavement of quartzite. These are sparsely vegetated; they occur as openings in the surrounding forest at 1800 - 2300 m elevation. They support several endemic plant species and disjunct occurrences of plants that are more common elsewhere. Occurs with *Eriogonum kennedyi* ssp. *austromontanum*. *Eremogone ursina* tolerates more shaded sites than other pebble plains associated species. Habitat does not recover well from disturbance. This species has a very narrow environmental specificity (NatureServe, 2015). This species is restricted to specific habitats (i.e., specialized niche) found within a narrow range of the San Bernardino Mountains and dependent upon undisturbed surface water flows and associated physical features that are easily and permanently altered by human activities. This species requires pebble plains in dry meadow-like openings within upper montane coniferous forest, pinyon-juniper woodlands, or Great Basin sagebrush, and seasonally wet clay, or sandy clay soils, generally containing quartzite pebbles, subject to natural hydrological processes that include water hydrating the soil and freezing in winter and drying in summer causing lifting and churning of included pebbles (USFWS, 2007).

Dispersal/Migration**Dispersal**

Adult: Low (inferred from USFWS, 2015)

Dispersal/Migration Narrative

Adult: The seeds of *E. ursina* are flat, reticulate, measure 2 millimeters (mm) (0.079 in) long, remain in open erect capsules for up to 2 months, and can bounce out of the capsule in a strong wind (O'Brien 1979, pp. 81–82) (USFWS, 2015).

Population Information and Trends**Population Trends:**

Not available

Species Trends:

10 - 50% decline (NatureServe, 2015)

Number of Populations:

10 (NatureServe, 2015)

Population Size:

2500 - 10,000 individuals (NatureServe, 2015)

Adaptability:

Low (inferred from USFWS, 2015)

Population Narrative:

As of 2008, 10 occurrences are documented (USFWS 2008). The species has experienced a short-term decline of 10 - 50% (NatureServe, 2015). Many descriptions from surveys describe unknown numbers of plants; however, three pebble plain complexes have recorded individual plant numbers greater than 1,000, and two locations have plant counts in the hundreds. This species exhibits several attributes that can limit its distribution and population growth, including low levels of gene transfer between populations (USFWS, 2015).

Threats and Stressors

Stressor: Urbanization (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Much of the habitat historically occupied by *Eremogone ursina* on private lands was lost to residential and commercial development (USFS 2012a, p. 31). Urban development (primarily residences) and related recreational development on city, county, or private lands within the Big Bear Lake and Baldwin Lake areas continue to represent an ongoing threat to *Eremogone ursina* at six of the pebble plain complexes. Several utilities operating within the San Bernardino Mountains provide either direct services to urbanized areas in the region or related infrastructure, and their operation and maintenance activities can affect populations of *Eremogone ursina* or its critical habitat. The primary threats to *E. ursina* from these utilities include ground disturbance and localized trampling of habitat related to operation and maintenance activities, such as pole replacements (USFWS, 2015).

Stressor: Road and trail use (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: An estimated 9.6 mi (15.4 km) or 223 ac (90 ha) (using 100 foot (30 meters) of centerline) of roads and trails affect *Eremogone ursina* occurrences within an estimated 1,591 ac (642 ha) of *E. ursina* occupied habitat located on lands owned and managed by the USFS (USFS 2012b, p. 22). Threats to *Eremogone ursina* from roads and trails include both direct effects, such as habitat alteration, and indirect effects, including alteration of water flow and drainage patterns, sedimentation, deposition of particulates (dust), and effects related to wildfire (USFS 2012b, pp. 21–24). Roads, road construction, and road maintenance can also facilitate the introduction and establishment of nonnative plants by creating open, continually disturbed habitat as well as disrupt hydrological processes within pebble plains habitats. Nonnative plants can be transported along these road corridors by equipment and vehicles, and are often more easily established on exposed cut-and-fill slopes of roads than native plants (USFS 2005b, Vol. 1, p. 114). Ongoing use and maintenance of USFS trails likely subjects *Eremogone ursina* to occasional localized crushing, uprooting, or burial of habitat and individuals in the Big Bear Lake, Baldwin Lake, and Sugarloaf–Onyx areas (USFS 2012b, pp. 59, 76–77, 82). Unauthorized OHV use has impacted all pebble plain complexes to varying degrees (USFS 2002, p. 25). Impacts also result from the effects of non-motorized trails and mountain biking due to the proximity of *E. ursina* and its habitat to urban areas (USFS 2012b, pp. 60–61). Along with soil compaction, soil erosion resulting from OHV use could significantly alter *Eremogone ursine* habitat. Vehicle traffic during the wet season is of particular concern, as this activity directly disturbs or destroys vegetation and creates deep ruts that change the hydrological patterns over the pebble plain (USFS 2002, p. 20). (Threats from alteration of hydrological conditions is discussed below). Vehicle traffic also increases breakdown in natural soil aggregates (structure) (Sadler 1989, pers. comm., cited in USFS 2002, p. 23). Associated with OHV activity is unauthorized collection of wood for fuel including removal of downed vegetation or trees (USFWS, 2015).

Stressor: Alteration of hydrology (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Alteration of hydrology can also result from land disturbance due to mining and fire suppression activities. Normally, surface water flows evenly across the relatively impervious pebble plains (Odell 1988, p. 19). However, changes in the hydrological pattern associated with a disturbed pebble plain could alter the soil composition by allowing for erosion of clay sediments during rainfall events, leaving only large cobbles and pebbles (Neel and Chaney 1992, p. 1). These potential changes to soil morphology and composition could theoretically result in invasion of both native and nonnative plant species that then out-compete *Eremogone ursina* for space and resources. Once established, native trees and shrubs alter the surrounding microhabitat by shading, increasing leaf litter, and probably by reducing temperature extremes (Derby 1979, pp. 72–73; USFS 2002, p. 15) (USFWS, 2015).

Stressor: Trampling by ungulates (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: At present, the threat of trampling to pebble plain habitat and to individual plants, including *Eremogone ursina*, due to burro activity is estimated to be very minor. However, if soils within pebble plain habitats are wet, trampling effects may be more significant to both habitat and individual plants (Eliason 2013b, pers. comm.). Hitchcock Ranch, a private inholding in the Holcomb Valley area, grazes approximately 30 to 40 horses in the Hitchcock Meadow (located within the Holcomb Valley pebble plain complex), which is occupied by *Eremogone ursina* and other federally listed plants (USFS 2012b, p. 74). The extent and severity of effects of trampling by horses in this portion of the Holcomb Valley to *E. ursina* habitat and individual plants is currently unknown (USFWS, 2015).

Stressor: Nonnative plants (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: The presence of *B. tectorum* within pebble plain habitat can provide a continuous “flashy” fuel load and the potential to increase the fire return interval (USFS 2005a, p. 101); though it is unclear to what extent fire has affected pebble plain communities, its presence represents an increasing concern for fire management (USFS 2005a, p. 101). *Bromus tectorum*, as well as *Erodium cicutarium* (filaree), represent very old invasions in the San Bernardino Mountains and are persistent threats within these complexes (Eliason 2012b, pers. comm.). More recent invasions of nonnative plant species within some of these pebble plain complexes include *Linaria dalmatica* (dalmatian toadflax), *Ranunculus testiculatus* (bur buttercup), and *Lepidium perfoliatum* (clasping pepperweed) (Eliason 2012b, pers. comm.) (USFWS, 2015).

Stressor: Mining (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Unpatented mining claims on USFS lands were previously reported for five pebble plain complexes occupied by *Eremogone ursina*: (1) Holcomb Valley (83 ac (33.6 ha)), (2) Fawnskin (24 ac (9.7 ha)), (3) Arrastre Flats (69 ac (28 ha)), (4) North Baldwin Lake (62 ac (25 ha)), and (5) Broom Flat (0.2 ac (0.08 ha)) (USFS 2002, pp. 42, 46, 48, 57, 65). These claims continue to represent a potential threat of ground disturbance for *E. ursina*, specifically, gold prospecting activities or mining operations related to the ownership of mineral rights. Some of these mining activities may fall under the Notice of Intent submission exceptions of 36 CFR § 228.4 (regulations that govern locatable minerals on USFS lands) and are therefore not reviewed by the USFS, which could result in the uprooting, burying, or crushing of meadow plants (USFS 2012b, p. 33). The Holcomb Valley area, which includes the Holcomb Valley and Arrastre Flats pebble plain complexes, is a particularly active area for small-scale mining activities (e.g., prospecting by clubs and individuals) and represents an area of concern for pebble plain plants and their habitats (USFS 2012b, p. 74). Small-scale mining activities around Doble in the North Baldwin Lake pebble plain complex could affect a small portion of occupied habitat (USFS 2012b, p. 80) (USFWS, 2015).

Stressor: Fire suppression (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Fire suppression activities typically include fire line construction, fire retardant and water drops, establishment of temporary fire camps, staging areas, parking sites, safety zones, helipads, and post-fire rehabilitation (USFWS 2005, p. 27). Each of these activities can have negative impacts to *E. ursina* and its habitat. For example, safety zone and fire line construction can involve using bulldozers to clear vegetation and parking areas, and fire camps result in heavy trampling and soil compaction from equipment and vehicles. Additionally, fire lines that cut through habitat can alter hydrological patterns as well as destroy individual plants or encourage the establishment of nonnative species (USFWS 2005, p. 27) (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Climate change has already altered, and will continue to alter, the water cycle. Changes in the water cycle, which are consistent with the warming observed over the past several decades, include, but are not limited to: (1) changes in precipitation patterns and intensity; (2) changes in the incidence of drought; (3) widespread melting of snow and ice; (4) increasing evaporation; and (5) changes in soil moisture and runoff (USGCRP 2009, p. 41). Although the effects of climate change on *Eremogone ursina* and its habitat have not been measured and there is uncertainty in future predictions of downscaled climate change models, projected climate change effects mentioned above could significantly alter the hydrology that sustain and characterize pebble plain habitat occupied by *E. ursina*. Freas and Murphy (1990, p. 8) reported reproductive failure of four pebble plain plant taxa—including *Eremogone ursina*—and significantly reduced vigor of adult plants in 1989 following several years of drought, particularly in the easternmost (i.e., driest) pebble plains. Thus, an increased number high temperature events due to the effects of climate change could create conditions that exceed the drought tolerance of *E. ursina*, causing direct mortality of individuals and decreased reproduction (USFWS, 2015).

Recovery

Reclassification Criteria:

Not applicable.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Recommendation for Future Action from 2015 5-Year Review: Work with biologists at the SBNF to reduce impacts from recreational use of roads and trails through uncontrolled access to pebble plain habitat occupied by *Eremogone ursina*. Prioritize protective measures being implemented (or planned) for controlling access to areas occupied by *E. ursina*. This should include providing comment on biological assessments for proposed activities to support SBNF program of road closures and/or assistance in securing resources for placement of more effective barriers in the areas that receive the highest recreational uses from motorized vehicles (USFWS, 2015).
- Recommendation for Future Action from 2015 5-Year Review: Conserve or preserve *Eremogone ursina* occurrences on private lands. Continue to work with the State and local

- groups to purchase *E. ursina* habitat from willing sellers, particularly within the Sawmill pebble plain complex (USFWS, 2015).
- Recommendation for Future Action from 2015 5-Year Review: Develop a monitoring plan to provide early detection of downward trends in the populations of pebble plain plants, such as *Eremogone ursina*, and quality of pebble plain habitat (adapted from USFS 2005a, p. 125). This monitoring plan should identify and prioritize surveys of plant populations, including abundance, and habitat conditions, in those areas most vulnerable to threats (e.g., pebble plain complexes with high levels of recreational activity) and should include remote sensing and mapping of unauthorized OHV trails (USFWS, 2015).
 - Recommendation for Future Action from 2015 5-Year Review: Evaluate reproductive life history characteristics of *Eremogone ursina*, such as seed germination requirements, mechanism of seed dispersal, and seed viability (USFWS, 2015).
 - Recommendation for Future Action from 2015 5-Year Review: Determine the distribution of genetic diversity in *Eremogone ursina* occurrences and identify the most appropriate means to preserve the diversity (USFWS, 2015).

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SPECIES ACCOUNT: *Argemone pleiakantha* (Sacramento prickly poppy)

Species Taxonomic and Listing Information

Listing Status: Endangered; 08/24/1989; Southwest Region (Region 2) (USFWS, 2016)

Physical Description

Sacramento prickly poppy is a robust, short-lived perennial, 0.5-1.5 m (1.5-5.0 ft) tall with 3-12 branching stems and striking, blue-green colored leaves. The leaves are about 10.0-15.0 cm (4.0-6.0 in) long, with rectangular sinuses and spine-tipped lobes extending almost to the midrib. The veins and midrib are armored with stout, yellow spines. The large and showy white flowers have 6 petals 3.0-4.0 cm (1.2—1.6 in) long and 8.0-9.0 cm (3.5 in) wide, with numerous orange stamens and a purple stigma. Capsule spines are simple. The small, round, black seeds are 2.5 mm (0.1 in) in diameter and dispersed by wind, water and possibly animals (R. Galeano-Popp, U.S. Forest Service (USFS), pers. comm., 1992; R. Sivinski, New Mexico Energy Minerals and Natural Resources Department (NMEMNRD), in litt., 1992). In addition to the deeply divided leaves and simple capsule spines, Sacramento prickly poppy has white—colored stem sap. (USFWS, 1994)

Taxonomy

Prior to this description, Sacramento prickly poppy was considered part of the *Arcemone platyceras* complex (Soreng 1982). However, this name included what are currently considered to be many taxa distributed throughout the western U.S. and Mexico. *Argemone platyceras* is now applied only to species endemic to Mexico (Soreng 1982). Although *Argemone* is a common genus in the New Mexico flora, no other species of *Argemone* occurs within the range of *Aroemone pleiakantha* ssp. *pinnatisecta*. These features readily distinguish the subspecies from *Argemone pleiakantha* ssp. *pleiakantha*, which has less deeply divided leaves, denser capsule spines with 1 or 2 minute spines at the base, and yellow-orange stem sap (Spellenberg 1977, Martin and Hutchins 1990, Wood 1990). Malaby (1988) provided additional information on the sap color, observing that stem sap is white but yellow sap is present in the roots of *Argemone pleiakantha* ssp. *pinnatisecta*. (USFWS, 1994)

Current Range

Endemic to 10 canyons on the western slope of the Sacramento Mountains in Otero County, central-southern New Mexico. (USFWS, 1994)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Dependency on Other Individuals or Species

Adult: The flowers have a variety of pollinators that include carpenter bees (*Xylocopa californica arizonensis*), honey bees (*Apis mellifera*), bumblebees (*Bombus* spp.), soldier beetles (*Cantharidae*), lizard beetles (*Liguriidae*), flies (*Diptera*), and butterflies (*Lepidoptera*) (U.S. Forest Service 2004). (USFWS, 2013)

Breeding Season

Adult: May through summer (USFWS, 2013)

Key Resources Needed for Breeding

Adult: Germination can only occur after cold stratification and is further enhanced if the seed coat is also scarified. (USFWS, 1994)

Reproduction Narrative

Adult: Generally, plants bloom during the second year, if moisture availability has allowed for sufficient growth. Flowering begins in May and continues throughout the summer depending on elevation and moisture conditions. The flowers have a variety of pollinators that include carpenter bees (*Xylocopa californica arizonensis*), honey bees (*Apis mellifera*), bumblebees (*Bombus* spp.), soldier beetles (*Cantharidae*), lizard beetles (*Liguriidae*), flies (*Diptera*), and butterflies (*Lepidoptera*) (U.S. Forest Service 2004). Studies of pollination biology and subsequent fruit set and seed production show that prickly poppy will set little or no fruit unless visited by pollinators. Self pollination, either within one flower or among flowers of the same plant, results in significantly fewer fruits and fewer seeds per fruit (Tepedino 1992). Seed output for mid- sized plants in Alamo and Dog canyons averaged about 2,000 seeds per plant (Malaby 1988). However, based on nursery results, seed germination is low (approximately 3 percent in 1989) and seedling mortality is high (Malaby 1988). Germination can only occur after cold stratification and is further enhanced if the seed coat is also scarified. (USFWS, 1994; USFWS, 2013)

Habitat Type

Adult: Terrestrial and palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Riparian, desert, forest/woodland, woodland- conifer (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 4,200 and 7,120 feet (USFWS, 1994)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1994)

Tolerance Ranges/Thresholds

Adult: High (USFWS, 1994)

Habitat Narrative

Adult: Sacramento prickly poppy is found in the dry hills, pinyon-juniper zone (Flora of North America Editorial Committee 1997) on loose, gravelly soils of open disturbed sites, canyon bottoms and slopes (McDonald 2010). Usually in areas of enhanced soil moisture such as north-facing slopes, canyon bottoms, along drainages, and near leaks in water pipelines. Sacramento prickly poppy occurs in rocky canyons on the western slope of the Sacramento Mountains. It ranges from 4,200 feet elevation in the lower Dog Canyon area to 7,120 feet elevation in upper Alamo Canyon area (Malaby 1987). The topography of the area is characterized by steep, rocky hillsides. Soils are primarily derived from limestone and may also contain sandstone and gypsum

(USFS 1992). Numerous large canyons and arroyos drain westward into the Tularosa Basin. Annual precipitation in the Sacramento Mountains averages about 38 cm (15 in) per year, most of which occurs from July through October, during brief but heavy thundershowers (U.S. Soil Conservation Service (SCS) 1981). All canyons on the west side of the Sacramento Mountains experience periodic and severe flash floods (USFS 1992). Wide fluctuation in diurnal and seasonal temperatures is characteristic of the western slope of the Sacramento Mountains. Temperatures average above 90 degrees Fahrenheit from mid—May to mid— September and may go as low as 16 degrees Fahrenheit during the winter (SCS 1981). High temperatures combined with high insolation and high evaporation rates create xeric conditions in the western foothills of the Sacramento Mountains (NMNP PAC 1984). Unlike seedlings, established poppy plants appear to be capable of weathering periods of drought by becoming dormant. (USFWS, 1994; USFWS, 2013)

Dispersal/Migration

Dispersal

Adult: Medium (USFWS, 1994)

Dispersal/Migration Narrative

Adult: The small, round, black seeds are 2.5 mm (0.1 in) in diameter and dispersed by wind, water and possibly animals (R. Galeano—Popp, U.S. Forest Service (USFS), pers. comm., 1992; R. Sivinski, New Mexico Energy Minerals and Natural Resources Department (NMEMNRD), in litt., 1992). The majority of Sacramento prickly poppy seeds do not travel far from the parent plant and would remain there if flash floods did not move these large and heavy seeds downslope through the canyon drainage channels. This large endosperm could be a potential source of food for various rodents, birds, and insects. Dispersal by animals to upland sites may account for the occasional presence of prickly poppy plants in areas away from drainages. Soreng (1982) observed ants transporting seeds. (USFWS, 1994)

Population Information and Trends

Population Trends:

Long-term trends suggest a decline of 30 to 50% (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

9 (NatureServe, 2015)

Population Size:

~1,000 (NatureServe, 2015)

Population Narrative:

Long-term population trends suggest a decline of 30 to 50%. Approximately 1,286 total plants of Sacramento prickly poppy occupy 10 canyons on the western slope of the Sacramento Mountains in south—central New Mexico. In the late 1980's, there were approximately 1300 plants (McDonald 2010). More recently, the total number of plants is estimated to be below 1000 (Sivinski 1999; Tonne 2008 cited by Cervantes et al. 2010). (USFWS, 1994; NatureServe, 2015)

Threats and Stressors

Stressor: Flooding (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Flooding and erosion are known threats to the poppy (Soreng 1982; U.S. Fish and Wildlife Service 1989, 1994, 2004, 2012; Sivinski 1992; Forest Service 2004; Tonne 2008). In 1977, severe floods were observed to remove up to 100 plants from lower Alamo Canyon (Fletcher 1978; Soreng 1982). Two years later, when Fletcher found only six plants in this location in 1979, he speculated that the population might be in jeopardy of extirpation. Observations since this time have shown that plants in and along arroyos are subject to periodic damage and loss of mature plants from floods, and numbers fluctuate considerably in response to flooding. Some plants are completely removed or buried by floods, and others re-sprout from roots (Tonne 2008). Recent floods have had severe, damaging effects to individual poppy plants, but long-term impacts to populations are unknown (U.S. Forest Service 2008). (USFWS, 2013)

Stressor: Livestock (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Grazing and trampling by livestock can destroy young seedlings and can potentially degrade the quality of poppy habitat. Livestock grazing can affect vegetation species composition, plant density, and plant vigor. Cattle tend to occupy canyon bottoms, where poppy seedlings are most likely to occur, because the steep sides of the canyon render most of the acreage in the pasture inaccessible. Out of the approximately 11,000 acres on the Alamo winter pasture, only about 3,000 acres are usable and accessible to livestock. Livestock may avoid eating most mature poppy plants due to their bitter-tasting latex; however, early season basal rosettes with spines have been grazed to the ground (Forest Service 2005). Detrimental effects to the poppy depend on the timing, intensity, and duration of livestock use. Trampling by cattle has been more frequently observed than herbivory, especially of adult plants. Herbivory by livestock appears to occur mostly during periods of drought, but trampling by livestock can impact the poppy at any time (Salas and Barker 2003; Tonne 2008). Healthy mature plants appear to be capable of re-sprouting after livestock tread on them, but mortality appears likely to occur in young plants or in stressed mature plants suffering from drought or disease. At higher stocking rates, the threat of seedling mortality is greatly increased because livestock have a direct negative impact on the poppy when their presence coincides with the emergence of seedlings (Soreng 1982; Wagner and Sabo 1982; U.S. Fish and Wildlife Service 1989, 1994, 2005, 2008, 2012; Wood 1992; Salas 2003). The period between germination and establishment of the mature poppy is the most vulnerable time in this plant's life cycle. This developmental stage is the main impediment to increased abundance in any colony or population of this taxon.

Germination has been documented throughout the range of the poppy, sometimes in great abundance. However, as with many plants, few of these seedlings survive to become reproductive adults. Some are killed almost immediately through trampling by livestock, while others face periods of dry weather, flooding, or other disturbance. Rotation dates have sometimes been violated, and cattle have remained in poppy habitat year-round, causing damage to poppy seedlings and likely contributing to poor watershed condition through the reduction of herbaceous and riparian vegetation (Tonne 2008, U.S. Forest Service 2008). (USFWS, 2013)

Stressor: Herbicide spraying (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: In 2007, herbicide was sprayed by the New Mexico Department of Transportation on U.S. Highway 82 near High Rolls, New Mexico, to reduce vegetation in the right-of-way. The herbicide was applied directly to at least five adult poppies, killing three of these. The Forest Service flagged areas that should not be sprayed, but this did not successfully protect the plants. The use of flagging does not appear to be adequate because, at best, it protects only adults known to the Forest Service employee deploying the flagging. It does not protect seedlings or young plants, or adults that are hidden from view (Tonne 2008). Due to this event, the New Mexico Department of Transportation has not sprayed herbicide in poppy habitat again. An agreement to improve protection of poppies from this activity has been discussed among the New Mexico Department of Transportation, U.S. Forest Service, and U.S. Fish and Wildlife Service. (USFWS, 2013)

Stressor: Road maintenance (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: During spring 2008, the City of Alamogordo cleared a maintenance road in upper Alamo Canyon, destroying many mature poppies (U.S. Forest Service 2008). During a survey in June 2008, only a few poppies had re-sprouted in this area. Some poppies that were previously located in or adjacent to the roadway were missing and presumed dead, but a few had re-sprouted in the road (U.S. Fish and Wildlife Service 2008). (USFWS, 2013)

Stressor: Water extraction (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: The City of Alamogordo captures water at the head of Alamo, Caballero, Fresno, and La Luz canyons, potentially reducing the amount of water available to the poppy. Because poppy seedlings are delicate and sensitive to drying until they establish their taproot, any factor that increases soil dryness is likely to affect seedling establishment and recruitment. This permanent removal of water at headwater springs under State water rights by local communities, combined with livestock presence, drought, and climatic fluctuations have degraded riparian and spring habitat (U.S. Forest Service 2003, 2008; Tonne 2008). These relatively mesic areas within the range of the poppy may have historically served as important reserves during periods of drought. (USFWS, 2013)

Stressor: Road and pipeline construction, maintenance (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Road and pipeline construction and maintenance activities sometimes destroy poppy plants. The Lincoln National Forest performs road maintenance on approximately 523 km (325 mi) of roads per year. Additional maintenance is conducted on Federal, State, and county non-National Forest System roads (U.S. Forest Service 2004). In Fresno Canyon, road maintenance by the Otero County Road Maintenance Department resulted in the loss of poppy plants along an unpaved National Forest System road. In Fresno Canyon, road maintenance by the Otero County Road Maintenance Department resulted in the loss of poppy plants along an unpaved National Forest System road. During spring 2008, the City of Alamogordo cleared a maintenance road in upper Alamo Canyon, destroying many mature poppies (U.S. Forest Service 2008). Surveys in June 2008, reported that only a few poppies had re-sprouted. Many poppies that were previously located in or adjacent to the road were missing and presumed dead (U.S. Forest Service 2008). The loss of plants in the upper reaches of occupied habitat leads to reductions in seed dispersal from this area to existing colonies and potential new habitat downstream. The City of Alamogordo maintains water pipelines that tap large springs on the upper western slope of the Sacramento Mountains. These pipelines occur in La Luz, Fresno, Alamo, and Caballero Canyons. The water rights for these systems pre-date the Lincoln National Forest. The pipelines in Alamo, Caballero, and Fresno Canyons, canyons occupied by poppy, have been replaced over time as the pipes become cemented in with calcium carbonate. The new pipelines no longer leak water along their route through the canyon bottoms, as they historically have, and, consequently, no longer provide water to limited areas that may have supported poppies in the past (U.S. Forest Service 2004). Municipal use of canyon water has changed the natural hydrology, making upland areas and canyons much drier, perhaps reducing poppy habitat. Pipeline repair, replacement, and maintenance are ongoing in four canyons. These pipelines and associated activities continue to impact the suitability of poppy habitat. Heavy equipment used to transport, excavate, position, and remove large sections of steel pipe may damage or destroy plants if not carefully controlled and monitored. The Forest Service has surveyed, consulted upon, and monitored these activities when informed of them in advance (U.S. Fish and Wildlife Service 2008). (USFWS, 2013)

Stressor: Mowing and herbicide application along roadways (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Roadway maintenance, including herbicide use and mowing, may threaten the poppy. Although the poppy is adapted to disturbed habitats, and, therefore, could benefit from some ground-disturbing activities, blading along drainage ditches and the shoulders of unpaved roads has destroyed some poppy plants (U.S. Forest Service 2004). Invasive plants such as Russian thistle, tamarisk, spotted knapweed, and Russian knapweed occur in poppy habitat. At present, the Forest Service and New Mexico State Highway and Transportation Department coordinate efforts at weed control and implement spraying of infested sites along the highways. Because plant competition may be a limiting factor to the distribution of the poppy based on the poppy's preference for sites that are more open and less densely vegetated, eliminating invasive plants may be beneficial for the poppy (U.S. Fish and Wildlife Service 1994). However, any spraying

performed near poppy individuals still may pose a threat to the survival of this species. Direct and indirect application of herbicides on poppies in 2007 resulted in loss of plants occurring along the Highway 82 corridor (Tonne 2008). Since this occurrence, the New Mexico State Highway and Transportation Department has ceased spraying herbicides in proximity to poppy plants. In addition, the Lincoln National Forest has completed consultation on their Noxious Weed Control Plan for treatments of noxious weeds in the vicinity of the poppy. (USFWS, 2013)

Stressor: Off-highway vehicles (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Off-highway vehicles are recognized to be a potential threat to the poppy. Off-highway use of motorized vehicles on established trails is permitted in Alamo, Caballero, and Dry canyons on the Lincoln National Forest. Dry Canyon is not currently occupied by the poppy, and the mouth and only western access route into Alamo and Caballero canyons through City of Alamogordo land is closed to motorized traffic. Unauthorized off-highway vehicles can crush individual poppy plants and threaten the health of poppy habitat. Off-highway vehicles can destabilize or compact soils, which affect seed germination and plant growth. Motorized travel is prohibited on the Forest beyond 91 meters (m) (300 feet [ft]) from a road, except for purposes of camping or parking. This excludes use in the channels of Fresno and La Luz canyons on National Forest System lands. Off-highway vehicles can crush or disturb poppy individuals and may modify the soils, local hydrology, and microclimates associated with seed germination and plant growth (U.S. Forest Service 2004). Furthermore, the creation of trails through poppy habitat can promote the spread of noxious weeds already present in the area (U.S. Forest Service 2004) into these areas which may threaten the poppy's establishment through competition. As an indication of increased interest in off-road riding in poppy habitat, a website exists that provides advice on how to circumvent Lincoln National Forest closures and lists detours to take in the vicinity of Alamo Canyon. Off-highway vehicles present a moderate threat to the poppy at this time. (USFWS, 2013)

Stressor: Fungal mold (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: The presence of *Alternaria* sp., a fungal mold that can be a plant pathogen, has been observed to be an intermittent problem throughout the distribution of the poppy (Tonne 2005). For example, this fungal stem canker caused 7 of 18 plants to fail to set fruit and subsequently die in Dog Canyon (Sivinski 1999). It appears to be most common and damaging in drought years (Tonne 2008). A link between decreased water availability and increased cases of disease may exist, as drying may weaken a plant's resistance to disease. (USFWS, 2013)

Stressor: Climate change (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Global climate change may be a threat to the poppy in the foreseeable future. The global average temperature has risen by approximately 0.6 degrees Celsius during the 20th Century, according to the Intergovernmental Panel on Climate Change (Intergovernmental Panel

on Climate Change 2001, 2007). Warming temperatures have been documented in recent decades in the southwestern United States. In New Mexico, mean annual temperature has increased by 0.6 degree per decade beginning in 1970, and warming is greatest in spring (Lenart 2005). Higher temperatures lead to higher evaporation rates which may reduce the amount of runoff, groundwater recharge, and consequently spring discharge (Stewart et al. 2004). Temperature changes and seasonal shifts may stimulate earlier growth in the spring or extend the growing season into the fall that is out of phase with available moisture, possibly leading to increased water stress and decreased survival for the poppy. Flowering phenology may also be affected by temperature shifts, potentially causing asynchronous relationships with pollinators and reducing chances of sexual reproduction for the plant. In recent years, the area occupied by the poppy has been under severe drought. These precipitation levels led to low soil moisture conditions that severely curtailed recruitment of poppies into the population (U.S. Fish and Wildlife Service 2004a; Tonne 2008). From 2008 continuing through to the present, the Palmer long-term drought severity index for Otero County has been primarily in the severe to extreme range (National Oceanographic and Atmospheric Administration 2008-2013). Thus climate change presents a significant threat to the poppy, with impacts likely from not only precipitation and temperature changes, but also from possible interactive effects with grazing, water extraction, and disease. (USFWS, 2013)

Stressor: Small population size and low genetic diversity (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Decreasing genetic diversity is an indirect threat capable of extirpating the limited populations of poppies. Populations composed of smaller numbers of plants with narrow distributions are more susceptible to elimination from stochastic events, such as flooding or drought, or demographic fluctuations, such as reduced numbers of adults or diminished seed banks, than are larger, more widely distributed populations. A loss of populations or individuals may contribute significantly to a reduction in the gene pool and the ability of the species to adapt to environmental changes. With fewer, more widely spaced plants, out-crossing may become more difficult, which Tepedino (1992) has shown reduces fruit and seed set and could preclude population recovery. At this time, the small population size and limited genetic diversity present a minor threat to the Sacramento prickly poppy. (USFWS, 2013)

Recovery

Reclassification Criteria:

1. Ensure long—term protection of the populations from human threats on Forest Service, City of Alamogordo, and BLM lands, and on land affected by NMSHD activities. (USFWS, 1994)
2. Maintain reproducing populations of Sacramento prickly poppy within each of the 10 presently occupied canyons (Dry, Alamo, Caballero, Fresno, La Luz, Salado, Mule, San Andres, Dog and Escondido canyons) on the western slope of the Sacramento Mountains. (USFWS, 1994)
3. Determine requirements for the germination and establishment of new individuals. (USFWS, 1994)
4. Study genetic variability within the species. (USFWS, 1994)

Delisting Criteria:

Delisting criteria are not available.

Recovery Actions:

- Study biological and habitat requirements of the species. (USFWS, 1994)
- Develop a management plan for the City of Alamogordo's water pipeline project in the Alamo and Fresno Canyon systems with measures to avoid or reduce impacts to populations. (USFWS, 1994)
- Develop a management plan with the Lincoln National Forest and the Bureau of Land Management for Sacramento prickly poppy plants located on lands under their jurisdiction. Conduct long-term monitoring studies to evaluate the impacts of livestock grazing and trampling, and off-road vehicles on these populations. (USFWS, 1994)
- Develop a management plan with the New Mexico State Highways and Transportation Department for populations occurring in the Highway 82 right-of-way and any other plants affected by their management. (USFWS, 1994)
- Develop a conservation agreement with private landowners to protect plants on private property. (USFWS, 1994)
- Conduct surveys in potential habitat. (USFWS, 1994)

Conservation Measures and Best Management Practices:

- Study biological and habitat requirements of the species. (USFWS, 2013)
- Develop a management plan for the City of Alamogordo's water pipeline project in the Alamo and Fresno Canyon systems with measures to avoid or reduce impacts to populations. (USFWS, 2013)
- Develop a management plan with the Lincoln National Forest and the Bureau of Land Management for Sacramento prickly poppy plants located on lands under their jurisdiction. Conduct long-term monitoring studies to evaluate the impacts of livestock grazing and trampling, and off-road vehicles on these populations. (USFWS, 2013)
- Develop a management plan with the New Mexico State Highways and Transportation Department for populations occurring in the Highway 82 right-of-way and any other plants affected by their management. (USFWS, 2013)
- Develop a conservation agreement with private landowners to protect plants on private property. (USFWS, 2013)
- Conduct surveys in potential habitat. (USFWS, 2013)

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SPECIES ACCOUNT: *Argyroxiphium kauense* (Mauna Loa (=Ka'u) silversword)

Species Taxonomic and Listing Information

Listing Status: Endangered; 04/07/1993; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

The Ka'u silversword is an erect rosette shrub, primarily with a single rosette, but occasionally branched. Leaves are pointed, 20 to 40 cm (8 to 16 in) long, 3 to 7 mm (0.1 to 0.3 in) wide at midpoint, and triangular in cross-section. The leaves are covered with a grayish-silver pubescence (downy hairs). Plants grow vegetatively for many years before flowering. Mature plants may be up to 1.3 m (4.25 ft) tall and 40 to 80 cm (16 to 31 in) in rosette diameter. Flowering generally occurs in July and August. The inflorescence (flowering stem) elongates from the apical meristem (growth tip) of the rosette and is 1 to 2 m (about 3.3 to 6.5 ft) tall and 15 to 30 cm (6 to 12 in) wide. The inflorescence usually has 100 to 350 capitula (flowering heads), each of which has between 50 to 200 florets (densely clustered small flowers). Ray florets usually number 3 to 11. Flowers are pale yellow, yellow with a rose tinge, rose, or sometimes wine-red. Fruits are dry, black, single-seeded achenes (thin-walled fruits) that are up to 1 cm (0.4 in) long and 1.5 mm (0.06 in) wide (Carr 1985, Meyrat 1982, Powell, unpublished data). (USFWS, 1995)

Taxonomy

The silverswords of Mauna Kea and Mauna Loa were considered the same taxon (*Argyroxiphium sandwicense*) by Hillebrand (1888), Skottsberg (1926), and Keck (1936a). Rock and Neal (1957) determined that the silverswords from the Ka'u district of Mauna Loa were different from those of Mauna Kea and Haleakala and named the silversword from Ka'u *Argyroxiphium sandwicense* var. *kauense* Rock and Neal. Meyrat (1982) found that the silverswords from Kahuku Ranch, Ka'u District, and those from Upper Waiakea Forest Reserve, South Hio District, of Mauna Loa differed significantly in five characters (plant length, leaf width, inflorescence length, number of capitula per raceme, and involucral bract length). The Ka'u silversword differs from the Mauna Kea silversword (*Argyroxiphium sandwicense* DC subspecies *sandwicense* and the Haleakala silversword (*Argyroxiphium sandwicense* subspecies *macrocephalum* (A. Gray) Meyrat), primarily by having the vegetative rosette of leaves elevated on an erect stem. The leaves of the Ka'u silversword are longer and thinner than those of the Mauna Kea or Haleakala silverswords and are triangular rather than flat in cross-section. Leaf pubescence (hairiness) is somewhat sparser than that of the Mauna Kea or Haleakala silverswords; therefore, leaves of the Ka'u silversword appear silvery-grey rather than silver-white. (USFWS, 1995)

Historical Range

The Ka'u silversword has been frequently sighted and collected on Mauna Loa, but may have also existed on Hualalai in historic times (Carr 1985). (USFWS, 1995)

Current Range

The current range is restricted slopes of Mauna Loa, Island of Hawaii. (NatureServe, 2015)

Critical Habitat Designated

Yes; 7/2/2003.

Legal Description

On July 2, 2003, the U.S. Fish and Wildlife Service designated critical habitat for *Argyroxiphium kauense*.

Critical Habitat Designation

Four critical habitat units are designated for *Argyroxiphium kauense*. Of the four units, only “Hawaii 10— *Argyroxiphium kauense*—a” is currently unoccupied by the species.

Hawaii 10—*Argyroxiphium kauense*—a: This unit, which contains no named natural features, lies in the Kiholo watershed and is completely within the Puuwaawaa Wildlife Sanctuary. This unoccupied unit, in combination with adjacent Kamehameha Schools land, provides habitat for one population of 2,000 individuals. This unit provides the northwesternmost critical habitat within the species’ historical range.

Hawaii 24—*Argyroxiphium kauense*—b: This unit contains the upper portions of Hionamoa, Kauhuula, Moaula, Pikea, and Waihaka gulches, Makaka Ravine, Puu Kinikini summit, and Maunaanu Waterhole. The southern portion lies in the Hilea watershed, the northern portion in Kapapala watershed, and the central portion in the Pahala watershed. The northeast portion is in the Kapapala Forest Reserve. This unit provides habitat for four populations of 2,000 individuals and is currently occupied by about 1,130 individuals of *A. kauense* in three locations. This unit provides the southernmost critical habitat within the species’ historical range.

Hawaii 25—*Argyroxiphium kauense*—c: This unit contains a portion of Kipuka Kulalio and Kipuka Maunaiu in the Kapapala watershed. This unit provides habitat for one population of 2,000 individuals and currently is occupied by about 1,000 outplanted individuals of *A. kauense*.

Hawaii 30—*Argyroxiphium kauense*—d: This unit contains portions of the lava flows of 1852 and 1942 and lies mostly in the Wailoa watershed, with the southern tip in the Kaahakini watershed. The upper area of the unit lies in portions of Upper Waiakea Forest Reserve and Mauna Loa Forest Reserve. The southern portion is part of the OlaaKilauea Partnership. This unit provides habitat for two populations of 2,000 individuals of *A. kauense* and is currently occupied by fewer than 500 individuals. This unit provides the easternmost critical habitat within the species’ historical range.

Primary Constituent Elements/Physical or Biological Features

The habitat features contained in these four units that are essential for this species include, but are not limited to:

- (i) subalpine forests,
- (ii) bogs, and
- (iii) mountain parkland.

Special Management Considerations or Protections

Not available

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (USFWS, 1995)

Lifespan

Adult: While it is a long-lived species, it is monocarpic (i.e., flowering only once before dying) (USFWS 1995). Therefore, for these purposes, it will be treated effectively as an annual that grows, flowers once, and dies, although over a longer period of time than an annual. The species does not behave biologically as a long-lived perennial, which could grow and flower annually and repeatedly for over 10 years prior to dying. (USFWS, 2019)

Dependency on Other Individuals or Species

Adult: Flying insects, including native bees (*Nesoprosopis* sp.), non-native flies, and native moths (*Agrotis* sp.), are typical pollinators of the Mauna Kea silversword (Powell 1992a) and may also be pollinators of the Ka'u silversword. (USFWS, 1995)

Reproduction Narrative

Adult: The species is monocarpic, that is, the single, non-flowering rosette grows for a number of years, and then produces a tall inflorescence; after fruit set, the entire plant dies. The life trait of this monocarpic (only flowering once before dying) species suggests it can take 10 to 50 years to first flower (Carr 1985; Carlquist et al. 2003). The Ka'u silversword probably reproduces only by seed; there is no evidence of vegetative reproduction. The low seed set found for certain individuals of the Ka'u silversword also indicates that this species is at least partially self-incompatible. Flying insects, including native bees (*Nesoprosopis* sp.), non-native flies, and native moths (*Agrotis* sp.), are typical pollinators of the Mauna Kea silversword (Powell 1992a) and may also be pollinators of the Ka'u silversword. (USFWS, 1995; USFWS, 2009)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Scattered (USFWS, 2015)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1995)

Tolerance Ranges/Thresholds

Adult: Moderate (USFWS, 1995)

Habitat Narrative

Adult: This species grows in boggy patches within wet forests or, in drier areas, in subalpine moist forests on old lava flows. The Keapohina population occurs in moist open forest with short stature o’hia trees and an understory of shrubs, grasses, and herbs. The substrate is a’ā (rough) lava with well-developed soil. The annual mean rainfall in the Keapohina area is about 10 to 15 cm (3.9 to 5.9 in), but moisture is also available to the silverswords as condensation from frequent afternoon fogs. The silverswords found in the Kapapala Forest Reserve in the past were on weathered, old pahoehoe (smooth) lava with pockets of soil, in subalpine mountain parkland vegetation dominated by shrubby o’hia and scattered shrubs. The historic range of the Ka’u silversword may have corresponded with a mean annual rainfall of about 100 to 300 cm (39 to 118 in). Rainfall of about 100 to 150 cm (39 to 59 in) currently occurs on the south slope of Mauna Loa in the Ka’u district from 1,500 to 2,100 m (5,000 to 7,000 ft) elevation (Giambella et al. 1986). On the east slope of Mauna Loa in South Hio District from 1,500 to 2,500 m (about 5,000 to 8,000 ft) elevation, mean annual rainfall is between 150 and 300 cm (59 and 118 in) (Giambella et al. 1986). *Argyroxiphium kauense* remains to be found in three geographically separated wild populations scattered across the species’ former range on Mauna Loa. (USFWS, 1995; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Resiliency:

Low (inferred from USFWS, 2009)

Redundancy:

Low (inferred from USFWS, 2009)

Number of Populations:

3 (USFWS, 2015)

Population Size:

626 individuals (USFWS, 2015)

Population Narrative:

Argyroxiphium kauense remains to be found in three geographically separated wild populations consisting of about 626 individuals scattered across the species’ former range on Mauna Loa. (USFWS, 2015)

Threats and Stressors

Stressor: Herbivory (USFWS, 1995)

Exposure:

Response:**Consequence:**

Narrative: Browsing by feral and domesticated ungulates has been identified as the primary reason for the decline of the Ka'u silversword. Mouflon sheep were introduced to Kahuku Ranch in 1968 (J. Canfield, personal communication 1992) and have steadily increased in numbers there (Mitchell 1981; Cuddihy and Stone 1990). Severe browse damage to Ka'u silverswords was noted in 1984 (E. Powell, personal observation 1984). Although a 1 hectare (2.5 acre) area of the Keapohina population was fenced by Kahuku Ranch personnel in 1982 to protect the silverswords, mouflon were able to gain entry to the fenced area. The mouflon apparently preferred the silversword and *Machaerina mariscoides* plants as browse species, as these two species were the only plants in the area that were severely browsed in 1984 (E. Powell, personal observation 1984). In 1991, browse damage to *Astelia* sp. was noted (J. Canfield, personal communication 1992). Feral pigs are currently a major threat to the Ka'u silversword both at Keapohina and in the Upper Waiakea Forest Reserve. Rooting by feral pigs disrupts natural vegetation and uproots and damages small silversword plants. Rooting by pigs is particularly destructive in bogs (Medeiros et al. 1991). Insects (including fruit parasites), drought, human disturbance, alien plants and disease have all been suggested as probable threats to the Ka'u silversword (U.S. Fish and Wildlife Service, 1990). Ungulate damage to the species has been so severe and population numbers have declined so rapidly that other possible threats are currently of lesser importance, but may become more significant if population sizes continue to drop. The single most serious threat to the immediate survival of the Ka'u silversword is that posed by feral and domestic ungulates, including cattle, goats, pigs, and mouflon sheep. (USFWS, 1995)

Stressor: Lava flows (USFWS, 1995)

Exposure:**Response:****Consequence:**

Narrative: Populations of the Ka'u silversword may have been eliminated by lava flows from Mauna Loa in historic times (Keck 1936b). Lava flows and the damage caused by feral ungulates may have combined to hasten the endangerment of the Ka'u silversword. However, the fact that the Ka'u silversword is endemic to Mauna Loa, an active volcano, indicates that the species was able to survive thousands of years of eruptive activity. Before feral and domestic ungulates arrived on Mauna Loa, the silversword apparently sustained a widespread population in dynamic equilibrium between chance extinctions of some populations from lava flows and founding of new populations in developing kipukas. (USFWS, 1995)

Stressor: Small population size (USFWS, 1995)

Exposure:**Response:****Consequence:**

Narrative: Small population size and localization are major threats to the survival of a species. In 1984, a lava flow from Mauna Loa came within about 2 kilometers (1.2 miles) of the silversword bog in the Upper Waiakea Forest Reserve. Because that silversword population is confined to a single bog, the population is vulnerable to chance lava flows, fires, or other natural disasters. Even an extended drought could drive the population to extinction. The Keapohina population is also threatened by lava flows from Mauna Loa, or potentially by fire, hurricane damage, or earthquakes. A widespread species is less likely to become extinct due to lava flows, other

natural disasters, or even human disturbance. It is almost certain that this species was historically widespread. (USFWS, 1995)

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Climate change destruction or degradation of habitat – Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Argyroxiphium kauense* is minimally vulnerable to the impacts of climate change. (USFWS, 2015)

Recovery

Reclassification Criteria:

- 1) There are 5 to 10 populations in suitable, protected habitat with 2,000 mature individuals per population; (USFWS, 2019)
- 2) All major threats are controlled around the target populations; (USFWS, 2019)
- 3) Populations are represented in an ex situ collection as defined in the Center for Plant Conservation guidelines (Guerrant et al. 2004) that is secure and well managed; (USFWS, 2019)
- 4) All target populations have been stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions may continue to be necessary. (USFWS, 2019)

Delisting Criteria:

- 1) All of the downlisting criteria have been met; (USFWS, 2019)
- 2) All target populations have been stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but an ongoing need for ecosystem-wide management actions may remain if long-term agreements are in place to continue management. (USFWS, 2019)

Recovery Actions:

- Securing habitat and stabilizing the current populations through negotiations with the Damon Estate, the State of Hawai'i and the National Park Service. (USFWS, 1995)
- Control of ungulates through improved fencing and hunting programs and monitoring of populations are of utmost importance. (USFWS, 1995)
- Reduction of human related disturbance and an investigation of the effects of alien plants on growth and reproduction are also important recovery activities. (USFWS, 1995)
- A research program should also be initiated to determine the physiological and environmental factors influencing habitat preferences; assess the factors limiting germination and seedling establishment and those influencing reproductive biology; determine the need for genetic management; study associated insects and causes of

mortality; and to develop methods to reduce other threats that may be discovered. (USFWS, 1995)

- An effort to re-establish the Ka'u Silversword in its former range should also be initiated, including the selection and protection of sites for re-establishment, cross-pollination of existing plants, collection and storage of seed, nursery propagation, seeding and/or transplantation of nursery grown plants, and monitoring and refinement of the program. (USFWS, 1995)

Conservation Measures and Best Management Practices:

- Continue maintenance of enclosure fencing. Establish new and expand existing enclosures within historical range. (USFWS, 2009)
- Continue reintroduction of new maternal lines into existing enclosures, and new enclosures as available, as additional wild individuals flower. (USFWS, 2009)
- Continue to work with the Tri-Mountain Alliance and Hawaii Volcanoes National Park to implement ecosystem-level restoration and management to benefit this species on Mauna Loa. (USFWS, 2009)
- Assess the pollination and natural recruitment of wild and reintroduced plants. (USFWS, 2009)
- Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. (USFWS, 2015)
- Augment current natural populations to increase numbers of individuals. (USFWS, 2015)
- Maintain existing enclosures and monitor for potential incursions. (USFWS, 2015)
- Continue control and maintenance of invasive plants within fenced enclosures. (USFWS, 2015)
- Continue monitoring wild and outplanted individuals for a thorough current assessment of the species' status. (USFWS, 2015)
- Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. (USFWS, 2015)
- Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2015)

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SPECIES ACCOUNT: *Argyroxiphium sandwicense* ssp. *macrocephalum* (*`ahinahina*, Hakeakala silversword)

Species Taxonomic and Listing Information

Listing Status: Threatened; 05/15/1992; Pacific Region (R1) (USFWS, 2016)

Physical Description

Haleakala silversword (*Argyroxiphium sandwicense* ssp. *macrocephalum*) is a long-lived perennial and a member of the aster family (Asteraceae). It is a distinctive, globe-shaped rosette plant with a dense covering of silver hairs. This subspecies is distinguished from *A. sandwicense* ssp. *sandwicense* by the number of ray florets per head; combination of longer, three-angled leaves; longer achenes (dry fruits); silvery leaf hairs, which completely hide the leaf surface; and the shape and ratio of the inflorescence dimensions (Carr 1985).

Historical Range

See current range/distribution.

Current Range

The Haleakala silversword is endemic to 2,500 acres between 6,900 and 9,800 feet elevation in the crater and outer slopes of Haleakala Volcano within the Park and The Nature Conservancy of Hawaii's Waikamoi Preserve, where it apparently occupies most of its historical range (Loope and Crivellone 1986). Near extinction in the 1920s due to human vandalism and browsing by goats and cattle, Haleakala silverswords have increased substantially due to protection and vigorous conservation efforts. The first reliable information on Haleakala silversword numbers is from the summer of 1935 when Ranger S. H. Lamb tallied 1,470 plants (88 of which were flowering) on a single cinder cone (Ka Moa o Pele) within Haleakala Crater (Lamb 1935). Since about 217 plants were flowering within the crater (Lamb 1935), a reasonable estimate of the total population at that time was about 4,000 individuals (Loope and Medeiros 1994). Information gathered illustrates the trend of the silversword population over a 70-year period of protection. Since plants occur on otherwise barren cinder, fairly accurate counts are possible. Plants have been counted by successive investigators on the cinder cone, Ka Moa o Pele, where the largest number of plants occurred in 1935. By 1979, the population on this volcanic cone had increased by 4.4 times, from 1,470 to 6,528 individuals (Kobayashi 1991). Elsewhere in Haleakala Crater, the silversword also increased in numbers and extent, with large local populations in areas where few plants occurred in 1935. A census of the entire Haleakala silversword population has been attempted four times since 1971, with the following results: 1971: 43,262 individuals (Kobayashi 1973); 1979-80: 35,000 total plants (Kobayashi 1991); 1982: 47,640 (Loope and Crivellone 1986); and 64,800 plants were counted in 1991 (Kobayashi 1993).

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service designated revised habitat for *Argyroxiphium sandwicense* ssp. *macrocephalum*.

Critical Habitat Designation

Maui—Montane Mesic—Unit 1, Maui—Subalpine—Unit 1, Maui— Subalpine—Unit 2, Maui—Alpine— Unit 1, Maui—Dry Cliff—Unit 1, Maui— Dry Cliff—Unit 2, Maui—Dry Cliff— Unit 3, and Maui—Dry Cliff—Unit 4 constitute critical habitat for *Argyroxiphium sandwicense* ssp. *macrocephalum* on Maui.

Maui—Montane Mesic—Unit 1 consists of 6,593 ac (2,668 ha) of State land, 707 ac (286 ha) of privately owned land, and 3,672 ac (1,486 ha) of federally owned land (Haleakala National Park), from Kealahou to Puualae, nearly circumscribing the summit of Haleakala on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem. They are occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Asplenium dielirectum*, *A. peruvianum* var. *insulare*, *Clermontia lindseyana*, *Cyanea horrida*, *C. obtusa*, *Cyrtandra ferripilosa*, *C. oxybapha*, *Diplazium molokaiense*, *Geranium arboreum*, *G. multiflorum*, *Huperzia mannii*, *Melicope adscendens*, and *Neraudia sericea*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations.

Maui—Subalpine—Unit 1 consists of 10,785 ac (4,365 ha) of State land, 1,622 ac (656 ha) of privately owned land, and 3,568 ac (1,444 ha) of federally owned land (Haleakala National Park), from Kanaio north to Puu Nianiau on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the subalpine ecosystem. They are occupied by the plants *Bidens micrantha* ssp. *kalealaha* and *Geranium arboreum*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui— Subalpine—Unit 1 is not known to be occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Asplenium peruvianum* var. *insulare*, *Geranium multiflorum*, *Phyllostegia bracteata*, *Schiedea haleakalensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these subalpine species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Subalpine—Unit 2 consists of 50 ac (20 ha) of privately owned land, and 9,836 ac (3,981 ha) of federally owned land (Haleakala National Park), from the summit north to Koolau Gap and east to Kalapawili Ridge on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the subalpine ecosystem. They are occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Geranium multiflorum*, and *Schiedea haleakalensis*, and by the forest bird, the *akohekohe* (*Palmeria dolei*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui— Subalpine—Unit 2 is not known to be occupied by the plants *Asplenium peruvianum* var. *insulare*, *Bidens micrantha* ssp. *kalealaha*, *Geranium arboreum*, *Phyllostegia bracteata*, or *Zanthoxylum hawaiiense*, or by the forest bird, the *kiwikiu* (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these subalpine species because it provides the

PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Alpine—Unit 1 consists of 475 ac (192 ha) of State land, 411 ac (166 ha) of privately owned land, and 911 ac (369 ha) of federally owned land (Haleakala National Park), at the summit of Haleakala on east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy native plant species identified as physical or biological features in the alpine ecosystem. This unit is occupied by the plant *Argyroxiphium sandwicense* ssp. *macrocephalum*, and contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Due to its small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 1 consists of 755 ac (305 ha) of federally owned land (Haleakala National Park), from Pakaoao to Koolau Gap on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. Although Maui—Dry Cliff—Unit 1 is not known to be occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Diplazium molokaiense*, *Geranium multiflorum*, *Plantago princeps*, or *Schiedea haleakalensis*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 2 consists of 688 ac (279 ha) of federally owned land (Haleakala National Park) from Haupaakea Peak to Kaupo Gap on east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. It is occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Geranium multiflorum*, *Plantago princeps*, and *Schiedea haleakalensis*, and contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations.

Maui—Dry Cliff—Unit 3 consists of 200 ac (81 ha) of federally owned land (Haleakala National Park) near Papaanui on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. It is occupied by the plant *Plantago princeps*, and contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Dry Cliff—Unit 3 is not currently occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Diplazium molokaiense*, *Geranium multiflorum*, or *Schiedea haleakalensis*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their

small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 4 consists of 315 ac (127 ha) federally owned land (Haleakala National Park), along Kalapawili Ridge on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. Although Maui—Dry Cliff—Unit 4 is not currently occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Diplazium molokaiense*, *Geranium multiflorum*, *Plantago princeps*, or *Schiedea haleakalensis*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

(i) In unit Maui—Montane Mesic—Unit 1, the physical and biological features of critical habitat are: (A) Elevation: 3,300 to 6,500 ft (1,000 to 2,000 m). (B) Annual precipitation: 50 to 75 in (130 to 190 cm). (C) Substrate: Deep ash deposits, thin silty loams. (D) Canopy: *Acacia*, *Ilex*, *Metrosideros*, *Myrsine*, *Nestegis*, *Nothocestrum*, *Pisonia*, *Pittosporum*, *Psychotria*, *Sophora*, *Zanthoxylum*. (E) Subcanopy: *Alyxia*, *Charpentiera*, *Coprosma*, *Dodonaea*, *Kadua*, *Labordia*, *Leptecophylla*, *Phyllostegia*, *Vaccinium*. (F) Understory: *Ferns*, *Carex*, *Peperomia*.

(ii) In units Maui—Subalpine—Unit 1 and Maui—Subalpine—Unit 2, the physical and biological features of critical habitat are: (A) Elevation: 6,500 to 9,800 ft (2,000 to 3,000 m). (B) Annual precipitation: 15 to 40 in (38 to 100 cm). (C) Substrate: Dry ash; sandy loam; rocky, undeveloped soils; weathered lava. (D) Canopy: *Chamaesyce*, *Chenopodium*, *Metrosideros*, *Myoporum*, *Santalum*, *Sophora*. (E) Subcanopy: *Coprosma*, *Dodonaea*, *Dubautia*, *Geranium*, *Leptecophylla*, *Vaccinium*, *Wikstroemia*. (F) Understory: *Ferns*, *Bidens*, *Carex*, *Deschampsia*, *Eragrostis*, *Gahnia*, *Luzula*, *Panicum*, *Pseudognaphalium*, *Sicyos*, *Tetramolopium*.

(iii) In unit Maui—Alpine—Unit 1, the physical and biological features of critical habitat are: (A) Elevation: Greater than 9,800 ft (3,000 m). (B) Annual precipitation: 30 to 50 in (75 to 125 cm). (C) Substrate: Barren gravel, debris, cinders. (D) Canopy: None. (E) Subcanopy: *Argyroxiphium*, *Dubautia*, *Silene*, *Tetramolopium*. (F) Understory: None.

(iv) In units Maui—Dry Cliff—Unit 1, Maui—Dry Cliff—Unit 2, Maui—Dry Cliff—Unit 3, and Maui—Dry Cliff—Unit 4, the physical and biological features of critical habitat are: (A) Elevation: Unrestricted. (B) Annual precipitation: Less than 75 in (190 cm). (C) Substrate: Greater than 65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: *Antidesma*, *Chamaesyce*, *Diospyros*, *Dodonaea*. (F) Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Schiedea*.

Special Management Considerations or Protections

The primary threats to the physical or biological features essential to the conservation of this species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change.

The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of this species will continue to be degraded and destroyed.

Life History

Food/Nutrient Resources

Breeding Season

Adult: Flowers from June to September

Reproduction Narrative

Adult: This monocarpic (flowers only once at the end of its lifetime) plant matures from seed to its final stage in approximately 15 to 50 years. The plant remains a compact rosette until it sends up an erect, central flowering stalk, sets seed, and dies. Flowering occurs from June to September, with annual numbers of flowering plants varying dramatically from year to year. Reliable counts of flowering plants were made in 1935 (217 flowered) and in 1941 (815 flowered) (Lamb 1935). Numbers recorded flowering in recent years have ranged from zero in 1970 to 6,632 in 1991 (USFWS 2011). The environmental stimulus for synchronous flowering is as yet unknown. An apparent relationship of the 1991 mass flowering event to stratospheric alteration by the eruption of Pinatubo Volcano in the Philippines has been considered. Investigations are underway by R. Pharis of the University of Calgary and L.L. Loope of the U.S. Geological Survey Biological Resources Division to explore whether enhanced flowering is related to increased UltraViolet-B radiation caused by temporary reduction of stratospheric ozone (USFWS 2003). Flying insects, especially native bees, moths, flies, bugs, and wasps, many of which are pollinators, are attracted in large numbers to the giant aromatic inflorescences. Haleakala silversword experiences a reduced reproductive success in low flowering years. This is probably an "Allee effect," in which individual fitness is reduced as population size decreases, with extinction becoming more likely as a population declines. Allee effects may be due to a variety of genetic, demographic, and/or ecological factors, including increased levels of inbreeding depression. A five year study of Haleakala silversword suggests that the allee effect with this species is pollinator-mediated (Forsyth 2003). The study demonstrated that plants flowering out of synchrony with mostly of the population (i.e., in low flowering years) exhibited lower percent seed set than synchronously-flowering plants (i.e., those flowering in high flowering years). Two pollination experiments conducted over multiple years measured pollen limitation and self-incompatibility in this species. In the three-year pollen limitation study, plants flowering asynchronously were pollen-limited, whereas plants flowering synchronously were not. Haleakala silversword cannot fertilize itself and is reliant on insect pollinators for reproduction. On rare occasion, hybrids between Haleakala silversword and *Dubautia menziesii* (naenae) have been observed. Primarily found within the Haleakala Crater and especially on the Puu o Pele and Puu o Maui cinder cones, these hybrid individuals can flower for several years before dying (Carr 1985, Loope and Crivellone 1986, Medeiros et al. 1998, USFWS 1997, 57 FR 20772).

Habitat Type

Adult: Sub-Alpine crater

Habitat Narrative

Adult: This introduced species occupies two distinct areas between 6,792 and 9,350 feet elevation, totaling about 400 acres in the Park.; Research by Perez (2015a) found that *Argyroxiphium sandwicense* subsp. *macrocephalum* has strong substrate preferences. This subspecies prefers (1) rock outcrops, (2) shallow soils, (3) areas with surface stones, and (4) organic litter. These soil types have higher moisture levels and retain moisture longer, stay cooler, and provide protection from falling debris (Perez 2015b). Overall, this subspecies avoids “barren, deep-soil areas.” (USFWS, 2018)

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Decreasing

Number of Populations:

7

Population Size:

approximately 29,000 individuals (USFWS, 2018)

Population Narrative:

The current population of silversword is approximately 16 times larger than the estimated population in 1935. However, recent surveys indicate the population has since declined to approximately 50,000 individuals (USFWS 2008) and are currently found in a total seven populations on Federal and privately owned land (Loope and Crivellone 1986; USFWS 1997; 57 FR 20772, USFWS 2011). Yearly measurements and counts of the taxon in 11 monitoring plots displayed a population decline. Each year’s census includes mapping individual plants, measuring live crown diameter of each plant, and noting life history changes (seedlings, flowered, death). The plots were established in 1982 and have been monitored almost every year. In 2007 and 2008, a 22 % population decline occurred. In 2009, the population numbers declined another 12 %, down to 111 individuals in the 11 plots. The total number of plants in the plots has dropped by 73 % since 1982 from 414 to 111 plants. No new seedlings were recorded in the plots in 2007, 2008, or 2009. Survival of the three seedlings from 2006 is now zero % (none still alive). In summary, 32 % (43) of the plants in plots are at least 27 years old. The smallest of these older plants are four centimeters in diameter; the largest is 32 centimeters in diameter. The largest plant in the plot has been recorded since 1986 and measures 40 centimeters in diameter (Starr et al. 2007, 2008, 2009).

Threats and Stressors

Stressor:

Exposure:

Response:

Consequence:

Narrative: Threats to the species include loss of native pollinators caused by predation by the non-native Argentine ant (*Iridomyrmex humilis*) and yellow jackets (*Vespula pennsylvanica*); seed predation by native seed-eating and herbivorous insects, such as the tephritid fly (*Trupanea cratericola*); herbivory and trampling by non-native ungulates; and competition and habitat alteration due to invasive introduced plant species (Perlman 2009); and human impacts (trampling and site degradation). Although goats and cattle have been removed from the Park, they remain a potential threat (Service 1997, 57 FR 20772). Drought, higher temperatures, and changes in the inversion layer may also be contributing to the recent decline in the silversword population (Krushelnysky et al. 2012). The limited natural range of this taxon makes it vulnerable to extinction due to a single catastrophic event such as a natural disaster or non-native plant or animal introduction. Protection of current populations from threats, the expansion of the current population, and the establishment of new populations are identified among the recovery plan actions necessary to conserve this species (Service 1997). The greatest threat to the native insect pollinators of the Haleakala silversword appears to be the Argentine ant. This introduced species occupies two distinct areas between 6,792 and 9,350 feet elevation, totaling about 400 acres in the Park. A marked expansion in the ant's range was noted in 1993, especially at the higher elevation area (Medeiros et al. 1994). Unless this ant species is controlled, it appears capable of spreading widely, with potentially catastrophic effects on endemic biota, including the silversword (Carr et al. 1986, Danoff-Burg and Shepherd 2003). Non-native yellow jackets pose a lesser but significant threat toward elimination of Haleakala silversword pollinators. The Haleakala silversword is dependent upon continuing seed production for its survival. On average, 60 % of the developing seeds are fed upon by the non-native tephritid fly and destroyed by the small, white grub-like larvae of this fly (Kobayashi 1974). Developing seeds are also fed upon by the larvae of the native phycitid moth (*Rhyncephestia rhabdotis*) (Swezey 1954, Zimmerman 1958), and an endemic cerambycid beetle (*Plagithmysus terryi*) that bores in roots and stems, and sometimes causes silversword plants to fall over. Possible future threats include competition from non-native plant species, namely mullein (*Verbascum thapsus*) and fountain grass (*Pennisetum setaceum*) (Loope et al. 1992 and Perlman 2009), and human impacts (collection and site degradation). One of the main impacts of long-term degradation of high-elevation habitat of the Haleakala silversword is the elimination of silversword populations in areas on the periphery of Haleakala Crater. However, as a result of fencing the boundary of the Park in the mid-1980s, these areas are now protected from feral goats, which had extirpated the silversword from certain peripheral areas. Protection of habitat from ungulates and reintroduction of plants into protected areas to reestablish significant numbers throughout the species' historical range are crucial for the conservation of this species (USFWS 1997, 2011).

Stressor: Competition with nonnative *Pinus* species

Exposure:

Response:

Consequence:

Narrative: *Pinus* species (pine trees) are tall, evergreen trees or shrubs native to all continents and some oceanic islands, but are not native to any of the Hawaiian islands. *Pinus caribaea* (Caribbean pine), *P. elliottii* (slash pine), *P. patula* (jeleco pine), *P. pinaster* (maritime pine), *P. radiata* (Monterey pine), and *P. taeda* (loblolly pine) are found on Moloka'i, Lāna'i, and Maui (Little and Skolmen 1989; Oppenheimer 2003; PIER 2011; IUCN 2017a–f) and were primarily planted by Hawai'i State foresters for reforestation and erosion control (Little and Skolmen 1989; Oppenheimer 2003; PIER 2010). *Pinus* species are known to establish readily, create dense stands

that shade out native plants and prevent regeneration, outcompete native plants for soil water and nutrients, change soil chemistry, promote growth of weed seeds dropped by perching birds, and are highly flammable (Oppenheimer 2010, in litt.; PIER 2010). On east Maui, *Pinus* species are a threat at higher elevations because they are invading native subalpine shrublands (Oppenheimer 2002; Oppenheimer 2010, in litt.). (USFWS, 2018)

Stressor: Invasive species - established invasive plant species competition (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Another nonnative plant, *Cortaderia jubata* (pampas grass), is noted as a new threat to *Argyroxiphium sandwicense* subsp. *macrocephalum* (Robertson 2016, in litt.). One of the most detrimental nonnative plant species in the area, along with *Pinus* species, pampas grass, a large, clump-forming, perennial herb, was first discovered in 1987 on east Maui, where it has escaped cultivation and is becoming invasive inside and on the outer slopes of Haleakalā Crater (Robertson 2016, in litt.). This species is a serious pest in California, and is on the Hawai'i State noxious weed list (Staples and Herbst 2005). Pampas grass produces abundant seed and spreads readily (Staples and Herbst 2005). (USFWS, 2018)

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this subspecies. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai'i using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that at the species level, *Argyroxiphium sandwicense* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.536 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). However, *Argyroxiphium sandwicense* subsp. *macrocephalum* occurs at the highest elevations on Maui. There is no area above its current range that it could occupy. Therefore, additional management actions, including possible translocations to other islands outside of its historic range, are needed to conserve this taxon into the future. Recent trends in drought associated with climate change are implicated in the population decline of this subspecies. Current research indicates that annual population growth rates of *Argyroxiphium sandwicense* subsp. *macrocephalum* are strongly tied to rainfall patterns, and that plants at lower-elevations are declining in numbers at a more rapid rate than higher-elevation plants (Krushelnicky et al. 2013; Robertson 2016, in litt.). Researchers suspect that unusually warm and dry conditions may create negative carbon balances leading to mortality through carbon starvation from depletion of carbon stores or interruption of carbon transport. Severe water stress may induce hydraulic failure, compounding the effect of carbon starvation. (USFWS, 2018)

Stressor: Lack of adequate biosecurity legislation

Exposure:

Response:

Consequence:

Narrative: Invasion of the State of Hawai'i by invasive nonnative plant species, and destruction of habitat and competition by nonnative plants are threats to *Argyroxiphium sandwicense* subsp. *macrocephalum*. The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, is authorized to prevent the introduction or dissemination of animal and plant pests on all ships, aircraft, and their cargo and baggage arriving in the U.S. and its territories; however, pest species continue to enter the State. In addition, Federal import regulations do not address many species that could be pests in Hawai'i (CGAPS 2009; Ikuma et al. 2002). (USFWS, 2018)

Recovery

Recovery Actions:

- Research of Haleakala silversword population dynamics with accurate mapping should be accomplished so that factors, such as blooming and seed set, can be correlated with abiotic factors, such as climate change. Studies should be conducted on pollinators and other insects visiting these flowers, especially the invasive Argentine ant, to determine which pollinators are most critical to seed set and thus the long-term survival of the species. Other conservation actions for this species should include a collaboration of the National Park Service, the Hawaii Division of Forestry and Wildlife, and other land managers to continue implementation of ecosystem-level restoration and management to benefit this species. Although this taxon has recovered dramatically under the ecosystem management practices of fencing, feral animal and alien plant control, observations in recent years have raised concern with plants dying prematurely at the lower end of the elevation range in the crater. Drought, higher temperatures, and changes in the inversion layer may be contributing to the recent decline in the Haleakala silversword population (Krushelnicky et al. 2012). Greenhouse experiments are being conducted to determine the extent to which founder populations or climate change may be contributing to this mortality. Recovery action based on the results of these experiments may include selection for hardier genetic stock, and differential propagation and planting in favorable portions of the range. Mitigation of invasions of argentine ants and yellow jackets has been heavily researched and attempted. Landscape level control for argentine ants and yellow jackets has not been achieved. Some success in localized control has been realized. Maintenance of feral animal control fences, timely dispatch of ingress animals and ongoing alien plant control including fuels and fire management is crucial. Park staff have made extensive efforts to collect, propagate, and out-plant Haleakala silversword. The Park's Service Research and Resource Management programs have developed and implemented state-of-the-art techniques for fencing and feral animal control and have removed all ungulates and implemented invasive introduced plant control, rodent control, introduced insect management, and ecosystem monitoring. In 2004, 21 ounces of seeds were collected from 79 founder individuals (Haleakala National Park Resource Management, Vegetation Management 2004). In 2005, 5,500 seeds were collected from 21 founders, and the Park nursery has 693 individuals in cultivation from the summit area representing 50 wild founder individuals. In 2004, seven individuals were out-planted. In 2005, 45 individual plants and thousands of seeds were reintroduced on the west slope of the summit and in the Crater. In 2006, 615 seeds were out-planted. In 2007, 57,500 seeds were planted from 15 founders. In 2008, 20 individuals were out-planted at the summit, 2000 seeds were collected, and 642 propagules were being grown from 50 founders at the Park nursery (Haleakala National Park 2008; USFWS 2008). The National Tropical Botanical Garden has two accessions of seeds collected in 1991, totaling 10,850

seeds (National Tropical Botanical Garden 2009). Haleakala silversword within the Park has recovered dramatically under intense ecosystem management. However, data from the last few years have raised concern because plants at the lower end of the elevation range in the crater are dying prematurely. Greenhouse experiments are being conducted to determine the extent to which founder populations or climate change may be contributing to this mortality. Plants have been propagated and planted in areas easily available to visitors to reduce trampling of roots and the temptation to violate the Park's Stay-On-Trail policy to get close to this dramatic and iconic species. Designated critical habitat for this species is primarily in the Park and spans the areas of greatest visitor and management activities.

- Ungulate monitoring and control—Continue to maintain large-scale fenced exclosures to protect individuals from the negative impacts of feral ungulates. Protect all occurrences against browsing and habitat disturbances from feral ungulates. (USFWS, 2018)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations; Control invasive nonnative species that compete with the species around all populations. (USFWS, 2018)
- Captive propagation for genetic storage and reintroduction—Continue to conduct research on outcrossing success, and collect seeds from outplanted individuals for adequate genetic representation.; Continue propagation efforts for maintenance of genetic stock. (USFWS, 2018)
- Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this subspecies. (USFWS, 2018)
- Climate change adaptation strategy—Assess the modeled effects of climate change on this subspecies, and determine future landscape needed for the recovery of the subspecies. (USFWS, 2018)
- Predator monitoring and control—Continue to study pollinators and other insects visiting flowers and their relationship to the nonnative Argentine ant.; Continue to determine which pollinators are most critical to seed set and to the long-term survival of the species. (USFWS, 2018)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from drought. (USFWS, 2018)
- Habitat and natural process management and restoration—Strategic planning—Work with the National Park Service, the Hawai'i Division of Forestry and Wildlife, and other land managers to continue implementation of ecosystem-level restoration and management to benefit this subspecies. (USFWS, 2018)
- Population biology research—Continue to study population dynamics over the entire population with accurate mapping so that factors such as blooming and seed set can be correlated with abiotic factors such as climate change. (USFWS, 2018)

References

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USFWS 2016. Status of the Species and Critical Habitat: *Argyroxiphium sandwicense* ssp. *macrocephalum*. U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016.

USFWS. 2018. 5-Year Review, Short Form Summary, *Argyroxiphium sandwicense* subsp. *macrocephalum*. PIFWO, Honolulu, Hawaii.

SPECIES ACCOUNT: *Argyroxiphium sandwicense ssp. sandwicense* (`ahinahina (Mauna Kea silversword))

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/21/1986; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

The Mauna Kea silversword is a giant rosette plant. The plant grows as a ball-shaped basal rosette composed of narrow lance-shaped leaves that may be up to 39 cm (15.35 ins) long and up to 1.5 cm (.59 in) wide at the midpoint. Leaves are coated with silvery hairs. Branched (polycarpic) individuals produce a tight cluster of rosettes of various sizes. The entire cluster may be up to 150 cm (59.06 in) in diameter. Unbranched (monocarpic) individuals produce a single large rosette, of up to 75 cm (29.53 in) in diameter. At flowering, monocarpic individuals produce a single large raceme, up to 300 cm (118.11 in) in height, and have numerous short branches, each terminating in a single capitula of flowers. The inflorescence stalk, the bracts that subtend the pedicels, and the involucre bracts are all covered with sticky glandular hairs that emit a faint sweet odor. Flower heads (capitula) are 2 cm (.79 in) in diameter, and have white to pink ray florets and pink to maroon disk florets. Each floret produces a single fruit, an achene, which may or may not contain a single seed. Achenes are black, 1 cm (.39 in) long, and have a pappus of 1 to 6 short scales (USFWS, 1993).

Taxonomy

The Mauna Kea silversword is the type species for the genus *Argyroxiphium*, which includes the Hawaiian silverswords and greenswords. The genus consists of four extant and one extinct species of silverswords and greenswords endemic to the islands of Maui and Hawai'i of the Hawaiian Islands (Carr 1985). The Hawaiian name for the silverswords is 'Ahinahina, which means "very gray" and is used for a number of unrelated plant species with silvery leaves. The similarity in vegetative features between Mauna Kea silversword and the Haleakala silversword has led several authors to consider these taxa as the same species. Keck (1936) placed both silverswords under *Argyroxiphium sandwicense* DC. St. John (1973) also considered the two taxa to be the same. Based on a morphometric analysis, Meyrat et al. (1984) designated Mauna Kea silversword and the Haleakala silverswords as subspecies of *Argyroxiphium sandwicense*. Carr (1985) followed this nomenclature in his monograph of the Hawaiian Madiinae. This nomenclature was also accepted by Wagner et al. (1990). The Service accepts the designation of Mauna Kea silversword at the subspecies level. The Mauna Kea silversword is distinguished from the Haleakala silversword by a high frequency of branching; taller, thinner inflorescences; green bracts subtending flower heads; fewer ray florets; and obvious pappus on disk achenes. (USFWS, 1993)

Historical Range

The Mauna Kea silversword probably only occurred on Mauna Kea, Hawaii. (USFWS, 1993)

Current Range

The Mauna Kea silversword is only found in Mauna Kea, Hawaii (USFWS, 2012)

Critical Habitat Designated

Yes;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (USFWS, 2012)

Lifespan

Adult: 50 years or more (inferred from USFWS, 2012)

Dependency on Other Individuals or Species

Adult: Pollinators such as insects (USFWS, 2012)

Breeding Season

Adult: June to September (USFWS, 2012)

Reproduction Narrative

Adult: Flowering of *Argyroxiphium sandwicense* subsp. *sandwicense*, which may be entirely absent in some years (R. Robichaux, Professor of Biology, University of Arizona, pers. comm. 2001), occurs between June and September (USFWS 1993; Bishop Museum 2011; National Tropical Botanical Garden 2011). An individual typically flowers only once during its life (monocarpic), or more infrequently it can form branches from near the base, each of which flowers and subsequently dies back (polycarpic) (Wagner et al. 1999; USFWS 1993). *Argyroxiphium sandwicense* subsp. *sandwicense* is mostly self-incompatible, which means it is dependent on insects or other vectors to pollinate its flowers. Observed and recorded hybridization events appear to be generally rare in the wild for *Argyroxiphium sandwicense* subsp. *sandwicense*. Individuals may live from 3 to 50 years before flowering (USFWS 1993). (USFWS, 2012)

Habitat Type

Adult: Terrestrial (USFWS, 1993)

Habitat Vegetation or Surface Water Classification

Adult: Alpine cinder deserts, alpine shrublands, lava outcrops, rocky gulches, cinder cones, and subalpine forests. (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations from 2,600 to 3,800 meters (USFWS, 1993)

Spatial Arrangements of the Population

Adult: Widely scattered (USFWS, 1993)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1993)

Site Fidelity

Adult: High (USFWS, 1993)

Habitat Narrative

Adult: The area of the probable original range of the Mauna Kea silversword includes several distinct vegetational and climatic zones of Mauna Kea. The upper region from 3400 to 3800 meters (11,152 to 12,464 feet) elevation is barren alpine cinder desert. The surface is covered with glaciated and unglaciated block lava and cinders. Mosses, lichens, and grasses (*Trisetum glomeratum* and *Agrostis sandwicensis*) grow in widely scattered patches in the shelter of or on the sheltered surface of rocks. The region between 3200 and 3400 meters (10,496 to 11,152 feet) elevation is scrub desert. The substrate is also block lava and cinders. The region between 2900 and 3200 meters (9512 and 10,496 feet) elevation may have been the area of the original treeline of Mauna Kea. This area is now alpine scrub and the substrate is lava outcrops and ash. Open mamane forest begins between 2600 and 2900 meters (8528 and 9512 feet) elevation. The soil in this region is mostly ash with lava outcrops. (USFWS, 1993)

Dispersal/Migration**Dispersal**

Adult: Abiotic (USFWS, 2012)

Dispersal/Migration Narrative

Adult: Dispersal of the seeds occurs by wind and water (USFWS, 2012).

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2012)

Redundancy:

Very low (inferred from USFWS, 2012)

Number of Populations:

2 wild populations; number of outplanting populations uncertain (USFWS, 2012)

Population Size:

Approx 27 individuals (wild); at least 10,000 individuals in several outplantings (USFWS, 2012)

Adaptability:

Low (inferred from USFWS, 2012)

Population Narrative:

Low seed set, self-incompatible, monocarpic. Recent summaries suggest that two wild populations of *Argyroxiphium sandwicense* subsp. *sandwicense* currently exist, comprising only approximately 27 individuals (Plant Extinction Prevention Program 2010; USFWS 2010). Several outplantings presently exist that collectively harbor at least 10,000 individuals (USFWS 2010; J.

Hatayama, Protection Forester, Hawaii Department of Land and Natural Resources, Division of Forestry and Wildlife, pers. comms. 2011a,b,c), but details concerning the number of outplanted populations and number of individuals within each outplanted population have not been confirmed with certainty. Data are not available that summarize what proportion of individuals flowered (and presumably die) each year (J. Hatayama, pers. comm. 2011a,b). What is certain, however, is that most individuals are on the east and north slopes of Mauna Kea between Kanakaleonui and the road accessing the summit, and most of these are in the Wailuku enclosure; smaller populations (numbers unknown) persist in the skyline and Puu Nanana enclosures; nearly all surviving individuals were reintroduced; seedling survival in the wild is nearly non-existent; and the subspecies is not sustaining itself naturally due to high seedling mortality (J. Hatayama, pers. comm. 2011a,b,c). (USFWS, 2012; NatureServe, 2015)

Threats and Stressors

Stressor: Herbivory (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Feral sheep (*Ovis aries*) and other ungulates readily eat the relatively succulent leaves of *Argyroxiphium sandwicense* subsp. *sandwicense*. Human-mediated declines in the overall population size, indirectly due to the intentional introduction of ungulate species such as cattle (*Bos taurus*), goats (*Capra hircus*), and sheep, may have occurred as much as 186 years ago, given that an early collector of specimens, James Macrae, observed a dead sheep near the summit of Mauna Kea in 1825 (USFWS 1993). Sheep may have been driven to the highest portions of Mauna Kea due to hunting pressure from humans and feral dogs, and the succulent leaves of *Argyroxiphium sandwicense* subsp. *sandwicense* likely were preferentially browsed by sheep in the arid, alpine habitat of Mauna Kea. The grazing pressure may have been enormous, given one estimate of approximately 40,000 sheep on Mauna Kea in the late 1930s. Goats also damage the subspecies (USFWS 1993). Feral pigs (*Sus scrofa*) up root and damage the species (USFWS 1993). Invertebrate predation or herbivory – Kobayashi (1974) reported that *Argyroxiphium sandwicense* is largely unaffected by insect predation in the seedling stage, and that such predation mostly commences after the terminal inflorescence forms. The predators most affecting this subspecies are *Rhynchepestia rhabdotis* and *Tephritis cratericola*, which feed on developing seeds. However, this study focused on subspecies *macrocephalum* (Kobayashi 1974), so it is uncertain whether these findings also apply to subspecies *sandwicense*. Rodent herbivory and predation may also occur. (USFWS, 2012)

Stressor: Collection (USFWS, 1993)

Exposure:

Response:

Consequence:

Narrative: Collection of silversword plants by humans has been, and is currently, a potential threat to the Mauna Kea silversword. The paucity of herbarium specimens of the Mauna Kea silversword, however, suggests that the species was never heavily collected for scientific purposes. Plants were occasionally removed from Mauna Kea for ornamental purposes in the 1920's, but these removals were probably not performed on a large scale. In areas where the silversword populations had already declined to a few individuals, removals may have represented a large reduction or the final elimination of a population. Between September 1987

and July 1988, three adult plants were removed from the Skyline population. This removal may affect the survival potential of this already small population (USFWS, 1993).

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2012)

Stressor: Invasive species (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: There are established invasive plant species competition by the following species: *Anthoxanthum odoratum* (sweet vernal grass), *Rytidosperma pilosum* (hairy oat grass), and *Verbascum thapsus* (mullein) (USFWS, 2012).

Stressor: Small population size (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: There is an increased likelihood of stochastic extinction due to changes in demography, the environment, genetics, or other factors (J. Hatayama, pers. comm. 2011c; Plant Extinction Prevention Program 2010) (USFWS, 2012).

Recovery

Reclassification Criteria:

- 1) There are 5 to 10 populations in suitable, protected habitat with 2,000 mature individuals per population; (USFWS, 2019)
- 2) All major threats are controlled around the target populations; (USFWS, 2019)
- 3) Populations are represented in an ex situ collection as defined in the Center for Plant Conservation guidelines (Guerrant et al. 2004) that is secure and well managed; (USFWS, 2019)
- 4) All target populations have been stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions may continue to be necessary. (USFWS, 2019)

Delisting Criteria:

- 1) All of the downlisting criteria have been met; (USFWS, 2019)
- 2) All target populations have been stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Subspecies-specific management actions must no

longer be necessary, but an ongoing need for ecosystem-wide management actions may remain if long-term agreements are in place to continue management. (USFWS, 2019)

Recovery Actions:

- Protect all extant individuals from feral ungulates, fire and human-related disturbances. (USFWS, 1993)
- Monitor and research existing populations. (USFWS, 1993)
- Develop and implement a program to enhance regeneration within existing populations. (USFWS, 1993)
- Reestablish the silversword within areas of historic abundance, and verify recovery objectives. (USFWS, 1993)
- Protect existing populations of Mauna Kea silversword (USFWS, 1993).
- Monitor and research existing populations (USFWS, 1993).
- Develop and implement a program to enhance regeneration within existing populations (USFWS, 1993).
- Reestablish Mauna Kea silversword within areas of historic abundance (USFWS, 1993).
- Verify recovery objectives (USFWS, 1993).

Conservation Measures and Best Management Practices:

- Captive propagation for genetic storage and reintroduction: Collect seed from all wild individuals that may be found for use in propagation, to increase the genetic variability of breeding stock. Continue to collect seed material from all populations. Attach tags to individuals to record which individuals have served as maternal parents in propagation efforts ex situ. (USFWS, 2012)
- Reintroduction / translocation implementation: Continue to reintroduce the species back into its known historical range. (USFWS, 2012)
- Ungulate enclosure: Construct large-scale fences around all existing and any new populations. Monitor fenced exclosures for evidence of breaching by feral ungulates. (USFWS, 2012)
- Ungulate control: Protect all populations against disturbances from feral ungulates. (USFWS, 2012)
- Surveys / inventories: Resurvey the historical range of *Argyroxiphium sandwicense* subsp. *sandwicense* for additional individuals or populations and to determine the current status of the species. (USFWS, 2012)
- Reintroduction / translocation site identification: Conduct surveys to determine which areas would be most appropriate for additional reintroductions. In particular, focus on the northern and western slopes of Mauna Kea, where reintroduction sites are less common. (USFWS, 2012)
- Competitive invasive plant species control: Remove invasive introduced plant species around all known populations, especially within fenced exclosures. (USFWS, 2012)
- Predator / herbivore control: Control rodents around existing populations. (USFWS, 2012)
- Threats research: Develop and implement effective measures to reduce the impact of collection. Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2012)
- Invertebrate control research: Research the effects of invertebrates around existing and reintroduced populations. If research deemed an immediate threat, determine and implement effective control measures. (USFWS, 2012)
- Reintroduced / translocation population management and monitoring: Continue to monitor reintroduced populations twice annually for signs of significant population decreases and for other signs of distress, such as insect damage or evidence of plant disease. (USFWS, 2012)

- Alliance and partnership development: Work with Hawaii Division of Forestry and Wildlife and other landowners to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2012)

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USFWS. 2019. Amendment to the Recovery Plan for the Mauna Kea Silversword (*Argyroxiphium sandwicense* ssp. *sandwicense*). PIFWO, Honolulu, Hawaii.

SPECIES ACCOUNT: *Argythamnia blodgettii* (Blodgett's silverbush)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/31/2016; Southeast Region (R4)

Physical Description

Argythamnia blodgettii, in the Euphorbia family, is an erect, perennial shrub or herb, 10 to 60 cm (4 to 24 in) tall, with a woody base and small, green flowers. The stems and leaves are covered with small hairs. The leaves, arranged alternately along the stems, are 1.5 to 4.0 cm (0.6 to 1.6 in) long, have smooth (or rarely toothed) edges, are oval or elliptic in shape, and often are colored a distinctive, metallic bluish green. The plants have separate male and female flowers. Staminate (male) flowers have a calyx 7 to 8 mm (0.27 to 0.31 in) wide, consisting of 4 to 5 lance-shaped sepals that are larger than the petals. The petals are broadly elliptic and shorter than the sepals. There are 10 stamens. Pistillate (female) flowers have 4 to 5 sepals that are 5 to 6 mm (0.19 to 0.24 in) long, lance-shaped, and often more narrow than those of male flowers. The petals are broadly elliptic, shorter than the sepals. The fruit is a woody capsule 4 to 5 mm (0.16 to 0.19 in) wide, which contains the seeds (Adapted from Small 1933, pp. 784–785; Bradley and Gann 1999, p. 2). (USFWS, 2015)

Taxonomy

Botanist John Torrey first described the species in Chapman (1884, p. 100) as *Aphora blodgettii*, reporting it for South Florida. In an 1896 (p. 100) revision of the genus, Pax placed it in the genus *Ditaxis*. In 1897 (p. 100), Chapman placed it in the genus *Argythamnia*. In 1903, Small placed it again in the genus *Ditaxis*. In 1914, Pax (p. 100) placed it in synonymy under *Ditaxis fendleri*, a plant of Colombia, Venezuela, Curacao, and Trinidad. Small (1933, pp. 784–785) retained it as *Ditaxis blodgettii*, treating it as a southern Florida endemic. Subsequent authors (Webster 1967, p. 100; Long and Lakela 1971, p. 558; Wunderlin 1998, p. 100; Wunderlin and Hansen 2003, p. 100) have retained it as a southern Florida endemic *Argythamnia blodgettii* (from Hodges and Bradley 2006, p. 10). The Integrated Taxonomic Information System (2015, p. 1) uses the name *Argythamnia blodgettii* and indicates that this species' taxonomic standing is accepted. The online Atlas of Florida Vascular Plants (Wunderlin and Hansen 2008, p. 1) uses the name *A. blodgettii*. In summary, there is consensus that *A. blodgettii* is a distinct taxon. We have carefully reviewed the available taxonomic information to reach the conclusion that the species is a valid taxon. Synonyms include *Aphora blodgettii* Torr. ex Chapm.; *Ditaxis blodgettii* (Torr. ex Chapm.) Pax; *Argyrothamnia blodgettii* (Torr. ex Chapm.) Chapm.; and *Ditaxis fendleri* Pax, not (Mull. Arg.) Pax and K. Hoof. (USFWS, 2015)

Historical Range

U.S., Florida, Miami-Dade and Monroe counties. *Argythamnia blodgettii* historically occurred from central and southern Miami-Dade County from Brickell Hammock to Long Pine Key in Everglades National Park, and in Monroe County throughout the Florida Keys from Totten Key south to Key West (Bradley and Gann 1999, p. 2) (USFWS, 2015).

Current Range

U.S., Florida, Miami-Dade County. *Argythamnia blodgettii* is currently known from central Miami-Dade County from Coral Gables and southern MiamiDade County to Long Pine Key in Everglades National Park, and the Florida Keys from nine islands, from Windley Key (Bradley and

Gann 1999, p. 3) southwest to Boca Chica Key (Hodges and Bradley 2006, pp. 10, 43) (USFWS, 2015).

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (USFWS, 2015)

Breeding Season

Adult: Flowering and fruiting take place throughout the year (USFWS, 2015).

Other Reproductive Information

Adult: Perennial (USFWS, 2015)

Reproduction Narrative

Adult: Reproduction is sexual; flowering and fruiting apparently takes place throughout the year (Bradley and Gann 1999, p. 3) (USFWS, 2015).

Habitat Type

Adult: Low, moist limestone areas near margins of pine rocklands. Sunny edges and gaps in pine rocklands, rockland hammocks, and coastal berm (USFWS, 2013).

Habitat Vegetation or Surface Water Classification

Adult: Forest/Woodland, Woodland - Conifer (USFWS, 2013)

Habitat Narrative

Adult: *Argythamnia blodgettii* grows in pine rocklands, in sunny gaps or edges of rockland hammock and coastal berm, and on roadsides (Bradley and Gann 1999, p. 3). It grows from crevices on oolitic limestone or on sand. The pine rocklands habitat where it occurs requires periodic fire to maintain an open, sunny understory with a minimum amount of hardwoods. Bradley and Gann (1999, p. 3) indicated that this species does tolerate some degree of human-induced disturbance. It can often be found along disturbed edges of pine rocklands, rockland hammock, and coastal berm, or in completely scarified pine rocklands (Bradley and Gann, 1999, p. 3) (USFWS, 2015).

Dispersal/Migration***Population Information and Trends*****Number of Populations:**

20 extant occurrences (USFWS, 2016)

Population Narrative:

There are 50 records for *Argythamnia blodgettii* in Miami-Dade and Monroe Counties. Twenty populations are extant, 15 are extirpated, and the status of 15 is uncertain because they have not been surveyed in 15 years or more (USFWS, 2016).

Threats and Stressors

Stressor: Agricultural and residential development (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Pine rocklands in Miami-Dade and Monroe Counties have lost nearly 90 percent of their area due to agricultural and residential development (OBrien 1998, p. 208). Development has reduced the coverage of pine rocklands from 130,358 acres (52,754 ha) to 15,256 acres (6,174 ha) (OBrien 1998, p. 208). Most of the ecosystems on the Keys have been impacted by humans, through widespread clearing of rockland hammocks in the 19th century for farming, or building of homes and businesses (Hodges and Bradley 2006, p. 6). Habitat loss continues to occur in its range, and most remaining suitable habitat has been negatively altered by human activity. Outside of ENP, only about one percent of the Miami Rock Ridge pinelands have escaped clearing, and much of what is left is in small remnant blocks isolated from other natural areas (Herndon 1998, p. 1) (USFWS, 2016).

Stressor: Habitat Fragmentation/Fire suppression (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Habitat fragmentation leads to the possibility of fire suppression in and around these isolated fragments. While this plant is not entirely limited to fire-maintained pine rocklands, fire suppression threatens the survival of Blodgett's silverbush. Pine rocklands need regular fires to prevent hardwood encroachment and excessive accumulations of litter. Under natural conditions, lightning fires typically occurred at 3- to 7-year intervals. With fire suppression, hardwoods eventually invade pine rocklands and shade out understory species like Blodgett's silverbush. Fire suppression has reduced the size of the areas that burn and habitat fragmentation has prevented fire from moving across the landscape in a natural way. Thus, many pine rocklands are gradually becoming tropical hardwood hammocks. Fire suppression threatens the Blodgett's silverbush at more than half of its remaining sites (Bradley and Gann 1999, p. 6; K. Bradley, pers. comm. 2007). The staff at NKDR is beginning to monitor the response of rare plants, including Blodgett's silverbush, to prescribed fire after years of fire suppression on the Refuge (Anderson 2010, slide 20). They have noted an increase in Blodgett's silverbush post fire. Approximately 20 plants were recorded in the monitored area prior to the burn, and 342 plants were detected 4 months post-fire (Anderson 2010, slide 20) (USFWS, 2016).

Stressor: Nonnative plants (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Nonnative (exotic) plant taxa have significantly affected pine rocklands. As a result of human activities, at least 277 taxa of exotic plants are now known to have invaded pine rocklands throughout south Florida (Service 1999, p. 3-175). A few of these exotic plants include

the *Schinus terebinthifolius* (Brazilian pepper), *Neyraudia reynaudiana* (Burma reed) and *Melaleuca quinquenervia* (melaleuca). *Lygodium microphyllum* (Old World climbing fern) is rapidly spreading and may become a serious problem (Volin et al. 2004, p. 445). Nearly all of the extant occurrences are threatened by exotic plant species (Bradley and Gann 1999, p. 6; Hodges and Bradley 2006, p. 43; K. Bradley, pers. comm. 2007). Exotic species have altered the type of fire that occurs in pine rocklands. Historically, pine rocklands had an open, low understory where natural fires remained patchy with low temperature intensity, thus sparing many native plants such as Blodgett's silverbush. The current density of exotic plant overgrowth throughout the range of Blodgett's silverbush may no longer allow the species to be conserved through fire. Dense growth can create intense fire temperatures and longer burning periods. Pine rockland plants cannot tolerate these extreme conditions. Given the current conditions, exotic plant control may require an alternate method, such as hand chopping followed by spot herbicide treatment, which requires extensive labor and is very costly. This method may not be feasible for publicly owned lands, because of the acreage and staffing and budget constraints (USFWS, 2016).

Stressor: Road maintenance (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Several occurrences exist near roads and road maintenance is a particular concern to each of these occurrences (Bradley and Gann 1999, p. 6; Hodges and Bradley 2006, pp. 11-15; K. Bradley, pers. comm. 2007). Clearing of vegetation along roads and the use of herbicides could impact populations; coordination needs to exist with road maintenance crews to prevent impacts (Hodges and Bradley 2006, pp. 11-15). Road enhancements (e.g., paving) or other infrastructure projects (e.g., underground cable, sewer and water lines) may also threaten some roadside populations (Hodges and Bradley 2006, pp. 11, 15). Illegal dumping is identified as a problem at two sites (Hodges and Bradley 2006, pp. 11, 13). Since Blodgett's silverbush (and 10 other rare species) are included in an Important Rare Plant Area (IRPA) on Big Pine Key, management along this FDOT right-of-way could improve (Gordon et al. 2007, pp. 2, 68) (USFWS, 2016).

Stressor: Natural disturbances (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Given the species narrow range and the small number of individuals at many sites, Blodgett's silverbush is vulnerable to natural disturbances, such as hurricanes. Storm surges associated with hurricanes result in inundation of habitat with saltwater for varying durations. In 2005, the Keys were impacted by three hurricanes (Katrina, Rita, and Wilma), and vegetation in many areas was top-killed due to salt water inundation (Hodges and Bradley 2006, p. 9). Storm surges may pose a threat to the population at Cactus Hammock on National Key Deer Refuge; however, hurricanes may also ultimately help this species by creating canopy gaps where this species thrives (Hodges and Bradley 2006, p. 12). According to the National Oceanographic and Atmospheric Administration, Miami-Dade County, the Keys, and western Cuba are the most storm-prone areas in the Caribbean so this threat is expected to continue (USFWS, 2016).

Stressor: Inbreeding depression (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: The species occurs in a restricted range, and many occurrences are small and isolated. As a result, threats associated with small population size ensue. These include potential vulnerabilities from environmental (catastrophic hurricanes), demographic (potential episodes of poor reproduction), and genetic (potential inbreeding depression) threats (USFWS, 2016).

Stressor: Pesticide effects on pollinators (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Critical habitat regulations for Bartram's scrubhairstreak butterfly and Florida leafwing have extended benefits to populations of these four plants and their pollinator guild by limiting mosquito insecticide activity in pine rocklands habitat in the Florida Keys. Nevertheless, we are proceeding cautiously and have initiated a multi-year research project to further investigate the level of impact pesticides have on these four plants and their pollinators throughout their ranges (USFWS, 2016).

Recovery**Reclassification Criteria:**

Not relevant.

Delisting Criteria:

Not defined; a Recovery Plan has not been issued as of December 2019.

Recovery Actions:

- Not defined; a Recovery Plan has not been issued as of December 2019.

Conservation Measures and Best Management Practices:

- Prevent further destruction or degradation of existing pine rocklands and hammocks (Service 1999, p. 3-191).
- Acquire available fragments, promote conservation easements and landowner agreements, work with private landowners, and enforce regulatory protection of pine rocklands (Service 1999, p. 3-191).
- Prevent further degradation of existing preserves from exotic plant species, fire exclusion, anthropogenic fires, unauthorized site uses, illegal dumping, improper siting of facilities (including interpretive trails), collecting of plants, hydrologic modifications including drainage, flooding and salt-water intrusion, and herbicides by working with Federal, State, county, and municipal agencies and non-governmental organizations (Service 1999, p. 3-192).
- Restore existing degraded pine rocklands through active management (e.g., where possible restore natural connections, natural fire regimes, and areas impacted by anthropogenic fires, unauthorized site uses, illegal dumping) (Service 1999, p. 3-192).
- Monitor populations on a regular basis to track trends within the population and changes in management needs (Hodges and Bradley 2006, p. 19).
- Design and implement a coordinated system of informing maintenance crews about populations of Blodgett's silverbush occurring along roads and rights-of-way (Hodges and Bradley 2006, p. 19). Raise awareness among maintenance workers and contractors.

- Evaluate the use of herbicide application along roadside populations.
- Conduct studies involving reproductive biology or life history (Hodges and Bradley 2005, p. 19). Ephemeral populations of this species present challenges; little is known about long-term continuity of population sizes (Hodges and Bradley 2005, p. 19). Reproductive biology studies would provide information on effects of unnatural disturbance and mosquito spraying on pollinators (Hodges and Bradley 2006, p. 19).
- Use prescribed fire and incorporate monitoring into plans to determine the effectiveness of the prescription; monitor the health of the community and species that occur with Blodgett's silverbush (Bradley and Gann 1999, p. 4).
- Consider a plan of action to establish a Florida Keys pine rockland core conservation area and ex-situ conservation of this species (Ross et al. 2009, p. 477)

References

USFWS. 2015. Endangered Species Status for *Chamaecrista Lineata* Var. *Keyensis* (Big Pine Partridge Pea), *Chamaesyce Deltoidea* Ssp. *Serpyllum* (Wedge Spurge), and *Linum Arenicola* (Sand Flax), and Threatened Species Status for *Argythamnia Blodgettii* (Blodgett's Silverbush)

Proposed Rule. 80 FR 58536-58567 (September 29, 2015).

USFWS. 2016. Endangered Species Status for *Chamaecrista lineata* var. *keyensis* (Big Pine Partridge Pea), *Chamaesyce deltoidea* ssp. *serpyllum* (Wedge Spurge), and *Linum arenicola* (Sand Flax), and Threatened Species Status for *Argythamnia blodgettii* (Blodgett's Silverbush)

Final Rule. 81 FR 66842 - 66865 (September 29, 2016).

USFWS 2013. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for *Argythamnia blodgettii* (Blodgett's silverbush). U.S. Fish and Wildlife Service, 03/26/2013, Region 4, Southeast Region. 17. p.

SPECIES ACCOUNT: *Asclepias meadii* (Mead's milkweed)

Species Taxonomic and Listing Information

Listing Status: Threatened; 9/1/1988; Midwest Region (R3) (USFWS, 2016)

Physical Description

A perennial herb with a single slender unbranched stalk, 8-16 inches (20-40 centimeters) high without hairs but with a whitish waxy covering. The hairless leaves are opposite, broadly ovate, 2-3 inches (5-7.5 centimeters) long, 3/8-2 inches (1-5 centimeters) wide, with a whitish waxy covering. A solitary umbel at the top of the stalk has 6-15 greenish ivory/cream colored flowers. Young green fruit pods appear by late June and darken as they mature, reaching 1.5-4 inches (4-8 centimeters) by late August or early September. Seeds are mature by mid-October (USFWS, 2003).

Taxonomy

Mead (1846) originally identified the plant as *Asclepias cordata*, but it was later described as a separate species by Torrey as *Asclepias meadii* (Gray 1856) (USFWS, 2003).

Historical Range

Indiana, Kansas, Missouri, Iowa, Illinois, and Wisconsin (USFWS, 2012)

Current Range

Extant populations are present in eastern Kansas, Missouri, south-central Iowa, and southern Illinois. Populations have been introduced into Indiana and Wisconsin; natural populations are considered extirpated (USFWS, 2012).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, Asexual (USFWS, 2003)

Lifespan

Adult: 15 years or more (USFWS, 2003)

Dependency on Other Individuals or Species

Adult: Bumblebees and miner bees for pollination (USFWS, 2003)

Breeding Season

Adult: Flowers in late May and early June; fruits from June to October (USFWS, 2003)

Reproduction Narrative

Adult: Flowers in late May and early June; fruits from June to October. This species has low reproductive rate; research suggests that Mead's milkweed will require 15 years or more to mature from a germinating seed to a flowering plant. Species is long-lived and may persist indefinitely or until destroyed by chance impacts from animals or pathogens (USFWS, 2003). Reproduction is apparently rare. In an 11 year study, Kettle et al. (2000) found that only 15% of flowering stems produced mature fruit (NatureServe, 2015).

Habitat Type

Adult: Terrestrial (USFWS, 2003)

Habitat Vegetation or Surface Water Classification

Adult: Tallgrass prairie, hay meadows, thin soil glades or barrens (USFWS, 2003)

Geographic or Habitat Restraints or Barriers

Adult: Elevation of 800-1200 ft (EPA, 2016)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Habitat Narrative

Adult: Habitat is mesic to dry mesic, upland tallgrass prairie, characterized by vegetation adapted for drought and fire. Most populations occur in virgin tallgrass prairies or unplowed native prairie hay meadows that have well-drained, or dry-mesic, soils. Plants also occur in igneous glades in the Missouri Ozarks and in limestone glades in the Shawnee Hills of southern Illinois. Elevations ranged from 800 to 1,200 ft. The soils for this plant consist of the following: well-drained, or dry-mesic, soils and in limestone glades in the Shawnee Hills of southern Illinois. Soil conditions in these habitats range from acid and nutrient poor in Missouri and southern Illinois to calcareous nutrient rich in Iowa and northern Illinois (EPA, 2016). Restricted to sites that have never been plowed and only lightly grazed, and hay meadows that are cropped annually for hay (USFWS, 2003).

Dispersal/Migration**Motility/Mobility**

Adult: Abiotic, Bird, Mammal (EPA, 2016)

Dispersal/Migration Narrative

Adult: Seeds are wind dispersed from follicles (USFWS, 2003) and by mammals and birds eating seeds (EPA, 2016).

Population Information and Trends**Population Trends:**

Decline of 70-80% (NatureServe, 2015)

Species Trends:

Decline of 10-30% (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

approximately 212 (NatureServe, 2015)

Population Size:

Uncertain (NatureServe, 2015)

Population Narrative:

As of February, 2015, there are approximately 212 occurrences observed since 1994: 177 in Kansas, 30 in Missouri, 3 in Iowa, and 2 in Illinois. The clone-forming nature of the species makes it difficult to determine number of individuals at each site. In addition, non-flowering stems are difficult to detect in tall grass (Alexander et al. 1997). There are 22 occurrences with good viability/integrity (NatureServe, 2015).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Mead's milkweed habitat is threatened by urbanization, conversion to agricultural land, and habitat fragmentation. Many Mead's milkweed populations are also experiencing habitat loss due to the lack of appropriate prairie management such as prescribed fire. Fire suppression provides opportunities for subsequent woody vegetation encroachment, and invasion by exotic cool season grasses. Habitat destruction from feral hogs has also reduced Mead's milkweed habitat (USFWS, 2012).

Stressor: Disease or predation (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Weevil damage to stems and developing fruits can affect seed viability. Other milkweed species may act as reservoirs for weevil populations, which then migrate to the rarer Mead's milkweed. Herbivory of Mead's milkweed from white-tailed deer has been observed at many sites across the species range and contributes to a lack of fruit production. Grazing by cattle and to a lesser degree by bison can adversely affect Mead's milkweed populations, especially when grazing occurs during flowering and fruiting periods from April to September. In Missouri, some Mead's milkweed populations are also experiencing fungal attacks (USFWS, 2012).

Stressor: Hay mowing (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Over 50% of Mead's milkweed sites are usually mowed annually for hay. Haying during the growing season prevents seed production of Mead's milkweed and results in reduced genetic diversity. Although haying and grazing occur on a large scale and may be a much more serious threat to the species, off-road vehicle use, in some cases associated with oil wells on a site, and trampling by researchers and school groups also adversely affects Mead's milkweed through excessive disturbance to its habitat. A proposed pipeline replacement project and highway construction project could potentially affect several Mead's milkweed populations in Kansas, however project sponsors are discussing alternatives with the USFWS Kansas Field Office (USFWS, 2012).

Stressor: Herbicide application (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: In the Osage Plains physiographic region, reference to herbicide damaged Mead's milkweed plants was specifically made in occurrence records for three populations (Doering Place, Mount Hope Prairie, and Nodding Polytaenia Prairie). Constant herbicide application has been reported as a contributing factor in the decline of Mead's milkweed in railroad prairies (USFWS, 2012).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: The protection of federally threatened plants on privately-owned lands is extremely limited in all states throughout the Mead's milkweed range, leaving those populations vulnerable to habitat destruction and eventual extirpation. Currently, only about 11% of Mead's milkweed sites have legal protection. Most Mead's milkweed populations occur on private land, most of these are hay meadows, and most are, therefore, not protected from habitat destruction, the primary threat to this species (USFWS, 2012).

Stressor: Other natural or manmade factors affecting its continued existence (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Climate change will be a particular challenge for endangered, threatened and other at-risk-species because the interaction of additional stresses associated with climate change and current stressors may push them beyond their ability to survive. In addition, populations of some species that are near the southern end of the range may be at particular risk. There is uncertainty about the exact nature and severity of climate change related impacts that may be anticipated to occur within the Mead's milkweed's range. A number of scientific studies project that there will be increased duration and intensity of heat waves in summer, higher levels of humidity and evaporation, changing patterns of precipitation with fewer rain events of greater intensity, increased frequency and more severe dry spells, and more flooding from heavy rains. Research

has suggested that climate change may also negatively impact pollinator species if plants and their pollinators respond differently to climate change. These climatic changes may threaten the Mead's milkweed in a variety of direct and indirect ways including: changes in the timing of blooming, loss of suitable habitat, loss of inter-specific relationships with pollinators, and increased threats from invasive species (USFWS, 2012).

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

1. Twenty-one populations are distributed across plant communities and physiographic regions within the historic range of the species (USFWS, 2003).
2. Each of these 21 populations is highly viable. A highly viable population is defined as follows: more than 50 mature plants; seed production is occurring and the population is increasing in size and maturity; the population is genetically diverse with more than 50 genotypes; the available habitat size is at least 125 acres (50 hectares); the habitat is in a late-successional stage; the site is protected through long-term conservation easements, legal dedication as nature preserves, or other means; and the site is managed by fire in order to maintain a late-successional graminoid-vegetation structure free of woody vegetation (USFWS, 2003).
3. Monitoring data indicates that these populations have had a stable or increasing trend for 15 years (USFWS, 2003).

Recovery Actions:

- Assess the viability of populations and protect habitat. Assess the viability of each population. Contact landowners and encourage conservation. Seek legal dedication. Increase number of sites managed or owned for the conservation of plant communities associated with Mead's milkweed in perpetuity (USFWS, 2003).
- Manage habitat. Conduct management assessment of public and private lands. Perform prescribed burns on a regular basis in Mead's milkweed habitat. Control invasive species in habitat with extant populations of Mead's milkweed (USFWS, 2003).
- Increase size and number of populations. Assess genetic condition of extant populations. Estimate the number of ramets and genotypes by collecting morphological data. Determine if genetic lineages occur among populations. Increase genetic diversity by introducing seeds or plants. Select sites for introduction and restoration. Select sites for augmentation based on variables in population viability index. Introduce or restore new populations in historic sites and newly identified habitat. Establish new populations using seeds or plants (USFWS, 2003).
- Conduct field surveys for new population occurrences or potential habitat for introduction
- Conduct research on restoration, management, and introduction techniques
- Maintain conservation populations. Collect and store seeds. Grow and maintain plants (USFWS, 2003).

- Promote public understanding. Produce a fact sheet and make it available on Service website. Hold workshops on managing Mead's milkweed sites. Create a traveling display. Promote news reports and press releases (USFWS, 2003).
- Review and track recovery progress. Reassess the viability of each population. Develop a post-delisting monitoring plan (USFWS, 2003).

Conservation Measures and Best Management Practices:

- It is recommended that a plan be developed and implemented to collect information required to complete a thorough Population Viability Index for each population of Mead's milkweed. Data that is currently missing for most populations include population trend, number of genotypes, habitat size, and management condition. Regular population monitoring will be required in order to establish a population trend. A prioritization of sites based on the population's potential to become highly viable and contribute to recovery should be considered, however, this prioritization cannot be completed without the data that is currently missing from most populations. At the time a prioritization of sites is possible, this information should be provided to all recovery partners (state, federal, and non-government organizations) to provide guidance on where recovery should best be targeted. Protection through conservation easement, acquisition and dedication, or other protection should be sought for Mead's milkweed populations within each physiographic region that have high viability or that have the potential to become highly viable. Land acquisition funding sources should be explored including the U.S. Fish and Wildlife Service's Non-Traditional Section 6 Recovery Land Acquisition Grant Program (USFWS, 2012).
- The number of populations managed with prescribed burns and removal of invasive species should be increased. Over 50% of sites continue to be mowed for hay. This activity prevents seed production and results in reduced genetic diversity. Increasing the number of hay meadows that are managed to allow reproduction of Mead's milkweed through a reduction in haying and grazing, especially on public lands, would be beneficial to Mead's milkweed populations. The exploration of incentives offered by the U.S. Department of Agriculture, Natural Resource Conservation Service's (NRCS) Conservation Programs, whereby landowners are encouraged to manage their lands for the conservation of natural resources, may be beneficial in recovering Mead's milkweed. Some populations are also experiencing herbivory by deer or habitat destruction by feral hogs. Grazing, in general, adversely affects Mead's milkweed and patch/burn/graze management appears to be reducing the quality of Mead's milkweed habitat. In addition, information on habitat size and management condition may already be available but needs to be compiled. Management condition can also be assessed during population monitoring (USFWS, 2012).
- Although management efforts to improve habitat and remove threats have occurred in some populations, actual increase in population size has been rare. Seven high priority recovery populations have been targeted in Missouri for intense recovery efforts. Introductions are underway in Illinois, Indiana and Wisconsin and planned in Missouri. Augmentation occurred in Illinois, Missouri, and Kansas (Kindscher et al. 2008; Menard 2012), in order to increase genetic diversity and promote successful reproduction. These introductions are not always located in the physiographic regions or community types indicated in the recovery criteria. For this reason, surveys are needed to locate suitable locations for the introduction and establishment of new populations in the physiographic regions and community types listed in the recovery criteria. Because Mead's milkweed grows slowly and rarely reproduces, it may be decades before the already introduced populations become viable (USFWS, 2012).
- There is a need for greater understanding of the species' life history requirements, specifically: phenology, pollination biology, and information on the species' reproduction in natural populations.

Research indicates that introduction by transplanting juveniles reared in nurseries or greenhouses reduces time to reproduction and therefore should increase the potential viability of introductions (Bowles et al. 2003). Further research on restoration, management, introduction techniques, and the lack of reproduction in natural populations of Mead's milkweed will assist in the recovery of the Mead's milkweed. Establishing long-term seed collection of representative populations as well as establishing new, and maintaining current, propagation nurseries will also assist in the recovery of Mead's milkweed. Although a genetically diverse nursery population of Mead's milkweed is being maintained at the Morton Arboretum for introduction and augmentation purposes, a long-term seed collection protocol focused on representing populations throughout the range has not been established and would contribute to recovery of Mead's milkweed (USFWS, 2012).

- Statewide recovery groups have been developed in Missouri and Kansas. It is recommended that the states of Illinois, Iowa, and Wisconsin also develop recovery groups, which can be defined as either one recovery group for each state or one recovery group for all three states (WI, IA, and IL) that would include representatives from each state (USFWS, 2012).

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SPECIES ACCOUNT: *Asclepias welshii* (Welsh's milkweed)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/28/1987; Mountain-Prairie Region (Region 6) (USFWS, 2015a)

Physical Description

Asclepias welshii is a tall, herbaceous plant in the milkweed family (Asclepiadaceae). The species stems are about 1 m (40 in) tall at maturity arising singularly or in clusters of about 10 stems from vertical taproots with horizontal runners connecting stem clusters. The leaves are displayed in opposite pairs along the stems. The upper leaves are broadly ovate shaped with a short petiole, about 8 cm (3 in) long and 5 cm (2 in) broad. The lower leaves are smaller, have acuminate tips and are borne directly on the stem without a petiole. The foliage and stems are covered with a very dense white-wooly pubescence (tomentum) early in the growing season. About 30 flowers are borne in a spherical inflorescence about 7 cm (3 in) in diameter at the end of a pedicel about 10 mm (0.4 in) long arising from the plant's upper leaf nodes. Individual flowers have the characteristic milkweed form. The reflexed calyx has individual lobes about 6 mm (0.25 in) long. The corolla, with the characteristic milkweed hoods and horns, is about 6 mm long, cream colored with a rose-tinged center. (USFWS, 1992)

Taxonomy

It is distinguished morphologically from other members of the large (approximately 140 species) genus, *Asclepias*, by the shape and size of the anther wings, the outer texture of its fruit, and its seed, which is the largest in the genus (Holmgren and Holmgren 1979; Service 1992). (USFWS, 2015b)

Historical Range

Not known from locations other than current (inferred from USFWS, 2015)

Current Range

Welsh's milkweed is endemic to active sand dunes of south central Utah (Kane County), northern Arizona (Coconino County) and the Navajo Indian Reservation in Arizona. (USFWS, 2015b)+H4

Critical Habitat Designated

Yes; 10/28/1987.

Legal Description

On October 28, 1987, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Asclepias welshii* (Welsh's milkweed) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Utah (52 FR 41435-41441).

Critical Habitat Designation

The critical habitat designation for *Asclepias welshii* includes one CHU in Kane County, Utah. This species critical habitat encompasses approximately 4,000 acres (ac) (52 FR 41435-41441).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Asclepias welshii* critical habitat consists of one component (52 FR 41435-41441):

The constituent elements of this critical habitat are the sand dunes themselves.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (seeds) and asexual (rhizomatous) (USFWS, 2015)

Dependency on Other Individuals or Species

Adult: Milkweed species are known to be insect pollinated, primarily by bees, wasps, and butterflies (Struven et al. 1994). (USFWS, 2015)

Breeding Season

Adult: May to June (USFWS, 2015)

Reproduction Narrative

Adult: Reproduction can occur by asexual (rhizomatous) and sexual (seeds) means. Welsh's milkweed flowers from May to June; fruits develop and seeds disperse from July through September (Service 1992). Flowers in the genus, *Asclepias* cannot self-pollinate; they require pollinators to produce fruits and seeds. Milkweed species are known to be insect pollinated, primarily by bees, wasps, and butterflies (Struven et al. 1994). (USFWS, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest/Woodland, Sand/dune, Shrubland/chaparral, Woodland - Conifer (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Heavy rainfall events (USFWS, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found on coral pink sand dunes in sagebrush, juniper, and ponderosa pine communities at 1700 to 1900 meters. Occupies both the crest and lee slopes of dunes, adjusting readily to changes in depth of the sand. (Welsh et al. 1993). (NatureServe, 2015)

Environmental Specificity

Adult: Narrow. Specialist or community with key requirements common. (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (USFWS, 2015)

Habitat Narrative

Adult: The soil supporting *A. welshii* is unconsolidated aeolian sand on active dunes while the surrounding habitat is either vegetated, stabilized sands, sandstone slickrock, or various exposed shales and other fine grained exposed geologic rock types or their finer grained developed soils. Found on coral pink sand dunes in sagebrush, juniper, and ponderosa pine communities at 1700 to 1900 meters. Occupies both the crest and lee slopes of dunes, adjusting readily to changes in depth of the sand. (Welsh et al. 1993). Widespread germination in the wild appears to be triggered by multiple heavy rainfall events in a season. Germination and survival of seedlings grown under greenhouse conditions were negatively affected by low moisture conditions. However, established plants are considered drought tolerant because of their deep taproot and extensive rhizome structure (Palmer 1999). Populations of *A. welshii* occur in a plant community dominated by sand mulesears (*Wvethia scabrida* var. *attenuata*) with prominent groves of ponderosa pine (*Pinus Donderosa*) and clumps of Gambel oak (*Quercus gambelii*). (USFWS, 1992; USFWS, 2015; NatureServe, 2015)

Dispersal/Migration**Dispersal**

Adult: High (USFWS, 2015)

Dispersal/Migration Narrative

Adult: After seeds mature, they drop and are buried near the fruits from which they fall or are dispersed along the surface of the dune by wind (Palmer 2001, Esplin 2007). Wind dispersal also allows for long-distance seed dispersal (Esplin 2007), as populations of Welsh's milkweed tend to be isolated with some of the known populations more than 70 miles apart (although unsurveyed, suitable habitat may exist between those points). Welsh's milkweed seeds have a pappus (a sometimes feathery or bristly modification to a flower) that is suitable for wind dispersal and the CPSD is subject to high winds. Seed dispersal may also be facilitated by birds or other animals. (USFWS, 2015)

Population Information and Trends**Population Trends:**

Short-term trends suggest a decline of 10 to 30% (NatureServe, 2015)

Resiliency:

Low (inferred from USFWS, 2015)

Representation:

Low (inferred from USFWS, 2015)

Redundancy:

Low (inferred from USFWS, 2015)

Population Growth Rate:

Unknown (NatureServe, 2015)

Number of Populations:

8 (USFWS, 2015)

Population Size:

~70,000 above-ground stems (NatureServe, 2015)

Adaptability:

Low (inferred from USFWS, 2015)

Population Narrative:

Known from a total of approximately 20,000 above-ground stems (the number of genetic individuals is unknown). One population on the Navajo Nation has at least several hundred stems and the other population is small with around 100 stems. In 1987 the populations in Utah numbered about 10,000 stems on the Coral Pink Sand Dunes and about 500 stems growing in the Sand Hills northeast of the Coral Pink Sand Dunes. In 1992, the populations on the Coral Pink Sand Dunes numbered 12,000 stems, while during the last census in 2002, about 72,000 stems were observed. In 2002 (Kneller), the entire Coral Pink Sand Dune was surveyed, with a total of 71,491 stems counted. Of these 16,133 (22.5%) were primary stems, 20,936 (29%) were secondary stems, and 34,422 (48%) were mature stems. The Service now recognizes a total of eight populations. The five additional populations were found after 1992; three in Coconino County, Arizona (Coyote Buttes, Sand Cove, and Thousand Pockets) and two on the Navajo Indian Reservation, Arizona (Tuba City and Comb Ridge) (Coconino, Navajo and Apache counties) (Franklin 1993; Hazelton 2013, pers. comm.). Short-term population trends suggest a decline of 10 to 30%. The Welsh's milkweed has a fragile habitat, making it easily degraded by surface disturbance including the movement of sand by wind. (NatureServe, 2015)

Threats and Stressors

Stressor: Recreation (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: In Utah, thousands of people visit the state park area for OHV, camping, hiking, etc. (NatureServe, 2015)

Stressor: Off highway vehicle use (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Off highway vehicles (OHVs) are also known as off road vehicles (ORVs) and include dune buggies and all-terrain vehicles. Five populations are protected from OHV use: Coyote Buttes, State Line, Thousand Pockets, Sand Cove and Sand Hills. OHV use is prohibited in Coyote Buttes, State Line, Thousand Pockets, and Sand Cove because they are in the Paria Canyon-Vermilion Cliffs Wilderness, while the Sand Hills population is located entirely within an OHV closure area for Welsh's milkweed designated critical habitat. The surrounding suitable habitat permits OHV use on designated trails only, and the compliance is high (BLM 2008; Church 2014 pers. comm.). The CPSD population is heavily used by OHVs. While a total of 27% of Welsh's milkweed designated critical habitat in CPSD is closed to OHV use, the majority of the dunes are open to cross country OHV use. The effects of OHV use on Welsh's milkweed are not fully

understood and are complicated by our lack of basic biological information on the species and limited monitoring. The deep root and rhizome system of established stands or individuals likely offers some protection from OHV damage, although it is reasonable to assume that seedlings are more vulnerable than juvenile and adult plants. Repeated damage to stems in high traffic areas may result in the mortality of individual plants or plant stands within the population, but this type of data has not been documented within the monitoring plots (Kneller 2003). OHV use physically damages Welsh's milkweed plants by either crushing or removing portions of the plants. OHVs can damage all above ground portions of the plants including vegetative stems, flowers and fruits (Esplin 2007; Kneller 2003). Of great concern is the damage and destruction of seed pods and flowers, which decreases the reproductive success of individual plants (Esplin 2007; Kneller 2003). Plants with damaged stems will likely spend more energy on new vegetative growth than reproduction, thereby indirectly reducing sexual and asexual reproductive output. (USFWS, 2015)

Stressor: Grazing (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: All populations of Welsh's milkweed are on land that is open to grazing. Livestock (cattle) grazing is known to occur at three populations, CPSD, Sand Hills, and Comb Ridge. No evidence of grazing or livestock impact has been documented at the remaining five populations, although none of these are frequently visited or surveyed. Some trampling of plants was noted at CPSD, Sand Hills, and Comb Ridge, and at Comb Ridge evidence of grazing on Welsh's milkweed stems was also observed (Hazelton 2013, pers. comm.; Roth 2013, pers. comm.). Aside from these observations, there are no data on livestock impacts on Welsh's milkweed. However, the impact of grazing on the species is likely limited because livestock do not typically walk on the dunes where Welsh's milkweed grows unless they need to cross a dune field to reach new grazing areas (Roth 2013; Palmer 1993). We consider livestock grazing to not be a threat at this time, as any stress to the plants from grazing appears to be extremely low. This would only be re-evaluated if there was an increase in grazing pressure on Welsh's milkweed habitat, or if additional evidence of livestock herbivory was documented in one or more of the populations. (USFWS, 2015)

Stressor: Insect predation (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Milkweed bugs (*Lygaeus* spp.) and milkweed beetles (*Tetraopes* spp.) have been observed feeding on plants within four Welsh's milkweed populations, CPSD, Sand Hills, Comb Ridge and Tuba City. Milkweed aphids (*Aphis nerii*) have also been observed feeding on Welsh's milkweed (Hazelton 2013, pers. comm.). These are all native insects that are common predators of other milkweed species and were likely historic predators of Welsh's milkweed. Damage to Welsh's milkweed plants from insect predation, primarily milkweed bug nymphs, includes damage to seedpods resulting in fruit desiccation and aborted or unviable seeds (Esplin 2006). (USFWS, 2015)

Stressor: Small population size (USFWS, 2015)

Exposure:

Response:**Consequence:**

Narrative: Four of the eight populations of Welsh's milkweed are small in size and consist of 100 stems or less. These populations likely consist of far fewer genetically distinct individuals than 100. Population size is likely the best predictor of extinction rate for isolated populations (Fischer and Stöcklin 1997; Pimm et al. 1988). Small plant populations are at an increased risk of extinction due to the potential for inbreeding depression, loss of genetic diversity, and lower sexual reproduction rates (Ellstrand and Elam 1993; Wilcock and Neiland 2002), and are more likely to succumb to natural catastrophes (e.g., drought, fire, and flood) and environmental stochasticity (Fisher and Stocklin 1997). (USFWS, 2015)

Stressor: Climate change (USFWS, 2015)

Exposure:**Response:****Consequence:**

Narrative: In the southwestern United States, including Utah, average temperatures have increased ~1.5°F (0.8°C) compared to a 1960 – 1979 baseline (Karl et al. 2009). By the end of this century, temperatures are expected to warm a total of 4 to 10°F (2 to 5°C) in the southwest (Karl et al. 2009). Much of the Southwest remains in a drought, recently assessed as the most severe western drought of the last 110 years (Karl et al. 2009). Water resources in the western United States are predicted to be sensitive to climate change (Karl et al. 2009). The levels of aridity of recent drought conditions are predicted to become the new climatology for the southwestern United States, and the most recent projections show the drought risk in this area for the remainder of the 21st century likely to reach unprecedented levels (Cook et al. 2015; Seager et al. 2007). Utah is expected to see longer periods between precipitation events, while those precipitation events become more intense (Steenburgh et al. 2007). Severe climate conditions have the potential to profoundly impact individuals, populations, and plant communities (Levine and Paige 2004). We do not have enough data to accurately assess the threat level to this species from climate change at this time. We have no immediate evidence of a negative impact on Welsh's milkweed populations from climate change but this has not been studied so we do not fully understand it. (USFWS, 2015)

Recovery**Reclassification Criteria:**

Reclassification criteria are not available.

Delisting Criteria:

1. The species known populations have been demonstrated to be at viable population levels. (USFWS, 1992)
2. Formal land management designations, which would provide long-term habitat protection for *A. welshii*, are established for the known populations. (USFWS, 1992)

Recovery Actions:

- Control activities which adversely affect the habitat of *A. welshii*. (USFWS, 1992)
- Inventory suitable habitat for *A. welshii* and determine abundance and distribution of the species. (USFWS, 1992)

- Determine the biological and ecological factors critical to the species conservation, and conduct minimum viable population studies in each of the species known populations. (USFWS, 1992)
- Develop public awareness and appreciation for the conservation of the species. (USFWS, 1992)

Conservation Measures and Best Management Practices:

- The Service recommends continued monitoring of the existing plots at Coral Pink Sand Dunes, with a focus on refining a protocol that takes into account the changing location of dunes and monitored stands and meaningfully measures the impact of OHV use, while returning consistent results that can be compared across years. (USFWS, 2015)
- Data on the presence and intensity of OHV activity in the plots and any damage should continue to be collected and recorded in a standardized, quantifiable form, and monitoring protocols should be expanded to more fully capture the total OHV usage over a season in monitored plots as opposed to only the most recent usage once per season. (USFWS, 2015)
- The Service recommends that targeted surveys of previously un-surveyed likely suitable habitat be conducted for Welsh's milkweed in, and detailed records kept of what locations have been surveyed. (USFWS, 2015)
- The Service recommends that all known populations be surveyed regularly with standardized and accurate methodology in order to obtain baseline population data, and that a targeted, scientifically-meaningful, range-wide monitoring scheme be developed and implemented. (USFWS, 2015)
- The Service recommends that monitoring protocol include provisions to distinguish new rhizomatous growth from true seedlings, and that the delineation of stem classes (particularly between secondary and mature stems) be made clear and consistently applied, including consideration of whether classifying stems as secondary is scientifically useful – a categorization such as seedling, primary stem, nonreproductive stem, reproductive stem may hold more value and be easier to apply. (USFWS, 2015)
- The Service recommends that monitoring data collected be expanded to include the presence of predatory insects on plants, damage observed, number of first year seedlings, and the number of desiccated or abortive seedpods vs healthy seed pods. (USFWS, 2015)
- The Service recommends that the Navajo Nation develop a monitoring plan for the Welsh's milkweed populations at Tuba City and Comb Ridge, to ensure that those populations are adequately surveyed and to assess what threats they face currently or may face in the future. (USFWS, 2015)
- The Service recommends that GIS data from the 2002 census at CPSD showing milkweed stand number and location in 1992 and 2002 be located and used to guide future surveying or censusing efforts at CPSD. If this data cannot be located, we recommend it be reconstructed by hand and digitized using existing maps from the 2002 census. (USFWS, 2015)
- The Service recommends that a census of the CPSD similar to the one performed in 2002 be completed to determine locations of stands, amount of occupied habitat, and what level of protection current closure areas are providing for that population. (USFWS, 2015)
- Determine the current level of OHV use in and on existing stands and how that use relates to species response and impacts on individual mortality, reproductive success, and population demographics, particularly during high traffic times of the season. Monitoring should evaluate plant and reproductive damage in low, medium, and high OHV use areas and ultimately determine the overall detriment to the species from OHV use. This should be weighed against any benefit from OHV

disturbance in the form of habitat creation, with the purpose of creating science-based OHV regulations within CPSD that are adequate for the protection of Welsh's milkweed. (USFWS, 2015)

- Assess the genetic variability of the species across the range and within populations in order to understand the population genetics of Welsh's milkweed. (USFWS, 2015)
- Genetic or other research should identify individual plants within a stand and develop protocols to distinguish individuals so monitoring methods follow individuals through time and so actual population size can be determined. (USFWS, 2015)
- Determine the mechanisms of species population dynamics including why certain populations appear to have declining stem counts, and whether those which appear to be increasing are actually increasing in number of individuals or only in stem counts. (USFWS, 2015)
- Gain a more complete understanding of the life history of Welsh's milkweed, particularly as it pertains to sexual reproduction, seedling recruitment, life span, and stem demographics, in order to be able to monitor the health and status of the populations effectively. (USFWS, 2015)
- Study the breeding biology, pollinators of the species and pollinator requirements for the species. Identify other community associates that may be important for the species (i.e. those species that support pollinators and provide corridors for pollinators). (USFWS, 2015)
- Study how and when Welsh's milkweed reproduces sexually and asexually. (USFWS, 2015)
- Determine the species' vulnerability to prolonged drought, temperature change, and the potential impacts of climate change, including impact on pollinators of Welsh's milkweed. (USFWS, 2015)

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SPECIES ACCOUNT: *Asimina tetramera* (Four-petal pawpaw)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/27/1986; Southeast Region (R4)

Physical Description

Asimina tetramera is a 1 to 3 m tall aromatic shrub that has one to several stems arising from a deep taproot. Leaves are oblong to oblanceolate, 5 to 10 cm long, arranged alternately on the stem, and are yellow-green to deep green. The leaves are narrow at the base (A. Cox, Florida International University, personal communication 1995), have broadly acute or blunt tips, and lack stipules. The flowers are maroon and fetid. They occur singly in the leaf axil; however, if the plant is burned or damaged, two or three flowers may develop. Perianth parts are typically in whorls of three, but may vary. The petals usually form whorls. The stamens are spirally arranged on an elevated torus or ballshaped receptacle, surrounding one to many separate carpels. After fertilization, the receptacle expands as fruit develops. The fruit is an aggregate of developing carpels, or monocarps, on the expanding receptacle. The monocarps are indehiscent and berry-like. An individual flower may produce from one to eight monocarps with one to nine seeds each (A. Cox, Florida International University, personal communication 1995). The fruit are oblong and greenish-yellow, emitting a banana-like aroma when ripe (A. Cox, Florida International University, personal communication 1995). The laterally flattened seeds are dark brown and shiny (Austin and Tatje 1979, Kral 1983). (USFWS, 1999)

Taxonomy

The four-petal pawpaw was discovered at Rio, Florida, in 1924 and subsequently named *ityothamnus tetramerus* (Small 1926, 1933). However, the new genus was rejected by other taxonomists (Kral 1960). According to Kral (1960), *Asimina tetramera* is grouped with *A. pygmaea*, *A. longifolia*, and *A. nashii*. These species have several common characteristics, including flower development on new growth, sparsely and omentulose young shoots, and glabrous petioles, peduncles and leaf surfaces. Kral (1960) concluded *A. tetramera* more closely related to *A. pygmaea* than to the other *Asimina* species based on floral similarities. Both species have strongly recurved inner petals, are maroon, have a pungent aroma and flower between April and July. However, several differences separate these two species: the gynoecium of *A. tetramera* is larger than *A. pygmaea*, adult plants of *A. tetramera* are larger than adult plants of *A. pygmaea*, and *A. tetramera* is limited to sand pine scrub ridges in Martin and Palm Beach counties, while *A. pygmaea* occurs in mesic slash pine or long leaf pine habitats and savannas. (USFWS, 1999)

Historical Range

Historically, *A. tetramera* occurred in sand pine scrub habitat on the coastal dune system in Martin and northern Palm Beach counties, Florida (USFWS, 1999)

Current Range

15 sites in Martin and northern Palm Beach Counties, Florida, along a 30-mile stretch of sand pine scrub. (USFWS, 2019)

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (USFWS, 1999)

Breeding Season

Adult: Flowering peaks in April and May, and continues throughout the summer. (USFWS, 1999)

Other Reproductive Information

Adult: Beetles are the most likely pollinators, although Dipterans (flies), Hymenopterans (wasps), and other insects have been observed visiting flowers. Gopher tortoises (*Gopherus polyphemus*), and small mammals such as the Florida mouse (*Peromyscus floridanus*) (Jones 1989) eat the fleshy fruit and may disperse seeds. Ingestion by animals is not necessary for seed germination. *Asimina tetramera* seeds germinate from September to March. Old, stored, or dried seeds will not germinate. Germination may take from 1 to 8 months after the seed is planted. The root system establishes several months before shoot emergence, and two to seven leaves are produced the first year. *Asimina tetramera* plants are deciduous, or partly so, with new leaves emerging in April and continuing to develop into summer. Buds are borne in the axils of the leaves as shoots develop. Flowers occur on new growth, and flower maturation proceeds from the base of the shoot toward the tip. Damaged stems sprout, producing new growth and may flower as late as September. Flowering peaks in April and May, and continues throughout the summer, with fruit ripening in 2 to 3 months. (USFWS, 1999)

Reproduction Narrative

Adult: Reproduction in *A. tetramera* is sexual. The perfect flowers open before all the parts are fully developed, and mature from the base of the stem toward the developing tip. They are protogynous, meaning that the stigmatic surface becomes receptive before anther maturation and pollen release. The petals fall from the flowers within one day of pollen release, and carpel development and receptacle enlargement follow successful pollination and fertilization. Flowers that are not pollinated fall soon after pollen release. (USFWS, 1999)

Habitat Type

Adult: sand pine scrub vegetation (USFWS, 1999)

Habitat Vegetation or Surface Water Classification

Adult: Terrestrial

Habitat Narrative

Adult: *Asimina tetramera* is found only in sand pine scrub vegetation on old, coastal dunes (Austin and Tatje 1979). The species grows in excessively-drained, quartz sand of both the Paola and the St. Lucie soil series (Austin et al. 1980; A. Cox, Florida International University, personal communication 1995); however, it shows a preference for the Paola soils (Farnsworth, 1988). *Asimina tetramera* is found in various seral stages of sand pine scrub, ranging from open [no canopy] to mature [closed canopy] (A. Cox, Florida International University, personal communication 1997). *A. tetramera* is adapted to infrequent, intense fires, perhaps every 20 to

80 years (FWS 1988). Abundant flowering and fruitset occur in years following fire and diminish with maturation of the community and subsequent canopy closure (A. Cox, Florida International University, personal communication 1996b). (USFWS, 1999)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Gopher tortoises, and small mammals such as the Florida mouse (*Peromyscus floridanus*) (Jones 1989) eat the fleshy fruit and may disperse seeds.

Population Information and Trends

Population Trends:

Declining (USFWS, 2019)

Number of Populations:

15 (USFWS, 2019)

Population Narrative:

The four-petal pawpaw can be found in sand pine scrub habitat in the coastal dune system of limited areas of Martin and Palm Beach Counties in southeast Florida (Kral 1960; Austin and Tatje 1979; Service 1999). The remaining four-petal pawpaw populations are declining due to further loss of habitat and may be characterized as existing on fragmented parcels within the historical range. While the four-petal pawpaw was historically documented in sand pine scrub areas of the south-central Atlantic Coastal Ridge of coastal Martin and northern Palm Beach counties, much habitat for the species has been destroyed or converted (Kral 1960; Service 1999; Florida Natural Areas Inventory (FNAI) 2000), and it is now found in a much smaller area from north of Palm Beach Gardens to the Savannas Preserve State Park in Martin County (Cox pers. comm. 1996a; Service 1999; Gann et al. 2002). The remaining populations of four-petal pawpaw occur within a narrow region of sand pine scrub habitat fragments that in 2018 included 15 sites — 11 public and 4 private sites (Service 1999; Gann et al. 2002; Cox pers. comm. 2018). Current information in 2018 shows four (4) of the 15 existing sites (27 percent) exist on private lands: three (3) in Martin County and one (1) in Palm Beach County (Cox pers. comm. 2018). Four-petal pawpaw occurred on approximately 26-27 historically known sites (Peterson 2008; Service 2009). (USFWS, 2019)

Threats and Stressors

Stressor: Habitat destruction or modification

Exposure:

Response:

Consequence:

Narrative: Continued habitat loss, fragmentation, and changes in land use threaten the existence of four-petal pawpaw. Where plants occur on private sites, development has led to both direct destruction of habitat as a result of land clearing and habitat degradation from lack of management. Even though 68 percent of the sites containing four-petal pawpaw are publicly owned and not at risk of being developed, the plants on these sites may still be vulnerable to habitat degradation from encroachment of exotic plant species and lack of fire or other

mechanical treatment. If sites are not properly managed, ecosystem health may deteriorate. Because the sites are fragmented on a developed landscape, fire management may not always be feasible and encroachment by exotic plant species from neighboring properties is likely. Degradation to habitat can also occur from damage by feral hogs. Therefore, habitat loss, degradation, and fragmentation due to increasing development and lack of management in sand pine scrub habitat and the encroachment of exotic plants will continue to threaten four-petal pawpaw. (USFWS, 2009)

Stressor: Inadequacy of existing regulatory mechanisms

Exposure:

Response:

Consequence:

Narrative: The ESA provides limited protection for the species and its habitat. Existing federal regulations prohibit the removal or destruction of listed plant species on Federal lands. The four-petal pawpaw is also listed by the Florida Department of Agriculture and Consumer Services (FDACS) as endangered (5B-40.0055 Regulated Plant Index), but this legislation does not provide any direct habitat protection. State regulations require both written permission from the owner or legal representative and a permit issued by FDACS to collect or remove plants listed as endangered on the Florida Regulated Plant Index. However, these regulations afford no protection to listed plants on private lands. Existing regulatory mechanisms do not appear to be adequate, as several properties with pawpaws on private lands have been developed. Because this plant occurs in habitat along the Atlantic coastal ridge, which is desirable for development due to its elevation, it remains vulnerable to development pressures where it occurs on private property. Where the species occurs on public land, there is protection from development but not necessarily from habitat degradation. (USFWS, 2009)

Stressor: Inadequate fire management

Exposure:

Response:

Consequence:

Narrative: This species occurs in scrub habitat, which is typically maintained by fire. On many privately owned sites, fire has historically been suppressed and habitat has not received regular maintenance. Because fragmented habitat is interspersed on a developed landscape, burning may also be unlikely due to proximity to neighbors (Peterson 2008). If sites are not regularly maintained through fire or mechanical treatment, the overall health of the scrub system may be compromised and flowering and fruit set of fourpetal pawpaws may be reduced. (USFWS, 2009)

Stressor: Invasive nonnative plants

Exposure:

Response:

Consequence:

Narrative: Another major threat to pawpaws is the establishment of exotic plant species such as Brazilian pepper, rosary pea (*Abrus precatorius*), guinea grass (*Panicum maximum*), and natal grass (*Rhynchelytrum repens*) in the absence of maintenance, especially where native soil is disturbed. However, herbicides used to control overgrowth, if not properly applied, also pose a threat to the four-petal pawpaw. Broad application of herbicide to remove Brazilian pepper and tall grasses can be especially damaging (Cox in litt. 2009). It is thought that plants on at least two sites have been affected by herbicide treatments (Cox 2006). (USFWS, 2009)

Stressor: Limited distribution and specialized habitat

Exposure:

Response:

Consequence:

Narrative: The species' restriction to specialized habitat, its limited distribution, and its limited reproductive capacity also renders it vulnerable to random natural events, such as hurricanes and drought. Although the species fared well through the 2004 and 2005 hurricanes, specific conditions such as storm surge and amount of debris dumping following the event vary greatly with each hurricane and may render sites with few plants vulnerable to destruction.

Unfortunately, long-term seed storage does not seem to be a viable option for this species, as the seed does not persist (Peterson et al. 2008). (USFWS, 2009)

Recovery

Reclassification Criteria:

1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to ensure 20 to 90 percent probability of persistence for 100 years (USFWS, 1999)
2. When sites within the historic range of *A. tetramera* are adequately protected from further habitat loss, degradation, and fragmentation (USFWS, 1999)
3. When these sites are managed to maintain the coastal sand pine scrub communities to support *A. tetramera* (USFWS, 1999)
4. When monitoring programs demonstrate that these sites support the appropriate numbers of self-sustaining populations, and those populations are stable throughout the historic range of the species. (USFWS, 1999)

Delisting Criteria:

1. At least 25 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (Factor A) (USFWS, 2019)
2. Populations (as defined in criterion 1) occur in coastal sand pine scrub and are distributed across the historical range of the species. (Factor A, E) (USFWS, 2019)
3. Populations (as defined in criterion 1) must be protected via a conservation mechanism and/or managed such that enough suitable habitat is present for the species to remain viable for the foreseeable future. (Factor A, D, E) (USFWS, 2019)

Recovery Actions:

- Determine current distribution of *A. tetramera*. Some portions of *A. tetramera*'s range have been well surveyed yet a total distribution has not been ascertained for this species. A thorough survey is needed to determine the distribution for this species. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Atlantic Coastal Ridge has been converted to agriculture or urban development. The remaining

habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)

- Continue research on life history characteristics of *A. tetramera*. To effectively recover this species more specific biological information is needed. (USFWS, 1999)
- Monitor existing populations of *A. tetramera*. Develop monitoring protocol to assess population trends for *A. tetramera*. Develop a quantitative description of the population structure of *A. tetramera*. Monitor introduced plants. (USFWS, 1999)
- Provide public information about *A. tetramera*. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of *A. tetramera* and other rare species requires self-sustaining, secure, natural populations in existing native scrub habitat. S6. Establish delisting criteria. (USFWS, 1999)
- Habitat-level Recovery Actions: Prevent degradation of existing habitat. Restore areas to suitable habitat. Continue habitat-level research projects. Monitor habitat/ecological processes. Provide public information about xeric vegetative communities and their unique biota. (USFWS, 1999)

Conservation Measures and Best Management Practices:

- Surveys: - Continue to survey potential habitat and pursue conservation agreements/implement management recommendations and/or acquire land and investigate incentives to encourage land managers to manage scrub for ecosystem health and listed species. - Conduct additional surveys for four-petal pawpaw on all known and potentially suitable sites in the two counties of occurrence and provide updated information to FNAI for consistent tracking. - Continue monitoring for plants on both reintroduced and natural sites. - Monitor sites of special interest, such as those with altered water tables or in ecotonal areas at lower elevations. (USFWS, 2009)
- Management: - Continue management actions to include removal of debris and exotics through careful herbicide application, controlling public access, and the reintroduction of prescribed fire into the ecosystem. - Portions of sites with four-petal pawpaw and dense sand pines should be burned on a regular basis to prevent accumulation of large fuel loads. - Focus conservation efforts on marginal and small sites to preserve the genetic diversity of the species. - Identify additional reintroduction sites and establish reintroduced populations; population augmentations should also be implemented. (USFWS, 2009)
- Research: - Conduct research on the response of four-petal pawpaw to fire and fire prescriptions necessary to benefit the species. - Conduct additional research on the biology, ecology, genetics, and management needs of the species. - Continue demographic studies to determine the age class structure and long-term viability of the species, especially in areas with active recruitment, and determine critical life stages. - Compare the viability of the small sites in the northern portion of the range to the much larger southern site. - Conduct additional life history studies to enhance our understanding of observed genetic variance. - Continue to evaluate insect pollinators associated with the species over a longer term, and evaluate impacts to pollinators from aerial mosquito spraying, especially in the small, isolated sites in the northern portion of the species' range. - Continue seed germination studies and make efforts to develop additional outplanting techniques. - Continue genetic characterizations on sites that have not yet been studied, and apply this

knowledge to future introductions and population augmentations. - Continue to collect germ plasm from the remaining sites not currently represented in the Center for Plant Conservation's National Collection of Endangered Plants. - Continue propagation efforts. - Evaluate the effects of climate change on the species, including those that result from precipitation pattern changes and temperature rise. (USFWS, 2009)

- Other: - Partnerships should be promoted to share information, conduct collaborative research on coastal scrub habitat conservation, and provide land managers and the interested public with information about the ecosystem, threats, recovery actions, and associated rare biota. - Conduct an ad hoc meeting to compile new information, discuss recovery actions, share land management strategies, and set and prioritize five- and ten-year goals. - Seek opportunities to include the media in conservation efforts to provide information about this species to the public. (USFWS, 2009)

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SPECIES ACCOUNT: *Astragalus albens* (Cushenbury milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/24/1994; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A winter annual or short-lived perennial herb, silvery-white with a covering of dense, appressed silvery hairs. Stems (several) are slender, decumbent, up to 3 dm in length, together forming a loose mat. Leaves have 5-9 leaflets. Purple flowers are borne in clusters of 5-14 towards the tips of the stems (NatureServe, 2015).

Taxonomy

Member of the Fabaceae (pea family) (USFWS, 2009).

Historical Range

Cushenbury milk-vetch is endemic to the San Bernardino Mountains, San Bernardino County, California (USFWS, 2009).

Current Range

Restricted to a carbonate belt in the northeastern San Bernardino Mountains (east slope of the Transverse Range) extending from Dry Canyon southeastward to the head of Lone Valley (approximately 24 km) in and adjacent to San Bernardino National Forest; San Bernardino County, California. Using GIS tools, range extent was calculated to be approximately 82 square km (NatureServe, 2015). Cushenbury milk-vetch occurs from Furnace Canyon southeast to the head of Lone Valley (USFWS 1994, p. 43654) (USFWS, 2009).

Critical Habitat Designated

Yes; 12/24/2002.

Legal Description

On December 24, 2002, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Astragalus albens* (Cushenbury milk-vetch) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in California (67 FR 78570-78610).

Critical Habitat Designation

The critical habitat designation for *Astragalus albens* includes one CHU (39 subunits) in San Bernardino County, California (67 FR 78570-78610).

Northeastern Slope Unit, San Bernardino County, California. (i) From USGS 1:24,000 quadrangle maps Fawnskin, Big Bear City, Rattlesnake Canyon, and Cougar Buttes, California.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Astragalus albens* critical habitat consists of three components (67 FR 78570-78610):

- (i) Soils derived primarily from the upper and middle members of the Bird Spring Formation and Undivided Cambrian parent materials that occur on hillsides or along rocky washes with limestone outwash/ deposits at elevations between 1,171 and 2,013 m (3,864 and 6,604 ft);
- (ii) Soils with intact, natural surfaces that have not been substantially altered by land use activities (e.g., graded, excavated, recontoured, or otherwise altered by grounddisturbing equipment); and
- (iii) Associated plant communities that have areas with an open canopy cover and little accumulation of organic material (e.g., leaf litter) on the surface of the soil.

Special Management Considerations or Protections

The SBNF is planning a revision of their Resource Management Plan in the near future that, among other functions, would provide conservation benefits to the two carbonate plant species and their habitat in this unit. These lands, however, currently do not have approved management provisions for the carbonate plants and their habitat, and habitat degradation may still be occurring due to ongoing activities identified in the final listing rule for these species (see USFWS 2001b). Therefore, the subject lands continue to require special management and protection to ensure the conservation of these species and their habitat. The core occurrences of the two carbonate plants in this unit are important as potential sources for the colonization events (e.g., seed dispersal) necessary to maintain the natural population dynamics of the species. Every carbonate plant occurrence in this unit is important as a seed source to colonize unoccupied sites and therefore maintain an equilibrium between local colonization and extirpation events. Every carbonate plant occurrence in this unit potentially provides important genetic material through pollen and seed dispersal which may help maintain genetic diversity and reduce the likelihood of regional extirpation events.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (inferred from NatureServe, 2015)

Breeding Season

Adult: March - May (USFWS, 1997)

Key Resources Needed for Breeding

Adult: Probably bee pollinators (USFWS, 2009)

Reproduction Narrative

Adult: Plants have a taproot and show no evidence of vegetative reproduction (Neel 2008) (NatureServe, 2015). Pollinators are probably small bees (USFS 2008) (USFWS, 2009). Flowers bloom from March to May (USFWS, 1997).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Pinyon-juniper woodland, pinyon woodland, Joshua tree woodland, blackbrush scrub, creosote bush-blackbrush scrub (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Generally 5,000 - 6,600 ft. elevation (USFWS, 2009)

Spatial Arrangements of the Population

Adult: Patchy (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Habitat Narrative

Adult: Primarily found on soils derived directly from decomposing limestone bedrock, especially on ridgetops and on open, very rocky, relatively gentle slopes at 1500-2000 m elevation. Also known from lower elevations (down to about 1170 m) in rocky washes that receive limestone outwash and from granite and granite-quartzite substrates. Plant communities are pinyon-juniper woodland, pinyon woodland, Joshua tree woodland, blackbrush scrub, and creosote bush-blackbrush scrub. Occupied sites tend to have low overstory and shrub canopy cover, high soil pH, and a high percentage of soil calcium. Associated species include *Fremontodendron californicum* (California Flannelbush), *Coleogyne ramosissima* (Blackbrush), *Echinocereus triglochidiatus* var. *mojavensis* (King-Cup Cactus), *Prunus fasciculata* (Desert Almond), and *Yucca schidigera* (Mojave Yucca). This species has a narrow environmental specificity, indicated by a restricted and patchy distribution in a highly specialized habitat (NatureServe, 2015). Cushenbury milk-vetch generally occurs with soils derived from limestone, dolomite, or a mixture of limestone and dolomite (Tierra Madre Consultants 1992, p. 33). Most occurrences are found between elevations of 5,000 and 6,600 feet (1,524 and 2,012 meters). Three occurrences are found below 5,000 feet (1,524 meters). Other habitat characteristics include an open canopy cover with little accumulation of organic material, rock cover exceeding 75 percent, and gentle to moderate slopes (5 to 30 percent) (USFWS 1997, p. 8). The primary constituent elements of Cushenbury milk-vetch designated critical habitat include: 1) soils derived primarily from the upper and middle members of the Bird Spring Formation and Undivided Cambrian parent materials that occur on dry flats and slopes or along rocky washes with limestone outwash/deposits at elevations between 3,864 and 6,604 feet (1,171 and 2,013 meters); 2) soils with intact, natural surfaces that have not been substantially altered by land use activities (e.g., graded, excavated, re-contoured, or otherwise altered by ground-disturbing equipment); and 3) associated plant communities that have areas with an open canopy cover and little accumulation of organic material (e.g., leaf litter) on the surface of the soil (USFWS, 2009).

Dispersal/Migration**Dispersal**

Adult: Low (inferred from NatureServe, 2015)

Dispersal/Migration Narrative

Adult: Fruits and seeds have no specialized dispersal mechanism (Neel 2008) (NatureServe, 2015).

Population Information and Trends

Population Trends:

Declining (NatureServe, 2015)

Resiliency:

Low (inferred from USFWS, 2009)

Representation:

High (inferred from NatureServe, 2015)

Redundancy:

Moderate to high (inferred from NatureServe, 2015 and USFWS, 2009)

Number of Populations:

16 (NatureServe, 2015); 33 (USFWS, 2009)

Population Size:

7000 - 7500 (NatureServe, 2015)

Population Narrative:

The number and size of populations has been reduced by surface mining activities. Approximately 7000 - 7500 plants were counted in the most recent surveys. In drought years, there are likely fewer plants than this (USFWS 1997). Approximately 16 occurrences are believed extant, with another 2 historical and 1 of unknown status, when mapped using the separation distance of the California Natural Diversity Database (CNDDB). Other reports, using a much smaller separation distance, have broken the total population into a smaller number of "patches" (e.g. 91 patches reported by Neel 2008). Approximately 11 occurrences are believed to have excellent or good viability (NatureServe, 2015). Cushenbury milk-vetch occurs over about 1,201 acres (486 hectares) of occupied habitat (Olson 2003, p. 19) distributed across approximately 15 miles (24 kilometers). After listing, additional survey effort, and perhaps additional rainfall in 1992, increased the number of known occurrences to about 33 (USFWS 1997, p. 2) (USFWS, 2009).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Mining activity remains the primary threat for Cushenbury milk-vetch (USFWS 2005a, p. 246). Mining activities can impact habitat for the plants through the removal of mined materials, disposal of overburden, and road construction. Other impacts to the plants are associated with dust and artificial lighting (USFWS 1997, pp. 13, 15–18). Dust can affect Cushenbury milkvetch's habitat by altering soil chemistry and light penetration into seedbanks

(USFWS 1997, pp. 17-18). Artificial lighting may affect Cushenbury milk-vetch's growing conditions by altering the photoperiod response or the behavior of pollinators or seed dispersers (USFWS 1997, p. 18). Off-road vehicle use and energy development projects could impact the species' habitat through ground disturbance or dust creation. Several threats such as dispersed target shooting, dispersed camping areas, fuelwood collection, and fire suppression activities were also identified since listing. However, the magnitude of these threats has been reduced through regulatory mechanisms, including implementation of the Act and actions taken by the U.S. Forest Service (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Cushenbury milk-vetch is endemic to isolated occurrences of particular carbonate soils in the San Bernardino Mountains. Therefore, any combination of environmental conditions, such as those attributed to climate change above, that force an upward shift in the distribution of the species, poses a profound threat to the taxon's persistence and recovery. If this species is affected by elevational shifts resulting from climate change, then there will be no suitable habitat when the elevational range exceeds the species' maximum elevation. As this occurs, the density and distribution may concentrate the species into a smaller area. This, in turn, may make the species even more susceptible to stochastic extinction (USFWS, 2009).

Recovery

Reclassification Criteria:

1. Sufficient habitat has been protected for existing populations of the plants to persist in their ecological contexts. The system of permanent biological reserves for the habitat will be designed to protect the largest populations, the best habitat, and to be manageable (USFWS, 1999).
2. Potential buffer zones for these reserve lands shall have been identified, albeit not necessarily secured, to meet this criterion. The interim estimate of additional lands needed for habitat connectivity, buffers, and natural community context is 1,860 hectares (USFWS, 1997).
3. Early detection of population instability or other problems in the reserve system is assured through population monitoring/habitat management programs (USFWS, 1997).
4. The chance that the most narrowly-distributed species might go extinct due to random naturally occurring events has been reduced through reintroductions or expansions of existing populations (USFWS, 1997).

Delisting Criteria:

Not available

Recovery Actions:

- Protect significant extant populations by developing a system of reserves on Federally owned land. Initially, preserves covering about 2,000 hectares are needed, based on known areas occupied by the plants. The reserve system includes buffer zones and maintenance of

selected habitat connections. The land managing agencies will conserve these plants in the context of applicable laws and regulations (USFWS, 1997).

- Restore habitat and conduct reintroductions and/or population enhancements where appropriate and feasible (USFWS, 1997).
- Identify and implement appropriate management measures (USFWS, 1997).
- Monitor populations (USFWS, 1997).
- Conduct limited surveys and taxonomic assessment to find new populations and resolve questions about the identity of several populations identified in the text (USFWS, 1997).

Conservation Measures and Best Management Practices:

- Prepare a new threats-based recovery plan specific to Cushenbury milk-vetch that identifies a recovery strategy, objectives, and criteria for reclassification to threatened, objectives and specific criteria for removal from the list of endangered and threatened species, and prioritizes recovery actions. In the interim, seek implementation of elements of the Carbonate Habitat Conservation Strategy that have direct benefit to the conservation of Cushenbury milk-vetch (USFWS, 2009).
- Work with the San Bernardino National Forest to conduct systematic monitoring of Cushenbury milk-vetch throughout known and potentially occupied sites as necessary to track the status of the species and identify management priorities. There is a need to continue to obtain quantitative information regarding the status of this species to evaluate the effectiveness of conservation efforts over time, especially in light of potential effects associated with global climate change (USFWS, 2009).
- Work with partners, such as the San Bernardino National Forest, to help conserve Cushenbury milk-vetch by identifying opportunities to: a) Continue monitoring programs for the effectiveness of measures to protect Cushenbury milk-vetch from recreational activities and make adjustments to signs, barriers, and roads as necessary. b) Avoid new developments in or near Cushenbury milk-vetch habitat (USFWS, 2009).

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SPECIES ACCOUNT: *Astragalus ampullarioides* (Shivwits milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/28/2001; Mountain-Prairie Region (Region 6) (USFWS, 2015)

Physical Description

Stems may grow along the ground or to a height of 8-20 in. (20-50 cm), although ungrazed flowering stems may attain a height of 40 in. (1 m). The leaves are pinnately (arranged opposite) compound, 1.6-7.1 in. (4-18 cm) long, and have 11 to 23 elliptical leaflets. Each plant produces approximately 45 small cream-colored flowers about 0.8 in. (2.0 cm) long on a single stalk in the spring. Seeds are produced in small pods, and the plant dies back to its root crown after the flowering season. The fruit is a short, broad pod between 0.3-0.6 in. (0.8-1.5 cm) long and 0.2-0.5 in. (0.6-1.2 cm) wide. (USFWS, 2006)

Taxonomy

Kartesz (1999), Isely (1998), and Barneby (1989) do not recognize this entity, at either the species or infraspecific levels, instead including *Astragalus ampullarioides* (also known as *A. eremiticus* var. *ampullarioides*) in *A. eremiticus*, with no varieties recognized. USFWS and Welsh (1998) recognize at the full species level: *A. ampullarioides* (Great Basin Naturalist 58(1):51). Barneby (1989) questioned the taxonomic significance of the variety and submerged *A. eremiticus* var. *ampullarioides* within typical *A. eremiticus*. Later research by Harper and Van Buren (1998) and Stubben (1997) demonstrated significant ecological and genetic differences between typical *A. eremiticus* and *A. eremiticus* var. *ampullarioides*. These differences are summarized as follows-(1) *A. ampullarioides* has more flowers per stem, (2) *A. ampullarioides* has longer flower stalks (from last leaf to flower), (3) *A. ampullarioides* has wider pods, (4) *A. ampullarioides* has taller stems, (5) *A. ampullarioides* has hollow stems while *A. eremiticus* stems are solid, and (6) *A. ampullarioides* plants are highly palatable to grazing animals while typical *A. eremiticus* is seldom if ever eaten (Barneby 1989; Welsh 1986, 1998; Welsh et al. 1987; Van Buren 1992; Harper and Van Buren 1998). (USFWS, 2006)

Historical Range

Historical distribution is not known for either species, that is, records are not available to ascertain whether the current distribution of *A. holmgreniorum* and *A. ampullarioides* populations represents either a loss of individual populations or a range contraction for either species. (USFWS, 2006)

Current Range

All known locations of *A. ampullarioides* occur within Washington County, Utah. Known populations of *A. holmgreniorum* occur within approximately 10 miles (mi) (16 kilometers (km)) of St. George in Washington County, Utah, and Mohave County, Arizona. (USFWS, 2006)

Critical Habitat Designated

Yes; 12/27/2006.

Legal Description

On December 27, 2006, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Astragalus ampullarioides* (Shivwits milk-vetch) under the Endangered Species Act of 1973, as

amended (Act). The critical habitat designation includes four critical habitat units (CHUs), in Utah (71 FR 77972-78012).

Critical Habitat Designation

The critical habitat designation for *Astragalus ampullarioides* includes four CHUs in Washington County, Utah. This species critical habitat encompasses approximately 2,181 acres (2,545 ha) (71 FR 77972-78012).

Unit 1—Pahcoon Spring Wash This unit includes 134 ac (54 ha), all on BLM UT lands adjacent to the Shivwits Indian Reservation. *Astragalus ampullarioides* was known to occupy this area at the time of listing. This population occurs in a small area where the density of *A. ampullarioides* is high (Van Buren and Harper 2004b, p. 3). In 2005, this population was estimated to contain approximately 300 to 350 individuals (Van Buren 2005). Unit 1 is determined to be critical habitat because it contains features essential to conservation of *A. ampullarioides*, is occupied by the species, and represents the northwestern-most occurrence of the species. Resources within this unit support the identified PCEs associated with outcroppings of the Chinle Formation. Special management may be required to minimize disturbance to the surface and subsurface structure within this unit, to control invasive species, to maintain the identified vegetation types, and to maintain pollinator habitat essential to the conservation of the species. Cattle grazing activities are present within this unit. The Chinle soils are soft and easily susceptible to erosion. A cost-share agreement between BLM UT and The Nature Conservancy (TNC) provides funding for signs and protective fencing; contracting for the fence is in process. As a part of the agreement, BLM UT and TNC will compare past plant survey data with population surveys to be completed in 2007 and 2009 to evaluate the effectiveness of the fence in eliminating habitat degradation.

Unit 3—Coral Canyon This unit, known to be occupied at the time of listing, is located adjacent to a golf course near Harrisburg Junction, and was estimated to contain 100 individuals in 2005 (Van Buren 2005). Land ownership for the 87 ac (35 ha) is 87 percent SITLA, 12 percent BLM UT, and 1 percent private. We included occupied habitats and adjacent areas of suitable soils and vegetation to allow for maintenance of the seed bank, seed dispersal, and pollinator services. This unit is determined to be critical habitat because it contains features essential to conservation of the taxon, is occupied by the taxon, is centrally located and may provide connectivity between populations, and contains a persistent occupied site of *Astragalus ampullarioides*. Plants within this subunit face threats from urban development. Special management may be required to minimize disturbance to the surface and subsurface structure within this subunit, maintain the identified soil and vegetation types, and control invasive weeds.

Unit 4—Harrisburg Junction In 2001, the final listing rule (66 FR 49560; September 28, 2001) referred to a population near Harrisburg Junction that contained four separate sites. Unit 4 is comprised of two subunits encompassing 759 ac (307 ha) that are spatially separated based on geography (Harrisburg Bench/Cottonwood and Silver Reef). Each of these subunits contains two of the plant occurrence sites that were known to be occupied at the time of the final listing rule (66 FR 49560; September 28, 2001). In 1999, the 4 sites contained approximately 300 plants (England 1999; Utah Natural Heritage Program 1999; Van Buren 2000). In the area of Harrisburg Junction, *Astragalus ampullarioides* populations or subpopulations are restricted to outcroppings of the Chinle soil. Each area may be relatively self-sustaining; however, their long-term persistence and stability relies on a balance of site extinctions and colonization of suitable, unoccupied outcroppings through dispersal events (Hanski 1985, p. 341; Olivieri et al. 1990, pp.

207–209; Hastings and Harrison 1994, pp. 175– 176, 180). Subunit 4a—Harrisburg Bench and Cottonwood This 297–ac (120–ha) subunit is 88 percent BLM land and 12 percent private land. Approximately 100 individual plants were located in this subunit during 2005 surveys (Van Buren 2005). This subunit contains PCEs necessary to support *Astragalus ampullarioides* growth, reproduction, and establishment. Land found between the northbound and southbound lanes of I–15 contains an occupied site. This intervening area within the highway right-of-way may allow pollinator flow between occupied sites (Douglas 2005). Habitat areas between known occupied sites are included in the critical habitat designation to support pollinators and seed dispersal between sites. Pollinator habitat and seed dispersal are considered important for the species' long-term survival (Steffan-Dewenter and Tschamntke 1999, pp. 437–438; Steffan-Dewenter 2003, pp. 1039–1040; Greenleaf 2005, pp. 72–74; Van Buren and Harper 2003a, p. 242). This subunit is determined to be critical habitat because it contains features essential to conservation of *Astragalus ampullarioides*, is occupied by the species, and contains a persistent occupied site for *A. ampullarioides* that is centrally located and may provide connectivity between other units. At the Harrisburg site, *Bromus tectorum* (cheatgrass) is a closely associated species (Van Buren 2005, p. 14). Part of this unit, east of I–15, burned during a wildfire in 2005; however, no suppression occurred in areas of occupied habitat. The status of seeds within the seed bank is unknown. Also unknown, but likely, is that most of the above-ground stems and foliage died back at the time of the fire (Van Buren 2005, p. 14). Revisits in 2006 indicated that *Astragalus ampullarioides* occupies the site and was not adversely affected by the fire (Van Buren 2006). Plants within this subunit may be threatened by urban development, recreation, and invasive plant species. Special management may be required to control invasive plant species, minimize disturbance to the surface and subsurface structure, and maintain the identified soil and vegetation types. BLM UT and TNC have entered into a cost-share agreement to provide signs and protective fencing to minimize human use at one occupied area within this subunit. Subunit 4b—Silver Reef The 462 ac (187 ha) in this subunit are composed of 90 percent BLM lands and 10 percent private lands. *Astragalus ampullarioides* individuals are found along intermittent outcroppings of the Chinle Formation. Approximately 150 individuals were identified in a partial survey in 2005 (Van Buren 2005). This subunit is determined to be critical habitat because it contains features essential to conservation of *A. ampullarioides*, is occupied by the species, contains a thriving population, and maintains a prevalence of soil substrate necessary for future expansion to maintain metapopulation dynamics. Special management may be required to minimize recreational use and disturbance to the soil surface and subsurface structure, control invasive plant species and domestic animals, maintain the identified vegetation types, and maintain pollinator habitat essential to the conservation of the species. Quantitative information on impacts from cattle grazing or recreational use is unknown. One occupied area within this subunit is under a cost-share agreement for protective fencing, which is to begin in the near future. Monitoring will be used to evaluate the effectiveness of the fences in eliminating habitat degradation from cattle and recreational use. Additional areas in this subunit remain unfenced, and special management may still be necessary to reduce impacts to habitat.

Unit 5—Zion The 1,201 ac (486 ha) in Unit 5 occur entirely on lands managed by Zion National Park. The population consisted of approximately 300 to 500 individuals in 2000 (66 FR 49560; September 28, 2001). More recent surveys document almost 4,200 individuals in the unit (Miller 2006). This unit is determined to be critical habitat because it contains features essential to conservation of *Astragalus ampullarioides*, is occupied by the species, is one of five known populations, represents the northeastern-most range of the species, and contains the largest known population of the species. The land within this unit supports the PCEs necessary for

growth, reproduction, and establishment. Special management is necessary in this unit to minimize recreation disturbance to the soil surface and subsurface structure, control invasive weedy species, maintain the identified vegetation types, and maintain pollinator habitat essential to the conservation of the species. Recreational use of Zion National Park and disturbance from park visitors and horses may affect *Astragalus ampullarioides*. An established hiking and horse trail that is used infrequently from November through April occurs near populations of *Astragalus ampullarioides*. Plants and habitat within this unit also are threatened by invasive nonnative plants, including *Moluccella laevis* (bells of Ireland), an introduced species not found at other sites. Although this unit is in a sparsely vegetated habitat that in the past did not carry fire, the invasions of exotic grasses are creating more continuous fuels. No management plan exists specific to *Astragalus ampullarioides* in Zion National Park; however, the current Zion National Park Fire Management Plan includes restrictions on fire management within a 0.75-mi (1.2-km) buffer zone of the area where *A. ampullarioides* is found. Zion National Park worked with us to complete a recovery plan for the species (71 FR 57557, September 29, 2006), and is partnering with the USGS to investigate biotic soil conditions and invasive weed interactions with *A. ampullarioides*.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Astragalus ampullarioides* critical habitat consists of three components (71 FR 77972-78012):

- (i) Outcroppings of soft clay soil, which is often purplish red, within the Chinle Formation and the Dinosaur Canyon Member of the Moenave Formation, at elevations from 920 to 1,330 m (3,018 to 4,367 ft);
- (ii) Topographic features/relief, including alluvial fans and fan terraces, and gently rolling to steep swales with little to moderate slope (3 to 24 percent), that are often markedly dissected by water flow pathways from seasonal precipitation; and
- (iii) The presence of insect visitors or pollinators, such as *Anthophora captognatha*, *A. damnersi*, *A. porterae*, other *Anthophora* species, *Eucera quadricincta*, *Bombus morrissonis*, *Hoplitis grinnelli*, *Osmia clarescens*, *O. marginata*, *O. titus*, *O. clarescens*, and two types of *Dialictus* species.

Special Management Considerations or Protections

Critical habitat does not include manmade structures existing on the effective date of this rule and not containing one or more of the primary constituent elements, such as buildings, aqueducts, airports, and roads, and the land on which such structures are located.

The features essential to the conservation of *A. holmgreniorum* and *A. ampullarioides*, in all areas we are designating, may require special management considerations and protections, including measures necessary to alleviate the effects of urban development, retaining plants and their habitat on Federal lands, fencing small populations, removing or limiting access routes, ensuring vehicles and pedestrians stay on designated routes, reducing land use practices that disturb the hydrologic regime, minimizing the effects of grazing and recreation use, managing invasive nonnative plant species, evaluating revegetation and restoration with native plant species, developing adequate fire management buffers for these plant species and their habitat,

and educating fire management staff on the location of the plants. Additionally these areas may require special management considerations and protections for ground-nesting and local pollinator communities.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 2006)

Lifespan

Adult: Unknown; >9 years (USFWS, 2007)

Dependency on Other Individuals or Species

Adult: Primary pollinators of *A. ampullarioides* include the native bees *Anthophora coptognatha*, *A. dammersi*, *Anthophora* spp., *Eucera quadricincta*, *Bombus morrisoni*, *Hoplitis grnnellei*, *Osmia clarescens*, *O. marginata*, and *O. titusi*, as well as the nonnative honeybee *Apis mellifera* (Tepedino 2005). *A. ampullarioides* relies solely on the production of seeds for reproduction, and pollination is thus highly linked to the survival of the species. (USFWS, 2007)

Breeding Season

Adult: April to May (USFWS, 2007)

Reproduction Narrative

Adult: Collection of demographic and life history data for *A. ampullarioides* began in 1992. *A. ampullarioides*, a perennial herb, has an unknown lifespan, although tracking of seedlings from 1995 indicates a lifespan of at least 9 years (Van Buren and Harper 2003b). *A. ampullarioides* does not reproduce through vegetative methods, and their sexual reproduction is contingent on pollen reaching receptive stigmas for seed production. Flowering occurs between April and late May; by the end of June plants dry up, although vestiges of dried plants may persist for several months. Each *A. ampullarioides* plant is capable of bearing up to 45 flowers per flower stalk (Welsh et al. 2003, 66 FR 49560), and plants frequently have several stalks. From 1992 to 2000, Van Buren and Harper (2003a) documented an average of 86.7 flowers per plant. The number of seeds per pod ranges from 2 to 17, with 7 to 80% of all ovules producing seed (Tepedino 2005). (USFWS, 2006; USFWS, 2007)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Great Basin Pinyon-Juniper Woodland, Colorado Plateau Blackbrush-Mormon-tea Shrubland, Mojave Mid-Elevation Mixed Desert Scrub, Intermountain Basins Mixed Salt Desert Scrub, Sonora Mojave Creosote-Whitebursage Desert Scrub, Intermountain Basins Semi-Desert Shrub Steppe, and North American Warm Desert Lower Montane Riparian Woodland and Shrubland (USFWS, 2007)

Dependencies on Specific Environmental Elements

Adult: Adequate rainfall (USFWS, 2007)

Geographic or Habitat Restraints or Barriers

Adult: A. ampullarioides populations are found at elevations between 3,018-4,367 ft (920-1,330 m); sparsely vegetated habitat with an average of 12% cover (USFWS, 2007)

Environmental Specificity

Adult: Narrow / specialist (USFWS, 2007)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from USFWS, 2007)

Habitat Narrative

Adult: A. ampullarioides populations are found at elevations between 3,018-4,367 ft (920-1,330 m), typically on purple-hued patches of soft clay soil of which 99% are associated with isolated outcrops of the Petrified Forest member of the Chinle Formation (Armstrong and Harper 1991; Harper and Van Buren 1997; M. Miller, pers. comm. 2006). This substrate, which is light, airy, and unstable when dry (Van Buren and Harper 2003a), expands greatly with precipitation, becoming slick and glue-like and forming mounds (Harper 1997). Equal contraction upon drying often results in the formation of deep, wide fissures, constricting root systems so that few perennial plants persist on Chinle soils (Harper 1997). A. ampullarioides is documented from the following soil map units described by USDA et al. (1977) C Stony colluvial land; Naplene silt loam, 2-6% slope; Eroded land-Shalet complex; Badland, very steep; Mathis-Rock outcrop complex, 20-50% slope; Rock land, stony; Bond sandy loam, 1-10%; Clovis fine sandy loam, 1-5% slope; Badland; and Rock land Hobog association (USFWS unpubl. data 2005). Soil texture by weight is 48.9% clay, 25.1% silt, and 26.0% sand, with an undetermined depth (Van Buren and Harper 2001). Percentage of gravel and rock on site is much lower than A. holmgreniorum and measures 13.8% (Van Buren and Harper 2003a). A. ampullarioides habitat is sparsely vegetated, with an average 12% cover (Van Buren and Harper 2003a). Due to soil shrinkage and expansion, native plant species found with A. ampullarioides are generally herbaceous forbs and grasses including Calochortus flexuosus (sego lily), Dichelostemma pulchellum (bluedicks), Hilaria rigida (galleta), H. jamesii (James' galleta), Sporobolus airoides (alkali dropseed), and Lotus humistratus (hill lotus) (Van Buren and Harper 2003a; M. Miller, pers. comm. 2006). The perennial rootstock allows A. ampullarioides to survive dry years, and in a drought year plants may not emerge (Van Buren and Harper 2003b). Dormancy is one strategy by which longer-lived plant species can survive changing climatic conditions, particularly in relation to rainfall (Epling and Lewis 1952). (USFWS, 2007)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Methods of A. ampullarioides seed dispersal have not been researched. However, water patterns, landscape erosion, and soil slumping likely contribute to the development of appropriate habitat sites and may transport seeds within sites (Van Buren and Harper 2003a). The disjunct populations of A. ampullarioides also could imply bird dispersal (S.L. Welsh, pers. comm. 2005). (USFWS, 2007)

Population Information and Trends

Population Trends:

Unknown (USFWS, 2007)

Resiliency:

Low (inferred from USFWS, 2007)

Representation:

Moderate (inferred from USFWS, 2007)

Redundancy:

Low (inferred from USFWS, 2007)

Number of Populations:

6 (USFWS, 2007)

Population Size:

< 1000 (NatureServe, 2015)

Population Narrative:

The total population is less than 1000 individuals All of *A. ampullarioides* populations are located in Washington County, Utah. Four of the six *A. holmgreniorum* populations are entirely in Washington County, Utah, while one population crosses into Mohave County, Arizona, and another is only found in Mohave County, Arizona. (USFWS, 2007; NatureServe, 2015)

Threats and Stressors

Stressor: Habitat loss (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Habitat loss due to the growing development pressures in the vicinity of St. George and associated infrastructure also threaten *A. ampullarioides* populations. (USFWS, 2007)

Stressor: Recreation (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Within the Zion population, a recreational trail poses a potential threat to individuals and habitat, albeit the frequency of habitat disturbance and/or direct plant loss is unknown. Research on user impact has been suggested so that Zion National Park can better manage and assess continuing threats of this species on its lands. (USFWS, 2007)

Stressor: Electric power transmission line (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: In the final listing rule, an electric power transmission line was projected to pass through the Pahcoon Spring Wash and Shivwits *A. ampullarioides* populations at the western edge of the species' range, as well as through the easternmost population within Zion National Park. Prior to these projects, surveys conducted for this species did not result in any new *A. ampullarioides* sites being found (L. England, pers. comm. 2006). In response to potential adjacent utility corridor activities, the Shivwits band of the Paiutes fenced the main area of plant occupancy. (USFWS, 2007)

Stressor: Silver mining (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Silver mining diminished by the early 1900s (R. Douglas, pers. comm. 2005) and is not believed to be a future threat for *A. ampullarioides*. Other mining, such as removal of landscaping rock, exists at a distance to the Pahcoon Springs Wash population but does not appear to constitute a threat. (USFWS, 2007)

Stressor: Off-road vehicles (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: At the time of listing, habitat degradation from ORV use was identified as a threat for *A. ampullarioides*, and it continues to be a serious threat, given the increasing popularity of ORV activities in Washington County (see *A. holmgreniorum* above for more details). The ORV activities in *A. ampullarioides* habitat are particularly damaging, as the localized clay substrate lacks soil stability and is easily disturbed. The ORV activities lead to associated plant loss, habitat degradation, and changes in native plant communities. Although fencing will not abate all ORV use within *A. ampullarioides* habitat, fencing at the Pahcoon Spring Wash, Harrisburg Bench and Cottonwood, and Silver Reef population, which is expected to be completed in October 2006, will reduce direct ORV impacts to sites on BLM lands. The Silver Reef population currently experiences the highest levels of ORV use, but a portion of this population has been incorporated into the Red Cliffs Desert Reserve (Washington County Habitat Conservation Plan (HCP), 1995) due to a boundary adjustment (J. Crisp, pers. comm. 2006) and thus will be afforded better protection through site-specific planning for recreational management, recreation use monitoring, and law enforcement. (USFWS, 2007)

Stressor: Trampling (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Milk-vetch habitat degradation is caused by cattle trampling, which disturbs the soil surface and seedbanks for these species. This is an issue for the Pahcoon Spring Wash, Shivwits, and Silver Reef *A. ampullarioides* populations. In particular, the Pahcoon Spring Wash habitat has recently experienced severe cattle trampling (Van Buren 2005), disturbing the fragile clay soils found on the Chinle and Moenave formations and crushing individual plants. Supporting soils are especially susceptible to disturbance and compaction caused by trampling and overuse (R. Van Buren, pers. comm. 2006). In addition to cattle trampling, *A. ampullarioides* may incur damage during survey efforts if these activities are conducted without sufficient caution. Cattle

or human trampling is expected to diminish in the future in light of recently funded fencing projects expected to be completed in October 2006. (USFWS, 2007)

Stressor: Fires (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Finally, as described for *A. holmgreniorum*, St. George, Utah, and surrounding areas are experiencing an increase in fires due to exotic, nonnative grasses such as cheatgrass and red brome. In 2005, fire ran through the Harrisburg Bench site of the Harrisburg Bench and Cottonwood population. Site visits in 2006 documented species presence and indicated a healthy return. Timing of the 2005 fire coincided with annual plant dormancy patterns, which appears to have reduced detrimental effects (R. Van Buren, pers. comm. 2006). Fires in past years and in 2006 occurred close to the Pahoon Springs Wash and Shivwits populations on the eastern slopes of the Beaver Dam Mountains. Both BLM and the Tribe are aware of *A. ampullarioides* population locations and efforts will be made to protect the plants. (USFWS, 2007)

Stressor: Development (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Residential and commercial development, which indirectly affects known occupied areas, is occurring at the Coral Canyon population and, to a lesser degree, at the Harrisburg Bench and Cottonwood and Silver Reef populations. (USFWS, 2007)

Stressor: Roads (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: New roads, highways, electric power transmission lines, and pipelines were constructed in *A. ampullarioides* areas prior to the final listing rule and probably caused past impacts on *A. ampullarioides* populations. For example, the construction of highway I-15 altered the Cottonwood site within the Harrisburg Bench and Cottonwood population areas. not known if additional utility or transportation corridors will be constructed in the future. Current and future highway maintenance (see *A. holmgreniorum* above for description of projected activities) is a potential threat. (USFWS, 2007)

Stressor: Herbivory (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: In terms of predation, *A. holmgreniorum* may be occasionally susceptible to herbivory, while *A. ampullarioides* is extremely palatable to both wildlife and domestic livestock. Tepedino (2005) indicates losses to herbivores, including cattle for research done at the State Line (*A. holmgreniorum*) and Coral Canyon (*A. ampullarioides*) populations; however, this information was not quantified. At the time of listing, livestock grazing at the two western *A. ampullarioides* populations, Pahoon Spring Wash and Shivwits, was of concern. However, protective fencing at

the Shivwits population has greatly reduced the threat at that site, as will fencing slated to be installed at the Pahcoon Spring Wash in October 2006. (USFWS, 2007)

Stressor: Overgrazing (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Overgrazing by livestock can eventually cause a shift in the plant communities, favoring invasive plants to the detriment of both *A. holmgreniorum* and *A. ampullarioides* (see Factor E). Recent herbivory at the *A. ampullarioides* demography study site at Pahcoon Spring Wash population is tentatively attributed to rabbits (Van Buren 2005), although it is not known if the level of herbivory negatively affects the plants at the population level. Some degree of natural herbivory occurs every year in *A. ampullarioides* populations (Van Buren 2005). High herbivory was seen in preliminary research conducted in 2006 at Zion National Park, where 90% reduction in fruit production was attributed to vertebrate herbivores. (USFWS, 2007)

Stressor: Parasitism and insect infestations (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: One additional factor that warrants further research is the potential for parasitism and insect infestations, particularly in regard to potential effects on *A. ampullarioides* populations. Past monitoring documented aphid infestations associated with *A. ampullarioides*. Also, an outbreak of white moths, which visited flowers in April 2005, may have restricted production of seeds. By May, flowers dropped off the stem, inhibiting fruit development, and these symptoms could either be related to white moth predation or to a coincidental lack of pollination. If this reoccurs, it will become a priority for further investigation. (USFWS, 2007)

Stressor: Invasive species (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Past habitat disturbance has caused the proliferation of invasive annual weeds into both species' occupied habitat (Harper 1997 and Van Buren and Harper 2000a, 2000b in 66 FR 49560). In fact, all populations of both *A. holmgreniorum* and *A. ampullarioides* have been affected to some degree by invasive nonnative annuals, which make up the highest percentage of living cover in the habitat of both species (Van Buren 2004). Because invasive annuals tend to emerge prior to the milk-vetches, competition for soil moisture and nutrients and displacement of the milk-vetches is an emerging threat. (USFWS, 2007)

Stressor: Fragmented habitats (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: *A. holmgreniorum* and *A. ampullarioides* are pollinated by native solitary ground-dwelling bees (Tepedino 2005). Fragmented, disjunct habitats hamper pollinator exchange between populations, which could cause genetic isolation and potentially lead to inbreeding and local extirpation of isolated populations (Heschel and Paige 1995). Urban expansion and

associated impacts may directly and indirectly affect pollinators through loss of pollinator habitat (Tepedino 2005). For both species, lack of pollinators would result in a gradual decrease in the number of seeds in the seedbank (Tepedino 2005). Additionally, small and restricted sites of other rare *Astragalus* were found to receive lower levels of pollinator visitors (Karron 1987). The Gardner Well, Stucki Spring, South Hills, and Purgatory Flat *A. holmgreniorum* sites are small and disjunct. Similarly, all *A. ampullarioides* sites, except for Zion, are small and disjunct. (USFWS, 2007)

Stressor: Climate change (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Climate change has emerged as a significant concern, particularly in regard to the potential for increasingly prolonged drought cycles (Miller 2005; R. Van Buren, pers. comm. 2006). Both *A. holmgreniorum* and *A. ampullarioides* have higher germination and survivorship rates during and following years of increased precipitation (Van Buren and Harper 2003a), and if consecutive years of low reproductive output caused by drought conditions outlast seedbank longevity, the affected populations could become extirpated (R. Van Buren, pers. comm. 2006). Given that drought events occur at a regional scale (Miller 2005), this could prove to be a serious limiting factor for both species. Frost kill also affects both species and could become a more prevalent problem with long-term seasonal changes (R. Van Buren, pers. comm. 2006). (USFWS, 2007)

Stressor: Stochastic events (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Additionally, some *A. holmgreniorum* and *A. ampullarioides* are small-sized and could be threatened by stochastic events. (USFWS, 2007)

Recovery

Reclassification Criteria:

1. Species presence is maintained at all recovery populations. (USFWS, 2006)
2. Population trends for four out of six recovery populations of each species are primarily stable or improving, as indicated by occupied habitat, density of occupied habitat, and predictive modeling. (USFWS, 2006)
3. The habitat base for each recovery population is large enough to allow for natural population dynamics, population expansion where needed, and the continued presence of pollinators, with sufficient connectivity to allow for gene flow within and among populations. (USFWS, 2006)
4. Population and habitat management is implemented for all recovery populations of each species in accordance with site-specific management plans. (USFWS, 2006)
5. Permanent land protection is achieved for at least four recovery populations of each species. (USFWS, 2006)

6. Site-specific conservation agreements are in place for all recovery populations and their habitat to protect these milk-vetches within existing State laws. (USFWS, 2006)
7. The conservation of these species is included in a long-term State plant conservation agreement. (USFWS, 2006)
8. Adverse population-level effects from herbivory, disease, or predation, if any, are identified and abated within *A. ampullarioides* and *A. holmgreniorum* recovery populations. (USFWS, 2006)
9. For at least four recovery populations of each species, effective measures are in place to control potential negative effects on invasive nonnative species that could harm these milk-vetches and/or their habitats. (USFWS, 2006)
10. The protected habitat base for at least four recovery populations of each species is large enough to offset loss or restriction of the species' pollinators. (USFWS, 2006)
11. Use of pesticides or herbicides detrimental to either of the milk-vetches or their pollinators is prohibited in the vicinity of all recovery populations. (USFWS, 2006)
12. Research indicates genetic fitness, alleviating concern about inbreeding or outbreeding depression. (USFWS, 2006)
13. Seed collection/storage is underway for all extant *A. holmgreniorum* and *A. ampullarioides* populations. (USFWS, 2006)

Delisting Criteria:

1. Two additional populations of each species are either located or successfully introduced to habitat in proximity to extant populations. Thus, a minimum of eight recovery populations will be needed to delist each species. (USFWS, 2006)
2. The available habitat base for each newly discovered or introduced recovery population is large enough to allow for natural population dynamics, population expansion where needed, and the continued presence of pollinators, with sufficient connectivity to allow for needed gene flow within and among populations. (USFWS, 2006)
3. Population trends for all *A. holmgreniorum* and *A. ampullarioides* recovery populations are primarily stable or improving, as indicated as indicated by species presence, occupied habitat, density of occupied habitat, and demographic modeling. (USFWS, 2006)
4. Each of the eight *A. holmgreniorum* and eight *A. ampullarioides* recovery populations has a post-delisting conservation plan with the species' conservation as a primary objective. (USFWS, 2006)
5. Permanent land conservation is achieved for all recovery populations whether extant or introduced (a minimum of 8 populations), such that Endangered Species Act (ESA) protection is no longer needed to compensate for regulatory inadequacies. (USFWS, 2006)

6. Adverse population-level effects from herbivory, disease, or predation, if any, are identified and abated within all *A. ampullarioides* and *A. holmgreniorum* recovery populations. (USFWS, 2006)

7. A long-term offsite conservation program is ongoing for all milk-vetch recovery populations. (USFWS, 2006)

Recovery Actions:

- Conserve known extant *A. holmgreniorum* and *A. ampullarioides* populations and their habitat. (USFWS, 2006)
- Locate and conserve additional extant populations, if any. (USFWS, 2006)
- Monitor *A. holmgreniorum* and *A. ampullarioides* sites for population information and trends. (USFWS, 2006)
- Establish a set of need-based research priorities aimed at abating or reducing threats and increasing population health and numbers. (USFWS, 2006)
- Develop and implement a rangewide strategy for augmentation and/or introduction of milk-vetch populations. (USFWS, 2006)
- Augment extant populations and/or establish new populations of each species in accordance with the rangewide strategy. (USFWS, 2006)
- Promote effective communications with partners and stakeholders regarding the milk-vetches' recovery needs and progress. (USFWS, 2006)
- Develop and implement educational and outreach programs. (USFWS, 2006)
- Develop and implement educational and outreach programs. (USFWS, 2006)
- Establish a technical working group to regularly review the status of the species and track the effectiveness of recovery actions. (USFWS, 2006)
- Revise the recovery program when indicated by new information and recovery progress. (USFWS, 2006)

Conservation Measures and Best Management Practices:

- In collaboration with interested local, State, and Federal agencies, institutions, and Indian Tribes, BLM will prepare conservation agreements and strategies designed to stabilize declining populations, and will promote protective management to ensure survival of the species. (USFWS, 2007)
- To reduce conflicts and additional disturbance, habitat areas will be designated as rights-of-way avoidance areas and closed to fuelwood and mineral material sales. Plants will be protected by restricting mountain bike use and off-road vehicle travel to designated roads and trails. (USFWS, 2007)
- Prior to surface-disturbing exploration or development associated with fluid mineral leasing, botanical surveys will be completed and known populations avoided to eliminate the taking of plants. (USFWS, 2007)
- Habitat areas will be kept free from use of chemical pesticides and herbicides. (USFWS, 2007)
- Where necessary to protect small isolated populations of Hermit's milk-vetch (aka Shivwits milk-vetch) under 10 ac (4 ha) in size, BLM will fence areas to prevent inadvertent destruction of plants. (USFWS, 2007)

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SPECIES ACCOUNT: *Astragalus applegatei* (Applegate's milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/27/1993; Pacific Southwest (R8)

Physical Description

A tap-rooted, herbaceous, perennial plant. The numerous tufted or trailing stems are 2.5-8 decimeters (10-33 inches) long, simple or branching, and may be smooth or have sparse stiff, short hairs. Leaves are 3.5-12 centimeters (1.5-5 inches) long, are on petioles, and have 7-11 linear to linear-elliptic flat leaflets, the terminal one usually the longest. Racemes typically bear 5-20 pea-like flowers with lavender-tipped white petals. The 8-13 millimeters (0.4-0.6 inches) long, stalked fruit pods are oblong, compressed, have short hairs and frequently have green or purple speckled valves. Pods split apart from the top (dehisce apically) then downward through the ventral suture, and contain up to 10 (but usually fewer than 3) dark brown minutely dotted seeds with depressions. (USFWS, 1998)

Taxonomy

Member of the Fabaceae (pea family). First discovered near Klanlath Falls, Oregon, in 1927 by Morton Peck. Peck subsequently collected the species 2 miles (3.2 kilometers) east of Keno, Oregon, in 1931 and then described it (Peck 1936). It was thought to be extinct until its rediscovery in 1983 by James Kagan of the Oregon Natural Heritage Program (Kagan 1983). (USFWS, 2009).

Historical Range

Endemic to the Lower Klamath Basin, in Klamath County, Oregon, about fifteen miles north of the Oregon-California border. (USFWS, 1998)

Current Range

Lower Klamath Basin, in Klamath County, Oregon (USFWS, 2019a)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual; self-fertilization and crossing occur (NatureServe, 2015)

Dependency on Other Individuals or Species

Adult: *Plebejus melissa* (USFWS, 2009)

Breeding Season

Adult: June - September (USFWS, 2009)

Key Resources Needed for Breeding

Adult: Possibly other insect pollinators (USFWS, 1998)

Reproduction Narrative

Adult: Reproduction is sexual; self-fertilization and crossing occur (4/98 Recovery Plan) (NatureServe, 2015). Flowers are present from June to September. The Melissa blue butterfly (*Plebejus melissa*) is a specific known pollinator (58 FR 40548). Despite ample production of viable seeds, very few Applegate's milk-vetch seedlings have been observed in native populations. Applegate's milk-vetch plants have eight to ten ovules per pod that can mature into seeds; however, it is rare that more than three do so (USFWS 1998) (USFWS, 2009). Applegate's milk-vetch is visited by numerous insects, with prominent visitors including bumble bees (*Apidae: Bombus* spp.), other polylectic bees (*Megachilidae: Osmia* spp.; *Andrenidae: Andrena* spp.), bee-flies (*Bombyliidae*), and the butterflies *Lycaedes argyrognomon* (Yamamoto 1985) and *Plebejus melissa* (ODA, unpublished) (USFWS, 1998).

Habitat Type

Adult: Terrestrial, wetland, riparian (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Floodplain grasslands (NatureServe, 2015); interior alkali grassland (USFWS, 2009)

Dependencies on Specific Environmental Elements

Adult: Probably periodic flooding (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs ~1250 m elevation (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow (USFWS, 2009)

Habitat Narrative

Adult: Inhabits flat seasonally moist remnants of alkaline floodplain grasslands of the Klamath Basin, at about 1250 meters. The substrate is poorly drained fine silt loam (an underlying hardpan impedes drainage). Prior to irrigation and water control along the Klamath River, periodic flooding probably limited the dominance of other species and provided openings for establishment of *Astragalus applegatei* (NatureServe, 2015). This species is limited to a very specific soil regime resulting in a very specific habitat type. The vegetative community in which Applegate's milk-vetch sites occurs is classified as interior alkali grassland (TNC 1999). Soils in typical Applegate's milk-vetch habitats are characterized as being gray in color, slightly alkaline, with a shallow water table and groundwater with a relatively high salinity due to periodic flooding and evaporation (TNC 1999). The soils on these sites belong to the Henley, Laki, and Poe series with inclusions in the Calimus series, and are very deep, coarse-loamy, mixed superlative, mesic Haplic Durixeroll (TNC 1999). A weakly developed duripan at 127 to 254 inches is usually present and accounts for the pooled surface water during the spring at most sites (TNC 1999) (USFWS, 2009).

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 1998)

Dispersal/Migration Narrative

Adult: Fruits shed their seed shortly after flowering and exhibit no specialized mechanisms for long-distance seed dispersal. Some seed dispersal may take place through ingestion by rodents or jackrabbits, although this has not been documented. Localized seed dispersal is supported by field observations, which document that the majority of seedling establishment is immediately adjacent to mature plants (Yamamoto 1985, Oregon Department of Agriculture [ODA]unpublished) (USFWS, 1998).

Population Information and Trends**Resiliency:**

We lack complete information on Applegate's milk-vetch demographics, including age structure, census, and population trends. As such, we rely on assumptions derived from the information we do have to estimate resiliency. For example, we correlate an Applegate's milk-vetch population containing a minimum of 2,200 reproductive plants, plus enough individuals in younger age classes to suggest population stability or growth, as a resilient population able to withstand stochastic events. This definition and the values used in Table 9 (of USFWS, 2019c) are partially based on data from the Ewauna Flats Preserve, where we observed a gradual change in plant abundance suggesting that populations of this size are able to increase. We also assume based on other *Astragalus* species research (Lesica 1995, DePtenger-Levine 2013) that Applegate's milk-vetch has a lifespan of about 10 years. We similarly assume that sites known to have existed for more than 10 years have experienced some level of recruitment, but that it has not been confirmed. Therefore, we evaluated the resiliency of each site based on minimum site age, number of populations with at least 2,200 reproducing plants, and the assumed suggestion of stability or growth (Table 10). Based on our assumptions, four sites were identified having populations greater than 2,200 reproducing plants, with three of them appearing to also have stable or growing total populations. Sites limited to a single, and possibly outdated, survey were assumed to have a stable population but more emphasis was placed on their total population, location, and connectivity during the analysis. The counts of subpopulations were documented but we determined the presence of subpopulations has an uncertain contribution to resiliency given our current understanding. (USFWS, 2019c)

Representation:

Representation is achieved when sufficient genetic diversity and gene flow are present to allow adaptation to changing environmental conditions. As stated above, we lack specific information on the genetic composition of the eight populations. However, we assume that there is genetic diversity between populations due to their spatial arrangement. Similarly, it seems reasonable to assume that gene flow between populations may be occurring if pollinators are able to move between populations. We anticipate this is more likely to occur when populations are in close proximity to one another (e.g., Miller Island and Collins or Ewauna Flats Preserve and OC&E). Based on these assumptions we believe there is likely adequate representation of genetic diversity. Since there is little variation in the habitat occupied by Applegate's milk-vetch, which, is common for narrow endemic species, this aspect of representation may not significantly contribute to the viability of this species. (USFWS, 2019c)

Redundancy:

A sufficient number and distribution of resilient populations are needed to ensure that a species is able to withstand catastrophic events. The multiple populations of Applegate's milk-vetch, while sometimes geographically close to one another are spatially isolated from one another by manmade or natural features. This spatial arrangement greatly restricts the potential for catastrophic events that could decimate multiple populations; therefore, we believe that the most basic definition of redundancy (greater than one) is applicable to Applegate's milk-vetch. We consider the species to have sufficient redundancy when two or more self-sustaining populations are present. Because there are eight populations, with more than two that are self-sustaining, and no reasonable expectation of catastrophic events, we believe that Applegate's milk-vetch has sufficient redundancy. Redundancy also increased with the recent discovery of another self-sustaining population (OC&E). (USFWS, 2019c)

Number of Populations:

8 (USFWS, 2019a)

Population Size:

!80,000 individuals (USFWS, 2019a)

Population Narrative:

Ongoing demographic monitoring of naturally occurring populations is providing data related to life stages and survival rates (Byrnes 2017b). The discovery of additional occupied sites through opportunistic observation increased the total number of known sites from two in 1993 to the current number of eight, although the current status of two smaller sites is uncertain (USFWS 2019a). Based on previous survey results, populations at four of the eight known sites appear to suggest population stability or growth. Population of a fifth site appears to be declining while the status of the remaining three populations is uncertain due to lack of data (USFWS 2019a). 2019 preliminary survey results from the Collins site also suggest site population stability and growth (J. Spaur, personal communication 7/17/19). Three of the sites are privately owned, two are state owned, one is city owned, and one is owned by an environmental organization for the purpose of Applegate's milk-vetch conservation. (USFWS, 2019a)

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The final rule states that irrigation and water control along the Klamath River have eliminated the seasonal flooding that once occurred along floodplains supporting the species. While some adverse affects cannot be ruled out from this hydrologic alteration, declines appear to be mostly due to declines appear to be mostly due to other factors. Agricultural and urban development has resulted in widespread depletion, fragmentation, and modification of Applegate's milk-vetch habitat, to the extent that even small (an acre or less) parcels of truly undisturbed habitat are uncommon (USFWS 1998). Habitat loss and modification from both urban and commercial development and expansion are still the most significant threats to the species within its historic range. At the Klamath Falls Airport, there are plans to expand and develop the area where the largest occurrence of Applegate's milk-vetch is currently found. The airport is currently filling in wetlands around the perimeter of the property to reduce bird

collisions with the air traffic where milk-vetch occurs. Additionally, the airport has plans to expand runways, build more hangars, and is looking to alter areas to provide better drainage along runways (USFWS, 2009).

Stressor: Herbivory (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: In 1991 and 1992, ORNHIC (2007b) noted that the Miller Island population was struggling due to rabbit grazing. In 2007, ORNHIC reported observations of jack rabbit pellets at several Applegate's milk-vetch sites at Miller Island (ORNHIC 2007a). Jack rabbits are plentiful at the Klamath Falls Airport site as well (Hancock, pers. comm. 2007). As a result of seed collection efforts, Oregon Department of Agriculture reported that the reduced seed output of Applegate's milk-vetch in 2002 appeared to be caused by predispersal seed predation by insects. Most seed pods showed damage by insects and the seed collection bags were littered with the bodies of seed weevils and beetles (Gisler 2002a). Limited seed production coupled with seed predation may be significantly affecting the reproductive opportunities of Applegate's milk-vetch occurrences but additional studies are needed to determine population-level effects. Cattle are currently grazed at the Collins site and it has been documented that cattle do consume this species. Herbivory from insects includes the larvae of the Melissa blue butterfly. The larvae of the Melissa blue butterfly have been observed defoliating Applegate's milk-vetch plants and chewing through large plant stems near their bases (Gisler and Meinke 2001). Herbivory is not likely a major threat to the species, but when combined with the limited distribution and population size of Applegate's milk-vetch, habitat loss or modification due to herbivory and seed predation on this species could have a negative impact on its reproductive output and therefore recovery (USFWS, 2009).

Stressor: Nonnative plants (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Habitat colonization by non-natives could indirectly limit Applegate's milk-vetch by increasing input of plant litter and nitrogen fixation by introduced legumes, and creating conditions favorable to secondary succession by shrubs and other herbaceous species historically restricted by harsh, bare soils (USFWS 1998). Likewise, habitat colonization by weeds, especially thatch-forming grasses, could promote greater densities of voles and other potential plant herbivores and granivores through increased cover and protection from predators (USFWS 1998). Thatch-forming grasses are also problematic for this species because it's difficult for seedlings to germinate and penetrate the thatch layer. All of the extant occurrences of Applegate's milk-vetch have some non-native weeds present. *Elitrigia* or *Elytrigia repens* (creeping quackgrass), *Lactuca serriola* (prickly lettuce) and *Apera interrupta* (dense silky bent) are just a few of the weed species found at Applegate's milk-vetch sites. Creeping quackgrass is present at the Ewauna Flat Preserve, Miller Island and Washburn Way-Railroad sites. The Miller Island and Klamath Falls Airport sites are mostly dominated by planted *Thinopyrum intermedium* (intermediate wheatgrass) (ORNHIC 2007a). Non-native plants at the Klamath Falls Airport site include: *Agropyron cristatum* (crested wheatgrass), intermediate wheatgrass, *Poa bulbosa* (bulbous bluegrass) and *Holosteum umbellatum* (jagged chickweed) (ORNHIC 2007a), although these species do not occur in high densities. Low densities of weedy species have also been observed at

the Collins Tract site, but of particular concern at this site is *Hordeum murinum* (mouse barley) and *Cirsium* spp. (thistles) (USFWS, 2009).

Stressor: Stochastic events (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The final rule for Applegate's milk-vetch states that with the small number of occurrences, and small number of individual plants for each occurrence, there is an increased potential for extinction from stochastic events such as flood or fire. The limited gene pool may depress reproductive vigor or a single human-caused or natural environmental disturbance could destroy many of the individuals of this species. There is no information available about the genetic diversity of the few occurrences of this species (USFWS, 2009).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: State-level protections do not apply to private lands. Federal protections under the Clean Water Act may not be protective. (USFWS, 2009)

Recovery

Reclassification Criteria:

1. A minimum of four self-sustaining populations/sites are under protected management³ for the benefit of the species. Includes the development of an Applegate's milk-vetch management plan addressing the mitigation and prevention of stressors and threats including agricultural and urban development (Factor A); wildlife and cattle grazing (Factor C); lack of regulatory protection (Factor D); and poor reproduction, competition with exotic weeds, seed predation, and low population viability (Factor E). (USFWS, 2019)
2. For a site to contribute as a self-sustaining population/site, a minimum of 2,200 reproductive plants need to be present at the site over five consecutive years of monitoring. (USFWS, 2019)

Delisting Criteria:

1. A minimum of four self-sustaining populations/sites are under secured management⁷ for the benefit of the species or six self-sustaining recovery populations/sites are under protected management for the benefit of the species. Habitat being managed for Applegate's milk-vetch under the oversight of long-term land ownership that is not expected to change (e.g., the Miller Island recovery area that is owned by the State and managed as a Wildlife Management Area or the Airport property owned and managed by the City). (USFWS, 2019)
2. A minimum of 2,200 reproductive plants occurring over five consecutive years of monitoring at each site that contributes toward the delisting threshold. (USFWS, 2019)

Recovery Actions:

- Conserve natural and introduced Applegate's milk-vetch populations. The heart of recovery efforts for Applegate's milk-vetch will be to: 1) increase the species' representation from the

- current three areas to at least six areas with a minimum of two populations occurring at each of the recovery areas; and 2) develop management strategies that provide for long-term stability. (USFWS, 1998)
- Long-term, off-site seed storage. Banking (long-term cryogenic storage) of Applegate's milk-vetch seeds will provide an additional level of security to the recovery and survival of the species, by creating a demographic and genetic reserve of plant propagules. Off-site seed storage may be particularly vital in instances when natural soil seed banks are depleted due to poor seed production and pre- and post-dispersal seed mortality, or destroyed by natural or anthropogenic catastrophe. Stored seeds may be useful in establishing and augmenting Applegate's milk-vetch populations, mitigation of future population losses, and potential sources of genetic variability in the event populations suffer from inbreeding depression and/or allele fixation through drift. (USFWS, 1998)
 - Conduct further research. The following areas of research must be addressed to increase our knowledge about the nature and extent of Applegate's milk-vetch threats, and improve the species' prospects of recovery. Define population self-sustainability. Perfect population establishment and augmentation techniques. Assess efficacy of habitat management strategies. Edaphic and hydrologic requirements. (USFWS, 1998)
 - Develop and implement an outreach program. Increasing public awareness of Applegate's milkvetch will facilitate efforts to preserve this plant and restore its habitat. Prepare informational brochures, audiovisual, and sign programs on habitat restoration and recovery. Disseminate the brochures to affected landowners and other community facilities. Provide the audio-visual materials to public facilities such as National Wildlife Refuge interpretive programs and school programs. (USFWS, 1998)
 - Recommended Future Action: While our Applegate's milk-vetch knowledge has increased substantially since its listing, much remains unknown regarding the species' life stages and resource requirements. Demographic monitoring efforts are currently ongoing for both naturally occurring populations and outsourced plants, including the collection of survivorship and life stage data. Data analysis for the first three years of the natural population survival study returned results for seedling survival at 11.5% for year one and 8.5% for year two. Work is needed to determine methods to increase seedling survival rates. (USFWS, 2019a)
 - Recommended Future Action: Another key remaining research question is the identification of the species or group of species of mycorrhizae that are necessary for Applegate's milk-vetch survival. Once we know how to identify the species/group of species, we'll be able to more successfully determine where future transplanting should occur, as we'll be able to test if the mycorrhizae/other potentially important soil microbiota are present in the soil. The Service will also gain a better understanding of how and when it colonizes milk-vetch roots. Preliminary efforts have been initiated but additional study is needed. (USFWS, 2019a)
 - Recommended Future Action: The Service believes that the highest priority actions during the next five years are to determine methods to increase seedling survival rates and to identify the species/group of species of mycorrhizae that are necessary for Applegate's milk-vetch survival. The next highest research priorities are those focusing on genetic or pollinator studies. Therefore, the Service recommends that current efforts continue and that additional methods are developed and implemented toward answering these highest priority research questions. (USFWS, 2019a)

- Recommended Future Action: The Service also periodically receives new information about potential sites where Applegate's milk-vetch may have been seen. It is recommended that the Service survey these sites, to the extent that there is access. (USFWS, 2019a)

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SPECIES ACCOUNT: *Astragalus bibullatus* (Guthrie's (=Pyne's) ground-plum)

Species Taxonomic and Listing Information

Listing Status: Endangered; 9/26/1991; Southeast Region (R4) (USFWS, 2015)

Physical Description

A low perennial herb with a stout taproot bearing 5-10 simple, glabrous, slender stems, 5-15 cm long. Leaves are alternate and pinnately compound with small leaflets. Flowering stems are 5-8 cm long, ascending with purple, pea-shaped flowers in compact clusters of 10-16 and blooming in April and May. Fruits are plump, fleshy globe shaped pods that ripen in May and lie on the ground, becoming red on the side facing the sun and yellow on the bottom. In the summer, the pods dry to stiff, 2-valved papery pods with flattened small dull black seeds (Somers and Gunn 1990). (NatureServe, 2015)

Taxonomy

Specimens that are now assigned to *A. bibullatus* were apparently first collected as early as 1881 by the Tennessee botanist, Augustin Gattinger. For over 100 years, this material was assigned to *A. crassicaupus*, a related but morphologically and geographically distinct species that occurs approximately 750 kilometers (466 miles) to the west. Milo Pyne discovered the Rutherford County, Tennessee, site in 1979, which later became the type locality for the species. Botanists familiar with the genus *Astragalus* determined that the plants found by Pyne might represent a new species. In 1985, flowering and fruiting material from the type locality was sent by Jerry Baskin to Rupert Barneby, a monographer of the genus at the New York Botanical Garden. Barneby concluded that this was a new species, *A. bibullatus*, and described it with Edwin Bridges (Barneby and Bridges 1987). Kartez (1994) recognizes *A. bibullatus* as the correct name for plants in Tennessee (USFWS, 2011a).

Historical Range

Astragalus bibullatus is endemic to the cedar glades of middle Tennessee (USFWS, 2011a).

Current Range

Extant occurrences are located in the Stones River watershed in the vicinity of Murfreesboro, Rutherford County, Tennessee (USFWS, 2011a).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (EPA, 2016)

Dependency on Other Individuals or Species

Adult: Insect pollinators (EPA, 2016)

Breeding Season

Adult: April - May (EPA, 2016)

Reproduction Narrative

Adult: Flowering occurs April to May and fruiting occurs May to June. Obligate sexual reproduction most likely occurs via insect pollination (EPA, 2016).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Limestone cedar glade ecosystems; barrens, forest edge, forest/woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Partial shade (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 500 - 700 ft. elevation (EPA, 2016)

Spatial Arrangements of the Population

Adult: Clumped (see population narrative)

Environmental Specificity

Adult: Narrow to moderate (inferred from USFWS, 2011a)

Habitat Narrative

Adult: Limestone cedar glade ecosystems in the Middle Tennessee Central Basin. The plants are associated with Lebanon limestone and occur in transitional areas or glade margins where the soils are deeper (5-15 cm) and there is partial shade from shrubs and small trees. Environmental conditions in limestone glades are extreme - wet in the spring and very dry in the summer (NatureServe, 2015). Occurs between 500 to 700 ft. elevation. Soil types generally associated with rock outcrops in Rutherford County are the Gladeville and Talbott series (EPA, 2016). It should be noted that the most recently discovered occurrence was found in a small opening in a closed cedar forest, suggesting the potential for long-term persistence of *A. bibullatus* in less than ideal conditions provided that habitat is not destroyed (USFWS, 2011).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Seeds are dispersed by gravity and water (EPA, 2016).

Population Information and Trends**Population Trends:**

Decline of 10-90% (NatureServe, 2015)

Species Trends:

Stable (USFWS, 2011a)

Resiliency:

Low (inferred from USFWS, 2011a)

Representation:

Low (inferred from USFWS, 2011a)

Redundancy:

Low (inferred from USFWS, 2011a)

Number of Populations:

3 (NatureServe, 2015)

Population Size:

1000 - 2500 individuals (NatureServe, 2015)

Adaptability:

Low (inferred from USFWS, 2011a)

Population Narrative:

It is known from three extant populations. Two populations of *Astragalus bibullatus* (collected in 1901 and 1948 respectively) are believed to have been extirpated (USFWS 1991). This species has experienced a long-term decline of 10-90% (NatureServe, 2015). The species status is stable based on the 2011 Recovery Data Call. It is presently known from 8 extant occurrences. The extant occurrences of *A. bibullatus* are typically small, consisting of tens to hundreds of individuals (Table 1). Only one occurrence has ever been estimated to include greater than 1,000 individuals. Morris et al. (2002) surmised that, because of environmental changes, *A. bibullatus* populations were reduced in size and gene flow among them was likely restricted, leaving them vulnerable to effects of genetic drift and inbreeding. An occurrence that TVA biologists discovered during a 2006 survey of a powerline right-of-way extended the currently known range approximately 16 km (10 mi) to the southwest and expanded the area encompassing the species' current range to approximately 235 km² (90 mi²) (USFWS, 2011).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2011a)

Exposure:

Response:

Consequence:

Narrative: All the occurrences of *Astragalus bibullatus* are within a short distance of the rapidly growing middle Tennessee city of Murfreesboro. Five of the occurrences are located on public lands and as such are protected from development threats. However, the three remaining occurrences are located on private lands where development pressures are great. Limestone cedar glades are relatively flat and clear areas that often attract developers. One occurrence (population 2 in the listing rule) has been either destroyed or significantly altered by commercial

development since *A. bibullatus* was listed and is now believed to be extirpated. Habitat degradation due to ORV use of sites on private lands remains a potential threat, as does illegal ORV use on sites protected by public ownership (USFWS, 2011a).

Stressor: Invasive species (USFWS, 2011a)

Exposure:

Response:

Consequence:

Narrative: All the known *Astragalus bibullatus* occurrences are threatened by the encroachment of more competitive herbaceous vegetation and/or woody plants, such as eastern red cedar, that produce shade and compete for limited water and nutrients. Invasive exotic species that currently are either being managed or have been noted as potential threats at *A. bibullatus* occurrences include spotted knapweed (*Centaurea biebersteinii*), Japanese honeysuckle (*Lonicera japonica*), privet (*Ligustrum* spp.), and sericea lespedeza (*Lespedeza cuneata*), among others. Active management to reduce or eliminate vegetation encroachment is required to ensure that the species continues to survive at all the sites (USFWS, 2011a).

Stressor: Herbivory (USFWS, 2011a)

Exposure:

Response:

Consequence:

Narrative: Herbivory has been observed to varying degrees during monitoring of *A. bibullatus* occurrences. Albrecht and McCue (2010) observed that some spring transplants were browsed, and Walck (2007) observed herbivory or signs of it at three sites (USFWS, 2011a).

Stressor: Climate change (USFWS, 2011a)

Exposure:

Response:

Consequence:

Narrative: The Service identified extended drought conditions as a threat to *Astragalus bibullatus*, because of the likely reduced resilience of the three small populations that were known at the time of listing to endure such stochastic environmental events (56 FR 48750, Service 1991). The occurrence of severe drought in middle Tennessee, during the summers of 2007 and 2008, provides an opportunity to assess effects of drought to populations that are periodically monitored. It is possible that alterations in precipitation and drought frequency or severity that might accompany climate change could pose a growing threat to *A. bibullatus* in the future. Estimates of the effects of climate change using available climate models lack the geographic precision needed to predict the magnitude of effects at a scale small enough to discretely apply to the range of *Astragalus bibullatus*. However, data on recent trends and predicted changes for the Southeast United States (Karl et al. 2009) provide some insight for evaluating the potential threat of climate change to *A. bibullatus*. Since 1970, the average annual temperature of the region has increased by about 2o F, with the greatest increases occurring during winter months. The geographic extent of areas in the Southeast region affected by moderate to severe spring and summer drought has increased over the past three decades by 12 and 14 percent, respectively (Karl et al. 2009). These trends are expected to increase. Rates of warming are predicted to more than double in comparison to what the Southeast has experienced since 1975, with the greatest increases projected for summer months. Depending on the emissions scenario used for modeling change, average temperatures are expected to

increase by 4.5o F to 9o F by the 2080s (Karl et al. 2009). While there is considerable variability in rainfall predictions throughout the region, increases in evaporation of moisture from soils and loss of water by plants in response to warmer temperatures are expected to contribute to increased frequency, duration, and intensity of droughts (Karl et al. 2009) (USFWS, 2011a).

Stressor: Population fragmentation (USFWS, 2011a)

Exposure:

Response:

Consequence:

Narrative: Small population sizes and fragmentation of cedar glade habitats could influence genetic structure of *Astragalus bibullatus* populations. As noted above, Morris et al. (2002) concluded that the among-site genetic structure they detected within the youngest soil seed layers of *A. bibullatus* occurrences was likely attributable to an increased incidence of inbreeding over time, due to the isolation of populations caused by fragmentation. They surmised that, because of increased fragmentation of cedar glade habitats and increased shading due to vegetation encroachment in those that remain, *A. bibullatus* populations were reduced in size and gene flow among them was likely restricted, leaving them vulnerable to effects of genetic drift and inbreeding (USFWS, 2011a).

Recovery

Reclassification Criteria:

There are 11 viable, protected occurrences distributed throughout the cedar glade ecosystem of the Stones River Basin within Davidson, Rutherford, or Wilson counties (USFWS, 2011a).

Delisting Criteria:

There are 16 viable, protected occurrences that are distributed throughout the cedar glade ecosystem of the Stones River Basin within Davidson, Rutherford, and Wilson counties (USFWS, 2011a).

Recovery Actions:

- Protect and manage existing occurrences and habitats (USFWS, 2011b).
- Search for new occurrences (USFWS, 2011b).
- Conduct long-term monitoring and assess population growth rates and viability (USFWS, 2011b).
- Conduct biological and ecological research (USFWS, 2011b).
- Develop protocols for establishing new occurrences or augmenting existing ones (USFWS, 2011b).
- Communicate with local officials to coordinate city and county planning (USFWS, 2011b).
- Develop and implement public education materials (USFWS, 2011b).
- Periodically assess the success of recovery efforts for the species (USFWS, 2011b).

Conservation Measures and Best Management Practices:

- Federal and state regulatory protection (USFWS, 2011b).
- Investigating the species' biology, ecology, and life history (USFWS, 2011b).
- Preserving germplasm and establishing or augmenting occurrences (USFWS, 2011b).
- Site protection and management (USFWS, 2011b).

- Surveys and monitoring (USFWS, 2011b).

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SPECIES ACCOUNT: *Astragalus brauntonii* (Braunton's milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/28/1997; Pacific Southwest (R8)

Physical Description

A robust, short-lived perennial in the pea family (Fabaceae) (Hickman 1993). It is one of the tallest members of the genus, reaching a height of 1.5 meters (5 feet) and is covered with fine, entangled hairs throughout. The stems are white, the leaves pale to greenish. A thick taproot and woody basal stem gives rise to several stems. The 4 to 16 centimeters (1.5 to 6.5 inches) long leaves are pinnately compound with 25 to 33 oblong-ovate, abruptly pointed leaflets. The light purple flowers are clustered in 35 to 60 flowered racemes (flowers are borne on stalks) 4 to 14 centimeters (1.5 to 5.5 inches) long. The beaked, slightly curved pods are oblong-ovoid, 6.5 to 9 millimeters (2.5 to 3.5 inches) long and two-celled, front to back, with three to six seeds. *Astragalus brauntonii* is readily distinguished from the only other perennial species of *Astragalus* in the area, *A. trichopodus*, by being woolly tomentose (covered with densely matted hairs) as opposed to strigose (covered with sharp, stiff-appressed hairs) or glabrous (without hairs), and by the twochambered, rather than one-chambered pods (Barneby 1964). (USFWS, 1999)

Taxonomy

Member of the pea family (Fabaceae) (USFWS, 2009). *Astragalus brauntonii* was described by Samuel Parish (1903) based on a specimen collected by Dr. H. E. Hasse in 1899 above Santa Monica. It was named for Ernest Braunton. Per Axel Rydberg published the name *Brachyphragma brauntonii* in his revision of the genus. However, Rydberg's fragmentation of the genus *Astragalus* has not been accepted by other botanists. Systematic treatments (Barneby 1964) and floristic treatments (Munz 1974, Spellenberg 1993) recognized Parish's original treatment of this taxon (USFWS, 1999).

Historical Range

See Current Range.

Current Range

Occurs in five disjunct geographic areas in Ventura, Los Angeles, and Orange Counties, California (USFWS, 2009).

Critical Habitat Designated

Yes; 12/14/2006.

Legal Description

On November 14, 2006, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective December 14, 2006) for *Astragalus brauntonii* (Braunton's milk-vetch) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six critical habitat units (CHUs), in California (71 FR 66374-66423).

Critical Habitat Designation

The critical habitat designation for *Astragalus brauntonii* includes six CHUs (including 10 subunits) in Ventura, Orange and Los Angeles Counties, California. Approximately 3,300 acres (ac) (1,337

hectares (ha)) fall within the boundaries of the critical habitat designation. The critical habitat is located in Ventura, Los Angeles, and Orange Counties, California. Brief descriptions are presented below; detailed coordinates and maps are included in the Final Rule. (USFWS, 2006).

Unit 1: Northern Simi Hills Unit: This unit is located south of Simi Valley in the northern Simi Hills in Ventura County and consists of 21 ac (9 ha) of local agency land (Rancho Simi Recreation and Parks District) and 413 ac (166 ha) of private lands. It is divided into four subunits mapped from occurrences identified after the time of listing but currently occupied; all occur within 1.5 mi (2.5 km) of each other. Unit 1, inclusive of the four subunits, is located within the same physiographic area (the Simi Hills) as Unit 2.

Unit 2: Southern Simi Hills Unit: This unit is located along the southern Simi Hills in Ventura and Los Angeles Counties and consists of 196 ac (80 ha) of Federal lands, 118 ac (48 ha) of State land, 427 ac (173 ha) of local agency lands (Conejo Open Space Conservation Authority (COSCA), City of Thousand Oaks, Santa Monica Mountains Conservancy, and Rancho Simi Recreation and District), and 278 ac (113 ha) of private land. This unit is divided into six subunits mapped from records known at the time of listing and occurrences identified after listing. These subunits are all within 3.2 mi (5.2 km) of each other and occur along the southern perimeter of the geologic Chatsworth Formation.

Unit 3: Santa Monica Mountains Unit: This unit is located in the eastern Santa Monica Mountains in upper Zuma Canyon, north of Point Dume in Los Angeles County. It consists of 172 ac (70 ha) of Federal land within the Santa Monica Mountains National Recreation Area, and 56 ac (23 ha) of private land. It includes an area where more than 300 plants were found in 1999 after a prescribed burn, and the entire unit is mapped from an occurrence identified after listing.

Unit 4: Pacific Palisades Unit This unit is located in the Santa Ynez Canyon north of Pacific Palisades in Los Angeles County and consists of 439 ac (178 ha) of State lands within Topanga State Park and 66 ac (27 ha) of private land. It includes plants found in three separate locations that are part of a single population complex, and is mapped from occurrences known at the time of listing.

Unit 5: Monrovia Unit This unit is located in the San Gabriel Mountains in the City of Monrovia in Los Angeles County and consists of 218 ac (88 ha) of local agency land owned by the City of Monrovia and managed as open space (Monrovia Wilderness Preserve) and 64 ac (26 ha) of private land. It includes plants found in several locations that are part of a single population complex, and is mapped from an occurrence known at the time of listing.

Unit 6: Coal Canyon Unit This unit is located south of the City of Yorba Linda in Coal Canyon and Gypsum Canyon in Orange County and consists of 589 ac (238 ha) of State land (Chino Hills State Park and California Department of Fish and Game—Coal Canyon Ecological Reserve) and 243 ac (98 ha) of private land. This unit includes plants found in several locations that are part of a large population complex, and is mapped from occurrences known at the time of listing.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Astragalus brauntonii* critical habitat consists of three components (71 FR 66374-66423):

- (i) Calcium carbonate soils derived from marine sediment;
- (ii) Low proportion (less than 10 percent) of shrub cover directly around the plant; and
- (iii) Chaparral and coastal sage scrub communities characterized by periodic disturbances that stimulate seed germination (e.g., fire, flooding, erosion) and reduce vegetative cover.

Special Management Considerations or Protections

Threats that may require special management are specified in the Final Rule for each Critical Habitat Unit: Unit 1: Road maintenance, which could result in disturbances that are too frequent and prevent replenishment of the seed bank, invasion of nonnative plants which could crowd out *A. brauntonii*, cattle grazing, and recreation activities such as equestrian and foot traffic, which could result in trampling of plants. Unit 2: Road and trail maintenance that could result in disturbances that are too frequent and prevent replenishment of the seed bank, invasion of nonnative plants that could crowd out *Astragalus brauntonii*, edge effects from urban development, and recreation activities such as off-road vehicles and equestrian and foot traffic, which could result in trampling of plants. Subunit 1c is threatened by additional part development. Unit 3: Road maintenance that could result in disturbances that are too frequent, preventing establishment or replenishment of the seed bank. Unit 4: Road maintenance that could result in disturbances that are too frequent, preventing establishment or replenishment of the seed bank, and growth of nonnative plants that could crowd out *Astragalus brauntonii*. Unit 5: Maintenance of fire roads, the growth of nonnative plants that could crowd out *Astragalus brauntonii*, and recreation activities such as foot and bicycle traffic, which could result in trampling of plants. Unit 6: Maintenance of fire roads and the growth of shrubs and nonnative plants, which could crowd out *Astragalus brauntonii*. (USFWS, 2006)

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual: self-fertilization, cross-pollination (USFWS, 2009)

Lifespan

Adult: 2 - 3 years (NatureServe, 2015); possibly 5+ years in favorable conditions (USFWS, 2009)

Key Resources Needed for Breeding

Adult: Fire/disturbance (NatureServe, 2015); insect pollinators (bees known), soil seed bank (USFWS, 2009)

Reproduction Narrative

Adult: The seeds germinate after fire or other disturbance and the plants live only 2-3 years before senescing (NatureServe, 2015). *A. brauntonii* is self-fertile, but also produces seed through cross-pollination (Fotheringham and Keeley 1998). Known pollinators include megachilid bees (*Ashmeadiella* spp.) and bumblebees (*Bombus* spp.) (Fotheringham and Keeley 1998). Disturbances such as fire, erosion, and mechanical scraping of soil (e.g., during road or trail maintenance) are known to stimulate germination (Fotheringham and Keeley 1998). Each

plant may support upwards of several hundred flowers, and each seed pod produces three to six seeds (Barneby 1964), therefore, each plant can produce a large number of seeds which are deposited in the soil (seed bank). Individual plants have a lifespan of two to three years, although some individuals may live five years or more if conditions are favorable, and then plants are not visible again until the next disturbance (Fotheringham and Keeley 1998) (USFWS, 2009).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Brush/chaparral (NatureServe, 2015); coastal sage scrub (USFWS, 2009)

Dependencies on Specific Environmental Elements

Adult: Periodic fire; interval unknown (possibly 20 - 100+ years) (USFWS, 1999)

Geographic or Habitat Restraints or Barriers

Adult: Occurs ~800 - 2,100 ft. elevation, shade-intolerant (USFWS, 2009)

Spatial Arrangements of the Population

Adult: Patchy (USFWS, 2009)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2009)

Habitat Narrative

Adult: Brush/chaparral communities. The natural frequency of fire in the species' habitat is unknown. The plants may be restricted to limestone substrates (NatureServe, 2015). The species appears to be limited to shallow calcium carbonate soils derived from marine substrates; it occasionally occurs on non-carbonate soils at down-wash sites near other known occurrences, although survivorship of plants may be reduced on noncarbonate soils (Mistretta 1992, Fotheringham and Keeley 1998, Landis 2005). *Astragalus brauntonii* is associated with chaparral and coastal sage scrub plant communities and generally occurs along the tops of knolls ranging from 800 to 2,100 ft. (244 to 640 m) in elevation (Fotheringham and Keeley 1998, CNDDDB 2007, Landis 2005). The habitat has been described as scrub dominated by chaparral with a high overall percentage (>80 percent) of vegetative cover, however, the species does not tolerate shading and is associated with surrounding bare ground (Carroll 1987, Fotheringham and Keeley 1998). It requires a low proportion (<10 percent) of shrub cover directly around the plant. Many of the plant species that comprise chaparral and coastal sage scrub communities regenerate after fire, either through the release of a dormant seed bank whose germination is stimulated by fire, or through basal burl sprouting (Hanes 1971, Keeley and Zedler 1978). The above-ground expression of *A. brauntonii* populations are patchy over time and space as a result of the dormant seed bank and are subject to the dynamic habitat conditions and physical processes where it occurs (USFWS, 2009). The natural fire interval in the habitat of *A. brauntonii* is unknown. Estimates range from 20 to more than 100 years, with an average of 70 year intervals (Minnich 1989; O'Leary 1990) (USFWS, 1999).

Dispersal/Migration

Dispersal

Adult: Low to moderate (inferred from USFWS, 2009)

Dispersal/Migration Narrative

Adult: Neither the fruits or the seeds have specialized adaptations to facilitate seed dispersal by wind; therefore, it is likely that most seeds fall within a short distance of the parent plant (Cain et al. 2000). Long-distance dispersal, however, is likely achieved by water (during rainstorms), and by transport of seeds by wildlife. Small mammals facilitate seed dispersal through consumption and elimination of undigested seed and through seed caching (Cain et al. 2000, Sieg 1987) (USFWS, 2009)

Population Information and Trends**Population Trends:**

Not available

Number of Populations:

20 (USFWS, 2009)

Population Size:

Variable; tens to thousands per population, depending on disturbance cycle (USFWS, 2009)

Population Narrative:

This plant is only visible for a short time following disturbance such as a fire (NatureServe, 2015). There are currently 20 known occurrences. In most cases, the number of plants within a population is in the hundreds to thousands following a disturbance, and declines to fewer than ten plants within a few years (CNDDDB 2007). (USFWS, 2009).

Threats and Stressors

Stressor: Habitat destruction and degradation (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Land management actions that result in frequent disturbances, such as yearly road maintenance where *Astragalus brauntonii* occurs, may be contributing to the decline of populations by mowing and removing plants before seeds mature and replenish the seed bank. This has been known to occur for plants along unpaved fire access roads and utility corridors. Other land management activities such as herbicide application, cattle grazing, and recreational activities such as off-road vehicle and equestrian use that results in trampling of plants may be affecting *A. brauntonii*. Of the currently known 20 occurrences, the Service is unaware of protections for the 6 occurrences on private lands and for 4 of the 8 occurrences on local agency lands, and therefore presumes they could be threatened by indirect or direct effects from existing or future urban development, recreational activities, or other land management activities. Since the time of listing, one occurrence in Oak Park on lands owned by Rancho Simi Recreation and Parks District was extirpated due to park expansion. Another occurrence was partially removed by the Ventura County Public Works Agency for creation of a detention basin,

and the remaining portion of this occurrence has been proposed for development into the Lang Ranch Community Park by Conejo Recreation and Park District (USFWS, 2009).

Stressor: Altered fire cycles (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: One threat to *Astragalus brauntonii* discussed in the listing rule is the impact of fire management policies over the last 200 years on southern California ecosystems. The listing rule stated that fire exclusion has resulted in an accumulation of fuels in woody vegetation, making fire intensity and duration more severe. However, wildlands near urban areas have been experiencing increased fire frequencies, resulting in vegetation changes from shrub to grass and facilitating the spread of non-native, invasive annual plants. Despite efforts to suppress fires in coastal southern California, the current fire frequency of every 15 years or less, is substantially higher than it was historically, which is thought to be every 50 to 100 years (Keeley 2006). The impacts of fire suppression and/or increased fire frequencies near urban areas on *Astragalus brauntonii* are unclear. As of 1997, the Service believed that fire suppression activities resulted in the extirpation of *A. brauntonii* during the Old Topanga fire of 1993 (Service 1997); however, more recent surveys have revealed plants growing in that area (CNDDDB 2007). Extirpation of populations is unlikely as long as habitat remains, although above-ground plants may cease to grow for many years until a disturbance stimulates dormant seeds to germinate. Therefore, *A. brauntonii* habitat that has undergone succession and is dominated by dense woody shrubs may not be harmful to the long-term persistence of the plant as long as periodic disturbances are allowed to occur (USFWS, 2009).

Stressor: Stochastic events (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: *Astragalus brauntonii* may be vulnerable to extirpation by stochastic factors including demographic stochasticity, environmental stochasticity, and genetic stochasticity (Shaffer 1981). Demographic stochasticity refers to random variability in survival or reproduction among individuals within a population (Shaffer 1981), and could play a role in the extirpation of small populations of *A. brauntonii*. In most cases, the number of plants within a population is in the hundreds to thousands following a disturbance, and declines to fewer than ten plants within a few years (CNDDDB 2007). The disjunct distribution of *A. brauntonii* decreases genetic exchange between populations, which could impair the species' ability to adapt to changes in the environment or contribute to inbreeding depression (i.e., loss of reproductive fitness or vigor) (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The Service recognizes that climate change is an important issue with potential effects to listed species and their habitats. While the Service lacks adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors such as small population size, will affect *Astragalus brauntonii*, small ranged species, such as

Astragalus brauntonii, may be more vulnerable to extinction due to these changing conditions (Pimm and Raven 2000, Loarie et al. 2008) (USFWS, 2009).

Recovery

Reclassification Criteria:

1. All 20 current populations are fully protected (including seed banks), and managed with the primary intention of preserving the populations in perpetuity. (USFWS, 1999)
2. Seed is securely stored and plants are successfully germinated from collected seed and/or historic sites e.g. propagation techniques for reintroduction are developed. (USFWS, 1999)

Delisting Criteria:

1. When monitoring shows that the habitat is secure; provisions for ecological requirements exist; and conditions for the species indicate stability over a minimum of 15 years. This 15 years of monitoring will be extended by an additional 5 years of monitoring which is required by the Endangered Species Act for newly listed species. (USFWS, 1999)

Recovery Actions:

- Protect and secure populations and habitat on unprotected lands. Habitat for the listed plants must be protected and secured in perpetuity, from identified threats of loss. Methods for securing lands include permanent conservation easements established through land use decisions, in-fee purchase, gifts of easement, or fee interest by property owner (USFWS, 1999).
- Manage and monitor protected areas. The process of evaluating past and current management and making adjustments as needed is termed “adaptive management.” Public and private conservation lands should be adaptively managed to maximize their potential to support listed species and their habitats. (USFWS, 1999)
- Survey historic locations and other potential habitat where species may occur, Surveys of the potential albeit limited, habitat within the species range should be done. Several California Natural Diversity Database occurrence records for the listed species are represented only by observations. Information on population status, threats, and abundance is also needed for these sites. Information gathered from the additional details will be used to provide lead agencies to determine protective land use designation for the listed plant species . Data gathered will assist in determining the range of site characteristics, population vigor, and species viability to help establish minimum population standards for rare plant reserves, and consequently, for recovery. (USFWS, 1999)
- Conduct biological and ecological research to define life history strategies and population dynamics to guide recovery/conservation efforts. A better understanding of the population dynamics and identification of ecological factors that may be affecting those dynamics are needed to develop appropriate management plans to recover the plant species. (USFWS, 1999).
- Develop outreach plans to conserve the species. Outreach is an important component of implementing this recovery plan. This plan should be developed to enhance the public’s understanding of issues related to conservation and recovery of the listed species. Participation from both public and private entities should be encouraged for the establishment of conservation plans for the listed species. (USFWS, 1999)

- Recommendations for Future Actions from 2009 5-Year Review: 1) Work with private landowners and local agencies to protect and manage habitat for *Astragalus brauntonii*. This may be accomplished by conservation easements or other permanent devices. 2) Work with local agencies, fire departments, and utility companies to ensure that maintenance activities, such as grading of roads and/or mowing along dirt fire access roads and utility corridors, do not negatively impact *Astragalus brauntonii*. This includes conservation measures such as waiting until seeds mature to cut plants, and depositing plants and seeds on-site so that they replenish the seed bank. 3) Examine genetic diversity in the species and incorporate that data into the sampling and maintenance methodologies for seed banking called for in the recovery plan. (USFWS, 2009)

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SPECIES ACCOUNT: *Astragalus clarianus* (Clara Hunt's milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/22/1997; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A slender, sparsely leafy annual herb, mostly 7-12 cm in height. Flowers (March-April) are bicolored, with the wings whitish and the banner and keel bright purple-tipped (NatureServe, 2015).

Taxonomy

Name generally spelled "clarianus" (e.g., by Barneby (Astragalus), Kartesz 1994 and 1999, Hickman 1993, and USFWS); has also appeared as the strictly Latinized version "claranus" but that spelling does not appear to be in current usage (NatureServe, 2015). A member of the pea family (Fabaceae) (USFWS, 2009).

Historical Range

Historically from Napa, Sonoma and Lake counties, throughout the southern Napa Valley and se Sonoma County, California (NatureServe, 2015).

Current Range

Highly limited today due to development of vineyards and urbanization (NatureServe, 2015). The species is currently known from five localities in Napa county and Sonoma county (USFWS, 2009).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 2009)

Breeding Season

Adult: March - April (USFWS, 2009)

Reproduction Narrative

Adult: Flowers from March through April (USFWS, 2009).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Manzanita and oak woodlands (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 75 - 225 m elevation (NatureServe, 2015)

Habitat Narrative

Adult: Openings in manzanita and oak woodlands, on thin, rocky clay soils derived from volcanic materials or on serpentine substrates. Occurs at 75 - 225 m elevation (NatureServe, 2015).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Declining (NatureServe, 2015)

Resiliency:

Low (inferred from USFWS, 2009; see current range/distribution)

Representation:

Low (inferred from USFWS, 2009)

Redundancy:

Low (inferred from USFWS, 2009)

Number of Populations:

5 (USFWS, 2009; see current range/distribution)

Population Size:

500 (NatureServe, 2015)

Population Narrative:

Only about 500 total plants in normal year. This species is declining due to habitat modification (USFWS 1997) (NatureServe, 2015). Currently, three occurrences support fewer than 100 individuals (CNDDDB 2008) (USFWS, 2009).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The loss and modification of habitat via development, recreational activities and uprooting by feral pigs continues to threaten this species, especially in areas where urbanization

is expected to expand further. Three populations are located on private lands where potential development is not precluded; the general trend of habitat loss due to urbanization has continued and will likely continue at or adjacent to known populations (USFWS, 2009).

Stressor: Competition with introduced species (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: *Centaurea solstitialis* (yellow star-thistle) has infested the Lake Hennessey and Bale Grist Mill populations and threatens *A. claranus* via competition for resources. The threat posed by introduced species may become more severe with climate change. The Lewelling Lane population is threatened by competition from *Genista monosperma* (French Broom) (CNDDDB 1996). Based on its annual habit and size, it is thought that *A. claranus* has difficulty competing with introduced annual grasses (Howald, in litt. 2008) (USFWS, 2009).

Stressor: Community succession (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Plant succession at Bale Grist State Historic Park is excluding or reducing the population of *A. claranus* (Ruygt 1994). Fire suppression has reduced fire frequency, allowing new manzanita seedlings to become established, which results in less space available for *A. claranus* (USFWS, 2009).

Stressor: Small population size (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Having few individuals leaves *A. claranus* susceptible to extirpation throughout a significant portion of its range from random events and increases the threat of genetic drift and inbreeding. Therefore, this species is threatened with extinction or extirpation throughout a significant portion of its range due to random events such as flood, drought, disease, or other events (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: While the particular impacts of climate change on *A. claranus* have not been investigated, evidence suggests that the distribution of appropriate habitat elements (microclimate, community associations) may be altered in the coming decades resulting in a further decline of the species (USFWS, 2009).

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- Complete a recovery plan for *Astragalus claranus* (USFWS, 2009).
- Develop habitat suitability model for *Astragalus claranus* and then project anticipated shifts in range and occurrences under various climate change scenarios (USFWS, 2009).
- Secure landowner agreements with property owners at the Lake Hennessey, Spring Valley, Lewelling Lane and St. Helena Road populations to facilitate the management of *Astragalus claranus* habitat to reduce or eliminate competition with introduced plant species and uprooting by feral pigs (at Lewelling Lane) (USFWS, 2009).
- Conduct three consecutive years of surveys at each of the five localities to better understand population sizes and inter-annual population fluctuations. Surveys should also include an assessment of current threats facing the *A. claranus* populations (USFWS, 2009).
- Work with California Department of Parks and Recreation at Bale Crist Mill State Historic Park to manage habitat (e.g., conduct introduced species control) near the *A. claranus* population in the park (USFWS, 2009).

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SPECIES ACCOUNT: *Astragalus cremnophylax* var. *cremnophylax* (Sentry milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Endangered; 01/04/1991; Southwest Region (R2)

Physical Description

Perennial herb with silvery-haired leaves and stems. Flowers have short, campanulate calyxes with pale, purplish-pink petals and white-tipped wings. It has compact, 3 to 12 millimeter (0.1 to 0.5 inch) long, pinnately compound leaves that bear 5 to 9 minute leaflets. Flowers are small white to pale-purple with banners 5 to 6 millimeters (0.2 inch) and keels not over 4.5 millimeters (0.2 inch) long. Pistils have 4 to 6 ovules; pods are 3.0 to 4.5 millimeters (0.1 to 0.2 inch) long, obliquely egg-shaped and densely hairy (USFWS, 2006).

Taxonomy

A. cremnophylax and three other species are in the subsection Humillimi of the genus *Astragalus*, family Fabaceae (pea family). Although Jones made the first collection of *Astragalus cremnophylax* in 1903, the species was not described until 45 years later (Barneby 1948). Barneby assigned a specific epithet that describes the dramatic site occupied by the species. The English translation of the Latin word *cremnophylax* means "watchman of the gorge." In 1979, Barneby described a new variety, *A. cremnophylax* var. *myriorrhaphis* (cliff milkvetch), from plants discovered by Ralph Gierisch, Bureau of Land Management (BLM), and associates in 1978, on Buckskin Mountain, Coconino County, Arizona (Barneby 1979). A third variety, *A. cremnophylax* var. *hevronii* (Marble Canyon milk-vetch), was also described by Barneby (1992). The Marble Canyon milk-vetch was discovered in 1991 by Bill Hevron of the Navajo Natural Heritage Program, on the east rim of Marble Canyon, Coconino County, Arizona. After the discovery of variety *myriorrhaphis*, the group of plants containing the type-specimen of the species was automatically assigned the name *A. cremnophylax* var. *cremnophylax*. (USFWS, 2006)

Historical Range

Coconino County, Arizona (USFWS, 2006).

Current Range

Three locations in the Grand Canyon National Park in Coconino County, Arizona (USFWS, 2006).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect (USFWS, 2006)

Dependency on Other Individuals or Species

Adult: Pollinators (USFWS, 2006)

Breeding Season

Adult: Flowers from March through April and from September through November (USFWS, 2006), 2015)

Other Reproductive Information

Adult: Pollinator studies conducted within the South Rim populations confirmed the mason bees *Osmia ribifloris* and *O. ribifloris ribifloris* are the primary spring pollinators of sentry milk-vetch when the plant flowers, typically in late April to May. At Maricopa Point, *O. ribifloris* was far more prevalent than *O. ribifloris ribifloris*. GRCA also noted several other small bee species pollinating sentry milk-vetch, but these bees were not collected or identified. Pollinator visits coincided with less windy periods, and peak pollination time for *O. ribifloris* was between 1300 and 1500 hours. (USFWS, 2018)

Reproduction Narrative

Adult: Sentry milk-vetch exhibits two episodes of flowering from March through April and from September through November. Spring is the most common flowering time and usually results in successful fruit and seed set (Maschinski 1990a). Fall flowering plants set fruit, but seeds may not germinate until the next year (Maschinski 1991). This bi-seasonal flowering pattern has also been observed in plants cultivated at The Arboretum at Flagstaff (Maschinski 1990a). Plants in cultivation produced flowers after one year of vegetative growth. Age of first reproduction in the wild population is known to occur as early as one year from germination in individuals that have not been stressed by external factors (e.g., damage to foliage, lack of moisture) (Warren 1993). Plants bearing the greatest number of mature fruits and seeds in May and June are generally the largest plants in the population. These large plants produced an average of 200 fruits in spring 1992 (Warren 1993). Smaller sized individuals produced disproportionately fewer fruits than projected based on the size of the plant (Warren 1993). The average number of seeds per fruit is 3.02, but the number can vary from one to six seeds (Maschinski 1990a, 1991) (USFWS, 2006). More seeds germinated in the moderate light level than in either high or low light levels. Seedlings grown in the high light level had greatest survival. Seeds germinated in both cold and warm treatments. Seedlings at ambient greenhouse temperature germinated an average of three days before their refrigerated counterparts. Tap water appeared to be best for seed germination and early growth and resulted in higher germination rate and lower mortality than reclaimed water. (USFWS, 2018).

Habitat Type

Adult: Terrestrial (USFWS, 2006)

Habitat Vegetation or Surface Water Classification

Adult: Pinyon-juniper woodland (USFWS, 2018)

Geographic or Habitat Restraints or Barriers

Adult: Elevations of 6102 - 27125 ft (USFWS, 2006)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Habitat Narrative

Adult: Sentry milk-vetch forms mats or shallow mounds in scarcely visible cracks on Kaibab limestone bedrock, in sand-filled hollows of rock (Barneby 1964), or on shallow gravelly soils. The species appears to occur on one specific, pure white layer of Kaibab limestone where the bedrock forms an unshaded platform. It has not been found on small, shaded ledges or cliffs. The Grandview Point plants occur in a large crack in a small isolated ledge. The habitat is characterized by shallow soils or bedrock on the limestone platforms (55 FR 50184-50187). Prevost (1991) investigated soils at Maricopa Point and found them to be extremely shallow at less than 7 centimeters (2.8 inches) deep. Textures ranged from very gravelly, very fine sandy loam to extremely gravelly loamy fine sand. Clay content ranged from about 8 to 14 percent. Soils were mildly alkaline, with a pH value of 7.8, and were only slightly effervescent. The first 2 centimeters (0.8 inch) of the soil profile was characterized by subangular to subrounded fragments of mixed mineralogy, predominantly comprised of limestone, chert, and basalt less than 2 centimeters (0.8 inch) in diameter. The soil profile from 2 to 6 centimeters (0.8 to 2.4 inches) was very gravelly, very fine sandy loam with a weak thick platy structure, which was soft, very friable, slightly sticky, and nonplastic with fine irregular and tubular pores. Below 6 centimeters (2.4 inches) lies the Kaibab limestone bedrock (Prevost 1991). (USFWS, 2006)

Dispersal/Migration**Motility/Mobility**

Adult: Probably obligate outcrossers (USFWS, 2006)

Dispersal

Adult: Uncertain (USFWS, 2006)

Dispersal/Migration Narrative

Adult: Dispersal of seeds is very limited. Because the soft, pliable pods do not forcefully expel seeds as they split, seeds may remain within the pod attached to the parent plant for months (Maschinski et al. 1994). Seeds often fall into the foliage of the parent plant. Ants have been seen visiting the plants, but their influence on sentry milk-vetch is unknown. Ants may act as dispersal agents, but some species of ants eat seeds, flowers, or flower parts. Wind and water likely play an important role in seed dispersal (Maschinski 1990b). Because the fruits and tiny orange seeds are inconspicuous and do not seem to attract birds and mammals, the seeds are probably not dispersed or eaten by them. (USFWS, 2006)

Population Information and Trends**Population Trends:**

Increasing (inferred from USFWS, 2018)

Species Trends:

Increasing (inferred from USFWS, 2018)

Number of Populations:

9 populations (USFWS, 2018)

Population Size:

Approximately 6,000 individual plants (USFWS, 2018)

Additional Population-level Information:

When we finalized the recovery plan (USFWS 2006), genetic material from the Lollipop, Shoshone, and recently discovered North Rim populations was not included in the published examinations of the genetic relationships of the various sentry milk-vetch populations. In addition, researchers observed anomalous characteristics (e.g., seed color, plant habit) among the populations in the wild and in the greenhouse. Therefore, in 2013, GRCA and U.S. Geological Survey (USGS) initiated taxonomic studies, including phenetic and genetic analyses, to determine which populations we would assign to the listed entity of sentry milkvetch. The study focused on determining if any the newly discovered populations on the North Rim, as well as of the previously studied North Rim populations, are *Astragalus cremnophylax* var. *cremnophylax* (Wood 2014). The current work, which is in the data analysis phase, includes 77 individual plant samples of North Rim populations that taxonomists tentatively referred to an unpublished taxon, "*Astragalus septentriorema*" (commonly referred to as "North Rim *Astragalus*"). The researcher used a technique called amplified fragment length polymorphism/polymerase chain reaction (AFLP-PCR) genotyping to determine if "North Rim *Astragalus*" is the same species as the South Rim populations of sentry milkvetch. In total, 290 individuals from these groups have been sampled and genotyped at 694 loci. Preliminary results suggest that we would ascribe the populations on the South Rim (listed entity) and the North Rim *Astragalus* to sentry milk-vetch. We are currently waiting on a full report and publication of these results. However, once the authors publish this information, it is likely to result in an increase in the number of sentry milk-vetch populations and an increase in the geographic extent of the species that would include areas on both the South and North rims of Grand Canyon. At this time, the full results of that additional taxonomic work are not available. Thus, the relationship of the populations, and even the current number of populations of the species, remain unconfirmed. (USFWS, 2018)

Population Narrative:

During GRCA's annual May monitoring of the wild population at Maricopa Point, staff counted 989 sentry milk-vetch plants in 2014, compared with 556 plants in 2009, 528 plants in 2010, 608 plants in 2011, 539 plants in 2012, and 624 plants in 2013. While some of this increase may be the result of increased accuracy resulting from the tagging process, there were also at least 400 new sentry milk-vetch plants in 2014 compared with 188 in 2013 and only 46 new plants in 2012. This increase in the number of new plants found in the May 2014 monitoring is likely due to the large number of seedlings that came up with the above average summer 2013 monsoon rains and survived the winter. Anecdotal observations made during the summer of 2014 indicate that many of these very small seedlings perish during the hot summer months and do not make it to the next monitoring cycle. In 2011 and 2012, GRCA completed North and South Rim surveys for all areas identified as potential sentry milk-vetch habitat. GRCA located 200 individuals in a new population at Walhalla Sky Island (North Rim location), 560 individuals in a new population at Cape Final North (North Rim location), and 30 individuals in a new population at Walhalla Glades (North Rim location). In 2013, GRCA discovered a new population of 139 individual plants near Shoshone Point (South Rim location). GRCA established three reintroduction sites: Maricopa Reintroduction, Lollipop Reintroduction and Grandview Reintroduction. Plantings of sentry milk-vetch at these sites were supplemented with wild-collected seeds. GRCA put new plants in cages immediately after planting and watered the plants on a regular schedule. (USFWS, 2018)

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2006)

Exposure:

Response:

Consequence:

Narrative: Because the largest known confirmed population has sustained severe declines, the species remains in danger of extinction. Human traffic indirectly affects the sentry milk-vetch population through habitat degradation. Over time, trampling has resulted in the loss of plant cover, which has resulted in erosion of the thin soil. Foot traffic can also displace what little soil builds on the limestone surface, thus reducing the number of microsites available for germination. Most seedlings establish near plants or other obstructions that stop the sheet flow. The loss of plant cover due to trampling can reduce the microsites available for seedling establishment. Maschinski et al. (1996) stated that the continued existence of the species would depend on continued protection, environmental conditions that promote recruitment, and recovery efforts such as habitat enhancement and augmentation (USFWS, 2006).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2006)

Exposure:

Response:

Consequence:

Narrative: The species is protected by National Park Service regulations, as are all plant species within the Park. Sentry milk-vetch is protected by the Arizona Native Plant Law. That law prohibits the collection of the species unless the Arizona Department of Agriculture grants a permit for educational or scientific purposes. However, the law does not provide habitat protection. Protection provided to the species under the Endangered Species Act is discussed below, in Conservation Measures (USFWS, 2006).

Stressor: Predation (USFWS, 2006)

Exposure:

Response:

Consequence:

Narrative: The threat of predation to sentry milk-vetch is not well understood. Damage to plants in 2006 may have been due to predation by rock squirrels, or the damage may have been collateral; that is, the plants were dug up when rock squirrels were digging for roots to eat (USFWS, 2006).

Stressor: Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2006)

Exposure:

Response:

Consequence:

Narrative: Plant collecting by botanists and other rare plant enthusiasts is a potential, but currently minor, threat to sentry milk-vetch. Although the extent of this threat is unknown, publicity could make this species susceptible to increased visitation and collection. Because the number of populations and individuals is so small, even a small or moderate amount of collecting could seriously impact the species. The minor threat of unauthorized collection must be weighed

against the potential benefits of education of the general public. The Park receives visitors from all over the globe, and the conservation status of this species could be enhanced by public education in the form of informational signs at Maricopa Point (USFWS, 2006).

Recovery

Reclassification Criteria:

1. There are at least four viable populations of 1,000 individuals each (4,000 total) protected in perpetuity (USFWS, 2006).
2. Naturally occurring populations are stable or increasing over a ten-year period (USFWS, 2006).
3. Reintroduced populations are stable or increasing over a thirty-year period (USFWS, 2006).

Delisting Criteria:

1. There are at least eight viable populations of 1,000 individuals each (8,000 total) protected in perpetuity (USFWS, 2006).
2. Naturally occurring populations are stable or increasing over a ten-year period (USFWS, 2006).
3. Reintroduced populations are stable or increasing over a thirty-year period (USFWS, 2006).

Recovery Actions:

- Protect the population at Maricopa Point from disturbance. Monitor threats and evaluate the need for additional protective measures. Conduct surveys to positively identify and determine taxonomic relationships of new populations as they are found. Increase the number of individuals and the amount of occupied habitat at all occupied sites to the carrying capacity of the habitat. Establish new populations as necessary to meet recovery criteria. Based on the results of the pilot project and availability of suitable introduction sites, establish additional new populations (USFWS, 2006).
- Coordinate research activities. Develop public awareness, appreciation, and support for preservation of sentry milk-vetch. (USFWS, 2006)
- Enforce laws and regulations. Ensure long-term protection (USFWS, 2006).
- Provide assistance to Grand Canyon National Park (and other land owners and managers) to recover and protect the species and its habitat. Adjust management as necessary. Conduct research on the existing populations. Establish an ex situ (botanical garden/greenhouse) conservation program. Exchange information between agencies, the public, and the scientific community (USFWS, 2006).
- Develop a post-listing monitoring plan. The plant and its habitat will be monitored for 5 years after recovery (delisting) has been achieved. (USFWS, 2006)
- Recommended Actions from 2018 5-Year Review: • USGS and GRCA need to complete the final report and publish the results of the taxonomic study that ascribe the populations on the South Rim (listed entity) and the North Rim *Astragalus* to sentry milk-vetch. 11 • Improve communication and coordination by all partners. We will plan to have regular meetings in order to share important findings, changes in the species status, and progress

towards recovery. • The Fish and Wildlife Service, GRCA, and The Arboretum at Flagstaff will address and determine what constitutes populations of the species and their locations in the context of the recovery plan. This group also should analyze and summarize the long-term data set and define what constitutes stability in terms of the recovery criteria. (USFWS, 2018)

Conservation Measures and Best Management Practices:

- As part of two section 7 consultations we conducted with GRCA, the following conservation measures are now part of the GRCA recovery program (USFWS 2011, 2012). GRCA updated their sentry milk-vetch reintroduction plan to follow the latest version of the Center for Plant Conservation Best Reintroduction Practices Guidelines.
- Restoration activities will avoid sentry milk-vetch plants. • The number of researchers and number of entries within each population will be limited to what is essential to accomplish the project. Researchers will wear soft shoes and will not enter the population area when soils are saturated. • GRCA will use a dedicated research greenhouse to grow and hold sentry milk-vetch plants. GRCA will keep field collected seed and seed received from The Arboretum at Flagstaff in a cool dry place until use and will ensure the seed is secure from rodents and insects. • Upon the completion of the project, GRCA will deposit any excess seed into the National Center for Genetic Resources Preservation, or distribute the seed according to instructions from the Fish and Wildlife Service. • GRCA will use only pure Maricopa Point sentry milk-vetch material for augmentation or introduction at Maricopa Point and the surrounding vicinity, only Lollipop Point material at Lollipop Point, and only Grandview material at Grandview, until the taxonomic relationships among the Maricopa, Lollipop, and Grandview populations are better defined. Until the taxonomy of the North Rim populations is known, genetic material will not be mixed at these sites as well. (USFWS, 2018)

References

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SPECIES ACCOUNT: *Astragalus holmgreniorum* (Holmgren milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Endangered; 9-28-2001; Mountain-Prairie Region (Region 6)

Physical Description

A member of the pea family, this species grows close to the ground and is a herbaceous, non-woody perennial that produces small purple flowers in the spring, and dies back to the root crown after the flowering season. The plant's pinnately compound (arranged on opposite sides of the stem in a row) leaves arise directly from the root crown. The leaves are pressed close to the ground, and are 4 to 13 cm (1.5 to 5.1 in) long, and have 9 to 15 leaflets. The leaflets are 0.8 to 1.6 cm (0.3 to 0.6 in) long and are broadly obovate (oval with the narrow end towards the base of the leaf) in shape. The flowers are purple, 1.8 to 2.4 cm (0.7 to 0.9 in) long, and 0.6 to 0.9 cm (0.2 to 0.4 in) wide and have the distinctive pea-like flowers with 5 petals. Flowers occur along the stalk in groups of 6 to 16. The fruits are pods 3 to 5 cm (1 to 2 in) long and 0.6 to 0.9 cm (0.2 to 0.4 in) across. The pods retain seeds even after the pods fully open up along the margin. With age, each pod eventually dries out and opens up at both the top and bottom ends (Barneby 1989; Stubben 1997).

Taxonomy

A. holmgreniorum was first collected in 1941 by Melvin Ogden; the species was subsequently rediscovered by Rupert Barneby and Noel and Patricia Holmgren in 1979. Barneby recognized the species as a unique taxon occurring along the western Utah-Arizona border and named the species for his co-discoverers.

Historical Range

Historical distribution is not known for this species, that is, records are not available to ascertain whether the current distribution of *A. holmgreniorum* populations represents either a loss of individual populations or a range contraction for the species. Given historical configurations of available habitat, it is possible that additional populations once occurred on the landscape. It is unknown, but also is possible that this species is a relatively new endemic, which has speciated relatively recently in or near its present locations.

Current Range

Washington County, Utah (4 populations); and Mohave County, Arizona (1 population). These *Astragalus* populations are distributed across a limited range. Known populations of *A. holmgreniorum* occur within approximately 10 miles (mi) (16 kilometers (km)) of St. George in Washington County, Utah, and Mohave County, Arizona. The largest concentration of this species spans the Utah-Arizona border, extending from the Atkinville Wash area eastward across Interstate 15 (I-15) to the Arizona Strip Highway; this concentration comprises three populations--State Line, Gardner Well, and Central Valley. Two populations, South Hills and Stucki Spring, are found south of the City of Santa Clara. An isolated population called Purgatory Flat is associated with a limestone outcrop found east of St. George. About half of the areas occupied by *A. holmgreniorum* are on lands owned and managed by the State of Utah (Van Buren and Harper 2003a).

Critical Habitat Designated

Yes; 12/27/2006.

Legal Description

On December 27, 2006, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Astragalus holmgreniorum* (Holmgren milk-vetch) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in Arizona and Utah (71 FR 77972-78012).

Critical Habitat Designation

The critical habitat designation for *Astragalus holmgreniorum* includes three CHUs (Including 5 subunits) in Mohave County, Arizona, and Washington County, Utah. This species critical habitat encompasses approximately 6,289 acres (ac) (2,545 hectares (ha)) (71 FR 77972-78012).

Unit 1—Utah-Arizona Border This unit consists of approximately 5,546 ac (2,244 ha) divided into three subunits: State Line, Gardner Well, and Central Valley. This unit contains PCEs and is important to the conservation of *Astragalus holmgreniorum* because it is one of only three populations of the plant and is the largest population of the species. Subunit 1a—State Line This subunit, known to be occupied at the time of listing, consists of 3,836 ac (1,552 ha), with 9 percent managed by BLM AZ, 44 percent managed by BLM UT, 23 percent managed by ASLD, 19 percent managed by SITLA, and 5 percent private land or land ownership unknown. Subunit 1a is located east and west of I-15 as this highway crosses the State line of Arizona and Utah, and is bounded by the Atkinville Wash and Virgin River to the north. Documents pertaining to occupancy, soil type, and land formations were evaluated to determine unit boundaries. Administrative lines were used for boundaries on the west and east sides of the unit, and soil type, land features, and straight connecting lines were used for northern and southern boundaries of the unit. Recent surveys on lands managed by SITLA (Van Buren 2004, p. 3) and BLM UT (Van Buren 2005) west and east of I-15 confirmed occupancy of *Astragalus holmgreniorum* individuals, and BLM AZ (Hughes 2005) verified *A. holmgreniorum* in several locations on BLM and ASLD lands. Suitable habitat conditions supporting the identified PCEs occur throughout the area. Land between sections 31, 32, and 8 contains known PCEs for *A. holmgreniorum*; however, information is incomplete on intervening occupancy. Subunit 1a has features that are essential to the conservation of the species, and it supports the highest number of individuals documented to date (Service 2006) within a continuous geographic area, fragmented only by I-15. *Astragalus holmgreniorum* also occupies land found between the northbound and southbound lanes of I-15. This intervening area within the highway right-of-way may allow pollinator flow between sites situated west and east of the highway (Douglas 2005). As a large population, subunit 1a retains importance as representative of the species' potential range of genetic diversity. Species surveys documented a high number of seedlings (Van Buren 2004, p. 2; 2005, p. 16), which indicates that this subunit supports a large seed bank. This information indicates a viable seed bank, the protection of which enhances the genetic diversity and boosts the likely persistence of the species (Van Buren 2003, p. 6). Seed bank protection is necessary for longterm species persistence (McCue and Holtsford 1998, p. 35). Special management considerations may be required to control invasive plant species, to control habitat degradation due to activities that lead to erosion, to maintain the identified vegetation types, and to maintain pollinator habitat essential to the conservation of the species. The BLM AZ and BLM UT do not currently have a management plan specific to *Astragalus holmgreniorum*; however, the agency worked in partnership with the Service on a recovery plan for the species (71 FR 57557, September 29, 2006). The BLM UT states that the timing of cattle grazing has been

adjusted to avoid the flowering period for the species (Douglas 2004). Additionally SITLA is signatory to a Letter of Intent intended to place roughly 175 ac (71 ha) of land occupied by *A. holmgreniorum* into long-term conservation (SITLA et al. 2005, pp. 3–4). Subunit 1b—Gardner Well Subunit 1b consists of 564 ac (228 ha), entirely managed by ASLD. This subunit is found in Arizona, south of the Arizona-Utah State border, 2 mi (3.2 km) east of I–15. Reconnaissance maps dating to the early 1990s and herbarium information for *Astragalus holmgreniorum* indicate plant occupancy on ASLD lands. The acreage proposed within this subunit was further refined based on known plant locations, geologic maps, and occurrence of PCEs, including soil types. This subunit is determined to be critical habitat because it contains features essential to the conservation of *Astragalus holmgreniorum*, is occupied by the species, and represents the southeastern-most site in Arizona within the primary population, as discussed in the final listing rule (66 FR 49560, September 28, 2001). Yearly monitoring indicates a relatively high density of *A. holmgreniorum* (Van Buren and Harper 2004a, p. 6). In 2005, the Gardner Well monitoring site contained an estimated 150 plants, all seedlings (Van Buren 2005). The abundance of seedlings indicates a persistent seed bank that is considered important for genetic diversity and local survivorship (McCue and Holtsford 1998, pp. 34–35; Van Buren 2003, p. 6; Van Buren 2005). This subunit also is historically significant because it includes the type locality (the location of the specimen from which the original species' description was made) for the species. Special management may be required to minimize disturbance to the surface structure within this subunit, to control invasive species, to maintain the identified vegetation types, and to maintain pollinator habitat essential to the conservation of the species. Currently, no management plan has been developed for these lands. Subunit 1c—Central Valley Subunit 1c consists of 1,146 ac (464 ha), entirely managed by SITLA. This subunit is found north of the Arizona-Utah State border, west of a geological feature called White Dome, and east of I–15. This subunit is determined to be critical habitat because it contains features essential to conservation of *Astragalus holmgreniorum*, it is occupied by the species, and contains a large, densely occupied portion of the primary population described in the final listing rule (66 FR 49560; September 28, 2001). This subunit contains the second largest continuous land base for *A. holmgreniorum* and the second largest number of individuals counted to date (Van Buren 2003, p. 5). Approximately 99.8 percent of plants identified in the 2003 surveys were seedlings (Van Buren 2003, p. 6). The high number of seedlings and near lack of reproductive adults indicates a historic seed bank (Van Buren and Harper 2004a, pp. 3–4). Protection of known seed banks is essential for longterm survival of the species. The retention of these seeds can have a dramatic effect on demography and reduce the expected inbreeding coefficient (McCue and Holtsford 1998, p. 34). Seed banks also ensure population persistence during periods of changing environmental conditions (Facelli, Chesson, and Barnes 2005, pp. 3001–3003). Plants within this subunit are threatened by urban development. Special management may be required to minimize disturbance to the surface and subsurface structure within this subunit, and to maintain the identified soil and vegetation types. No management plan currently exists. A Letter of Intent signed by SITLA indicates a willingness to develop a management plan for this species on a limited portion of their property; however, SITLA plans to develop a master planned community in the area (SITLA et al. 2005, pp. 5–6).

Unit 2—Santa Clara Unit Unit 2 comprises 567 ac (229 ha) divided into two subunits: Stucki Spring and South Hills. Unit 2 contains the PCEs, and is also important to conserving genetic diversity of the taxon because plants in this area contain a unique genetic marker not present in the other two populations (Stubben 1997, p. 46). Therefore, the two subunits in the Santa Clara Unit are needed to conserve genetic variation held within the gene pool for this taxon (Van Buren 2005). Additionally, this unit represents one of only three known populations of the species.

Subunit 2a—Stucki Spring Subunit 2a consists of 438 ac (177 ha) managed by BLM UT. This unit is found west of Box Canyon, in an area before Box Canyon Wash narrows, and near Stucki Spring. *Astragalus holmgreniorum* was known to occupy this subunit at the time of listing (66 FR 49560; September 28, 2001). In 2005, individuals were confirmed in a roadside visit (Van Buren 2005). This subunit is determined to be critical habitat because it contains features essential to conservation of *Astragalus holmgreniorum*, is occupied by the species, supports genetic diversity, and provides connectivity between Subunits 1a (State Line) and 1c (Central Valley) to the south, and Subunit 2b (South Hills) to the north. The land within this unit supports the PCEs for the species that are necessary for the growth, reproduction, and establishment of *Astragalus holmgreniorum*. Special management may be required in this subunit to minimize habitat fragmentation, to minimize disturbance to the surface and subsurface structure due to recreation or other activities, and to maintain the identified soil and vegetation types. Plants within this subunit are currently threatened by unmanaged ORV use. Additionally, BLM is considering selling adjacent areas for urban development; we anticipate that the proximity of the development would result in an indirect effect to *Astragalus holmgreniorum*. BLM UT does not currently have a management plan specific to *A. holmgreniorum*, but the agency worked with us to develop a recovery plan for this species (71 FR 57557, September 29, 2006). The objective of the Santa Clara River Reserve Recreation and Open Space Management Plan is development of user-specific trails and areas of activities to reduce the effects of unregulated and potentially damaging activities on habitat components, including plants (USDI 2005, p. 10). However, specific details regarding facility locations, impacts, and conservation measures have not been identified.

Subunit 2b—South Hills Subunit 2b consists of approximately 129 ac (52 ha), with 97 percent managed by BLM UT and 3 percent private lands (or land ownership unknown). This subunit was known to be occupied at the time of listing (66 FR 49560; September 28, 2001). A 2005 survey of the area documented a healthy number of plants in this subunit (Van Buren 2005). This subunit is determined to be critical habitat because it contains features essential to conservation of *Astragalus holmgreniorum*, is occupied by the species, supports genetic diversity, and represents the northcentral-most occupied site of the species. The land within this subunit supports the PCEs necessary for the growth, reproduction, and establishment of *A. holmgreniorum*. Special management may be required to minimize urban encroachment, maintain land in Federal ownership, reduce disturbance to the surface and subsurface structure, control invasive species, maintain the identified vegetation types, and maintain pollinator habitat essential to the conservation of the species. Plants within this subunit are threatened by urban development, land trades, and recreation. Public land sales are authorized for eligible parcels under the Federal Land Transaction Facilitation Act of 2000 (Crisp 2004). BLM is working with the city of Santa Clara and the local community to sell approximately 1,400 ac (567 ha) in the Santa Clara area. This proposed sale is believed to contain all *Astragalus holmgreniorum* individuals in this subunit. The intent of the local community would be to develop the land for residential housing.

Unit 3—Purgatory Flat Unit 3 consists of approximately 176 ac (72 ha) of land; 68 percent is managed by BLM UT, and 32 percent is under private ownership or county ownership. Part of the critical habitat contains lands within a regional shooting range. The final listing rule (66 FR 49561, September 28, 2001) indicated that there were 30 to 300 plants at this location. More recent site visits confirm the presence of individual plants (Barnes 2005; Van Buren 2005); however, a census was not conducted. Purgatory Flat is determined to be critical habitat because it contains features essential to conservation of *Astragalus holmgreniorum*, is occupied by the species, and represents the northeastern-most occupied site and third known population. This unit is the farthest from all other critical habitat units. Distant populations are often the most active regions

of speciation and may be important for protecting genetic diversity (Lesica and Allendorf 1995, p. 756). The land within this unit supports the PCEs that are necessary for the growth, reproduction, and establishment of *A. holmgreniorum*. Special management may be required to minimize disturbance to the surface structure within this subunit, control invasive species, maintain the identified vegetation types, and maintain pollinator habitat essential to the conservation of the species.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Astragalus holmgreniorum* critical habitat consists of three components (71 FR 77972-78012):

- (i) Soils that support individual *Astragalus holmgreniorum* plants. These include the Virgin Limestone member, middle red member, and upper red member of the Moenkopi Formation, and the Petrified Forest member of the Chinle Formation. Associated soils are Badland; Badland, very steep; Eroded land-Shalet complex, warm; Hobog-rock land association; Isom cobbly sandy loam; Ruesh very gravelly fine sandy loam; Gypill Hobog complex, 6 to 35 percent slopes; Gypill very cobbly sandy loam, 15 to 40 percent slopes; and Hobog-Grapevine complex, 2 to 35 percent slopes;
- (ii) Topographic features/relief (mesas, ridge remnants, alluvial fans and fan terraces, their summits and backslopes, and gently rolling to steep swales) and the drainage areas along formation edges with little to moderate slope (0 to 20 percent); and
- (iii) The presence of insect visitors or pollinators, such as *Anthophora captognatha*, *A. damnersi*, *A. porterae*, other *Anthophora* species, *Eucera quadricincta*, *Omia titus*, and two types of *Dialictus* species.

Special Management Considerations or Protections

Critical habitat does not include manmade structures existing on the effective date of this rule and not containing one or more of the primary constituent elements, such as buildings, aqueducts, airports, and roads, and the land on which such structures are located.

When designating the three critical habitat units, including Subunits 1a, 1b, 1c, 2a, and 2b, for *Astragalus holmgreniorum*, and the four critical habitat units, including Subunits 4a and 4b, for *A. ampullarioides*, we assessed whether the areas determined to be occupied at the time of listing and containing the primary constituent elements may require special management considerations or protections. As discussed in more detail in the proposed critical habitat designation (71 FR 15966, September 26, 2006) and in the unit and subunit descriptions below, we found that the features essential to the conservation of *A. holmgreniorum* and *A. ampullarioides*, in all areas we are designating, may require special management considerations and protections, including measures necessary to alleviate the effects of urban development, retaining plants and their habitat on Federal lands, fencing small populations, removing or limiting access routes, ensuring vehicles and pedestrians stay on designated routes, reducing land use practices that disturb the hydrologic regime, minimizing the effects of grazing and recreation use, managing invasive nonnative plant species, evaluating revegetation and restoration with native plant species, developing adequate fire management buffers for these plant species and their habitat, and educating fire management staff on the location of the

plants. Additionally these areas may require special management considerations and protections for ground-nesting and local pollinator communities.

Life History

Food/Nutrient Resources

Food Source

Adult: Soil nutrients

Competition

Adult: Nonnative annuals make up the highest percentage of living cover in *A. holmgreniorum* habitat, and they tend to emerge prior to *A. holmgreniorum*, thus potentially competing for soil moisture and nutrients.

Food/Nutrient Narrative

Adult: The primary geological layers or parent materials associated with *A. holmgreniorum* occurrences include the Virgin Limestone member and Upper Red member of the Moenkopi Formation (Harper and Van Buren 1997). It is typically found on the skirt edges of hill and plateau formations slightly above or at the edge of drainage areas; it occurs on soils characterized by small stone and gravel deposits and where living cover averages less than 20 percent of the landscape. Runoff received from nearby sloping areas, combined with slower evaporation due to shading produced by the stone and gravel, may increase water availability for the plants in excess of regional rainfall (Harper 1997; Harper and Van Buren 1997). Nonnative annuals make up the highest percentage of living cover in *A. holmgreniorum* habitat, and they tend to emerge prior to *A. holmgreniorum*, thus potentially competing for soil moisture and nutrients.

Reproductive Strategy

Adult: Iteroparous (capable of producing seed in more than 1 year); not capable of vegetative reproduction, so setting of seed is necessary.

Lifespan

Adult: Few plants live past two growing seasons (Stubben 1997; Van Buren and Harper 2003) and less than 2% of seedlings (nonreproductive plants with a rosette diameter of 0-2.4 in. (0-6 cm)) tracked in 1993 lived into their fourth growing season (Van Buren and Harper, 2001a).

Dependency on Other Individuals or Species

Adult: Solitary bees are the primary pollinators. *Anthophora poterae* is the most frequent; other pollinators include *Anthophora coptognatha*, *Anthophora dammersi*, *Eucera quadricincta*, *Osmia titusi*, two *Dialictus* species, an undetermined *Anthophora* species, and the introduced honeybee, *Apis mellifera* (Tepedina 2005).

Breeding Season

Adult: Flowering occurs between March and April; the majority of plants set fruit by the end of April; seed pods persist until the end of May.

Key Resources Needed for Breeding

Adult: A variety of suitable ground nesting substrates is probably required for these pollinators.

Reproduction Narrative

Adult: *A. holmgreniorum* is an extremely short-lived perennial herb with low survivorship from germination to 1 year-old juvenile or reproductive adult. Few plants live past two growing seasons (Stubben 1997; Van Buren and Harper 2003) and less than 2% of seedlings (nonreproductive plants with a rosette diameter of 0-2.4 in. (0-6 cm)) tracked in 1993 lived into their fourth growing season (Van Buren and Harper, 2001a). Although very few plants live to exhibit this quality *A. holmgreniorum* is iteroparous, capable of producing seed in more than 1 year. Nonseedlings, i.e., plants entering their second year of growth or older plants, appear several weeks before seedlings, generally in late February or early March, although some emerge as early as mid-January. Seedlings are present several weeks following adult emergence. The best time to detect the species is while it is producing flowers and fruit. Flowering occurs between March and April, and the majority of plants set fruit by the end of April. Seed pods persist until the end of May. Plants then die back to roots between late May and mid-June (Van Buren and Harper 2003a). Depending on precipitation, *A. holmgreniorum* has variable seedling output followed by a low rate of survivorship, limiting the number of reproductive adults within a population. Solitary bees are the primary pollinators. *Anthophora poterae* is the most frequent; other pollinators include *Anthophora coptognatha*, *Anthophora dammersi*, *Eucera quadricincta*, *Osmia titusi*, two *Dialictus* species, an undetermined *Anthophora* species, and the introduced honeybee, *Apis mellifera* (Tepedino 2005). For bees to be present in a landscape, habitat must provide suitable nesting substrate and resources such as food, water, and nesting materials (Tepedino et al. 1997, Tepedino 2000). With the diversity of bees visiting *A. holmgreniorum*, a variety of suitable ground nesting substrates is probably required for these pollinators (V. Tepedino, pers. comm. 2006). Also, several of these species nest in wood rather than the ground (V. Tepedino, pers. comm. 2006).

Habitat Type

Adult: Terrestrial; warm desert shrub communities on gravelly clay hills.

Habitat Vegetation or Surface Water Classification

Adult: Desert, Shrubland/chaparral;

Tolerance Ranges/Thresholds

Adult: Elevations between 2,480-2,999 feet (ft) (756-914 meters (m)) in areas that drain to the Santa Clara and Virgin rivers; 20% slope or less (USFWS unpubl, data 2005).

Site Fidelity

Adult: High

Habitat Narrative

Adult: *A. holmgreniorum* occurs at elevations between 2,480-2,999 feet (ft) (756-914 meters (m)) in areas that drain to the Santa Clara and Virgin rivers. It is typically found on the skirt edges of hill and plateau formations slightly above or at the edge of drainage areas; it occurs on soils characterized by small stone and gravel deposits and where living cover averages less than 20 percent of the landscape. Runoff received from nearby sloping areas, combined with slower evaporation due to shading produced by the stone and gravel, may increase water availability for the plants in excess of regional rainfall (Harper 1997; Harper and Van Buren 1997). The

species is associated with geological layers or parent materials found within the Moenkopi formation. The majority of plants (approximately 95%) are found on a 20 percent slope or less (USFWS unpubl, data 2005). *A. holmgreniorum* is thinly and discontinuously distributed within its habitat. At the landscape level, the dominant plant community or land cover within which *A. holmgreniorum* occurs is described as Sonora-Mojave Creosotebush-White Bursage Desert Scrub (NatureServe 2003) and, alternatively, as Mohave Mixed Shrub and Mohave Creosote/Bursage habitats (Bennett et al. 2004).

Dispersal/Migration**Motility/Mobility**

Adult: Low

Dispersal

Adult: By water mammals, birds

Dependency on Other Individuals or Species for Dispersal

Adult: Rodents and smaller, ground-dwelling birds are likely dispersal agents as well as water.

Dispersal/Migration Narrative

Adult: *A. holmgreniorum* habitat is dynamic, and within a given locality occupancy and distribution of plants may shift over time. Seeds are thought to be dispersed by water, as the plants are generally found on the skirt edges of washes or in run-off channels around mounds (Van Buren and Harper 2004a). Rodents and smaller, ground-dwelling birds are other likely dispersal agents (S.L. Welsh, Brigham Young University, pers. comm. 2005).

Population Information and Trends**Number of Populations:**

6 populations within 3 major areas of concentration

Population Narrative:

Currently, the species continues to exhibit fluctuating population numbers, influenced by drought and rainfall, and populations and habitat are affected by urban development, ORV use, grazing practices, and an increase of invasive plants coupled with increased intervals in the fire return cycle. The species has restricted distribution and all remaining populations are threatened by one or more of the aforementioned threats. Fluctuating numbers of individuals and low reproductive output, marked by several years of drought (1999-2003), have caused the species to decline (USFWS 2006).

Threats and Stressors

Stressor: Development activities

Exposure: See narrative.

Response: See narrative.

Consequence: See narrative.

Narrative: Development activities result in an irredeemable loss of habitat, unlike invasive species, which may be amenable to control if effective management techniques can be

developed. Land development not only causes direct habitat destruction, it also can result in disturbance of nearby habitat (e.g., through soil disturbance, changes in hydrology, and increased human access), which could in turn set the stage for additional problems with invasive species. Together, habitat loss and disturbance could cause the extirpation of local populations and, through synergistic effects, rangewide extinction. This is an acute problem for the Central Valley population, which coincides with the planning area for a large residential community that will destroy most of the plant's habitat. Some onsite areas are being set aside for the plant, but as planned, these will provide habitat for only a small, isolated portion of the extant population, and there are doubts about the long-term continued viability of this population unless additional and linked habitat preserves can be secured. The acquisition of land and its protection would directly offset population loss and would highly improve recovery scenarios. Unfortunately, habitat conservation through land acquisitions and easements is costly due to sharply increasing property values in the vicinity of St. George.

Stressor: Introduction of invasive plants

Exposure: See narrative.

Response: See narrative.

Consequence: See narrative.

Narrative: Introduction of invasive plants is one of the fastest growing threats for many rare and endangered species, and bringing invasive species under control once they are established has proven to be a difficult issue; however, as long as the soil substrate and seedbank for *A. holmgreniorum* are protected, a remedy to invasive species may be achieved. Just as invasive species affect all known *A. holmgreniorum* populations, so could fires associated with the spread of nonnative invasive species. The spread of fire through vegetation communities occupied by *A. holmgreniorum* has not been a problem in the past and is not an active concern at the present time, but as exotic plant species become more prevalent within the Mojave Desert ecosystem, fire holds the potential to affect this species throughout its range.

Stressor: Drought

Exposure: See narrative.

Response: See narrative.

Consequence: See narrative.

Narrative: Although long-term changes in regional precipitation and temperature regimes may affect the distribution and viability of this and other endemic plant species in the future, much uncertainty remains about climatic trends and the ability of *A. holmgreniorum* to adapt to gradual changes. The primary concern at this point with regard to climate change is the potential for drought -- whether part of a broader climatic trend or not -- to outlast the period over which the species can withstand consecutive years of reduced reproductive output and seedbank depletion. Thus, while climate change is viewed as a potential rather than current threat, drought years warrant close observation for effects on each population. Measures to mitigate loss of reproductive adults and seed output may be necessary on an emergency and ongoing basis.

Stressor: Authorized and unauthorized outdoor activities

Exposure: See narrative.

Response: See narrative.

Consequence: See narrative.

Narrative: Natural resource utilization for outdoor recreation, particularly ORV use, affects all populations; however, human use at one population (Purgatory Flat) has been effectively

controlled with fencing. Other human uses in milk-vetch habitat have included the illegal dumping of household items. Subsequent use of these household items for target practice results in increased litter accumulation from ammunition cartridges. If left unabated, these activities, particularly ORV use in the direct localities of the plants, could cause long-term, irreparable harm. Although known populations of *A. holmgreniorum* could rebound and persist with effective management controls, the required enforcement efforts will be substantial. In addition, the demand for recreational and general access is likely to grow as the regional population increases and land development expands, exerting more pressure on *A. holmgreniorum*.

Stressor: Impacts on pollinators

Exposure: See narrative.

Response: See narrative.

Consequence: See narrative.

Narrative: The presence of pollinators depends on meeting their habitat and foraging requirements, which can be impaired by the same activities that affect the plants. Reduced availability of pollinators could severely reduce *A. holmgreniorum* population viability; thus, impacts on the plants and their pollinators must be considered together.

Stressor: Cattle activities

Exposure: See narrative.

Response: See narrative.

Consequence: See narrative.

Narrative: Impacts associated with cattle include trampling of individual *A. holmgreniorum* plants (R. Van Buren, pers. comm. 2006), as well as the defoliation and removal of palatable plant species, which changes plant community structure, soil compaction, abrasion, and destabilization, and redistribution of soil nutrients and ecological succession (Fleischner 2006; Cole and Landres 1996). The normal grazing period for the River Pasture, containing the State Line population, within the Curly Hollow Allotment is November 1 to January 31; however, due to recent wildfires, adjustments have allowed Spring grazing in River Pasture to allow the restoration of other pastures within this allotment (J. Crisp, BLM, St. George Field Office, pers. comm. 2006). Additionally, the Gardner Well population experiences grazing under a Arizona State grazing lease (Lizard allotment). Soil compaction due to cattle activities, can indirectly impact the soil seedbank. If seedlings cannot emerge from the soils, germination will not occur (R. Van Buren, pers. comm. 2006). Also, soil compaction reduces the ability for moisture to penetrate into soils and thus be available to seeds (R. Van Buren, pers. comm. 2006). Nonetheless, the effects of cattle at the State Line and Gardner Well populations are considered to be of low severity due to undemonstrated potential.

Stressor: Herbicide use

Exposure: See narrative.

Response: See narrative.

Consequence: See narrative.

Narrative: Herbicide use may affect the State Line population due to vegetation control on Interstate highway I-15 (Northwest Economic Associates 2006). Herbicide use within or adjacent to other *A. holmgreniorum* populations has not been documented. The threat of herbicide use is thus localized and of lesser concern with regard to *A. holmgreniorum* survival and recovery. However, it should be noted that threat scenarios can change over time, and all activities thought to pose a current or future threat to the species should be monitored and addressed.

Recovery**Reclassification Criteria:**

When population trends for four out of six extant *A. holmgreniorum* recovery populations are primarily stable or improving, as indicated by species presence, mean occupied habitat, density of occupied habitat, and demographic modeling, over a 20-year period.

When the habitat base for each recovery population is large enough to allow for natural population dynamics, population expansion where needed, and the continued presence of pollinators, with sufficient connectivity to allow for gene flow within and among populations.

Population and habitat management is implemented for all recovery populations in accordance with site-specific management plans.

Delisting Criteria:

Two additional populations of the species are either located or successfully introduced to habitat in proximity to extant populations. Thus, a minimum of eight recovery populations will be needed to delist the species.

The available habitat base for each newly discovered or introduced recovery population is large enough to allow for natural population dynamics, population expansion where needed, and the continued presence of pollinators, with sufficient connectivity to allow for needed gene flow within and among populations.

Population trends for all *A. holmgreniorum* recovery populations are primarily stable or improving, as indicated as indicated by species presence, occupied habitat, density of occupied habitat, and demographic modeling.

Each of the eight *A. holmgreniorum* recovery populations has a post-delisting conservation plan with the species' conservation as a primary objective.

Permanent land conservation is achieved for all recovery populations whether extant or introduced (a minimum of 8 populations), such that Endangered Species Act (ESA) protection is no longer needed to compensate for regulatory inadequacies.

Adverse population-level effects from herbivory, disease, or predation, if any, are identified and abated within all *A. holmgreniorum* recovery populations.

A long-term offsite conservation program is ongoing for all milk-vetch recovery populations.

Recovery Actions:

- Achieve committed land protection to abate impacts and direct habitat loss, in collaboration with various landowners and land management agencies.
- Complete surveys to locate and document presence/absence and conserve identified populations and habitat type.
- Develop a range-wide monitoring plan and protocol.
- Seek funding to provide need-based research aimed at abating or reducing threats.

- Develop propagation techniques for potential population augmentation and/or introduction.
- Continue and increase communications with partners, stakeholders, and the public regarding the milk-vetch's recovery needs and progress.

Conservation Measures and Best Management Practices:

- Habitat conservation through land acquisitions and easements
- Protect soil substrate and seedbank
- Enforcement efforts to control authorized and unauthorized recreational activities and waste disposal.
- Restoration of pasture-land.

References

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USFWS 2006b. *Astragalus holmgreniorum* (Holmgren Milk-Vetch) and *Astragalus ampullarioides* (Shivwits Milk-Vetch) Recovery Plan, September 2006, U.S. Fish and Wildlife Service, Utah Ecological Services, Salt Lake City, UT. 124 p.

U.S. Fish and Wildlife Service. 2006. Endangered and Threatened Wildlife and Plants, Designation of Critical Habitat for *Astragalus ampullarioides* (Shivwits milk-vetch) and *Astragalus holmgreniorum* (Holmgren milk-vetch). Final Rule. 71 FR 77972-78012 (December 27, 2006).

USFWS. 2006b. *Astragalus holmgreniorum* (Holmgren Milk-Vetch) and *Astragalus ampullarioides* (Shivwits Milk-Vetch) Recovery Plan, September 2006, U.S. Fish and Wildlife Service, Utah Ecological Services, Salt Lake City, UT. 124 p.

SPECIES ACCOUNT: *Astragalus humillimus* (Mancos milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/1985; Southwest Region (Region 2) (USFWS, 2016)

Physical Description

The Mancos milkvetch is a diminutive, tufted perennial forming clumps up to 30 cm (12 in) across, that are crowned with a dense aggregation of persistent, spiny leaf stalks. The stems are up to 1 cm (0.4 inch) long, and are crowded with leaves along their entire length. The leaves are up to 4 cm (1.6 in) long, each with 7—11 oval leaflets, 0.7—2.0 mm (0.1 in) in length. Flowers are lavender to purplish with a conspicuous lighter-colored spot in the throat of the corolla tube. The banner is usually 7—10 mm (0.25—0.4 in) long, with the keel and banner petal between 6—8 mm (0.25 in) in length. Fruits are egg shaped, are about 4.5 mm (0.2 in) long and 2 mm (0.1 inch) wide, and each produces 4—9 seeds. Flowers are lavender with white veins and have a sweet-pungent smell. (USFWS, 1989; NatureServe, 2015)

Taxonomy

Astragalus humillimus was first described by Gray in 1876 in the Bulletin of the U.S. Geological Survey. The name was changed to *Tragacantha humillima* by Kuntze (1891), changed again to *Phaca humillima* by Rydberg (1905), and was finally placed in the genus *Astragalus*, Section *Humillimi*, by Barneby (1964). The Mancos milkvetch is most closely related to *A. siliceus* and *A. wittmanii*, and is easily distinguished from these species by its persistent subspinescent petioles. (USFWS, 1989)

Historical Range

Mancos milkvetch is known only from remote semi—arid sandstone rimrock ledges and mesa tops of northwest New Mexico and southwest Colorado. (USFWS, 1989)

Current Range

The known geographic distribution of Mancos milkvetch extends from Mancos Canyon, Colorado, in the north, continuing southward for about 25 miles to just south of the San Juan River in San Juan County, New Mexico. The distribution closely follows a narrow band of Mesozoic sandstone (USFWS, 1989).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (selfing and outcrossing) (NatureServe, 2015)

Breeding Season

Adult: Late April to early May (USFWS, 2011)

Key Resources Needed for Breeding

Adult: Flowers of rare plants, including *A. humillimus*, often require pollination by native bees to produce seeds (Tepedino 2002). Researchers found the most common visitors were two members of the bee family Megachilidae: *Osmia titusi* and *O. sculleni*. Honey bees and butterflies, including the painted lady butterfly (*Vanessa cardui*), were also noted as potential pollinators (Service 1989).

Reproduction Narrative

Adult: *Astragalus humillimus* flowers in late April and early May (Service 1989). Larger plants may produce over 100 flowers in a growing season and fruits mature by mid-June (Service 1989). The fruit is egg-shaped and laterally compressed measuring about 4.5 millimeters (mm) (0.2 in) long and 2 mm (0.1 in) in diameter (Barneby 1964), and each produces 4 to 9 seeds (Service 1989). *Astragalus humillimus* plants produce viable fruit by outcrossing and self-pollination (Tepedino 2002). Flowers of rare plants, including *A. humillimus*, often require pollination by native bees to produce seeds (Tepedino 2002). Researchers found the most common visitors were two members of the bee family Megachilidae: *Osmia titusi* and *O. sculleni*. Honey bees and butterflies, including the painted lady butterfly (*Vanessa cardui*), were also noted as potential pollinators (Service 1989). *A. humillimus* and the closely related *A. cremnophylax* var. *cremnophylax* (sentry milkvetch), appear to have low fecundity (fertility). (USFWS, 2011)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Bare rock/talus/scree, desert, sand/dune (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at an average elevation of 1,854 meters (5,650 ft); vegetative cover is less than 5% (USFWS, 2011)

Spatial Arrangements of the Population

Adult: Scattered (USFWS, 2011)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Habitat Narrative

Adult: This species occurs on sandstone substrate ledges and mesa tops in cracks or shallow bowl-like depressions (tinajas) that accumulate sandy soils and rainfall (Service 1989; New Mexico State Forestry Division 2008). Populations are found along the Colorado Plateau subdivision of the Great Basin Desert of northwestern New Mexico and southwestern Colorado within pinyon-juniper woodland and desert scrub communities (Dick-Peddie 1993). Potential habitat corresponds to rimrock outcrops of the Point Lookout and Cliffhouse members of the Mesa Verde sandstone series with flat or gently sloping surfaces at an average elevation of 1,854 meters (m) (5,650 feet [ft]) (Service 1989). This species is confined to large sheets of exfoliating whitish-tan colored sandstone (New Mexico State Forestry Division 2008) alongside *Fraxinus anomala* (single leaf ash), *Brickellia microphyla* var. *scabra* (scabrous bricklebrush),

Cercocarpus intricatus (small leaf mohagany), and *Ipomopsis roseata* (rosy ipomopsis) (Service 1989). Overall cover is very low (less than five percent), and resource competition for all of these species is minimal (Service 1989). The majority of plants remaining were small to medium in size; dead plants were observed in almost all locations; plants were widely scattered and only a very small fraction of the habitat was occupied in a study in 2008 (Navajo Natural Heritage Program 2008a; Navajo Nation Department of Fish and Wildlife 2009). (USFWS, 2011)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Long-term trends are unknown, whereas short-term trends indicate a decline of >10% (NatureServe, 2015)

Resiliency:

Low (inferred from USFWS, 2011)

Representation:

Low (inferred from USFWS, 2011)

Redundancy:

Low (inferred from USFWS, 2011)

Number of Populations:

12 (USFWS, 2011)

Population Size:

250 - 1000 individuals (NatureServe, 2015)

Adaptability:

Low (inferred from NatureServe, 2015)

Population Narrative:

Long-term population trends are unknown, whereas short-term trends indicate a decline of >10%. Research has shown that this species has low fecundity (USFWS 2011). In addition, there has been no long-term propagation success despite numerous attempts (USFWS 2011). In 2007/2008, less than 400 plants total were found in 12 populations on the Navajo Nation and only 2 of the 12 populations had more than 50 live plants (Navajo Natural Heritage Program 2008, Navajo Nation Department of Fish and Wildlife 2009 cited by USFWS 2011). (USFWS, 2011; NatureServe, 2015)

Threats and Stressors

Stressor: Energy exploration and development (USFWS, 2011)

Exposure:**Response:****Consequence:**

Narrative: The majority of known occupied and potential *A. humillimus* habitat is located on the Navajo Nation lands. Most of this habitat is located on Palmer Mesa and the Hogback areas covering approximately 16,187 ha (40,000 ac) on Navajo Nation lands. These areas contain active and plugged oil and gas wells, including numerous roads associated with these activities. Navajo Nation and BLM lands contain significant deposits of oil and natural gas, and the development of these energy resources in the Four Corners Basin continues to increase (Energy, Minerals, and Natural Resources Department 2008). Nearly all known and potential *A. humillimus* habitat may be affected by natural gas or oil exploration and development. Most damage occurs after vehicles and heavy equipment drive over and crush individual plants as well as break apart sandstone areas that contain tinajas, which are required for *A. humillimus* seedling establishment (Navajo Nation Department of Fish and Wildlife 2009). *Astragalus humillimus* populations and their habitat have been negatively impacted by crushing from vehicles and equipment, direct removal and destruction from energy-related activities, and indirect effects of unauthorized traffic using roads constructed by oil and gas companies. Oil and gas well construction has resulted in a variety of unauthorized roads, multiple pipelines, and small but enduring piles of waste, all of which further degrade *A. humillimus* habitat over the larger landscape. Also, some habitat damage has been reported by Navajo Nation from vandalism associated with theft of copper cables running between oil wells (Navajo Natural Heritage Program 2008b). Thus, we believe oil and gas development remains a severe threat to the species and will likely increase in the foreseeable future. (USFWS, 2011)

Stressor: Transmission lines (USFWS, 2011)

Exposure:**Response:****Consequence:**

Narrative: Transmission lines have likely impacted *A. humillimus* populations because potential habitat and recently surveyed plants have been found along several major transmission line corridors (Ecosphere Environmental Services 2007). A large population of approximately 1,000 plants was bisected by two major transmission lines, the Glen Canyon-Shiprock and the CurecantiShiprock transmission lines, which were constructed in 1962 and 1963 prior to the National Environmental Policy Act taking effect (50 FR 26570). Immediate impacts were complete scraping of topsoil and vegetation directly underneath the power line, thus it is unknown how many plants may have been destroyed. Since that time, any plants underneath and nearby the power line have been driven over by either maintenance vehicles or off-road recreation vehicles. At the time of listing in 1985, no repopulation had occurred, but the most recent survey done by Western Area Power Administration found 71 plants over approximately 45 km (28 mi) of Navajo Nation, State of New Mexico, and BLM lands; total area surveyed was 138 ha (342 ac) (Ecosphere Environmental Services 2007). Impacts are generally associated with maintaining transmission line roads and the associated vehicles that crush plants. Conservation measures recommended in the recovery plan (Service 1989) and the HMP for Navajo Nation lands (House and Engelking 1992), such as avoidance and transplanting, could minimize impacts within the construction footprint of these types of projects. We do not know if these conservation measures were enacted on past projects, and whether they are being implemented currently. Thus, we believe that the ongoing impacts associated with transmission lines could be

severe if they involve *A. humillimus* habitat, but could be easily mitigated by implementing recommended conservation measures along these proposed corridors. (USFWS, 2011)

Stressor: Off-highway vehicles (OHVs) (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Off-highway vehicles (OHVs) were not a threat until recently, but their impacts are now being considered. The recreational use of OHVs has increased dramatically since the plant was listed. This increase is most likely due to the recent expansion of oil and gas extraction and the resultant population growth within San Juan County. From 1980 to 2006, the human population of San Juan county increased by 55 percent (<http://wrdc.usu.edu/htm/publications/>). OHV-related damage to *A. humillimus* and its habitat has increased, especially around oil and gas well pads and transmission line corridor roads (Service 1989; House and Engelking 1992; Bureau of Land Management 2007; Navajo Nation Natural Heritage Program 2007, 2008, and 2008b; Navajo Nation Department of Fish and Wildlife 2009). Unauthorized roads, trails, and recreational OHV use on sandstone cliffs and outcrops have been observed on and near known populations of *A. humillimus* (Bureau of Land Management 2006). For example, surveys undertaken in 2006 on BLM plots found scattered glass and OHV tire marks where 24 plants were found alive and 11 dead; cause of mortality was unknown, but this site is a popular recreational parking area with unrestricted access (Bureau of Land Management 2006). Not only did several plants appear damaged from being crushed, but their micro-habitat (small depressions or tinajas) has been fractured leaving a dearth of required habitat for future seedling establishment. Although most OHV activity is restricted to the southern part of the ACEC (outside of known milkvetch habitat), the potential for impacts still exists (Kendall 2011). Lack of law enforcement continues to be problematic for both BLM and Navajo Nation. We believe that use of OHVs is presently a moderate threat to this species and will likely increase in the foreseeable future. (USFWS, 2011)

Stressor: Predation (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Some insect herbivory by seed weevils and Lepidoptera larvae has been reported (NatureServe 2010), but appears to occur at insignificant levels during favorable rainfall years (New Mexico State Forestry Division 2008). Spider mite infestations have been recorded and appear to kill plants particularly during drought periods when the plant is already stressed (Sivinski and Knight 2001). The mites pierce the epidermis to ingest the sap which results in leaf discoloration and death, weakening the plant even further and causing mortality (Sivinski and Knight 2001). Insect infestations appear to be relatively rare, but could increase if drought continues into the foreseeable future. Thus, insect predation is considered a minor threat at this time. (USFWS, 2011)

Stressor: Pesticide use (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Pesticides are considered a potential threat because they could directly harm a plant, but also could indirectly kill pollinators of *A. humillimus* or their host plants (Service 1989). Herbicides are commonly used for noxious weed control, but no documentation has been provided on whether any *A. humillimus* populations have been directly or indirectly affected. In the Navajo Nation Habitat Management Plan for *A. humillimus* from 1992, agricultural use of pesticides is mentioned in regard to the Navajo Indian Irrigation Project and local Navajo farmers along the San Juan River (House and Engelking 1992). Pesticides, particularly insecticides, are linked to bee declines (Kearns et al. 1998, Kremen et al. 2002, National Academy of Sciences 2007), with the abundance and diversity of wild bee communities negatively correlated with increasingly intensive chemical applications of pesticides (Tuell and Isaacs 2010). Although the toxicity of pesticides to pollinators is challenging to quantify in a field setting and varies depending on the chemistry, quantity applied, degree of contact, area treated, and seasonal timing (Mineau et al. 2008, Tuell and Isaacs 2010), some pesticides cause immediate mortality to bees if applied upon crops while bees are actively foraging (Johansen 1977). Both wild and honey bee (*Apis mellifera*) declines have been found in areas adjacent to sprayed fields, suggesting a wider spatial impact to the pollinator community than just a targeted area (Kevan 1975, Kevan et al. 1990). Furthermore, depending on the seasonal timing of pesticide application, effects to pollinator communities may be chronic and cumulative, yet difficult to assess due to the different phenologies and nesting situations of pollinator species (Desneaux et al. 2007, Tuell and Isaacs 2010). Pesticide application, particularly aerial spraying, occurs in the local agricultural areas to control crop pests in Farmington, New Mexico. Most of the *A. humillimus* populations are miles away, but could be affected by drift if aerial spraying were to occur on Navajo Nation lands, particularly the Navajo Indian Irrigation Project or local Navajo farmers (House and Engelking 1992). There is no information on pesticide use and subsequent monitoring on Navajo lands and local farmers are not monitored. Due to the lack of information, we are uncertain whether pesticides directly or indirectly affect the survival of *A. humillimus*. Thus, we do not consider pesticides to be a threat to this species currently or in the foreseeable future. (USFWS, 2011)

Stressor: Natural processes (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Natural processes such as erosion could account for some mortality, yet they also are responsible for soil deposition in the bedrock depressions that are essential habitat for this species. Since this species is restricted to small and widely dispersed segments of sandstone, the resulting populations are disjunct and scattered. This fragmented distribution impedes gene flow among subpopulations. Without the maintenance of genetic diversity to buffer against stochastic events, the species becomes increasingly vulnerable to external threats. Genetic limitations (low fecundity) and ecological isolation (disjunct and small populations) increase the risk of extinction when considering additional pressure from human impacts as well as stochastic events such as severe drought. (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Based on the unequivocal evidence of warming of the earth's climate from observations of increases in average global air and ocean temperatures, widespread melting of glaciers and polar ice caps, and rising sea levels recorded in the Intergovernmental Panel on Climate Change Report (IPCC 2007), climate change is now a consideration for Federal agency analysis (GAO 2007). The earth's surface has warmed by an average of 0.74 °C (1.3 °F) during the 20th century (IPCC 2007) and, since 1960, the annual average temperature across the United States has increased by more than 2° F (1.1° C) (Global Climate Change Impacts in the United States [GCCIOUS] 2009). The IPCC (2007) projects that there will very likely be an increase in the frequency of hot extremes, heat waves, and heavy precipitation events as a result of climate change. The IPCC projects there will be an increase in the frequency of extreme weather events that are temporally and spatially more variable as a result of climate change (IPCC 2007). *Astragalus humillimus* is likely to have experienced and rebounded from periods of drought in the past. If climate change materializes with increased severity and frequency of drought, it would likely reduce the long-term survivorship of this species. Narrow endemics, like *A. humillimus*, often have very specific habitat requirements. This species has affinity for depressions in the sandstone, suggesting that water is critical for its germination and development, thus climate change could affect its continued existence. We believe the 2008 low population numbers are likely caused by cumulative losses since the 1980s due to several notable drought periods for this region, thus we believe that climate change is a severe threat to this species in the foreseeable future. (USFWS, 2011)

Recovery

Reclassification Criteria:

1. Develop formal documentation of the long—term mineral, oil, gas and energy development potential of the Mancos milkvetch habitat. (USFWS, 1989)
2. Develop habitat management plans to alleviate threats to the species and ensure permanent protection of 75 percent of the known habitat according to steps outlined in this plan. (USFWS, 1989)
3. Census and monitor known populations and establish permanent study plots at these sites. (USFWS, 1989)

The main objective of this recovery plan is to protect *Astragalus humillimus* and manage its essential habitat so that healthy populations can be sustained in their natural habitats. To meet these objectives and to downlist the Mancos milkvetch to threatened, the following actions are required: (USFWS, 1989).

1. Develop formal documentation of the long—term mineral, oil, gas and energy development potential of the Mancos milkvetch habitat (USFWS, 1989).
2. Develop habitat management plans to alleviate threats to the species and ensure permanent protection of 75 percent of the known habitat according to steps outlined in this plan (USFWS, 1989).
3. Census and monitor known populations and establish permanent study plots at these sites (USFWS, 1989).

Delisting Criteria:

Delisting criteria are not available.

Actions identified as necessary for meeting the main objective and for removing *Astragalus humillimus* from the list of threatened or endangered species include: (USFWS, 1989).

1. Demonstrating long—term stability of populations and habitat through at least 10 years of monitoring (USFWS, 1989).
2. Implementing actions that will provide permanent protection for all of the presently known plants and habitat, and 75 percent of any plants and habitat discovered in the future. These actions include: 1) contacting individual landowners or grazing leaseholders and reaching agreements on protecting plants; and 2) implementing management plans that provide guidelines for energy or minerals exploration and development, management of oil spills, chemical spills, or oil and gas well by-products, management of ORV use, and management of pipeline, powerline, and road rights-of-way (USFWS, 1989).

Recovery Actions:

- 1. Demonstrating long—term stability of populations and habitat through at least 10 years of monitoring. (USFWS, 1989)
- 2. Implementing actions that will provide permanent protection for all of the presently known plants and habitat, and 75 percent of any plants and habitat discovered in the future. These actions include: 1) contacting individual landowners or grazing leaseholders and reaching agreements on protecting plants; and 2) implementing management plans that provide guidelines for energy or minerals exploration and development, management of oil spills, chemical spills, or oil and gas well by—products, management of ORV use, and management of pipeline, powerline, and road rights— of-way. (USFWS, 1989)
- Protect existing populations of *Astragalus humillimus* by removing threats to the species and by managing its habitat (USFWS, 1989).
- Study populations in their natural habitat (USFWS, 1989).
- Conduct laboratory studies on the Mancos milkvetch (USFWS, 2011).
- Develop public awareness, appreciation, and support for preservation of Mancos milkvetch (USFWS, 2011).

Conservation Measures and Best Management Practices:

- Revise recovery plan to incorporate new information on biology, ecology, threats, and conservation recommendations (USFWS, 2011).
- Recommend Federal plant permittees report on number of seeds collected over time and status of attempts to germinate (success/failures). Because native seed bank viability and longevity in the field is unknown, knowing how many cumulative seeds are being taken from this rare species could be important to its future regenerative capacity in the field, particularly during drought periods (USFWS, 2011).
- Provide viable *A. humillimus* seeds to a seed bank operating under the Center for Plant Conservation guidelines (USFWS, 2011).
- Continue research on species biology, ecology, reclamation, and transplantation (USFWS, 2011).

- Develop standardized survey and monitoring protocols for this species to be conducted annually by experienced personnel (USFWS, 2011).
- Develop a mitigation banking requirement (a system whereby proponents of projects that may cause harm to *A. humillimus* or its habitat pay for plants to be preserved in an area suitable for their preservation as mitigation for losses incurred during projects) (USFWS, 2011).
- Develop an *A. humillimus* multi-agency working group to share and disseminate information regarding this listed species by promoting education, protection, and recovery actions (USFWS, 2011).
- Work with the BLM Farmington Field Office to develop and implement consistent conservation measures in the Resource Management Plan revision that will avoid and minimize impacts to *A. humillimus* and its habitat from livestock trampling, ORV activities, and energy development. Include protection for all occupied and suitable habitat in the conservation measures (USFWS, 2011).
- Work with the Ute Mountain Ute tribe to encourage and support surveys, monitoring and conservation measures for *A. humillimus* on their land, and development of their management plan to include this species (USFWS, 2011).

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SPECIES ACCOUNT: *Astragalus jaegerianus* (Lane Mountain milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/6/1998; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

Perennial; somewhat woody at the base. Stems often grow in a zigzag pattern, usually up through low bushes. Leaves have 7-15 silvery pubescent linear leaflets. Flowers, 5-15 per stalk, are cream to purple, or lighter with veins of a deeper color. Fruits are pencil-shaped, linear, smooth, and pendant (NatureServe, 2015).

Taxonomy

Astragalus jaegerianus is a member of the pea family (Fabaceae) (USFWS, 2004).

Historical Range

Narrowly endemic to a small area in the Mojave desert, San Bernardino County, California (NatureServe, 2015).

Current Range

Known populations are arrayed more or less linearly along a 32 km long axis that trends in a northeasterly-to-southwesterly direction (USFWS 2004) (NatureServe, 2015). It is restricted in its range to a portion of the west Mojave Desert north of Barstow, in San Bernardino County, CA (USFWS, 2004).

Critical Habitat Designated

Yes; 5/19/2011.

Legal Description

On May 19, 2011, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Astragalus jaegerianus* (Lane Mountain milk-vetch) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in California (76 FR 29108-29129).

Critical Habitat Designation

The critical habitat designation for *Astragalus jaegerianus* included two CHUs in San Bernardino County, California. This species critical habitat encompasses approximately 14,069 acres (ac) (5,693 hectares (ha)) (76 FR 29108-29129).

Paradise Unit The Paradise unit consists of approximately 7,032 ac (2,846 ha). We are designating critical habitat for *Astragalus jaegerianus* on 964 ac (390 ha). Of this, 318 ac (129 ha) is Army-owned land adjacent to the NTC (off Fort Irwin), 237 ac (96 ha) is privately owned land located adjacent to the NTC, and approximately 409 ac (166 ha) is on adjacent Federal lands managed by the Bureau. The remaining 6,068 acres (2,456 ha) within this unit are on Army lands at NTC subject to the INRMP and have been exempted under section 4(a)(3) of the Act (see Exemptions section below). As part of the plan amendments to the CDCA, the Bureau in 2005

designated an area of approximately 1,000 ac (405 ha) as part of the West Paradise Valley Conservation Area. It generally overlaps with the 964 ac (390 ha) in this designation of critical habitat. The boundary of the West Paradise Valley Conservation Area encompasses some Army lands not on NTC and some private inholdings. This unit contains the PBFs essential to the conservation of the species. The unit supports a portion of the Paradise population which is one of the four populations of *Astragalus jaegerianus*. In 2001, approximately 1,667 individuals were observed in this population. The land within this unit supports the granitic soils (PCE 1) and host shrubs (PCE 2) that are necessary for the growth, reproduction, and establishment of *A. jaegerianus* individuals. These granitic soils and host shrubs also provide habitat for (1) the pollinators that visit *A. jaegerianus* flowers that result in the production of seed; (2) seed dispersers (birds, small mammals, and large insects) that carry seed between the coppices of suitable host shrubs; and (3) sites for long-term storage for seedbank of *A. jaegerianus*. The Paradise unit may require special management considerations or protection due to the threats to the species and its habitat posed by: Invasions of nonnative plants such as Sahara mustard (*Brassica tournefortii*) and other plant species that may take over habitat for the species; habitat fragmentation that detrimentally affects plant-host plant and plant-pollinator interactions (i.e., composition and structure of the desert scrub community), leading to a decline in species reproduction and increasing susceptibility to nonnative plant invasion; and vehicles that cause direct and indirect impacts, such as excessive dust, to the plant. Habitat for *Astragalus jaegerianus* in the Paradise unit has been fragmented to a minor extent. We anticipate that, in the future, habitat fragmentation may increase, composition and structure of the plant community may be altered by the spread of nonnative plants, and direct and indirect effects of dust may increase. All of these threats would render the habitat less suitable for *A. jaegerianus*, and special management may be needed to address them.

Coolgardie Unit The Coolgardie unit consists of approximately 13,105 ac (5,303 ha), primarily on Federal lands managed by the Bureau. The designated Coolgardie critical habitat unit overlaps to a great extent with the Bureau's Coolgardie Mesa Conservation Area (CMCA). Of this acreage, approximately 9,479 ac (3,836 ha) are managed by the Bureau, and approximately 964 ac (390 ha) were formerly in private ownership, but have been acquired by the Army since 2005 for the purposes of conservation of *Astragalus jaegerianus*. These lands are not contiguous with the NTC and are not covered under the Army's INRMP. Parcels of private land are scattered throughout this unit and total approximately 2,662 ac (1,077 ha). Some of these parcels may be acquired by the Bureau and added to the CMCA. This unit supports one of only four populations of *A. jaegerianus*. In 2001, surveyors observed 2,014 plants in this population. The land within this unit contains the PBFs essential to the conservation of the species and supports the granitic soils (PCE 1) and host shrubs (PCE 2) that are necessary for the growth, reproduction, and establishment of *Astragalus jaegerianus* individuals. It should be noted that the proposed critical habitat does not include the "donut hole" in the center of the unit, where granitic soils are absent. Within the proposed unit, the granitic soils and host shrubs: (1) Provide habitat for the pollinators that visit *A. jaegerianus* flowers and result in the production of seed; (2) provide habitat for seed dispersers (birds, small mammals, and large insects) that carry seed between the coppices of suitable host shrubs; and (3) provide for longterm seedbank storage for *A. jaegerianus*. The Coolgardie unit may require special management considerations or protection due to the threats to the species and its habitat posed by: Invasions of nonnative plants such as Sahara mustard (*Brassica tournefortii*) and other plant species that may take over habitat for the species; habitat fragmentation that detrimentally affects plant-host plant and plant-pollinator interactions (composition and structure of the desert scrub community), leading to a decline in species

reproduction and increasing susceptibility to nonnative plant invasion; vehicles that cause direct and indirect impacts, such as excessive dust, to the plant; and limited mining activities that can lead to changes in habitat conditions (e.g., decreases in plant cover, and increases in nonnative species). Habitat for *Astragalus jaegerianus* in the Coolgardie unit has been fragmented to a moderate extent from current and historical mining and from off-road vehicle use, and non-native species have been introduced into the area. We anticipate that in the future, habitat fragmentation may increase, and composition and structure of the plant community may be altered by the continued spread of nonnative plants. Due to increased recreational pressure, off-road vehicle use has increased in the past 4 years. All of these threats would render the habitat less suitable for *A. jaegerianus*, and special management may be needed to address them.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Astragalus jaegerianus* critical habitat consists of two components (76 FR 29108-29129):

- (i) Shallow soils at elevations between 3,100 and 4,200 ft (945 to 1,280 m) derived primarily from Jurassic or Cretaceous granitic bedrock, and less frequently on soils derived from diorite or gabbroid bedrock, or on granitic soils overlain by scattered rhyolitic cobble, gravel, and sand.
- (ii) Host shrubs at elevations between 3,100 and 4,200 ft (945 to 1,280 m). The primary host shrubs include, but are not limited to: *Thamnosma montana* (turpentine bush), *Ambrosia dumosa* (burro bush), *Eriogonum fasciculatum* ssp. *Polifolium* (California buckwheat), *Ericameria cooperi* var. *cooperi* (golden bush), *Ephedra nevadensis* (Mormon tea), and *Salazaria mexicana* (paperbag bush) that are usually found in mixed desert shrub communities.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain the features that are essential to the conservation of the species and may require special management considerations or protection. A detailed discussion of threats affecting the PBFs essential to the conservation of *Astragalus jaegerianus*, and that may require special management considerations or protection, can be found in the previous proposed critical habitat designation of April 6, 2004 (69 FR 18018), and the 5- year review (Service 2008, pp. 1–21). In summary, these threats include surface mining, unauthorized OHV recreation, military training activities, competition with nonnative species, and habitat fragmentation. In addition, the Bureau has received interest from wind energy companies that are seeking sites for wind energy development, although no specific plans for the areas occupied by *Astragalus jaegerianus* are currently being considered for any energy development projects. The areas included in this revised critical habitat designation will require some level of management to address the current and future threats to *Astragalus jaegerianus* and to maintain the PBFs essential to the conservation of the species. In units that were occupied at the time of listing and are currently occupied, special management will be needed to ensure that designated habitat is able to provide areas for germination, pollination, reproduction, and sites for the host plants that provide structural support for *A. jaegerianus*; intervening areas that allow gene flow and provide connectivity or linkage within segments of the larger population; and areas that provide basic requirements for growth, such as water, light, and minerals. There will be impacts from military activities on *Astragalus jaegerianus* and its habitat at NTC. We will not discuss these impacts any further, because areas where *A. jaegerianus* occurs on NTC are

being exempted (see Exemptions section below). Army-owned lands in the Paradise and Coolgardie units that are not part of the NTC were purchased for *A. jaegerianus* conservation and will not be impacted by military activities. The designation of critical habitat does not imply that lands outside of critical habitat do not play an important role in the conservation of *Astragalus jaegerianus*. Activities with a Federal nexus that may affect those areas outside of critical habitat, such as surface mining, off-highway vehicle recreation, land transfer programs, and military training activities, are still subject to review under section 7 of the Act, if they may affect *A. jaegerianus*. The prohibitions of section 9 of the Act applicable to plants also continue to apply both inside and outside of designated critical habitat. With respect to plants, section 9 of the Act includes among its prohibitions the import or export of listed species, the removal to possession or malicious damage or destruction of species on areas under Federal jurisdiction, or the removal, damage, or destruction of species in violation of State law (16 U.S.C. 1538(a)(2)).

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual; self-pollination, cross-pollination (USFWS, 2008)

Lifespan

Adult: ~15 years (USFWS, 2008)

Key Resources Needed for Breeding

Adult: High to moderate precipitation (NatureServe, 2015); insect pollinators, soil seed bank (USFWS, 2008)

Reproduction Narrative

Adult: Does not reproduce vegetatively - relies on reproduction by seed. It seems that successful recruitment requires high precipitation in one year, followed by at least moderate precipitation the following year so that germinated seedlings are able to persist (R. Sharifi pers. comm. 2009) (NatureServe, 2015). Estimates from several studies indicate that the maximum lifespan of an individual may be on the order of 15 years, though many will not reach that age (Rutherford, in litt. 2005; Prigge et al. 2006). The most abundant insects observed that are likely effective pollinators included the leaf-cutter and metal leaf-cutter bees (*Anthidium dammersi*, *A. emarginatum*, and *Osmia latisculata*). Under greenhouse conditions, Rundel et al. (2005) found that the number of flowers producing seed resulting from both self-pollination and cross-pollination manipulations was higher (40 and 30 percent, respectively) than the number of flowers producing seed without being pollinated (8 percent); these results support the importance of pollinators in achieving seed production. Because substantial recruitment may be an episodic event that occurs on the order of once every 10 to 15 years, long-term persistence of populations may depend on maintaining sufficient numbers of reproductive individuals to build up a soil seed bank available for the next recruitment event (USFWS, 2008). In favorable years, seed production may be substantial. In unfavorable years, the plants may desiccate prior to flowering or setting seed, or the taproots may remain dormant and not resprout (USFWS, 2004).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Mojave mixed woody scrub, creosote bush scrub (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 950 - 1300 m elevation (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Linear (USFWS, 2008)

Habitat Narrative

Adult: Found within *Larrea tridentata*-*Ambrosia dumosa* (Mojave mixed woody scrub or creosote bush scrub) communities. The plants are almost exclusively found growing up through shrubs or, occasionally, through clumps of dead bunchgrass. Prefers coarse shallow soil underlain by decomposing granite. Associated shrub species include turpentine bush (*Thamnosma montana*), white bursage (*Ambrosia dumosa*), Mormon tea (*Ephedra nevadensis*), Cooper goldenbush (*Ericameria cooperi* var. *cooperi*), California buckwheat (*Eriogonum fasciculatum* var. *polifolium*), brittlebush (*Encelia farinosa* or *E. actoni*), desert aster (*Xylorrhiza tortifolia*), goldenheads (*Acamptopappus spheroccephalus*), spiny hop-sage (*Grayia spinosa*), cheesebush (*Hymenoclea salsola*), winter fat (*Kraschennikovia lanata*), and paper bag bush (*Salazaria mexicana*). Occurs at 950 - 1300 m elevation. Usually found growing within the canopy of a host shrub which provides a climbing support, protection from rabbit herbivory (R. Sharifi pers. comm. 2009), and perhaps a suitable microhabitat for germination (USFWS 2004). A variety of species are used as host shrubs (USFWS 2004) (NatureServe, 2015). The populations are arrayed more or less linearly along a 20-mile-long (32-kilometer) axis. Most individuals occur on shallow, well-drained soils derived from either Jurassic or Cretaceous granitic bedrock (90 percent) or diorite or gabbroid bedrock (9 percent) (Prigge et al. 2000; Charis Corporation 2003b) (USFWS, 2008).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Ants likely play a role in seed dispersal (USFWS 2004) (NatureServe, 2015). Seeds are likely used by small mammals and birds in the area (USFWS, 2008).

Population Information and Trends**Population Trends:**

Decline of <30% to increase of 25% (NatureServe, 2015)

Species Trends:

Declining (USFWS, 2008)

Resiliency:

Low (inferred from USFWS, 2004; see current range/ distribution)

Representation:

Low (inferred from USFWS, 2008)

Redundancy:

Low (inferred from USFWS, 2008)

Number of Populations:

4 (USFWS, 2008)

Population Size:

~5,723 (USFWS, 2008)

Population Narrative:

Declines appear to be related to recruitment difficulties. No evidence as yet supports the idea that this species was once more widespread (USFWS 2004). This species has experienced a long-term decline of <30% to increase of 25% In 1985 a total of 87 plants were counted; in 1989 two additional populations totaling 42 individuals were located; surveys conducted in 1991 resulted in locating a total of six individuals - these surveys combined resulted in a small population estimate, < 160 individuals (USFWS 1992). However, throughout the 1990s, hundreds more plants were found. The cumulative total number of individuals found from all surveys through 2002 was approximately 5,800; more individuals may exist in suitable habitat in the vicinity of counted plants (USFWS 2004). However, the total number of individuals is likely much lower in climatically unfavorable years (NatureServe, 2015). The four general areas in which *Astragalus jaegerianus* occurs comprise approximately 21,400 acres (8,660 hectares), totaling 5,723 individuals. Walker and Metcalf (2005a, 2005b) did not detect genetic variation within or between populations using DNA sequencing within chloroplast and nuclear genomes. The species currently appears to be in a downward trend since 2001 (USFWS, 2008).

Threats and Stressors

Stressor: Habitat destruction and degradation (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Most of the current mining claims are held by members of “mining clubs” that engage in small-scale recreational gold mining. The effects of such surface disturbance are cumulative, even though the size of these mining operations falls below the threshold that would require the claimholder to file a plan of operations, including restoration, with the Bureau. The extent of the overlap between mining claims and patches of *Astragalus jaegerianus* has not been determined. Since the time of listing, unauthorized off-road vehicle use has increased within the Coolgardie and Paradise areas. Although most of the increased use has been dispersed in nature, one area on the west side of Coolgardie sustained a large increase in concentrated use. Training activities are scheduled to commence in the year 2009. These activities will affect approximately 4,600 acres (1,862 hectares) and 20 percent of the known distribution of the species. Due to the nature of the training activities (force-on-force tank maneuvers), habitat for *Astragalus jaegerianus* will likely be adversely affected over a period of years. Pockets of habitat that support *A. jaegerianus* within the Montana-Brinkman and Paradise populations may persist for several decades even after training commences, particularly in portions of the training area that are rocky and where tanks are less likely to go. However, over time, the remaining habitat will become more

fragmented and these individuals will become reproductively isolated from the rest of the population and cease to contribute to the long-term persistence of the species. The Bureau has recently received recent expressions of interest from wind energy companies that are seeking sites for wind energy development; one such inquiry was made concerning the Coolgardie area. The development of wind farms within habitat for *Astragalus jaegerianus* would most likely alter the habitat such that the long-term persistence of the species would be compromised (USFWS, 2008).

Stressor: Fire (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: At the time of listing, the threat of fire due to an increase in fuel load contributed by non-native species was considered a threat, particularly for the Coolgardie population of *Astragalus jaegerianus* due to its closer proximity to human activities, which can be the source of both the increase in non-native species and the ignition source. Nonnative grasses such as schismus (*Schismus* spp.) and bromes (*Bromus* spp.) have been shown to carry fire in the western Mojave Desert (Brooks 1999). Ongoing research supports the theory that desert ecosystems were not adapted to burn frequently, and are unable to regenerate as easily as fire-adapted plant communities (Brooks 1999; U.S. Geologic Survey 2005). An increase in fires would likely alter the composition of the vegetation community and reduce the number of host shrubs available to support *A. jaegerianus* (USFWS, 2008).

Stressor: Low recruitment (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Although the total number of *Astragalus jaegerianus* individuals is much larger than that known at the time of listing, ongoing research indicates that substantial recruitment may occur in only the most favorable years (Rundel et al. 2005). Patches of plants may die out prior to being replaced if the interval between substantial recruitment events is too long. Within the Coolgardie population, patches of plants that were visible in the early 1990s have not been seen in the last 5 years (C. Rutherford, pers. obs. 2006). In addition, in a series of unfavorable years, not only would recruitment be low, but extant plants that are persisting as dormant underground rootstalks would be spending more resources on maintaining vegetative biomass rather than using it for reproduction in the future. In long-term plots, the number of living plants has declined between 1999 and 2005 (Rundel et al. 2005; Sharifi et al. 2006) (USFWS, 2008).

Stressor: Nonnative species (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Non-native plant species have increased in abundance across the Mojave Desert with the increase and spread of human activities. Species including schismus and bromes can occur beneath the canopy of shrubs, or in interspaces between shrubs, and can increase the probability that fires will carry across the desert landscape (Brooks 1999). If fire frequency increases, the shrubs that serve as hosts to *Astragalus jaegerianus* could become less common over time and provide fewer sites for individuals to persist. A second threat to *Astragalus jaegerianus* posed by

non-native grasses is competition for space, light, and nutrients during the seedling stage. Researchers have observed that bromes beneath the shrub canopy were so dense that they had overtaken *A. jaegerianus* seedlings (R. Sharifi, pers. obs. 2006; B. Prigge, pers. obs. 2006; C. Rutherford, pers. obs. 2006), making it unlikely the seedlings would be able to survive to adulthood (USFWS, 2008).

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- Continue to work cooperatively with the Army and the Bureau to ensure that we are supporting them in carrying out monitoring and management actions that have been called for in the Integrated Natural Resources Management Plan and the West Mojave Plan (USFWS, 2008).
- Assess recruitment rates across all four populations. Most of these efforts are currently focused within the Montana-Brinkman population. Comparison of recruitment rates across all populations is important to determine whether low recruitment is a concern at all sites (USFWS, 2008).
- Carry out research on soil seed bank ecology to assist in understanding patch dynamics within each population, including assessment of the presence and abundance of seed banks at all four populations and determination of the longevity and viability of seed (USFWS, 2008).
- Carry out research on short- and long-distance seed dispersal. Determine if small mammals are utilizing and dispersing seed, and if so, the proportion that is consumed (and lost) and the proportion that is cached (USFWS, 2008).
- Store seed from all four populations (including the two genetically different populations at Coolgardie) in a long-term seed-storage facility sponsored by the Center for Plant Conservation, to hedge against local extirpations (USFWS, 2008).

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SPECIES ACCOUNT: *Astragalus lentiginosus* var. *coachellae* (Coachella Valley milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/6/1998; Pacific Southwest Region (R8) (USFWS, 2015)

Physical Description

An erect winter annual or short-lived perennial covered with white-silky hairs. Flowers are deep pink-purple, in a loose or dense 13-25 flowered raceme. Fruits are two-chambered and strongly inflated (NatureServe, 2015).

Taxonomy

A member of the Fabaceae (pea family). *Astragalus lentiginosus* var. *coachellae* (Coachella Valley milk-vetch) was described by Rupert C. Barneby (1964, p. 695) based on a specimen collected in 1913 by Alice Eastwood in Palm Springs, California. *Astragalus lentiginosus* var. *coachellae* is one of 19 varieties of *A. lentiginosus* found in California (Spellenberg 1993, pp. 597 – 598), none of which occur in the same region or habitat types (USFWS, 2009).

Historical Range

Endemic to the Coachella Valley, Riverside County in the southern California portion of the western Sonoran Desert (USFWS, 2009).

Current Range

The spatial distribution of *Astragalus lentiginosus* var. *coachellae* has remained the same since the taxon was listed as endangered in 1998, and at that time the distribution was effectively the same as the known historical distribution of the taxon (USFWS, 2009). Occurs in the Coachella Valley from Cabazon to Salton Sea, Riverside County, California. Also known from one disjunct occurrence 50 miles east in the Chuckwalla Valley (USFWS 2005) (NatureServe, 2015).

Critical Habitat Designated

Yes; 2/13/2013.

Legal Description

On February 13, 2013, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Astragalus lentiginosus* var. *coachellae* (Coachella Valley milk-vetch) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four critical habitat units (CHUs), in California (78 FR 10450-10497).

Critical Habitat Designation

The critical habitat designation for *Astragalus lentiginosus* var. *coachellae* includes four CHUs in Riverside County, California. This species critical habitat encompasses approximately 9,603 acres (3,886 ha) (78 FR 10450-10497).

Unit 1: San Geronio River/Snow Creek System Unit 1 consists of 1,172 ac (474 ha) of Federal land, 61 ac (25 ha) of private land, and 102 ac (41 ha) of local government-owned land in the Coachella Valley, Riverside County. Unit 1 contains approximately 238 ac (96 ha) of unoccupied

fluvial sand transport area associated with the San Gorgonio River and Snow Creek drainages. These areas are being designated under section 3(5)(A)(ii) of the Act, because they are specific areas outside the geographical area occupied by the species at the time of listing and are essential for the conservation of the species. The remainder of Unit 1 consists of approximately 1,097 ac (444 ha) of occupied suitable habitat extending approximately from the eastern edge of the community of Cabazon to just west of Whitewater River, and is approximately bound by State Route 111 to the north and the foot of the San Jacinto Mountains to the south. These areas are being designated under section 3(5)(A)(i) of the Act, because they are within the geographical area occupied by the species at the time of listing and contain those physical or biological features essential to the conservation of the species. In total, Unit 1 consists of 1,335 ac (540 ha) of land. Unoccupied fluvial sand transport areas in this unit contain active washes associated with San Gorgonio River and Snow Creek, which carry substrates created by fluvial erosion of the surrounding hills to occupied fluvial deposition areas in Unit 1 on the valley floor (Griffiths et al. 2002, pp. 10–11). The unoccupied areas in Unit 1 are essential for the conservation of *Astragalus lentiginosus* var. *coachellae* because they support the fluvial sand transport process crucial to the maintenance of the sand formations that form the foundation of *A. l.* var. *coachellae* habitat in the occupied areas of Unit 1. Occupied habitat areas of Unit 1 constitute one of the four main habitat areas supporting *Astragalus lentiginosus* var. *coachellae* (Coachella Valley MSHCP/NCCP, p. 9–21) and contain the physical or biological features essential to the conservation of *A. l.* var. *coachellae*, including active sand dunes, sand fields, and stabilized and partially stabilized sand fields that provide substrate components and conditions suitable for the growth of *A. l.* var. *coachellae* (Coachella Valley MSHCP/ NCCP 2008, Table 10–1a) and areas over which unobstructed aeolian sand transport can occur. The essential features in Unit 1 may require special management considerations or protection to address threats from nonnative invasive plants and unauthorized OHV activity in the occupied areas and threats from alteration of stream flow in the unoccupied areas that impact habitat in the occupied areas. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to *A. l.* var. *coachellae* habitat and potential management considerations. The physical or biological features in the occupied areas in Unit 1 are also essential to the conservation of *Astragalus lentiginosus* var. *coachellae* because they support the westernmost occurrences of the taxon. Because of their geographic location, these plants and their habitat receive more rainfall than occurrences and suitable habitat farther east, which allows many individuals to survive more than one year, grow larger, and produce more seed, all of which promote the stability and reduce the chance of extirpation of the occurrences in this unit (Meinke et al. 2007, p. 33). Also, due to strong winds moving through this area from the west to east, the occupied habitat in Unit 1 likely acts as a source of seed (and hence, a source of genetic diversity) for areas of suitable habitat to the southeast (Meinke et al. 2007, p. 40). Unit 1 likely also contributes to the maintenance of genetic diversity in other occupied areas through the movement of pollinators (Meinke et al. 2007, p. 37).

Unit 2: Whitewater River System Unit 2 consists of 1,955 ac (791 ha) of Federal land; 19 ac (8 ha) of private land; and 176 ac (71 ha) of local government-owned land in the Coachella Valley, Riverside County. Unit 2 contains approximately 554 ac (224 ha) of unoccupied fluvial sand transport areas associated with the Whitewater River watershed. These areas are being designated under section 3(5)(A)(ii) of the Act because they are specific areas outside the geographical area occupied by the species at the time of listing and are essential for the conservation of the taxon. The remainder of Unit 2 consists of approximately 1,596 ac (646 ha) of occupied suitable habitat and is approximately bound by State Route 111 to the west, the

Southern Pacific Railroad to the north and east, and dense urban development in the cities of Palm Springs and Cathedral City to the south. These areas are being designated under section 3(5)(A)(i) of the Act because they are within the geographical area occupied by the species at the time of listing and contain those physical or biological features essential to the conservation of the species. In total, Unit 2 consists of 2,150 ac (870 ha) of land. Unoccupied fluvial sand transport areas in this unit contain active washes associated with Whitewater River, which carry substrates created by fluvial erosion of the surrounding hills to occupied fluvial deposition areas in Unit 2 on the valley floor (Griffiths et al. 2002, pp. 10–11). The unoccupied areas in Unit 2 are essential for the conservation of *Astragalus lentiginosus* var. *coachellae* because they contain portions of the Whitewater River that support the fluvial sand transport process crucial to the maintenance of the sand formations that form the foundation of *A. l.* var. *coachellae* habitat in the occupied areas of Unit 2. Occupied habitat areas of Unit 2 constitute one of the four main habitat areas supporting *Astragalus lentiginosus* var. *coachellae* (Coachella Valley MSHCP/NCCP, p. 9–21) and contain the physical or biological features essential to the conservation of *A. l.* var. *coachellae*, including active and ephemeral sand fields and stabilized and partially stabilized sand fields that provide substrate components and conditions suitable for the growth of *A. l.* var. *coachellae* (Coachella Valley MSHCP/NCCP 2008, Table 10–1a) and areas over which unobstructed aeolian sand transport can occur. The essential features in Unit 2 may require special management considerations or protection to address threats from nonnative plants, urban development, alteration of stream flow, unauthorized OHV activity in the occupied depositional areas, and threats from alteration of stream flow that impact habitat in occupied areas. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to *A. l.* var. *coachellae* habitat and potential management considerations. The physical or biological features in the occupied areas in Unit 2 are also essential to the conservation of *Astragalus lentiginosus* var. *coachellae* because they serve as a corridor between the habitat and occurrences to the west in Unit 1 and the habitat and occurrences to the east in Unit 3. Although Unit 2 does not serve as a substantial source of aeolian sand to Unit 3 relative to the onsite fluvial sand transport areas in Unit 3 (Mission Creek and Morongo Wash), it may serve as a corridor for gene flow by means of pollen and seed dispersal between Units 1, 2, and 3 due to dispersal of seeds from Unit 1 into Unit 2 and from Unit 2 into Unit 3, combined with movement of pollinators among the three units (Meinke et al. 2007, p. 37).

Unit 3: Mission Creek/Morongo Wash System Unit 3 consists of 502 ac (203 ha) of Federal land, 1,497 ac (606 ha) of private land, and 268 ac (108 ha) of local government-owned land in the Coachella Valley, Riverside County. Unit 3 contains approximately 1,055 ac (427 ha) of unoccupied fluvial sand transport area associated with the Mission Creek watershed and a portion of the Morongo Wash watershed (north of Pierson Boulevard). These areas are being designated under section 3(5)(A)(ii) of the Act because they are specific areas outside the geographical area occupied by the species at the time of listing and are essential for the conservation of the taxon. The remainder of Unit 3 consists of approximately 1,211 ac (490 ha) of occupied habitat and includes sand deposits on the floodplain terraces of Morongo Wash south of Pierson Boulevard, and fluvial depositional areas and aeolian transport and depositional areas approximately bound (clockwise from the western boundary) by Little Morongo Road, 18th Avenue, Palm Drive, 20th Avenue, Artesia Road, and Mihalyo Road, in or near the City of Desert Hot Springs. These areas are being designated under section 3(5)(A)(i) of the Act, because they are within the geographical area occupied by the species at the time of listing. In total, Unit 3 consists of 2,313 ac (936 ha) of land. Unoccupied fluvial sand transport areas in this unit contain

active washes associated with Mission Creek and Morongo Wash (north of Pierson Boulevard), which carry substrates created by fluvial erosion of the surrounding hills to occupied fluvial deposition areas in Unit 3 on the valley floor (Griffiths et al. 2002, pp. 10–11). The unoccupied areas in Unit 3 are essential for the conservation of *Astragalus lentiginosus* var. *coachellae* because they contain portions of Mission Creek and Morongo Wash that support the fluvial sand transport process crucial to the maintenance of the sand formations that form the foundation of *A. l.* var. *coachellae* habitat in the occupied areas of Unit 3. Occupied habitat areas of Unit 3 constitute one of the four main habitat areas supporting *Astragalus lentiginosus* var. *coachellae* (Coachella Valley MSHCP/NCCP, pp. 9–21–9–22) and contain the physical or biological features essential to the conservation of *A. l.* var. *coachellae* including stabilized and partially stabilized sand dunes, active and ephemeral sand fields, stabilized and partially stabilized sand fields, fluvial sand deposits on floodplain terraces of active washes (certain areas of Morongo Wash), and mesquite hummocks that provide substrate components and conditions suitable for the growth of *A. l.* var. *coachellae* (Coachella Valley MSHCP/ NCCP 2008, Table 10–1a). Unit 3 also contains areas over which unobstructed aeolian sand transport can occur. The essential features in Unit 3 may require special management considerations or protection to address threats from nonnative plants, urban development, OHV use in the occupied floodplain terrace areas, and threats from alteration of stream flow that impact habitat in occupied areas. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to *A. l.* var. *coachellae* habitat and potential management considerations. The physical or biological features in occupied areas in Unit 3 are also essential to the conservation of *Astragalus lentiginosus* var. *coachellae* because they support the northernmost extent of the taxon's range and large occurrences containing high densities of the taxon. Each of these factors contributes to the overall genetic diversity of *A. l.* var. *coachellae* (Meinke et al. 2007, p. 35) and the maintenance of genetic diversity via the movement of seeds and pollinators (Meinke et al. 2007, p. 37). The large numbers of individuals also likely contribute numerous seeds to the soil seed bank. Unit 3 also contains the only area where *A. l.* var. *coachellae* is known to occur in large numbers on floodplain terraces of an active wash (Morongo Wash).

Unit 4: Thousand Palms System Unit 4 consists of 3,670 ac (1,485 ha) of Federal land, and 182 ac (74 ha) of private land in the Coachella Valley, Riverside County. Unit 4 contains approximately 206 ac (83 ha) of unoccupied lands supporting fluvial sand transport and fluvial deposition (this unit contains alluvial sand deposition areas that are not occupied) associated with drainages originating in the Indio Hills. These areas are being designated under section 3(5)(A)(ii) of the Act because they are specific areas outside the geographical area occupied by the species at the time of listing and are essential for the conservation of the species. The remainder of Unit 4 consists of approximately 3,646 ac (1,475 ha) of occupied habitat area in the Thousand Palms Preserve along Ramon Road. These areas are being designated under section 3(5)(A)(i) of the Act because they are within the geographical area occupied by the species at the time of listing and contain those physical or biological features essential to the conservation of the species. In total, Unit 4 consists of 3,851 ac (1,559 ha) of land. Unoccupied areas in this unit contain active ephemeral washes that carry substrates from alluvial deposits to alluvial fan areas where they can be transported to occupied habitat areas via wind (Lancaster et al. 1993, p. 28). The unoccupied areas in Unit 4 are essential for the conservation of *Astragalus lentiginosus* var. *coachellae* because they contain alluvial sand deposits that support the fluvial and aeolian sand transport processes crucial to the maintenance of the sand formations that form the foundation of *A. l.* var. *coachellae* habitat in the occupied areas of Unit 4. Occupied habitat areas of Unit 4 constitute one of the four main habitat areas supporting *Astragalus lentiginosus* var. *coachellae* (Coachella Valley MSHCP/NCCP,

p. 9–22) and contain the physical or biological features essential to the conservation of *A. l. var. coachellae*, including active dunes, active sand fields, and mesquite hummocks that provide substrate components and conditions suitable for the growth of *A. l. var. coachellae* (Coachella Valley MSHCP/NCCP 2008, Table 10–1a), and areas over which unobstructed aeolian sand transport can occur. The essential features in the occupied portion of Unit 4 may require special management considerations or protection to address threats from nonnative plants. According to Meinke et al. (2007, p. 18), this area supports infestations of *Brassica tournefortii* (Saharan mustard); researchers observed thousands of acres of *A. l. var. coachellae* habitat inundated with dense populations of this nonnative plant species. Existing suburban development may require active management measures (for example, collection of sand from developed areas for redistribution within the wind movement corridor). The expansion of new urban development in areas supporting fluvial sand transport and deposition is also a threat to the essential features in this unit that may require special management considerations or protection, as are unauthorized OHV activity and a proposed flood control project that could disrupt or permanently destroy the sand transport system in the Thousand Palms area by diverting drainages that provide sand to occupied areas during large flooding events. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to *A. l. var. coachellae* habitat and potential management considerations. The physical or biological features in the occupied areas of Unit 4 are also essential to the conservation of the species because they support occurrences containing large numbers of the taxon that contribute to the overall genetic diversity of *Astragalus lentiginosus var. coachellae* (Meinke et al. 2007, p. 35) and because they are located in the southeasternmost portion of the taxon's range that is hydrologically independent and physically isolated from the other units. As such, this unit is important to help buffer excessive losses in other parts of the range.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Astragalus lentiginosus var. coachellae* critical habitat consists of three components (78 FR 10450-10497):

- (i) They are active sand dunes, stabilized or partially stabilized sand dunes, active or stabilized sand fields (including hummocks forming on leeward sides of shrubs), ephemeral sand fields or dunes, and fluvial sand deposits on floodplain terraces of active washes.
- (ii) They are found within the fluvial sand depositional areas, and the aeolian sand source, transport, and depositional areas of the sand transport system.
- (iii) They comprise sand originating in the hills surrounding Coachella Valley and alluvial deposits at the base of the Indio Hills, which is moved into the valley by water (fluvial transport) and through the valley by wind (aeolian transport).

Special Management Considerations or Protections

Special management considerations or protection of the essential physical or biological features within critical habitat areas are needed to address the threats posed to *Astragalus lentiginosus var. coachellae* habitat by urban and recreational development. Management actions that could ameliorate these threats include, but are not limited to: Protection of lands that support suitable habitat and associated sand transport systems and siting future development such that disruption of fluvial and aeolian sand transport processes is minimized and deposition areas are

preserved. These management actions will protect the essential physical or biological features for the taxon by decreasing the direct loss of habitat to development and by helping to maintain the sand transport system and sand deposition areas that together provide the sand formations that are necessary components of *A. l. var. coachellae* habitat

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual: self-pollination (USFWS, 2009); cross-pollination (inferred from USFWS, 2009)

Lifespan

Adult: 1 - 2+ years (USFWS, 2009)

Breeding Season

Adult: December - April (USFWS, 2009)

Key Resources Needed for Breeding

Adult: Soil seed bank, insect (especially bee) pollinators (USFWS, 2009), winter rains (USFWS, 2004)

Reproduction Narrative

Adult: *Astragalus lentiginosus* var. *coachellae* seeds germinate in fall to early winter (Meinke et al. 2007, p. 46). Seasonally dormant root crowns (i.e., the point at which the root and stem of a plant meet) sprout new shoots in December - January. The date of first flowering may be as early as December in perennial plants, but usually not until January or February for plants in their first year, and continues into April (Meinke et al. 2007, p. 6). Plants in the northwestern portion of the range where rainfall is higher may survive into their second year or longer, while plants that occur in the southeastern extent of the range which receives less rain are primarily annuals (Meinke et al. 2007, p. 31). *Astragalus lentiginosus* var. *coachellae* populations can survive prolonged drought periods as dormant seeds (seed bank) (Sanders and Thomas Olsen Associates 1996, p. 3) in the soil, so the numbers of above ground plants at any given time is only a limited and partial indication of population size. *Astragalus lentiginosus* var. *coachellae* is genetically self-compatible (i.e., capable of producing viable seeds from the union of pollen and ovules from the same plant), although it is only minimally autogamous (self pollinating) (Meinke et al. 2007, pp. 36 – 37). Experiments demonstrate that seed production in *Astragalus lentiginosus* var. *coachellae* is highly dependent on pollinators. Bees in the family Megachilidae are known to visit flowers of *Astragalus lentiginosus* taxa. The primary pollinator of *Astragalus lentiginosus* var. *coachellae* in some instances may be nonnative honeybees (*Apis mellifera*) (Meinke et al. 2007, p. 36) (USFWS, 2009). *Astragalus lentiginosus* var. *coachellae* seeds germinate in response to winter rains (White 2004). Also in response to these winter rains, seasonally dormant root crowns (the point at which the root and stem of a plant meet) sprout new shoots (USFWS, 2004).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Creosote bush scrub, sand dune (NatureServe, 2015); alluvial washes (USFWS, 2004)

Dependencies on Specific Environmental Elements

Adult: Aeolian sand transport system (USFWS, 2009); suitable flooding regime (USFWS, 2004)

Habitat Narrative

Adult: Sandy areas in washes and sometimes on dunes in creosote bush scrub or in blow sand areas around valley margins (NatureServe, 2015). *Astragalus lentiginosus* var. *coachellae* is strongly affiliated with active, stabilized, and shielded sandy substrates (Sanders and Thomas Olsen Associates 1996). Most of the sandy habitat suitable for *A. lentiginosus* var. *coachellae* is generated from aeolian sand derived from alluvial fans and floodplains. The distribution, maintenance, and morphology of sand dunes in the Coachella Valley that support *A. lentiginosus* var. *coachellae* depend upon adequate sand sources and an intact aeolian sand transport system that is not blocked by structures or windbreaks. Active sand dunes are an important habitat type for *Astragalus lentiginosus* var. *coachellae* and are generally characterized as almost barren expanses of moving sand where few perennial shrub species survive. *Astragalus lentiginosus* var. *coachellae* also occur in localized patches of aeolian sand or along active washes that are, in some cases, fairly distant from large dunes or sand field areas (USFWS GIS data) (USFWS, 2009). *Astragalus lentiginosus* var. *coachellae* is found on loose windblown sands in dunes and flats, and in sandy alluvial washes. This species requires suitable flooding regimes to transport unconsolidated sands from rivers and tributaries to the alluvial fans (USFWS, 2004).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Fruits of *A. lentiginosus* var. *coachellae* are inflated, an apparent adaptation for being dispersed by wind (USFWS, 2009). At maturity, the pods dry and fall to the ground, where they are then dispersed by wind (USFWS, 2004).

Population Information and Trends**Population Trends:**

Unknown (USFWS, 2009)

Resiliency:

Low (inferred from USFWS, 2004)

Representation:

High (inferred from USFWS, 2009)

Redundancy:

High (inferred from NatureServe, 2015)

Number of Populations:

~34 (NatureServe, 2015)

Population Size:

Unknown (USFWS, 2009)

Adaptability:

Low (inferred from NatureServe, 2015)

Population Narrative:

Population sizes vary widely from year to year, depending on environmental conditions. Surveys for the plant in 1987, a drought year, resulted in the location of less than 300 individuals. Annual monitoring of 1 population showed a drop from 209 individuals in 1979 to 2 individuals in 1982. At sites monitored in 1995, densities varied from 1.25 plants per hectare to 60 plants per ha (Fish and Wildlife Service 1998). Approximately 34 occurrences observed since 1989 (CNDDDB 2008). Small population sizes, particularly in drought years, leave the Coachella Valley milk-vetch vulnerable to extinction from stochastic events (NatureServe, 2015). Detecting changes in numbers of individuals of *A. lentiginosus* var. *coachellae* and demographic trends over time is difficult because the number seeds in a given area that germinate and produce standing plants can vary widely from year to year depending on environmental conditions (Sanders and Thomas Olsen Associates 1996, p. 3). Additionally, the number of standing plants at any given time is only a partial indication of population size because the other portion of the population is the seed bank in the substrate that can persist dormant for a number of years (Sanders and Thomas Olsen Associates 1996, p. 3). A great deal of genetic variation has been observed between *A. lentiginosus* var. *coachellae* individuals, possibly due to the apparently long-lived seed bank of the taxon, which may result in grossly overlapping generations (i.e., young seeds and much older seeds germinating contemporaneously) (Knaus pers. comm. 2008). *Astragalus lentiginosus* var. *coachellae* continues to exist in the Coachella Valley, although population estimates are unknown (USFWS, 2009). Its distribution in the Coachella Valley area roughly spans from just east of Cabezon to the dunes off Washington Avenue, north and west of Indio. The occurrences in the Chuckwalla Valley are all along a 5-mile stretch of Highway 177 just north of Desert Center (USFWS, 2004).

Threats and Stressors

Stressor: Development (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Coachella Valley has experienced significant growth since the 1970s. The projection of a population of 500,000 people by 2010 in the listing rule (USFWS 1998, p. 53605) is close to current projections of approximately 418,300 people by the year 2010 and 518,500 by 2010 forecasted by the Southern California Association of Governments and provided in the Coachella Valley MSHCP (Coachella Valley MSHCP 2007, Table 2-1, p. 2-2). This predicted growth suggests urban and commercial/industrial development pressures will continue to rise within the extant range of *A. lentiginosus* var. *coachellae*. Development continues to result in direct or indirect impacts to *Astragalus lentiginosus* var. *coachellae* habitat. Direct impact includes loss of habitat by conversion of the sandy substrates to development. Development activities indirectly impact habitat through alteration of the wind sand transport systems of wind, and modifications of flood scour and sediment deposition patterns. These impacts, in turn, ultimately diminish the amount and distribution of sand available to maintain habitat for the species, and diminish the amount and ecological functions of sandy habitats themselves (causes of habitat degradation). Direct loss

of *Astragalus lentiginosus* var. *coachellae* habitat results when essential habitat features are displaced by structures, roads, or landscaping. These losses include complete loss of specific habitat types necessary for germination and survival of future cohorts of *A. lentiginosus* var. *coachellae* as well as the mortality of any plants and seeds in the seed bank occupying the developed former habitat. Development of *A. lentiginosus* var. *coachellae* habitat has continued since the taxon was listed in 1998, although many of these development projects have been subject to consultation under section 7 of the Act (Service files). Structures, percolation ponds, utility substations, spoil piles and levees, road fill, and windrows associated with development have been constructed or planted within most of the sand source and sand transport corridors remaining in the Coachella Valley. This development has artificially stabilized, confined, re-directed, or blocked the majority of fluvial or aeolian sand that previously would have moved freely southeasterly down the valley. Therefore, the continued replenishment of blow sand in *Astragalus lentiginosus* var. *coachellae* habitat has been greatly reduced or prevented in many areas. Mesquite hummocks contribute to the creation and stabilization of sand dunes and sand fields by anchoring dunes and making them less vulnerable to wind erosion. The honey mesquite shrubs associated with the Banning Fault are senescent, degraded, and appear to be dying along its western extent (between Mission Creek and Morongo Wash), likely due to ongoing artificial lowering of groundwater levels in the subbasin to provide water for human use (Mission Springs Water District 2008); they are predicted to be effectively dead by 2016. Loss of the mesquite hummocks may lead to the erosion of blow sand deposits, therefore affecting *Astragalus lentiginosus* var. *coachellae* habitat created/maintained by the trapping of blow sand (USFWS, 2009).

Stressor: Nonnative plants (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Invasive, nonnative plant species can potentially affect *A. lentiginosus* var. *coachellae* habitat by stabilizing loose sediments in otherwise unsuitable locations and obstructing transport of sediment to occupied habitat downwind. Nonnative plants, in particular the annual *Brassica tournefortii*, potentially pose a significant threat to *Astragalus lentiginosus* var. *coachellae*. *Brassica tournefortii* has invaded most suitable habitat occupied by *A. lentiginosus* var. *coachellae* in the Coachella Valley, and in years when precipitation has been high, dense populations of *B. tournefortii* have been found in reserve areas vital to the persistence of *A. lentiginosus* var. *coachellae* (Meinke et al 2007, p. 51). *Brassica tournefortii* populations reproduce prolifically and create large, long-lived seed banks which sustain populations through dry years, and make eradication of the species effectively impossible (Meinke et al 2007, p. 64). In addition to competition for space, nonnative plants that germinate and grow more readily even in dryer years may also directly compete with *A. lentiginosus* var. *coachellae* for water (USFWS, 2009).

Stressor: Off-highway vehicles (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Off-highway vehicle use continues to threaten the taxon and its habitat, although control of unauthorized OHV use in habitat occupied by *Astragalus lentiginosus* var. *coachellae* has recently improved through stepped-up local enforcement. Habitat effects of OHV use include

disruption of soil hydrology and changes in plant community composition (USFWS 2008a, p. 8766). Off-highway vehicle use also impacts *A. lentiginosus* var. *coachellae* by directly damaging plants and seed (USFWS, 2009).

Stressor: Predation (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Predation of *Astragalus lentiginosus* var. *coachellae* seeds was documented in a 2005/2006 study (Meinke et al. 2007, p. 40). The most commonly observed larval seed predators were a chalcid wasp (*Bruchophagus mexicanus*) and seed beetles (*Brucidae*; genus *Acanthoscelides*). Additionally, weevil larvae (*Curculionidae*; possibly genus *Tychius*) and stinkbug nymphs (*Pentatomidae*; genus *Chlorochora*) were believed to feed on ovules and seeds in pods (Meinke et al. 2007, pp. 40 – 43). Larval predation of ovules and seeds may result in the destruction of a sizable proportion of the annual seed output for *A. lentiginosus* var. *coachellae*. For example, in 2005 and 2006, 78.4 percent and 64.2 percent, respectively, of mature pods sampled by Meinke et al. (2007, p. 43) had been impacted by at least one larval seed predator, all of which were native species. Mammal herbivory on *Astragalus lentiginosus* var. *coachellae* leaves and green seed pods was also observed (Meinke et al. 2007, pp. 43 – 44). Herbivory by mammals (possibly rabbits and ground squirrels) was more prevalent in 2006 than 2005, possibly because 2006 was a drier year and forage was at a premium. Destruction and presumed predation of green seed pods (most likely by ground squirrels and/or kangaroo rats) though uncommon overall, was also observed more often in 2006. Herbivory likely decreases the survival and reproductive potential of the plants and therefore input to the seed bank (USFWS, 2009).

Stressor: Disease (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: An unidentified fungal or viral disease was observed to infect *Astragalus lentiginosus* var. *coachellae* during 2005, possibly due to the wetter, cooler weather conditions (the disease was not observed in 2006; Meinke et al. 2007, p. 45). The disease caused all flowers on infected racemes to wilt, which prevented pollination and production of fruit, and at times killed the entire plant (Meinke et al. 2007, p. 45) (USFWS, 2009).

Stressor: Habitat fragmentation (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: As habitat for the taxon becomes increasingly fragmented by urban development, remaining populations become more vulnerable to edge effects at the habitat/development interface. Impacts often thought to increase edge effects include: disturbance caused by OHV use, roadside maintenance or subsequent paving/landscaping, and nonnative plant invasions that may accompany such activities (USFWS 2008c, p. 30). Fragmentation increases the potential for stochastic events to detrimentally affect long-term survival of smaller or more isolated occurrences. Similarly, fragmentation decreases the taxons' resilience to rebound from periodic or local extinctions (USFWS 2008c, p. 17). Seed dispersal and pollinator movement can be inhibited by habitat fragmentation or degradation. *Astragalus lentiginosus* var. *coachellae*

depends on insect pollinators and wind dispersal of fruits and habitat fragmentation poses a significant threat to the populations of *A. lentiginosus* var. *coachellae* by diminishing the opportunities for these actions (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: A trend of warming in the mountains of western North America is expected to decrease snowpack, hasten spring runoff, and reduce summer stream flows, and increased summer heat may increase the frequency and intensity of wildfires (IPCC 2007). While it appears reasonable to assume *Astragalus lentiginosus* var. *coachellae* may be affected, the Service lacks sufficient certainty regarding how and when climate change will affect the species and the extent of average temperature increases in California (USFWS, 2009).

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- Work with partners and identify opportunities through the Service's Partners for Fish and Wildlife Program to seek habitat management, restoration, and enhancement opportunities for *Astragalus lentiginosus* var. *coachellae* (USFWS, 2009).
- Determine the magnitude of the threat posed to *Astragalus lentiginosus* var. *coachellae* and its habitat from nonnative plants, especially *Brassica tournefortii* (Sahara mustard), and effective management options (USFWS, 2009).
- Determine the identity of native *Astragalus lentiginosus* var. *coachellae* pollinators, their ecology, and management needs. a. Incorporate management of native pollinators and their habitat into management strategies for *A. lentiginosus* var. *coachellae*. b. Determine threshold habitat conditions for *Astragalus lentiginosus* var. *coachellae* and its pollinators to include occupancy patterns (USFWS, 2009).
- Implement a system for tracking *Astragalus lentiginosus* var. *coachellae* habitat losses (or habitat degradation), and gains due to permanent conservation (USFWS, 2009).
- Develop a Recovery Plan for *Astragalus lentiginosus* var. *coachellae* that would coordinate and direct survey and research actions beneficial to species recovery and that will reduce or eliminate threats to the species. Include occurrence map with risk assessment (USFWS, 2009).

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SPECIES ACCOUNT: *Astragalus lentiginosus* var. *piscinensis* (Fish Slough milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Threatened; Pacific Southwest (R8) (USFWS, 2016)

Physical Description

A perennial herb with a few hairy, branched, prostrate stems radiating from a central rootstock. Stems can be as long as 1 m and individual plants can occupy a 2.7 square m area. Leaves have only 3-5 leaflets, the terminal leaflet elongated. Loose clusters of pale lavender flowers bloom in late spring. Fruits are brightly mottled, strongly inflated, leathery pods, with a complete septum and an incurved beak (NatureServe, 2015)

Taxonomy

Astragalus lentiginosus var. *piscinensis* was described by Barneby (1977) based on a collection made by Mary DeDecker in 1974, from BLM Spring, Fish Slough, northwest of Bishop, California. Spellenberg (1993) retained this variety in his treatment of *Astragalus* for the Jepson Manual, and no other changes in taxonomic classification or nomenclature have been made since then. (USFWS, 2009)

Current Range

Restricted to a 10-mile stretch of alkaline flats paralleling Fish Slough, Mono County, California. (NatureServe, 2015)

Critical Habitat Designated

Yes; 6/9/2005.

Legal Description

On June 9, 2005, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Astragalus lentiginosus* var. *piscinensis* (Fish Slough milk-vetch) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in California (70 FR 33774-33795).

Critical Habitat Designation

The critical habitat designation for *Astragalus lentiginosus* var. *piscinensis* includes one CHU Mono and Inyo Counties, California. In total, approximately 8,007 acres (ac) (3,240 hectares (ha)) fall within the boundary of the critical habitat designation (70 FR 33774-33795).

Mono Counties, California. From USGS 1:24,000 quadrangle maps Chidago Canyon and Fish Slough, California.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Astragalus lentiginosus* var. *piscinensis* critical habitat consists of four components (70 FR 33774-33795):

- (i) Alkaline soils that occur in areas with little or no slope, and which overlay a groundwater table that is 19 to 60 in (48 to 152 cm) below the land surface;
- (ii) Plant associations dominated by *Spartina-Sporobolis*, or where a sparse amount of *Chrysothamnus albidus* occurs in the transition zone between *Spartina-Sporobolis* and *Chrysothamnus albidus-Distichlis* plant associations;
- (iii) The presence of pollinator populations for *Astragalus lentiginosus* var. *piscinensis*; and
- (iv) Hydrologic conditions that provide suitable periods of soil moisture and chemistry for *Astragalus lentiginosus* var. *piscinensis* germination, growth, reproduction, and dispersal.

Special Management Considerations or Protections

The SBNF is planning a revision of their Resource Management Plan in the near future that, among other functions, would provide conservation benefits to the two carbonate plant species and their habitat in this unit. These lands, however, currently do not have approved management provisions for the carbonate plants and their habitat, and habitat degradation may still be occurring due to ongoing activities identified in the final listing rule for these species (see USFWS 2001b). Therefore, the subject lands continue to require special management and protection to ensure the conservation of these species and their habitat. The core occurrences of the two carbonate plants in this unit are important as potential sources for the colonization events (e.g., seed dispersal) necessary to maintain the natural population dynamics of the species. Every carbonate plant occurrence in this unit is important as a seed source to colonize unoccupied sites and therefore maintain an equilibrium between local colonization and extirpation events. Every carbonate plant occurrence in this unit potentially provides important genetic material through pollen and seed dispersal which may help maintain genetic diversity and reduce the likelihood of regional extirpation events.

When designating critical habitat, we assess whether the physical and biological features determined to be essential for conservation may require special management considerations or protection. As we undertake the process of designating critical habitat for a species, we first evaluate lands defined by those physical and biological features essential to the conservation of the species for inclusion in the designation pursuant to section 3(5)(A) of the Act. Secondly, we then evaluate lands defined by those features to assess whether they may require special management considerations or protection. In 1982, BLM established the Fish Slough ACEC in an effort to provide protection for the federally endangered Owens pupfish, several rare plant taxa including *Astragalus lentiginosus* var. *piscinensis*, and the wetland and riparian habitats upon which these species depend. The Fish Slough ACEC has three zones (BLM 1984). The designated critical habitat unit is predominantly located within Zone 1 of the ACEC, includes a very small portion of Zone 2, and also extends slightly beyond the southern boundary of the ACEC. The land in Zone 1 is owned by BLM, CDFG, LADWP, and one private landowner. The portion of the designated critical habitat unit in Zone 2, or in the area immediately south of the ACEC, is owned by BLM or LADWP. A management plan for the ACEC was finalized in 1984, but the plan has not been revised since it was completed. Previously identified threats to *Astragalus lentiginosus* var. *piscinensis* include the presence of roads, effects related to the use of OHV, effects related to cattle grazing, and effects from herbivory by native vertebrates and insects (Service 1998). A potential threat to *A. l.* var. *piscinensis* not previously identified in other documents includes competition with, or displacement by, nonnative plant species (P. Hubbard, LADWP, pers. comm.

2003). The modification of wetland habitats that results from groundwater pumping or water diversion activities altering the surface and underground hydrology of Fish Slough is also a threat to the species (Service 1998). The suite of threats affecting *Astragalus lentiginosus* var. *piscinensis* is complex. The establishment of the Fish Slough ACEC has helped provide some benefit for *A. l. var. piscinensis* by coordinating the activities of staff from BLM, LADWP, and CDFG on various land management challenges that exist in the local area. Because the long, narrow configuration of the slough is bounded by upland habitat, the amount of alkaline habitat that can be occupied by *A. l. var. piscinensis* is limited. Ferren (1991b) summarizes threats to botanical resources at Fish Slough, noting that those threats related to the enhancement of fisheries (construction of ponds, impoundments, roads, and ditches) may have had the greatest effect on the Fish Slough ecosystem because they modified the hydrological conditions that historically occurred in Fish Slough. In the central portion of the slough, Fish Slough Lake appears to have expanded in size between 1944 and 1981. This increase may be due to natural geologic subsidence, the construction of Red Willow Dam, or the construction of water impoundments by beavers. The increase in aquatic habitat has likely resulted in the loss of alkaline habitat for *Astragalus lentiginosus* var. *piscinensis* as soils near the lake are now saturated for greater portions of the year (Ferren 1991c). Some earthquake events in Chalfant Valley appear to have resulted in decreases in spring discharge or changes in local water table levels (Brian Tillemans, LADWP, pers. comm. 2000), thereby making it more difficult to clearly understand the nature of the local aquifer. Modifications to the slough environment from changes in the local hydrology are not well understood or easily reversed. These factors, in combination with essential data gaps that include, but are not limited to, a more thorough understanding of the ecology and habitat requirements of the species, have made it difficult for local land managers to understand and reverse the decline in the number of *A. l. var. piscinensis* within the ACEC over the past decade. A downward trend in the species' abundance during the past decade suggests that, despite the ongoing efforts by the relevant land management agencies, additional factors need to be addressed to reverse the decline in the status of *A. l. var. piscinensis*. We believe that the designated critical habitat unit may require special management considerations to maintain the identified primary constituent elements. These include the potential need to respond to the following: (1) Activities that have the potential to change the hydrology of Fish Slough and adversely affect the survivorship, seed germination, growth, or photosynthesis of *Astragalus lentiginosus* var. *piscinensis*, unless such activities are designed and have the effect of recreating the historic environmental conditions that existed in Fish Slough; (2) Activities that have the potential to adversely affect the suitability of alkaline areas that could provide habitat for *Astragalus lentiginosus* var. *piscinensis* including, but not limited to, OHV use, levels of cattle grazing that could result in increased soil compaction, road construction and maintenance activities, and water diversion activities; (3) Activities that have the potential to modify the species composition, character, or persistence of the native plant associations that are associated with *Astragalus lentiginosus* var. *piscinensis*; (4) Activities that could adversely affect the insect pollinators that inhabit the native upland desert scrub community that is adjacent to alkaline habitats in Fish Slough, including, but not limited to, livestock grazing at levels that would increase soil compaction, use of heavy-wheeled vehicles or OHVs (including motorcycles and all terrain vehicles), pesticide use, and incompatible recreational activities; and (5) Management activities, particularly those that involve cattle grazing and road maintenance, which have the potential to introduce new nonnative plant species that may compete with or displace *Astragalus lentiginosus* var. *piscinensis*.

Life History

Food/Nutrient Resources**Reproductive Strategy**

Adult: Sexual (USFWS, 1998)

Lifespan

Adult: 15 to 35 years; median of 10 years (USFWS, 2009)

Dependency on Other Individuals or Species

Adult: the most likely pollinators (based on records of pollinators on other *Astragalus*) include bumble bees, leafcutting and mason bees (Megachilidae: *Anthidium* spp., *Hoplitis* spp., *Osmia* spp., *Megachile* spp.), non-corbiculate (no pollen basket on hind tibia) Apidae (Anthophorinae, Eucerini: *Melissodes* spp., *Synhalonia* spp., and Anthophorini: (*Anthophora* spp., *Habropoda* spp.), and Andrenidae (Thorp in litt. 2004). (USFWS, 2009)

Breeding Season

Adult: Late spring (USFWS,

Reproduction Narrative

Adult: *Astragalus lentiginosus* var. *piscinensis* cannot self-pollinate; therefore, seed production is dependent on cross-pollination (Mazer and Travers 1992). Although specific pollinators of *A. lentiginosus* var. *piscinensis* have not been studied, the most likely pollinators (based on records of pollinators on other *Astragalus*) include bumble bees, leafcutting and mason bees (Megachilidae: *Anthidium* spp., *Hoplitis* spp., *Osmia* spp., *Megachile* spp.), non-corbiculate (no pollen basket on hind tibia) Apidae (Anthophorinae, Eucerini: *Melissodes* spp., *Synhalonia* spp., and Anthophorini: (*Anthophora* spp., *Habropoda* spp.), and Andrenidae (Thorp in litt. 2004). *Astragalus lentiginosus* var. *piscinensis* is an herbaceous perennial that produces relatively few seeds with narrow germination requirements and low probability of dispersal. Seed scarification is essential for seed germination. The potential life span is estimated at 15 to 35 years, but median life span appears to be about 10 years. (USFWS, 2009)

Habitat Type

Adult: Terrestrial and palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Wetlands, alkali flats (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found along borders of a slough but not in lower wetter habitats (USFWS, 2009)

Site Fidelity

Adult: High (USFWS, 2009)

Habitat Narrative

Adult: This taxon occurs in alkali flats in *Spartina-Sporobolus* (cord grass and dropseed) plant associations and in the transition zone between *Spartina-Sporobolus* and *Distichlis-Chrysothamnus* (salt grass and rabbit brush) plant associations. Soils are loamy fine sands,

usually with an alkali crust. The plants are typically found along spring-fed wetlands on the borders of a slough. This species is absent from nearby lower, wetter habitats. (USFWS, 2009; NatureServe, 2015)

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 2009)

Dispersal/Migration Narrative

Adult: The seeds have narrow germination requirements and low probability of dispersal. (USFWS, 2009)

Population Information and Trends

Population Trends:

Short-term trends suggest a relatively stable population (NatureServe, 2015)

Resiliency:

Low (inferred from USFWS, 2009)

Representation:

Low (inferred from USFWS, 2009)

Redundancy:

Low (inferred from USFWS, 2009)

Number of Populations:

8 (NatureServe, 2015)

Population Size:

3,100 individuals (NatureServe, 2015)

Population Narrative:

Short-term trends suggest a relatively stable population. There are 8 known populations totaling about 3,100 plants (USFWS 1996). (Rutherford, 1992). (NatureServe, 2015)

Threats and Stressors

Stressor: Grazing (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: In the listing rule we noted that grazing that began in the 1860s was ongoing on all LADWP lands except in the northern 80 ac (32 ha) enclosure (63 FR 53608). Over time, trampling by livestock alters the composition of the plant community by reducing or eliminating those that cannot tolerate trampling and increasing those species that tolerate disturbance. This may also introduce taxa that were not previously part of the native plant community. Currently a limited

amount of cattle grazing occurs on LADWP lands in all three regions of the Fish Slough ACEC, the exception being land in the northern region within the cattle enclosure (Hubbard in litt. 2007). (USFWS, 2009)

Stressor: Alteration of habitat (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Threats attributed to impoundments created to protect and enhance habitat for the Owens pupfish have increased ground water levels, reducing the amount of suitable habitat for *Astragalus lentiginosus* var. *piscinensis*. (USFWS, 2009)

Stressor: Herbivory (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Herbivory remains a threat to *Astragalus lentiginosus* var. *piscinensis*. Seedling herbivory remains a threat to recruitment of new individuals. Field observations suggest that several factors (herbivory, seed germination requirements, seedling establishment, and interspecific competition) interact, placing constraints on *Astragalus lentiginosus* var. *piscinensis* survival (Murray and Sala 2003). Infestations of vegetative parts and root systems by phloem-sucking insects and red ants, respectively, and high rabbit herbivory were all reported for individuals of *Astragalus lentiginosus* var. *piscinensis* in the middle region of Fish Slough by Mazer and Travers (1992). (USFWS, 2009)

Stressor: Lack of recruitment (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: At the time of listing, the Service noted that lack of recruitment was a potential threat to *Astragalus lentiginosus* var. *piscinensis*. Potential causes cited in the rule were high rabbit/rodent herbivory of seedlings (discussed in Factor C) and changes in soil hydrology or chemistry that make the area less hospitable for seedlings (63 FR 53608). We also discussed the threat of livestock grazing under Factor E of the rule. However, Factor A (which would include alteration in habitat due to cattle grazing) and Factor C (which would include grazing of individual *Astragalus* plants) are more appropriate. Data on numbers of individuals of *A. lentiginosus* var. *piscinensis*, collected from plots in cattle-grazed or trampled and ungrazed areas of Fish Slough from 1991 to 1996, suggest that some recruitment was occurring in both the grazed and ungrazed sample areas. Because the alkali meadow habitat that *A. lentiginosus* var. *piscinensis* occupies is likewise moist, cattle may facilitate the establishment of new individuals. (USFWS, 2009)

Stressor: Seismic activity (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Although not mentioned in the listing rule, seismic activity leading to changes in hydrology have and will likely continue to have significant effects on the distribution and extent

of water availability in Fish Slough and will influence the distribution and viability of *Astragalus lentiginosus* var. *piscinensis* habitat (Halford in litt. 2007). (USFWS, 2009)

Stressor: Small population size (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: *Astragalus lentiginosus* var. *piscinensis* may be vulnerable to extirpation by stochastic factors including demographic stochasticity, environmental stochasticity, and genetic stochasticity (Shaffer 1981). Demographic stochasticity refers to random variability in survival or reproduction among individuals within a population (Shaffer 1981), and could play a role in the extirpation of small populations of *A. lentiginosus* var. *piscinensis*. Environmental stochasticity is the variation in birth and death rates from one season to the next in response to weather, disease, competition, predation, or other factors external to the population (Shaffer 1981), and this could also play a role in extirpations of small populations. Genetic stochasticity results from the changes in gene frequencies due to founder effect, random fixation, or inbreeding (Shaffer 1981). The naturally disjunct distribution of *A. lentiginosus* var. *piscinensis* decreases genetic variation within the population, which could impair the species' ability to adapt to changes in the environment or contribute to inbreeding depression (i.e., loss of reproductive fitness or vigor). Small population size makes it difficult for *A. lentiginosus* var. *piscinensis* to persist while sustaining the impacts of high seedling herbivory rates and changes in soil hydrology or chemistry that make the area less hospitable for seedlings; while impacts from cattle grazing have been reduced, they still remain a concern, exacerbating concerns about the risks associated with small population size. (USFWS, 2009)

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Climate change was not discussed at the time of listing. Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). Recently, the potential impacts of climate change on the flora of California were discussed by Loarie et al. (2008). Based on modeling, they predicted that species' distributions will shift in response to climate change and that the species will "move" or disperse to higher elevations and northward, depending on the ability of each species to do so. Increases in species diversity in these higher elevations and northern locations due to climate change have the potential to result "...in new species mixes, with consequent novel patterns of competition and other biotic interactions..." with unknown consequences to the species which currently exist there (Loarie et al. 2008). While we lack adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors such as small population size, will affect *Astragalus lentiginosus* var. *piscinensis*; small ranged species, such as *Astragalus lentiginosus* var. *piscinensis*, are more vulnerable to extinction due to these changing conditions (Loarie et al. 2008). (USFWS, 2009)

Recovery

Reclassification Criteria:

Reclassification criteria are not available.

Delisting Criteria:

1. The Fish Slough vegetation communities [specifically for *Astragalus lentiginosus* var. *piscinensis*] are restored and are being managed to maintain conditions such as those described in the Natural Resources Conservation Service (NRCS) Ecological Site Descriptions, the Bureau of Land Management's (BLM) Desired Plant Community Definitions for springs and wet meadows, and the guidelines for riparian zone proper functioning condition. (USFWS, 2009)
2. Colonies in the north, middle and south regions of the slough are secured from the negative effects of invasive nonnative species, livestock grazing and other human induced threats. (USFWS, 2009)
3. Recruitment of new individuals into the populations and other demographic factors appear sufficient to ensure viability over time as determined by monitoring over a 10 to 15-year period. (USFWS, 2009)
4. Unless research and monitoring show otherwise, population targets for juvenile and adult plants should be a minimum of 2,100 plants in the northern region of Fish Slough, 1,200 in the middle region of Fish Slough and 105 plants in the southern region of Fish Slough; these targets assume that habitat restoration will increase carrying capacity beyond the 1992 levels. (USFWS, 2009)

Recovery Actions:

- Needed recovery actions include protection of spring discharges, modification of livestock grazing to ensure that its habitat is not being degraded, restoration of previously suitable habitat that no longer supports the milk-vetch, removal and control of nonnative species and other threats that may arise, protection of lands on which the milk-vetch occurs through a conservation easement or other permanent mechanism, and research to determine its critical life history and habitat components and how these are affected by management actions. Continued monitoring will also be needed. (USFWS, 1998)

Conservation Measures and Best Management Practices:

- CDFG, BLM and LADWP should work to lower water levels by regulating flow in Fish Slough Lake and monitor *Astragalus lentiginosus* var. *piscinensis* recruitment results. (USFWS, 2009)
- BLM should study the benefits of soil disturbances on *Astragalus lentiginosus* var. *piscinensis* recruitment. (USFWS, 2009)
- BLM should continue with propagation and out-planting projects to enhance recruitment. (USFWS, 2009)
- BLM should study the extent and population impacts of herbivory and ant colony infestations on *Astragalus lentiginosus* var. *piscinensis* recruitment. (USFWS, 2009)
- The Service should work with LADWP to develop and implement a grazing plan for LADWP cattle allotment lands within the Fish Slough ACEC. (USFWS, 2009)

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SPECIES ACCOUNT: *Astragalus magdalenae* var. *peirsonii* (Peirson's milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/05/1998; Pacific Southwest Region (R8)

Physical Description

An erect to spreading, herbaceous, short-lived perennial in the Fabaceae (Pea family) (Barneby 1959, 1964). This taxon is a psammophyte, meaning that it grows in shifting sands. Plants may reach 8 to 35 inches (in) (20 to 90 centimeters (cm)) in height (Barneby 1964, pp. 862–863, Wojciechowski and Spellenberg 2012). The root system is composed of a deep taproot and shallow lateral roots; taproots of older plants may be as long as 13 feet (ft) (4 meters (m)) deep (Porter et al. 2005, p. 28). The stems and leaves are covered with fine, silky appressed hairs. The leaflets, which may fall off in response to drought, are small and widely spaced, giving the plants a brushy appearance. The terminal leaflet (leaflet at the tip) is continuous with the rachis (the central axis of a compound leaf along which leaflets are attached) rather than articulated with it (Barneby 1959, p. 879; Wojciechowski and Spellenberg 2012). Each raceme (flower stalk) supports 10 to 17 purple flowers (Barneby 1959, p. 879). The inflated, single-chambered fruits (pods) of *A. m. var. peirsonii* are 0.8 to 1.4 in (20 to 35 mm) long and 0.4 to 0.8 in (10 to 20 mm) wide (Barneby 1964, Wojciechowski and Spellenberg 2012). Barneby (1964) reported 11 to 16 ovules per fruit, but only a portion of a pod's ovules develop into mature seeds (McKinney et al. 2006, p. 85). (USFWS, 2019c)

Taxonomy

Although originally described at the species rank by Munz and McBurney (Munz 1932, p. 7) Peirson's milk-vetch is currently recognized at the varietal level as *A. magdalenae* var. *peirsonii* (Wojciechowski and Spellenberg 2012). However, 2007 genetic analysis suggested that Barneby's (1964, pp. 862–863) reduction of Peirson's milk-vetch to varietal status may have been inappropriate, and that *A. magdalenae* var. *peirsonii* should be recognized at the rank of species (Porter and Prince 2007, p. 10). Since 2008, no taxonomic changes have been formalized, and so we continue to recognize the taxon as *Astragalus magdalenae* var. *peirsonii* across its range. (USFWS, 2019c)

Historical Range

Found in Sonoran Desert dune environments in southeastern California, United States, and in Sonora, Mexico. (USFWS, 2019c)

Current Range

In the United States, *A. m. var. peirsonii* is restricted to the western portion of the Algodones Dunes (also referred to as the Imperial Sand Dunes) of eastern Imperial County, California. This taxon occurs within about 53,000 acres (ac) (21,500 hectares (ha)) in a narrow band running 40 miles (mi) (64 kilometers (km)) northwest to southeast along the western portion of the dunes. (USFWS, 2019c)

Critical Habitat Designated

Yes; 3/17/2008.

Legal Description

On February 14, 2008, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective March 17, 2008) for *Astragalus magdalenae* var. *peirsonii* (Peirson's milk-vetch) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four critical habitat units (CHUs), in California (73 FR 8748-8785).

Critical Habitat Designation

The critical habitat designation for *Astragalus magdalenae* var. *peirsonii* includes three CHUs (with seven sub-units) in Imperial County, California. This species' critical habitat encompasses approximately 9,758 acres (ac) (3,949 hectares (ha)) (73 FR 8748-8785). Brief descriptions are provided below; detailed coordinates and maps are available in the Final Rule (USFWS, 2008).

Unit 1: Mammoth Wash/North Algodones Dunes Wilderness: Unit 1 consists of 4,675 ac (1,892 ha) of land, further divided into 4 subunits (1A, 1B, 1C, 1D), the majority of which is primarily Federal land under BLM management. This unit includes land in the BLM's Mammoth Wash and North Algodones Dunes Wilderness Management Areas. Areas are as follows: Subunits 1A (421 ac (170 ha)) and 1B (1,411 ac (571 ha)); Subunits 1C (741 ac (300 ha)) and 1D (2,103 ac (851 ha)) (USFWS, 2008)

Unit 3: Adaptive Management Area (AMA)/Ogilby: Unit 3 consists of 7,212 ac (2,919 ha) of land further divided into 3 subunits (3A, 3B, 3C), which are Federal lands under BLM management. This unit includes lands in the BLM's AMA and Ogilby Management Areas. Areas are as follows: Subunits 3A (4,487 ac (1,816 ha)), 3B (1,176 ac (476 ha)), and 3C (1,549 ac (627 ha)) . (USFWS, 2008)

Unit 4: Buttercup Unit 4 consists of 218 ac (88 ha) of Federal land entirely under BLM management. This unit includes lands in the BLM's Buttercup Management Area. (USFWS, 2008)

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Astragalus magdalenae* var. *peirsonii* critical habitat consists of the following components (73 FR 8748-8785):

(i) West and/or northwest-facing sides of bowls, swales, and slopes consisting of Rositas fine sands within intact, active sand dune systems (defined as sand areas that are subject to sandmoving winds) in the existing range of the species that provide space needed for individual and population growth, including sites for germination, reproduction, seed dispersal, seed bank, and pollination (USFWS, 2008)

(ii) The associated co-adapted psammophytic scrub plant community characterized by *Croton wigginsii*, *Eriogonum deserticola*, *Helianthus niveus* ssp. *tephrodes*, *Palafoxia arida* var. *gigantea*, *Pholisma sonora*, *Tiquilia plicata*, *Petalonyx thurberi*, and *Panicum urvilleanum* that provides habitat for insect pollinators, particularly the white-faced digger bee (*Habropoda pallida*), required for reproduction (USFWS, 2008)

(iii) Areas within intact, active sand dune systems between occupied bowls, swales, and slopes that allow for pollinator movement and wind dispersal of fruit and seeds. (USFWS, 2008)

Special Management Considerations or Protections

Special management considerations or protection may be required to minimize impacts to *Astragalus magdalenae* var. *peirsonii* habitat resulting from OHV recreation. The BLM (2003, Appendix 1, p. 13) listed the following possible management options to protect *A. m.* var. *peirsonii* and its habitat: (1) Use restrictions based on a permit system that would allow a specified level of use (high, medium, low, no use); (2) temporally based closures or limitations (open during some months or years, closed in others); (3) recognition and management of certain areas within a management area; and/or (4) increased education and outreach to OHV users to avoid certain areas. Special management considerations or protection needed may also include additional enforcement to ensure visitor compliance with these management options. (USFWS, 2008)

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Obligate outcrossing (NatureServe, 2015)

Breeding Season

Adult: mid-November through May (USFWS, 2019c)

Key Resources Needed for Breeding

Adult: Sufficient rain (USFWS, 2019c)

Other Reproductive Information

Adult: Plants, regardless of age, may flower from as early as mid-November through May. Mature fruits are found on plants from the beginning of February to late June, with peak production occurring in March and April. In the spring of 2002, Porter et al. (2005) documented fruit set in *Astragalus magdalenae* var. *peirsonii*. They found a range of 0 to 4,311 fruits per plant, with a mean of 629. There was a significant correlation between the number of seed pods and plant size, and plant size explained approximately 39 percent of the observed variation in fruit set. (USFWS, 2019c)

Reproduction Narrative

Adult: The seeds of *Astragalus magdalenae* var. *peirsonii* exhibit a long-term dormancy mechanism in which the hardened layers of the outer seed coat are impermeable to water. Seeds must be scarified (abraded, cut, or disrupted in some way) for water to penetrate the seed and induce germination. *Astragalus magdalenae* var. *peirsonii* displays different reproductive strategies depending on the level and time of precipitation. If winter rains begin in early November, seeds germinating in early December may grow rapidly, flower by February, and set seed in March. In wetter years, a second germination event may occur in late winter, but these plants often fail to reproduce and die in large numbers at the onset of summer drought. If winter rains do not occur until late January, sufficient soil moisture or time may not exist for young plants to develop the root structure needed to flower and set seeds before the onset of desiccating summer heat. Both seedling and adult plants display very high annual mortality. Young plants often die during summer in significant numbers, likely because such

plants lack a sufficiently developed root system to tap water from deeper soils. Older plants also die during the summer. However, some plants develop an adequate root system and perennate to live 2 to 3 years. Some perennial individuals will flower and produce seeds in years with no precipitation. Years with optimal or prolonged precipitation may experience two or more germinations and increased seed production. (USFWS, 2019c)

Habitat Type

Adult: Terrestrial (USFWS, 2019c)

Habitat Vegetation or Surface Water Classification

Adult: Sonoran desert scrub, sand dune (USFWS, 2019c)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2003)

Habitat Narrative

Adult: *Astragalus magdalenae* var. *peirsonii* occurs on the bowls, swales, and slopes of active, windblown sand dunes. The majority of *A. m. var. peirsonii* habitat within the Algodones Dunes is located along the western edge of the dune system. In this area, a series of barchan dunes is oriented northwest to southeast, and aligned with seasonal wind patterns. Each dune is a sequence composed of a back dune, a dune slip face, and a bowl. Winds move sand along the back dune and over-deposit sand grains on the slip face, which is highly unstable. The dune bowl is a blow-out area from the bottom of the slip face that transitions up-slope to the back dune of the next dune sequence. *Astragalus magdalenae* var. *peirsonii* is generally associated with the upwind back dune area of most dune sequences, where sand is wind-packed and more stable. (USFWS, 2019c)

Dispersal/Migration**Dispersal**

Adult: Low (inferred from USFWS, 2003)

Dispersal/Migration Narrative

Adult: *Astragalus magdalenae* var. *peirsonii* seeds are the largest of any *Astragalus* in North America (Barneby 1964, pp. 862–863). Bowers (1996, p. 69) found that *A. m. var. peirsonii* seeds averaged 0.2 inches (4.7 (millimeters (mm))) in length and 15 milligrams (mg) in weight, and McKinney et al. (2006, p. 85) reported similar average seed lengths of approximately 0.2 in 6 (4.98 mm) (n=73). Seed pods may contain 11 to 16 ovules (Barneby 1964, p. 862). McKinney et al. (2006) reported an average of 11.41 mature seeds and ovules per pod (n=78) (p. 85). An average of 5.2 mature seeds were present per pod (McKinney et al. 2006, p. 85), indicating that only a portion of ovules develop into mature seeds. The inflated fruits may be blown by winds (ASA 2002, p. 23; Porter 2003, p. 5), and may become buried in the dune surface (ASA 2002, p. 23). While some seeds may remain within the fruits, both Porter (2003, p. 3) and Phillips and Kennedy (ASA 2002, pp. 23–24) noted that a large number of solitary seeds were found on the dune surface. It is possible that the large, inflated fruits may have some role in seed germination (Porter 2003, p. 3), but this observation has not been studied further. Porter (2003, p. 5) observed rodent seed caches of *A. m. var. peirsonii* within the Algodones Dunes Wilderness, but

it is not known whether caches occur in other parts of the dunes, or whether rodent caching is an important seed dispersal mechanism for this taxon. (USFWS, 2019c)

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Number of Populations:

1 - 20 (NatureServe, 2015)

Population Size:

< 100,000 to > 1.5 million, depending on climatic conditions (NatureServe, 2015)

Population Narrative:

Porter et al. (2005, p. 21) considered *Astragalus magdalenae* var. *peirsonii* at the Algodones Dunes to be a single, extensive population. However, *Astragalus magdalenae* var. *peirsonii* is not evenly distributed throughout the dunes. The population extends northwest to southeast across the dunes, and plants generally occur in the western, interior portions of the dunes. Plant density is generally lower in the northern areas of the dunes, and higher in southern areas of the dunes. The Service's analysis of BLM's 2005 surveys indicate that *A. m. var. peirsonii* occurred in 21 percent of the cells surveyed across the dune system. Eleven percent of the cells surveyed contained fewer than six plants per cell, and half of the total number of plants recorded in 2005 occurred in just 0.7 percent of the cells. (USFWS, 2019c)

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2019a)

Exposure:

Response:

Consequence:

Narrative: The primary threat to *Astragalus magdalenae* var. *peirsonii* was considered to be the destruction of individuals and dune habitat from OHV use and the associated recreational development. The Service's 2008 12-month finding and 5-year review continued to consider OHV activity to be the primary threat to *A. m. var. peirsonii* habitat. The implementation of BLM's 2013 Imperial Sand Dunes Recreation Area Management Plan (ISD-RAMP) have largely ameliorated Factor A threats to *A. m. var. peirsonii* in areas designated as critical habitat. *Astragalus magdalenae* var. *peirsonii* habitat continues to be impacted by OHV use within the Open Management Area, and by vehicle trespass into critical habitat closures. Continued educational efforts by BLM and dune associations may reduce the incidence of trespass over time). (USFWS, 2019a)

Stressor: Predation and herbivory (USFWS, 2019a)

Exposure:

Response:

Consequence:

Narrative: Herbivory and seed predation by native insects and rodents may impact *Astragalus magdalenae* var. *peirsonii* at the Algodones Dunes by reducing plant reproductive output or

consuming seeds post-dispersal. However, information about these impacts is observational, and impacts have not been well studied across the dunes or through time. The degree to which native insects and rodents may benefit *A. m. var. peirsonii*—for example, by scarifying or dispersing seeds—is also unknown. We do not believe that herbivory and seed predation by native taxa are likely to pose a direct threat to the conservation of *A. m. var. peirsonii*. Rather, these taxa are part of the ecology of *A. m. var. peirsonii*, and other threats to this variety should be considered in the context of baseline levels of herbivory and predation by native taxa. Nonnative aphids have been observed on *A. m. var. peirsonii*, but we do not have enough information to fully analyze the geographic scope, magnitude, or immediacy of this potential threat. We will update our threats assessment if new information about the impacts of nonnative aphids becomes available. (USFWS, 2019a)

Stressor: Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: BLM's closure and ongoing management of *Astragalus magdalenae* var. *peirsonii* critical habitat has largely ameliorated direct OHV impacts to several stages of the taxon's life cycle within critical habitat. Plants within the Open Management area are still vulnerable to impacts from OHV use, and trespass into critical habitat closures also occurs. Other Factor E threats—low reproduction, loss of genetic diversity, and changing climate (changes in temperature and precipitation)—need additional study. Since *A. m. var. peirsonii* plants are self-incompatible, limited gene flow, loss of S-alleles within the population, or impacts to the primary pollinator could affect population viability. (USFWS, 2019a)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2019a)

Exposure:

Response:

Consequence:

Narrative: Though there have been ongoing recreational impacts to *Astragalus magdalenae* var. *peirsonii* and its habitat since listing, Federal regulatory mechanisms have reduced the overall loss and degradation of habitat because of the taxon's occurrence on BLM lands. BLM completed the ISD- RAMP in 2013, which provides management and protections for *A. m. var. peirsonii*. In order to comply with the Service's Biological Opinion, BLM is implementing (1) a monitoring plan for *A. m. var. peirsonii* which monitors the status of the taxon within and outside of critical habitat (CM 1) (BLM 2018a, pp. 5–7), and (2) four management actions to minimize recreational impacts to Peirson's milk-vetch and its habitat (CM 2) (BLM 2018a, pp. 7–14). We believe that the Act continues to remain the primary regulatory mechanism providing for the conservation of *A. m. var. peirsonii*. BLM's management and implementation of provisions in the ISD-RAMP have also contributed considerably to the protection of this taxon. (USFWS, 2019a)

Recovery

Reclassification Criteria:

Not applicable.

Delisting Criteria:

A.1 Occupancy is maintained within the seven *Astragalus magdalenae* var. *peirsonii* occurrences at the Algodones Dunes. Population connectivity among the seven occurrences is maintained at a level that allows seed bank regeneration and gene flow. (USFWS, 2019b)

A.2 The level, timing, and duration of permitted OHV use in the Open Management Area occupied by *Astragalus magdalenae* var. *peirsonii* is compatible with the recovery and longterm conservation of the taxon. (USFWS, 2019b)

E.1 The life history, genetics, and seed bank dynamics of *Astragalus magdalenae* var. *peirsonii* are sufficiently understood to allow confident scientific conclusions that impacts from OHV use in occupied areas are consistent with the long-term resilience of this taxon. (USFWS, 2019b)

E.2 Mean population size of *Astragalus magdalenae* var. *peirsonii* at the Algodones Dunes is stable or increasing for 20 years. (Twenty years represents the time frame over which three full-scale monitoring events are likely to occur. Stable or increasing population size would be demonstrated by analysis of data from at least three additional full-scale monitoring efforts, analyzed in conjunction with previously collected monitoring data and controlled for growing season precipitation.) (USFWS, 2019b)

E.3 Long-term adaptive management plans have been developed throughout the U.S. range of *Astragalus magdalenae* var. *peirsonii* and are being implemented to ensure the long-term viability of the taxon. Adaptive management plans should be designed in consideration of ongoing management efforts and with post-delisting monitoring requirements in mind. (USFWS, 2019b)

E.4 Adequate levels of genetic diversity at S-loci are maintained and preserved in the U.S. population of *A. m.* var. *peirsonii* to maintain long-term viability of the taxon, and an ex situ seed bank representative of the genetic diversity in the population is established at an institution certified by the Center for Plant Conservation. (USFWS, 2019b)

Recovery Actions:

- 1. Continue monitoring of *Astragalus magdalenae* var. *peirsonii*, and ensure that the current monitoring protocol informs management of the taxon and allows us to accurately assess population trends. (USFWS, 2019d)
- 2. Conduct research projects to inform management actions that further *Astragalus magdalenae* var. *peirsonii* recovery. There are numerous gaps in our understanding of *A. m.* var. *peirsonii* biology and ecology. Additional information will also inform the development of an adaptive management plan and future status reviews. 2.1. Further study seed predation by native taxa and seed scarification mechanisms. (USFWS, 2019d)
- 3. Ameliorate Factor A threats associated with present or threatened destruction, modification, or curtailment of the habitat or range of *Astragalus magdalenae* var. *peirsonii* at the Algodones Dunes. (USFWS, 2019d)
- 4. Ameliorate Factor E threats associated with other natural or manmade factors affecting the continued existence of *Astragalus magdalenae* var. *peirsonii* at the Algodones Dunes. (USFWS, 2019d)

References

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USFWS. 2019d. Recovery Implementation Strategy for *Astragalus magdalenae* var. *peirsonii*. U.S. Fish and Wildlife Service, Pacific Southwest Region, Sacramento, California. ii + 15.

SPECIES ACCOUNT: *Astragalus montii* (Heliotrope milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/06/1987; Mountain-Prairie Region (Region 6) (USFWS, 2016)

Physical Description

Astragalus montii is a small, tufted perennial herb, 1-5 cm tall, producing pink-purple flowers, the wings white-tipped, and purple-mottled, globe-shaped fruits. (NatureServe, 2015)

Taxonomy

It has also been recognized as a variety of *Astragalus limnocharis* (Isely, 1983), but the Service considers it to be a distinct species. (USFWS, 1987)

Historical Range

The species has not been found in areas other than those currently known. (USFWS, 1995)

Current Range

Occurs on the southern Wasatch Plateau on Ferron, Heliotrope and White mountains in Sanpete and Sevier counties (Franklin, 2005). (NatureServe, 2015)

Critical Habitat Designated

Yes; 11/6/1987.

Legal Description

On November 6, 1987, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Astragalus montii* (Heliotrope milk-vetch) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Utah (52 FR 42652-42657).

Critical Habitat Designation

The critical habitat designation for *Astragalus montii* includes one CHU in Sanpete County, Utah. This species critical habitat encompasses approximately 65 acres (52 FR 42652-42657).

Utah, Sanpete County, western Heliotrope Mountain.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Astragalus montii* critical habitat are the following (52 FR 42652-42657):

The primary constituent element is the white limestone barrens of the Flagstaff Formation.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Mixed selfing and outcrossing (USFWS, 1995)

Dependency on Other Individuals or Species

Adult: Wild bees for pollination (USFWS, 1995)

Breeding Season

Adult: Flowers as soon as snow melts - usually mid-June (USFWS, 1995)

Reproduction Narrative

Adult: Astragalus montii reproduction is sexual. Asexual reproduction is unknown. The plants begin flowering immediately after winter snows melt in their subalpine habitat, usually about mid-June. The stigmas are receptive during the first three days of anthesis. The species is capable of self-fertilization but has significantly higher seed production and presumed higher vigor from cross-fertilization (Geer and Tepideno 1993). The species is pollinated by wild bees of the family Megachilidae, especially those of the genus Osmia (Tepideno and Griswold 1990). The seeds are shed beginning in July and continuing into August. (USFWS, 1995)

Habitat Type

Adult: High elevation limestone barrens (USFWS, 1995)

Habitat Vegetation or Surface Water Classification

Adult: Subalpine mixed grass-forb communities. (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Rocky, limestone soils (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Presumably clumped (inferred from USFWS, 1995)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Site Fidelity

Adult: High (USFWS, 1995)

Habitat Narrative

Adult: The habitat of A. montii is high elevation, 3,200 to 3,352 meters (10,500 to 11,000 ft), limestone barrens derived from the Flagstaff Geological Formation. The species habitat type is an inclusion within a subalpine mixed grass-forb plant community with scattered stands of subalpine fir (Abies lasiocarpa) and Engelmann spruce (Picea engelmannii) krummholz. (USFWS, 1995)

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Not well known (USFWS, 1995)

Species Trends:

Not well known (USFWS, 1995)

Resiliency:

Low (inferred from USFWS, 1995)

Representation:

Low (inferred from USFWS, 1995)

Redundancy:

Low (inferred from USFWS, 1995)

Number of Populations:

3 (NatureServe, 2015)

Population Size:

~2,000,000 individuals (NatureServe, 2015)

Adaptability:

Low (inferred from USFWS, 1995)

Population Narrative:

The heliotrope milk-vetch is slow growing and intolerant of habitat disturbance. The three populations numbered about 2500, 4000, and 4000 each as of 1985 (Lowe, 1990, WWF Guide to Endangered Sp.). Franklin (2005) estimated that 2 million individuals were present across three populations, with 65% of those individuals occurring at one site. Three known populations: Ferron Mountain, White Mountain and Heliotrope Mountain (Franklin 2005). (NatureServe, 2015) The size of the populations in the limited area it occupies, along with the apparent fluctuation in numbers, implies a healthy population growth rate. (inferred from USFWS, 1995; NatureServe, 2015)

Threats and Stressors

Stressor: Oil and gas activities (USFWS, 1995)

Exposure:

Response:

Consequence:

Narrative: Oil and gas exploration, drilling, and production, are past, existing and potential threats to the habitat of *A. montii*. The population of *A. montii* is underlain by petroleum deposits associated with the "Overthrust Belt" of the western United States. Habitat disturbance associated with unrestricted oil and gas exploration and production could have a serious impact on its survival. (USFWS, 1995)

Stressor: Sheep grazing (USFWS, 1995)

Exposure:

Response:

Consequence:

Narrative: Limited sheep grazing under grazing management plans occur in the habitat of *A. montii*. Actual detrimental impacts to this species resulting from direct grazing or trampling have not been observed. The Wasatch Plateau was more intensely grazed historically, but Forest Service grazing management plans have reduced grazing to levels believed to be compatible with the conservation of *A. montii* and its immediate plant community. The harshness of the alpine environment contributes to the fragility of the *A. montii* ecosystem. Disturbances may have catastrophic and as yet unknown long-term consequences to such a narrow endemic occupying these subalpine habitats. (USFWS, 1995)

Recovery

Delisting Criteria:

A total population of 200,000 *A. montii* individuals is documented for 5 consecutive years. (USFWS, 1995)

All three populations have been maintained at minimum viable population levels for 5 consecutive years. (USFWS, 1995)

Establish and implement formal land management designations and resource management plans for each of the three populations to assure their continued long-term protection. (USFWS, 1995)

Recovery Actions:

- Control activities which affect the habitat of *A. montii* through Sections 7 and 9 of the Endangered Species Act and other relevant laws and regulations. (USFWS, 1995)
- Inventory suitable habitat for *A. montii* and determine with a high degree of accuracy the population and distribution of the species. (USFWS, 1995)
- Determine the biological and ecological factors critical to the species conservation and conduct minimum viable population studies in each of the species known populations. (USFWS, 1995)
- Establish and implement formal Forest Service land management designations and habitat management plans which will provide for long term, undisturbed protection for *A. montii* and its habitat. (USFWS, 1995)
- Develop public awareness, appreciation, and support for the conservation of *A. montii*. (USFWS, 1995)

Conservation Measures and Best Management Practices:

- None specified

References

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Final Rule To Determine *Astragalus montii* (Heliotrope milkvetch) To Be Threatened Species, With Designation of Critical Habitat. Final Rule. 52 FR 42652-42657 (November 6, 1987).

SPECIES ACCOUNT: *Astragalus osterhoutii* (Osterhout milkvetch)

Species Taxonomic and Listing Information

Listing Status: Endangered; 07/13/1989; Mountain-Prairie Region (R6) (USFWS, 2015)

Physical Description

A tall rush-like plant with linear leaflets and several bright green stems up to 100 centimeters (40 inches) tall. There are 12-25 large white flowers, 2.4 centimeters (1.0 inch) long, per inflorescence (flowering stalk), and stipitate pendulous pods, 4.5 centimeters (1.8 inches) long. (USFWS, 1992)

Taxonomy

Astragalus osterhoutii Jones was described in 1923 by Marcus Jones (in Barneby 1964) from material first collected by George Osterhout in 1905 and 1906 at "Sulphur Springs" in Grand County. A member of the pea family (Fabaceae). (USFWS, 1992)

Historical Range

Endemic to Middle Park near Kremmling in Grand County, Colorado (USFWS, 1992).

Current Range

Near Kremmling in Grand County, Colorado. (USFWS, 1992)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: self-pollination, cross-pollination (USFWS, 1992)

Lifespan

Adult: 2+ years (NatureServe, 2015)

Breeding Season

Adult: June - August (NatureServe, 2015)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 1992)

Reproduction Narrative

Adult: A perennial plant. Flowers bloom June - August, followed by fruit (NatureServe, 2015). Karron (1987a) found that *Astragalus osterhoutii* shared generalist pollinators (polylectic bees) with the common *Astragalus Dattersonii*, rather than its own specialist species of pollinator, but it apparently had less pollinator visits (Karron 1987b). As expected for rare plant species,

Astragalus osterhoutii, although an outcrosser, is still more self-compatible than widespread congenes, evidenced by higher fruit set (Karron 1989) (USFWS, 1992).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Badlands, open shrubland (USFWS, 1992)

Geographic or Habitat Restraints or Barriers

Adult: 2250 - 2400 m elevation (NatureServe, 2015); mountains surrounding Middle Park, closed shrubland vegetation (USFWS, 1992)

Spatial Arrangements of the Population

Adult: Scattered colonies (USFWS, 1992; see current range/distribution)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Inhabits highly seleniferous soils (grayish-brown clays) derived from Niobrara Shale. On moderate slopes, sometimes found growing up through sagebrush (Spackman et al. 1997). Occurs at 2250 - 2400 m elevation. Associated species: *Artemesia tridentata*, *Chrysothamnus viscidiflorus*, *Gutierrezia sarothrae*, *Eurotia lanata*, *Phlox hoodii*, *Eriogonum brevicaulis*, *Agropogon smithii* (NatureServe, 2015). Expansion and migration to possibly suitable habitats elsewhere is blocked by the high mountains surrounding Middle Park. Where shrubs, particularly big sagebrush, have increased in density, resulting in a more closed shrubland vegetation type, the Osterhout milkvetch is reduced in density. Osterhout milkvetch shows evidence of light grazing and can be found on old road cuts and fills, indicating some tolerance for disturbance (Bio/West 1987). The badlands where this species grows are characterized by an open grassy vegetation with scattered shrubs (USFWS, 1992).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Number of Populations:

5 (NatureServe, 2015)

Population Size:

2,500 - 50,000 (NatureServe, 2015)

Adaptability:

Low (inferred from USFWS, 1992)

Population Narrative:

The long term population trend is unknown. Restricted to a specialized soil type which is vulnerable to alteration by human activities. The Federal Register (1998) states that there are 25,000 to 50,000 individuals. There are 6 principal occurrences documented in the Colorado Natural Heritage Program database. One of the 6 occurrences has not been observed in over 20 years (NatureServe, 2015). Life history studies indicate that *Astracalus osterhoutii* has the rare plant attributes of low pollinator visitation and low genetic polymorphism. (USFWS, 1992).

Threats and Stressors

Stressor: Off-highway vehicles (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: Presently, the major threat is from habitat destruction from all-terrain vehicles going off road. OHVs target the barren hillsides that are *Astragalus osterhoutii*'s habitat. The Colorado Natural Areas Program has worked with the State Land Board and the local OHV community on the Idiot's Hill population to mitigate OHV impacts, by keeping folks on trails and away from *A. osterhoutii*, and in 2011 put up an interpretative sign at the site (NatureServe, 2015).

Stressor: Reservoir construction (USFWS, 1992)

Exposure:

Response:

Consequence:

Narrative: The major population of *Astracalus osterhoutii* along Muddy Creek, on 132 acres and representing about 90 percent of the total for the species, is threatened by the proposed Muddy Creek Reservoir. With construction of the high dam proposal at 7,485 feet elevation, 18 acres or about 3 percent of the Muddy Creek population would be inundated. In addition, 80 acres, or 60 percent of the habitat of *Astracalus osterhoutii*, could be threatened by secondary impacts from recreational activities associated with the Muddy Creek Reservoir proposal. Additional direct losses from reservoir construction could result from the raised water table through perennial soil saturation and from surface disturbance due to construction activities such as road building, creation of borrow pits, and heavy equipment movement (Bio/West 1988, Grah and Neese 1987). The presence of the reservoir would likely stimulate private development within the plant's range near the reservoir (USFWS, 1992).

Stressor: Mining and energy development (USFWS, 1992)

Exposure:

Response:

Consequence:

Narrative: Mining claims exist along Muddy Creek where the Osterhout milkvetch occurs. This habitat is open to oil and gas leasing (USFWS, 1992).

Recovery

Reclassification Criteria:

The following criteria should ensure the continued existence of the species and the maintenance of its habitat:

1. Land management designations are established and habitat management programs are developed and implemented for all known populations of *Astracalus osterhoutii* (USFWS, 1992).
2. The species is protected from detrimental environmental impacts through fulfillment of informal and formal consultation responsibilities under Section 7 and protection regulations under Section 9 of the Endangered Species Act (USFWS, 1992).

Factors required to establish and maintain minimum viable populations of the species are identified and minimum viable populations are documented as being maintained (USFWS, 1992).

Delisting Criteria:

N/A: removal from the list of endangered and threatened species (recovery) is not considered feasible because of small natural populations, limited habitat, and persistent nature of potential threats (USFWS, 1992).

Recovery Actions:

- Inventory any remaining potential habitat: Identifying and surveying potential habitat is important for both species, but especially so for *Penstemon penlandii* due to its very limited known distribution. The best way to ensure this species long-term viability would be to discover more populations and ensure their protection and management. Most populations of *Penstemon oenlandii* occur on private lands. The discovery of additional populations of this species on public lands would decrease the species vulnerability and help ensure its long-term viability. Surveys for this species on public lands are a high priority need. (USFWS, 1992)
- Protect existing habitat: Because of the limited amount of habitat, it is important that known habitats be impacted as little as possible. Various strategies are needed for the different threats and landownerships. (USFWS, 1992)
- Protect pollinators Successful reproduction and maintenance of genetic diversity requires sufficient numbers and types of pollinators. (USFWS, 1992)
- Conduct life history/ecology studies In order to understand how to establish and maintain minimum viable populations of each species, additional population biology and ecology studies are necessary. (USFWS, 1992)
- Future actions: The necessity of these actions will be determined by the results of the studies described above. These may include: Management of surface disturbance; Management of plant communities; and Restoration of disturbed habitats. (USFWS, 1992)

References

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SPECIES ACCOUNT: *Astragalus phoenix* (Ash meadows milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Threatened; 5/20/1985; Pacific Southwest Region (R8) (USFWS, 2015)

Physical Description

A low, mat-forming perennial herb; mats up to 5 dm in diameter. Purple flowers are borne on tiny erect stems from April to early May (NatureServe, 2015).

Taxonomy

A member of the Fabaceae (pea family) (USFWS, 2009).

Historical Range

This species is endemic to the Ash Meadows area of Nye County, Nevada (USFWS, 2009).

Current Range

Occurs in a 7 x 3 mile area in Ash Meadows, Nye Co., Nevada (NatureServe, 2015). The range of the species encompasses the Ash Meadows National Wildlife Refuge and adjacent Bureau of Land Management and private lands (USFWS, 2009).

Critical Habitat Designated

Yes; 5/20/1985.

Legal Description

On May 20, 1985, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Astragalus phoenix* (Ash meadows milk-vetch) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Nevada (50 FR 20777-20794).

Critical Habitat Designation

The critical habitat designation for *Astragalus phoenix* includes one CHU in Nye County, Nevada (50 FR 20777-20794).

Nevada, Nye County, Ash Meadows.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Astragalus phoenix* critical habitat consists of one component (50 FR 20777-20794):

Known primary constituent elements include dry, hard, white, barren, saline, clay flats, knolls, and slopes.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Self-fertilization (USFWS, 2009)

Lifespan

Adult: Unknown, presumed > 10 years (USFWS, 2009)

Dependency on Other Individuals or Species

Adult: Probably *Anthophora porterae* (USFWS, 2009)

Key Resources Needed for Breeding

Adult: Winter and early spring rains (USFWS, 2009)

Reproduction Narrative

Adult: Flowers are present from April to early May (Reveal 1979, pp. 2 - 4 and 14 - 15). The biology and life history of the Ash Meadows milkvetch are consistent with a stress-tolerant life history as described by Grime (1977, pp. 1175 - 1181; 1984, pp. 29 - 33). Stress-tolerant plants are typically relatively long-lived with low annual seed production, except during favorable conditions (Grime 1977, pp. 1174 and 1180). Reveal notes winter and early spring rains are required to produce large numbers of flowers, but some flowering probably occurs each year regardless of conditions. During a year with above average precipitation, seed production was estimated to be between 45 and 246 fully formed seeds per average size plant. An examination of the seed to ovule ratio in mature fruits suggested that the ash Meadows milkvetch is an inbreeding species with no pollinator limitations (Pavlik et al. 2006, p. 29). More recent studies indicate that it is visited by a bee (*Anthophora porterae*) that is likely a vital pollinator for the species (Bio-West 2009, pg 3). Germination events and seedlings are rare (Reveal 1978, p. 12). The lifespan of individual plants is not known, but is believed to exceed 10 years (USFWS, 2009).

Habitat Type

Adult: Terrestrial, wetland, spring (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Desert wetland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 2,200 - 2,300 ft. elevation (USFWS, 2009)

Environmental Specificity

Adult: Very narrow (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: High (inferred from USFWS, 2009; see reproduction narrative)

Habitat Narrative

Adult: Occurs on dry, hard, white, barren flats, washes, and knolls of calcarious alkaline soils at Ash Meadows - a desert wetland ecosystem maintained by several dozen springs and seeps (NatureServe, 2015). Given the presence of salt crusts and occurrence of halophytes, it is likely that Ash Meadows milkvetch has adaptations that allow it to tolerate saline soils. It grows between 2,200 and 2,300 feet above sea level. Surface and/or subsurface groundwater that

reaches the surface through capillary action may be an important habitat determinant for at least some populations (USFWS, 2009).

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 2009)

Dispersal/Migration Narrative

Adult: Wind and water appear to be the primary vectors for dispersal (Reveal 1978, p. 12). Reveal (1978, p. 14) observed much of the seed produced probably does not disperse long distances and remains within the leaves and branches of the parent plant (USFWS, 2009).

Population Information and Trends

Population Trends:

Not available

Species Trends:

Improving (USFWS, 2009)

Resiliency:

Low (inferred from USFWS, 2009; see current range distribution)

Representation:

Low (inferred from USFWS, 2009; see reproduction narrative)

Redundancy:

Low (inferred from USFWS, 2009)

Population Growth Rate:

Slow (USFWS, 2009)

Number of Populations:

6 (USFWS, 2009)

Population Size:

~11,643 (USFWS, 2009)

Population Narrative:

Research conducted by Pavlik et al. (2006, p. 27) indicates population growth is probably constrained by low seed output per plant. Refuge-wide surveys of listed and rare plants were begun in 2008; the total population on the Refuge is now estimated at 11,643 individuals (Bio-West 2008, p. 24). There are six general areas where the species is known to occur. The status of the Ash Meadows milkvetch has substantially improved since it was petitioned for listing in 1983 (USFWS, 2009).

Threats and Stressors

Stressor: Groundwater pumping (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: This species depends, in part, on near-surface water for its survival. Although the Service has established water rights to 96% of the spring discharge within the Refuge, the Service will have to demonstrate through analyses that the net impact of any change applications will have a negative effect on Ash Meadows. To the extent that the Service is unsuccessful in demonstrating net negative impacts in at least some of these cases, additional incremental declines in spring discharge may occur at Ash Meadows. Such incremental declines could be difficult to attribute to any particular cause after the fact and, therefore, would be difficult to remedy (USFWS, 2009).

Stressor: Surface mining (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The playa sediments covering much of the ash Meadows area contain clays and other minerals, which may be considered "uncommon varieties", and therefore could potentially be classified as "locatable minerals" under existing mining laws. New mineral claims and subsequent mining could cause direct loss of Ash Meadows milkvetch habitat, as well as indirect impacts by diverting or draining water away from occupied habitat. About 80% of the known occurrences of Ash Meadows milkvetch within the Refuge are open to mineral entry (USFWS, 2009).

Stressor: Nonnative species (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Over 100 nonnative species occur on the Refuge. Of these, salt cedar, Russian knapweed, five hook bassia, Malta star thistle, yellow star thistle, and hoary cress are noxious weeds that could potentially threaten the Ash Meadows milkvetch (Service 2006, p. 8). Cheatgrass, red brome, Mediterranean grass, and annual fescue are annual grasses that could potentially threaten the Ash Meadows milkvetch (USFWS, 2009).

Stressor: Rabbit herbivory (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: During a demographic study initiated in the spring of 2005, Pavlik et al. (2006, p. 9) found that a very high proportion of developing fruits had been clipped off at the pedicel and eaten by rabbits. They found an 80% loss of potential reproductive output across all subpopulations. Herbivory poses no short-term threat to Ash Meadows milkvetch because individual plants are long-lived, but the significance of any threat posed by rabbits to its persistence over the foreseeable future is poorly understood (USFWS, 2009).

Recovery

Reclassification Criteria:

1. All non-native animals and plant species must be eradicated for essential habitat. These non-native species currently include sailfin mollies, mosquito fish, largemouth bass, black bullheads, bullfrogs, crayfish, turban snails, wild horses, salt cedar, and Russian olive (USFWS, 2009).
2. Secure and protect the Ash Meadows aquifer so that all spring flows return to historic discharge rates, and the water level in Devils Hole is maintained at a minimum level of 1.4 feet below the copper washer (USFWS, 2009).
3. Reestablish water to historic springbrook channels, which are free of barriers that eliminate genetic exchange between populations by preventing movement of native fishes throughout their historic range (USFWS, 2009).
4. The essential habitat must be secure from detrimental human disturbance including mining, OHVs, and the introduction of non-native species (USFWS, 2009).

Delisting Criteria:

1. Criteria shown above for downlisting from endangered to threatened (USFWS, 2009).
2. Secure, protect, and maintain in natural vegetation, corridors, and adjacent buffer areas for gene flow and dispersal of listed plant species within the essential habitat (USFWS, 2009).
3. Native plant communities and aquatic communities have been reestablished to historic structure and composition within all essential habitats (USFWS, 2009).
4. All of the listed plant species and the candidate plant species are present in all the sites that they have historically occupied as identified in Appendix A Table XV of the Recovery Plan. Within each critical habitat unit, the listed plant has a frequency value equal to or greater than the frequency value determined by Task 644 needed as an indicator of a self-sustaining plant population (USFWS, 2009).

Recovery Actions:

- Secure habitat and water sources for the Ash Meadows ecosystem (USFWS, 1990).
- Conduct research on the biology of the species (USFWS, 1990).
- Conduct management activities within essential habitat (USFWS, 1990).
- Reestablish populations/monitor new & existing populations (USFWS, 1990).
- Determine/verify recovery objectives (USFWS, 1990).

Conservation Measures and Best Management Practices:

- Over the next five years, the Service should focus on clarifying or resolving the uncertainties regarding the significance of the remaining threats to Ash Meadows milkvetch, i.e., groundwater pumping, surface mining, and herbivory (USFWS, 2009).
- The Service anticipates that major issues with respect to the significance of the threat posed by groundwater pumping will become clear over the next five years. Specifically, we expect that the Nevada State Engineer will clarify how Order 1197 will be implemented. In addition, environmental analyses will likely be completed on the anticipated effects of at least some of the proposed solar energy projects, and these should include detailed assessments of the potential effects of any

groundwater development requirements on the regional and local aquifers, including potential effects on the springs and groundwater table within the Refuge. The Service should participate in the review of these analyses to ensure that they adequately disclose all potential impacts that could affect Ash Meadows milkvetch. The Service will also continue its participation in interagency monitoring, modeling, and assessment of the Death Valley Groundwater Flow System (USFWS, 2009).

- The Service and BLM should continue to work toward the completion of the land and mineral withdrawals for public lands within the Refuge and the ACEC. This will likely require that once the withdrawal packages have been forwarded by BLM's Nevada State Director to BLM's Washington Office, that briefings be scheduled with the Service's Washington Office to ensure that the importance of this withdrawal to all of the listed species at Ash Meadows, as well as the ash Meadows ecosystem, is recognized (USFWS, 2009).
- Research on the potential significance of the rabbit herbivory on the long-term viability of Ash Meadows milkvetch should be prioritized, especially research focused on whether a sufficient seed bank is present to support recruitment when the proper environmental conditions occur. This research should also address potential management options to mitigate the impacts of herbivory on Ash Meadows milkvetch. Additional research is also needed on the sensitivity of the species to hydrological alterations and, in particular, its dependency on soil moisture drawn by capillary action from the near surface groundwater table. Finally, research is needed on the role of hydrologic process in seed dispersal and the extent to which past surface modifications have disrupted this process and the degree to which that affects the viability of current populations (USFWS, 2009).

References

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U.S. Fish and Wildlife Service. 1990. Recovery plan for the endangered and threatened species of Ash Meadows, Nevada. U.S. Fish and Wildlife Service, Portland, Oregon. 123 pp.

SPECIES ACCOUNT: *Astragalus pycnostachyus* var. *lanosissimus* (Ventura Marsh Milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Endangered; 5/21/2001; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

Astragalus pycnostachyus var. *lanosissimus* is a short-lived herbaceous perennial. It has a thick taproot and multiple erect, reddish stems, 40 to 90 centimeters (cm) (16 to 36 inches (in)) tall that emerge from the root crown. The pinnately compound leaves are densely covered with silvery-white hairs with 27 to 39 leaflets that are 5 to 20 millimeters (mm) (0.2 to 0.8 in) long. The numerous yellowish-white to cream colored flowers are in dense clusters and are 7 to 10 mm (0.3 to 0.4 in) long with 2 to 4 cm (0.8 to 1.6 in) peduncles (Spellenberg 1993). The calyx tube is 3 to 4 mm (0.12 to 0.16 in) long with 1.2- to 1.5-mm (0.04-in) long calyx teeth (Spellenberg 1993). The nearly sessile, single-celled pod is 8 to 11 mm (0.31 to 0.43 in) long (Barneby 1964) (USFWS, 2010).

Taxonomy

Member of the Fabaceae (pea family) (USFWS, 2010).

Historical Range

Historically, Ventura to Orange County, California; along the coast in salt marshes (NatureServe, 2015).

Current Range

Currently known from one naturally-occurring site in Ventura County (U.S. Fish and Wildlife Service 2001). There are also four introduction sites, two in Ventura County and two in Santa Barbara County (which is outside the historic range of this taxon) (M. Meyer pers. comm. 2010) (NatureServe, 2015).

Critical Habitat Designated

Yes; 5/20/2004.

Legal Description

On May 20, 2004, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Astragalus pycnostachyus* var. *lanosissimus* (Ventura Marsh Milk-vetch) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in California (69 FR 29081-29100).

Critical Habitat Designation

The critical habitat designation for *Astragalus pycnostachyus* var. *lanosissimus* includes three CHUs in Santa Barbara and Ventura Counties, California. This species critical habitat encompasses approximately 420 acres (ac) (170 hectares (ha)) (69 FR 29081-29100).

Mandalay Unit: The Mandalay Unit is approximately 153 ac (62 ha) in size and is essential to the conservation of *Astragalus pycnostachyus* var. *lanosissimus* because it contains the only known

location where *Astragalus pycnostachyus* var. *lanosissimus* naturally exists and the remainder of the unit also supports the primary constituent elements. The State-owned Mandalay State Beach is managed by the Ventura County Parks and Recreation Department and comprises about 49 ac (20 ha) of this unit. The remaining area of the unit is privately owned and is currently undeveloped, but has been chosen as the site for a 300-housing-unit subdivision (Economic and Planning Systems, Inc. 2003). The pending development is called North Shore at Mandalay and would occur in the eastern portion of this critical habitat unit. The project includes a 1.65-ac (0.67-ha) "milk-vetch preservation area" encompassing the entire natural population (California Coastal Commission 2002), which in turn, would be inside a 23.8-ac (9.6-ha) resource protection area (RPA). The RPA would be buffered from adjacent residential development by a 50-ft (15 m) wide landscaped area. The population will be mostly isolated from surrounding vegetation, and the ecological processes sustaining the population may be interrupted. Also, the project may allow increased human intrusion, provide habitat for nonnative plants and snails, alter the hydrologic regime, and introduce pesticides and fertilizers that adversely affect the plants. Therefore, the risk of extinction of the subspecies is high without the development of additional populations. The portion of this unit on Mandalay State Beach is identified by Wilken and Wardlaw (2001) as a possible site for establishing a new population of *Astragalus pycnostachyus* var. *lanosissimus*. In 2003, the first efforts at researching how new populations could be established in this unit were begun. The proximity of Mandalay State Beach to the extant population indicates that some natural exchange of seeds or pollen could take place if a second population were established at Mandalay State Beach. The site contains one or more of the primary constituent elements defined for *Astragalus pycnostachyus* var. *lanosissimus* critical habitat, although Wilken and Wardlaw (2001) note some dense cover of nonnative annuals. Also, using their five parameters, Wilken and Wardlaw (2001) ranked the Mandalay State Beach portion of this unit as one of the most similar to the natural occurrences of *Astragalus pycnostachyus* var. *lanosissimus* and the closely related *Astragalus pycnostachyus* var. *pycnostachyus*, and hence one of the top candidates for establishing a new population. California Department of Parks and Recreation (CDPR) has approved experimental introductions of *Astragalus pycnostachyus* var. *lanosissimus* conducted by the CDFG. Because the area is public land owned by the CDPR and the species is Statelisted, we will work with the State to develop conservation strategies to reintroduce the subspecies and develop and manage reserves. As discussed above, this unit is essential for the conservation of *Astragalus pycnostachyus* var. *lanosissimus* because it contains the primary constituent elements for *Astragalus pycnostachyus* var. *lanosissimus*. The population of *Astragalus pycnostachyus* var. *lanosissimus* at the North Shore at Mandalay site is the only naturally occurring, self-perpetuating population of the species in existence. It has provided all of the initial propagules for establishing research populations of the species at other sites, and continues to be the source of genetic variability for future propagation. The research populations at McGrath State Beach and Carpinteria Marsh are not intended to become new populations for the recovery of the species, but were established to generate data on the species' needs when such introductions for recovery begin. Their persistence is uncertain, and we have observed some failures (see Background section). Consequently, the population of *Astragalus pycnostachyus* var. *lanosissimus* on the North Shore at Mandalay site is currently the only one of which we can be relatively certain that the plants will persist. If this population is extirpated, and the research populations ultimately fail, all of the remaining individuals of *Astragalus pycnostachyus* var. *lanosissimus* will exist as seeds in collections or propagated in greenhouses. The designation of the North Shore at Mandalay site as critical habitat recognizes that this population is essential to the species' conservation. This southernmost unit is geographically separated from other critical habitat within its historical

range. This will reduce the likelihood of all populations being destroyed by one naturally occurring catastrophic event.

McGrath Unit: The site within McGrath Beach State Park is adjacent to McGrath Lake on the leeward side of the southern end of the lake, between the lake and Harbor Boulevard. The unit covers 62 ac (25 ha). It includes 35 ac (14 ha) of private land and 27 ac (11 ha) of State-owned land managed by CDPR. Of the sites they examined, Wilken and Wardlaw (2001) identify the McGrath Lake area as having the best combination of habitat characteristics similar to that of the extant population of *Astragalus pycnostachyus* var. *lanosissimus* and its closest relative, *Astragalus pycnostachyus* var. *pycnostachyus* based upon five parameters (i.e., dominant vegetation composed of a shrub canopy less than 75 percent; absence of competitive annual or perennial exotic plants; water table in close proximity; soil types consistent with that at the site of the extant population; and native habitat supporting pollinators). CDPR agreed to allow CDFG and RSABG establish a research population on this site. This effort is still in its early stages, and no conclusive data have yet been retrieved. Because the area is currently operated by CDPR and is public land, there is opportunity to work with the State to develop reintroduction strategies for *Astragalus pycnostachyus* var. *lanosissimus* and to form manageable reserves. This unit is also one of the last known places where the subspecies was observed growing naturally, and it is close to the extant population and shares many of the broader climatic and habitat features of that site. As discussed above, this unit is essential for the conservation of *Astragalus pycnostachyus* var. *lanosissimus* because it once supported a population *Astragalus pycnostachyus* var. *lanosissimus* until it was extirpated in 1967. It contains the primary constituent elements for *Astragalus pycnostachyus* var. *lanosissimus*. It includes habitat that is necessary for the expansion of the only known population, which may become nonviable in the future. It contains habitat features that are essential for this species including, but not limited to, high diversity of native plants, open canopy, sandy dune hollows, seep margin areas, subterranean water table. This central unit is geographically separated from other critical habitat within *Astragalus pycnostachyus* var. *lanosissimus* historical range. This will reduce the likelihood of all populations being destroyed by one naturally occurring catastrophic event.

Carpinteria Salt Marsh Unit: The Carpinteria Salt Marsh Unit extends from the Southern Pacific Railroad tracks south and west to Sand Point Drive and Santa Monica Creek and is approximately 205 ac (83 ha) in size. The entire unit is managed by the UC, Santa Barbara. This unit includes saltmarsh habitat, which is essential to support the pollinators and other ecological processes that *Astragalus pycnostachyus* var. *lanosissimus* requires for its survival. The research population of *Astragalus pycnostachyus* var. *lanosissimus* was introduced in April 2002 into a portion of the unit. As of February 2003, 44 percent (68) of the 155 original plants survived. By June 2003, only 20 seedlings had been produced by plants at one of the planting sites. We have determined that this area contains the primary constituent elements necessary for the introduction of *Astragalus pycnostachyus* var. *lanosissimus* based on Wilken and Wardlaw's (2001) description of five parameters of habitat suitability. These parameters closely parallel the primary constituent elements, so one or more of the elements are represented at this site. The diverse native vegetation provides for a robust pollinator community. The unit is bordered by a residential community where nonnative snails were observed; protection is required for herbivory by snails on *Astragalus pycnostachyus* var. *lanosissimus* plants. This site in Santa Barbara County is near the range of the subspecies as predicted by the historical collections and described by Skinner and Pavlik (1994), who list the known counties as Ventura, Los Angeles, and Orange. We have included this unit because, although it is outside the historical range for *Astragalus*

pycnostachyus var. lanosissimus: (1) Insufficient suitable habitat for the subspecies remains within its historical range; and (2) the area has habitat features essential to the conservation of the subspecies, which suggests a high potential for successful establishment of a new population (Wilken and Wardlaw 2001). This unit is essential for the conservation of *Astragalus pycnostachyus* var. *lanosissimus* because it supports the pollinators and other ecological processes for *Astragalus pycnostachyus* var. *lanosissimus*. It contains habitat features that are essential for this species including, but not limited to, dominant vegetation composed of a shrub canopy less than 75 percent; absence of competitive annual or perennial exotic plants; water table in close proximity; soil type; and native habitat supporting pollinators. Seedling recruitment has been observed at this site in the research population. This northernmost unit is geographically separated from other critical habitat. This will reduce the likelihood of all populations being destroyed by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Astragalus pycnostachyus* var. *lanosissimus* critical habitat consists of five components (69 FR 29081-29100):

- (i) Vegetation cover of at least 50 percent but not exceeding 75 percent, consisting primarily of known associated native species, including but not limited to, *Baccharis salicifolia*, *Baccharis pilularis*, *Salix lasiolepis*, *Lotus scoparius*, and *Ericameria ericoides*;
- (ii) Low densities of nonnative annual plants and shrubs;
- (iii) The presence of a high water table, either fresh or brackish, as evidenced by the presence of channels, sloughs, or depressions that may support stands of *Salix lasiolepis*, *Typha* spp., and *Scirpus* spp.;
- (iv) Soils that are fine-grained, composed primarily of sand with some clay and silt, yet are well-drained; and
- (v) Soils that do not exhibit a white crystalline crust that would indicate saline or alkaline conditions.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the areas determined to be essential for the conservation of the species may require special management or protections. The Mandalay Unit may require special management considerations or protections due to the threats to the species and its habitat posed by development (e.g., loss of native vegetation, disruption of pollinator community, herbivory by snails, increase in non-native plants, soil remediation), herbivory by rabbits, and trampling as a result of human activity. Currently, competition by non-native plants, herbivory by snails and rabbits, and human activity are ongoing in the Mandalay Unit. The McGrath Unit may require special management considerations or protections due to the threats to the species and its habitat posed by invasive, non-native plants and trampling as a result of human activity. Currently, competition from non-native plants and human activity are ongoing in the McGrath Unit. The Carpinteria Salt Marsh Unit may require special management considerations or protections due to the threats to the species and its habitat posed by

nonnative plants and high salinity. Currently, competition from non-native plants and fluctuations in salinity levels are ongoing in the Carpinteria Salt Marsh Unit.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: self-pollination, cross-pollination (USFWS, 2010)

Lifespan

Adult: 3 - 4 years (USFWS, 2010)

Breeding Season

Adult: July - October, one observation in June (USFWS, 2010)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 2010); soil seed bank (USFWS, 2004)

Reproduction Narrative

Adult: It is believed to have a 3 to 4-year life span (Wilken and Wardlaw 2001). The blooming time has been recorded as July to October (Barneby 1964); however, the population at the site where the plants were rediscovered, referred to as the site of natural occurrence, was observed in flower in June 1997. Wilken and Wardlaw (2001) observed peak flowering of the plants at this site in mid-July with most flowers maturing into fruits by early September. The variety appears to be self-compatible and partly self-pollinating (Wilken and Wardlaw 2001); however, the flower structure of this variety, and other *Astragalus* species, suggests that pollination requires manipulation of flower parts by insects (Wilken and Wardlaw 2001). Wilken and Wardlaw (2001) observed a limited number of skippers (family Hesperidae) and bumblebees (*Bombus* spp.) visiting the plants. Other researchers have observed various bee and butterfly species frequently visiting *A. pycnostachyus* var. *lanosissimus* (Meyer 2007a, Jensen 2007), indicating that insects may be the natural pollinators of this plant. The life cycle of *A. pycnostachyus* var. *lanosissimus* likely requires a pollinator community to be present (Greer et al. 1995; Karron 1987). Wilken and Wardlaw (2001) observed an average of 26 inflorescences per plant, with an average of 36 flowers per inflorescence, and between 7 and 9 ovules per ovary (a potential maximum of 7 to 9 seeds per flower). However, the number of seeds per fruit was only approximately 2 on average. This level of productivity is low relative to many other species of *Astragalus* that are known to be self compatible and therefore would be expected to produce more seed (Karron 1987). Seed production is suspected to be limited by a lack of pollination. This delayed seed germination, combined with the observation that plants may not become reproductive until 18 to 30 months following germination, and a low seedling survival rate (Wilken and Wardlaw 2001), indicates a low recruitment rate for the variety (USFWS, 2010). The population is able to persist due to having established a seedbank (not all seeds produced in one year will germinate the following year) (USFWS, 2004).

Habitat Type

Adult: Terrestrial, wetland, aquatic (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Dune, grassland, shrubland, spring, herbaceous wetland (NatureServe, 2015); coastal dune-swales (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: 0 - 30 m elevation (NatureServe, 2015); high competition from other plant species (USFWS, 2010)

Environmental Specificity

Adult: Very narrow to narrow (NatureServe, 2015)

Habitat Narrative

Adult: Historically probably occurred on open sites near the coast on soils with a high water table, such as on bluffs or flats near seeps or bodies of brackish or fresh water, or in or near coastal marshes. Currently, a population occurs on an abandoned oil-field waste site in remnant backdunes. This area has an artificially compact substrate of clay, sand, and small gravel, above a capped oil layer, generally about 45 cm below the soil surface. Occurs from 0 - 30 m elevation. The environmental specificity is very narrow to narrow, although habitat requirements are poorly understood (NatureServe, 2015). Based on existing information from historical collections, Wilken and Wardlaw (2001) concluded that the variety occurs in low elevation coastal dune-swale areas where freshwater levels (in the form of saturated soils or groundwater) are high enough to reach the roots of the plants. The soils associated with *Astragalus pycnostachyus* var. *lanosissimus* are well-drained, yet contain a mix of sand and clay. Meyer (2007a) indicated that low competition from native and nonnative species contributes to the success of *Astragalus pycnostachyus* var. *lanosissimus* establishment in these areas (USFWS, 2010). Primary constituent elements include vegetation cover of at least 50 percent but not exceeding 75 percent; low densities of nonnative annual plants and shrubs; the presence of a high water table, either fresh or brackish; soils that are fine-grained, composed primarily of sand with some clay and silt, yet are well-drained; and soils that do not exhibit a white crystalline crust that would indicate saline or alkaline conditions (USFWS, 2004).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Decline of 50-90% (NatureServe, 2015); believed extinct until 1997 (USFWS, 2010)

Species Trends:

Declining (USFWS, 2010)

Resiliency:

Low (inferred from NatureServe, 2015; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2004)

Population Growth Rate:

Slow (inferred from USFWS, 2004)

Number of Populations:

1 naturally occurring (USFWS, 2004); 4 introduced (NatureServe, 2015)

Population Size:

Natural site: 31 (USFWS, 2010); introduced sites: 801 (NatureServe, 2015)

Adaptability:

Low (inferred from NatureServe, 2015)

Population Narrative:

For the only known naturally-occurring population, low population size increases vulnerability to decline/extirpation from stochastic events. This species has experienced a long-term decline of 50-90%. Recent population sizes at the naturally-occurring site include 104 plants (60 flowering) in 2006 and 27 plants (19 flowering) in 2009 (M. Meyer unpublished data 2010). This represents an overall decline corresponding to two low rainfall years and completion (in 2007) of remediation on the surrounding area outside the 1.6 acre enclosure in which plants occur. Collectively, the four introduced sites had 801 plants (283 flowering) in 2009; most of these individuals were at one of the Santa Barbara County sites (M. Meyer unpublished data 2010). Most historical or extirpated; one naturally-occurring site discovered in Ventura County in 1997 (U.S. Fish and Wildlife Service 2001). The presumption is that the original source of seed at this site came from some either onsite or nearby top soil brought in to cap the oil waste facility when it closed in 1982 (M. Meyer pers. comm. 2010). There are also four introduction sites, two in Ventura County and two in Santa Barbara County (which is outside the historic range of this taxon). As yet, it is unclear whether these introductions will persist and become self-sustaining populations (M. Meyer pers. comm. 2010) (NatureServe, 2015). It was believed to be extinct until its rediscovery in 1997. Currently the North Shore site supports only 31 individuals and the habitat at the site has possibly been permanently negatively altered by remediation activities in areas surrounding the plants. Research was conducted to identify potential suitable habitat characteristics and introductions were attempted at several sites within and outside the historic range of the species, including Ormond Beach, Mandalay State Beach, McGrath Beach, Carpinteria Salt Marsh, and Coal Oil Point. *Astragalus pycnostachyus* var. *lanosissimus* did not survive at Ormond Beach. Plants currently remain at the other outplanting sites, but have shown a relatively steady decline in abundance since the heavy rains of 2004-2005, and may benefit from another substantially wet season (USFWS, 2010). The single natural population of *Astragalus pycnostachyus* var. *lanosissimus* near the city of Oxnard is in a degraded backdune community. Due to the combination of poor seedling and young plant survivorship and low seed production, the single naturally occurring population of *Astragalus pycnostachyus* var. *lanosissimus* has continued to decline since its rediscovery in 1997 and through the 2001 season (Impacts Sciences 1997, 1998; Wilken and Wardlaw 2001; Dieter Wilken, Santa Barbara Botanic Garden, pers. comm. 2002) (USFWS, 2004).

Threats and Stressors

Stressor: Habitat destruction (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: much of the habitat that supported historical populations of *Astragalus pycnostachyus* var. *lanosissimus* has been altered or destroyed such that it is no longer suitable for the species. Habitat conditions at the North Shore site have been altered by remediation activities, but will be protected by a preserve created as part of the MOU between CDFG and the project proponent (USFWS, 2010).

Stressor: Disease and predation (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The seeds of *Astragalus pycnostachyus* var. *lanosissimus* at the site of natural occurrence were heavily infested with seed beetles (Bruchidae: Coleoptera) in 1997. In a seed collection made for conservation purposes in 1997, most fruits partially developed at least 4 seeds but seed predation reduced the average number of undamaged seeds to only 1.8 per fruit (Steeck and Meyer, in litt. 1997). The nonnative milk snail (*Otala lactea*) was observed causing damage to the foliage of *Astragalus pycnostachyus* var. *lanosissimus* in 1998 and 1999 concurrent with a dramatic decline in seedling plants (Meyer 2007a). European brown garden snails (*Helix aspersa*) are frequently observed at the outplanting sites and can potentially defoliate individual plants, damage new growth, and compromise vigor (Jensen 2007; Meyer 2007a). Meyer (2007a) reports that gophers (*Thomomys bottae*), rabbits (presumably *Lepus* spp. or *Sylvilagus* spp.), and meadow voles (*Microtus* spp.) are common at the milk-vetch outplanting sites and impact plants by removing seedlings and damaging established plants. Sooty fungus continues to be occasionally observed on *A. pycnostachyus* var. *lanosissimus* individuals, but does not appear to substantially adversely affect the health or productivity of the plants (USFWS, 2010).

Stressor: Stochastic events (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: At the time of listing *Astragalus pycnostachyus* var. *lanosissimus* in 2001, the Service discussed that the taxon is threatened with extinction from unanticipated human activities and natural events by virtue of the very limited number of individuals in, and the small area occupied by, the only known extant population. A wildlife predation event in the summer before seeds have matured, a plane crash (the taxon is under the extended center flight line of the Oxnard airport and a crash occurred on the site in 1995), and other natural or unanticipated human-caused events could eliminate the existing population and result in the extirpation of this taxon from the only known remaining site of natural occurrence in the wild.

Stressor: Inadequate preserve design (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The small size of the preserve and its proximity to future urban and suburban uses makes it subject to the effects of nonnative, invasive plant and animal species, increased nutrient-rich water supply due to suburban irrigation runoff and increased impervious surfaces, and chemicals such as herbicides, pesticides, and fertilizers (see Conservation Biology Institute 2000, CDFG 2000 and references therein). Independently or in combinations, these factors present difficult management challenges which, if not adequately addressed, could lead to the elimination of *A. pycnostachyus* var. *lanosissimus* from the North Shore site. Nonnative plant and animal species are competitors and predators, respectively, that can directly reduce survival of native plants and they can also upset the invertebrate (pollinator) and vascular plant associations upon which native plants depend (Conservation Biology Institute 2000). While the life history requirements of *A. pycnostachyus* var. *lanosissimus* are not well understood, any factor that substantially alters the hydrology of the site, such as increases or decreases in urban/suburban runoff, may make the site unsuitable for this wetland species (Conservation Biology Institute 2000). Likewise, increased levels of chemicals arriving via runoff or drift can be expected in small preserves and can harm native species (Conservation Biology Institute 2000). These increases could harm *A. pycnostachyus* var. *lanosissimus* directly, or alter the pollinator or plant associations upon which it depends (USFWS, 2010).

Stressor: Competition (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Nonnative weeds such as iceplant, as well as some native species such as *Anemopsis californica* (yerba mansa), *Potentilla anserina* (silverweed) and *Distichlis spicata* (salt grass) can form dense continuous patches that exclude *Astragalus pycnostachyus* var. *lanosissimus* (Meyer 2007a) (USFWS, 2010).

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Recently, the potential impacts of climate change on the flora of California were discussed by Loarie et al. (2008). Based on modeling, they predicted that species' distributions will shift in response to climate change, and that species will "move" or disperse to higher elevations and northward, depending on the ability of each species to do so. While the Service lacks adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors such as small population size, will affect *Astragalus pycnostachyus* var. *lanosissimus*, small-ranged species, such as *A. pycnostachyus* var. *lanosissimus*, are generally more vulnerable to extinction due to these changing conditions (Pimm and Raven 2000, Loarie et al. 2008) (USFWS, 2010).

Stressor: Sea level rise (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: An increase in the rate of sea level rise has been predicted for the coast of California (California Climate Change Center 2006). The occurrences of *Astragalus pycnostachyus* var. *lanosissimus* at Mandalay State Beach, McGrath Lake, and Carpinteria Salt Marsh Reserve are

bounded by residential, industrial, or agricultural areas that would preclude the taxon's migration inland as sea level rises (USFWS, 2010).

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- Convene a recovery team and develop a recovery plan for *Astragalus pycnostachyus* var. *lanosissimus* (USFWS, 2010).
- Work with CDPR staff to continue iceplant removal and habitat restoration around McGrath Lake to improve and expand available habitat for *Astragalus pycnostachyus* var. *lanosissimus* (USFWS, 2010).
- Determine if changes in the upper aquifer at the North Shore site have resulted from remediation activities surrounding the plants, and determine whether a supplemental watering system can compensate for altered water availability, or if additional measures are needed to compensate for negative impacts (USFWS, 2010).
- Build on the work of Meyer, Jensen, Wilken, and others to identify freshwater-dominated coastal wetlands with sufficient surrounding area and proper vegetation (i.e., sufficiently sparse areas, free of dense mats of vegetation) for *Astragalus pycnostachyus* var. *lanosissimus* introduction (USFWS, 2010).

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SPECIES ACCOUNT: *Astragalus robbinsii* var. *jesupi* (Jesup's milk-vetch)

Species Taxonomic and Listing Information

Commonly-used Acronym: JMV

Listing Status: Endangered; 7/6/1987; Northeast Region (R5)

Physical Description

A short-lived perennial, herbaceous legume that is 10 to 50 centimeters (cm) (4 to 20 inches [in]) tall with a tap root. Jesup's milk-vetch stems originate from a single root crown and may branch several times. Older plants tend to be more profusely branched than younger plants. Its leaves are pinnately compound, divided into 9 to 15 oblong to elliptical, glabrous leaflets 8 to 20 millimeters (mm) (0.3 to 0.8 in) long. The first true leaves of seedlings are produced in triads and arrayed in a clover-leaf fashion; as plants mature, the number of leaflets per leaf increases. The raceme of 8 to 21 small (9 to 12 mm [0.3 to 0.5 in long]), pale bluish-violet, pea-like flowers is borne at the top of the stem. Flowering plants may have from 1 to 120 racemes. The inflorescence is compact initially, but as flowering proceeds, the axis of the raceme continues to elongate somewhat throughout fruit development, especially in more shaded conditions (Farnsworth and Harvey 2004). The fruit is a legume about 1.5 to 2 cm (0.6 to 0.8 in) long, borne on a short stem, narrowed at both ends and terminated with a distinctive beak 1.5 to 3 mm (0.8 to 0.1 in) long. The body of the legume has scattered black, appressed hairs. Inflorescences produce, on average, approximately 56 seeds per inflorescence (8 legumes per inflorescence, 7 seeds per legume), although larger plants produce more legumes and seeds per legumes. (USFWS, 2019)

Taxonomy

A member of the legume family (Fabaceae). Jesup's milk-vetch was first collected in 1877 at Sumner Falls in Plainfield, NH by Professor Henry Griswold Jesup of Dartmouth College. The variety (as "jesupi") was subsequently described by Eggleston and Sheldon in 1894 in *Minnesota Botanical Studies* 1: 155, following collection of the specimens (deposited at MINN) by Eggleston on June 7, 1891, on "old ledges above high water of the Connecticut River near Hartland, Vt.... and on ledges near Sumner Falls, near Plainfield, N.H." (Barneby 1964: 131; Revised Jesup's Milk-Vetch Recovery Plan 4 w 3Tropicos Database 2019). Recent synonyms for this taxon include *Astragalus jesupii* (Egglest. & Sheldon) Britt. (published in Britton 1901: 1048) and *Atelophragma jesupii* (Egglest. & Sheldon) Rydberg published in *Bulletin of the Torrey Botanical Club* 55: 125 (1928). Although the taxon was federally listed endangered under the variant spelling *Astragalus robbinsii* var. *jesupi*, and the first recovery plan recognized the taxon as *Astragalus robbinsii* var. *jesupi*, the current nomenclature for the species is *Astragalus robbinsii* var. *jesupii*, following the standards outlined in the International Code of Botanical Nomenclature (accessed February 4, 2019). (USFWS, 2019)

Historical Range

In Sullivan County, New Hampshire, and Windsor County, Vermont. Known from five distinct sites along a 16-mi sector of the Connecticut River between central New Hampshire and central Vermont. (USFWS, 2019)

Current Range

In Sullivan County, New Hampshire, and Windsor County, Vermont. Extant at three distinct sites along a 16-mi sector of the Connecticut River between central New Hampshire and central Vermont. (USFWS, 2019)

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Insect and Self-fertilization (USFWS, 2019)

Lifespan

Adult: Generally 3 years (USFWS, 2019)

Breeding Season

Adult: Flowers in late May or early June; sets seed through August (USFWS, 2019)

Other Reproductive Information

Adult: The Jesup's milk-vetch life cycle consists of seed germination and growth to seedling in year one; emerging as a small, generally nonflowering plant in year two, flowering and dying after flowering in year three. Some plants may produce small Revised Jesup's Milk-Vetch Recovery Plan 14 numbers of flowers in the second year, in which case the plants will typically flower again the following year. Alternatively, depauperate plants may live for 4 years with minimal flowering. Some vegetative plants survive to a fourth year. Self-fertilization is commonly documented in the genus *Astragalus*, facilitated by simultaneous maturation of anthers and stigmas (Barneby 1964). Experiments that excluded pollinators from flowers have shown Jesup's milk-vetch to be capable of self-fertilization. The most common insect visitors of Jesup's milk-vetch flowers are bumblebees identified as *Bombus vagans vagans* Smith (USFWS, 2019)

Reproduction Narrative

Adult: Jesup's milk-vetch plants emerge in April (or as soon as ice cover and temperature permits), and bloom in early- to mid-May. Flowering times are variable year to year (Dunlop 1994). Dunlop (1994) observed that the plants closest to the water's edge at all three sites are the last to flower, possibly reflecting longer periods of spring inundation or a cooling effect on the lower slope. Flowering generally lasts to early July, and seed set occurs from late June to mid-July (Brumback 2009). Most fruits have dehisced by early July. Some fruiting stems have typically withered by mid-August, but vegetative stems usually remain green until September or October (Brumback and Piantedosi 2018a). Seed germination is delayed until the following year (or later) (Brumback 2009). This latter group typically includes depauperate individuals that have not previously flowered or produced very sparse blooms. (USFWS, 2019)

Habitat Type

Adult: Terrestrial (USFWS, 2019)

Habitat Vegetation or Surface Water Classification

Adult: Calcareous bedrock outcrops which are ice-scoured annually (USFWS, 2019)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2019)

Habitat Narrative

Adult: Jesup's milk-vetch inhabits bedrock outcrops of chlorite or phyllite schist that are periodically scoured by flooding and ice-rafting along the Connecticut River. As such, these riparian ledges are sparsely vegetated; however, they support a globally rare natural community type and several rare plant species in addition to Jesup's milk-vetch. Plants at each site occupy a narrow band between a lower bound determined by typical water levels during the growing season and an upper bound defined by the deep shade of long-lived woody vegetation that is at a high enough elevation to survive the occasional severe scouring by ice. (USFWS, 2019)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Seed dispersal mechanisms are unknown for this species, although there is evidence that long distance dispersal is extremely unusual. Given the proximity of the populations to water, it is reasonable to expect that flooding, especially spring freshets, would play a role in transporting overwintering seeds among sites. However, seed dispersal may be naturally limited since mature seeds readily sink in water (Kane 2011a, It is probable that the vast majority of seeds produced by a population likely remain in close proximity to parent plants and that long-distance dispersal is rare. (USFWS, 2019)

Population Information and Trends**Population Trends:**

Tenuous (USFWS, 2019)

Species Trends:

Stable (inferred from USFWS, 2019)

Number of Populations:

3 (USFWS, 2019)

Population Size:

Approx 736 natural plants (USFWS, 2019)

Population Narrative:

This species is known from only three extant populations along the Connecticut River in New Hampshire and Vermont: Sumner Falls and Jarvis Hill (NH) and Hartland Ledges (VT). These populations comprised 736 plants in 2018 (not including introduced plants at one site). Population sizes are highly variable among years; in the years between 1997 and 2018, the global population has ranged from 260 plants to over 2,000 plants. As this 2018 population

value is based on careful searches of all available habitat at all known populations, it is unlikely to underestimate actual population size by a considerable amount. The Jarvis Hill population has been consistently and significantly larger than the other two populations throughout this time period. Despite intensive surveys, no additional extant Jesup's milk-vetch populations were discovered, although potential suitable habitat was documented. (USFWS, 2019)

Threats and Stressors

Stressor: Herbivory (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: Herbivory has been noted on the stems, leaves, fruits, and seeds of Jesup's milk-vetch since 1990. The major herbivores remain unidentified, but deer and woodchucks were suspected in 1990 and 1992, respectively. The proportion of stems affected is generally small (less than 10 percent). Nothnagle noted the loss of an "estimated 95 percent of flowers to herbivory in 1998" without identifying the herbivore (NHNHI 2002). No similar incidents of large-scale herbivory have been documented in the last decade. (USFWS, 2019)

Stressor: Trampling (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: Trampling of plants has been noted at Sumner Falls on several occasions: 1990, 1992, and 2001. Sumner Falls receives many visits from kayakers who shoot the nearby rapids, fishermen, and other recreational users. Picnicking, boat landing, and campfire building can threaten plants. Vandalism was noted in the past; several plants were "pulled up" in 1990. Likewise, activities nearby can also have inadvertent impacts: a crew erecting signage at Sumner Falls in 2003, for example, dumped brush very near to the plants (but fortunately did not damage any). With so few plants present at the site, the population is vulnerable to even small-scale disturbances. Other sites are not as attractive for boat landings, they are too steep to access from the water and overland access points are in private ownership. (USFWS, 2019)

Stressor: Land use change (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: Because Jesup's milk-vetch habitats typically occur far apart from each other, colonization of new habitat and establishment of new populations depends on rare long-distance dispersal events. Land use changes that reduce the availability of appropriate Jesup's milk-vetch habitat can reduce the prospects for successful establishment of new populations. Residential and recreational development is increasing along the Connecticut River. While local regulations may prevent siting of new development in the riparian buffers that provide potential habitat for Jesup's milk-vetch, logging and construction activities in the upland areas can cause erosion of shoreline habitats, lead to dumping of materials (e.g., coarse woody debris) in shoreline habitats, and result in increased human visitation to shoreline habitats. These effects can result in degradation of Jesup's milk-vetch habitat and trampling of Jesup's milk-vetch plants. (USFWS, 2019)

Stressor: Invasive Species (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: Jesup's milk-vetch relies on the availability of open habitat, which is maintained in an early-successional state by periodic flooding and ice scour. Populations of black swallowwort, shrubby honeysuckle, cypress spurge, and purple loosestrife have been noted by surveyors at one or more sites since 1997. As of 2002, all of these species were present at all three sites (with the exception of purple loosestrife, which occurred only at Hartland Ledges and Jarvis Hill) and (with the exception of cypress spurge) are the focus of intensive removal efforts. Recently, *Cardamine impatiens* (bushy rock-cress) is being treated manually at Sumner Falls and Hartland Ledges (Brumback and Piantedosi 2018b) (appendix 3 and 4). The Hartland Ledges site has the highest percent cover of invasive species. Black swallowwort appears to be spreading more rapidly than other species, particularly at Hartland Ledges, where a nearby railroad bed is infested in places with up to 100 percent cover and plants are rapidly spreading into the surrounding forest and down onto the riverbank and the rock outcrops where Jesup's milk-vetch grows. Despite repeated herbicide application to control swallowwort at Hartland Ledges, the upslope population by the railroad continues to shed seed, providing the source for recruitment of this highly invasive species. Shrubby honeysuckle has been increasing more slowly. Several other native, aggressive species are also increasing in cover at the sites, including *Toxicodendron radicans* (poison ivy) and *Apios americana* (ground-nut) at Hartland Ledges. (USFWS, 2019)

Stressor: Problems intrinsic to small populations (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: Jesup's milk-vetch populations are subject to dramatic "boom and bust" cycles. In 2003, 2009, and 2012 through 2014, all three populations were at some of their lowest numbers since consistent monitoring began in 1997 (appendix 6). While apparent rebounds have occurred after some of the precipitous declines (e.g., 2004 and 2010), monitoring data indicate that these are likely to be followed by future dips under normal conditions. However, extreme storm events in 2008, 2009, and 2011 may have been responsible for the prolonged decline in total plant numbers from 2012 through 2014. Demographic stochasticity can lead to random extinction, and small populations are particularly vulnerable (Morris and Doak 2002; Farnsworth 2008). These populations are also clearly subject to environmental stochasticity, which further compounds year-to-year variation in population size and is a major driver of extinction probabilities in rare plants. The distinctiveness of the three populations is critical to maintaining the genetic diversity represented by each population. The loss of any population would result in a substantial loss of the species-wide genetic diversity and potentially impact the species' ability to respond to stochastic changes in the environment, including climate change. Maintaining genetic representation of all three populations will be critical in the recovery of the species. (USFWS, 2019)

Stressor: Hydrological alteration (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: The extant Jesup's milk-vetch populations are located in the 90-mi (145-km) stretch of river with flows directly affected by two hydropower dams, Wilder Dam (Wilder, VT/Hanover, NH) and Bellows Falls Dam (Rockingham, VT/Walpole, NH) (NHNHB 2014). Specifically, the three Jesup's milk-vetch populations occur in the 25 mi (40 km) of free-flowing river between the two dams. The Sumner Falls population is approximately 9.5 river-mi (15 river-km) downriver of Wilder Dam, the Hartland Ledges population is approximately 12.5 river-mi mid-way between the Wilder Dam and Bellows Falls Dam (20 river-km), while the Jarvis Hills population is above the head of the impoundment for the Bellows Falls Dam. Both dams influence the hydrology of the Connecticut River in the vicinity of the Jesup's milk-vetch populations. (USFWS, 2019)

Stressor: Climate change (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: Climate change models predict that precipitation will increase by 14 percent with the greatest increase in the fall and winter and in the form of rain rather than snow (Runkle et al. 2017a; Runkle et al. 2017b). In Jesup's milk-vetch habitat, riverbank ledges are kept clear by ice scour and spring flooding. These disturbances remove other vegetation that might colonize Jesup's milk-vetch habitat and shade out Jesup's milk-vetch seedlings (USFWS 1989), and/or deposit alluvial sediment to renourish Jesup's milk-vetch plants. The most significant annual floods currently occur during spring runoff, with decreasing flows during the summer. With increasing winter temperatures and winter precipitation in the form of rain, the decrease in snowpack may result in reduced spring flooding and ice scour, critical components to reduce competing vegetation in the rock outcrops. (USFWS, 2019)

Recovery

Reclassification Criteria:

Demographic criteria: 1a: A minimum of four persisting populations occurring within the historically known and/or expanded that conserve the genetic diversity of the species. (USFWS, 2019)

Demographic criteria: 1b: A persisting population is defined as having a site-specific median number of total plants (excluding transplants)¹¹ over 5 consecutive years (based on a minimum of one generation) as described below. (i) Sumner Falls: A median of 113 natural plants; (ii) Hartland Ledges: A median of 132 natural plants; (iii) Jarvis Hill: A median of 477 natural plants; (iv) expanded range populations: (1) sites similar in area to the Sumner Falls population: a median of 100 plants; and (2) sites similar in area to the Jarvis Hill population: a median of 400 plants. (USFWS, 2019)

Threats-abatement criteria: 2a: A long-term landowner agreement or other mechanism is in place for each of the four persisting populations that provides: (i) protection against habitat loss. For example, forested buffers are established/maintained between a population and developed land (agricultural land, development, etc.); and (ii) access for long-term monitoring and management. (USFWS, 2019)

Threats-abatement criteria: 2b: A rapid response plan is in place for each of the four persisting populations that addresses new threats (e.g., invasive species) and the need for population augmentation (adaptive management). (USFWS, 2019)

Delisting Criteria:

Demographic criteria 1a: A minimum of six resilient populations occurring within the historically known and/or expanded ranges that conserves the genetic diversity of the species. (USFWS, 2019)

Demographic criteria 1b: A resilient population is defined as having a site-specific median number of plants and a median number of total inflorescences (excluding transplants) over 8 consecutive years (based on a minimum of three generations) as described below. (i) extant populations: (1) Sumner Falls: A median of 113 natural plants and a median of 193 inflorescences; (2) Hartland Ledges: A median of 132 natural plants and a median of 507 inflorescences; (3) Jarvis Hill: A median of 477 natural plants and a median of 4337 inflorescences; (ii) expanded range populations: (1) sites similar in area to the Sumner Falls population: A median of 100 plants and a median of 193 inflorescences; and (2) sites similar in area to the Jarvis Hill population: a median of 400 plants and a median of 4,337 inflorescences. (USFWS, 2019)

Threats-abatement criteria 2a: A long-term landowner agreement or other mechanism is in place for each of the six resilient populations that provides: (i) protection against habitat loss. For example, forested buffers are established/maintained between a population and developed land (agricultural land, development, etc.); and (ii) access for long-term monitoring and management. (USFWS, 2019)

Threats-abatement criteria 2b. A rapid response plan is in place for each of the six resilient populations that addresses new threats (e.g., invasive species) and the need for population augmentation (adaptive management). (USFWS, 2019)

Recovery Actions:

- Protect extant and introduced populations: Securing Jesup's milk-vetch populations requires protecting them from land and water use impacts that cause habitat loss or degradation or result in direct mortality of plants. Protect occupied habitat with conservation easements, management agreements, or acquisition. Conserve vegetative buffers at Jesup's milk-vetch populations. Develop protective hydrological management regimes for dams potentially impacting historically known and expanded range populations. (USFWS, 2019)
- Establish additional populations: Increasing population redundancy for Jesup's milk-vetch requires establishment of additional populations. Introduced populations should represent the range of genetic diversity of the three populations. Because no suitable introduction sites have been identified within the historically known range to date, populations must be established at suitable introduction sites outside the historically known range. (USFWS, 2019)
- Evaluate status of existing populations: Annual quantitative monitoring of historically known and expanded range populations is necessary to assess population trends and status. Annual monitoring of Jesup's milk-vetch populations will determine whether augmentation is warranted and whether there are a sufficient number of plants to allow for seed collection. Annual monitoring for the presence and density of invasive plant species will

- determine recovery management actions needed to maintain viable Jesup's milkvetch populations, or document new threats from future invasive species. (USFWS, 2019)
- Manage Habitat: Securing Jesup's milk-vetch populations requires managing their habitats to reduce threats from invasive plant species, recreational activities, and herbivory. Habitat management protocols must be thoroughly documented and data collected in a statistically meaningful way so that successes can be replicated elsewhere and future failures averted. (USFWS, 2019)
 - Bank seeds and perfect propagation and transplantation techniques: Seed banking provides insurance against catastrophic declines in natural populations by enabling the propagation of seedlings for population augmentation or introduction efforts. Genetic representation of all populations is maintained by collecting and preserving seed from the three extant populations. Jesup's milk-vetch seeds are collected and banked at NPT. (USFWS, 2019)

References

USFWS. 2019. Jesup's Milk-vetch (*Astragalus robbinsii* var. *jesupii*) Revised Recovery Plan. U.S. Fish and Wildlife Service, Concord, New Hampshire. 71 pp.

SPECIES ACCOUNT: *Astragalus schmolliae* (Chapin Mesa milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Candidate; (USFWS, 2016); Proposed Threatened

Physical Description

Schmoll milkvetch plants are upright perennials, 30 to 60 cm (12 to 24 in.) tall with one to several stems branching from an underground root crown. Its leaves are typical of many of the legumes, with 11 to 20 small leaflets on a stem. Leaves and stems are ash-colored due to a covering of short hairs. Flowers are creamy white, on upright stalks that extend above the leafy stems. The fruit is a pod, 3 to 4 cm (1 to 1.5 in.) long, covered with flat, stiff hairs, pendulous and curving downward (Barneby 1964, pp. 277278). The deep taproot grows to 40 cm (16 in.) or more (Friedlander 1980, pp. 5962). Young Schmoll milkvetch plants without flowers or fruit strongly resemble young plants of a similar species, *Astragalus wingatanus* (Fort Wingate milkvetch) (Wender 2012a, p.1).

Taxonomy

Astragalus schmolliae was first collected in Montezuma County, southwestern Colorado, in 1890. It was formally described as a species in 1945, when C.L. Porter named it after Dr. Hazel Marguerite Schmoll (Porter 1945, pp. 100102; Barneby 1964, pp. 277278; Isely 1998, p. 417). *Astragalus schmolliae* is a member of the family Fabaceae (legume family).

Historical Range

Same as current range.

Current Range

Schmoll milkvetch habitat collectively occupies approximately 1,619 ha (4,000 ac) in MEVE and on the Ute Mountain Ute Tribal Park (Tribal Park). About 809 ha (2,000 ac) are in MEVE on Chapin Mesa including Fewkes and Spruce Canyons, on the West Chapin Spur, and on Park Mesa (CNHP 2010, pp. 1219; Anderson 2004, p. 25, 30; Nelligan 2010, p.1). Occupied habitat on Chapin Mesa in the Tribal Park south of MEVE probably covers another 809 ha (2,000 ac), where surveys have not been done (Anderson 2004, p. 6; Friedlander 1980, p. 53; CNHP 2010, pp. 2021). In 2012, 9 plants were found in Navajo Canyon and 7 along canyon benches near Square Tower House. This increases the evidence that Schmoll milkvetch is not limited to mesa tops, although that remains the core habitat. (Wender 2012b, p. 1). The distribution of Schmoll milkvetch is typical of narrow endemics, which are often common within their narrow range on a specific habitat type (Rabinowitz 1981 in Anderson 2004, p. 3). However, Schmoll milkvetch is unusual because similar habitat is widespread on nearby mesas where the species has not been found. Thus, the causes of its rarity are unknown. Its distribution may be limited by habitat variables that are not yet understood (Anderson 2004, p. 8). On Chapin Mesa, most of the Schmoll milkvetch plants are on higher ground near the border with MEVE. Plants are most abundant and many recruits are observed where they are shaded by pinyon pine. Plants become increasingly sparse and no recruits are seen on the lower southern tip of Chapin Mesa, where there is less tree cover and the ground is warmer and drier (Natori and Clow 2011, pers. comm.).

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Food Source**

Adult: sunlight

Competition

Adult: nonnatives

Food/Nutrient Narrative

Adult: This species obtains its energy from sunlight via photosynthesis, and competes with invasive species for suitable habitat and resources.

Reproductive Strategy

Adult: seeds; pollinator insects

Lifespan

Adult: presumably 20 years

Dependency on Other Individuals or Species

Adult: pollinator insects

Breeding Season

Adult: spring and early summer

Key Resources Needed for Breeding

Adult: pollinator

Reproduction Narrative

Adult: Schmoll milkvetch plants emerge in early spring and usually begin flowering in late April or early May. Flowering continues into early or mid-June (Friedlander 1980, p. 63, Peterson 1981, p. 14). Fruit set begins in late May and occurs through June, and by late June most fruits have opened and released their seeds, while still attached to the plant. The typical plant lifespan of Schmoll milkvetch is unknown, but individuals are thought to live up to 20 years (Colyer 2002 in Anderson 2004, p. 11). During very dry years, as observed in 2002, the plants can remain dormant with no above-ground growth (Colyer 2003 in Anderson 2004, p. 11). Most of the plants produce above-ground shoots and flower profusely during growing seasons following wet winters. Schmoll milkvetch requires pollination by insects to set fruit. Flowers require a strong insect for pollination, such as a bumblebee, because the insect must force itself between the petals of the butterfly-shaped flowers. Pollinators observed on Schmoll milkvetch include several species of bumblebees (*Bombus* spp.) and bee flies (*Bombylius* spp.) (Friedlander 1980, p. 63). In a 2012 study, nearly all observed pollinators were ground-nesting bees, which indicates that their preferred nesting habitats should be identified and protected from compaction and trampling disturbances (Green 2012, p. 6).

Habitat Type

Adult: mature pinyon-juniper woodland

Dependencies on Specific Environmental Elements

Adult: deep, reddish loess soils

Environmental Specificity

Adult: specific habitat and reproductive requirements

Tolerance Ranges/Thresholds

Adult: drought tolerant

Site Fidelity

Adult: high

Dependency on Other Individuals or Species for Habitat

Adult: not applicable

Habitat Narrative

Adult: The habitat for Schmoll milkvetch is mature pinyon-juniper woodland of mesa tops in the Mesa Verde National Park (MEVE) area at elevations between 1,981 to 2,286 meters (6,500 to 7,500 feet) (Anderson 2004, p. ii). The plants are found in both sunny and shaded locations (Peterson 1981, p. 12), primarily on deep, reddish loess soils, and are generally less common near cliff edges and in ravines where the soil is shallower. No Schmoll milkvetch plants are found in the mountain shrublands at the upper elevations on MEVE.

Dispersal/Migration**Motility/Mobility**

Adult: not mobile

Dispersal

Adult: unknown

Dependency on Other Individuals or Species for Dispersal

Adult: unknown

Dispersal/Migration Narrative

Adult: There is not much available information regarding the dispersal of this species.

Population Information and Trends**Population Trends:**

Declining

Species Trends:

Declining

Resiliency:

low

Representation:

low

Redundancy:

low

Population Growth Rate:

unknown

Population Size:

253,000 plants

Minimum Viable Population Size:

unknown

Resistance to Disease:

unknown

Adaptability:

adaptations to resist drought conditions

Population Narrative:

The total estimated number of Schmoll milkvetch plants in MEVE was 482,786 in 2001 before the Long Mesa fire. In 2003 after the fire the total estimated number of plants was 294,499 (CNHP 2010, pp. 121; Anderson 2004, p. 6, 30). A 2011 population estimate based on CNHP surveys was 253,000 plants (Wender and Owen 2012). Surveys in the headquarters and adjacent picnic areas indicated a decline in plant density from the population-wide density estimates from 2003 (Wender 2012, p.1). A slight decline in density of Schmoll milkvetch on Chapin Mesa was also found in a comparison of monitoring results from 2003 and 2011 (Anderson and Kuhn 2012, p. 3). Below-average precipitation in 2012 resulted in smaller, less vigorous plants than in 2011 (Wender 2012b, p.1). In 2013, a new patch of several plants was found on a bench in the slope northwest of Pictograph Point at about 6,500 ft (San Miguel 2014, p. 7). Abundant plants were observed on the tribal land in 1987 (Colyer 2002, in Anderson 2004, p. 4; CNHP 2010, p. 21). We have no estimate of plant numbers on the Tribal Park because no inventories have been completed (Clow 2010, pers. comm.). Schmoll milkvetch is considered critically imperiled globally (G1) by the CNHP, a rank used for species with a restricted range, a global distribution consisting of less than five occurrences, a limited population size, or significant threats (CNHP 2006, p. 1).

Threats and Stressors

Stressor: Wildfire

Exposure:

Response:

Consequence:

Narrative: The direct effects of fire on Schmoll milkvetch are both positive and negative. Plants burn to the ground and then resprout the following spring if the fire is not too intense, but then have competition from weeds and grasses. All of the burned and remaining unburned habitat on MEVE and the Tribal Park is at risk of burning within the foreseeable future. Although we remain concerned about the potential impacts of recurring fires, the best available information indicates that the direct effects of wildfires do not pose a threat to Schmoll milkvetch. However, the indirect effect of wildfire in facilitating invasion of the habitat by cheatgrass may pose a significant threat to the species

Stressor: Invasive Nonnative Plants

Exposure:

Response:

Consequence:

Narrative: The main threat to the species is the indirect effect of invasion by nonnative plant species (weeds). This invasion is facilitated by the increased frequency of burns as well as the clearing of areas within occupied Schmoll milkvetch habitat (CNHP 2006, p. 4). In MEVE, large wildfires that occurred earlier in the twentieth century (1934, 1959, 1972) were not associated with weed invasion (Floyd et al. 1999, p. 148), but the pinyon-juniper forests that have burned extensively in the past two decades are being replaced by significant invasions of weedy species, especially cheatgrass (*Bromus tectorum*), musk thistle (*Carduus nutans*), and Canada thistle (*Cirsium arvense*) (Floyd et al. 2006, p. 1). Musk thistle was not found in either disturbed or undisturbed ground in 1980, but it was particularly invasive in burned areas of MEVE by 1999 and was aggressively invading areas occupied by Schmoll milkvetch (Floyd-Hanna et al. 1999, p. 148; Romme et al. 2003, p. 344). Since 1996, MEVE has seen more large fires and more cumulative area burned than occurred during the previous 200 years (Romme et al. 2006, p. 3). This recent increase in fire activity is a result of severe drought conditions preceded by wet climatic conditions and increasing fuel load due to fire suppression in the pinyon-juniper woodlands, all coinciding with the natural end of a long fire cycle (Floyd et al. 2006, p. 247). A recent development in the post-fire habitat response is the remarkably rapid spread of cheatgrass. This weedy winter annual germinates in the fall, grows slowly during the winter, and then grows rapidly in the early spring. By early summer it has set seed and died, creating a continuous fuel bed of quick-drying, flashy fine fuel that can readily carry fire, even without wind. Cheatgrass has been in MEVE for many years. However, it was never widespread until 2000, when unusually warm dry summers and winters coupled with heavy fall rains allowed cheatgrass to rapidly expand its range, especially in places where fire or other disturbances have created bare ground (Romme et al. 2006, p. 3). Mature pinyon-juniper woodlands are highly vulnerable to post-fire weed invasion (Floyd et al. 2006, p. 254). Cheatgrass is now a dominant species in much of the area burned in MEVE (Romme et al. 2006, pp. 23) and it has inundated the burned and disturbed portions of Schmoll milkvetch habitat on Chapin Mesa (Hanna et al. 2008, p. 18). The highest infestation occurred in an area that had burned both in the 1996 and the 2002 fires on Park Mesa. This had been an old-growth pinyon-juniper woodland before the 1996 fire, and was seeded with native grasses. After re-burning in 2002, this area was inundated by cheatgrass (Hanna et al. 2008, p. 9). Given the seasonal overlap of Schmoll milkvetch seedling growth with the peak growth of cheatgrass, it is likely that the presence of cheatgrass in populations of Schmoll milkvetch compromises its viability (Anderson 2004, pp. 6061). Landscape modeling of the effects of projected cheatgrass increase on fire frequency in MEVE indicates the potential for frequent reburning. Projections show a fire rotation of about 45 years for MEVE. Such a frequent disturbance regime would be far outside the historical range of variability for the pinyon-juniper,

and would likely impact or eliminate many native plant species (Turner et al., p. 40). We have no data to indicate whether Schmoll milkvetch will successfully adapt to a post-fire habitat of open clearings between shrubs, and competition from cheatgrass, thistles, and native grasses versus a pinyon-juniper dominated community.

Stressor: Wildfire and Fuels Management

Exposure:

Response:

Consequence:

Narrative: Clearing for fuel reduction impacts Schmoll milkvetch in the following ways: (1) above-ground stems are directly removed; (2) plants that resprout the following spring have less water available because the soil dries due to exposure to sun and wind; and (3) invasive weeds, the native grass muttongrass, and seeded native grasses provide increased competition. However, we have no data that indicates the degree to which these impacts are occurring or will occur in the future. Because clearing and prescribed burns affect 19 percent of the range of Schmoll milkvetch, we believe that clearing or burning for fire management may have a detrimental effect on the species. As with wildfire, the indirect effect of facilitating invasion of the habitat by cheatgrass poses a threat to the species because it increases the likelihood of more frequent fires. Fuel reduction projects at MEVE during 2012 resulted in very little direct mortality of Schmoll milkvetch due to avoidance measures used by work crews (Wender 2012b, p. 2). In 2013, fuel reduction was conducted on 17 acres of occupied habitat. An unknown number of Schmoll milkvetch plants were cut because there was no time to flag them (San Miguel 2014, p.4).

Stressor: Development of Infrastructure

Exposure:

Response:

Consequence:

Narrative: Trampling of plants by visitors and staff is an ongoing impact that does not rise to the level of a threat because it affects plants in a very limited portion of the species range in MEVE and in the Tribal Park. Schmoll milkvetch may recover from this kind of disturbance if the below-ground parts are not damaged, or if undamaged plants remain nearby to provide a seed source and the disturbance is not constantly repeated or followed up with additional disturbances. One attempt to transplant mature plants that were growing in a planned construction area was unsuccessful because the taproots were severed (Nelligan 2010, p. 2)

Stressor: Drought and Climate Change

Exposure:

Response:

Consequence:

Narrative: Drought may negatively affect Schmoll milkvetch. In 2002, severe drought caused most Schmoll milkvetch individuals to remain dormant (Anderson 2004, p. 4). The total annual precipitation measured at MEVE in 2002 was 28 cm (11 in.), well below the average of 44 cm (17.5 in.) for 1948 to 2003. However, there were 5 years between 1948 and 1989 in which MEVE received less than 28 cm (11 in.) of precipitation. Tree ring analysis indicates that droughts were as common during the Ancestral Puebloan occupation of MEVE, from approximately A.D. 600 to A.D. 1300, as they are today. It is likely that drought is common enough that Schmoll milkvetch can recover from its effects (Anderson 2004, p. 35), provided that severity and duration of drought does not exceed historical levels, or that threats such as weed invasion do not increase

significantly as a result. Periodic drought causes Schmoll milkvetch plants and seedlings to dry out during a given year, and contributes to increased fire frequency and weed invasion. We believe that drought has a low-level direct impact on the species. It also indirectly facilitates cheatgrass invasion and increased fire frequency and therefore is a threat to the species.

Stressor: Inadequate regulations

Exposure:

Response:

Consequence:

Narrative: Despite the positive management for Schmoll milkvetch that occurs within MEVE and the Tribal Park, the existing regulatory mechanisms cannot control the primary threats from cheatgrass and other fire effects on such a large scale. Therefore, the existing regulatory mechanisms are not adequate to protect or recover the species.

Stressor: Restricted Range

Exposure:

Response:

Consequence:

Narrative: The global range of Schmoll milkvetch is restricted to pinyon-juniper woodlands on about 1,619 ha (4,000 ac) on 3 adjacent mesas. It does not grow in grasslands below the mesas or in adjacent shrublands at higher elevation on the mesas, nor has it been found in pinyon-juniper woodlands on nearby mesas. Such a restricted range makes the species vulnerable to habitat modification caused by wildfire, cheatgrass invasion, increased drought, and climate change, but is not considered a threat in itself.

Recovery

Reclassification Criteria:

Not applicable

Delisting Criteria:

Not applicable

Recovery Actions:

- The permanent vegetation ecologist position at MEVE was vacated in November of 2012, and has remained vacant since then. This critical position held primary responsibility for investigating and tracking impacts and findings regarding Schmoll milkvetch, including studying the effects of imazapic herbicide on and developing a Conservation Plan for this species. The Natural Resource Program manager and seasonal work crews attempted to fill some of these functions. However, the Conservation Plan is on permanent hold and the imazapic study cannot be restarted to test higher concentration dosing unless a replacement is authorized, hired, and retained (San Miguel 2014 p. 8.). Additional appropriate conservation measures for this candidate species will depend on the results of ongoing research regarding effective measures for controlling cheatgrass and other invasive species that are competing with Schmoll milkvetch on MEVE.

Conservation Measures and Best Management Practices:

- continued implementation of the plans for cheatgrass control, monitoring population trends in response to fire management, invasive species, and tracking of development impacts that are now being conducted by MEVE;
- additional plant surveys to document the entire range of the species on MEVE and Tribal lands;
- removal of feral horses from MEVE;
- avoidance of impacts to the plants during ground disturbing activities within MEVE.

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03/31/2016

SPECIES ACCOUNT: *Astragalus tener* var. *titi* (Coastal dunes milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/12/1998; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A small annual herb with slender stems, usually 1-1.2 dm tall. Flowers (March-May) are 5-6 mm long, lavender to purple in color. Seed pods are straight to half-moon shaped, 1-2.5 cm long (NatureServe, 2015).

Taxonomy

A member of the pea family (Fabaceae) (USFWS, 2009).

Historical Range

It was once a regional endemic with a range including San Diego, Los Angeles, and Monterey counties; it was never very common in its range though, being restricted to a very specific habitat (NatureServe, 2015).

Current Range

Today it is only verified at one area in Monterey County. The total known range in the 3 areas adds up to about 270 sq mi (NatureServe, 2015). It is currently known from one highly fragmented population located on a coastal terrace grassland along 17-Mile Drive in Pebble Beach on the Monterey Peninsula, Monterey County, California. The population is bordered along one side by the Pacific Ocean and the other side by a golf course; 17-Mile Drive bisects the population. (USFWS, 2019).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, self-fertilization (USFWS, 2009)

Breeding Season

Adult: March - May (USFWS, 2004)

Reproduction Narrative

Adult: Crossing studies conducted by Liston (1992) indicate that the plants are self-compatible and capable of self-fertilization. Doak et al. (2000) investigated reproductive biology. They found that seed set could be high; mean seed set in plants not damaged by gophers or other herbivores was 44 seeds per individual, and of 207 pods checked for seed production, approximately 70 percent had a seed set of between 4 and 7 seeds per pod. At the same time,

they observed only one pollinator in the field over the course of 3 years, and also that greenhouse-grown plants without access to pollinators set high numbers of seed. Based on these combined observations, they concluded that this species is a successful self-pollinator and that pollinators are not a strong concern in the establishment and maintenance of populations (Doak et al. 2000) (USFWS, 2009). *Astragalus tener* var. *titi* flowers between March and May. Small bees have been presumed to be its main pollinators based on floral structure (USFWS, 2004).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Coastal terrace, dune (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs within 100 ft. of ocean surf zone, 25 ft. elevation; shade-intolerant (USFWS, 2004)

Spatial Arrangements of the Population

Adult: Scattered clumps (USFWS, 2009)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from USFWS, 2004)

Habitat Narrative

Adult: The extant population grows in shallow swales on the flat surface of a coastal terrace. These depressions hold standing water during wet winter and spring seasons. The substrate is a loamy fine sand. The plants are associated with the non-native hottentot fig (*Carpobrotus edulis*) and cut-leaf plantain (*Plantago coronopus*). The environmental specificity is very narrow; it is only known from 3 small areas along the immediate coast in sandy soil (NatureServe, 2015). The entire distribution of the population occurs on patches of remaining habitat that is interspersed with roads, trails, golf greens, and other recreational facilities (USFWS, 2009). *Astragalus tener* var. *titi* occurs on sandy soil within 30 meters (100 feet) of the ocean surf zone and 25 ft. above sea level. plants occur primarily on Antioch soils, with a few colonies found on compacted Sheridan soils (Jones and Stokes Associates 1996). *Astragalus tener* var. *titi* plants will germinate and grow to healthy maturity in areas of low-level disturbance, such as that caused by gophers or light pedestrian traffic (Doak et al. 2000, M. Stromberg in litt. 2002). Research conducted on plants under cultivation confirms that any competition or shading will result in unhealthy plants (V. Yadon, in litt. 2002, M. Stromberg in litt. 2002) (USFWS, 2004).

Dispersal/Migration**Dispersal**

Adult: Low (inferred from USFWS, 2004)

Dispersal/Migration Narrative

Adult: Under cultivation, seed capsules may burst and throw their seeds up to 2 meters (6.5 feet) (V. Yadon in litt. 2002). Many capsules are not dehiscent and simply drop to the soil where they may float to other areas to colonize if those areas become flooded during winter rains (V. Yadon, in litt. 2002) (USFWS, 2004).

Population Information and Trends

Population Trends:

Decline of 70 - 90% (NatureServe, 2015)

Species Trends:

10 - 30% decline (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015; see current range/distribution)

Representation:

Low (inferred from USFWS, 2009; see reproduction narrative)

Redundancy:

Very low (inferred from NatureServe, 2015)

Number of Populations:

1 (NatureServe, 2015))

Population Size:

Variable; 100 - 7,000 depending on climatic conditions (USFWS, 2009). Approximately 2,000 individuals were observed in 2011, the last year that the population was surveyed. (USFWS, 2019).

Adaptability:

Low (inferred from NatureServe, 2015)

Population Narrative:

Very vulnerable due to habitat type and small size. Long term trend is one of steep decline due to habitat destruction in 3/4 of its range. This species has experienced a long-term decline of 70-90%. The short term trend is one of decline (10 - 30%) due to presence on private land. The Pebble Beach Corporation site on the Monterey Peninsula had 4000 plants in 1995. 6 known EO's, but 5 are extirpated or historical. Only 1 extant occurrence is known (NatureServe, 2015). Annual population numbers have fluctuated between less than 100 and approximately 7,000, depending on winter and spring climatic conditions (USFWS, 2009).

Threats and Stressors

Stressor: Habitat loss and degradation (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Although vehicles have been prevented from entering the habitat of the plant in one roadside area, the individuals remain vulnerable to vehicles as well as trampling from other recreational activities along other portions of the roadside. Inundation by salt water and beach cobble during storm events may be new threats that may affect the portion of the population closest to the ocean. Little opportunity for population expansion is available adjacent to the existing population because habitat has already been converted to other uses, including roads, trails, and golf courses (USFWS, 2009).

Stressor: Predation (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: California voles (*Microtus californicus*), which are known to harvest seeds of many species in general (Martin et al. 1951, Peronne 2002), are known to occur in the area occupied by the plant (Yadon in litt. 2002; Stromberg in litt. 2002). No data have been gathered to determine the extent of this threat. Since the time of listing, herbivory by snails (various species), slugs (various species), and aphids (*Aphis* spp.) has also been observed on both vegetative and reproductive structures (Doak et al. 2000, Stromberg in litt. 2002) (USFWS, 2009).

Stressor: Stochastic events (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The existence of only one population and small number of individuals in the population place *Astragalus tener* var. *titi* at extreme risk of extinction from stochastic events. The conservation biology literature commonly notes the vulnerability of taxa known from one or very few locations and/or from small and highly variable populations (e.g., Shaffer 1981, 1987; Primack 2006; Groom et al. 2006). In particular, although the plants are apparently self-compatible and capable of self-fertilization, the small size of the population makes it difficult for this species to persist while sustaining the impacts of soil damage (compaction and erosion) and habitat alteration that favors non-native species (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). In addition, an increase in the rate of sea level rise has been predicted for the coast of California (California Coastal Commission (CCC) 2001, California Climate Change Center 2006). In particular, ocean bluffs along the coast will be subject to greater and more frequent wave attack, resulting in erosion and shoreline retreat (CCC 2001). The extent to which such events are caused by climate change and the extent to which it could affect *Astragalus tener* var. *titi* are unknown at this time (USFWS, 2009).

Recovery

Reclassification Criteria:

1. At least five viable populations (i.e., populations that are stable or increasing based on multiple years of monitoring, including at least two populations in San Diego or Los Angeles Counties) occur on suitable habitat with few to no nonnative competitors, and no threats from trampling. The area surrounding each population should allow for movement and expansion (USFWS, 2009).
2. A minimum of five populations are on land that is permanently protected from development (e.g., residential, commercial, recreational, etc.) including the population that currently exists on Pebble Beach Company and Monterey Peninsula Country Club property. Funds must be available for appropriate long-term management. Protected habitat must be of adequate size and configuration to ensure that ecosystem and community processes (e.g., hydrologic regime, food webs, pollinator fauna, coastal dune community associates, and associated species) are maintained, and an adequate diversity of sites exist for colonization of new areas as microhabitat conditions change (USFWS, 2009).
3. Site selection, restoration, and plant reintroduction has been initiated in at least two historical localities in Los Angeles or San Diego Counties. These two reintroduced populations will be considered as part of the five populations of plants described in 1 (a) and 1(b) above (USFWS, 2009).
4. The populations of plants are being adequately maintained, such that encroachment by nonnative plants, excessive herbivory, fire prevention activities, or other threats are not negatively affecting *Astragalus tener* var. *titi* directly or indirectly (USFWS, 2009).
5. The 17-Mile Drive population and additional populations have been appropriately managed such that monitoring has determined that these populations are stable or increasing for a minimum of 3 consecutive years (USFWS, 2009).
6. A seed bank has been established at a recognized institution that is certified by the Center for Plant Conservation (CPC) (USFWS, 2009).

Delisting Criteria:

Delisting Criterion 1) threats are reduced or eliminated so that protected populations are capable of persisting without significant human intervention or perpetual endowments are secured for management necessary to maintain the continued existence of the species. The most outstanding management needs currently are: protection from recreational activities such as hiking, picnicking, equestrian use, and golfing; research is needed on soil seed bank dynamics. (USFWS, 2019).

Delisting Criterion 2) unoccupied habitat in the area has been assessed for its suitability for reintroduction efforts directly adjacent to occupied patches to allow for expansion, especially to offset losses of patches along the immediate coast due to storm surge and saltwater intrusion; and three additional, new populations are established and protected where appropriate, with a goal of increasing redundancy and representation with the establishment of new populations on the Central Coast, in Los Angeles County, and San Diego County. (USFWS, 2019).

Delisting Criterion 3) all protected populations remain viable for at least 10 years to demonstrate long-term viability under a range of environmental conditions. We expect above-

ground population size to fluctuate annually, based on response to amount and timing of rainfall (e.g. see Fox et al. 2006). Therefore, a period of 10 years should be long enough to include most of the variability in rainfall that occurs in this region (Zedler & Black 1989; NOAA 2018). (USFWS, 2019).

Recovery Actions:

- Secure and protect existing populations and habitat on private or unprotected lands through willing landowners (USFWS, 2004).
- Manage lands to control or eliminate threats to the plants and their habitat (USFWS, 2004).
- Conduct research to document life history characteristics and plants' responses to vegetation management (USFWS, 2004).
- Survey for additional populations and suitable habitat for reintroduction or reestablishment and establish new populations (USFWS, 2004).
- Develop management strategies and monitor populations to determine effectiveness of management (USFWS, 2004).
- Coordinate recovery actions with other listed species or species of concern (USFWS, 2004).
- Develop and implement a public outreach program (USFWS, 2004).
- Reevaluate recovery criteria and revise recovery plan based on knowledge obtained from research, monitoring, and management (USFWS, 2004).

Conservation Measures and Best Management Practices:

- Work with Pebble Beach Company and Monterey Peninsula Country Club to clarify current management practices within *Astragalus tener* var. *titi* habitat and determine if any modifications could be made to improve the status of the taxon (USFWS, 2009).
- Develop and implement a population monitoring design that focuses on aerial extent of populations rather than exact population counts, and includes the full range of the population (USFWS, 2009).
- Experiment with establishment of new populations in other coastal terrace habitat on the Monterey Peninsula or at Point Lobos State Reserve. If these efforts are successful, attempts to establish other populations could be undertaken in Los Angeles and San Diego Counties (USFWS, 2009).
- Survey historical occurrence areas and potential habitat in San Luis Obispo, Los Angeles, and San Diego counties to detect populations and assess habitat for potential restoration and reintroduction. This effort should include a broader habitat definition to accommodate previously overlooked potential habitat (USFWS, 2009).
- Continue with research on seed characteristics, particularly to determine whether there is a difference in seed viability between those produced from self-fertilization and those produced by cross-pollination (USFWS, 2009).

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SPECIES ACCOUNT: *Astragalus tricarinatus* (Triple-ribbed milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/6/1998; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

Short-lived erect perennial. Leaves with 17-20 leaflets that are silvery strigose on the upper surface. Flowers are white or pale cream-colored, arranged in loose 6-17 flowered racemes. Fruit is narrow, glabrous and distinctly 3-ribbed (NatureServe, 2015).

Taxonomy

A member of the Fabaceae (pea) family (USFWS, 2009).

Historical Range

Endemic to a small area of the state extending from Morongo Wash to the hills northeast of Mecca in Riverside and San Bernardino counties, California (NatureServe, 2015).

Current Range

Since listing, 8 of the original occurrences are considered extant (lower section of Whitewater Canyon, Mission Creek, Dry Morongo Creek and Wash, Big Morongo Canyon, Coyote Hole Spring, Key's Ranch, Orocopia Mountains, and Agua Alta (discounting Cushenberry Canyon); and 4 additional occurrences (Wathier Landing, Catclaw Flat, Long Canyon, and East Deception Canyon; have been detected at the northern end of the historical distribution and in Joshua Tree NP (USFWS, 2009).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: 3 - 5 years (USFWS, 2009)

Reproduction Narrative

Adult: This species is a short lived (3 to 5 years) perennial (USFWS, 2009).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Desert: Dry wash, canyon slope, scree slope (USFWS, 2009)

Geographic or Habitat Restraints or Barriers

Adult: 1,300 - 4,000 ft. elevation (USFWS, 2009)

Habitat Narrative

Adult: Occurs on sandy and gravelly soils of dry washes, or on decomposed granite or gravelly soils at the base of canyon slopes (NatureServe, 2015). *Astragalus tricarinatus* habitat includes dry washes, bases of canyon slopes, and scree slopes (Barrows 1987, p. 2; Sanders and Thomas Olsen Associates 1996, p. 3). *Astragalus tricarinatus* is found in transition areas of the Sonoran and Mojave Deserts from 1,300 feet to 4,000 feet (400 to 1,220 meters) (Sanders 1999, p. 4) (USFWS, 2009).

Dispersal/Migration**Dispersal**

Adult: Low to moderate (inferred from USFWS, 2009)

Dispersal/Migration Narrative

Adult: Specific seed dispersal mechanisms for *A. tricarinatus* are unknown. Seeds likely disperse from standing plants only over short distances. Based on patterns of occurrence known at the time of listing, there is potential for downstream dispersal over several miles based, in part, on patterns of occurrences known at time of listing (USFWS, 2009).

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Increasing (USFWS, 2009)

Resiliency:

Low (inferred from USFWS, 2009)

Redundancy:

Moderate (inferred from USFWS, 2009)

Number of Populations:

12 (USFWS, 2009)

Population Size:

< 500 (USFWS, 2009)

Population Narrative:

The only known extant occurrence consisted of twenty plants in 1992 (Fish and Wildlife Service 1998). Was known from four sites in the Coachella Valley. No plants had been seen since 1985 (Rutherford 1992). Now known from only one extant occurrence (Fish and Wildlife Service 1998) (NatureServe, 2015). Since listing, the number of occurrences has increased to 12. Although the number of occurrences has increased, the total number of individuals known remains low (i.e., less than 500 individuals range-wide). It ranges within transition areas of the Sonoran and Mojave Deserts in San Bernardino and Riverside Counties in California (USFWS, 2009).

Threats and Stressors

Stressor: Habitat destruction and degradation (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The only potential habitat threat to *Astragalus tricarlinatus* since listing is residential development. Pipeline maintenance and unanticipated pipeline ruptures continue to be a potential threat to *A. tricarlinatus* habitat at Big Morongo Canyon. Potential threats associated with pipelines affect Big Morongo Canyon (EO 1, 2, 6, 7, and 13) where a natural gas pipeline extends the length of the canyon. Since the pipeline carries natural gas, leaks and/or ruptures present the increased threat of fire. The pipeline is still in use though specific impacts have not been recorded since listing. Additionally, maintenance activities may crush existing plants. Impacts from illegal OHV use have been identified as a threat to occurrences in Joshua Tree NP (USFWS, 2009).

Stressor: Small population size (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: With the exceptions of two source populations, all present and historical occurrences are comprised of waif individuals or demes. These small population sizes of *A. tricarlinatus* make them particularly vulnerable to extinction from random natural events (e.g., large flood events and climate change) or other potentially calamitous anthropogenic events (e.g., wildfire suppression activities and pipeline leaks or repairs). Five categories of small population vulnerability are outlined: (1) species with a very narrow geographic range; (2) species with only one or a few populations; (3) species in which population size is small (identified as one of the best predictors of species extinction rate); (4) species in which population size is declining; and (5) species that are hunted or harvested by people (Primack 2006, p.159). Three of these categories apply to *Astragalus tricarlinatus* (#2–4). Additionally, demographic fluctuations, environmental variation, and loss of genetic variability and related problems of inbreeding depression and genetic drift; and/or to natural catastrophes are cause for greater vulnerability to extinction of small populations (Barrett and Kohn 1991, p. 3). By these measures, the species is at increased risk of extinction (USFWS, 2009).

Stressor: Fire (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Wildland fires have impacted occurrences of *Astragalus tricarlinatus* in recent years. The Wathier Landing occurrence burned in the Verbenia Fire in 1995 and again in the Millard fire in 2006. Also, sections of Big Morongo Canyon Preserve and Dry Morongo Wash were burned in the 2005 Paradise Fire. In 2006, the Sawtooth Complex burned the upper half of Dry Morongo Wash. Fire can burn existing plants and possibly affect seeds in the soil. Additionally, response to wildland fires can affect the species. Direct physiological impacts to a source population or a floral bloom of competing nonnative invasive plants from a phosphate-rich fire retardant drop are very realistic scenarios. Wildland fires are possible throughout the range of *Astragalus*

tricarinatus. Suppression activities including fire retardant drops and bulldozer use threaten populations in small areas (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. One study predicted that 5 to 10 percent of California's native plant species would no longer find suitable habitat within the state, and thus be vulnerable to extinction, if average temperatures warmed 5–6° F (Morse et al. 1995, p. 393). Impacts to the species under predicted future climate change are unclear. A trend of warming in the mountains of western North America is expected to decrease snowpack, hasten spring runoff, and reduce summer stream flows, and increased summer heat may increase the frequency and intensity of wildfires (IPCC 2007). While it appears reasonable to assume *Astragalus tricarinatus* may be affected, the Service lacks sufficient certainty regarding how and when climate change will affect the species, the extent of average temperature increases in California, or potential changes to the level of threat posed by fire and increased fire frequency (USFWS, 2009).

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- Perform annual surveys at known extant occurrences to acquire demographic and survival information related to abundance. Also perform predictive GIS modeling involving source soil type in search of new source populations. The Wildlands Conservancy is a potential partner for occurrences under its preservation (USFWS, 2009).
- Develop a site-specific plan to coordinate fire-fighting that is available to dispatch authority of interagency fire response. The Forest Service, BLM, and NPS-Joshua Tree National Park may be partners for occurrences in their respective jurisdictions. This plan might contain suggestions regarding areas to avoid when accessing the areas, cutting bulldozer lines, or making aerial retardant drops. These same areas would become areas of post-fire surveys in coordination with a BAER plan (USFWS, 2009).
- Surveying all known occurrences (including extralimital sites such as Agua Alta Canyon, Key's Ranch, and the Orocopia Mountains) within the next 5 years. Make use of descriptive parameters of more recently detected upland occurrences to assemble predictive maps of likely habitat (USFWS, 2009).
- Coordination with Four Corners Pipeline on protocol to ensure low-impact pipeline maintenance procedures. Vehicles driven along the pipeline and trenching equipment used to maintain the pipeline can minimize their impacts (USFWS, 2009).

- Produce a Recovery Plan which would coordinate and direct survey and research actions beneficial to species recovery and that will reduce or eliminate threats to the species. Include occurrence map with risk assessment (USFWS, 2009).

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SPECIES ACCOUNT: *Astrophytum asterias* (Star cactus)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/18/1993; Southwest Region (R2) (USFWS, 2016)

Physical Description

A small, spineless, disk or dome-shaped member of the Family Cactaceae (Cactus Family). It is 2 to 15 centimeters (156 inches) across, and up to 7 centimeters (3 inches) tall. Star cactus is dull green-to-brown in color, often speckled with a covering of tiny white scales. The body is divided into eight, vaguely triangular sections. Each triangular section has a central line of circular indentations (areoles) filled with whitish, wooly hairs. During periods of adequate moisture, star cactus is usually a dull green color; however, during droughts, the cactus becomes brownish and loses fullness so that it becomes flush with the ground and almost perfectly camouflaged (Figure 2). Flowers are yellow with orange centers, and up to 15 centimeters (6 inches) in diameter. The fruits of star cactus are green to grayish-red, somewhat obscured by white wooly hairs, about 1.25 centimeters (0.5 inches) long, oval, and fleshy when mature. The seeds are glossy, dark brown with an enlargement of a chamber of the seed coat forming a flaring collar that encircles the hilum (Damude and Poole 1990, Benson 1982) (USFWS, 2003).

Taxonomy

This plant is a member of the cactus family (Cactaceae) (USFWS, 2016). *Astrophytum asterias* was originally collected by Baron von Karwinsky in 1843 and described as *Echinocactus asterias* by Joseph Zuccarini in 1845 (Damude and Poole 1990, USFWS 2003). Charles Lemaire described the new genus *Astrophytum* in 1868, into which he placed *A. asterias*. Common names for *A. asterias* include: Biznaga-algononcillo de estrella, sand dollar, sea urchin star cactus, and false peyote (Integrated Taxonomic Information System 2011) (USFWS, 2013).

Historical Range

The historical range of star cactus included Hidalgo, Starr, Zapata, and possibly Cameron Counties in South Texas and the States of Nuevo Leon and Tamaulipas in Mexico. The Nuevo Leon site near Linares was probably extirpated by collectors (USFWS, 2003). When listed in 1993, only two extant populations of *A. asterias* were known, one population in the United States, in Starr County, Texas; and one population in Tamaulipas, Mexico (USFWS, 2013).

Current Range

Currently only known from Starr County in extreme south Texas and the adjacent state of Tamaulipas, Mexico (NatureServe, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Food/Nutrient Narrative

Adult: Two growth rates were determined using different calculation methods. Based on the assumption that the mean annual growth rate is constant among all size classes, the growth rate was determined to be 2.71 millimeters (mm)/year (0.10 in/year). The second method took into account the premise that growth rates differ by size class (growth rates range from -0.85 – 3.65 mm/year (-0.03 – 0.14 in/year). This resulted in the mean diameter growth rate of 2.1 mm/year (0.08 in/year) (USFWS, 2013).

Reproductive Strategy

Adult: Sexual: cross-pollination (USFWS, 2013)

Dependency on Other Individuals or Species

Adult: *Diadasia rinconi* (USFWS, 2013)

Breeding Season

Adult: March - May (USFWS, 2013)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 2013)

Reproduction Narrative

Adult: Flowers usually bloom from March - May, opening in the morning and closing in the evening. *Astrophytum asterias* is an obligate outcrosser (USFWS 2003, 2013). Using the estimated growth rates, it would take 15 - 25 years to reach the 4-cm (1.57 in) benchmark for reproductive maturity. The cactus specialist bee *Diadasia rinconis* was found to be the most effective of all the observed pollinators (Janssen et al. 2010). Other insects visited the flowers more frequently but because of low effectiveness, they are not considered the most important (Janssen et al. 2010) (USFWS, 2013). Fruiting occurs April through June (USFWS, 2003).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Historical: subtropical grassland or grassland/savannah; current: shrubland, non-native grassland (NatureServe, 2015); Tamaulipan thornscrub (USFWS, 2013)

Dependencies on Specific Environmental Elements

Adult: Partial shade (NatureServe, 2015)

Habitat Narrative

Adult: Currently, this species is found in sparse, fairly open brushland. It is most often found growing in gravelly, sometimes saline, clays or loams in the partial shade of other plants or rocks. The vegetation in these areas was originally a subtropical grassland or grassland/savannah, but fire suppression, overgrazing, and pasture improvement have converted it to thorny shrublands and stands of non-native pasture grass. It is uncertain what habitat this species occupied in the original grassland ecosystem (NatureServe, 2015). *Astrophytum asterias* occurs on flats in shrublands and grasslands in Tamaulipan thornscrub. Soil analysis indicates that the highest density of *A. asterias* was found on saline-sodic, followed by saline soils (Janssen et al. 2010) (USFWS, 2013).

Dispersal/Migration**Dispersal**

Adult: Low (inferred from USFWS, 2013)

Dispersal/Migration Narrative

Adult: Seed dispersal mechanisms in the wild are virtually unknown. Mature fruits appear to disintegrate while still attached to the plant and leave a small cluster of seed on top of the plant. Wind and rain may carry the seeds away to establishment sites. Small rodents may also store the seeds at cache sites. Additionally, ants may play a role in seed dispersal (USFWS, 2013).

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Low (inferred from NatureServe, 2015; see current range/distribution)

Redundancy:

Moderate (inferred from USFWS, 2013)

Number of Populations:

U.S.: 24; Mexico: 9 (USFWS, 2013)

Population Size:

U.S.: 5,125; Mexico: 1,275 (USFWS, 2013)

Population Narrative:

This species has experienced a short term decline of > 30%; the Nuevo Leon site is believed to have been extirpated by collectors, and the Tamaulipas site has been reduced to very few individuals (NatureServe, 2015). In Starr County, Texas, 2011 surveys brought the known total of extant *A. asterias* populations to 24, containing a total of 5,125 individual plants. There are nine populations in Mexico, totaling 1,275 plants (Janssen et al. 2010, Martinez-Avalos 2002) (USFWS, 2013).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: The leading threat to *A. asterias* throughout its range currently, and at the time of listing, is habitat loss. All *A. asterias* populations in Starr County, Texas, are located on private property; the majority of which do not have signed conservation agreements. An extensive land area in Starr County has been root-plowed and converted to buffelgrass (*Pennisetum ciliare*) pasture; this has presumably destroyed an unknown amount of star cactus habitat. Mechanical

disturbance makes habitat unsuitable for *A. asterias*. An additional but unknown amount of habitat has probably been lost to urban and residential development and highway construction. Highly competitive introduced grasses (specifically buffelgrass) are clearly incompatible with *A. asterias* conservation. Buffelgrass reduces native vegetation coverage, density, species richness, and diversity (Sands et al. 2009). Seismic surveys, oil and gas well development, and other construction related to oil and gas exploration can cause surface damage and irrevocably damage or completely destroy the habitat (Conner 2011) (USFWS, 2013).

Stressor: Overutilization due to collection (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Collectors for many years have removed cacti for private collections. *Astrophytum asterias* are collected by individuals for personal use or trade, sometimes being mistaken for peyote (*Lophophora williamsii*). The demand for rare cacti by collectors has escalated in the United States and in other countries, including Asia and Europe (Westlund 1991). In 1991 the TPWD published a report on the cactus trade, monitoring impacts by investigating 72 individual collectors, family nurseries, and commercial nurseries (Westlund 1991). Although many of these collectors/growers had less than 50 individual cactus plants, representing only three to four species, one “digger” had more than 1,000 freshly dug cacti of 13 subspecies. Four hundred field-collected *A. asterias* were observed in nurseries, and eight mail order catalogs had *A. asterias* listed for sale (USFWS, 2013).

Stressor: Disease and predation (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: In the U.S. and Mexican populations, the leading cause of mortality was found to be herbivory by Mexican-ground squirrels. It does appear that during periods of drought, the level of herbivory is increased. Other causes of mortality were found to be insect herbivory and fungal infections. Combination of pathogens and herbivory was shown to greatly reduce the population by over 50 percent (Martinez-Avalos 2007). Several animal and insect species appear to utilize and destroy *A. asterias*. The threat to *A. asterias* continues to remain high, especially during periods of drought (USFWS, 2013).

Stressor: Climate change (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Rising temperatures might enable the species to survive further north than at present, but might also reduce the southern limit of the range. Similarly, changes in the frequency and amount of precipitation could favor a shift in geographic range or habitat type. However, the limited seed dispersal range, and the existence of new barriers to migration could impede alteration of the range of *A. asterias* (Malanson and Cairns 1997). Changes in temperature and rainfall amounts and patterns could alter the species’ competitive advantage in the unique micro-habitats it now inhabits. Regardless of how these changes may affect the autecology of *A. asterias*, the altered synecology may be far more significant. For example, higher winter temperatures could increase competition from invasive grasses (Patterson 1993) (USFWS, 2013).

Stressor: Reduction of genetic variability (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: At the time of listing, the one site known to have the star cactus present contained fewer than 2,100 plants. Genetic variability and viability decrease with reduced numbers of plants across the range (Ledig 1986). This, along with the pressures of other natural and anthropogenically-induced threats, increases the possibility of extinction of the species in the wild (USFWS, 2013).

Recovery

Reclassification Criteria:

1. Maintain or establish ten geographically distinct, fully protected, self-sustaining populations of star cactus in the United States or Mexico, each with a minimum of 2,000 individuals and an age class structure reflecting that plants are reproducing and becoming naturally established within the population (USFWS, 2013).
2. Develop and implement a formal conservation agreement between the U.S. and Mexico (USFWS, 2013).

Delisting Criteria:

Delisting criteria have not yet been developed (USFWS, 2013).

Recovery Actions:

- Protect and manage existing star cactus populations and habitat in the United States and Mexico (USFWS, 2003).
- Gather information for management and monitoring programs for star cactus (USFWS, 2003).
- Search for new populations of star cactus in the United States and Mexico (USFWS, 2003).
- Establish and maintain a botanical garden population of star cactus (USFWS, 2003).
- Establish new populations in natural habitat as necessary to meet reclassification criteria (USFWS, 2003).
- Develop and implement a formal conservation agreement for star cactus between the United States and Mexico through the Trilateral Agreement (USFWS, 2003).
- Develop a public education and awareness program for the species (USFWS, 2003).
- Evaluate progress toward recovery, management direction, and status of information needed for development of delisting criteria within five years (2008-2009) (USFWS, 2003).

Conservation Measures and Best Management Practices:

- Continue periodic monitoring of the known populations in Texas and Mexico to track demographic trends, and to detect and attempt to alleviate threats to these populations (USFWS, 2013).
- Conduct public outreach efforts to encourage conservation of the species and its habitat on private lands. Work with private landowners to establish a private landowner support group and pursue conservation agreements with landowners (USFWS, 2013).

- Conduct surveys of high-potential habitat within the known range of the species in South Texas and Mexico, focusing on sites that have not previously been surveyed (USFWS, 2013).
- Develop an official reintroduction plan for *A. asterias*. Collect seeds from the known populations, propagate in a greenhouse to produce seedlings, and reintroduce at protected sites, in accordance with Service policy on controlled propagation of endangered species (65 FR 56916) (USFWS, 2013).
- Although the recovery plan (USFWS 2003, p. 13) stated that at least two distinct tracts of National Wildlife Refuge (NWR) land in Texas have the type of soil and habitat necessary for *A. asterias* reintroduction, and Recovery Action 5 further stated that reintroduction could be implemented on Lower Rio Grande Valley NWR, subsequent habitat assessments, conducted by two separate teams of star cactus experts (in 2005 and in 2010), did not find any suitable star cactus habitat on any existing tracts of Lower Rio Grande valley NWR. However, this refuge could target some future land acquisitions to include suitable habitat for *A. asterias* (USFWS, 2013).

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SPECIES ACCOUNT: *Atriplex coronata* var. *notatior* (San Jacinto Valley crownscale)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/13/1998; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An annual herb, 1-3 dm tall, with gray-scaly herbage. Flowers are inconspicuous, with rounded, often bumpy bracts developing in the fruiting stage. Usually flowers in April and May and sets fruit by May or June (NatureServe, 2015).

Taxonomy

Atriplex coronata var. *notatior* (San Jacinto Valley crownscale) was first described by Willis Jepson in 1914, based on specimen material he collected in 1901 from the dried bed of San Jacinto Lake, Riverside County, California. This taxon was considered a minor variant in a monographic treatment of the genus *Atriplex* (Hall and Clements 1923) and was generally not recognized as distinct from *A. coronata* until Munz (1974) concurred in Jepson's findings in his treatment of southern California plants (USFWS, 1994). It is a member of the Chenopodiaceae (goosefoot family) (Zacharias 2012, p. 629) (USFWS, 2012).

Historical Range

See Current

Current Range

Restricted to the San Jacinto, Perris, Menifee, and Elsinore Valleys of western Riverside County, California. Occurrences are associated primarily with the San Jacinto River and Old Salt Creek tributary drainages, with an additional occurrence near Lake Elsinore (USFWS 2008) (NatureServe, 2015).

Critical Habitat Designated

Yes; 4/16/2013.

Legal Description

On April 17, 2012, the U.S. Fish and Wildlife Service (Service) proposed to designate critical habitat for San Jacinto Valley crownscale (*Atriplex coronata* var. *notatior*) under the Endangered Species Act of 1973, as amended (77 FR 23008 - 23057). On April 26, 2013, the Service issued a Final Rule in which no critical habitat was designated for San Jacinto Valley crownscale (78 FR 22626 - 22658). The Final Rule states "The Secretary is exercising his discretion to exclude approximately 8,020 ac (3,246 ha) of previously proposed critical habitat for *Atriplex coronata* var. *notatior*. The Service determined that the benefits of exclusion outweigh the benefits of inclusion for lands previously proposed as critical habitat within areas covered under the Western Riverside County Multiple Species Habitat Conservation Plan, the Rancho Bella Vista Habitat Conservation Plan, and the Southwestern Riverside Multi-species Reserve Cooperative Management Agreement." On October 13, 2005, the Service issued a Final Rule that did not designate critical habitat for this species (70 FR 59952 - 59974).

Life History**Food/Nutrient Resources****Breeding Season**

Adult: April - August (USFWS, 2012)

Key Resources Needed for Breeding

Adult: Wind (USFWS, 2012)

Reproduction Narrative

Adult: Seeds may remain viable for more than five years, such that a soil seed bank may be present at occupied and formerly-occupied sites (USFWS 2008) (NatureServe, 2015). *Atriplex coronata* var. *notator* is monoecious (plants bear separate male and female flowers on the same plant) and is believed to be wind-pollinated. *Atriplex coronata* var. *notator* is reported to be a prolific seed producer (Ogden Environmental and Energy Services Corporation [OEESC] 1993, p. 27). Seeds generally germinate in the spring as flows recede, flower in April and May, and set fruit by May or June (Bramlet 1992, pers. comm.). The flowering period may extend to August in years when the water recedes late in the spring season (Munz 1974, p. 355; California Native Plant Society [CNPS] 2001, p. 93) (USFWS, 2012).

Habitat Type

Adult: Wetland, terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Alkali vernal plain, alkali playa, alkali scrub, alkali grassland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Dynamic hydrological regime (NatureServe, 2015); seasonal large-scale flooding (USFWS, 2012)

Environmental Specificity

Adult: Very narrow to narrow (NatureServe, 2015)

Habitat Narrative

Adult: Occurs in seasonal wetlands, such as floodplains and vernal pools, on slow-draining alkali soils; communities include alkali vernal plain, alkali playa, alkali scrub, and alkali grassland. Sites are typically flooded by winter rains, after which the water drains or evaporates over a variable period of time. Prefers areas with a dynamic hydrological regime that includes both local and large-scale flooding events (USFWS 2008). The environmental specificity is very narrow to narrow (NatureServe, 2015). It is associated with alkaline-saline soils. A hydrologic regime that includes seasonal and large-scale flooding in combination with slow drainage in alkaline soils with low nutrient loads is a key habitat element for this taxon. *Atriplex coronata* var. *notator* is adapted to grow in slow-draining alkaline-saline clay soils, primarily the Willows soil series and, to a lesser extent, the Domino, Traver, Waukena, and Chino soils series (Knecht 1971, p. 23; Bramlet 1993, p. 4) (USFWS, 2012).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Fruits appear capable of floating, which would allow them to be dispersed by annual flood waters (NatureServe, 2015).

Population Information and Trends**Population Trends:**

Decline of 50 - 90% (NatureServe, 2015)

Species Trends:

50 - 70% decline (NatureServe, 2015)

Resiliency:

Low (inferred from USFWS, 2012)

Representation:

Moderate to high (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from USFWS, 2012)

Number of Populations:

4 (USFWS, 2012)

Population Size:

106,000; variable depending on year (USFWS, 2012)

Adaptability:

Low (inferred from USFWS, 2012)

Population Narrative:

The U.S. Fish and Wildlife Service (1998) estimates that approximately 75% of this taxon's historically suitable habitat has been destroyed or heavily impacted. This species has experienced a long-term decline of 50-90%. Between 1992 and 1998, the number of individuals and area occupied appeared to decline about 70% (U.S. Fish and Wildlife Service 1998). Between 1998 and 2008, the overall extent of the range did not change appreciably, but fragmentation of the spatial distribution within the range (in both space and time) continued due to ongoing threats (USFWS 2008). In 2000, the rangewide population was estimated to be 106,000 individuals (Glen Lukos Associates cited in USFWS 2008); as of 2008, this was still considered the best available estimate. However, the 2000 survey was conducted under the unusually favorable conditions of a two-year suspension of discing and manure dumping by the majority of landowners; these activities have since resumed and are expected to have decreased the number of plants (USFWS 2008). In addition, this annual plant undergoes significant year-to-year fluctuations in the number of standing individuals in response to annual rainfall, extent of winter flooding, temperature, and habitat conditions; therefore, estimates of plant numbers based on short-term data should be used very cautiously (USFWS 2008). Approximately 8 occurrences are believed to have excellent or good viability (CNDDB 2008) (NatureServe, 2015). The Service has

defined three geographic locations representing four occurrences of *A. c. var. notatior* in western Riverside County. A rangewide population estimate of 106,000 individuals of *Atriplex coronata var. notatior* is based on estimates from surveys conducted in the spring of 2000 (Glenn Lukos Associates, Inc. 2000, p. 15). This taxon exhibits several attributes that might limit its distribution and population growth; particularly habitat specificity and dependence on hydrologic processes represent significant vulnerabilities for *Atriplex coronata var. notatior* (USFWS, 2012).

Threats and Stressors

Stressor: Urban and agricultural development (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: The Alberhill Creek occurrence of *Atriplex coronata var. notatior* in the floodplain north of Lake Elsinore is located in an increasingly urbanized area that contains both local and private lands. An example of a recent development threat at this occurrence is a proposed subtransmission line (in association with a recently completed electrical power substation), as part of the Southern California Edison Valley-Ivyglen Subtransmission Line and Fogarty Substation Project (W. Worthey, Consultant, 2011, pers. comm.). Efforts are in place to reduce threats to *Atriplex coronata var. notatior* from urban development and related infrastructure; however, comprehensive surveys have not been conducted for the Lower San Jacinto and Alberhill Creek occurrences. An increase in the addition of manure and biosolids along the Lower San Jacinto River occurrence related to agricultural activities has been observed (USFWS 2008, p. 10). These soils amendments can permanently impact alkaline soil habitat where *Atriplex coronata var. notatior* is found as a result of: (1) disruption of essential physical or biological features due to continued ground disturbance and (2) alteration of soil chemistry, which causes permanent habitat conversion to a different plant community and expansion of nonnative plants that invade and may outcompete native taxa (Roberts 1999, pers. comm.). The Service believes that these agricultural developments continue as important direct threats to *Atriplex coronata var. notatior* within the Lower San Jacinto River occurrence. However, based on the best available information, the magnitude of this threat is high for this occurrence because many of the point localities of *A. c. var. notatior* in portions of the Upper and Lower San Jacinto River occurrences are found on private land that continue to be tilled for dryland farming or negatively impacted by soil amendments. Within the Upper San Jacinto River occurrence, overland flows that cross over agricultural lands into Mystic Lake during major flood events (i.e., winter storms) can transport sediments containing nutrients into the lake, which has increased in recent years as smaller flow events have caused failure of the Diversion Channel levees and flooding of agricultural lands in the San Jacinto Gap region (Tetra Tech and WRIME 2007, Appendix A, p. 1) (USFWS, 2012).

Stressor: Alteration of hydrology (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Habitats that support *Atriplex coronata var. notatior* are vulnerable to alteration of the supporting watershed, including prolonged inundation from increases in urban run-off as well as drainage of wetlands from removal of water supply (USFWS 1998, pp. 54984–54985). These alterations of hydrological processes are often the result of agriculture or urban development

activities adjacent to alkaline wetlands. The San Jacinto River floodplain is often dry due to groundwater infiltration enhanced by low groundwater levels from excessive pumping and limited recharge (Tetra Tech and WRIME 2007, p. 28), which alter the seasonal flooding cycle. The Upper Salt Creek occurrence is bisected north to south by the San Diego Aqueduct Canal and currently includes open fields and cow pastures within the remaining alkaline vernal pool, alkaline grassland, and alkali scrub habitats (RECON 1995, pp. 15, 17; CNDDDB 2012, EO 9). Additionally, historical drainage patterns in the Upper Salt Creek occurrence are disrupted by local roads, road ditches, and agricultural drainage ditches, which have reduced the degree and duration of ponding during the wet season (RECON 1995, p. 18) (USFWS, 2012).

Stressor: Disking (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: More than 500 ac (200 ha) of occupied or potential habitat for *Atriplex coronata* var. *notator* has been disked for the purposes of fire suppression or weed abatement (USFWS 1998, p. 54984, citing Roberts 1993, p. 2). Disking (or tilling) is also used to prepare areas for farming activities. This activity changes the microtopography of the natural floodplains and the alkaline soils themselves, both of which are important features for establishment of this taxa and other native plants found in these seasonally flooded habitats (Bramlet 2009, pers. comm.). Disking for dryland farming has been an ongoing activity in the San Jacinto River floodplain for perhaps 100 years; however, this activity was, in the past, intermittent, allowing for recovery periods for *Atriplex coronata* var. *notator* during fallow periods (Roberts 1999, pers. comm.) (USFWS, 2012).

Stressor: Invasive nonnative plants (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Displacement of *Atriplex coronata* var. *notator* by nonnative plants was identified as a threat at the time of listing. In particular, the expansion of a nonnative grass, *Crypsis schoenoides* (swamp prickly grass), was described as an important threat as a result of its seeding as a food source for migratory waterfowl along the San Jacinto River (USFWS 1998, p. 54988). establishment of nonnative plants such as *Brassica nigra* (black mustard) and *Salsola traga* (Russian thistle) as a result of manure and sludge dumping along the Lower San Jacinto River floodplain has been documented (USFWS 2008, pp. 15–16). The continued planting of cover crops such as *Festuca perennis* (rye grass) (as *Lolium multiflorum* (Italian rye grass)) or *Festuca* (as *Lolium*) *rigidum* (Wimmera ryegrass; rigid Italian rye grass) for waterfowl, competes with existing alkali plant communities (Bramlet 2009, pers. comm.), displacing *Atriplex coronata* var. *notator* and other native plants. The prevalence of nonnative plants remains a threat to *Atriplex coronata* var. *notator* due to continued disturbance of these areas and the proximity of *A. c.* var. *notator* occurrences to consistent sources of nonnative species of grasses and forbs from nearby residential development and highways (USFWS, 2012).

Stressor: Sheep grazing (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: At the time of listing, intensive sheep grazing was described for the San Jacinto River and Hemet floodplain areas occupied by *Atriplex coronata* var. *notator* (USFWS 1998, p. 54985). Sheep grazing in habitat occupied by *A. c.* var. *notator* in the Upper Salt Creek occurrence was reported in 2005 (Roberts 2005, pers. comm.). Grazing is a recurring threat to the taxon at the Upper Salt Creek and the Lower San Jacinto River occurrences (USFWS, 2012).

Stressor: Trampling (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Sheep grazing has been previously described as the primary impact related to trampling to individual stands of plants. Trampling resulting from off-road vehicle use is likely to be a localized, individual threat to some populations of *Atriplex coronata* var. *notator* within the most southern portion of the Lower San Jacinto River occurrence based on visible off-road trails and land disturbance observed with aerial imagery (ESRI 2010) (USFWS, 2012).

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Projected effects of climate change in the southwestern California ecoregion occupied by *Atriplex coronata* var. *notator* from regional climate models indicate a mean annual temperature increase of 1.7 to 2.2° Celsius (C) (3.06 to 3.96° Fahrenheit (F)) by 2070, and a general consensus of a 2° C (3.6° F) increase in most months over the next 100 years (Point Reyes Bird Observatory [PRBO] Conservation Science 2011, p. 40). Vegetation changes are also expected. Drier climatic conditions can increase the threat to taxon such as *Atriplex coronata* var. *notator* that rely on seasonal rainfall (USFWS 1998, p. 54989). Although there is currently uncertainty with current model projections of precipitation in southern California, the Service believes that predictions of warmer temperatures and increased variability in extreme rain or flood events are a threat to *A. c.* var. *notator* through resultant changes in precipitation patterns that create conditions essential for maintaining habitat that supports plant populations (USFWS, 2012).

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- Survey all historical and extant occurrences to determine the location, status, and acreage of occupied and suitable habitat of each population to establish a comprehensive baseline against which to measure future changes. Surveys should be concentrated on the remaining Willows soil

series within the basin and valley floors that form the U-shaped region surrounding the Lakeview Mountains, encompassing the San Jacinto River and Upper Salt Creek 100-year floodplains. Additionally, a more focused survey for *Atriplex coronata* var. *notatior* should be conducted within the Alberhill Creek floodplain during a year with above average rainfall (USFWS, 2012).

- Conserve or preserve *Atriplex coronata* var. *notatior* occurrences on private lands. Continue to identify key property easements or parcels in the San Jacinto and Upper Salt Creek floodplains for Partners for Fish and Wildlife programs or purchase through the Act's section 6 funding program (USFWS, 2012).
- Manage *Atriplex coronata* var. *notatior* occurrences to prevent potential impacts from recreational activities, dumping, or other human-related activities. This may include fencing or posting to prevent access to managed areas and evaluation of appropriate use of disking practices for fire suppression and weed abatement (USFWS, 2012).
- Engage in the State of California's TMDL program to ensure that water quality (as discussed in FACTOR A and FACTOR D) within habitat occupied by sensitive taxon, such as *Atriplex coronata* var. *notatior*, is evaluated in determining "beneficial uses" within the Temescal Creek (and its tributaries) and Lake Elsinore TMDL process (USFWS, 2012).
- Develop a Population Viability Analysis model such as a metapopulation occupancy model for *Atriplex coronata* var. *notatior* to determine the key features for survival. Conduct a sensitivity analysis to identify those elements that represent the most important threats to maintaining minimum population size (USFWS, 2012).
- Conduct research to evaluate reproductive life history characteristics such as seed germination requirements, mechanism of seed dispersal, and seed viability. This will assist in identifying reasons for the persistence of certain occurrences and actions needed to help conserve others (USFWS, 2012).

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USFWS 1994. Endangered and Threatened Wildlife and Plants

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Revised Designation of Critical Habitat for *Allium munzii* (Munz's Onion) and *Atriplex coronata* var. *notatior* (San Jacinto Valley Crownscale)r. Final rule. 78 FR 22626-22658 (April 16, 2013)

U.S. Fish and Wildlife Service. 2012. Endangered and Threatened Wildlife and Plants

Designation of Revised Critical Habitat for *Allium munzii* (Munz's onion) and *Atriplex coronata* var. notatior (San Jacinto Valley crownscale)

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SPECIES ACCOUNT: *Auerodendron pauciflorum* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 3/20/1994; Southeast Region (R4) (USFWS, 2015)

Physical Description

An evergreen shrub or small tree which may reach up to 5 meters in height. The leaves are opposite or subopposite, ovate to ovate-elliptic, 6 to 15 centimeters long and 3.5 to 6 centimeters wide, glabrous, and with minute black glandular dots. Paired ovate-triangular, ciliate stipules, 1.5 millimeters long, are present at the base of the petiole. The peduncles vary from millimeters in length. Two to three flowers are borne in the leaf axils. The calyx tube is broadly campanulate, 2 millimeters long and 3 millimeters wide. The fruit is unknown at the present time (Proctor 1991). (USFWS, 1996)

Taxonomy

Auerodendron pauciflorum belongs to the family Rhamnaceae, a family consisting of approximately 55 to 58 genera and 900 species of cosmopolitan distribution but most common in the tropics and subtropics. The genus *Auerodendron* Urban includes eight or nine species: one in the Bahamas and Cuba, five or six endemic to Cuba, one endemic to Jamaica, and one endemic to Puerto Rico (Breckon and Kolterman 1994) (USFWS, 1996).

Historical Range

It is endemic to Puerto Rico (Lioger 1994) (USFWS, 2011).

Current Range

Currently known only from the limestone hill region on the northern karst of Puerto Rico. (USFWS, 2011)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from EPA, 2016)

Dependency on Other Individuals or Species

Adult: Insect pollinators (EPA, 2016)

Reproduction Narrative

Adult: One herbarium specimen was in flower in November. It is probably insect pollinated (EPA, 2016).

Habitat Type

Adult: Terrestrial (EPA, 2016)

Habitat Vegetation or Surface Water Classification

Adult: Subtropical moist forest (EPA, 2016)

Environmental Specificity

Adult: Narrow (inferred from EPA, 2016)

Habitat Narrative

Adult: Occurs in the limestone hill region on the northern karst of Puerto Rico within the subtropical moist forest life zone. It is restricted to limestone cliffs in a small area in the Coto Ward of the municipality of Isabela. The area receives from 175 to 200 centimeters of rainfall per year, with the dry season extending from January to March and the wet season from May through November. Forest is made up of two strata and a mix of deciduous and evergreen plants. Underlain by limestone rocks. Soils are shallow, well-drained, alkaline, and interspersed with outcrops of hard limestone (EPA, 2016).

Dispersal/Migration**Dependency on Other Individuals or Species for Dispersal**

Adult: Unknown (EPA, 2016)

Dispersal/Migration Narrative

Adult: Dispersal mechanisms are unknown but probably occurs via biotic and abiotic factors (EPA, 2016).

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Unknown (USFWS, 2011)

Resiliency:

Very low (inferred from USFWS, 2011)

Redundancy:

Very low (inferred from USFWS, 2011)

Number of Populations:

1 (USFWS, 2011)

Population Size:

~21 (USFWS, 2011)

Additional Population-level Information:

The most recent report from 2014 (Acevedo-Rodríguez, 2014) documented a new locality of *Auerodendron pauciflorum* within a federal land in the municipality of Aguadilla. Acevedo-

Rodríguez (2014) reported a single mid-sized, healthy individual without evidence of sexual reproduction (flower or fruit) at the Ramey Solar Observatory property. (USFWS, 2017).

Population Narrative:

The species status is unknown; additional surveys are needed to update information on species' abundance and distribution. Only one fragmented population of approximately 21 individuals occurs (USFWS, 2011).

Threats and Stressors

Stressor: Habitat destruction and fragmentation (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The fact that only one fragmented population of *Auerodendron pauciflorum* occurs on privately-owned land is a concern for the Service. This site is located in the Coto Ward of Isabela, an area threatened with commercial, residential and tourist development projects. During the last decade, the Service has reviewed numerous projects in the northern karst region of Puerto Rico, where the only known population of *Auerodendron pauciflorum* is known to exist. We have provided technical assistance to the Puerto Rico Highway Authority for the expansion of the Highway PR-22 from Hatillo to Aguadilla to minimize possible adverse effects to *Auerodendron pauciflorum* and several other species. The currently proposed route (the preferred alternative) is located south of the existing population of *Auerodendron pauciflorum*, where adverse effects are not anticipated for the species. However, if the preferred route is not selected, the proposed highway may affect the species restricting more of its habitat or eliminating the entire population. In addition, indirect effects related to commercial, residential and tourist development associated with the road may affect the species and its habitat. Currently, road PR-113 already divides the principal population of *Auerodendron pauciflorum*. The numerous residential and tourist development projects proposed in the area may result in a higher demand for bigger roads to support the increased traffic in the area. *Auerodendron pauciflorum* remains threatened by habitat modification or destruction because of the development pressure for tourist and residential projects as well as roads and/or highways in the area (USFWS, 2011).

Stressor: Small population size (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: In rare species like *Auerodendron pauciflorum*, genetic variation is very important because the loss of genetic variation can reduce the ability of the species to adapt to environmental changes. In addition, it may increase the susceptibility to diseases and pests. In addition, the limited number of individuals and its limited distribution is a threat for the species because any disturbance by human interaction or a natural disaster like a hurricane can eliminate the only known population (USFWS, 2011).

Recovery

Reclassification Criteria:

Not available

Delisting Criteria:

1. Populations on privately owned land area placed under protective status (USFWS, 2011).
2. New populations (the number of which should be determined following the appropriate studies) of each species, capable of self-perpetuation, have been established within protected areas, such as the Guajataca Commonwealth Forest, the Cambalache Commonwealth Forest, or the Río Abajo Commonwealth Forest (USFWS, 2011).

Recovery Actions:

- Protect the existing populations known from privately owned land (USFWS, 1996).
- Develop management plans for known populations (USFWS, 1996).
- Monitor known populations (USFWS, 1996).
- Enforce existing Commonwealth and Federal endangered species regulations (USFWS, 1996).
- Educate the public on conservation values and regulations (USFWS, 1996).
- Conduct research on the life history of the species and evaluate propagation techniques (USFWS, 1996).
- Conduct propagation and enhance existing populations or establish new ones on protected lands (USFWS, 1996).

Conservation Measures and Best Management Practices:

- Surveys should be conducted to establish the actual status of the species. New information will lead us to better knowledge of the species and its requirements and thus provide beneficial information towards the recovery of the species (USFWS, 2011).
- The Service, in cooperation with DNER and academia, needs to determine how many individuals constitute a self-sustainable population (USFWS, 2011).
- Efforts to protect privately-owned populations should be started to reduce habitat deterioration and maintain habitat or promote sustainable land use practices. Private lands initiatives (such as Partners for Fish and Wildlife and Coastal Program) are needed to further protect the area where *Auerodendron pauciflorum* is known to occur naturally (USFWS, 2011).
- Foster a working partnership with regulatory agencies to address and minimize potential adverse effects of development projects on the species and its habitat (USFWS, 2011).
- Monitor *Auerodendron pauciflorum* to see if we encounter the species in reproduction and try to propagate the species (USFWS, 2011).
- Develop and learn other propagation techniques to ensure the continued survival of the species and complement the existing population (USFWS, 2011).

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SPECIES ACCOUNT: *Ayenia limitaris* (Texas ayenia)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/23/1994; Southwest Region (R2)

Physical Description

A spineless shrub with a canopy reaching up to 2.0 meters (m) (6.6 feet [ft]) in height and 2.8 m (9.2 ft) in breadth. However, mature, reproductive plants may be as little as 0.3 m (1.0 ft) tall and broad. The alternate, soft, heart-shaped leaves have minute hairs and toothed margins; microscopically, the hairs on the lower surfaces of the leaves are stellate. The older, woody stems are reddish-brown, up to 2 centimeters (cm) (0.8 inches [in]) thick, and dotted with cream-colored lenticels. Inflorescences arise from the leaf axils, from 1 to 4 per node; the peduncles are about 1 cm (0.4 in) long, usually bearing 3 flowers on pedicels up to 1 cm (0.4 in) long. The flowers are about 6 millimeters (mm) (0.24 in) wide, with five greenish, 3 mm- (0.12 in-) long sepals and 5 yellow- to cream-colored, kidney-shaped petals (having two prominent, ovate lobes) bearing filamentous claws. The fruit, a five-chambered capsule up to 1 cm (0.4 in) in diameter before drying, is covered with curved, velcro-like appendages that may adhere to the hair of animals. Capsules produce up to 5 dark brown to black, tuberculate seeds 4 to 5 mm (0.16 to 0.20 in) in length. The maturing capsules turn from green to straw-colored; eventually the 5 chambers split apart, ejecting the seeds up to about 3 m (10 ft) from the parent plant. (USFWS, 2016)

Taxonomy

Tamaulipan kidneypetal was first collected by C.G. Pringle (Pringle no. 2272) in 1888 in the vicinity of Hidalgo, Texas. This collection was initially identified as *Ayenia berlandieri* S. Watson; the genus *Ayenia* was classified at that time in the Sterculiaceae (cacao family). Robinson and Greenman (1896) based their description of a new species, *Nephropetalum pringlei* B.L. Rob. & Greenm., on Pringle's specimen. Tamaulipan kidneypetal was collected several times in Cameron County, Texas, between 1924 and 1955 (see Table 3), and identified as *A. berlandieri*. Cristóbal (1960) first described the species *limitaris*, based on Shiller's 1955 specimen from Brownsville, in her monograph on the genus *Ayenia*, which she also placed in the Sterculiaceae; this continues to be the authoritative treatment of the genus (Tropicos 2009). Both *A. limitaris* and *N. pringlei* were recognized as valid species until Dorr and Barnett (1986) established their synonymy. The name *A. limitaris* was retained, since Cristóbal had already described another species as *A. pringlei* Cristóbal. (USFWS, 2016)

Historical Range

In Texas, in Cameron, Hidalgo, and Willacy counties; also northeast Mexico. (USFWS, 2016)

Current Range

In Texas, in Cameron, Hidalgo, and Willacy counties, and northeast Mexico. (USFWS, 2016)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources**Reproductive Strategy**

Adult: Sexual: cross-pollination, based on closely related species (USFWS, 2016)

Lifespan

Adult: Unknown; propagated plants: 10+ years (USFWS, 2016)

Breeding Season

Adult: May - June, September - November: bimodal (USFWS, 2016)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 2010); direct sunlight, rainfall (USFWS, 2016)

Reproduction Narrative

Adult: *A. limitaris* is effectively pollinated by a locally abundant insect of the Rio Grande delta (USFWS, 2010). It appears to require at least some direct sunlight for successful reproduction. Herbarium specimens and observations of Tamaulipan kidneypetal in Texas indicate that wild plants flower most often in June, July, September, October, and November. The more consistent and prolific flowering and fruiting lasts from September through November; flowers and capsules may also be observed from May to June following significant rainfall. This pattern coincides with the prevailing bimodal rainfall pattern in the Rio Grande delta. During seasons when there has been little or no precipitation, Tamaulipan kidneypetal plants do not flower. Therefore, reproduction appears to be stimulated primarily by rainfall. Most members of the genus *Ayenia*, including *A. limitaris*, are obligately allogamous; their floral morphology renders self-fertilization mechanically impossible (Cristóbal 1960). The longevity of individual Tamaulipan kidneypetal plants is unknown. However, propagated plants in experimental plots and reintroduction sites have lived at least 10 years without any apparent decline in vigor. These plants began flowering and producing viable seed at about 1 to 2 years of age (USFWS, 2016).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Subtropical woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Partial shade (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: Inland aridity, freezing temperatures, high elevations (USFWS, 2014)

Habitat Narrative

Adult: Dense subtropical woodland communities at low elevations. The current Texas site is within the Texas Ebony-Anacua (*Pithecellobium ebano*-*Ehretia anacua*) plant community - a closed-canopy community of riparian terraces that once covered much of the Rio Grande delta, but is now reduced to remnant fragments surrounded by agricultural fields, pastures, and urban areas. The site was once an active floodplain, and the effects of hydrologic changes on *Ayenia*

limitaris are unknown (NatureServe, 2015). Wild populations have now been documented in a wide range of alluvial soil types, from fine sandy loam to heavy clay. The species establishes well and reproduces rapidly in disturbed soils. Wild populations frequently occur in partial shade, or at the edge of shrub canopies, rather than under dense shrub or forest canopies (USFWS, 2010). The species' range appears to be restricted by increasing aridity further inland and by the prevalence of freezing weather further north and at higher elevations in the mountain ranges of northeast Mexico (USFWS, 2016).

Dispersal/Migration

Dispersal

Adult: Low (inferred from USFWS, 2010)

Dispersal/Migration Narrative

Adult: The capsules dehisce upon drying, scattering the seeds up to a few meters away from the parent plant. The recurved appendages of the fruit capsule may also serve to disperse entire capsules by adhering to animal hair or feathers. Additional seed dispersal may be caused by insects, water flow, or other factors (USFWS, 2010).

Population Information and Trends

Population Trends:

Declining (inferred from USFWS, 2016)

Number of Populations:

U.S.: 5; Mexico: 10 (USFWS, 2016)

Population Size:

U.S.: 1,400 - 1,800; Mexico: 4,000+ (USFWS, 2010)

Minimum Viable Population Size:

250 mature plants (USFWS, 2016)

Population Narrative:

Five extant populations, ranging from about 100 to 1,000 individuals, have been documented in the three southernmost counties of Texas. Ten extant populations, totaling at least 4,000 individuals, occur in two municipios of the Mexican State of Tamaulipas. At least seven populations in Texas have been extirpated. One population reported from Coahuila, Mexico has not been seen since 1936. A specimen was collected in 1985 in Topia, Durango, Mexico, but the species has not subsequently been reported from that area. (USFWS, 2016)

Threats and Stressors

Stressor: Habitat fragmentation and isolation (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Fragmentation and isolation may prevent gene flow among populations and lead to a depletion of genetic diversity. Cristóbal (1960) stated that *Ayenia* species are allogamous and insectpollinated. Therefore, viable populations of Tamaulipan kidneypetal must be large enough to contain sufficient genetic diversity for out-crossing to occur, and habitats must be sufficiently large and diverse to sustain populations of the insect pollinators. The remaining habitats throughout the species' known range are greatly fragmented, and remaining populations are isolated from each other. Since the genetic diversity within and among populations has not been investigated, we do not know to what extent genetic depletion may have occurred or how soon it could occur. Currently, the known populations continue to reproduce successfully. In synthesis, we consider that habitat fragmentation and isolation and the resulting depletion of genetic diversity are real threats of unknown magnitude and immediacy. However, if not addressed, these are likely to become high magnitude, imminent threats. Furthermore, once genetic diversity has been lost it cannot be recovered. Therefore, the recovery actions that mitigate these threats should not be delayed. (USFWS, 2016)

Stressor: Ungulate browsing (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Ungulate browsing. Contreras-Arquieta (2005) observed several Tamaulipan kidneypetal sites in the municipio of Soto la Marina, Tamaulipas, that were used as goat pasture. He included goat browsing as a potential threat to the species. Although we have no information on the palatability of Tamaulipan kidneypetal to livestock, or the impacts of grazing on its populations and habitat, it is important to note that the largest U.S. population, and most if not all Mexican populations, occur on land that has been grazed by cattle. We conclude that cattle grazing is not a threat to the species and that goat browsing is an imminent but low-magnitude threat. Browsing by white-tailed deer (*Odocoileus virginiana*) may also constitute a threat where deer populations are high. (USFWS, 2016)

Stressor: Climate change (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: We do not know how past climate changes have affected Tamaulipan kidneypetal populations and distribution, nor can we predict how future climate changes, forecast by the range of models and emissions scenarios, will affect the synecology of the species and its habitat. For example, a reduced amount or frequency of rainfall could reduce the species' range, while a decreased incidence of freezing could expand its range northward or into higher elevations in Mexican mountains. Furthermore, if the optimal geographic range of Tamaulipan kidneypetal shifts, the species may not be able to migrate fast enough to keep up with the rapid pace of climate changes. Conditions favorable to Tamaulipan kidneypetal might also increase competition from invasive plants, such as guineagrass, or allow new parasites and pathogens to spread into its range, affecting both Tamaulipan kidneypetal and guineagrass in an infinitely complex aggregation of interacting effects. Consequently, we currently have no evidence that the combined effects of climate changes threaten Tamaulipan kidneypetal. However, it is possible that threats induced by climate changes, based on predicted slight increases in temperature and evaporative deficit, may arise in the future. (USFWS, 2016)

Stressor: Competition from introduced invasive grasses (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Several introduced grass species of African and Asian origin are invasive throughout the Tamaulipan region of Texas and northeast Mexico, and have replaced much of the herbaceous plant diversity. In particular, guineagrass has been recorded at most Tamaulipan kidneypetal sites in Texas, and is probably present at all sites in Texas and Tamaulipas. Guineagrass competes directly with Tamaulipan kidneypetal for the same partially-shaded niches. Buffelgrass, King Ranch bluestem (*Bothriochloa ischaemum*), and Angleton bluestem (*Dichanthium aristatum*) were also listed as threats in the listing (USFWS 1994). Buffelgrass is extremely abundant throughout the region, and is a major threat to many rare plant species. Although buffelgrass is not shade-tolerant, it might exclude Tamaulipan kidneypetal from the more open portions of the habitat. Tamaulipan kidneypetal is probably threatened more by Kleberg bluestem and Angleton bluestem than by King Ranch bluestem. The former two grass species are abundant in alluvial, fine-textured soils in the deltas and flood plains of south Texas and northeast Mexico. The latter species prevails in well-drained, rocky uplands, such as the Edwards Plateau of central Texas. These three closely-related taxa pertain to a species complex often generically referred to as Old World bluestems; they are difficult to distinguish in the field and are often confused. Other invasive plants, such as introduced *Kalanchoe* species, may also threaten Tamaulipan kidneypetal in some sites. In summary, competition from introduced invasive grasses is a high-magnitude, imminent threat to all known populations of Tamaulipan kidneypetal. (USFWS, 2016)

Stressor: Loss of pollinators (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Currently, flowers of Tamaulipan kidneypetal plants are effectively fertilized by unknown insect pollinators even when isolated from wild populations. This indicates that suitable pollinators are widespread and abundant in the region. Nevertheless, insect pollinators could be depleted, and pollinator access could be disrupted, by the loss and fragmentation of habitats, pesticide drift, or depletion of the native plant diversity. Pollinator loss is currently not a known, imminent threat, but could become a threat in the future. Several recovery actions included in this plan will help prevent the loss of Tamaulipan kidneypetal pollinators. (USFWS, 2016)

Stressor: Catastrophic events (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Since there are few populations, most populations have few individuals, and populations are confined to limited geographic areas, individual populations are vulnerable to chance catastrophic events, such as hurricanes or the introduction of an invasive pathogen or parasite. However, due to the geographic range of known populations, it is unlikely that a single event could impact all populations. We conclude that catastrophic events represent a low-magnitude, non-imminent threat. (USFWS, 2016)

Stressor: Pesticide drift and runoff (USFWS, 2016)

Exposure:**Response:****Consequence:**

Narrative: This potential threat has not been observed. However, due to the fragmentation and small size of occupied habitats and their proximity to agricultural fields and highway rights-of-way, herbicide and insecticide drift and chemical spills could harm some populations or the pollinators they depend on. Nevertheless, it is unlikely that accidental herbicide contamination will impact significant numbers of Tamaulipan kidneypetal plants. This low-magnitude, non-imminent threat can be further reduced through outreach to owners and managers of Tamaulipan kidneypetal habitats. (USFWS, 2016)

Stressor: Trampling (USFWS, 2016)

Exposure:**Response:****Consequence:**

Narrative: Foot traffic can damage individual plants that occur along trails in parks and natural areas, or where people illicitly traverse habitats off-trail. Ordinarily, people avoid walking through dense thickets of spiny shrubs. However, undocumented aliens entering the U.S. from Mexico often pass through stands of native vegetation to avoid detection, and have damaged vegetation in natural areas along the border. Nevertheless, little if any actual damage to Tamaulipan kidneypetal plants has been observed from trampling. Consequently, we do not consider trampling to be a threat to the species. (USFWS, 2016)

Stressor: Oil and gas development (USFWS, 2016)

Exposure:**Response:****Consequence:**

Narrative: In Texas, mineral rights owners take precedence over surface owners and may clear land for drilling operations without landowner consent. Many surface landowners in south Texas, including most federal and state conservation agencies and non-governmental conservation organizations, do not own mineral rights. Similarly, mineral rights in Mexico are owned by the Mexican federal government rather than the surface owner. Oil and gas exploration and extraction continues at a rapid pace throughout much of south Texas and northeast Mexico, and an ever-increasing proportion of the land has or will be cleared for drilling platforms, pipelines, access roads, and related infrastructure. In addition to the direct loss of populations and habitat through land clearing, these operations will increase the fragmentation of habitat and will create new colonization pathways for invasive grasses. Tamaulipan kidneypetal populations on private lands are particularly vulnerable, since the U.S. ESA does not protect endangered plants on private lands unless there is another form of prevailing federal nexus, such as a federally-funded program or regulated action. Therefore, oil and gas development is an imminent threat; the magnitude is medium to high, depending on the duration and intensity of hydrocarbon exploration that in turn is dependent on economic factors and the intricacies of energy markets. (USFWS, 2016)

Stressor: Altered vegetation structure and composition (USFWS, 2016)

Exposure:**Response:****Consequence:**

Narrative: Many ecologists believe that grasslands and savannas were more abundant in south Texas and northeast Mexico prior to European settlement, and that these vegetation types were converted to dense shrubland and forest as a consequence of poor rangeland management and changes in the natural fire cycle (see discussion in section I.d.-Ecology). This dramatic shift in vegetation composition and structure and fire dynamics may also have contributed to the decline of Tamaulipan kidneypetal. (USFWS, 2016)

Stressor: Unintended impacts of propagation and reintroduction (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: The recovery actions proposed under the 2016 Recovery Plan include propagation and reintroduction of Tamaulipan kidneypetal into suitable habitats. These actions could cause unintended harm to the species, such as depletion of the seed banks of wild populations, genetic swamping due to excessive propagation from a genetically limited source population, inbreeding depression, outbreeding depression, and the spread of pathogens or parasites into healthy populations. Pilot reintroduction efforts conducted at LRGV NWR in the 1990s preceded the adoption, in 2000, of the USFWS policy on controlled propagation of endangered species (USFWS and NMFS 2000). This policy now requires that the potential risks of propagation be assessed and addressed prior to initiating propagation by USFWS or through USFWS support. Section E.13 of the policy requires preparation of a controlled propagation and reintroduction plan prior to the reintroduction of federally-listed threatened or endangered species. The plan should be based on strategies identified in an approved recovery plan, and should include protocols for health management, disease screening and disease-free certification, monitoring and evaluation of genetic, demographic, life-history, phenotypic, and behavioral characteristics, data collection, recordkeeping, and reporting, as appropriate. We conclude that, through compliance with USFWS policy on propagation and reintroduction, these actions will not threaten the species. (USFWS, 2016)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Tamaulipan kidneypetal is not protected by other U.S. federal or state laws. Federally-listed plants occurring on private lands have limited protection under the ESA, unless also protected by state laws; the State of Texas provides very little protection to listed plant species on private lands. Approximately 95 percent of Texas land area is privately owned. It is reasonable to assume that the vast majority of existing Tamaulipan kidneypetal habitat, including sites that have not been documented, occurs on private land. Therefore, most of the species' populations and habitats are not subject to federal or state protection unless there is a federal nexus, such as provisions of the Clean Water Act or a federally-funded project. (USFWS, 2016)

Recovery

Reclassification Criteria:

1. The successful accomplishment of threats reduction and mitigation is demonstrated by a stable or improving status of Tamaulipan kidneypetal, compared to the baseline conditions,

throughout its known range over a period of at least 10 years. (Threat-based objective) (USFWS, 2016)

2: At least 10 populations of Tamaulipan kidneypetal, and at least 1 per recovery unit, are documented in optimal habitats for a period of at least 10 years. Habitat is considered optimal when: It is protected for conservation purposes; it is managed in a manner that promotes the long-term survival of Tamaulipan kidneypetal; it has less than 10% cover of introduced invasive plant species; it consists of at least 400 ha (988 ac) of contiguous habitat; and where Tamaulipan kidneypetal populations are observed to be stable or increasing. (Habitat-based objective) (USFWS, 2016)

3. Conserve, protect, and restore populations of Tamaulipan kidneypetal needed for its recovery. Populations must be self-sustaining, of sufficient size to endure climatic variation and stochastic events, of sufficient number to endure catastrophic losses, and must represent the full range of the species' geographic and genetic variability. (Population-based objective) (USFWS, 2016)

Delisting Criteria:

Criteria 1 through 3: Same as Downlisting Criteria (USFWS, 2016)

4: Twenty (20) or more protected populations, including no less than 5 per recovery unit, have maintained stable or increasing populations of at least 500 mature individuals, 47 and at least 1 population per recovery unit maintains 1,000 or more individuals, for a total of at least 20 years. (USFWS, 2016)

Recovery Actions:

- 1. Protect and conserve the known populations and their habitats in the U.S. and Mexico. Promote cooperative efforts to conserve occupied habitats and protect known populations from invasive grass competition, excessive browsing, trampling, and other potential threats. Seek sources of financial and technical assistance to support these efforts. This action faces the following challenges: 1) Several known populations in the U.S. occur on private land; 2) a majority of the known populations, and almost all of the species' global range, occur in Mexico; 3) the known Mexican populations all occur on private or ejido land. Consequently, the U.S. ESA confers no authority to enforce the degree of population and habitat protection that is necessary to prevent a significant decline (jeopardy) of the species. Therefore, this action must rely heavily on voluntary conservation efforts and on close collaboration with Mexican agencies and conservation organizations. Furthermore, since it is probable that some populations on private and ejido lands will be destroyed or deteriorated through urban and agricultural development or other causes, this action addresses an objective of no net loss of populations and habitats; losses and deterioration of some populations and habitats may be offset through successful habitat restoration, improved management and protection of existing occupied habitat, or the discovery of new occupied habitats. (Priority 1) [More details are available in the 2016 Recovery Plan] (USFWS, 2016)
- 2. Develop a monitoring plan, and monitor known populations and habitats. The objectives and requirements of the monitoring plan are discussed in II.1 of the 2016 Recovery Plan. Visit known populations at least once per year, if possible, to make qualitative observations of habitat conditions and the growth and reproduction of Tamaulipan kidneypetal. Determine if there are any new or existing threats to the population and recommend

actions to alleviate threats. Collect quantitative data on population size and reproduction at least 5 times every 10 years to track long-term population dynamics. (Priority 1)[More details are available in the 2016 Recovery Plan] (USFWS, 2016)

- 3. Develop partnerships with Mexican government agencies, academic institutions, and NGOs to promote investigation, conservation, and recovery of the species in Mexico. Potential Mexican agency partners include the Secretaría de Desarrollo Urbano y Medio Ambiente (Secretary of Urban Development and Environment, State Government of Tamaulipas; SEDUMA) and SEMARNAT, CONANP, and CONABIO (federal). Academic institutions may include Universidad Autónoma de Tamaulipas, Universidad Autónoma de Nuevo León (particularly the Facultad de Ciencias Forestales [Forestry Sciences Department]), and the Instituto Tecnológico y de Estudios Superiores de Monterrey (Monterrey Institute for Technology and Advanced Studies; ITESM). Pronatura Noreste a.c., based in Monterrey, Nuevo León, is a potential NGO partner. (Priority 1) [More details are available in the 2016 Recovery Plan] (USFWS, 2016)
- 4. Improve management of known populations and habitats, based on monitoring data and the conclusions of scientific investigations (adaptive management). (Priority 2) [More details are available in the 2016 Recovery Plan] (USFWS, 2016)
- 5. Conduct public outreach in the U.S. and Mexico to promote the species' conservation and recovery. Disseminate outreach materials, attend public meetings, communicate with interested members of the public, and meet interested landowners to discuss conservation and recovery of Tamaulipan kidneyplant. (Priority 2) [More details are available in the 2016 Recovery Plan.] (USFWS, 2016)
- 6. Conduct scientific investigations necessary for conservation and recovery. (Priority 2) [More details are available in the 2016 Recovery Plan] (USFWS, 2016)
- 7. Search for new and historic populations in U.S. and Mexico. Seek permissions from public, private, and ejido landowners to conduct surveys in areas of intact habitat where the climate, soils, and vegetation are similar to known and historic populations. (Priority 2) [More details are available in the 2016 Recovery Plan] (USFWS, 2016)
- 8. Restore and subsequently manage native vegetation within the Rio Grande delta recovery units to increase the amount of suitable available habitat and to establish functioning ecological corridors that reconnect isolated habitat fragments. Restoration methods must use local ecotypes of native species, and must restore a diverse sub-shrub, native grass, and forb understory and a partially open tree and shrub canopy to be considered suitable for Tamaulipan kidneyplant. Effective habitat restoration will offset unpreventable losses of habitat on private lands, and will make the criterion of no net habitat loss more achievable and practical. (Priority 3) [More details are available in the 2016 Recovery Plan] (USFWS, 2016)
- 9. Augment and reintroduce populations in appropriate habitats within the known range in U.S. and Mexico. Augmentation is the supplementation of an existing population with progeny of the same population or another population that is genetically suitable. Reintroduction is the establishment of new populations within the species' known range and habitat types, but where a population currently does not exist. The objective in either case is to attain the criteria of an MVP of 250 or more mature individuals per population, 5 or more populations per recovery unit, at least 1 population per recovery unit with 1,000 or more mature individuals, and a minimum of 20 populations overall. All propagation and reintroduction will conform to the guidelines stipulated in an established controlled

propagation and reintroduction plan.(Priority 3) [More details are available in the 2016 Recovery Plan] (USFWS, 2016)

- 10. Prepare post-delisting monitoring plan. In accordance with ESA section 4(g)(1), upon recovery and removal from the endangered species list, the status of delisted species must be monitored for not less than five years. In consideration of the potential responses of 59 Tamaulipan kidneypetal populations, based on its lifespan, reproductive rate, and demography, to the removal of federal protection, monitoring should be continued for at least 10 years to ensure that the populations and criteria upon which delisting are based continue to be secure. Post-delisting monitoring must quantitatively document the extant populations upon which delisting is based, including population sizes, age structures, reproduction, recruitment and mortality, habitat conditions, invasive species impacts, degree and effectiveness of protection, and impacts of threats. (Priority 3) [More details are available in the 2016 Recovery Plan] (USFWS, 2016)

Conservation Measures and Best Management Practices:

- Complete an approved recovery plan for the species (USFWS, 2010).
- Continue periodic monitoring and surveys of the known populations in Texas and Tamaulipas to track demographic trends, and to detect and attempt to alleviate threats to these populations (USFWS, 2010).
- Conduct surveys of high-potential habitat within the known range of the species in south Texas and Tamaulipas, focusing on sites that have not previously been surveyed (USFWS, 2010).
- Survey existing habitats in the municipios of Múzquiz, Coahuila and Topia, Durango to attempt to confirm extant populations at those sites (USFWS, 2010).
- Collect seeds from the known populations and implement a reintroduction program at LRGV NWR, in accordance with USFWS policy on controlled propagation of endangered species (65 FR 56916) (USFWS, 2010).
- Conduct scientific investigations of the species' reproductive biology, the genetic structure of known populations, and the genetic relationship between *Ayenia limitaris* and closely related species (USFWS, 2010).
- Conduct scientific investigation of the species' ecology, with emphasis on vegetation structure and fire ecology (USFWS, 2010).
- Conduct public outreach efforts to encourage conservation of the species and its habitat on private lands; establish a private landowner support group (USFWS, 2010).

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SPECIES ACCOUNT: *Baccharis vanessae* (Encinitas baccharis)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/7/1996; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A shrub, < 2 m tall, broom-like in appearance with dense, erect branches, often leafless when the plants are in flower. Leaves are linear. Herbage is generally sticky-resinous. Whitish flower heads, lacking rays, bloom in the fall (August-November), Male and female flowers are borne on separate plants (NatureServe, 2015).

Taxonomy

A member of the Asteraceae (sunflower family) (USFWS, 2011).

Historical Range

Endemic to a narrow band of central-coastal San Diego County, California, from Encinitas eastward to Woodson Mountain, near Poway and southward to Mira Mesa; an area of ca 30 km E-W by 17 km N-S. Reported from 45 historical occurrences distributed within the same general range as that known at the time of listing, except for a southward extension of the range based on an occurrence detected in the Otay Mountain area. (NatureServe, 2015).

Current Range

This species is restricted to a patchy distribution along the coast and occasionally interior areas of San Diego County, California (USFWS, 2011).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (USFWS, 2012)

Lifespan

Adult: Presumed long-lived (NatureServe, 2015)

Breeding Season

Adult: August - November (USFWS, 2011)

Key Resources Needed for Breeding

Adult: Wind, insect pollinators (USFWS, 2011)

Reproduction Narrative

Adult: The blooming period is between August and November (CNPS 2010; San Diego Plant Atlas 2010). *Baccharis vanessae* is dioecious, meaning separate plants of both sexes must be in close

proximity for pollination and subsequent seed production to occur. Pollinated *Baccharis* flowers develop one-seeded dry fruits (achenes). *Baccharis vanessae* is probably pollinated by both wind and insects. Steffan (1997, pp. 52–54) collected native wasps, flies, beetles, and true bugs (from the order Hemiptera) from *Baccharis pilularis* (coyote bush), a related species that has flowers similar to *B. vanessae* and which also occurs in the same chaparral habitat. It exhibits an apparently low incidence of successful seedling establishment (USFWS, 2011). This species is presumed to be long-lived (NatureServe, 2015).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Maritime chaparral, mixed chaparral (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Disturbance/fire (USFWS, 2011)

Geographic or Habitat Restraints or Barriers

Adult: 60 - 335 m elevation (NatureServe, 2015), tall leafy shrubs (USFWS, 2011)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2011)

Habitat Narrative

Adult: Occupies steep slopes on sandstone and volcanic (1 site) substrates in fairly open southern maritime chaparral and dense mixed chaparral communities. Occurs at 60 - 335 m elevation (NatureServe, 2015). Observations suggest that *Baccharis vanessae* is not able to compete with taller, leafier shrubs such as *Arctostaphylos* spp. (manzanita) and *Ceanothus* spp., (ceanothus) or that it is a short-lived plant (KEA 1999, p. 15). *Baccharis vanessae* appears to be a pioneer species that increases in numbers after disturbance, such as fire, that opens up the chaparral canopy (Messina 2001, pp. 2–3; CNDDDB 2011, EOs 17 and 18). Overall, *B. vanessae* appears to increase in numbers in burned areas following fire events. *Baccharis vanessae* has been observed to occur on the following soil types: Cieneba series, Corralitos loamy sand alluvial Huerhuero, San Miguel Exchequer, granitic, andesite rock outcrops, and soils derived from acid igneous rock (CNDDDB 2011) (USFWS, 2011).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Achenes are each attached to a cluster of bristly hairs (a pappus), which facilitates wind dispersal (Steinberg 2002, p. 5). (USFWS, 2011).

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Increasing (USFWS, 2011).

Resiliency:

Low (inferred from USFWS, 2011; see current range/distribution)

Redundancy:

High (inferred from USFWS, 2011)

Number of Populations:

30 (USFWS, 2011)

Population Size:

Unknown (USFWS, 2011)

Adaptability:

Low (inferred from USFWS, 2011)

Population Narrative:

The species is now presumed extant at 30 occurrences. accurate plant counts for *B. vanessae* do not exist because no rangewide surveys have been conducted using a single monitoring protocol. Life history traits and habitat specificity seem to comprise the most significant vulnerabilities of *Baccharis vanessae*. The number of occurrences currently considered extant increased from 16 to 30 since listing (USFWS, 2011).

Threats and Stressors

Stressor: Development (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Following listing, occurrences continued to be impacted by development. A portion of one occurrence in Rancho Cielo (CNDDDB 2011 EO 7 that currently includes EOs 11, 13, and 14) was eliminated by urban development. development remains a threat to *B. vanessae* occurrences or portions of those occurrences as well as occurrences identified as REGSS points not encompassed by a CNDDDB polygons or the quarter-mile buffer zone around them. Of the 30 extant occurrences, 11 continue to be threatened by development associated impacts (EOs 1, 3, 5, 7, 8, 9, 24, 25, 27, 31, and SD 115244) (USFWS, 2011).

Stressor: Altered fire regime (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: In southern California, populated areas in proximity to natural vegetation often are under some form of fuel modification requirements. Fuel modification generally includes the clearing or thinning of fire prone natural vegetation, which would include that occupied by *B. vanessae*. Historically, natural fire regimes in southern California were likely characterized by many small lightning ignited fires in the summer and a few large fires in the fall of varying fire intensity (Keeley and Fotheringham (2003, pp. 242–243). The current fire regime in southern

California results in numerous small fires that periodically escalate into megafires that are generally driven by extreme “Santa Ana” weather conditions of high temperatures, low humidity, and strong erratic winds (Keeley and Zedler 2009, p. 90). The primary difference between the current fire regime and historical fire regimes in southern California is that human-induced or anthropogenic ignitions have increased primarily due to an increase in human population density since 1960, resulting in human-triggered fire ignitions and in particular, megafires in many more localities (Keeley and Fotheringham 2003, p. 240), than were known historically. The primary concern with frequent megafires is the plant mortality associated with these extensive and intense events which may kill individual plants and thereby potentially precludes recolonization of burned areas by *B. vanessae*. The lack of habitat clearing brushfires, of adequate frequency and intensity, may pose a threat to *B. vanessae* reproduction. The absence of an appropriate disturbance regime may also limit opportunities for recruitment of *B. vanessae* (USFWS, 2011).

Stressor: Nonnative plants (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Prevalence of nonnative plants is expected to increase with proximity to persistent sources such as residential development and highways. Nonnative plants may crowd out suitable establishment sites for *B. vanessae*, as may unchecked native plants, and they may alter the fire regime of the site. *Carpobrotus edulis* (iceplant, Hottentot fig) has the ability to invade maritime chaparral after brushfires (Zedler and Scheid 1988, pp. 196–201). The thick mat of this nonnative plant can prevent seedlings of native plants from becoming established (D’Antonio and Mahall 1991, pp. 886–888). *Centaurea* seeds are known to germinate much faster than those of some *Baccharis* species, grow rapidly during the winter and spring, and reduce the performance (biomass gain) of *Baccharis* seedlings (Gomez-Gonzalez et al. (2009, p. 81) (USFWS, 2011).

Stressor: Restricted distribution and small population size (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: *Baccharis vanessae* is at risk of extinction from naturally occurring events because of its restricted distribution and small population size (USFWS 1996, p. 52381). The distribution of the species is relatively narrow and likely habitat limited. This situation may exacerbate any other threats that are rangewide in scope, such as wildfires or broad jurisdictional fire suppression efforts. The small size of many *Baccharis vanessae* populations increases the probability that those populations will disappear or be otherwise compromised through random fluctuations in the environment (such as severe droughts or fires), failure to be cross-pollinated, or random human caused events (such as the clearing of a parcel of southern maritime chaparral in northern Lux Canyon in 2009) (S. Vurbeff, City of Encinitas, pers. comm., 2010). Small populations are also more susceptible to the expression of deleterious genes (USFWS, 2011).

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The impacts of predicted climate changes on individuals and habitat of *Baccharis vanessae* and similar species are unknown at this time. *Baccharis vanessae* may already be

suffering adverse effects from past climate changes resulting in a drier Holocene climate in present-day southern California. The observed lack of *B. vanessae* seedlings could possibly indicate that this species is unable to survive the length, severity, or the current timing of the annual dry season in San Diego County. Williams and Hobbs (1989, pp. 62, 64–66) discovered that *B. pilularis* seedlings tend to survive only during rainy springs (March to May) brought on by rare mega-El Niños like the one in 1982 to 1983 because the seedlings' root growth is negligible prior to March (USFWS, 2011).

Stressor: Trampling (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Currently, unauthorized camping occurs at Oak Crest Park in Encinitas (CNDDDB 2011, EO 1) even though the area is conserved (Thiede, pers. obs., 2010). Visitor foot traffic, as well as potential trail maintenance activities, also pose a threat to the *B. vanessae* populations at EOs 17 and 18, and rock climbers at Woodson Mountain likely impact plants at EO 15 (CNDDDB 2011) (USFWS, 2011).

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- Survey all historical and extant occurrences to determine the location, status, age-class representation, and sex composition of each population to establish a comprehensive baseline against which to measure future changes. Survey all areas that support “maritime-like” southern mixed chaparral for additional occurrences (USFWS, 2011).
- Manage *Baccharis vanessae* occurrences to maintain plants of both sexes. Outplantings could be considered at occurrences such as EO 28 where only one plant has been observed (USFWS, 2011).
- Investigate the possible causes of seed mortality and low reproductive success, and identify likely remedies (USFWS, 2011).
- Conserve or preserve *Baccharis vanessae* occurrences on private lands. Property easements or purchases of parcels could also be made through the Act’s section 6 funding and other programs (USFWS, 2011).
- Determine the appropriate use or substitute for a natural fire regime to perpetuate suitable habitat for *Baccharis vanessae* (USFWS, 2011).
- Determine which areas are most susceptible, to reduce impacts to *Baccharis vanessae* from fuel modification and fire suppression activities (i.e. using GIS analysis) (USFWS, 2011).
- Determine the distribution of genetic diversity in the species occurrences and identify the most appropriate means to preserve the diversity (USFWS, 2011).

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SPECIES ACCOUNT: *Banara vanderbiltii* (Palo de ramon)

Species Taxonomic and Listing Information

Listing Status: Endangered; 1/14/1987; Southeast Region (R4) (USFWS, 2015)

Physical Description

A small evergreen tree endemic to the island of Puerto Rico. The species is known only from two widely disjunct locations: the northwest karst limestone hills and the central mountains, volcanic in origin. (USFWS, 1991)

Taxonomy

The family Flacourtiaceae, to which it was formerly assigned, has been dismantled and the genus *Banara* has been transferred to the Salicaceae family (D. Kolterman and J. Chinea, UPRM, unpubl. data, 2013) (USFWS, 2014).

Historical Range

Palo de ramón is endemic to northern and south central Puerto Rico (D. Kolterman and J. Chinea, UPRM, unpubl. data, 2013) (USFWS, 2014).

Current Range

Known to exist in two populations, five at the central mountain “Tetas de Cayey” site and six in the Rio Lajas limestone hills near Bayamon in northwestern Puerto Rico. Both of these known populations occur on private land. (USFWS, 1991)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from EPA, 2016)

Dependency on Other Individuals or Species

Adult: Insect pollinators (EPA, 2016)

Breeding Season

Adult: April - June (EPA, 2016)

Reproduction Narrative

Adult: Produces flowers April through June. Ripe fruit observed late August to early September. Pollination occurs via insects and abiotic factors (EPA, 2016). The flowers of *Banara vanderbiltii* are bisexual (USFWS, 1991).

Habitat Type

Adult: Terrestrial (EPA, 2016)

Habitat Vegetation or Surface Water Classification

Adult: Subtropical moist forest, mogote (EPA, 2016)

Geographic or Habitat Restraints or Barriers

Adult: 33 - 2756 ft. elevation (EPA, 2016)

Habitat Narrative

Adult: Found on limestone karst hills (or mogotes) on the northwestern coast and the central mountains in the area of Cayey. Grows in semi-evergreen forests of the subtropical moist forest life zone. Forests usually contain an upper canopy (mostly deciduous) and a lower canopy (mostly evergreen). Woody and herbaceous lianas are common; sparse groundcover and open understory. Populations are found on limestone hills or mogotes (Mean annual precipitation 1570 millimeters. A dry period occurs from February to April, followed by a rainfall peak in May, and a second peak from June to November) and in the central mountains of volcanic origin (mean rainfall at a lower elevation, is 92 inches. Here, the driest months are January through March and the wet season extends from May to October. Soils are limestone origin or volcanic origin. Limestone derived soils are poorly developed and excessively drained. Some volcanic alluvial sediments have been incorporated into bottomland soils. The volcanic soils are made up of Caguabo clay loam soils in the more level areas (well-drained, shallow, and acidic); tanama clay series, robles formation; caguabo clay loam. Occurs at elevations around 328 to 492 ft (limestone hills); and greater than 2624 ft (central mountains) (EPA, 2016).

Dispersal/Migration**Dependency on Other Individuals or Species for Dispersal**

Adult: Bananaquit and stripe-headed tanager (EPA, 2016)

Dispersal/Migration Narrative

Adult: Birds (bananaquit and stripe-headed tanager) have been observed taking fruit (EPA, 2016).

Population Information and Trends**Population Trends:**

Increasing (USFWS, 2014)

Species Trends:

Unknown (USFWS, 2014)

Representation:

Low to moderate (inferred from USFWS, 2014)

Redundancy:

Moderate (inferred from USFWS, 2014)

Number of Populations:

10 (USFWS, 2014). As of 2017, only 3 natural populations of this species are known to occur (PRDNER 2016). (USFWS, 2019).

Population Size:

201 (USFWS, 2014). As of 2017: The (3) natural populations consist of approximately 39 individuals on Las Piedras del Collado in Salinas (also known as Las Tetas de Cayey), 2 individuals on Finca Tres Vidas in Aibonito; and 14 individuals on Rio Lajas, a private property within the municipality of Dorado (known as La Virgencita site) (PRDNER 2016). (USFWS, 2019).

Population Narrative:

The species status is unknown; status and distribution of the Palo de ramón has not been re-evaluated since 1991 (Service 1991). New information on the Palo de ramón indicates that the overall species' abundance has increased since the time of listing in 1987 (Table 1, Service unpubl. data, 2013). At the time that the recovery plan was approved, Palo de ramón was known from 11 individuals in two populations: one at Rio Lajas ward in Dorado and another at Las Piedras del Collado in Salinas (Service 1991). To date, 201 individuals of Palo de ramón are known from 10 populations. No information on the genetic variability within the species was found during this review, but the restricted range and limited number of individuals reported to date may suggest a low level of genetic variation. However, it would be reasonable to expect some genetic differentiation between the populations in northern and south central Puerto Rico, given their separation and the notable differences in elevation, substrate, and rainfall between the two areas (USFWS, 2014).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: The Rio Lajas population occurs on private land located near to the metropolitan area of San Juan. This area is under intense development pressure for industrial and residential expansion. Currently, some agricultural practices and deforestation for residential, industrial, and commercial projects (i.e., landfills, construction of dwellings and roads, power lines, and limestone quarrying) remain threats to this species, and we believe some of these sources have been responsible for elimination of some mature individuals. Deforestation for urban development and agriculture practices have resulted in habitat degradation through fragmentation, soil erosion, and changes in forest structure at the Rio Lajas ward (C. Pacheco, Service, pers. obs. 2013). The Palo de ramón population in Rio Lajas is located a short distance from the right-of-way of a power line that provides energy to an adjacent community (Service 1991). Occasionally, the Puerto Rico Energy and Power Authority (PREPA) conduct maintenance activities such as trimming and removal of vegetation growing under power lines and along their rights-of-way (USFWS, 2014).

Stressor: Stochastic events (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: One of the most important factors affecting the continued existence of the Palo de ramón is its limited distribution. In the Caribbean, native plant species, particularly endemics with limited distribution, may be vulnerable to natural or anthropogenic events such as hurricanes, human induced fire, landslides, and genetic variation. Palo de ramón is more susceptible to natural disturbances such as hurricanes, wildfire or landslides, because it is confined to geographically small areas (Service 1991). Due to the extremely limited range of the species, low number of individuals, and lack of information about its natural recruitment and habitat requirements, the Service believes that stochastic events such as severe tropical storms or hurricanes may have adverse impacts on the species, particularly in their natural populations in Rio Lajas and Las Piedras del Collado. Human induced fire is a current threat for the species at Salinas. Areas potentially used by the species in the municipalities of Salinas and Cayey have been negatively affected by human induced fires (C. Pacheco, Service, pers. obs. 2013). Fire is not a natural event in the subtropical moist forest of Puerto Rico. Thus, most species found in this type of forest are not fire-adapted. Human-induced fires may lead to destruction of the native vegetation seed bank and may create conditions favorable for the establishment of exotic plant species (e.g., guinea grass [*Megathyrsus maximus*]), which serve as fuel for fires. The populations of Palo de ramón that occur in both northern and south central Puerto Rico may be subject to human induced fires, particularly on private lands where fire could be accidentally or deliberately ignited (USFWS, 2014).

Stressor: Genetic variation (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Given the extremely small numbers of individuals in natural populations and the limited geographic distribution of the Palo de ramón, it is highly likely that its genetic variability is very low. This would result in the loss of alleles by random genetic drift, which would limit the species' ability to respond to changes in the environment (Honney and Jacquemyn 2007) (USFWS, 2014).

Stressor: Invasive species (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: As mentioned under Factor A, habitat modification for vegetation removal along the power lines right-of-way may increase the magnitude of the threat to Palo de ramón due to an increase in invasive species in these areas. Any disturbance of vegetation within the Palo de ramón habitat may create conditions favorable for the establishment of invasive species that may outcompete native plant species, changing the vegetation structure of the species' habitat. Invasive species (e.g., *Leucaena leucocephala* and *Megathyrsus maximus*) may spread and colonize the Palo de ramón habitat, altering fire regimes, microclimate, and nutrient cycling of the habitat the species depends on (USFWS, 2014).

Stressor: Climate change (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: An expected effect of climate change is the increase in intensity of hurricanes and tropical storms, followed by extended period of drought (IPCC 2012). These events may alter the surrounding vegetation around the populations of the Palo de ramón. Hurricanes followed by extended periods of drought may result in changes in soil conditions and microclimate and may allow other plants (native or non-native, herbaceous or woody) adapted to drier conditions to become established (Lugo 2000). Invasive species (e.g. *Leucaena leucocephala* and *Megathyrus maximus*) may spread and colonize the Palo de ramón habitat, and it could alter fire regime, microclimate, and nutrient cycling of the habitat that the species depends on (USFWS, 2014).

Recovery

Reclassification Criteria:

1. The known populations at Rio Lajas and Las Piedras del Collado are placed under protective status (USFWS, 2014).
2. At least two new populations capable of self-perpetuation (basically self-sustaining) have been established within protected units of the Commonwealth Forest System in the karst region (e.g., Vega or Cambalache Commonwealth Forests), and in the central mountain region (e.g., Carite or Toro Negro Commonwealth Forests) (USFWS, 2014).

Delisting Criteria:

1. Threats reduction and management activities have been implemented to a degree that the species will remain viable into the foreseeable future (addresses Factor A). (USFWS, 2019).
2. Existing three (3) populations on Rio Lajas, Las Piedras del Collado, and Finca Tres Vidas show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factor A and E). (USFWS, 2019).
3. Within the historic range, establish four (4) additional populations with a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factor E). (USFWS, 2019).

Recovery Actions:

- Monitor existing populations (USFWS, 1991).
- Provide protection for existing populations and their habitat (USFWS, 1991).
- Conduct research on the life history of the species, evaluate methods of propagation, and to look for introduction sites (USFWS, 1991).
- Propagate and produce seedlings for enhancement of existing populations and for the establishment of new populations on identified sites (USFWS, 1991).
- Added in 2019: Genetic material from all populations is preserved through long-term seed storage and/or propagation efforts at a credited botanical garden. (USFWS, 2019).

Conservation Measures and Best Management Practices:

- The recovery of the species should focus both on the protection of the known populations and their habitat in private lands and also on increasing the number and size of the populations of Palo de ramón (USFWS, 2014).

- Field surveys on Palo de ramón should be conducted within historical sites and in non-traditional sites with suitable habitat to determine the existence and distribution of the species (USFWS, 2014).
- Studies should be conducted to determine the species' phenology and reproductive biology (USFWS, 2014).
- Studies should be conducted to determine the patterns of genetic variation, in order to develop a plan to preserve the species' germplasm (USFWS, 2014).
- Studies should be conducted to determine the effects of the lobate lac scale bugs (*Paratachardina pseudolobata*) on the Palo de ramón (USFWS, 2014).
- Propagation and reintroduction of the species should be conducted in order to strengthen the existing population. This action should be carefully evaluated by the Service, taking into consideration the effects of seeds and/or seedlings removal effects on the species, existing threats, genetic variations, and considering ways to propagate by cuttings (USFWS, 2014).
- The populations, both natural and introduced, should be monitored on a regular basis, and additional surveys should be conducted after hurricanes, landslides, fires, or other major disturbances. The natural populations should be monitored on a long term basis to determine the species' trends (USFWS, 2014).
- The Service should work with partners (e.g., PRDNER, UPRM and USDA) to update the recovery plan as new information becomes available on the species. Such collaboration should lead to establish measurable criteria, including how many individuals constitute a self-sustainable population and how many populations would be needed to delist the species (USFWS, 2014).

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SPECIES ACCOUNT: *Baptisia arachnifera* (Hairy rattleweed)

Species Taxonomic and Listing Information

Listing Status: Endangered; 5/27/1978; Southeast Region (R4) (USFWS, 2015)

Physical Description

A perennial herb, 5-8 dm tall, that is covered with grayish-white cobwebby hairs. Leaves are heart-shaped. Flowers (late June-early August) are bright yellow, borne in terminal clusters. (NatureServe, 2015)

Taxonomy

Dr. Wilbur H. Duncan first collected the hairy rattleweed in the summer of 1942, and suspected that it was distinct from other *Baptisia* species which occur in the coastal plain of GA and FL. Subsequent collections in 1943 confirmed his suspicion (USFWS, 1984).

Historical Range

It is endemic to portions of Brantley and Wayne counties in southeastern GA (USFWS, 1984).

Current Range

Baptisia arachnifera only occurs in a 50-square mile area in Brantley and Wayne counties in Southeast Georgia, on the Lower Coastal Plain (Georgia Department of Natural Resources 1995). (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual (NatureServe, 2015); sexual (inferred from EPA, 2016)

Dependency on Other Individuals or Species

Adult: Insect pollinators, especially Say's weevil (EPA, 2016)

Reproduction Narrative

Adult: Capable of asexual reproduction if roots are cut (NatureServe, 2015). Flowering occurs June to August and fruiting occurs August to September. Pollinators are presumably insects. The weevil *Apion rostrum* Say (Say's weevil) is possibly a major pollinator (EPA, 2016). Humphrey (1987) estimated that 25% of plants reproduce and found the number of fruit per individual plant is highly variable, with a mean of 52 seeds per fruiting plant per year; therefore, the seed production per 100 plants has been estimated as 1300 (USFWS, 2011).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Longleaf pine-saw palmetto flatwoods (NatureServe, 2015); early successional forest (EPA, 2016)

Dependencies on Specific Environmental Elements

Adult: Periodic fires (EPA, 2016)

Geographic or Habitat Restraints or Barriers

Adult: 55 - 85 ft. elevation (EPA, 2016)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow to moderate (inferred from EPA, 2016)

Habitat Narrative

Adult: This species naturally occurred in open sandy areas within longleaf pine-saw palmetto flatwoods. It is now persisting in intensively managed slash and loblolly pine plantations, powerline right-of-ways, roadsides and a few small natural areas. *B. arachnifera* can occur as widely scattered individual plants or in dense clusters. Research done by the Rayonier Corporation suggest that populations tend to be clumping (B. Krueger, written comm.) (NatureServe, 2015). Longleaf slash-pine flatwoods with sparse canopy, fewer larger shrubs, greater light penetration and greater cover of herbs (mainly wiregrass) and low shrubs of the Lower Coastal Plain of Georgia. Habitat has early successional characteristics of open canopy and low abundance of larger shrubs. Habitat includes mesic pine lowland forest or pine flatwoods. Also occurs in floristically similar but more open pine-wire grass (*Aristida stricta*) shrub woodlands with occasional oaks (*Quercus laevis*, *Q. virginiana*, *Q. nigra*). Fire adapted communities that would naturally burn every 2-4 years. Most abundant in communities with the early successional characteristics of open canopy and low abundance of larger shrubs. Often adjacent to/grades into pocosin or bay swamp habitats scrub-shrub wetlands toward the wetter end of spectrum to habitats typical of longleaf pine-turkey oak communities towards the drier end. Identified soils series include: Mascotte Sand, Rigdon Sand, Sapelo Fine Sand, Pottsburg Sand, and Olustee Sand. These are sandy to a depth of 3 ft or more and have spodic horizons within 20 inches of the surface. Acidic, low fertility. These soils are poorly drained to somewhat poorly drained and moderately permeable with Rigdon sand being the best drained. Runoff is slow and internal drainage is impeded by the shallow water table. Occurs at elevations between 55 to 85 ft. (known population sites) (EPA, 2016).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Seed dispersal occurs September to March; plants break off in wind and may disperse tumbleweed fashion with seeds still on the plant (EPA, 2016).

Population Information and Trends**Population Trends:**

Declining (inferred from NatureServe, 2015)

Species Trends:

Declining (USFWS, 2011)

Resiliency:

Low (inferred from NatureServe, 2015)

Representation:

High (inferred from USFWS, 2011)

Redundancy:

Moderate (inferred from EPA, 2016)

Number of Populations:

22 (EPA, 2016)

Population Narrative:

Occurrences are scattered over a 125 square mile area. An estimated 95-99% of its original habitat has been converted to pine plantations (NatureServe, 2015). 22 extant populations occur entirely in Lower Coastal Plain of Georgia (EPA, 2016). The species status is declining; overstocking of trees, lack of fire management and seed predation by insects are the factors driving the species' decline. Ceska et al. (1997) found a substantial genetic diversity and relative uniformity in ten sampled plots (USFWS, 2011).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Silvicultural practices in the timber industry have altered approximately 2741 acres of hairy rattlesnake habitat and directly destroyed individual plants. Hairy rattlesnake populations are able to survive clear-cutting, but site preparation and replanting severely impact populations (U.S. Fish and Wildlife Service 1984, Humphrey 1987, Kral 1980). The effects of bedding, unnaturally high stocking densities of seedlings and fire exclusion in pine plantations are dramatically impacting this species (U.S. Fish and Wildlife Service 1984, Tassin and McGee 1999, Humphrey 1988, Lege and Squire 2006). High stocking densities are used to maximize the Net Present Value on industrial timber land. As a result, canopy closure is achieved and growing space is fully occupied, resulting in shading and elimination of the herbaceous ground cover, including hairy rattlesnake. Following timber harvest, populations do not respond to the release from shading and competition with increased recruitment, as might be expected. The loss of ground cover contributes to a change in the fire community and reduces the opportunity for natural fires to play a role in the ecology to the site. In the past, wildfires and use of fire by man maintained habitat suitable for hairy rattlesnake (U.S. Fish and Wildlife Service 1984, Humphrey 1987). Suppression of fire has resulted in increased competition from shrubs, which is considered to be a major factor responsible for reduction in abundance of hairy rattlesnake (U.S. Fish and Wildlife Service 1984). Fire is still used for forest management, but the frequency and time of

year of burning may not be beneficial to hairy rattleweed (U.S. Fish and Wildlife Service 1984, Humphrey 1987). The use of herbicides in powerlines and road rights-of-way could adversely affect populations of hairy rattleweed, although, the effects of herbicides are solely based on field observations. Two extant populations occur on 274 acres of hairy rattleweed habitat in areas where rural housing development has occurred. The houses and surrounding landscaping directly destroy hairy rattleweed (USFWS, 2011).

Stressor: Drought (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: It is expected that severe drought could be a threat to small populations and would likely reduce recruitment into the population (USFWS, 2011).

Recovery

Reclassification Criteria:

Four self sustaining populations are secured (USFWS, 2011).

Delisting Criteria:

1. There are at least eight self-sustaining populations secured and maintained within its historic or current range (eight would provide a reasonable degree of security against catastrophic loss and/or site alteration) (USFWS, 2011).
2. The number of individuals in the various populations has reached an optimum level or cover percentage and frequency occurrence, as established by management studies (USFWS, 2011).
3. Its biology is sufficiently understood to allow perpetuation of the species should circumstances require immediate or drastic alteration of populations and/or sites (USFWS, 2011).
4. Continuing protection and management after delisting are assured (U.S. Fish and Wildlife Service 1984) (USFWS, 2011).

Recovery Actions:

- Protect habitat and existing populations of the hairy rattleweed (USFWS, 1984).
- Monitor populations and their habitats (USFWS, 1984).
- Conduct searches for new stands of the hairy rattleweed (USFWS, 1984).
- Preserve existing germ plasm through cultivation and storage (USFWS, 1984).
- Conduct autoecological research (USFWS, 1984).
- Develop public awareness and support (USFWS, 1984).

Conservation Measures and Best Management Practices:

- Investigate potential for longleaf pine planting on private land. Projects could be partially funded by the US Fish and Wildlife Service (USFWS, 2011).
- Secure funding for land acquisition to facilitate permanent protection for recovery of populations (USFWS, 2011).

- Implement conservation easements where possible (USFWS, 2011).
- Develop and distribute an information factsheet on hairy rattleweed (USFWS, 2011).
- Share with the local Natural Resource Conservation office information about the distribution and best management practices of hairy rattleweed (USFWS, 2011).
- Contact and cooperatively work with Okefenokee Electric Membership Cooperation/Georgia Department of Transportation regarding rights-of-way management (broadcast spraying along right-of-ways) (e.g., Georgia Power – mowing) (USFWS, 2011).
- Document change in industrial timber management over time and relate the change in management to the change in habitat (USFWS, 2011).
- Work with partners to help secure funding for protection and management efforts (USFWS, 2011).
- Reintroduce fire on select industrial timberland sites to study effects (USFWS, 2011).
- Create demonstration sites to establish effective hairy rattleweed habitat management (reflective of management guidelines that will be established and further researched) (USFWS, 2011).
- Investigate and provide incentives for hairy rattleweed management on private lands (e.g., appropriate mowing regimes or other management options) (USFWS, 2011).
- Prioritize tracts/sites for different purposes – acquisition/conservation, research plots, seedling recruitment, vulnerability to development, etc. (USFWS, 2011).
- Identify safeguarding sites (Sansavilla, others) for reintroduction efforts and potential expansion of the currently recognized distribution within historical area (USFWS, 2011).

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SPECIES ACCOUNT: *Berberis nevinii* (Nevin's barberry)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/13/1998; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An evergreen shrub, 1-4 m tall. Leaves have 3-5 leaflets with serrated, spine-tipped edges. Produces yellow flowers (March-April), followed by red or yellow-red berries (NatureServe, 2015).

Taxonomy

A member of the Berberidaceae (barberry family). *Berberis nevinii* is distinguished from other members of the genus by its nearly flat, narrow, serrate, pinnately veined leaflets, few flowered racemes, and reddish fruits (Munz 1974, p. 245; Niehaus 1977, p. 1; Williams 1993, pp. 362-363) (USFWS, 2009).

Historical Range

Its historical distribution likely consisted of fewer than 30 scattered occurrences in Los Angeles, San Bernardino, and Riverside Counties (Service 1998, p. 54958), and possibly San Diego County (Niehaus 1977, p. 1; Reiser 2001, p. 3; CNDDDB 2008, Element Occurrence (EO) 45) (USFWS, 2009).

Current Range

Ranges from the foothills of the San Gabriel Mountains of Los Angeles County to near the foothills of the Peninsular Ranges of southwestern Riverside County, California (Fish and Wildlife Service 1998) (NatureServe, 2015).

Critical Habitat Designated

Yes; 2/13/2008.

Legal Description

On February 13, 2008, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Berberis nevinii* (Nevin's barberry) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat units (CHU), in California (73 FR 8412-8440).

Critical Habitat Designation

The critical habitat designation for *Berberis nevinii* includes one CHU (six sub-units) in Riverside County, California. This species critical habitat encompasses approximately six acres (ac) (three hectares (ha)) (73 FR 8412-8440).

Unit 1: Agua Tibia/Vail Lake: Unit 1 comprises approximately 6 ac (3 ha) and is divided into two subunits: Big Oak Mountain Summit (1A) and Agua Tibia Mountain Foothills (1B). The lands in Unit 1 were occupied at the time of listing, contain the physical and biological features essential to the conservation of *Berberis nevinii*, and may be important for maintaining genetic diversity for the species as they include occurrences in ecologically unique areas. Subunit 1A: Big Oak Mountain Summit: Subunit 1A consists of approximately 5 ac (2 ha) of Federal land managed by

the BLM on Big Oak Mountain to the north of Vail Lake in southern Riverside County. Two *Berberis nevinii* individuals of different sizes (ages) occur in this subunit on the summit of Big Oak Mountain at approximately 2,700 ft (823 m) elevation (i.e., the lower edge of the marine layer) (PCE 1 and 3). One individual is an old plant that is covered in lichens, and the other individual is considerably smaller and at some distance to the northeast of the older plant. This location is considered unusual (i.e., ecologically unique) for the species in that it is at higher elevation and on relatively flat clay lenses consisting of heavy adobe/gabbro type soils with high water-holding capacity, derived from Mesozoic basic intrusive rock (PCE 2) (Soza 2003, unpaginated). Soils in this area are classified primarily as Auld clay, 8 to 15 percent slopes, and Las Posas loam, 8 to 15 percent slopes, eroded (PCE 2) (Service GIS data 2006). This occurrence is located in an open grassland area with chaparral nearby. Associated plant species include *Chenopodium californicum*, *Avena fatua*, *Harpagonella palmeri*, *Plantago erecta*, *Convolvulus simulans*, *Galium porrigens*, and *Delphinium* sp. We are designating this subunit as critical habitat even though it is occupied by only two *Berberis nevinii* plants because it represents an ecologically unique site for the species and contains the physical and biological features essential to the conservation of *B. nevinii*. Additionally, this site contains naturally occurring *B. nevinii* of different sizes (ages). Because this occurrence is on an ecologically unique site, this subunit may be important in terms of preserving genetic diversity throughout the range of the species. *Berberis nevinii* occupied this subunit at the time of listing (63 FR 54956; October 13, 1998). Bureau of Land Management land on Big Oak Mountain consists of three small parcels totaling 888 ac (360 ha) surrounded by private land. The primary threats to *Berberis nevinii* habitat in this area are the indirect effects associated with urban and residential development on private lands adjacent to BLM lands, such as increased human recreation; incursion or spread of invasive, nonnative plants; and changes to the natural fire regime (i.e., increased ignitions and fire frequency, and shortened fire return intervals that can lead to type conversion of shrublands to annual grasslands). The BLM Resource Management Plan indicates that these parcels are closed to motorized vehicles and livestock grazing (BLM 1994, p. 28). However, special management considerations or protection for the physical and biological features may be needed to minimize disturbance to the vegetation and soils within this subunit; control invasive, nonnative plants; and maintain the natural hydrologic and fire regime of the area resulting from urban and residential development.

Subunit 1B: Agua Tibia Mountain Foothills: Subunit 1B consists of approximately 1 ac (<1 ha) of federally-owned land managed by the USFS on the CNF near the Agua Tibia Wilderness Area in southern Riverside County, California. Five *Berberis nevinii* individuals are known from this area and are located at the edge of a stream channel (PCE 1) growing in association with coast live oak and riparian woodland species (PCE 3). Nearby chaparral includes such species as *Quercus berberidifolia*, *Adenostoma fasciculatum*, and *Haplopappus squarrosus*, and nearby desert species include *Yucca schidigera* (CNDDDB 2007). These *B. nevinii* plants are growing under a canopy of *Quercus agrifolia* and *Platanus racemosa* with the following species: *Heteromeles arbutifolia*, *Q. berberidifolia*, *Elymus condensatus*, *Mimulus aurantiacus*, *Lonicera subspicata*, *Pterostegia drymarioides*, and *Epilobium canum*. Soils in this area are classified as rough broken land and Visalia gravelly sandy loam, with 5 to 9 percent slopes (PCE 2) (Service GIS data 2007). We are designating this subunit as critical habitat because it contains the physical and biological features essential to conservation of *Berberis nevinii* and it contains a relatively large natural occurrence of the species. Additionally, Service personnel visited this site in June 2006 while *B. nevinii* was in fruit and found that several of the fruits had three to four seeds, which may be significant for a species that appears to rarely set seed. *Berberis nevinii* occupied this subunit at the time of listing, as identified in the final listing rule (63 FR 54956, October 13, 1998). The *Berberis nevinii* occurrence on the CNF is not as well protected as the occurrence on the ANF (USFS 2005, p. 238).

The primary threats to *B. nevinii* habitat in this area are human recreation (off-highway vehicle use, shooting); wildland fire, including an increased risk of fire ignition due to the proximity of State Highway 79 (USFS 2005, pp. 232, 237); fuels and fire management activities (USFS 2005, p. 237); and invasive, nonnative plants, including potential short-term adverse effects associated with control efforts (USFS 2005, p. 234). This occurrence on the CNF burned in 1996 and vigorously resprouted following the fire (USFS 2005, p. 237). According to the USFS, this location has shown signs of disturbance from road activities, with unauthorized use of off-highway vehicles occurring close to, but not within, the area occupied by the species (USFS 2005, p. 235). Nonetheless, the magnitude of impacts associated with roads and recreational activity in this area appears to be low (USFS 2005, p. 238). Also, the USFS does not anticipate substantial camping and hiking-related impacts to *B. nevinii* habitat, and intends to avoid or mitigate these impacts through implementation of Forest Plan standards (USFS 2005, p. 234). The February 6, 2007, proposed rule (72 FR 5552) identified the proximity of Highway 79 as a potential threat to the *Berberis nevinii* occurrence and habitat on the CNF, in part due to proposed highway widening and realignment activities (72 FR 5565). However, we no longer anticipate that these activities will affect Subunit 1B as there currently are no plans for widening or realigning Highway 79 in the section of roadway closest to this subunit. The revised subunit is now more than 525 ft (160 m) south of the highway. As discussed in the Special Management Considerations or Protection section above, the presence of invasive, nonnative plants may impact the *B. nevinii* occurrence and habitat at this site. However, the CNF anticipates an eradication effort of the nonnative *Arundo donax* and other invasive grasses (USFS 2005) present in this subunit, which should minimize the impacts of this threat to the species and its habitat. One of the greatest threats to occupied habitat on the CNF and the physical and biological features contained therein is from wildland fire and the management of fire and fuels (i.e., fire suppression and prevention activities). This subunit is within the Wildland-Urban Interface (WUI) Defense Zone (USFS 2005, p. 237; Service 2005, p. 127). Some plants or habitat within the WUI Defense Zone could be removed or degraded under the Revised Land and Resource Management Plan due to fuel removal for fire protection or overly frequent fuel treatments (Service 2005, p. 127). Special management considerations or protection of the physical and biological features may be required to minimize disturbance to the vegetation and soils within this subunit; control invasive, nonnative plants; and maintain the natural fire regime of the area.

Subunit 1C: South Flank Big Oak Mountain: We are excluding this subunit from the final designation of critical habitat under section 4(b)(2) of the Act (Table 1). See the Relationship of Critical Habitat to Habitat Conservation Plan Lands—Exclusions Under Section 4(b)(2) of the Act section below for a discussion of this exclusion.

Subunit 1D: North of Vail Lake: We are excluding this subunit from the final designation of critical habitat under section 4(b)(2) of the Act (Table 1). See the Relationship of Critical Habitat to Habitat Conservation Plan Lands—Exclusions Under Section 4(b)(2) of the Act section below for a discussion of this exclusion.

Subunit 1E: South of Vail Lake/ Peninsula: We are excluding this subunit from the final designation of critical habitat under section 4(b)(2) of the Act (Table 1). See the Relationship of Critical Habitat to Habitat Conservation Plan Lands—Exclusions Under Section 4(b)(2) of the Act section below for a discussion of this exclusion.

Subunit 1F: Temecula Creek East: We are excluding this subunit from the final designation of critical habitat under section 4(b)(2) of the Act (Table 1). See the Relationship of Critical Habitat to Habitat Conservation Plan Lands—Exclusions Under Section 4(b)(2) of the Act section below for a discussion of this exclusion.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Berberis nevinii* critical habitat consists of three components (73 FR 8412-8440):

- (i) Low-gradient (i.e., nearly flat) canyon floors, washes and adjacent terraces, and mountain ridge/summits, or eroded, generally northeast to northwest-facing mountain slopes and banks of dry washes typically of less than 70 percent slope that provide space for plant establishment and growth;
- (ii) Well-drained alluvial soils primarily of non-marine sedimentary origin, such as Temecula or sandy arkose soils; soils of the CajalcoTemescal-Las Posas soil association formed on gabbro (igneous) or latite (volcanic) bedrock; metasedimentary substrates associated with springs or seeps; and heavy adobe/gabbro-type soils derived from metavolcanic geology (Mesozoic basic intrusive rock) that provide the appropriate nutrients and space for growth and reproduction; and
- (iii) Scrub (chaparral, coastal sage, alluvial, riparian) and woodland (oak, riparian) vegetation communities between 900 and 3,000 feet (275 and 915 meters) in elevation that provide the appropriate cover for growth and reproduction.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the areas within the geographical area occupied by the species at the time of listing contain the physical or biological features essential to the conservation of the species, and whether these features may require special management considerations or protection. As stated in the final listing rule (63 FR 54956, October 13, 1998), threats to the species and its physical and biological features include urban development, off-road vehicle use, human recreation (e.g., horseback riding), highway projects, fire management strategies (suppression measures, brush clearing) that alter natural fire processes to which native plant communities are adapted, and the introduction of invasive, nonnative plants that may compete with *Berberis nevinii* or contribute to combustible fuel loads (63 FR 54961). These threats can directly or indirectly result in the loss, modification, degradation, or fragmentation of *B. nevinii* habitat, thereby eliminating or reducing potential habitat for seed production and germination, seedling establishment, plant growth and maturation, and population growth. Individually or combined, these threats may require special management considerations or protection of the physical and biological features as addressed here and in more detail within the individual critical habitat unit descriptions that follow. Urbanization, flood control measures, road widening, and habitat degradation from extensive recreational use have contributed to the loss of *Berberis nevinii* habitat and have apparently resulted in the extirpation of several occurrences, particularly in the San Fernando Valley of Los Angeles County (63 FR 54961). Urban development is currently the primary threat to *B. nevinii* habitat and occurrences in the vicinity of Vail Lake and Oak Mountain in Riverside County. Urbanization may destroy, degrade, fragment, or otherwise alter the topography, soil, and vegetation community structure in ways that make areas less suitable for *B. nevinii*. Land grading for residential development and road projects may affect the topography of the site (PCE 1); alter soil composition and structure (PCE 2); change vegetation community composition and structure through clearing or thinning of vegetation and the introduction of nonnative plants (PCE 3); increase erosion potential (PCE 1 and 2); and change hydrological (drainage and water infiltration) patterns, thereby decreasing the quality and extent of available habitat for *B. nevinii*. Additionally, urban development within

or near *B. nevinii* habitat may increase the frequency of fire on the landscape due to increased combustible fuel loads that may result from the incursion and spread of annual nonnative grasses and an increased potential for fire ignition. In the February 6, 2007, proposed rule (72 FR 5552), we focused primarily on potential indirect impacts of urbanization on *Berberis nevinii* habitat and occurrences in the vicinity of Vail Lake and Oak Mountain (72 FR 5565– 5567). Urban development is not expected to directly impact the known occurrences of *B. nevinii* on Federal land in the Vail Lake and Oak Mountain area, although indirect impacts associated with increased urbanization may occur. On the other hand, *B. nevinii* habitat on private land in this area may be subject to some degree of residential development, as described below in the critical habitat subunit descriptions (see the Critical Habitat Designation section of this final rule). However, these private lands are located within the Criteria Area of the Western Riverside County MSHCP and are targeted, in whole or in part, for acquisition and inclusion in the MSHCP Conservation Area as Additional Reserve Lands. Specifically, the conservation objectives of the MSHCP include conservation and management of at least 8,000 ac (3,238 ha) of suitable habitat, including all known locations of *B. nevinii* in the Vail Lake area (see the Relationship of Critical Habitat to Habitat Conservation Plan Lands—Exclusions Under Section 4(b)(2) of the Act section below for a detailed discussion of the MSHCP). Recreational activities may also impact the physical and biological features essential to the conservation of the species by destroying, degrading, fragmenting, or otherwise altering the topography, soil, and vegetation community in ways that make areas less suitable for *Berberis nevinii*. For example, off-highway vehicle use, hiking, camping, horseback riding, and recreational facility development in or near *B. nevinii* occurrences could alter or destroy surface and subsurface structure through trampling and clearing or thinning of vegetation (PCE 3), the introduction of nonnative plants (PCE 3), soil disturbance or compaction (PCE 2), and increased erosion and changes to hydrological (drainage and water infiltration) patterns that may in turn affect the topography, soil, and vegetation of the site (PCE 1, 2, and 3). Activities associated with fire management, such as fuel treatments, prescribed burns, and wildfire suppression, may also impact the physical and biological features essential to the conservation of the species. The creation of fuel breaks, brush clearing or thinning, and the use of heavy equipment and off-road vehicles for fire management could physically remove or disturb soils and alter soil composition (PCE 2), remove or destroy vegetation (PCE 3), increase erosion, and alter the topography (PCE 1) and hydrologic patterns in or near *Berberis nevinii* occurrences. Fire management activities could facilitate the incursion or spread of invasive, nonnative plants by potentially dispersing seeds and creating (disturbance) conditions that increase the competitive edge of nonnative species over native species, thereby altering the composition of the vegetation community (PCE 3). As pointed out in the proposed critical habitat rule (72 FR 5552), vegetation community composition and structure could be altered by fire management activities such as prescribed fires that are too frequent or that occur at times of the year atypical of the natural fire regime, or by fire suppression that allows overgrowth of high canopy cover, limiting or eliminating plant species that require full or partial sun from the plant community (72 FR 5563). *Berberis nevinii*'s life history characteristics indicate that it likely recruits into chaparral during fire-free periods and may require long intervals between fires for recruitment and population increases; thus, overly frequent fire is a substantial and immediate threat to this species (White 2007, p. 1). While highway projects were identified in the final listing rule (63 FR 54956, October 13, 1998) and proposed critical habitat rule (72 FR 5552; February 6, 2007) as a threat to *Berberis nevinii*, we do not anticipate that this activity will affect designated critical habitat in the foreseeable future. Specifically, the proposed critical habitat rule identified the proximity of Highway 79 as a potential threat to the *B. nevinii* occurrence and habitat on the CNF (Subunit 1B) in part due to proposed highway widening and realignment

activities (72 FR 5565). However, we no longer anticipate that these activities will affect Subunit 1B because: (1) There are currently no plans to widen the portion of State Route 79 closest to Subunit 1B, and (2) the revised subunit is now more than 525 ft (160 m) south of the highway, which is far enough away that impacts to the subunit from construction or widening activities are unlikely. Based on information provided for the economic analysis, nonnative *Arundo donax* (*Arundo*) and other invasive grasses are present in Subunit 1B, and the CNF anticipates an eradication effort based on the weed management strategy in the USFS' Revised Land Management Plan for the Four Southern California National Forests (USFS 2005). Additional information obtained on water storage at Vail Lake indicates that lake level fluctuations could affect proposed subunits bordering Vail Lake (specifically, proposed subunits 1D and 1E). While we revised proposed critical habitat boundaries for these subunits based on the currently permitted storage capacity of Vail Lake (see the Criteria Used to Identify Critical Habitat section in this final rule), fluctuating water levels that surpass permitted storage levels and lake storage capacity could still affect *Berberis nevinii* in subunits that border Vail Lake. However, the occurrences that are located closest to Vail Lake have not been inundated or affected by rising water levels and fluctuations in the recent past (Boyd 2007, p. 1), and we do not anticipate that any *B. nevinii* individuals in this area will be affected.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual: cross-pollination (USFWS, 2009)

Lifespan

Adult: > 50 years (USFWS, 2009)

Breeding Season

Adult: March - April (USFWS, 2009)

Reproduction Narrative

Adult: This species flowers from March through April. *Berberis nevinii* shrubs are long-lived (more than 50 years) (Mistretta and Brown 1989, p. 5) with low reproductive rates likely due to sporadic production of fertile seed (Mistretta and Brown 1989, p. 5). Several occurrences of *B. nevinii* consist of only single plants that have existed for years or decades without reproducing sexually (Mistretta and Brown 1989, p. 5), suggesting a self-incompatible breeding system (White 2001, p. 36). *Berberis nevinii* likely does not reproduce by vegetative means (Mistretta and Brown 1989, p. 5; S. Boyd, Rancho Santa Ana Botanic Garden, in litt. 2006, p. 1) (USFWS, 2009).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Alluvial shrub communities, chaparral (NatureServe, 2015); oak woodland, riparian scrub, riparian woodland (USFWS, 2009)

Dependencies on Specific Environmental Elements

Adult: Periodic fire (USFWS, 2009)

Geographic or Habitat Restraints or Barriers

Adult: 1,400 - 2,700 ft. elevation (USFWS, 2009)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2009)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from USFWS, 2009)

Habitat Narrative

Adult: This species is found in 2 habitat types: the margins of dry washes with sandy and gravelly substrates and alluvial shrub communities; and steep slopes with coarse soils and chaparral communities. The presence of groundwater flow may be a habitat requirement (NatureServe, 2015). This species generally grows on sandy soils in low-gradient washes, alluvial terraces, and canyon bottoms, along gravelly wash margins, or on coarse soils on steep, generally north-facing slopes in association with the following plant communities: alluvial scrub, cismontane (e.g., chamise) chaparral, coastal sage scrub, oak woodland, and/or riparian scrub or woodland. *Berberis nevinii* is a fire-adapted species, where mature individuals may survive and re-sprout following fire (Mistretta and Brown 1989, p. 5; White and Leatherman 2001, p. 36). Most native occurrences of *B. nevinii* are between 1,400 and 1,700 feet (427 to 518 meters) in elevation (Boyd 1987, p. 2; CNDDDB 2008, pp. 1–34), although one native occurrence on the Oak Mountain summit north of Vail Lake is at approximately 2,700 feet (823 meters). Native occurrences are strongly associated with alluvial soils or soils derived from nonmarine sedimentary based substrates, especially sandy arkose (sandstone derived from granitic material) (Boyd 1987, p. 7; Boyd and Banks 1995, p. 24; Soza and Boyd 2000, p. 25). *Berberis nevinii* is considered a drought-tolerant species, but it will also tolerate large amounts of water in cultivation without apparent damage (Wolf 1940, p. 2; Lenz and Dourley 1981, p. 130; A. Sanders, University of California Riverside, in litt. 1997, p. 2) (USFWS, 2009).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Fruits are adapted for animal dispersal (USFWS, 2009).

Population Information and Trends**Population Trends:**

Declining (inferred from NatureServe, 2015)

Resiliency:

Low to moderate (inferred from NatureServe, 2015; see current range/distribution)

Redundancy:

Moderate (inferred from USFWS, 2009)

Number of Populations:

14 native (USFWS, 2009)

Population Size:

< 370 (USFWS, 2009)

Population Narrative:

Historically, the range of this species probably consisted of fewer than thirty scattered occurrences. At least seven populations of the thirtyish known occurrences have been extirpated (Fish and Wildlife Service 1998) (NatureServe, 2015). Currently, there are 14 extant, native occurrences of *Berberis nevinii*. The total number of native *B. nevinii* individuals across its range may be less than 370 (USFWS, 2009).

Threats and Stressors

Stressor: Urbanization (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: A majority of the occurrences and individuals of *B. nevinii* are on private lands subject to urbanization. Urban development is the primary threat to *Berberis nevinii* and its habitat in the vicinity of Vail Lake (USFWS 2008a, p. 8423). Land grading for residential development and associated roads may affect the topography of the site; alter soil composition and structure; change vegetation community composition and structure through clearing or thinning of vegetation and the introduction of nonnative plants; increase erosion potential; and change hydrological (drainage and water infiltration) patterns, thereby decreasing the quality and extent of available habitat for *B. nevinii*. In addition, urban development may increase the frequency of fire on the landscape due to increased combustible fuel loads and potential for fire ignition resulting from the incursion and spread of annual nonnative grasses (USFWS, 2009).

Stressor: Recreation (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Since listing, hiking, camping, and recreational facility development have been included with off-road vehicles and horseback riding as recreational activities that threaten *Berberis nevinii* (USFWS 2008a, p. 8423). These activities may alter or destroy surface and subsurface structure through trampling and clearing or thinning of vegetation, the introduction of nonnative plants, soil disturbance or compaction, and increased erosion and changes to hydrological (drainage and water infiltration) patterns (USFWS 2008a, p. 8423). Although not discussed in the listing rule, recreational uses associated with the Vail Lake Village Resort and Campground (private) and the Dripping Springs Campground (Cleveland National Forest) were identified as a threat to three *Berberis nevinii* occurrences (CNDDDB 2008, EOs 2, 20, 24). Since listing, hiking and biking along an adjacent fire road was noted as threat to the Cobal Canyon occurrence consisting of a single individual (CNDDDB 2008, EO 46). At least 36 percent (5 of 14) of *Berberis nevinii* occurrences are currently known to be threatened by recreational activities. Seven additional occurrences near urban areas are likely threatened by these activities due to lack of protection from off-road vehicle access and close proximity to roads (USFWS, 2009).

Stressor: Proposed road widening (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: A proposal to widen State Route 79 (SR-79) south of Vail Lake was noted as a potential threat as it may directly impact *B. nevinii* occurrences and promote development in the area (USFWS 1998, p. 54961). An occurrence consisting of two plants in Arroyo Seco Creek (Table 1) is in close proximity to SR-79. According to geographic information system (GIS) data provided by the County of Riverside, planned widening of SR-79 in that area partially overlaps one of the *B. nevinii* individuals mapped in CNDDDB (Dudek 2003a, pp.7-25, 7-26, 7-31; USFWS GIS data 2008) (USFWS, 2009).

Stressor: Altered fire regimes (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Activities associated with fire management, such as fuel treatments, prescribed burns, and wildfire suppression, may impact the physical and biological features essential to the conservation of *Berberis nevinii*. The creation of fuel breaks, brush clearing or thinning, and the use of heavy equipment and off-road vehicles for fire management could physically remove or disturb soils and alter soil composition, remove or destroy vegetation, increase erosion, and alter the topography and hydrologic patterns in or near *B. nevinii* occurrences. Fire management activities could facilitate the incursion or spread of invasive, nonnative plants by potentially dispersing seeds and creating (disturbance) conditions that increase the competitive edge of nonnative species over native species, thereby altering the composition of the vegetation community (USFWS 2008a, p. 8423). Increases in urbanization and human activity in or near *B. nevinii* habitat are generally accompanied by an increased incidence of accidental fires (USFWS 1998, p. 54964). Overly frequent fire on the landscape could potentially kill young *B. nevinii* before they reach their reproductive potential and may adversely affect mature *B. nevinii* by causing repeated resprouting that depletes stored resources faster than they can accumulate during fire-free periods (White 2007, in litt., p. 1). In addition, repeated burnings over short intervals could eventually lead to type conversion (wholesale replacement) of chaparral/shrublands with nonnative annual grassland (Keeley et al. 1999, p. 1831) (USFWS, 2009).

Stressor: Small population size and low reproductive output (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Since listing, the total number of native *Berberis nevinii* individuals across its range was reduced from 500 to fewer than 370 because of the reclassification of the San Francisquito Canyon occurrences from native to nonnative. In addition, 57 percent (8 of 14) of *B. nevinii* occurrences consist of three or fewer individuals, and 29 percent (4 of 14) of occurrences consist of only one individual. Low reproductive output of *Berberis nevinii* may be evidence of the potential impact of small population size on fitness described above. There appears to be little to no regeneration by seed occurring at most *B. nevinii* sites (Mistretta 1994, p. 186). Low seed set (including plants bearing fruits that lack seed) and lack of viable seed has been noted by both

botanists and horticulturalists trying to obtain seed for propagation, even from within larger occurrences (Wolf 1940, p. 2; Boyd 1987, pp. 3, 44, 56; Mistretta and Brown 1989, pp. 4–5; Mistretta 1994, p. 186; Wall 2009, in litt., p. 5). In addition, several occurrences of *B. nevinii* consist of only a single plant that has existed for years or decades without reproducing (Mistretta and Brown 1989, p. 5; CNDDDB 2008, EO 5). (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: One study predicted that 5 to 10 percent of California's native plant species would no longer find suitable habitat within the state, and thus be vulnerable to extinction, if average temperatures warmed 5–6° F (Morse et al. 1995, p. 393). Whether or not this would include *Berberis nevinii* is unknown. While the Service recognizes that climate change is an important issue with potential effects to listed species and their habitats, it lacks adequate information to make accurate predictions regarding its effects to *B. nevinii* at this time. Any changes in fire frequency resulting from climate change could directly threaten the persistence of the fire-prone occurrences of *B. nevinii* near Vail Lake in Riverside County (USFWS, 2009).

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- Cooperate with the Western Riverside Regional Conservation Authority to acquire occupied *Berberis nevinii* habitat around Vail Lake, and to establish land management practices on these lands that will benefit the species (USFWS, 2009).
- Determine causes and remedies of low reproductive output in *Berberis nevinii*. Investigate its breeding system; pollinators; seed dispersal mechanisms; and seedling requirements and establishment (USFWS, 2009).
- Work with partners to help conserve *Berberis nevinii*. Identify opportunities through the Service's Partners for Fish and Wildlife Program to seek habitat restoration and enhancement opportunities (USFWS, 2009).
- Identify partners to help support efforts to survey *Berberis nevinii* occurrences around Vail Lake, including occurrences within or partially within the perimeter of the 2004 Eagle fire (USFWS, 2009).
- Verify presence of the occurrence near the mouth of Scott Canyon in San Bernardino County (USFWS, 2009).
- Determine the genetic origins of cultivated specimens that are successfully reproducing, in particular, the *Berberis nevinii* in San Francisquito Canyon (USFWS, 2009).

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SPECIES ACCOUNT: *Berberis pinnata ssp. insularis* (Island Barberry)

Species Taxonomic and Listing Information

Listing Status: Endangered; 7/31/1997; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An evergreen shrub with spreading stems that reach 2-8 m high and with glossy, compound leaves. Produces clusters of yellow flowers in March, followed by waxy-blue berries (NatureServe, 2015).

Taxonomy

Previously *Mahonia pinnata* (Lagasca) Fedde subsp. *insularis* (Munz) J.B. Roof. A member of the Barberry family (Berberidaceae). The taxon was first collected by Mason in 1927, but was first described by Munz (Munz and Roos 1950) based on a specimen collected by Wolf in 1932 “west of the summit of Buena Vista Grade (also known as Centinela Grade), interior of Santa Cruz Island.” (USFWS, 2013).

Historical Range

Once thought to exist on three of the California Channel Islands (Anacapa, Santa Cruz, and Santa Rosa) (USFWS, 2013).

Current Range

Occurs on Santa Cruz Island (Channel Islands, CA) (NatureServe, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual: vegetative; sexual: self-pollination (USFWS, 2013)

Lifespan

Adult: 80+ years (USFWS, 2013)

Breeding Season

Adult: February (USFWS, 2013)

Key Resources Needed for Breeding

Adult: Bee pollinators, based on closely related species (USFWS, 2013)

Reproduction Narrative

Adult: Flowers are produced in February; each flower generally produces two or three ovules. The round grayish blue berries develop in late May. Island barberry reproduces through asexual reproduction (vegetatively) as well as through sexual reproduction, though the latter is rarely

achieved. Because it sprouts from an underground root stalk, or rhizome, a single plant can consist of several stems spread over many square meters and represent one genetic clone (Hochberg et al. 1980, California Native Plant Society 1984, Williams 1993). These clones are long-lived; one individual from Santa Cruz Island is likely more than 80 years old and presumed to be the same plant that Mason collected in 1927 (McEachern et al. 2007). Although pollinator studies have not been conducted specifically for island barberry, other species of *Berberis* in California have been observed to be pollinated by bees (Bombyliidae), particularly in the genus *Andrenae* (Moldenke 1976). Island barberry is genetically self-compatible (pollen from the same plant is able to produce fertile seeds); however, it still requires insect visitation for pollination to be achieved (Wilken 1996). Island barberry plants only produce a limited number of fruits each season, and many of these fruits do not make it to maturity. In addition to low seed production in island barberry, natural recruitment from seed is not occurring in the wild, and the cause or causes are unknown (Wilken 1996; McEachern and Chess 2006; McEachern et al. 2007) (USFWS, 2013).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Chaparral, oak woodlands, pine forests (USFWS, 2013)

Dependencies on Specific Environmental Elements

Adult: Shady, mesic conditions (USFWS, 2013)

Geographic or Habitat Restraints or Barriers

Adult: Occurs < 1,150 ft. elevation (USFWS, 2013)

Habitat Narrative

Adult: Inhabits moist, shaded canyons (NatureServe, 2015). It is associated with north facing, rocky slopes in chaparral, oak woodlands, and pine forests. Island barberry appears to favor shady, mesic conditions in closed-cone pine forest, oak woodland, and chaparral habitats below 350 meters (1,150 feet) (Williams 2012) (USFWS, 2013).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Because the fruits of *Berberis* species can be eaten and dispersed by birds (Martin et al. 1951), some predation by birds is likely part of the natural dispersal strategy of island barberry (USFWS, 2013).

Population Information and Trends**Population Trends:**

Decline of 70-90% (NatureServe, 2015)

Resiliency:

Very low (inferred from USFWS, 2013)

Representation:

Very low (inferred from USFWS, 2013)

Redundancy:

Very low (inferred from USFWS, 2013)

Number of Populations:

5 (USFWS, 2013)

Population Size:

5 (USFWS, 2013)

Adaptability:

Very low (inferred from USFWS, 2013)

Population Narrative:

There are 3 known individuals, no seedlings observed in the wild, low seedling viability and slow seedling growth rate (Wilken, 2003). Over the last 20 years, the known population has declined from 20 to 3 individuals. This species has experienced a long-term decline of 70-90%. There are only 3 known individuals in the wild, although it is likely more individuals will be found (D. Wilken, pers. comm.) (NatureServe, 2015). Each of the five remaining populations of island barberry is comprised of only one plant (McEachern et al. 2010). The extremely small population size, and limited range and distribution (five known individuals on one island) also make this subspecies susceptible to extinction by stochastic events such as fire, erosion, pests, and disease (USFWS, 2013).

Threats and Stressors

Stressor: Past habitat alteration (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: At the time the subspecies was listed, sheep and most of the cattle had been removed from Santa Cruz Island. However, the listing rule did identify sheep as a major contributor to past alteration of the habitat, with sheep being one of the greatest contributors to soil erosion. Pigs continued to contribute to habitat alteration on Santa Cruz Island by rooting up native vegetation, causing massive erosion, and spreading invasive weeds (National Park Service 2005). The loss of canopy and understory plant species, due to rooting by feral pigs, resulted in a reduction of the mesic conditions on which island barberry depends (McEachern pers. comm. 2007a). Island barberry is not at risk from ongoing or threatened destruction of its habitat or range. However, native habitat for the subspecies is still recovering from past alteration (USFWS, 2013).

Stressor: Fruit predation (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation of island barberry fruits by island scrub jays (*Aphelocoma insularis*) has been observed in the wild (Wilken pers. comm. 2012). Insect predation on fruits and developing flower buds has been documented (McEachern et al. 2010), appears extensive (McEachern pers. comm. 2007a), and is a likely cause of fruit failure (McEachern pers. comm. 2007b). The limited fruit production (McEachern et al. 2010) is restricting island barberry from natural recruitment in the wild (USFWS, 2013).

Stressor: Limited distribution and small population size (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: The loss of genetic diversity island barberry has suffered due to the extremely small number of extant individuals may be contributing to its reduced fitness and reduced reproductive vigor, and potentially a factor contributing to the demonstrated lack of recruitment in this subspecies (Wilken 1996; McEachern et al. 2007). Species with few populations and individuals are threatened by stochastic events in several ways: loss of genetic diversity, susceptibility to factors that inhibit the successful completion of their life cycle, and random natural events (62 FR 40970) (USFWS, 2013).

Stressor: Climate change (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Island barberry's small and isolated range increases its vulnerability to random fluctuations in annual weather patterns and environmental disturbances such as can be brought about by climate change. It is unknown at this time if climate change will result in a warmer trend with localized drying, higher precipitation events, or other effects. Small-ranged species such as island barberry are more vulnerable to extirpations due to these changing conditions (Loarie et al. 2008) (USFWS, 2013).

Recovery

Reclassification Criteria:

1. Discover or establish five populations on Santa Rosa and Santa Cruz Islands, and two to three populations on Anacapa Island (USFWS, 2013).
2. Maintain populations as stable or increasing with evidence of natural recruitment for a period of 15 years that includes the normal precipitation cycle (USFWS, 2013).

Delisting Criteria:

1. Discover or outplant five additional populations per island (USFWS, 2013).
2. No decline after downlisting for 10 years (USFWS, 2013).

Recovery Actions:

- Develop successful outplanting techniques (USFWS, 2000).
- Restore habitats and control competitive weeds for long-term management of the listed species and their habitats (USFWS, 2000).

- Conduct thorough surveys for all species in the recovery plan (USFWS, 2000).
- Conduct research that aids in the conservation and recovery of the species in the recovery plan (USFWS, 2000).
- Store seeds at facilities certified by the Center for Plant Conservation and develop successful seed germination and propagation techniques (USFWS, 2000).
- Support and intensify active control programs where herbivory or habitat alteration by alien animals exists (USFWS, 2000).
- Develop and implement a plan to achieve the goals and standards of the Conservation Strategy. The Conservation Strategy is a draft strategy for conservation of island resources prepared by biologists from the National Park Service, U.S. Fish and Wildlife Service, and the U.S. Geological Survey, Biological Resources Division. This Strategy is essentially a primer or guide that provides the basis for the recovery of the species in this recovery plan and should be referred to as a supporting document (USFWS, 2000).

Conservation Measures and Best Management Practices:

- Continue field surveys and monitoring, demographic monitoring, population viability analyses, and further investigations into recovery prescriptions (USFWS, 2013).
- Study the predation of island barberry fruit and other potential sources of reproductive failure (USFWS, 2013).
- Restore native habitat at historical locations on Santa Cruz and Anacapa Islands (USFWS, 2013).
- Implement outplanting at historical locations on Santa Cruz and Anacapa Islands (USFWS, 2013).

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SPECIES ACCOUNT: *Betula uber* (Virginia round-leaf birch)

Species Taxonomic and Listing Information

Listing Status: Threatened; 5/27/1978; Northeast Region (R5) (USFWS, 2016)

Physical Description

A deciduous, moderate-sized tree, up to 15 m tall, with smooth dark-brown to black, aromatic bark and a compact crown. The alternately arranged, simple leaves are round to slightly oblong in outline, 3.3-5.3 cm long, heart shaped at the base, rounded to obtuse at the tip, with 4-5 pairs of lateral veins and 21-33 coarse teeth along each margin. The fruiting structures (catkins) are 1.7 - 2.8 cm long and possess nearly smooth, 4.8-6.0 mm long scales with three broadly divergent lobes. At the base of each scale are three winged nutlets (samaras), ranging in length from 1.7-2.0 mm (USFWS, 1990).

Taxonomy

Originally described as a variety of the common sweet birch or black birch (*Betula lenta* L.) by W.W. Ashe (1918). The taxon was subsequently elevated to the species level by M.L. Fernald (1945) and transferred from series *Costatae* (dark-barked tree birches) to series *Humiles* because of presumed affinities to the shrub birches (USFWS, 1990).

Historical Range

See current range/distribution.

Current Range

Known from a 700-m stretch of highly disturbed, second-growth forest less than 100 m wide along the banks of Cressy Creek, near the town of Sugar Grove, in Smyth County, Virginia (USFWS, 1990).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Abiotic (EPA, 2016)

Breeding Season

Adult: Flowers in late April to early May with fruiting in September (USFWS, 2016)

Reproduction Narrative

Adult: Reproduction is abiotic, with pollination by wind (EPA, 2016). The tree flowers in late April to early May with fruiting in September (USFWS, 2016).

Habitat Type

Adult: Terrestrial, Wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forested riparian (NatureServe, 2015)

Habitat Narrative

Adult: This birch is a subcanopy tree growing in rocky debris that is strongly acidic and very permeable. The natural population is within a narrow strip of second-growth forest that includes many sweet and yellow birches. The band of forest is nearly surrounded by agricultural land (USFWS, 2016).

Dispersal/Migration**Motility/Mobility**

Adult: Abiotic (EPA, 2016)

Dispersal/Migration Narrative

Adult: Seed dispersal is by wind (EPA, 2016).

Population Information and Trends**Population Trends:**

Stable (USFWS, 2006)

Species Trends:

Stable (inferred from USFWS, 2006)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Population and species level trends are stable (USFWS, 2006). An analysis of cross-breeding studies with this species indicates that it is actually a variation of the common sweet birch. Cultivated birch seedlings have increased the current population numbers. While the single natural population has continued to dwindle, recovery for the round-leaf birch hinges on the successful establishment of these cultivated populations (USFWS, 2016). The natural population consisted of 41 individuals when it was rediscovered in 1975; by 1984 it had declined to eleven individuals. Greenhouse-grown seedlings were planted from 1984 to 1987; the number of individuals peaked at 1400 in 1999. As of 2003, only eight of the naturally occurring individuals (including four adult trees) were still extant; additionally, 953 planted individuals were still alive. Between 1984 and 1987, twenty populations of 96 seedlings each were planted on USFS lands. These populations are not yet clearly established (NatureServe, 2015).

Threats and Stressors

Stressor: Habitat destruction, modification, or curtailment or its habitat or range (USFWS, 2006)

Exposure:**Response:****Consequence:**

Narrative: The species needs small forest openings, especially during years that it produces abundant seed. Rarely do these two factors coincide. Thus, natural reproduction is rare; it has only been documented once - in 1981-1982. The natural population is surrounded by agricultural land. Because the species relies on wind for pollination and seed dispersal, opportunities for range expansion are limited (USFWS, 2006).

Stressor: Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2006).

Exposure:**Response:****Consequence:**

Narrative: Overcollection for cultivation and research was a problem until the 1990s, when seeds that were germinated in captivity provided ample seedlings. In addition, providing propagated plants to the nursery trade created a supply of commercially available round-leaf birches that has virtually eliminated the demand for the wild plants (USFWS, 2006).

Stressor: Disease or predation (USFWS, 2006).

Exposure:**Response:****Consequence:**

Narrative: Disease is not a threat, but herbivory by deer, rabbits, mice, and domestic livestock has been a problem. Cages placed around seedlings have proven effective in reducing herbivory (USFWS, 2006).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2006).

Exposure:**Response:****Consequence:**

Narrative: Plants on U.S. Forest Service property are protected by the ESA, but the plants on private property are not protected unless an action has Federal involvement (USFWS, 2006).

Recovery**Reclassification Criteria:**

Not available.

Delisting Criteria:

Establishment of 10 self-sustaining populations, defined on the basis of having each produced through natural regeneration 500-1000 individuals > 2 m tall (USFWS, 1990).

Recovery Actions:

- Manage existing individuals and habitat for maintenance and expansion of the single wild population. Provide immediate protection for existing habitat. Monitor individuals for general condition and incidence of disease and insect infestations. Expand zone of management adjacent to existing population. Consider purchase of private property should

- it become available. Determine essential habitat. Encourage natural regeneration (USFWS, 1990).
- Retain existing germplasm through cultivation. Distribute propagated materials to public and private sectors. Establish pollen and seed banks (USFWS, 1990).
 - Determine the systematic relationships of round-leaf birch. Conduct morphological, anatomical, and chemical studies on existing individuals of round-leaf birch and closely related taxa. Conduct studies of the reproductive and genetic systems of round-leaf birch and closely related taxa (USFWS, 1990).
 - Establish and maintain additional natural populations. Establish several sites containing numerous genotypes. Maintain sites to reduce competition and retain vigor (USFWS, 1990).
 - Implement educational programs to facilitate management of round-leaf birch (USFWS, 1990).
 - Continue search for additional natural populations (USFWS, 1990).

Conservation Measures and Best Management Practices:

- The recovery plan should be revised to include required threats-reduction criteria and to focus on actions conducive to achieving in situ reproduction (USFWS, 2006).
- The taxonomy of the birch is not universally agreed upon. Scientific evidence to date has been inconclusive, as some evidence points to the species level and some points to the variety level. If the plant is determined to be a variety, the variety should remain listed under the ESA until revised recovery criteria are met (USFWS, 2006).
- Natural reproduction is the most essential recovery criterion not yet met. The U.S. Forest Service should conduct management activities to expose mineral soil and remove other nearby birch species as they did in 1981. The management actions need to occur until a year when the Virginia round-leaf birch produces abundant seeds. Once ten populations reproduce naturally (in situ), delisting may be warranted (USFWS, 2006).

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SPECIES ACCOUNT: *Bidens amplexans* (Ko'oko'olau)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/18/2012; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Erect perennial or facultatively annual herbs 0.5-1.3 m tall, slightly woody at the base. Leaves pinnately compound, usually 9-15 cm long including the petiole, leaflets 3-5. Flower heads 10-30 in diffuse compound cymes terminating the main stems and lateral branches. Rays yellow, 25-40 mm long. (NatureServe, 2015)

Current Range

Endemic to the northern end of the Waianae Mountains of Oahu, Hawaii. Elsewhere (from near Kaena Point at least to the head of the Makua Valley) it is involved in hybrid swarms with *Bidens torta*. (NatureServe, 2015)

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003 (Revised September 18, 2012), the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Bidens amplexans* (Ko'oko'olau) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes ten critical habitat units (CHUs), in Hawaii (77 FR 57648-57862).

Critical Habitat Designation

The critical habitat designation for *Bidens amplexans* includes ten CHUs in Honolulu County, Hawaii (77 FR 57648-57862).

Oahu—Coastal—Unit 1 consists of 946 ac (383 ha) of State land, 11 ac (4 ha) of Federal land, and 2 ac (1 ha) of privately owned land in the coastal ecosystem along the northwestern coast of Oahu from Kaena Point east to Kauhao Pali and southeast to Keawaula. This unit is partially within Kaena Point State Park. It is occupied by the plants *Achyranthes splendens* var. *rotundata*, *Chamaesyce celastroides* var. *kaenana*, and *Sesbania tomentosa*, and includes the mixed herbland and shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 4). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Coastal—Unit 1 is not known to be occupied by *Bidens amplexans*, *Centaurium sebaeoides*, *Schiedea kealiae*, or *Vigna o-wahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Dry—Unit 1 consists of 49 ac (20 ha) of State land and 53 ac (22 ha) of privately owned land in the Waianae Mountains, extending from Haili Gulch to Kawaipahai. This unit is

occupied by the plants *Bidens amplexans*, *Hibiscus brackenridgei*, *Nototrichium humile*, and *Schiedea kealiae*, and includes the dry forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 4). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Lowland Dry—Unit 1 is not known to be occupied by the plants *Achyranthes splendens* var. *rotundata*, *Bonamia menziesii*, *Chamaesyce celastroides* var. *kaenana*, *Euphorbia haeleeleana*, *Gouania meyenii*, *G. vitifolia*, *Isodendron pyriformis*, *Melanthera tenuifolia*, *Neraudia angulata*, *Pleomele forbesii*, *Schiedea hookeri*, or *Spermolepis hawaiiensis*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Dry—Unit 2 consists of 29 ac (12 ha) in the lowland dry ecosystem in the Waianae Mountains, on Federal land within Kaena Point State Park. This unit is occupied by the plants *Bonamia menziesii*, *Melanthera tenuifolia*, *Nototrichium humile*, and *Pleomele forbesii*, and includes the dry forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 4). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Lowland Dry—Unit 2 is not known to be occupied by the plants *Achyranthes splendens* var. *rotundata*, *Bidens amplexans*, *Chamaesyce celastroides* var. *kaenana*, *Euphorbia haeleeleana*, *Gouania meyenii*, *G. vitifolia*, *Hibiscus brackenridgei*, *Isodendron pyriformis*, *Neraudia angulata*, *Schiedea hookeri*, *S. kealiae*, or *Spermolepis hawaiiensis*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Dry—Unit 8 consists of 96 ac (40 ha) of privately owned land and 3 ac (1 ha) of State land as part of the old railroad right-of-way in the lowland dry ecosystem, at the Kalaeloa Barber's Point Harbor area. The area was occupied by *Chamaesyce skottsbergii* var. *skottsbergii* at the time the species was listed (see 47 FR 36846, August 24, 1982), although it is not currently known to be occupied by *C. skottsbergii* var. *skottsbergii*. The species was last observed on this site in 1989. However, even though the site is degraded, during two recent field surveys (November 2011 and June 2012), we verified that the area being designated contains the physical and biological features of the lowland dry ecosystem and the coral outcrop substrate that is essential for the conservation of *C. skottsbergii* var. *skottsbergii* (see Tables 4 and 5). Based on the field visits, the boundaries of the unit were revised to remove areas that were modified by construction and excavation activities, and do not contain essential features. This resulted in the reduction of the unit from the 292 ac (118 ha) that were originally proposed to the 99 ac (40 ha) that are included in this final rule. These physical and biological features are essential to the conservation of the species in this location because the conservation of the species requires reestablishment of populations of this species in areas where it once occurred. Based on our evaluation of the conservation needs for *Chamaesyce skottsbergii* var. *skottsbergii*,

a plant requiring another individual for pollination (obligate-outcrosser) and living 10 years or less (short-lived perennial), we will need 7 to 8 populations containing a total of 10,000 mature individuals with at least 1,000 mature individuals per population in order to recover the species. The numbers of individuals and numbers of populations calculated for the 4 Lowland Dry units for akoko was based on our analysis (white paper) “Recovery Needs and Strategy for Akoko”, June 20, 2012. This analysis incorporated data from the Recovery Plan for *C. skottsbergii* var. *skottsbergii* and *Achyranthes splendens* var. *rotundata* (1993), surveys/species reports from 1979, 1981, 1984, and 2012, the Revised Recovery Objective Guidelines as determined by the Hawaii and Pacific Plants Recovery Coordinating Committee (HPPRCC) 2011, and plant genetics information from Guerrant et al. (2004, pp. 419–441) and Neel and Cummings (2003). Currently, *Chamaesyce skottsbergii* var. *skottsbergii* is found in 2 occurrences in the lowland dry ecosystem on the Ewa Plain in southwestern Oahu, totaling approximately 200 wild individuals and 600 outplanted individuals (Guinther and Withrow 2008, pp. 6, 9–10; Whistler 2008, pp. 7–9; U.S. Navy et al. 2012, pp. 19–20). In our review of areas on the Ewa Plain where the features essential to the conservation of this species are still present, we were only able to find four sites that still had the essential features; were not already modified by construction, development, or excavation activities; were large enough to provide habitat for at least one self-sustaining population; and provided adequate distribution across the historical range of the species. To the extent that portions of this unit may not have been occupied at the time of listing, they are essential to the conservation of the species because, as discussed above, conservation of this species will require establishment of additional populations and this is one of the few suitable locations. Oahu—Lowland Dry—Unit 8 is one of four locations included in this final critical habitat designation that is essential to the conservation of *Chamaesyce skottsbergii* var. *skottsbergii*. It was previously occupied by the species and still contains the features essential to its conservation, such as the unique coral outcrop substrate. Oahu—Lowland Dry—Unit 8 may be able to provide for two separate populations of *C. skottsbergii* var. *skottsbergii*. A designation limited to areas presently occupied by the species would be inadequate to ensure the conservation of the species because the one occupied unit (only Oahu—Lowland Dry—Unit 11, see below, is occupied by wild individuals; Oahu—Lowland Dry—Unit 9 contains outplanted, propagated individuals) would not provide enough area to support 7 to 8 populations needed for recovery, as determined in the “Recovery Needs and Strategy for *Chamaesyce skottsbergii* var. *skottsbergii* (Ewa Plains akoko)” (Service 2012, entire). There are no other geographic areas that are both undeveloped and contain the species-specific PCE of coral outcrop substrate. Oahu—Lowland Dry—Unit 8 is not known to be occupied by *Bidens amplexans*, one of the plants being listed in this rule as endangered. However, we have determined the lands within this unit are essential for the conservation of this lowland dry species, because they provide the habitat necessary for the reestablishment of wild populations within the historical ranges of the species (see Table 4). Due to their small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Additionally, Oahu—Lowland Dry—Unit 8 was not occupied by the endangered plants *Achyranthes splendens* var. *rotundata*, *Bonamia menziesii*, *Chamaesyce celastroides* var. *kaenana*, *Euphorbia haelealeana*, *Gouania meyenii*, *G. vitifolia*, *Hibiscus brackenridgei*, *Isodendron pyriformis*, *Melanthera tenuifolia*, *Neraudia angulata*, *Nototrichium humile*, *Schiedea hookeri*, *S. kealiae*, or *Spermolepis hawaiiensis* (see 51 FR 10518, March 26, 1986, and 68 FR 35950, June 17, 2003, for previous Federal actions), at the time they were listed, and is not currently known to be occupied by these 14 species. However, we have determined the lands within this unit are essential for the conservation of these lowland dry species, because they provide the habitat necessary for the reestablishment of wild populations within the

historical ranges of the species (see Table 4). Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Dry—Unit 9 consists of 17 ac (7 ha) of City and County land, 3 ac (1 ha) of privately owned land, 1 ac (0.5 ha) of State land, and 16 ac (6 ha) of Federal (Pearl Harbor NWR) land in the lowland dry ecosystem at Kalaeloa. This unit was not occupied by *Chamaesyce skottsbergii* var. *skottsbergii* at the time the species was listed (see 47 FR 36846, August 24, 1982). As noted in the description of Oahu—Lowland Dry—Unit 8 above, we have determined that for *C. skottsbergii* var. *skottsbergii*, a plant requiring another individual for pollination (obligate-outcrosser) and living 10 years or less (short-lived perennial), we will need 7 to 8 populations containing at least a total of 10,000 mature individuals with at least 1,000 mature individuals per population in order to recover the species (HPPRCC 2011; Guerrant et al. 2004, pp. 419–441; Neel and Cummings 2003). Oahu—Lowland Dry—Unit 9 is one of the four locations included in this final critical habitat designation that is essential to the conservation of *C. skottsbergii* var. *skottsbergii*; please see discussion of the importance of these areas on the Ewa Plain, above, in the description of Oahu—Lowland Dry—Unit 8. This unit is currently occupied by recently outplanted individuals of *Chamaesyce skottsbergii* var. *skottsbergii*, and includes the dry forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland dry ecosystem, and the unique PCEs for the species *C. skottsbergii* var. *skottsbergii* (see Tables 4 and 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing populations. Oahu—Lowland Dry—Unit 9 may be able to provide for one separate population of *C. skottsbergii* var. *skottsbergii*. Oahu—Lowland Dry—Unit 9 is not known to be occupied by another plant being listed as endangered in this rule, *Bidens amplexans*. We have determined this area to be essential for the conservation and recovery of both of these lowland dry species because it provides the habitat necessary for the reestablishment of wild populations within the historical ranges of the species (see Table 4). Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. A designation limited to areas presently occupied by the species would be inadequate because the one occupied unit (only Oahu—Lowland Dry—Unit 11, see below, is occupied by wild individuals; Oahu—Lowland Dry—Unit 9 contains outplanted, propagated individuals) would not provide enough area to support 7 to 8 populations needed for recovery, as determined in the “Recovery Needs and Strategy for *Chamaesyce skottsbergii* var. *skottsbergii* (Ewa Plains akoko)” (Service 2012, entire). There are no other geographic areas that are both undeveloped and contain the species-specific PCE of coral outcrop substrate. Additionally, Oahu—Lowland Dry—Unit 9 was not occupied by the endangered plants *Achyranthes splendens* var. *rotundata*, *Bonamia menziesii*, *Chamaesyce celastroides* var. *kaenana*, *Euphorbia haelealeana*, *Gouania meyenii*, *G. vitifolia*, *Hibiscus brackenridgei*, *Isodendron pyriformis*, *Melanthera tenuifolia*, *Neraudia angulata*, *Nototrichum humile*, *Schiedea hookeri*, *S. kealiae*, or *Spermolepis hawaiiensis* (see 51 FR 10518, March 26, 1986 and 68 FR 35950, June 17, 2003), at the time they were listed, and is not currently known to be occupied by these 14 species. We have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species (see Table 4). Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Dry—Unit 10 consists of 43 ac (17

ha) of State land (DHHL) in the lowland dry ecosystem at Kalaeloa. This unit was not occupied by *Chamaesyce skottsbergii* var. *skottsbergii* at the time the species was listed (see 47 FR 36846, August 24, 1982); however, *C. skottsbergii* var. *skottsbergii* was observed in the area in 1998, but has not been re-observed since that time. As noted in the description of Oahu—Lowland Dry—Unit 8, above, we have determined that *C. skottsbergii* var. *skottsbergii*, a plant requiring another individual for pollination (obligate outcrosser) and living 10 years or less (short-lived perennial), we will need 7 to 8 populations containing a total of 10,000 mature individuals with at least 1,000 mature individuals per population in order to recover the species (HPPRCC 2011; Guerrant et al. 2004, pp. 419–441; Neel and Cummings 2003). Oahu—Lowland Dry—Unit 10 is one of the four locations included in this final critical habitat designation that is essential to the conservation of *C. skottsbergii* var. *skottsbergii*; please see discussion of the importance of these areas on the Ewa Plain, above, in the description of Oahu—Lowland Dry—Unit 8. This unit was previously occupied by *Chamaesyce skottsbergii* var. *skottsbergii* and still contains the features essential to its conservation, such as the unique coral outcrop substrate (see Tables 4 and 5). In the future, Oahu—Lowland Dry—Unit 10 may be able to provide for one separate population of *C. skottsbergii* var. *skottsbergii*. A designation limited to areas presently occupied by the species would be inadequate to ensure the conservation of the species, because the one occupied unit (Oahu—Lowland Dry—Unit 11) would not provide enough area to support 7 to 8 populations needed for recovery, as determined in the “Recovery Needs and Strategy for *Chamaesyce skottsbergii* var. *skottsbergii* (Ewa Plains akoko)” (Service 2012, entire). There are no other geographic areas that are both undeveloped and contain the species-specific PCE of coral outcrop substrate.

Oahu—Lowland Dry—Unit 10 is not known to be occupied by another plant being listed as endangered in this rule, *Bidens amplexans*. However, we have determined this area to be essential for the conservation and recovery of this lowland dry species, because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species (see Table 4). Due to its small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Additionally, Oahu—Lowland Dry—Unit 10 was not occupied by the endangered plants *Achyranthes splendens* var. *rotundata*, *Bonamia menziesii*, *Chamaesyce celastroides* var. *kaenana*, *Euphorbia haeleeleana*, *Gouania meyenii*, *G. vitifolia*, *Hibiscus brackenridgei*, *Isodendron pyriforme*, *Melanthera tenuifolia*, *Neraudia angulata*, *Nototrichium humile*, *Schiedea hookeri*, *S. kealiae*, or *Spermolepis hawaiiensis* (see 51 FR 10518, March 26, 1986, and 68 FR 35950, June 17, 2003), at the time they were listed, and is not currently known to be occupied by these 14 species. We have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species (see Table 4). Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. We are aware of the planned development of the Kalaeloa Solar One and Two alternative energy facilities (DHHL 2011, in litt.) on lands within, and adjacent to, this unit. The facilities, which are independently owned and operated, are being developed for the purpose of reducing Oahu’s dependence on fossil-fuel for power generation. The January 2011 Draft Environmental Assessment prepared for this project states that no Federal funding or Federal authorizations will be required to develop this facility. We are also unaware of any Federal nexus for this project. Accordingly, since a critical habitat designation only triggers a consultation under

section 7(a)(2) of the Act for activities that have a Federal nexus, the designation of this unit as critical habitat is not anticipated to have an impact on this project as proposed.

Oahu—Lowland Dry—Unit 11 consists of 166 ac (67 ha) of federal land (U.S. Navy) in the lowland dry ecosystem at Kalaeloa. The area was occupied by *Chamaesyce skottsbergii* var. *skottsbergii* at the time the species was listed (47 FR 36846, August 24, 1982), and is currently occupied by *C. skottsbergii* var. *skottsbergii*. As noted in the description of Oahu—Lowland Dry—Unit 8, above, we have determined that for *C. skottsbergii* var. *skottsbergii*, a plant requiring another individual for pollination (obligate-outcrosser) and living 10 years or less (short-lived perennial), we will need 7 to 8 populations containing a total of 10,000 mature individuals with at least 1,000 mature individuals per population in order to recover the species (HPPRCC 2011; Guerrant et al. 2004, pp. 419- 441; Neel and Cummings 2003). Oahu— Lowland Dry—Unit 11 is one of the four locations included in this final critical habitat designation that is essential to the conservation of *C. skottsbergii* var. *skottsbergii*; please see discussion of the importance of these areas on the Ewa Plain, above, in the description of Oahu—Lowland Dry—Unit 8. Oahu—Lowland Dry—Unit 11 includes the dry forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland dry ecosystem, as well as unique PCEs for *Chamaesyce skottsbergii* var. *skottsbergii* (see Tables 4 and 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the habitat necessary for the expansion of the existing wild populations. A designation limited to areas presently occupied by the species would be inadequate to ensure the conservation of the species because this occupied unit (only Oahu—Lowland Dry—Unit 11 is occupied by wild individuals; Oahu— Lowland Dry—Unit 9 (see above) contains outplanted, propagated individuals, not wild plants) would not provide enough area to support 7 to 8 populations needed for recovery, as determined in the “Recovery Needs and Strategy for *Chamaesyce skottsbergii* var. *skottsbergii* (Ewa Plains akoko)” (Service 2012, entire). There are no other geographic areas that are both undeveloped and contain the species-specific PCE of coral outcrop substrate. In the future, Lowland Dry—Unit 11 may be able to provide for three or four separate populations of *C. skottsbergii* var. *skottsbergii*. Oahu—Lowland Dry—Unit 11 is not known to be occupied by another plant being listed as endangered in this rule, *Bidens amplexans*. However, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species (see Table 4). Due to its small numbers of individuals or low population sizes, this species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Additionally, Lowland Dry—Unit 11 was not occupied by the endangered plants *Achyranthes splendens* var. *rotundata*, *Bonamia menziesii*, *Chamaesyce celastroides* var. *kaenana*, *Euphorbia haelealeana*, *Gouania meyenii*, *G. vitifolia*, *Hibiscus brackenridgei*, *Isodendron pyriformis*, *Melanthera tenuifolia*, *Neraudia angulata*, *Nototrichium humile*, *Schiedea hookeri*, *S. kealiae*, or *Spermolepis hawaiiensis* (see 51 FR 10518, March 26, 1986, and 68 FR 35950, June 17, 2003) at the time they were listed, and is not currently known to be occupied by these 14 species. We have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species (see Table 4). Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. We are aware and supportive of the efforts underway by State and the Navy, in coordination with the Service, to develop a long-term preservation or conservation plan for

Chamaesyce skottsbergii var. *skottsbergii* within this unit. These include the development of a State of Hawaii Habitat Conservation Plan and the conditional transfer of some of the Navy lands within this unit to the Hawaii Community Development Authority (HCDA). The State of Hawaii Endangered Species Act already prohibits the take of individual listed plants by the State or any other non-Federal entity, without State review and authorization. If the lands are transferred by the Navy, the deed will require Grantees and successors to enter into a legally binding conservation and management plan approved by the Hawaii Department of Land and Natural Resources, to ensure protection of *C. skottsbergii* var. *skottsbergii* before conveying the property (U.S. Navy 2011, in litt.), based on the species being State and federally listed. The purpose of this agreement is to ensure the use or development of the transferred property does not adversely affect *C. skottsbergii* var. *skottsbergii*, as long as the species remains listed under the Act. If the Navy lands are transferred to HCDA, a portion of the lands may be used to develop a photovoltaic alternative energy project (HCDA 2012, in litt.; HDOFAW 2012, in litt.). The HCDA plans to use a portion of the revenue generated by commercial use of HCDA property to fund the conservation actions required under a conservation management plan (U.S. Navy 2011, in litt.). The Service is committed to working with the Navy and HCDA in the development of this conservation plan, to ensure it will provide for the long-term conservation of the plant and its habitat. Because of this close coordination, and because the deed restriction stipulates that *C. skottsbergii* var. *skottsbergii* will not be adversely affected, we believe the development of the photovoltaic alternative energy project, as proposed, will not be impacted by the designation of critical habitat in this unit, and it is our intent to work with our partners to facilitate this project.

Oahu—Coastal—Unit 13 consists of 19 ac (8 ha) of City and County land, 1 ac (0.5 ha) of State land, and 3 ac (1 ha) of privately owned land in the coastal ecosystem at Kalaeloa. This unit is occupied by the plant *Achyranthes splendens* var. *rotundata*, and includes the mixed herbland and shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 4). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Coastal—Unit 13 is not known to be occupied by *Bidens amplexans*, *Centaurium sebaeoides*, *Chamaesyce celastroides* var. *kaenana*, *Schiedea kealiae*, *Sesbania tomentosa*, or *Vigna owahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Coastal—Unit 14 consists of 2 ac (1 ha) of City and County of Honolulu land, and 2 ac (1 ha) of Federal land (U.S. Coast Guard) in the coastal ecosystem at Kalaeloa. This unit is occupied by the plant *Achyranthes splendens* var. *rotundata*, and includes the mixed herbland and shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 4). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Coastal—Unit 14 is not known to be occupied by *Bidens amplexans*, *Centaurium sebaeoides*, *Chamaesyce celastroides* var. *kaenana*, *Schiedea kealiae*, *Sesbania tomentosa*, or *Vigna owahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within the

historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Coastal—Unit 15 consists of 9 ac (4 ha) of State land, 2 ac (1 ha) of privately owned land, and 21 ac (9 ha) of Federal (Pearl Harbor NWR) land at Kalaeloa. This unit is occupied by the plant *Achyranthes splendens* var. *rotundata*, and includes the mixed herbland and shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 4). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Coastal—Unit 15 is not known to be occupied by *Bidens amplexans*, *Centaurium sebaeoides*, *Chamaesyce celastroides* var. *kaenana*, *Schiedea kealiae*, *Sesbania tomentosa*, or *Vigna o-wahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Bidens amplexans* critical habitat consists of two components (Coastal and Lowland dry). Species occurs within the indicated ecosystem in the Waianae Mountain caldera complex (77 FR 57648-57862):

Ecosystem: Coastal. Elevation: <980 ft (<300 m). Annual precipitation: <20 in (<50 cm). Substrate: Well-drained, calcareous, talus slopes; dunes; weathered clay soils; ephemeral pools; mudflats. Canopy: *Hibiscus*, *Myoporum*, *Santalum*, *Scaevola*. Subcanopy: *Gossypium*, *Sida*, *Vitex*. Understory: *Eragrostis*, *Jacquemontia*, *Lyceum*, *Nama*, *Sesuvium*, *Sporobolus*, *Vigna*.

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, little weathered lava. Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*, *Sapindes*. Subcanopy: *Chamaesyce*, *Dodonaea*, *Leptecophylla*, *Osteomeles*, *Psydrax*, *Scaevola*, *Wikstroemia*. Understory: *Alyxia*, *Artemisia*, *Bidens*, *Chenopodium*, *Nephrolepis*, *Peperomia*, *Plumbago*, *Sicyos*, *Sida*, *Waltheria*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur.

(Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliff, forest- hardwood, forest/woodland, shrubland/chaparral (NatureServe, 2015)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: This species is found in dry shrublands and forests on cliffs and steep rocky slopes restricted to windward cliffs and crests. (NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Short-term trends suggest declines of 10-30% (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

9 (NatureServe, 2015)

Population Size:

500 to >1000 individuals (NatureServe, 2015)

Population Narrative:

Short-term trends suggest declines of 10-30%. Estimated anywhere from 500 to >1000 individuals (USFWS 2006). Total number of occurrences are 9, of those 7 are extant occurrences found only on Oahu. Observation records range from 1987-1999 (HBMP 2007). (NatureServe, 2015)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative plants, animals (pigs and goats), fire, hurricanes, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Fire can destroy dormant seeds as well as the plants themselves, even in steep or inaccessible areas. Successive fires that burn farther and farther into native habitat destroy native plants, and remove habitat for native species by altering microclimate conditions favorable to alien plants. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. The projected effects of climate change will likely exacerbate the effects of the other threats to the species (USFWS, 2012).

Stressor: Predation and herbivory (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs and goats) is considered an ongoing threat to *Bidens amplexans* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2012).

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

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SPECIES ACCOUNT: *Bidens campylotheca pentamera* (Ko`oko`olau)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Perennial herbs 0.7-4 m tall, with sprawling horizontal lateral branches. Leaves pinnate, pinnatifid, or bipinnatifid. Disk florets 25-45 per head, often divergent so that the heads have a loose, globose appearance. Rays yellow, 9-17 mm long. Achenes irregularly twisted or coiled, usually awnless. (NatureServe, 2015)

Current Range

This taxon is endemic to the island of Maui in the Hawaiian Islands, on the eastern volcano (East Maui) as well as the western volcano (West Maui). The taxon had been recorded only from East Maui until a single occurrence was found on West Maui in 1988. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Bidens campylotheca pentamera* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 21 critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Bidens campylotheca pentamera* includes 21 CHUs in Maui County, Hawaii (81 FR 17790-18110).

Maui—Lowland Dry—Unit 5 consists of 3,615 ac (1,463 ha) of State land, and 43 ac (17 ha) of privately owned land, from Panaewa to Manawainui on the western and southern slopes of west Maui. This unit is occupied by the plants *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, *Cenchrus agrimonioides*, *Gouania hillebrandii*, *Kadua coriacea*, *Remya mauensis*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and *Tetramolopium capillare*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 5 is not known to be occupied by *Ctenitis squamigera*, *Cyanea obtusa*, *Hesperomannia arbuscula*, *Hibiscus brackenridgei*, *Lysimachia lydgatei*, *Neraudia sericea*, *Schiedea salicaria*, *Sesbania tomentosa*, or *T. remyi*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 6 consists of 3 ac (1 ha) of State land, and 237 ac (96 ha) of privately owned land, from Paleaahu Gulch to Puu Hona on the southern slopes of west Maui. This unit is occupied by the plants *Hibiscus brackenridgei* and *Schiedea salicaria*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 6 is not known to be occupied by *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, *Cenchrus agrimonoides*, *Ctenitis squamigera*, *Cyanea obtusa*, *Gouania hillebrandii*, *Hesperomannia arbuscula*, *Kadua coriacea*, *Lysimachia lydgatei*, *Neraudia sericea*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Spermolepis hawaiiensis*, *Tetramolopium capillare*, or *T. remyi*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Mesic—Unit 2 consists of 1,034 ac (419 ha) of State land, and 113 ac (46 ha) of privately owned land, from Honokohau to Launiupoko on the western slopes of west Maui. This unit is occupied by the plants *Ctenitis squamigera*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, and *Zanthoxylum hawaiiense*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Mesic—Unit 2 is not known to be occupied by *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, or *Colubrina oppositifolia*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within its historical range. Due to its small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could approach recovery.

Maui—Lowland Mesic—Unit 3 (and) *Palmeria dolei*—Unit 1—Lowland Mesic (and) *Pseudonestor xanthophrys*—Unit 1— Lowland Mesic This area consists of 477 ac (193 ha) of State land at Ukumehame on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). Although Maui—Lowland Mesic—Unit 3 is not currently occupied by the plants *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Zanthoxylum hawaiiense*, or by the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 1 (and) *Palmeria dolei*—Unit 10—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 10— Montane Wet This area consists of 1,313 ac (531 ha) of State land and 798 ac (323 ha) of privately owned land, at Haiku Uka on the northern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Cyanea duvalliorum*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *Phyllostegia pilosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 1 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 11—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 11— Montane Wet This area consists of 4,075 ac (1,649 ha) of State land, 9,633 ac (3,898 ha) of privately owned land, and 875 ac (354 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Puukaukanu and upper Waihoi Valley, on the northern and northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Geranium hanaense*, *G. multiflorum*, and *Wikstroemia villosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 2 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea glabra*, *C. maritae*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, and *Schiedea jacobii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 3 (and) *Palmeria dolei*—Unit 12—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 12— Montane Wet This area consists of 2,228 ac (902 ha) of federally owned

land (Haleakala National Park) in Kipahulu Valley, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. maritae*, and *Melicope ovalis*, and by the forest bird, *kiwikiu* (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 3 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea duvalliorum*, *C. glabra*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest bird, the *akohekohe* (*Palmeria dolei*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 4 (and) *Palmeria dolei*—Unit 13—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 13— Montane Wet This area consists of 180 ac (73 ha) of State land and 1,653 ac (669 ha) of federally owned land (Haleakala National Park), in Kaapahu Valley on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *Cyrtandra ferripilosa*, and *Huperzia mannii*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 4 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea duvalliorum*, *C. glabra*, *C. mceldowneyi*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 5 (and) *Palmeria dolei*—Unit 14—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 14— Montane Wet This area consists of 222 ac (90 ha) of State land, and 165 ac (67 ha) of federally owned land (Haleakala National Park), near Kaumakani on the eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological

features in the montane wet ecosystem (see Table 5). These units area occupied by the plant *Bidens campylotheca* ssp. *pentamera*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 5 is not currently occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 1 (and) *Palmeria dolei*—Unit 18—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 18— Montane Mesic This area consists of 6,593 ac (2,668 ha) of State land, 707 ac (286 ha) of privately owned land, and 3,672 ac (1,486 ha) of federally owned land (Haleakala National Park), from Kealahou to Puualae, nearly circumscribing the summit of Haleakala on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Asplenium dielirectum*, *A. peruvianum* var. *insulare*, *Clermontia lindseyana*, *Cyanea horrida*, *C. obtusa*, *Cyrtandra ferripilosa*, *C. oxybapha*, *Diplazium molokaiense*, *Geranium arboreum*, *G. multiflorum*, *Huperzia mannii*, *Melicope adscendens*, and *Neraudia sericea*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 1 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Cyanea glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. mceldowneyi*, *Phyllostegia bracteata*, *P. mannii*, *Santalum haleakalae* var. *lanaiense*, *Wikstroemia villosa*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 1 (and) *Palmeria dolei*—Unit 26—Dry Cliff (and) *Pseudonestor xanthophrys*—Unit 26— Dry Cliff This area consists of 755 ac (305 ha) of federally owned land (Haleakala National Park), from Pakaoao to Koolau Gap on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). Although Maui—Dry Cliff— Unit 1 is not known to be occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Diplazium molokaiense*, *Geranium multiflorum*, *Plantago princeps*, or *Schiedea*

haleakalensis, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 2 consists of 688 ac (279 ha) of federally owned land (Haleakala National Park) from Haupaakea Peak to Kaupo Gap on east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). It is occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Geranium multiflorum*, *Plantago princeps*, and *Schiedea haleakalensis*, and contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Dry Cliff—Unit 2 is not known to be occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, or *Diplazium molokaiense*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 3 (and) *Palmeria dolei*—Unit 27—Dry Cliff (and) *Pseudonestor xanthophrys*—Unit 27—Dry Cliff This area consists of 200 ac (81 ha) of federally owned land (Haleakala National Park) near Papaanui on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). It is occupied by the plant *Plantago princeps*, and contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Dry Cliff—Unit 3 is not currently occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Diplazium molokaiense*, *Geranium multiflorum*, or *Schiedea haleakalensis*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 4 (and) *Palmeria dolei*—Unit 28—Dry Cliff (and) *Pseudonestor xanthophrys*—Unit 28—Dry Cliff This area consists of 315 ac (127 ha) federally owned land (Haleakala National Park), along Kalapawili Ridge on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). Although Maui—Dry Cliff—Unit 4 is not currently occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Diplazium molokaiense*, *Geranium multiflorum*, *Plantago princeps*, or *Schiedea haleakalensis*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor*

xanthophrys), we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 1 (and) *Palmeria dolei*—Unit 30—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 30—Wet Cliff This area consists of 290 ac (117 ha) of privately owned land along the wall of Keanae Valley on the northern slopes of east Maui. These units include the mixed hermland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff—Unit 1 is not currently occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *Cyanea horrida*, *Melicope ovalis*, *Phyllostegia bracteata*, *P. haliakalae*, or *Plantago princeps*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 2 (and) *Palmeria dolei*—Unit 31—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 31—Wet Cliff This area consists of 475 ac (192 ha) of State land, 20 ac (8 ha) of privately owned land, and 912 ac (369 ha) of federally owned land (Haleakala National Park), from Kalapawili Ridge along Kipahulu Valley and north to Puuhoolio, on the northeastern slopes of east Maui. These units include the mixed hermland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plants *Bidens campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *Melicope ovalis*, *Phyllostegia bracteata*, and *Plantago princeps*. These units also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 2 is not known to be occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Cyanea horrida*, or *Phyllostegia haliakalae*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 3 (and) *Palmeria dolei*—Unit 32—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 32—Wet Cliff This area consists of 5 ac (2 ha) of State land and 433 ac (175 ha) federally owned land (Haleakala National Park) along the south rim of Kipahulu Valley on east Maui. These units include the mixed hermland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff—Unit 3 is not currently occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. horrida*, *Melicope ovalis*, *Phyllostegia bracteata*, *P. haliakalae*,

or *Plantago princeps*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 4 (and) *Palmeria dolei*—Unit 33—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 33— Wet Cliff This area consists of 184 ac (75 ha) of State land along the north wall of Waihoi Valley, on the northeastern slopes of east Maui. These units include the mixed hermland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plant *Bidens campylotheca* ssp. *pentamera* and *B. campylotheca* ssp. *waihoiensis*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 4 is not known to be occupied by the plants *Cyanea copelandii* ssp. *haleakalaensis*, *C. horrida*, *Melicope ovalis*, *Phyllostegia bracteata*, *P. haliakalae*, or *Plantago princeps*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 6 (and) *Palmeria dolei*—Unit 35—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 35— Wet Cliff This area consists of 1,858 ac (752 ha) of State land, and 253 ac (102 ha) of privately owned land, at the summit ridges of west Maui. These units include the mixed hermland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plants *Alectryon macrococcus*, *B. conjuncta*, *Ctenitis squamigera*, *Cyrtandra munroi*, *Remya mauiensis*, and *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 6 is not known to be occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Bonamia menziesii*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyriformis*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, or *Tetramolopium capillare*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 7 (and) *Palmeria dolei*—Unit 36—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 36— Wet Cliff This area consists of 556 ac (225 ha) of State land along Honokowai ridge on the northwestern side of west Maui. These units include the mixed hermland and shrubland, the moisture regime, and the subcanopy and understory native plant species

identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units are occupied by the plants *Cyrtandra filipes* and *C. munroi*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 7 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyriformis*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 8 consists of 337 ac (137 ha) of State land along Kahakuloa ridge on the north side of west Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff—Unit 8 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyriformis*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Bidens campylotheca* *pentamera* critical habitat consists of six components. Lowland dry (west Maui), Lowland mesic (west Maui), Montane wet (east Maui), Montane mesic (east Maui), Dry cliff (east Maui) and wet cliff (east Maui and west Maui) (81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*. Subcanopy: *Chamaesyce*, *Dodonaea*, *Leptecophylla*, *Osteomeles*, *Psydrax*, *Scaevola*, *Wikstroemia*. Understory: *Alyxia*, *Artemisia*, *Bidens*, *Chenopodium*, *Nephrolepis*, *Peperomia*, *Sicyos*.

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freyinetia*, *Leptecophylla*,

Melanthera, Osteomeles, Pleomele, Psydrax. Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: Acacia, Charpentiera, Cheirodendron, Metrosideros. Subcanopy: Broussaisia, Cibotium, Eurya, Ilex, Myrsine. Understory: Ferns, Carex, Coprosma, Leptecophylla, Oreobolus, Rhynchospora, Vaccinium.

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: Acacia, Ilex, Metrosideros, Myrsine, Nestegis, Nothocestrum, Pisonia, Pittosporum, Psychotria, Sophora, Zanthoxylum. Subcanopy: Alyxia, Charpentiera, Coprosma, Dodonaea, Kadua, Labordia, Leptecophylla, Phyllostegia, Vaccinium. Understory: Ferns, Carex, Peperomia.

Ecosystem: Dry Cliff. Elevation: unrestricted. Annual precipitation: < 75 in (< 190 cm). Substrate: >65 degree slope, rocky talus. Canopy: None. Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: Broussaisia, Cheirodendron, Leptecophylla, Metrosideros. Understory: Bryophytes, Ferns, Coprosma, Dubautia, Kadua, Peperomia.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and

Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkii*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*,

Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (inferred from NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Wet forests, shrubland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Restricted to high elevations (NatureServe, 2015)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: On East Maui individuals are at high elevation in wet forests, sometimes close to where the forest grades into subalpine shrubland above the forest. At the only recorded site for this taxon on West Maui was found in a moist forest on a gulch slope. (NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Short-term trends suggest a decline of 10-30% (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

6 (NatureServe, 2015)

Population Size:

300-500 individuals (NatureServe, 2015)

Population Narrative:

Short-term population trends suggest a decline of 10-30%. Estimated to be about 300 to 500 individuals. A total of 6 occurrences have been observed since 1973, 5 on East Maui (1973-2003), and one on West Maui (1988). All are thought likely to be still extant. (NatureServe, 2015)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs, goats, and axis deer), nonnative plants, fire, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Fire can destroy dormant seeds and plants, even in steep and inaccessible areas. Successive fires can remove habitat for native species by altering microclimate conditions favorable to alien plants. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, goats, axis deer, and rats) is considered an ongoing threat to *Bidens campylotheca pentamera* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor: Hybridization (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Hybridization will adversely impact this species because it may lead to extinction of one or both of the original genotypically distinct species. Hybrids have been reported between *Bidens campylotheca* ssp. *pentamera* and *B. campylotheca* ssp. *waihoiensis*, two subspecies that occur in close proximity on east Maui (USFWS, 2013).

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

References

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NatureServe. 2015. NatureServe Explorer: an encyclopedia of life [web application]. Accessed August 2016

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SPECIES ACCOUNT: *Bidens campylotheca waihoiensis* (Ko`oko`olau)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

An erect, suffrutescent perennial herb 0.7-1.3 m tall with ascending lateral branches. Leaves tripinnatifid or bipinnate, with 5-9 leaflets. Flower heads in diffuse panicles or compound cymes terminating lateral branches only. Disk florets are 25-32 per head and often divergent so that the heads have a loose, globose appearance. (NatureServe, 2015)

Taxonomy

There are 3 subspecies recognized within *Bidens campylotheca*. (NatureServe, 2015)

Current Range

Known only from the eastern slopes of Haleakala, Island of Maui, State of Hawaii. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Bidens campylotheca waihoiensis* (Ko`oko`olau) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes ten critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Bidens campylotheca waihoiensis* includes ten CHUs in Maui County, Hawaii (81 FR 17790-18110).

Maui—Lowland Wet—Unit 1 (and) *Palmeria dolei*—Unit 2—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 2— Lowland Wet This area consists of 6,616 ac (2,677 ha) of State land, 7,425 ac (3,005 ha) of privately owned land, and 2,038 ac (825 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Kipahulu Valley on the northern and eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia samuelii*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *M. ovalis*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 1 is not known to be occupied by the plants *Clermontia oblongifolia* ssp. *mauiensis*, *C. peleana*, *Mucuna sloanei* var. *persericea*, *Phyllostegia haliakalae*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet

species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 1 (and) *Palmeria dolei*—Unit 10—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 10— Montane Wet This area consists of 1,313 ac (531 ha) of State land and 798 ac (323 ha) of privately owned land, at Haiku Uka on the northern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Cyanea duvalliorum*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *Phyllostegia pilosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 1 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 11—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 11— Montane Wet This area consists of 4,075 ac (1,649 ha) of State land, 9,633 ac (3,898 ha) of privately owned land, and 875 ac (354 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Puukaukanu and upper Waihoi Valley, on the northern and northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Geranium hanaense*, *G. multiflorum*, and *Wikstroemia villosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 2 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea glabra*, *C. maritae*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, and *Schiedea jacobii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes,

suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 3 (and) *Palmeria dolei*—Unit 12—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 12— Montane Wet This area consists of 2,228 ac (902 ha) of federally owned land (Haleakala National Park) in Kipahulu Valley, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. maritae*, and *Melicope ovalis*, and by the forest bird, kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 3 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea duvalliorum*, *C. glabra*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest bird, the akohekohe (*Palmeria dolei*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 4 (and) *Palmeria dolei*—Unit 13—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 13— Montane Wet This area consists of 180 ac (73 ha) of State land and 1,653 ac (669 ha) of federally owned land (Haleakala National Park), in Kaapahu Valley on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *Cyrtandra ferripilosa*, and *Huperzia mannii*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 4 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea duvalliorum*, *C. glabra*, *C. mceldowneyi*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 5 (and) *Palmeria dolei*—Unit 14—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 14— Montane Wet This area consists of 222 ac (90 ha) of State land, and 165 ac (67 ha) of federally owned land (Haleakala National Park), near Kaumakani on the eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units area occupied by the plant *Bidens campylotheca* ssp. *pentamera*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 5 is not currently occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 1 (and) *Palmeria dolei*—Unit 30—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 30— Wet Cliff This area consists of 290 ac (117 ha) of privately owned land along the wall of Keanae Valley on the northern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff— Unit 1 is not currently occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *Cyanea horrida*, *Melicope ovalis*, *Phyllostegia bracteata*, *P. haliakalae*, or *Plantago princeps*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 2 (and) *Palmeria dolei*—Unit 31—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 31— Wet Cliff This area consists of 475 ac (192 ha) of State land, 20 ac (8 ha) of privately owned land, and 912 ac (369 ha) of federally owned land (Haleakala National Park), from Kalapawili Ridge along Kipahulu Valley and north to Puuhoolio, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plants *Bidens campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *Melicope ovalis*, *Phyllostegia bracteata*, and *Plantago princeps*. These units also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 2 is not known to be occupied by the plants

Bidens campylotheca ssp. *pentamera*, *Cyanea horrida*, or *Phyllostegia haliakalae*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 3 (and) *Palmeria dolei*—Unit 32—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 32—Wet Cliff This area consists of 5 ac (2 ha) of State land and 433 ac (175 ha) federally owned land (Haleakala National Park) along the south rim of Kipahulu Valley on east Maui. These units include the mixed hermland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff—Unit 3 is not currently occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. horrida*, *Melicope ovalis*, *Phyllostegia bracteata*, *P. haliakalae*, or *Plantago princeps*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 4 (and) *Palmeria dolei*—Unit 33—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 33—Wet Cliff This area consists of 184 ac (75 ha) of State land along the north wall of Waihoi Valley, on the northeastern slopes of east Maui. These units include the mixed hermland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plant *Bidens campylotheca* ssp. *pentamera* and *B. campylotheca* ssp. *waihoiensis*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 4 is not known to be occupied by the plants *Cyanea copelandii* ssp. *haleakalaensis*, *C. horrida*, *Melicope ovalis*, *Phyllostegia bracteata*, *P. haliakalae*, or *Plantago princeps*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Bidens campylotheca waihoiensis* critical habitat consists of three components. Lowland wet (east Maui), Montane wet (east Maui) and wet cliff (east Maui). Species-specific physical or biological features are streambanks (81 FR 17790-18110):

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. Understory: Bryophytes, Ferns, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative

ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Wet forests (NatureServe, 2015)

Habitat Narrative

Adult: This species is usually along streambanks in wet forests. (NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Short-term trends suggest declines of 10-30% (NatureServe, 2015)

Resiliency:

Very low (inferred from NatureServe, 2015)

Redundancy:

Very low (inferred from NatureServe, 2015)

Number of Populations:

1 (NatureServe, 2015)

Population Size:

<200 plants (NatureServe, 2015)

Population Narrative:

Short-term population trends suggest declines of 10-30%. One population has less than 200 plants. Known from one extant occurrence (1994) and two historical occurrences on the island of Maui. (NatureServe, 2015)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs, goats, and axis deer), nonnative plants, flooding, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and

seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Flooding destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, goats, axis deer, rats, and slugs) is considered an ongoing threat to *Bidens campylotheca waihoiensis* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor: Hybridization (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Hybridization will adversely impact this species because it may lead to extinction of one or both of the original genotypically distinct species. Hybrids have been reported between *Bidens campylotheca* ssp. *pentamera* and *B. campylotheca* ssp. *waihoiensis*, two subspecies that occur in close proximity on east Maui (USFWS, 2013).

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

References

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

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Final Rule. 78 Federal Register 102, May 28, 2013. Pages 32014 - 32065.

SPECIES ACCOUNT: *Bidens conjuncta* (Ko`oko`olau)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Perennial herbs, slightly woody at the base, erect, 0.7-2 m tall, with horizontal or ascending lateral branches. Leaves simple or pinnately compound. Cymes compound, terminating lateral branches only. Heads 15-45 or more. Disk florets 8-15 per head. Rays yellow, 15-22 mm long. (NatureServe, 2015)

Current Range

Bidens conjuncta is endemic to the island of Maui, state of Hawaii. It has been found only on the island's western mountain mass, the West Maui Mountains. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Bidens conjuncta* (Ko`oko`olau) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Bidens conjuncta waihoiensis* includes six CHUs in Maui County, Hawaii. (81 FR 17790-18110).

Maui—Lowland Wet—Unit 2 (and) *Palmeria dolei*—Unit 3—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 3—Lowland Wet (and) *Newcombia cumingi*—Unit 1—Lowland Wet This area consists of 65 ac (26 ha) of State land at Moomoku, on the northwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. Although Maui—Lowland Wet—Unit 2 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendrion pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), or by the Newcomb's tree snail (*Newcombia cumingi*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 4 (and) *Palmeria dolei*—Unit 5—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 5— Lowland Wet This area consists of 864 ac (350 ha) of State land at Kahakuloa Valley on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta* and *Cyanea asplenifolia*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 4 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwiku* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 5 (and) *Palmeria dolei*—Unit 6—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 6— Lowland Wet This area consists of 30 ac (12 ha) of State land at Iao Valley on the eastern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 5 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwiku* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 7 (and) *Palmeria dolei*—Unit 8—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 8— Lowland Wet This area consists of 898 ac (364 ha) of State land at Olowalu Valley, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Alectryon macrococcus*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 7 is not

currently occupied by the plants *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 8 (and) *Palmeria dolei*—Unit 9—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 9—Lowland Wet This area consists of 230 ac (93 ha) of State land at upper Ukumehame Gulch, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 8 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 7 (and) *Palmeria dolei*—Unit 16—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 16—Montane Wet This area consists of 80 ac (32 ha) of State land near Hanaula and Pohakea Gulch on the southeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). They are occupied by the plants *Cyrtandra oxybapha* and *Platanthera holochila*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 7 is not known to be occupied by the plants *Acaena exigua*, *Bidens conjuncta*, *Calamagrostis hillebrandii*, *Cyanea kunthiana*, *Geranium hillebrandii*, *Huperzia mannii*, *Myrsine vaccinioides*, *Phyllostegia bracteata*, or *Sanicula purpurea*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Bidens conjuncta* critical habitat consists of three components. Lowland wet (west Maui), Montane wet (west Maui) and Wet cliff (west Maui) (81 FR 17790-18110):

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. Understory: Bryophytes, Ferns, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and

6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylothea* ssp. *pentamera*, *B. campylothea* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkii*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*,

Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial and palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Bog/fen, scrub-shrub wetland, forest- hardwood, forest/woodland (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow to moderate. (NatureServe, 2015)

Habitat Narrative

Adult: This species is found in wet forests and bogs on ridges and in gulches. (NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Short-term trends suggest a decline of 10-30% (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

11 (NatureServe, 2015)

Population Size:

~2,200 plants (NatureServe, 2015)

Population Narrative:

Short-term population trends suggest a decline of 10-30%. There are 2200 plants estimated (USFWS 2006) among 11 extant (1990-1998) occurrences on the island of Maui. (NatureServe, 2015)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs and goats), nonnative plants, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, goats, rats, and slugs) is considered an ongoing threat to *Bidens conjuncta* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

References

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

USFWS. 2016. Environmental Conservation Online System (ECOS) – Species Profile.
<http://ecos.fws.gov/speciesProfile/>. Accessed August 2016

U.S. Fish and Wildlife Service. 2016. Endangered and Threatened Wildlife and Plants

Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

Final Rule . 81 FR 17790-18110 (March 30, 2016).

NatureServe. 2015. NatureServe Explorer: an encyclopedia of life [web application]. Accessed August 2016

USFWS. 2013. Determination of Endangered Status for 38 Species on Molokai, Lanai, and Maui

Final Rule. 78 Federal Register 102, May 28, 2013. Pages 32014 - 32065.

SPECIES ACCOUNT: *Bidens hillebrandiana* ssp. *hillebrandiana* (kookoolau)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/29/2013; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Perennial herbs, erect or usually decumbent, 0.2-0.3 m or (rarely) up to 0.5 m tall. Leaves rarely simple, usually pinnately or bipinnately compound, usually 3.5-8 cm long including the petiole, leaflets 3-9. Heads 1-3 or (rarely) 4 per inflorescence. Ray florets 5-6 per head, sterile. Rays yellow, 9-12 mm long, 3-4 mm wide. Disk florets 11-21; corollas yellow. Achenes 6-8 mm long, 0.8-1.2 mm wide. (NatureServe, 2015)

Current Range

Bidens hillebrandii ssp. *hillebrandii* is endemic to the island of Hawaii in the Hawaiian Islands. It is known only from the windward (eastern) coast of Kohala near the northern tip of the island. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (inferred from NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Coastal bluffs and seacliffs (NatureServe, 2015)

Habitat Narrative

Adult: Found on coastal bluffs and seacliffs. (NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Resiliency:

Very low (inferred from NatureServe, 2015)

Redundancy:

Very low (inferred from NatureServe, 2015)

Number of Populations:

1 (NatureServe, 2015)

Population Narrative:

A single occurrence is known to be extant. (NatureServe, 2015)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs and goats), nonnative plants, hurricanes, rockfalls, landslides, high surf, and erosion. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Rockfalls, landslides, high surf, and erosion destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, goats, and rats) is considered an ongoing threat to *Bidens hillebrandiana* ssp. *hillebrandiana* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor: Small populations (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: *Bidens hillebrandiana* ssp. *hillebrandiana* faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). The only known occurrences are threatened either by landslides, rockfalls, inundation by high surf, or erosion, or a combination of these, because of their locations in lowland wet, montane wet, coastal, and dry cliff ecosystems. (USFWS, 2013).

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

References

NatureServe. 2015. NatureServe Explorer: an encyclopedia of life [web application]. Accessed August 2016

USFWS. 2016. Environmental Conservation Online System (ECOS) – Species Profile. <http://ecos.fws.gov/speciesProfile/>. Accessed August 2016

USFWS. 2013. Determination of Endangered Species Status for 15 Species on Hawaii Island

Final Rule. 78 Federal Register 209, October 29, 2013. Pages 64638 - 64690.

SPECIES ACCOUNT: *Bidens micrantha ctenophylla* (Ko`oko`olau)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/29/2013; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

An erect, suffrutescent perennial herb 0.5-1.5 m tall. Leaves simple or occasionally trifoliolate. Heads in dense inflorescences terminating main stem and lateral branches. (NatureServe, 2015)

Current Range

Endemic to the district of North Kona on the island of Hawaii, on the dry leeward slopes of Hualalai volcano (HBMP 2006, Ball 2007). (NatureServe, 2015)

Critical Habitat Designated

Yes; 9/20/2018.

Primary Constituent Elements/Physical or Biological Features

1. Lowland dry ecosystem. 2. Elevation <1000 meters. 3. Annual precipitation <130 cm. 4. Substrate: Weathered silty loams to stony clay, rocky ledges, little weathered lava. 5. Supporting one or more of these associated native plant genera (a) Canopy (Diospyros, Erythrina, Metrosideros, Myoporum, Pleomele, Santalum, Sapindus) (b) Subcanopy (Chamaesyce, Dodonaea, Osteomeles, Psydrax, Scaevola, Wikstroemia) (c) Understory (Alyxia, Artemisia, Bidens, Capparis, Chenopodium, Nephrolepis, Peperomia, Sicyos.)

Special Management Considerations or Protections

For *Bidens micrantha* ssp. *ctenophylla*, *Isodendron pyrifolium*, and *Mezoneuron kavaense*, we have determined that the features essential to their conservation are those required for the successful functioning of the lowland dry ecosystem in which they occur (see Table 2, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: It is uncertain whether the PuuAnahulu plants are currently persistent and/or reproductive, and the Kohala plant is currently vegetative although it has reproduced - but not established any seedlings - in the past). (NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliff, forest- hardwood, forest/woodland, shrubland/chaparral, woodland- hardwood (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 180 and 640 meters (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow to narrow. (NatureServe, 2015)

Habitat Narrative

Adult: *Bidens micrantha ctenophylla* is found on slopes, ridges, and cliffs in dry shrublands (including open mixed shrubland and *Canthium/Schinus* shrubland) to *Metrosideros polymorpha* lowland dry forest. This species is found at elevations between 180 and 640 meters. Substrate is usually an old lava flow (a'a lava). Common native associates include *Psydrax odorata*, *Myoporum sandwicense*, *Reynoldsia sandwicensis*, and *Sophora chrysophylla*, while alien associates include *Schinus terebinthifolius*, *Pennisetum setaceum*, *Leucana leucocephala*, and *Grevillea robusta*. (NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Short-term trends suggest declines of 10-30%, whereas long-term trends unknown. (NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

4-6 (NatureServe, 2015)

Population Size:

2,000-3,100 plants (NatureServe, 2015)

Population Narrative:

Short-term population trends suggest declines of 10-30%; long-term trends unknown. The majority of individuals are found at the Kaloko Honokohau lava flow site (approximately 1000 plants) and the Kealakehe site (approximately 1000- 2000 plants) (Ball 2007). The PuuWaaWaa site has 5 individuals (Ball 2007), and the natural plants at Kaupulehu have been described as "few" and "scattered" (S. Perlman pers. comm. 2008). The road between the Kaloko Honokohau lava flow and the Kaloko-Honokohau National Historical Park has 3 individuals (L. Perry pers. comm. 2008), and the Kaloko-Honokohau National Historical Park site had three natural individuals, now augmented to 20-30 individuals by propagation (J. Wagner pers. comm. 2008). At the outplanted sites, 20-30 individuals were reported at Kaupulehu and 5 at PuuAnahulu (Ball 2007). One outplanted individual survives in the Kohala mountains, but it is not currently reproductive (K. Kawakami pers. comm. 2008). Total population size is estimated to be 2000-

3100 plants. There appear to be approximately 4-6 extant, natural occurrences of this variety, all on the island of Hawaii in the North Kona region. (NatureServe, 2015)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from agricultural and urban development, nonnative animals (pigs and goats), nonnative plants, fire, hurricanes, and drought. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Fire can destroy dormant seeds and plants, even in steep and inaccessible areas. Successive fires can remove habitat for native species by altering microclimate conditions favorable to alien plants. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Severe episodes of drought cannot only directly kill individuals of a species or entire populations, but drought frequently leads to an increase in the number and intensity of forest and brush fires. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Hybridization (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Hybridization is a threat to *Bidens micrantha* ssp. *ctenophylla* because hybridization may lead to extinction of the original genotypically distinct species. Hybrid swarms (hybrids between parent species, and subsequently formed progeny from crosses among hybrids and crosses of hybrids to parental species) have been reported between the *B. micrantha* ssp. *ctenophylla* and *B. menziesii* ssp. *filiformis* (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, goats, and rats) is considered an ongoing threat to *Bidens micrantha* ssp. *ctenophylla* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

References

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NatureServe. 2015. NatureServe Explorer: an encyclopedia of life [web application]. Accessed August 2016

USFWS. 2013. Determination of Endangered Species Status for 15 Species on Hawaii Island

Final Rule. 78 Federal Register 209, October 29, 2013. Pages 64638 - 64690.

SPECIES ACCOUNT: *Bidens micrantha* ssp. *kalealaha* (Ko`oko`olau)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/15/1992; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Bidens micrantha ssp. *kalealaha* is an erect perennial herb in the aster family (Asteraceae). The base of the 50-150 cm (20-60 in) plant is somewhat woody. Leaves are 6-19 cm (2.6-7.5 in) long with 1-9 (usually 5-9) lance-shaped leaflets 3.5-13.5 cm (1.4-5.3 inches) long; some populations have ciliate (haired) leaf margins. Yellow flowers occur at the ends of branches in loose clusters of 15-75 heads; each flower is 15-45 mm (0.6-1.8 in) in diameter on 1-40 mm (0.04-1.6 in) stalks (peduncles). There are 5 sterile petal-like ray florets and 11-12 minute disk florets per head. The small seeds (5-14 x 0.7-2 mm [0.2-0.6x 0.03-0.08 in achenes) are black, straight, and wingless. (USFWS, 1997)

Taxonomy

Sherff (1951a) described *Bidens micrantha* var. *rudimentifera* based on a specimen of *Bidens* collected on Haleakala, Maui, by William H. Hatheway and Amy B.H. Greenwell in 1950. The ssp. *kalealaha* was described by Kenneth Nagata and Fred Ganders ((landers and Nagata 1983) to combine the Maui and Lanai populations, hence *Bidens micrantha* ssp. *kalealaha* Nagata and Ganders. The subspecific epithet *kalealaha* is an anagram of the place name “Haleakala” (Nagataand Ganders 1983). (USFWS, 1997)

Historical Range

Historically, *Bidens micrantha* subsp. *kalealaha* was known from Lanai, the south slope of Haleakala on East Maui, and from one location on West Maui. (USFWS, 2011)

Current Range

Current known from East Maui. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/18/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Bidens micrantha* ssp. *kalealaha* (Ko`oko`olau) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 18 detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Bidens micrantha* ssp. *kalealaha* includes 18 CHUs in Maui County, Hawaii with detailed unit information. There are also an unknown number of units on Lanai that contain this species (number of units is unknown because detailed unit descriptions for Lanai are not available) (81 FR 17790-18110).

Maui—Lowland Dry—Unit 1 consists of 11,465 ac (4,640 ha) of State land, 2,069 ac (837 ha) of federally owned land, and 3 ac (1 ha) of privately owned land, from Kanaio to Kahualau Gulch on

the southern slopes of east Maui. This unit is occupied by the plants *Bonamia menziesii*, *Cenchrus agrimonioides*, *Flueggea neowawraea*, *Melicope adscendens*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 1 is not known to be occupied by *Alectryon macrococcus*, *Bidens micrantha* ssp. *kalealaha*, *Canavalia pubescens*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Sesbania tomentosa*, *Solanum incompletum*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 2 consists of 1,851 ac (749 ha) of State land at Keokea on the southern slopes of east Maui. This unit is occupied by the plants *Bonamia menziesii*, *Canavalia pubescens*, and *Hibiscus brackenridgei*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 2 is not known to be occupied by *Alectryon macrococcus*, *Bidens micrantha* ssp. *kalealaha*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 3 consists of 188 ac (76 ha) of privately owned land, at Keauhou on the southern slopes of east Maui. This unit is occupied by the plant *Canavalia pubescens*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 3 is not known to be occupied by *Bidens micrantha* ssp. *kalealaha*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low

population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 4 consists of 1,266 ac (512 ha) of State land (including the Department of Land and Natural Resources) at Ahihi-Kinau Natural Area Reserve on the southern slopes of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Maui—Lowland Dry—Unit 4 is not currently occupied by *Bidens micrantha* ssp. *kalealaha*, *Bonamia menziesii*, *Canavalia pubescens*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 2 (and) *Palmeria dolei*—Unit 3—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 3—Lowland Wet (and) *Newcombia cumingi*—Unit 1—Lowland Wet This area consists of 65 ac (26 ha) of State land at Moomoku, on the northwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. Although Maui—Lowland Wet—Unit 2 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendrion pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwiku* (*Pseudonestor xanthophrys*), or by the Newcomb's tree snail (*Newcombia cumingi*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 3 (and) *Palmeria dolei*—Unit 4—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 4—Lowland Wet This area consists of 1,247 ac (505 ha) of State land at Honanana Gulch on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta*, *Cyanea asplenifolia*, and *Pteris lidgatei*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 3 is not known to be occupied by the plants *Alectryon macrococcus*,

Asplenium dielerectum, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 4 (and) *Palmeria dolei*—Unit 5—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 5— Lowland Wet This area consists of 864 ac (350 ha) of State land at Kahakuloa Valley on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta* and *Cyanea asplenifolia*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 4 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 5 (and) *Palmeria dolei*—Unit 6—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 6— Lowland Wet This area consists of 30 ac (12 ha) of State land at Iao Valley on the eastern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 5 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small

numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 6 (and) *Palmeria dolei*—Unit 7—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 7— Lowland Wet This area consists of 136 ac (55 ha) of State land at Honokowai and Wahikuli valleys on the western slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 6 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriform*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 7 (and) *Palmeria dolei*—Unit 8—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 8— Lowland Wet This area consists of 898 ac (364 ha) of State land at Olowalu Valley, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Alectryon macrococcus*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 7 is not currently occupied by the plants *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriform*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 8 (and) *Palmeria dolei*—Unit 9—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 9— Lowland Wet This area consists of 230 ac (93 ha) of State land at upper Ukumehame Gulch, on the southern slopes of west Maui. These units include the mixed herbland

and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 8 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 1 (and) *Palmeria dolei*—Unit 18—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 18—Montane Mesic This area consists of 6,593 ac (2,668 ha) of State land, 707 ac (286 ha) of privately owned land, and 3,672 ac (1,486 ha) of federally owned land (Haleakala National Park), from Kealahou to Puualae, nearly circumscribing the summit of Haleakala on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Asplenium dielerectum*, *A. peruvianum* var. *insulare*, *Clermontia lindseyana*, *Cyanea horrida*, *C. obtusa*, *Cyrtandra ferripilosa*, *C. oxybapha*, *Diplazium molokaiense*, *Geranium arboreum*, *G. multiflorum*, *Huperzia mannii*, *Melicope adscendens*, and *Neraudia sericea*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 1 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Cyanea glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. mceldowneyi*, *Phyllostegia bracteata*, *P. mannii*, *Santalum haleakalae* var. *lanaiense*, *Wikstroemia villosa*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Subalpine—Unit 1 (and) *Palmeria dolei*—Unit 24—Subalpine (and) *Pseudonestor xanthophrys*—Unit 24—Subalpine This area consists of 10,785 ac (4,365 ha) of State land, 1,622 ac (656 ha) of privately owned land, and 3,568 ac (1,444 ha) of federally owned land (Haleakala National Park), from Kanaio north to Puu Nianiau on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the subalpine ecosystem (see Table 5). They are occupied by the plants *Bidens micrantha* ssp. *kalealaha* and *Geranium arboreum*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Subalpine—Unit 1 is not known to be occupied by the plants *Argyroxiphium sandwicense* ssp.

macrocephalum, *Asplenium peruvianum* var. *insulare*, *Geranium multiflorum*, *Phyllostegia bracteata*, *Schiedea haleakalensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these subalpine species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Subalpine—Unit 2 (and) *Palmeria dolei*—Unit 25—Subalpine (and) *Pseudonestor xanthophrys*—Unit 25— Subalpine This area consists of 50 ac (20 ha) of privately owned land, and 9,836 ac (3,981 ha) of federally owned land (Haleakala National Park), from the summit north to Koolau Gap and east to Kalapawili Ridge on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the subalpine ecosystem (see Table 5). They are occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Geranium multiflorum*, and *Schiedea haleakalensis*, and by the forest bird, the akohekohe (*Palmeria dolei*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui— Subalpine—Unit 2 is not known to be occupied by the plants *Asplenium peruvianum* var. *insulare*, *Bidens micrantha* ssp. *kalealaha*, *Geranium arboreum*, *Phyllostegia bracteata*, or *Zanthoxylum hawaiiense*, or by the forest bird, the kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these subalpine species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 1 (and) *Palmeria dolei*—Unit 26—Dry Cliff (and) *Pseudonestor xanthophrys*—Unit 26— Dry Cliff This area consists of 755 ac (305 ha) of federally owned land (Haleakala National Park), from Pakaoao to Koolau Gap on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). Although Maui—Dry Cliff— Unit 1 is not known to be occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Diplazium molokaiense*, *Geranium multiflorum*, *Plantago princeps*, or *Schiedea haleakalensis*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 2 consists of 688 ac (279 ha) of federally owned land (Haleakala National Park) from Haupaakea Peak to Kaupo Gap on east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). It is occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Geranium multiflorum*, *Plantago*

princeps, and *Schiedea haleakalensis*, and contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Dry Cliff—Unit 2 is not known to be occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, or *Diplazium molokaiense*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 3 (and) *Palmeria dolei*—Unit 27—Dry Cliff (and) *Pseudonestor xanthophrys*—Unit 27— Dry Cliff This area consists of 200 ac (81 ha) of federally owned land (Haleakala National Park) near Papaanui on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). It is occupied by the plant *Plantago princeps*, and contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Dry Cliff—Unit 3 is not currently occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Diplazium molokaiense*, *Geranium multiflorum*, or *Schiedea haleakalensis*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 4 (and) *Palmeria dolei*—Unit 28—Dry Cliff (and) *Pseudonestor xanthophrys*—Unit 28— Dry Cliff This area consists of 315 ac (127 ha) federally owned land (Haleakala National Park), along Kalapawili Ridge on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). Although Maui—Dry Cliff— Unit 4 is not currently occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Diplazium molokaiense*, *Geranium multiflorum*, *Plantago princeps*, or *Schiedea haleakalensis*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Bidens micrantha* ssp. *kalealaha* critical habitat consists of six components. Lowland dry (east Maui and Lanai), Lowland mesic (Lanai), Lowland wet (west Maui), Montane mesic (east Maui), Sub-alpine (east Maui) and Dry cliff (east Maui and Lanai). Species- specific physical or biological features are streambanks (81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: Diospyros, Myoporum, Pleomele, Santalum. Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Sicyos.

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Ecosystem: Lowland Wet. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: Acacia, Ilex, Metrosideros, Myrsine, Nestegis, Nothocestrum, Pisonia, Pittosporum, Psychotria, Sophora, Zanthoxylum. Subcanopy: Alyxia, Charpentiera, Coprosma, Dodonaea, Kadua, Labordia, Leptecophylla, Phyllostegia, Vaccinium. Understory: Ferns, Carex, Peperomia.

Ecosystem: Subalpine. Elevation: 6,500–9,800 ft (2,000–3,000 m). Annual precipitation: 15–40 in (38–100 cm). Substrate: Dry ash, sandy loam, rocky, undeveloped soils, weathered lava. Canopy: Chamaesyce, Chenopodium, Metrosideros, Myoporum, Santalum, Sophora. Subcanopy: Coprosma, Dodonaea, Dubautia, Geranium, Leptecophylla, Vaccinium, Wikstroemia. Understory: Ferns, Bidens, Carex, Deschampsia, Eragrostis, Gahnia, Luzula, Panicum, Pseudognaphalium, Sicyos, Tetramolopium.

Ecosystem: Dry Cliff. Elevation: unrestricted. Annual precipitation: <75 in (<190 cm). Substrate: >65 degree slope, rocky talus. Canopy: None. Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight

plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet

Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: *Bidens micrantha* is known to hybridize with other native *Bidens* such as *B. mautensis* (Gray) Sherff and *B. menziesii* (Gray) Sheriff, and possibly *B. conjuncta* Sheriff (Wagner et al. 1990). (USFWS, 1997)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Shrublands, forests, cliffs, and gulches (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Typically grow on sheer rock walls at elevations of 1,600-2,300 meters (5,250-7,550 feet) (USFWS, 1997)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1997)

Habitat Narrative

Adult: The original habitat of *Bidens micrantha* ssp. *kalealaha* is diverse, from open-canopy *Metrosideros*/*Acacia* *koa* forest to montane shrubland to cliff faces. All populations are growing on steep slopes, and are only accessible via rappelling. Annual precipitation is in the range of 75-150 cm (30-59 in). The substrate is comprised mostly of blocky lava flows with little or no soil development. Surviving *Bidens micrantha* ssp. *kalealaha* typically grow on sheer rock walls at elevations of 1,600-2,300 meters (5,250-7,550 feet). Associated native species include *Styphelia tameiameia*, *Coprosma montana*, *Dodonaea viscosa*, *Lysimachia remyt*, *Viola chamissoniana*, *Dubautia menziesii*, and *Dubautia platyphylla*. Associated alien species include *Holcus lanatus*,

Hypochoeris radicata, Oenothera stricta, and Sporobolus africanus (A.C. Medeiros, personal observation 1990). (USFWS, 1997)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Resiliency:

Low (inferred from USFWS, 2011)

Redundancy:

Low (inferred from USFWS, 2011)

Number of Populations:

7 (USFWS, 2011)

Population Size:

< 200 (Wild individuals), ~800 (outplanted individuals) (USFWS, 2018)

Population Narrative:

The 2011, the 5-year review for *Bidens micrantha* subsp. *kalealaha* reported seven populations on Lānaʻi and Maui that totaled between 2,252 and 2,272 individuals. In 2016, the IUCN reported that there were four subpopulations from Lānaʻi and Maui that totaled 1,500 individuals (Caraway et al. 2016).; There was one widely scattered population in Haleakalā Crater on east Maui. In 2001, 550 individuals were estimated to be between Waikāne Springs in west Kaupō Gap to the south slope above Kapalaoa Cabin. In 2004, there were three individuals in the central crater area, and in 2010 a single plant was found in eastern Kaupō Gap (Robertson 2016, in litt.). In 2011, there were at least 100 individuals along the bluffs at Kapalaoa (Haleakalā-Kahikinui) (Oppenheimer 2011, in litt.). No new population estimates have been made for Haleakalā National Park since 2011 (Robertson 2016, in litt.).; PEPP monitors 170 individuals east of Puʻukeōkea on east Maui and 20 wild individuals last observed in 2011 at Waiapaa (east Maui) (PEPP 2011). In 2009, there were approximately 75 individuals at Kanaio, and 31 individuals counted in the same area between 2010 and 2012 (Oppenheimer 2018, in litt.); About four to six individuals were observed at Kapunakea on west Maui in 2011.; After the fire at Waiapaa in 2006 (which destroyed all individuals), 20 more individuals were found in the same area by 2011 (PEPP 2011). In 2017, fewer than 50 individuals were found at Kānepuʻu on Lānaʻi (PEPP 2011). (USFWS, 2018)

Threats and Stressors

Stressor: Habitat destruction via animals (USFWS, 1997; USFWS, 2011)

Exposure:

Response:**Consequence:**

Narrative: Threats to this species include goats (*Capra hircus*), pigs (*Sus scrofa*), rats (*Rattus* spp.), and Axis deer (*Axis axis*) (Hawaii Department of Land and Natural Resources 2009; Perlman 2009; Wood 2009). Apparently this species is highly palatable to feral goats (Listing Factor C). In addition, feral goats have almost destroyed the subalpine woodland habitat of the East Maui region, particularly unfenced areas outside Haleakala National Park. Goats were not believed to be a problem at the remaining Lanai population (Bernice P. Bishop Museum 2003), but Axis deer are (Hawaii Department of Land and Natural Resources 2009). Continuing habitat destruction by feral goats and pigs are major threats to the long-term survival of *Bidens micrantha* ssp. *kalealaha*. On leeward East Maui, within the habitat of this species outside Haleakala National Park, feral goats have destroyed much of the original native vegetation, except in those areas inaccessible to them such as sheer rock faces and steep water course sides. In these areas, ridge tops and flat areas are often eroded and pasture-like, with an abundance of alien plants. *Bidens micrantha* ssp. *kalealaha*, quite conspicuous when flowering, is restricted to largely inaccessible sites. Feral goats have been functionally eliminated within the habitat of this species in Haleakala National Park. While they are no longer an immediate threat to *Bidens micrantha* ssp. *kalealaha* within the Park, the potential still exists for the ingress and reestablishment of goats. Feral pigs are also present on the leeward slopes of East Maui within the habitat of this species but outside Haleakala National Park. They pose a moderate threat to this species, but modest in comparison to that of feral goats. Cattle ranching occurs on the southern slope of Haleakala in the vicinity of *Bidens micrantha* ssp. *kalealaha* (R.W. Hobdy, personal communication 1990 in USFWS 1992a). Escaped domestic cattle pose a moderate threat to the long-term survival of this species. (USFWS, 1997; USFWS, 2011)

Stressor: Invasive plants (USFWS, 1997; USFWS, 2011; USFWS, 2018)

Exposure:**Response:****Consequence:**

Narrative: Invasive introduced plants which alter habitat and compete with *Bidens micrantha* subsp. *kalealaha* on East Maui include *Holcus lanatus* (common velvet grass), *Ageratina adenophora* (sticky snakeroot), *Sporobolus indicus* (smutgrass), *Senecio madagascariensis* (fireweed), *Oenothera stricta* (evening primrose), and *Melinis repens* (natal redtop) (Medeiros et al. 1986, 1998; Wood 2009). On Lanai, competing introduced invasive plants include *Melinis minutiflora* (molasses grass), *Lantana camara* (lantana), *Psidium guajava* (common guava), *Schinus terebinthifolius* (Christmasberry), *Cymbopogon refractus* (barbwire grass), *Asclepias physocarpa* (balloon plant), *Emilia* sp. (Flora's paintbrush), *Conyza* sp. (horseweed), and *Psidium cattleianum* (strawberry guava) (Bernice P. Bishop Museum 2003; Hawaii Department of Land and Natural Resources 2009). Competition from a variety of invasive plant species threatens *Bidens micrantha* ssp. *kalealaha*, especially in conjunction with ecosystem damage caused by ungulates. Alien plant cover within Haleakala National Park slows the recovery of this taxon; establishment of new individuals is largely limited to streambeds, talus slopes, etc., where competition with alien grasses is not intense (L. Loope, Haleakala National Park, personal observation, October 22, 1990). (USFWS, 1997; USFWS, 2011); Nonnative plant species including *Cortaderia jubata* (pampas grass), *Lantana camara* (lantana), *Melinis minutiflora* (molasses grass), *Passiflora suberosa* (huehue haole), and *Schinus terebinthifolius* (Christmas berry) compete with *Bidens micrantha* subsp. *kalealaha* for water, light, and nutrients (PEPP 2012; Robertson 2016, in litt.). The nonnative plant, *Pinus radiata* (Monterey pine), is now found inside and on the slopes

of Haleakalā Crater (Robertson 2016, in litt.). This pine species is known for its rapid growth and can quickly spread and outcompete other species for soil water and nutrients, carry wildfire, change soil chemistry, and promote growth of other nonnative plants (IUCN 2017). (USFWS, 2018)

Stressor: Climate change (USFWS, 2011; USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to *Bidens micrantha* ssp. *kalealaha*. However, current climate change models do not allow us to predict specifically what those effects, and their extent, would be for this species. Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2011); Climate change may pose a threat to this subspecies. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai'i using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The analysis by Fortini et al. (2013) was conducted at the species level, and concluded that *Bidens micrantha* is vulnerable to the impacts of climate change, with a vulnerability score of 0.45 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2018)

Stressor: Fire (USFWS, 1997; USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Fire is a major potential threat to the survival of *Bidens micrantha* ssp. *kalealaha*; a single fire could affect a significant portion of the population of *Bidens micrantha* ssp. *kalealaha* (A.C. Medeiros, personal communication 1990 in USFWS 1992a). (USFWS, 1997); Fire is reported to be a threat to *Bidens micrantha* subsp. *kalealaha* at Waiapaa Gulch and Kānepu'u Preserve on Lāna'i (Caraway et al. 2016; PEPP 2012, 2013, 2015, 2017). In 2006, fire destroyed over half the population at Waiapaa Gulch on Lāna'i, and by 2007 no plants remained (Oppenheimer 2010, in litt.). Fire can destroy dormant seeds as well as individual plants. Successive fires burn farther into native habitat and alter microclimate conditions and further alter habitat conditions to favor nonnative plants. Nonnative plants convert native plant communities to nonnative dominated plant communities D'Antonio and Vitousek 1992; Tunison et al. 2002). (USFWS, 2018)

Stressor: Drought degradation of habitat (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Drought is noted as a threat to the Waiapaa and Kānepu'u Preserve occurrences of *Bidens micrantha* subsp. *kalealaha* on Lāna'i and at the occurrences on Haleakala, east Maui (Oppenheimer 2010, in litt.; PEPP 2011, 2013, 2015, 2017; Robertson 2016, in litt.). Over the past 100 years, the Hawaiian Islands have experienced an annual decline in precipitation from just

over 9 percent, to as much as 15 percent within the last 20 years (US-NSTC 2008; Chu and Chen 2005; Diaz 2005). Drought affects plants directly by desiccation, and leads to an increase in the number of forest and brush fires (Giambelluca et al. 1991), causing a reduction of native plant cover and habitat (D'Antonio and Vitousek 1992). Recent episodes of drought have also driven deer farther into urban and forested areas in search of food, increasing their negative impacts to native vegetation from herbivory and trampling (Waring 1996, in litt; Nishibayashi 2001, in litt.). The increase in drought frequency and intensity leads to a self-perpetuating cycle of increase in cover of nonnative plants, increase in the number of fires, and an increase of erosion (US-GCRP 2009; Warren 2011). (USFWS, 2018)

Stressor: Landslides (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Landslides are reported to be a threat to *Bidens micrantha* subsp. *kalealaha* (Caraway et al. 2016). Landslides and erosion due to natural weathering or feral ungulates destabilizes substrates, damages and destroys individual plants, and alters hydrological patterns (Stearns 1985). (USFWS, 2018)

Stressor: Lack of adequate hunting regulations (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Two of the five known populations of *Bidens micrantha* subsp. *kalealaha* occur in state hunting areas. One of these, in Kānepu'u Preserve on Lāna'i, is fenced; however, any breach in the fence may lead to the loss of this population. Habitat destruction, and predation, by feral pigs, goats, and axis deer are threats to this subspecies. Public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations are at risk (DLNR 2010). (USFWS, 2018)

Stressor: Lack of adequate biosecurity legislation (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Invasion of the State of Hawai'i by invasive nonnative plant species, and destruction of habitat and competition by nonnative plants are threats to *Bidens micrantha* subsp. *kalealaha*. The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, is authorized to prevent the introduction or dissemination of animal and plant pests on all ships, aircraft, and their cargo and baggage arriving in the U.S. and its territories; however, pest species continue to enter the State. In addition, Federal import regulations do not address many species that could be pests in Hawai'i (CGAPS 2009; Ikuma et al. 2002). (USFWS, 2018)

Stressor: Hybridization impacts (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: This subspecies may hybridize with the more common *B. mauiensis* on Lānaʻi and west Maui, and may possibly hybridize with *B. conjuncta* on west Maui (Ganders and Nagata in Wagner et al. 1999), which could lead to loss of species diversity, loss of local adaptations, and loss of genetic representation of *B. micrantha* subsp. *kalealaha*. (USFWS, 2018)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1997)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)
2. Each population must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)
3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1997)

Recovery Actions:

- Construct exclosures on State lands between Kahua cabin and Pahihi. (USFWS, 1997)
- Outplant into protected sites within former range in a manner that would preserve genetic distinctiveness of populations. (USFWS, 1997)
- Monitor recovery of this taxon within upper elevation western Kaupo Gap in Haleakala National Park. (USFWS, 1997)
- Surveys and inventories—Survey to determine current status of all wild populations and for additional populations of *Bidens micrantha* subsp. *kalealaha* in areas of potentially suitable habitat. (USFWS, 2018)
- Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect individuals from the negative impacts of feral ungulates. Protect all occurrences against browsing and habitat disturbances from feral ungulates to prevent imminent extinction. (USFWS, 2018)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. Control invasive nonnative species that compete with the species around all populations. (USFWS, 2018)

- Captive propagation for genetic storage and reintroduction—Continue seed collection and propagation efforts for maintenance of genetic stock. (USFWS, 2018)
- Reintroduction and translocation—Continue reintroduction of individuals into suitable habitat within historic range that is being managed for known threats to this subspecies. (USFWS, 2018)
- Climate change adaptation strategy—Assess the modeled effects of climate change on this subspecies, and determine future landscape needed for the recovery of the subspecies. (USFWS, 2018)
- Fire monitoring and control—Develop and implement fire prevention management plans. (USFWS, 2018)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals throughout historic range to reduce impacts from nonnative plant competition, landslides, drought, and hybridization. (USFWS, 2018)
- Habitat and natural process management and restoration—Strategic planning—Continue to work with the National Park Service, the Hawai'i Division of Forestry and Wildlife, watershed partnerships, and other land managers to continue implementation of ecosystem-level restoration and management to benefit this subspecies. (USFWS, 2018)

Conservation Measures and Best Management Practices:

- Survey to determine current status of all wild and reintroduced populations. (USFWS, 2011)
- Implement seed collection for propagation and storage for all populations. (USFWS, 2011)
- Propagate for reintroduction and augmentation. (USFWS, 2011)
- Monitor and assess populations on East Maui in the Kula Forest Reserve and near Poli Poli State Park for management actions needed. (USFWS, 2011)
- Fence Lanai populations, and develop and implement fire management plans. (USFWS, 2011)
- Work with Hawaii Division of Forestry and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2011)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2011)

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SPECIES ACCOUNT: *Bidens wiebkei* (Ko`oko`olau)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/08/1992; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Bidens wiebkei, a member of the aster family (Asteraceae), is a perennial herb which is somewhat woody at the base and grows from 0.5 to 1 meters (1.6 to 3.3 feet) tall. The opposite, pinnately (consisting of many small leaflets) compound leaves are 7 to 13 cm (2.8 to 5.1 in) long and each has three to seven leaflets, 2.5 to 8 cm (1 to 3 in) long and 1 to 2.5 cm (0.4 to 1 in) wide. Flower heads are arranged on side branches in clusters of usually 10 to 30, each 1.6 to 2.5 cm (0.6 to 1 in) in diameter and comprising 4 to 6 sterile, yellow ray florets (small flowers), about 10 to 12 mm (0.5 in) long and 2 to 5 mm (0.08 to 0.2 in) wide, and 9 to 18 bisexual, yellow disk florets. Fruits are brownish-black achenes (dry, one seeded fruits), which are curved or twisted and winged and measure 6 to 9 mm (0.2 to 0.4 in) long and 0.9 to 2 mm (0.04 to 0.08 in) wide. This plant is distinguished from other *Bidens* species growing on Molokai by its erect habit and the curved or twisted, winged achenes (USFWS 1992). (USFWS, 1996)

Taxonomy

In the current treatment of the genus, Fred R. Ganders and Kenneth M. Nagata (1990) tentatively consider *B. nematocera* to be synonymous with *B. wiebkei*. (USFWS, 1996)

Current Range

Currently known in East Molokai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Bidens wiebkei* (Ko`oko`olau) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 13 critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Bidens wiebkei* includes 13 CHUs in Maui County, Hawaii (81 FR 17790-18110).

Molokai—Coastal—Unit 1 consists of 70 ac (28 ha) of privately owned land, and 54 ac (22 ha) of federally owned land (U.S. Coast Guard) at Laau Point, from Kahaiawa to Keawakalani, along the western coast of Molokai. This unit is occupied by the plant *Marsilea villosa*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 1 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*,

Ischaemum byrnei, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 2 consists of 263 ac (106 ha) of State land, and 710 ac (287 ha) of privately owned land, from Ilio Point to Kaa Gulch, along the northwestern coast of Molokai. This unit is occupied by the plant *Marsilea villosa* and includes the mixed hermland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 2 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrnei*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 3 consists of 794 ac (321 ha) of State land, and 3 ac (1 ha) of federally owned land (Kalaupapa National Historical Park), from Kahi Point to Wainene, along the north-central coast of Molokai. This unit is occupied by the plants *Pittosporum halophilum*, *Schenkia sebaeoides*, and *Tetramolopium rockii*, and includes the mixed hermland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 3 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrnei*, *Marsilea villosa*, *Peucedanum sandwicense*, or *Sesbania tomentosa*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 4 consists of 10 ac (4 ha) on Mokapu Island on the northern coast of Molokai. This area is State-owned, and is classified as a State Seabird Sanctuary. This unit is occupied by the plants *Peucedanum sandwicense* and *Pittosporum halophilum*, and includes the mixed hermland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 4 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*,

Ischaemum byrnone, *Marsilea villosa*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 5 consists of 1 ac (0.5 ha) on Huelo islet on the northern coast of Molokai. This area is State-owned, and is classified as a State Seabird Sanctuary. This unit is occupied by the plants *Brighamia rockii*, *Peucedanum sandwicense*, and *Pittosporum halophilum*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 5 is not known to be occupied by *Bidens wiebkii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrnone*, *Marsilea villosa*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 7 consists of 49 ac (20 ha) of privately owned land from Alanuihipaka Ridge to Kalanikaula, on the northeastern coast of Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). Although Molokai—Coastal—Unit 7 is not known to be occupied by *Bidens wiebkii*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrnone*, *Marsilea villosa*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 1 (and) *Palmeria dolei*—Unit 38—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 38—Lowland Wet This area consists of 2,195 ac (888 ha) of State land, and 754 ac (305 ha) of privately owned land (partly within The Nature Conservancy's Pelekunu Preserve), from Pelekunu Valley to Wailau Valley, in north-central Molokai. These units are occupied by the plant *Cyrtandra filipes*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Lowland Wet—Unit 1 is not known to be occupied by *Asplenium dielirectum*, *Bidens wiebkii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Lysimachia maxima*, *Melicope reflexa*, *Peucedanum sandwicense*,

Phyllostegia hispida, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 2 (and) *Palmeria dolei*—Unit 39—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 39— Lowland Wet This area consists of 1,356 ac (549 ha) of State land and 594 ac (241 ha) of privately owned land, from Kahanui to Pelekunu Valley, in north-central Molokai. These units are occupied by the plant *Lysimachia maxima*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Wet—Unit 2 is not known to be occupied by *Asplenium dielerectum*, *Bidens wiebkkei*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Cyrtandra filipes*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 3 consists of 94 ac (38 ha) of State land, and 3,125 ac (1,265 ha) of privately owned land, from Waiahookalo gulch to Moaula stream and Puniuohua, on eastern Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Molokai—Lowland Wet—Unit 3 is not known to be occupied by *Asplenium dielerectum*, *Bidens wiebkkei*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Cyrtandra filipes*, *Lysimachia maxima*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 1 (and) *Palmeria dolei*—Unit 40—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 40— Montane Wet This area consists of 1,545 ac (625 ha) of State land, and 1,851 ac (749 ha) of privately owned land, from the headwaters of Waialeia Stream and above Pelekunu Valley, eastward along the summit area to Mapulehu, in northcentral Molokai. These units are occupied by the plants *Bidens wiebkkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. profuga*, *Phyllostegia hispida*, and *Pteris lidgatei*,

and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Montane Wet—Unit 1 is not known to be occupied by *Adenophorus periens*, *Cyanea procera*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Melicope reflexa*, *Phyllostegia mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 41—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 41—Montane Wet This area consists of 871 ac (353 ha) of State land, and 39 ac (16 ha) of privately owned land, from Honukaupu to Olokui (between Pelekunu and Wailau valleys), in north-central Molokai. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). Although Molokai—Montane Wet—Unit 2 is not known to be occupied by *Adenophorus periens*, *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. procera*, *C. profuga*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Melicope reflexa*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Pteris lidgatei*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 3 consists of 77 ac (31 ha) of State land, and 726 ac (294 ha) of privately owned land, above the east rim of Wailau Valley on eastern Molokai. This unit is occupied by the plant *Melicope reflexa*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Montane Wet—Unit 3 is not known to be occupied by *Adenophorus periens*, *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. procera*, *C. profuga*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Pteris lidgatei*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Mesic—Unit 1 (and) *Palmeria dolei*—Unit 42—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 42— Montane Mesic This area consists of 257 ac (104 ha) of State land, and 559 ac (226 ha) of privately owned land from Kamiloloa to Makolelau in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Bidens wiebkiei*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Montane Mesic—Unit 1 is not known to be occupied by *Asplenium dielerectionum*, *Cyanea dunbariae*, *C. mannii*, *C. procera*, *C. solanacea*, *Cyperus fauriei*, *Kadua laxiflora*, *Melicope mucronulata*, *Neraudia sericea*, *Plantago princeps*, or *Stenogyne bifida*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Bidens wiebkiei* critical habitat consists of four components. Coastal (Molokai), Lowland wet (Molokai), Montane wet (Molokai) and Montane mesic (Molokai) (81 FR 17790-18110):

Ecosystem: Coastal. Elevation: <980 ft (<300 m). Annual precipitation: <20 in (<50 cm). Substrate: Well-drained, calcareous, talus slopes; dunes; weathered clay soils; ephemeral pools; mudflats. Canopy: *Hibiscus*, *Myoporum*, *Santalum*, *Scaevola*. Subcanopy: *Gossypium*, *Sida*, *Vitex*. Understory: *Eragrostis*, *Jacquemontia*, *Lyceum*, *Nama*, *Sesuvium*, *Sporobolus*, *Vigna*.

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: *Ferns*, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: *Acacia*, *Ilex*, *Metrosideros*, *Myrsine*, *Nestegis*, *Nothoecstrum*, *Pisonia*, *Pittosporum*, *Psychotria*, *Sophora*, *Zanthoxylum*. Subcanopy: *Alyxia*, *Charpentiera*, *Coprosma*, *Dodonaea*, *Kadua*, *Labordia*, *Leptecophylla*, *Phyllostegia*, *Vaccinium*. Understory: *Ferns*, *Carex*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cooki*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant

species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Breeding Season**

Adult: Includes May (USFWS, 1996)

Reproduction Narrative

Adult: This species was observed in flower during May 1982 (HHP 1 990a). (USFWS, 1996)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland, shrubland/chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 250 and 1,050 meters (USFWS, 1996)

Spatial Arrangements of the Population

Adult: Scattered (USFWS, 1996)

Habitat Narrative

Adult: This species is found in moist shrublands and forests in gulches and on ridges. Four populations of this species are scattered along steep, exposed slopes (USFWS 1992) in *Metrosideros polymorpha* (ohia) dominated mesic shrublands and forests at 250 to 1,050 meters (820 to 3,450 feet) in elevation (USFWS 1992). Other associated plant taxa include *Antidesma* (hame), *Nestegis sandwicensis* (olopua), *Pisonia* (papala kepau), and *Scaevola gaudichaudii* (naupakakuahiwi) (USFWS 1992). (USFWS, 1996; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Low (inferred from USFWS, 2011)

Redundancy:

Low (inferred from USFWS, 2011)

Number of Populations:

6 occurrences (USFWS, 2018)

Population Size:

200 plants (USFWS, 2018)

Population Narrative:

At the time of listing in 1992 there were 5 populations of no more than 60 total individuals of *Bidens wiebkei* (USFWS 1992). Currently, there are at least 7 populations with as many as 500 individuals on East Molokai. (USFWS, 2011); In 2011, there were seven populations that totaled fewer than 250 individuals on Moloka'i. Currently, there are six populations totaling fewer than 200 individuals: below Pu'ukolekole Gulch in Kamakou Preserve and extending below (50 individuals) (NTBG 2014; PEPP 2017); 10 individuals at Kumu'eli (NTBG 2014); west of Waialua (10 individuals) (PEPP 2013, 2017); Waialua below Kahawaiiki Gulch (3 individuals) (NTBG 2006; Bakutis 2006, in litt.); Lamaloa Gulch (15 individuals) (PEPP 2013, 2017); and Kua Gulch (100 individuals) (PEPP 2017). There are no new observations of the 100s of individuals at Pāpalaua east to Puahanunui (last observed in 2010) (PEPP 2010). (USFWS, 2018)

Threats and Stressors

Stressor: Ungulates (USFWS, 2011)

Exposure:

Response:**Consequence:**

Narrative: Threats to *Bidens wiebkai* are feral ungulates, including pigs (*Sus scrofa*), goats (*Capra hircus*), and deer (*Ovis montanus*), which degrade the habitat. (USFWS, 2011)

Stressor: Invasive plant species (USFWS, 2011)

Exposure:**Response:****Consequence:**

Narrative: In addition, invasive introduced plant species that alter the habitat and compete for resources include *Buddleia asiatica* (dogtail), *Acacia confusa* (Formosan koa), *Ageratum conyzoides* (billygoat weed), *Ageratina riparia* (spreading mist flower), *Andropogon virginicus* (broomsedge), *Axonopus fissifolius* (narrow-leaved carpetgrass), *Chamaecrista nictitans* (partridge pea), *Christella dentata* (downy wood fern), *Drymaria cordata* (white snow), *Hypochoeris radicata* (hairy cat's ear), *Lantana camara* (lantana), *Melinis minutiflora* (molasses grass), *Pluchea carolinensis* (fleabane), *Rubus rosifolius* (thimbleberry), *Sacciolepis indica* (Glenwood grass), *Schinus terebinthifolius* (Christmas berry), and *Setaria parviflora* (yellow foxtail). (USFWS, 2011)

Stressor: Fire (USFWS, 2011)

Exposure:**Response:****Consequence:**

Narrative: At Halawa and Makakupaia, within the Molokai Forest Reserve, *Melinis minutiflora* creates a fire hazard (USFWS 1996). Part of the Makakupaia area burned in a fire in September 2009 (Kubota 2009). (USFWS, 2011)

Stressor: Rats (USFWS, 2011)

Exposure:**Response:****Consequence:**

Narrative: Rats (*Rattus* spp.) are believed to be predators of this species (Listing Factor C) (Wood and Perlman 2002). Spittle bugs (species unknown) have been observed on other native species of *Bidens* (Listing Factor C) (H. Oppenheimer, pers. comm. 2009). (USFWS, 2011)

Stressor: Climate change (USFWS, 2011; USFWS, 2018)

Exposure:**Response:****Consequence:**

Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2011); habitat—Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai'i using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by

Fortini et al. (2013) concluded that *Bidens wiebkei* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.735 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2018)

Stressor: Landslides and erosion (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Botanists noted that landslides are a threat to individuals of *Bidens wiebkei* at Kumu'eli, below Pu'ukolekole, and Lamaloa (NTBG 2002, 2005; PEPP 2013). In addition, erosion of sea cliffs is a threat to *B. wiebkei* that occurs east of Pāpalaua (PEPP 2010). Landslides and erosion due to natural weathering destabilizes substrates, alters hydrological patterns, and damages and destroys individual plants (Stearns 1985). (USFWS, 2018)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1996)
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1996)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1996)
2. Each population must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1996)
3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1996)

Recovery Actions:

- Protect habitat and control threats. (USFWS, 1996)
- Expand existing wild populations. (USFWS, 1996)
- Conduct essential research. (USFWS, 1996)
- Develop and implement detailed monitoring plans for all species. (USFWS, 1996)
- Establish new populations as needed to reach recovery objectives. (USFWS, 1996)

- Validate and revise recovery criteria. (USFWS, 1996)
- Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect individuals from the negative impacts of feral ungulates. Protect all occurrences against browsing and habitat disturbances from feral ungulates. (USFWS, 2018)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. Control invasive nonnative species that compete with the species around all populations. (USFWS, 2018)
- Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. (USFWS, 2018)
- Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2018)
- Fire monitoring and control—Develop and implement fire prevention management plans. (USFWS, 2018)
- Predator and herbivore monitoring and control—Implement effective control methods for rodents. (USFWS, 2018)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and erosion. (USFWS, 2018)
- Alliance and partnership development—Continue to work with partners in planning and implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2018)
- Climate change adaptation strategy—Assess the modeled effects of climate change on this species, and determine future landscape needed for the recovery of the species. (USFWS, 2018)

Conservation Measures and Best Management Practices:

- Fence to exclude feral ungulates. (USFWS, 2011)
- Control introduced invasive plant species. (USFWS, 2011)
- Collect seed from all seven populations for genetic storage and reintroduction. (USFWS, 2011)
- Propagate for augmentation of smaller wild populations when threats are abated. (USFWS, 2011)
- Work with Hawaii Division of Forestry and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2011)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2011)

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

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SPECIES ACCOUNT: *Blennosperma bakeri* (Sonoma sunshine)

Species Taxonomic and Listing Information

Listing Status: Endangered; 1/2/1992; Pacific Southwest (R8)

Physical Description

Blennosperma bakeri plants are less than 30 centimeters (cm) (11.8 inches (in)) tall with alternate, linear leaves (Ornduff 1977a, Baldwin 2012). The leaves have smooth margins and are 5.1 to 15.2 cm (2.0 to 6.0 in) long with zero to five lobes (Baldwin 2012). From March to May, the plants have a butter-yellow, daisy-like flower head at the tip of each branch. Each flower head is less than 1.5 cm (0.6 in) across. The 6 to 15 outer petals are 5 to 7 millimeters (mm) (0.20 to 0.28 in) long. Occasionally the flowers may be white instead of yellow. The pollen is white. The flowers produce tapered achenes (dry, one-seeded fruits) that are 3 to 4 mm (0.12 to 0.16 in) long and have 4 to 6 sharp angles along the sides. The achenes are covered with tiny bumps and become slimy when wet giving the species one of its common names, “Baker’s sticky seed” (Ornduff 1963, Munz and Keck 1968, Ornduff 1977a, Baldwin 2012). (USFWS, 2016)

Taxonomy

Blennosperma bakeri is an annual plant in the aster family. It has been known by the scientific name *Blennosperma bakeri* (Heiser) since it was first described by Heiser (1947). Two other species are recognized in this genus; *B. nanum* (dwarf blennosperma) grows in California and *B. chilense* (Chilean blennosperma) occurs in Chile (Baldwin 2012). (USFWS, 2016)

Historical Range

Sonoma County, California. (USFWS, 2016)

Current Range

Sonoma County, California. (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (USFWS, 2016)

Lifespan

Adult: ~ 1 year (USFWS, 2016)

Dependency on Other Individuals or Species

Adult: Pollinators, such as *Andrena blennospermatis* (USFWS, 2016)

Breeding Season

Adult: March - April (USFWS, 2016)

Key Resources Needed for Breeding

Adult: Heavy fall rains, insect pollinators (USFWS, 2016)

Reproduction Narrative

Adult: Flower from March through April. The flowers of *B. bakeri* are self-incompatible, meaning that they can set seed only when fertilized by pollen from a different plant (USFWS, 2016). *Blennosperma bakeri* is an annual; its entire life cycle from seed germination to seed set is completed in a single growing season. In nature, *B. bakeri* seeds germinate in the fall following heavy rains, and the plants can grow even when submerged (Patterson et al. 1994). The most abundant native pollinator of *B. bakeri* was the solitary bee, *Andrena blennospermatis*. Other pollinators that visited *B. bakeri* included *Apis mellifera* (European honeybee), four species of generalist native bees, and syrphid flies. Under dry conditions, or in dense populations, *B. bakeri* may bear only a single flower head per plant (Patterson et al. 1994), thus producing a maximum of 15 achenes. However, when pools dry and fill repeatedly in a single growing season, each plant may produce as many as 20 flower heads (Patterson et al. 1994), with potential for 300 achenes per plant (USFWS, 2016).

Habitat Type

Adult: Wetland, aquatic (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Vernal pool, wet grassland (USFWS, 2016)

Geographic or Habitat Restraints or Barriers

Adult: Occurs < 330 ft. elevation (USFWS, 2016)

Habitat Narrative

Adult: Occurs predominantly on the Santa Rosa Plain, which is located in central Sonoma County, California, and is characterized by seasonal wetlands, predominately in the form vernal pools, and associated upland grassland habitat. Vernal pools form in depressions having a shallow, impermeable soil layer that restricts the downward movement of water. The pools have an outlet barrier that further causes ponding (CH2M Hill 1995) and may be connected and fed by shallow drainage pathways called "swales." Vernal pools generally fill during winter rains and dry in late spring or summer. "Natural" vernal pools are those that are found occurring naturally in the landscape. "Created" vernal pools are those that have been constructed in an area that was not a vernal pool in the recent past (within the last 100 to 200 years) and that is isolated from existing vernal pools (Gwin et al. 1999 and Lewis 1989). This species grows only in seasonal wetlands. (USFWS, 2016)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Dispersal mechanisms for the achenes have not been studied. However, seed dispersal of *B. nanum* var. *nanum*, a species that occupies similar habitat to *B. bakeri*, was found by Ornduff (1964) to be within a small radius of the parent plants based on the area occupied by flower-color variants. (USFWS, 2016)

Population Information and Trends**Population Trends:**

Unknown (USFWS, 2016)

Species Trends:

Decreasing (USFWS, 2016)

Number of Populations:

18 (USFWS, 2016)

Population Size:

Variable among years; < 100 to > 1.5 million (USFWS, 2016)

Population Narrative:

After listing, the number of sites with many individuals decreased, and the number with less than 10 individuals increased. The percentage of sites with fewer than 10 individuals increased by 15 percent between the time of listing and 1994 (USFWS, 2008). The most current occurrence information documents the presence of 18 extant occurrences. Populations exhibit extreme fluctuations in size among years, often varying by one or two orders of magnitude (CNDDDB 2013). Individual occurrence sizes ranged over time from fewer than 100 plants to more than 1.5 million plants (CNDDDB 2013). Collection of annual abundance data has been sporadic; therefore, determination of population trends is difficult. A 2009 study by Sloop and Ayres found that moderate genetic diversity existed among the occurrences of *Blennosperma bakeri* on the Santa Rosa Plain (USFWS, 2016).

Threats and Stressors

Stressor: Development and conversion to agriculture (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Today, the largest continuing threats to this species are urban development and land conversion to agriculture (such as vineyards) and associated agricultural activities and wastewater irrigation. The most recent estimates from the California Department of Conservation (2002) are that about 71,000 acres of Sonoma County have been converted to urban uses (Sonoma County Permit and Resource Management Department 2014). The threat of urban development to these species in the Santa Rosa Plain is expected to continue. In addition to urban development, land conversion to agriculture and associated agricultural activities has reduced occurrences of these plants (CNDDDB 2014). In 1991, at the time of the listing, approximately 34,500 acres of land were in wine grape production in Sonoma County (Sonoma County Agricultural Commissioner 1991). As of 2012, the acreage of wine grapes in Sonoma County had increased to approximately 58,400 acres (Sonoma County Agricultural Commissioner 2013). Additionally, irrigation with recycled water, a practice that began in the Santa Rosa Plain in the 1970s, has emerged as a major threat. Although the California Regional Water Quality Control Board regulations (Water Quality Control Plan for the North Coast Region) prohibit discharge of recycled water to surface waters during the summer, the regulations did not contemplate that recycled water would be used to irrigate vernal pools and other types of

seasonal wetlands (J. Short, pers. comm., 2007). Recycled water, as opposed to wastewater, is tertiary-treated (City of Santa Rosa, in litt. 2015** [comment letter]). Wastewater, however, can come from many sources including livestock waste ponds and runoff from agricultural fields (City of Santa Rosa, in litt. 2015** [comment letter]). (USFWS, 2016)

Stressor: Alteration of hydrology (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Some actions, such as runoff from irrigation or irrigation with recycled water, can result in increased water on the landscape. The vernal pool habitat may receive more water than it normally would or receive it at an inappropriate time, resulting in flooding and death of listed plant seedlings. If water from urban or agricultural runoff continues to fill pools during spring and summer months, the listed plants will disappear because they cannot tolerate permanent inundation; invasion by plant species adapted to permanent inundation will occur. Additionally, irrigation with recycled water and runoff from irrigation can contain chemicals, such as herbicides, and other nutrients (Pereira et al. 1996) that can alter the vernal pool plant community, prevent germination, or kill seedlings. Nitrogen deposition from automobile traffic may also modify habitat by increasing soil nutrients, thus posing a continuing threat to remnant habitat that might otherwise be suitable for these species. Weiss and Luth (2003, p. 1) conducted research on the effects of nitrogen deposition along a highway south of the San Franciscan peninsula in San Francisco County. They found that nitrogen deposition within 100 m to 400 m from the highway was correlated with increased nonnative grass cover within these areas, resulting in competition for space with native plants. An increase in nonnative grass cover through changed habitat conditions could threaten the three plant species by competing for soil moisture and nutrients and inhibiting successful germination. (USFWS, 2016)

Stressor: Off-highway vehicles (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Damage by off-highway vehicles was noted as a threat to *Blennosperma bakeri*. Currently, on Department-owned properties that support the listed plants, some damage to preserves from vehicle trespass does occur, but without damage to the vernal pools. The most significant damage to vernal pools from vehicles has resulted from a Mosquito Vector Control vehicle driving through the vernal pools to spray for mosquitoes during the time when the pools were wet in 2014. Disturbance to the pools included physical damage to the pools and swales from tire ruts and crushing and uprooting the plants (S. Martinelli, CDFW, in litt. 2014). The level of this threat is likely to be variable and is difficult to predict or monitor. (USFWS, 2016)

Stressor: Grazing management and thatch accumulation (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Appropriate levels of grazing may provide some control of weedy plants, reduce competition between native plants and invasive plants, and can provide some bare soil for germination of native plants, all of which may provide opportunities for native plants to germinate. Cessation of cattle grazing has been found to exacerbate the negative effects of

invasive nonnative plants on vernal pool inundation period. If grazing is removed, areas of bare soil can be quickly occupied by nonnative, invasive plants. Removal of grazing from vernal pool grasslands where grazing is the traditional land use practice may have devastating impacts on vernal pool habitat, particularly on upland habitat surrounding vernal pools (G. Cooley, in litt., 2014). For example, non-native grasses increased and native grasses decreased in vernal pools when grazing was discontinued at a site in the Southeastern Sacramento Valley, resulting in a 50 to 80 percent reduction in vernal pool inundation (Marty 2005). Since the time of listing, grazing has been removed at many locations and has resulted in thatch build-up. Anecdotal evidence supports the theory that thatch build-up of nonnative vegetation has caused a reduction in the size of extant populations of the listed plants. The Department is re-establishing appropriate grazing practices on some Department-owned lands to reduce thatch build-up and nonnative competitors to the three listed plants (e.g., Todd Road Unit Ecological Preserve). However, reintroduction of grazing may not return a site to its former condition because nonnative plants may continue to occupy the once-vacant niches. For example, harding grass (*Phalaris aquatica*), a robust, invasive perennial grass, can be present in a grazed field, and not be obvious. If grazing is removed, however, the suppressed harding grass can become vigorous and dominate the entire field within a year or two and grazing will not remove this species once it is established (G. Cooley, in litt. 2014). We recognize that there is disagreement among biologists as to the extent of the threat of inappropriate grazing on the three species. As the final rule concluded, we believe that although the effect of well-managed livestock grazing may be beneficial to vernal pool ecosystem. (USFWS, 2016)

Stressor: Loss of Genetic Diversity / Inappropriate Mixing of Populations(USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: An additional potential threat to these three plants is the disruption of normal gene flow due to population restoration efforts that may mix populations, which may cause unanticipated adverse effects such as disruption of locally adapted gene complexes and outbreeding depression (when offspring from individuals from different populations have lower health/fitness than progeny from individuals from the same population). Several sites are proposed as Preserves in the Santa Rosa Plain and include proposals to seed/inoculate created or restored vernal pools. Seed from a limited number of donor occurrences has already been used for several years to inoculate multiple created or restored sites, creating a risk of overrepresentation of a small gene pool (swamping). The threat level of this activity is unknown; however, the 2007 Programmatic Biological Opinion (Service 2007) includes measures to reduce this potential threat as well as the requirement to obtain a collection permit from the Department. (USFWS, 2016)

Stressor: Climate change (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Since the 1950s, the Northern Hemisphere has experienced warmer air temperatures and decreased snowfall (Ackerly et al. 2010, IPCC 2013). By the end of the 21st century, climate change is predicted to result in more intense precipitation events in the form of rain, increased summer continental drying, extreme weather events, and increased wildfire (Ackerly et al. 2010, IPCC 2013). However, current climate change predictions for terrestrial areas in the Northern

Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2013). Climate simulations have shown that California temperatures are likely to increase by 2.7 degrees Fahrenheit (1.5 degrees Celsius) to 8.1 degrees Fahrenheit (4.5 degrees Celsius) depending on the emissions scenario (Cayan et al. 2008). The predicted impacts on California's ecosystems projected with a high certainty include (1) higher sea level and (2) decreased suitable habitat for many terrestrial species as climate change intensifies human impacts [for example isolated patches of vernal pools can be so poorly connected with other patches that migrations required by climate change may be difficult or impossible without human intervention (Field et al. 1999)]. Climate change threatens to increase the loss of pollinators if the abundance of flowers preferred by pollinators decreases. Pollinator emergence times may also be altered by a warming climate. If this occurs, the synchrony of bloom periods and pollinator emergence could be disrupted. The loss of pollinators would further reduce the amount of seed produced by the listed plants because of the plants' limited ability to self-pollinate. Although there currently are no data available regarding changes in plant bloom periods or emergence dates of pollinators in the Santa Rosa Plain in response to climate change, Forister and Shapiro (2003) found that over a period of 31 years, warmer and drier winter conditions were associated with earlier butterfly appearance in the Central Valley of California. Although the loss of seed produced in a single year would not likely lead to the extirpation of the species, the continued reduction of the seed crop or dependence on self-pollination would reduce the seedbank, genetic variation, and the potential for population expansion. Monitoring of vernal pool ecosystems to determine effects from climate change is necessary to determine what adaptive land management practices would be the most appropriate to ensure the sustainability of vernal pool species (Pyke and Marty 2005), including *B. bakeri*, *L. burkei*, and *L. vinculans*. (USFWS 2016)

Stressor: Extirpation due to Stochastic Events, Isolated Occurrences, and Small Size of Occurrences (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Chance events constitute a serious threat to *Blennosperma bakeri*. Because the known occurrences of *B. bakeri* are limited in number and in range, the species are vulnerable to stochastic (random) events—natural but damaging environmental perturbations and catastrophes such as droughts, storm damage, disease outbreaks, and fires, from which large wide-ranging populations can generally recover, but may lead to extirpation of small isolated populations (Gilpin and Soule 1986). The majority of the remaining habitat associated with the three species is vernal pools and swales in the Santa Rosa Plain. The nature of the vernal pool and swale habitat associated with the three plants may also increase the effects of drought. Vernal pools and swales are inundated only briefly and may not fill during dry years. As a result, we consider stochastic events to be of significant concern for these species. Isolated, small occurrences may also be at risk from a decrease in reproductive rate resulting from decreasing population density. The correlation of reproductive rate with population density, called the Allee effect, may be the result of either increased density or quality of compatible mates, or increased pollination, or both (Stephens et al. 1999). In small populations, if either the plants or their pollinators decline, consequences on the reproductive output of the other may result in an extinction vortex in which each generation is more likely to go extinct (Gilpin and Soule 1986, Soule and Mills 1998). (USFWS, 2016)

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: The Service found that many existing regulatory mechanisms were not sufficient to protect plants, including section 404 of the Clean Water Act, the protections of the California Endangered Species Act, and the California Environmental Quality Act. The 1991 final rule also found that listing the plants under the Federal Endangered Species Act would provide better protection by requiring the Army Corps of Engineers (and other Federal agencies) to consult with the Service prior to final determinations on a proposed activity. (USFWS, 2016)

Stressor: Non-native invasive species (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: creating a drier habitat and facilitating the invasion of non-native upland species, may permanently change the plant community and the non-native plants may outcompete the listed species (Bauder 2000, Marty 2005, competition discussed further below). With insufficient water, the distribution of plant species that are normally found higher on the edge of the vernal pools may shift downward along the moisture gradient in response to the introduction of invasive plants that now flourish at pool edges. Non-native grasses maintain dominance at pool edges, sequestering light and soil moisture, promoting thatch build-up, and shortening inundation periods. Species strongly associated with vernal pools may disappear from shallow pools as a result of invasion by upland non-native plants. In addition, the invasive species can further alter the hydrology of the site by reducing the inundation period (Marty 2005). Reduction in inundation period is thought to be due to increased evapo-transpiration associated with dense cover of nonnative plants at the vernal pools (Marty 2005). Once non-native, invasive plants are introduced to vernal pools, competition with native species can come from several interactions including root competition (roots of one species are more efficient at absorbing moisture and nutrients from the soil) and pollination success (one species will set more seed and produce more plants). Plant size can also confer superiority when competing with smaller plants. A larger plant can shade smaller or shorter plants and seedlings, depriving them of adequate sunlight which is necessary for plant and seedling growth and survival, and in some cases necessary for seed germination (Barbour et al. 1987). (USFWS, 2016)

Recovery

Reclassification Criteria:

A/1: Eighty percent of extant, native occurrences, not protected as of December 2014, within each core area (Windsor Core Area, Alton Lane Core Area, and *Blennosperma bakeri* Southern Core Area) are permanently protected to maintain the current geographic, elevational, and ecological distribution of the species. Priority should be given to preserve isolated and/or genetically unique occurrences. (USFWS, 2016)

A/2: The following additional habitat is needed in order to downlist *B. bakeri*. New preserves protect a minimum of 50 ac in the Windsor Core Area, a minimum of 500 ac in the Alton Lane Core Area, and a minimum of 300 ac in the *Blennosperma bakeri* Southern Core Area. These preserves consist of occupied habitat that is not currently protected. The ecological integrity

(e.g., water quality, hydrology, uplands conditions) of these areas is not threatened by adverse habitat modification. Buffers between the protected habitat and incompatible land uses must be sufficient to ensure that there are no significant adverse effects to *Blennosperma bakeri*, such as changes in hydrology, or contamination by pesticides or herbicides, currently and into the foreseeable future. (USFWS, 2016)

A/3: New preserves (comprised of restored or created habitat) must be 10 ac or greater; however, preserves with native occurrences may be less than 10 ac. The preserves should be as near to new or existing preserves as possible. (USFWS, 2016)

A/4: The total new preserve acreage in core area includes no less than 175 ac of vernal pools and swales in the Alton Lane Core Area, no less than 105 ac in the *Blennosperma bakeri* Southern Core Area, and no less than 18 ac in the Windsor Core Area. However, new preserves are no more than 35 percent wetland which is based on general wetland to upland percentages. (USFWS, 2016)

A/5: Service-approved conservation and management plans that protect vernal pool habitat and upland habitat and address effects of invasive plants are developed and are being effectively implemented. (USFWS, 2016)

A/6: Service shall work with Mosquito Abatement Districts so that their practices in the core and management areas are implemented to avoid impacts to the species. (USFWS, 2016)

E/1: Native occurrences, extant as of December 2014, in (a) the Windsor Core Area, and (b) the *Blennosperma bakeri* Southern Core Area are replicated at 1:3 (quadrupled in numbers of occurrences) in permanently protected sites. Extant native occurrences in the Alton Lane Core Area are replicated at 1:2 (tripled) in permanently protected appropriate sites²⁴. Replication is accomplished by collecting seed or inoculum from a natural occurrence and planting it at additional sites. For example: collecting seed or inoculum at one site and planting it at two additional sites increases the original single occurrence to 3 occurrences (1:2); planting it at three additional sites increases the original occurrence to 4 occurrences (1:3). (USFWS, 2016)

E/2: The preserves noted in Factor A are occupied by *Blennosperma bakeri* seeds at a density of 2,500 seeds per square meter averaged over whole vernal pools and swales when measured on a 25-year moving average which includes at least one above average and one average rainfall year, and a multi-year drought. A multi-year drought is defined as a period of 3 or more years of below average local rainfall. (USFWS, 2016)

E/3: Service-approved conservation and management plans that protect vernal pool habitat and address the effects of small occurrence size, and climate change, among other threats, are developed and are being effectively implemented. (USFWS, 2016)

Delisting Criteria:

A/1: At least 90 percent of all known native occurrences of *Blennosperma bakeri* that are extant as of December 2014, have been fully protected in perpetuity. (USFWS, 2016)

A/2: 100 ac of habitat containing *Blennosperma bakeri* is preserved and appropriately managed in the Sonoma Valley Management Area. (USFWS, 2016)

E/1: In addition to replication noted in E/1 of the downlisting criteria for *Blennosperma bakeri*, all occurrences in management areas have been replicated at 1:2 at appropriate locations. Bouverie Preserve, east of the Town of Glen Ellen, may be considered as part of the Sonoma Valley Regional Park Management Area and replicated at 1:2 if *Blennosperma bakeri* is still found there. This occurrence, if not already lost, could provide important genetic diversity and thus be valuable for the recovery of the species. The occurrences in the Sonoma Valley Management Area should be replicated at 1:3. (USFWS, 2016)

E/2: All replicate occurrences from E/1 have achieved the same rates of seed density (2,500 seeds per square meter), as the core area occurrences. (USFWS, 2016)

E/3: All genetically unique and isolated unprotected sites in management areas are permanently protected in situ including: occurrences in Sonoma Valley Regional Park and the Wood Road area in the northern portion of the Alton Lane core area. Identification of some genetically unique occurrences is not yet known but will be determined during research listed in Table 6 of the Recovery Plan. (USFWS, 2016)

Recovery Actions:

- 1. Protect extant occurrences and potential habitat for *Blennosperma bakeri*. Natural areas that are known to contain species covered in this recovery plan should be protected in perpetuity through land acquisition, conservation easements, or other means. Protection of these areas will need to be followed by identification of threats and application of appropriate and adaptive management to ensure abatement of these threats. In addition to areas that currently support the species, two other types of natural areas also need to be protected or secured: areas where the endangered plants have been found in the past but not been seen recently, and that retain habitat that can be readily restored so that plants can be reintroduced successfully; and areas where the plants have not been found but are appropriate for vernal pool creation, and subsequent introduction of the endangered plants. (USFWS, 2016)
- 2. Develop a central database for survey data from all natural and created occurrences of *Blennosperma bakeri* including information on protection status. Data should include numbers of plants; area occupied by the species; presence of invasive species; site condition; land ownership; level of management; disturbance; whether the site is natural, restored, or created; and degree of genetic uniqueness. If the site has been seeded, the origin of the seed should be identified by name and location of parcel where seed was collected, location of specific pools where seed was collected, and date of seed collection. Any observations of pollinators, such as species or type of pollinator, should also be recorded. This information will serve as the current baseline for evaluating progress of the Factor A and Factor E comparative downlisting and delisting recovery criteria for each of the three plant species. This database should be updated regularly and should be available to all management agencies (USFWS, 2016). In addition, the database should track the location of source seed for sites with created occurrences (USFWS, 2019).
- 3. Collect and store seed from all occurrences of *Blennosperma bakeri*. Seed collections for each plant taxon should be representative of both population- and species-level genetic diversity; seeds should be collected from multiple plants at each occurrence. Seed collection guidelines published by the Center for Plant Conservation (1991) should be followed. Seed collection should be conducted with caution to ensure that donor populations are not

adversely affected by the collection. No more than 5 percent of the reproductive output should be removed from donor populations. Store seeds at two storage facilities certified by the Center for Plant Conservation. Seeds should be collected every 5 years to ensure that seeds in storage are viable. Permits will be required for collecting federally-listed plant seed on federal lands. (USFWS, 2016)

- 4. Survey historical locations and other potential habitat (not previously surveyed) where *Blennosperma bakeri* may occur. (USFWS, 2016)
- 5. Conduct research necessary to develop a population viability analysis for *Blennosperma bakeri*. Table 2 of the Recovery Plan lists research tasks needed for the development of a population viability analysis for all three species in the Recovery Plan. All research tasks need to be performed for each of the three species. To maximize efficiency, it may be possible to study the effects of an experimental factor on all three species in the Recovery Plan via the same experiment. (USFWS, 2016)
- 6. Conduct necessary biological research on *Limnanthes vinculans* and use results to guide recovery efforts. Table 6 of the Recovery Plan the needed research tasks for the recovery of *Blennosperma bakeri*, *Lasthenia burkei*, and *Limnanthes vinculans*. All research tasks need to be performed for each of the three species. To maximize efficiency, it may be possible to study the effects of an experimental factor on all three species via the same experiment. (USFWS, 2016)
- 7. Habitat management for *Blennosperma bakeri*. Develop adaptive management plans and implement appropriate management actions for all protected sites. Work with local agricultural commissions to track conversion of agricultural uses to vineyards or other non-suitable agricultural uses. Decrease acreage of vernal pool habitat within priority preservation and restoration areas that are subjected to altered hydrologic regimes through irrigation practices. Develop treatment protocol with mosquito abatement district to avoid impacts to listed species and vernal pool habitat during treatment. (USFWS, 2016)
- 8. Restore or create vernal wetlands, followed by reintroduction of the species per a restoration techniques white paper and a Reintroduction and Genetic Management Plan. As noted in the Factor A discussion, much of the habitat and occurrences of the three listed plants has been destroyed or fragmented by urban development and conversion to agricultural use. Restoration or creation of habitat, when appropriate, will be necessary to maintain the numbers of plants and occurrences at levels sufficient for survival of the species. Restoration and creation of vernal pool habitat has been conducted for many years in the Santa Rosa Plain for the three plants. To better understand these processes and their rates of success, a white paper and a Reintroduction and Genetic Management Plan should be developed. (USFWS, 2016)
- 9. Monitor all protected occurrences. Monitoring plans should be developed and implemented for all protected natural and replicated occurrences. Protected occurrences should be monitored annually for plant density, area occupied by the listed species, site condition, changes in hydrology, application of recycled water and wastewater, effects of grazing, invasive species, vandalism, and whether management is appropriate for the listed species' needs. The responsible party for monitoring should also keep an ongoing record of management activities and precipitation on the site, so that changes in rare plant populations can be related to changes in management activities. Monitoring efforts for co-occurring species (e.g. *Blennosperma bakeri* and *Limnanthes vinculans* at Wright Mitigation Bank) should be coordinated to increase efficiency and reduce costs. (USFWS, 2016)

- 10. Engage and educate the public about *Blennosperma bakeri* recovery. Public education and outreach is important to inform residents and land managers in the Santa Rosa Plain and other areas that support habitat for the species about the significance of the plants and the importance of management and protection of habitat for their persistence. Education and outreach activities should include: (1) develop a public outreach plan, (2) outreach to enhance public understanding of vernal wetlands in general and of imperiled vernal wetland species in particular, (3) information on regulatory responsibilities with regard to endangered species, (4) programs to encourage local interest and involvement in site stewardship, and (5) programs including conservation easements and incentive programs that are available to landowners who may have the vernal pool species on their land. (USFWS, 2016)
- 13. Agency coordination. Partner with California Department of Fish and Wildlife, Army Corps of Engineers, Regional Water Quality Control Board, Sonoma County, Marin/Sonoma Mosquito and Vector Control District, and Cities of Santa Rosa, Cotati, Rohnert Park, and Windsor to ensure resource management practices are aligned with species conservation needs. Resource management practices to be addressed include: irrigation of vernal pool habitat with recycled water and wastewater within priority preservation and restoration areas; protection of habitat buffers; stream ordinances, grading ordinances, and water quality regulations; and vineyard conversion or other agricultural conversion of areas adjacent to vernal pool habitat that contribute to hydrologic regime and/or provide upland habitat for sustaining the Sonoma County California tiger salamander. Provide legal assurances to willing landowners who implement projects that provide a net conservation benefit. (USFWS, 2016)
- Recommendation for future action: In response to the recently discovered range expansion of Sonoma sunshine, the Service recommends surveying vernal pools in Mendocino County near the recent observation of Sonoma sunshine to search for additional occurrences. (USFWS, 2019)

References

USFWS. 2019. Sonoma sunshine (*Blennosperma bakeri*), Burke's goldfields (*Lasthenia burkei*) and Sebastopol meadowfoam (*Limnanthes vincularis*)

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USFWS. 2016. Recovery Plan for the Santa Rosa Plain: *Blennosperma bakeri* (Sonoma sunshine)

Lasthenia burkei (Burke's goldfields)

Limnanthes vincularis (Sebastopol meadowfoam)

California Tiger Salamander Sonoma County Distinct Population Segment (*Ambystoma californiense*). U.S. Fish and Wildlife Service, Pacific Southwest Region, Sacramento, California. vi + 128 pp.

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

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https://ecos.fws.gov/docs/five_year_review/doc6010.pdf

SPECIES ACCOUNT: *Boltonia decurrens* (Decurrent false aster)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/14/1988; Great Lakes-Big Rivers Region (R3) (USFWS, 2016)

Physical Description

A robust, short-lived perennial herb, up to 2 m tall, that produces numerous flower heads with white or pale violet ray flowers surrounding a yellow central disk (NatureServe, 2015).

Taxonomy

Formerly classified as *Boltonia asteroides* var. *decurrens* or *B. latisquama* var. *decurrens*; now recognized as a distinct species (*B. decurrens*) by Flora of North America (2006) and Kartesz (1994), the U.S. Fish and Wildlife Service, and the Illinois and Missouri Heritage Programs (NatureServe, 2015).

Historical Range

Historical collection records reveal that *Boltonia decurrens* once occurred in almost contiguous populations along a 400 km stretch between LaSalle, Illinois and St. Louis, Missouri within the Illinois and Mississippi River floodplain. A disjunct population, reported in 1976, but not found since, is known from Cape Girardeau, MO, about 195 km down the Mississippi River from St. Louis (Schwegman and Nyboer, 1985) (NatureServe, 2015).

Current Range

The species is currently limited to disjunct populations from Woodford County, Illinois to Madison County, Illinois. In some years, ephemeral populations occur in St. Charles County, Missouri, in the area of confluence of the Mississippi and Illinois Rivers (NatureServe, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual: vegetative, sexual: self-pollination, cross-pollination (NatureServe, 2015)

Lifespan

Adult: 1 - 2+ years (USFWS, 2012)

Breeding Season

Adult: August - October (NatureServe, 2015)

Key Resources Needed for Breeding

Adult: Unshaded soil surface (NatureServe, 2015)

Reproduction Narrative

Adult: Vegetative reproduction occurs through shoots formed from a basal rosette (Smith and Keevin 1998). The species is primarily outcrossing, but some selfing occurs (Smith, 1995). Seed production is prolific with an average of ca. 50,000 seeds produced per plant (Smith & Keevin 1998; Smith, 1990). Seedling survival in the field is < 1%. However, under optimal conditions, the average plant produces 40,000 seedlings but the rate of seedling survival is low (Smith & Keevin 1998). *Boltonia decurrens* blooms from August through October throughout its range (Schwegman and Nyboer, 1985). Germination and seedling establishment do not occur where the soil surface is shaded, such as in places where natural succession has been uninterrupted for a period of 3 - 5 years. Seed germination is also inhibited by silt deposition (NatureServe, 2015). It is considered a perennial plant but also exhibits annual and biennial lifecycles (USFWS, 2012).

Habitat Type

Adult: Riparian, wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forested wetland, herbaceous wetland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Disturbance regime, preferably flooding (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Successional vegetation (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 1990)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from NatureServe, 2015)

Habitat Narrative

Adult: It colonizes periodically disturbed riverine moist soil habitats (Smith et al. 2005). In general, sites where the species is successful in reproducing sexually and maintaining a self-sustaining population are characterized by moist, sandy soil and regular disturbance, preferably periodic flooding, which maintains open areas with high light levels. Analysis of 19th-century habitat data taken from herbarium sheets indicates that natural habitat was the shores of lakes and the banks of streams, including the Illinois River. In these habitats, regular flooding prevented succession, allowing sunlight to reach the seedlings. *Boltonia decurrens* is still found in these occasional natural habitats, but it is now primarily restricted to disturbed lowland areas, where it appears to be dependent on human activities (mowing, cultivation) for survival. Although prolonged flooding by extremely turbid water can damage a population (US Fish and Wildlife Service, 1990), the species is extraordinarily flood tolerant (Stoecker, Smith and Melton, 1995) and is known to survive several months of complete inundation by relatively clear groundwater (Smith, 1990). The palustrine habitat is characterized as forested wetland and herbaceous wetland (NatureServe, 2015). As many as 11 plants have been observed to grow

from a single stem of the previous year, giving a 2-year-old wild population a definite clumped appearance (USFWS, 1990).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Achenes float and are often dispersed by flowing water (Baskin and Baskin 2002). (NatureServe, 2015).

Population Information and Trends

Population Trends:

Unknown, periodic expansion and contraction (USFWS, 2012)

Species Trends:

10 - 30% decline (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015; see current range/distribution)

Representation:

High (inferred from NatureServe, 2015)

Redundancy:

High (inferred from USFWS, 2012)

Number of Populations:

43 (USFWS, 2012)

Population Size:

1000 - 10,000 individuals (NatureServe, 2015)

Population Narrative:

Like the numbers of populations, numbers of individuals of *B. decurrens* also fluctuate greatly from year to year. Larger stands sometimes have several thousand plants in good years, occasionally exceeding 10,000. Because of the vulnerability of this species to changes in flooding regime, population number is expected to continue to fluctuate in upcoming years. The short term population trend has been relatively stable to a < 30% decline. Preliminary isozyme data developed by Thomas Ranker (University of Colorado, Boulder) from seeds collected from three populations in Illinois in 1994 indicate that there is a high level of genetic diversity (Smith, 1995). This rare species is much more variable, by all the measures examined, than most rare or geographically-restricted plant species, and is even slightly more variable than the average plant species (NatureServe, 2015). Approximately 43 populations have been discovered and monitored intermittently from 1984 to present. Due to the intermittent nature of the available data, long-term trends are not readily apparent but appear to include a periodical expansion and contraction of populations (USFWS, 2012).

Threats and Stressors

Stressor: Habitat degradation (NatureServe, 2015 and USFWS, 1990)

Exposure:

Response:

Consequence:

Narrative: *Boltonia decurrens* is threatened primarily by anthropogenic disturbance of natural habitat. Principal threats include flood-control measures; agricultural use of marginal river-bottom land; increased siltation of floodwater, which decreases light availability and prevents germination and seedling establishment; herbicide use for weed control; and marina construction (NatureServe, 2015). *Boltonia decurrens* populations may also be vulnerable to destruction by discing and herbicide use in low-lying marginal lands for crop weed control. Nearly all stands are in habitats kept open by occasional cropping (USFWS, 1990).

Stressor: Hybridization (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Preliminary allozyme research has been conducted on the potential hybridization of *B. decurrens* and a related species in the genus, *B. asteroides*. Hybridization could pose a threat to the species through decreased fertility, genetic swamping, and ecological competition from hybrid individuals (DeWoody 2011). DeWoody et.al. (2011) tested for hybridization in sympatric populations using allozyme genetic marker data. The results revealed a very low rate of hybridization and introgression, indicating that cross-pollination and hybridization may not pose an immediate threat to the species. However, higher resolution genetic testing has yet to be performed, and therefore the level of threat posed by hybridization is currently indeterminable (USFWS, 2012).

Stressor: Prolonged flooding (USFWS, 1990)

Exposure:

Response:

Consequence:

Narrative: Prolonged flooding during the growing season appears to be a limiting factor. A flood in 1981 inundated most of the unvegetated flood plain of the Illinois River with turbid flood water for an extended period during the summer. Shrubs such as *Cephalanthus occidentalis* were killed by the prolonged total inundation in some areas, and herbs were buried under heavy deposits of silt. Despite intensive searches, no *B. decurrens* was found for 2 subsequent seasons along the Illinois River. Such conditions severely limit natural reproduction and survival by *B. decurrens* (USFWS, 1990).

Recovery

Reclassification Criteria:

Not available

Delisting Criteria:

1. A basic research program to determine the requirements of a naturally reproducing population must be completed (USFWS, 2012).

2. Twelve geographically distinct self-sustaining natural or established populations of the species must be protected through purchase in fee, easement, or by cooperative management agreements (USFWS, 2012).

3. Populations must be monitored for a period of five years to determine if they are self-sustaining. Self-sustaining is defined for recovery purposes as a population which is found to be stable or expanding during the five-year monitoring period (USFWS, 2013).

Recovery Actions:

- Survey suitable habitat for additional populations (USFWS, 1990).
- Protect existing and established populations (USFWS, 1990).
- Establish new populations (USFWS, 1990).
- Conduct research on the biology of the species (USFWS, 1990).
- Monitor natural and established populations (USFWS, 1990).
- Develop and maintain public support (brochure/display) (USFWS, 1990).

Conservation Measures and Best Management Practices:

- Continue to monitor known *B. decurrens* sites and search for new populations annually, collecting GPS location and census data. Include survey efforts for *B. decurrens* in suitable habitat at the confluence of the Illinois River and Mississippi River to determine the extent of the species' southern range (USFWS, 2012).
- Finalize the draft cooperative management agreement between the ILDNR and the Service (USFWS, 2012).
- Establish a consensus among the workgroup regarding the core sub-populations that are important for the survival of the species during times of adverse hydrologic conditions. Also, normal, expected patterns of expansion and contraction of populations over time should be identified to facilitate the definition of population stability in the context of recovery (USFWS, 2012).
- Based on the results of the genetic primer research by Drs. Romano, explore genetic relationships between sub-populations and refine the metapopulation model for the species. Specifically, dispersal patterns and important source populations could be identified through microsatellite research in combination with spatial analysis (USFWS, 2012).
- Explore the phenomenon of hybridization between *B. decurrens* and *B. asteroides* using microsatellite genetic markers. Research should include a confirmation of hybridization between the two species and an analysis of the extent of hybridization in the population (USFWS, 2012).

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SPECIES ACCOUNT: *Bonamia grandiflora* (Florida bonamia)

Species Taxonomic and Listing Information

Listing Status: Threatened; 12/2/1987; Southeast Region (R4)

Physical Description

A perennial vine with appressed hairs and long prostrate stems a meter or more in length. It has a long, relatively slender tap root. The leathery sessile or subsessile leaves are up to 4 cm in length and ovate in shape. The flowers are solitary and sessile in the leaf axils. The funnel-shaped corolla is 7 to 10 cm long and 7 to 8 cm across. It has a deep blue or bluish-purple color with a white throat. The flowers open in the morning and are wilted by early afternoon (G. Romano, University of Florida, personal communication 1996). The fruits are capsules, normally containing four seeds. The seeds are smoothish, pale brown or greenish-brown, 5 to 8 mm long, and oblong (G. Romano, University of Florida, personal communication 1995). The outer face is convex, and the inner two faces are flat, forming an angle (Wunderlin et al. 1980). *B. grandiflora* is the only morning glory vine found in scrub areas with a large blue flower (Wunderlin et al. 1980), but could be confused with *Stylisma villosa*. (USFWS, 1999)

Taxonomy

Bonamia grandiflora was originally named by Asa Gray in 1880 as *Breweria grandiflora*. In 1897, Hans Hallier transferred it to the genus *Bonamia*. There have been no other taxonomic treatments of the species since then (Myint and Ward 1968). (USFWS, 1999)

Historical Range

Florida bonamia is found in herbaria with collection locations in Volusia and Marion counties south through Lake, Orange, Polk, Highlands, Hardee, and west to Hillsborough, Manatee, and Sarasota counties (Institute for Systematic Botany 2006). Of these records, three are historical (Sarasota County in 1878, Manatee County in 1916, and Volusia County in 1900) and no recent records exist. (USFWS, 2017)

Current Range

The South Florida multispecies Recovery Plan (1999) indicated that Florida bonamia was found in Charlotte, Hardee, Highlands, Hillsborough, Lake, Manatee, Marion, Orange, Osceola, and Polk counties in Florida. (USFWS, 2017)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, asexual (USFWS, 1999)

Lifespan

Adult: 3 or more years (USFWS, 1999)

Dependency on Other Individuals or Species

Adult: Insect pollinators (USFWS, 1999)

Key Resources Needed for Breeding

Adult: Fire (NatureServe, 2015)

Other Reproductive Information

Adult: Seedling survival rates are not known but are currently being investigated (G. Romano, University of Florida, personal communication 1996). Due to the nature of *Bonamia*'s growth, identifying seedlings from older individuals' stems that are actually connected to other stems below-ground can be difficult. However, it is possible to distinguish these two life phases. Hartnett and Richardson (1989) excavated several plants and found that the clumps of prostrate stems seen at the surface are all connected to a "large central and somewhat woody rootstock." They had no difficulty distinguishing such well-established older individuals from young single-stem plants that had grown from seed. According to Hartnett and Richardson (1989), fire stimulates seed production and germination as well as regrowth from clonal stems. The first season after a fire, clonal stem production is the greatest and then declines. However, seed production is greatest during the second season after a fire. The lag is probably due to the increased energy needed for regrowth following fire; seed production is postponed to conserve energy. New seed production replaces the seed banks that are often destroyed by fire. (USFWS, 1999)

Reproduction Narrative

Adult: *Bonamia grandiflora* grows for 3 or more years (50 FR 42068, Wunderlin et al. 1980), flowering from spring to summer (Small 1933). It has a mixed mating system; it is highly self-compatible, it can self-pollinate, and it can produce seeds without fertilization (G. Romano, University of Florida, personal communication 1998). Pollinators are essential, however, to ensure substantial seed production by self- as well as cross-fertilization. *Bonamia grandiflora* shows some inbreeding depression in selfed fruits and seeds but it does not appear to be enough to hinder the present populations (G. Romano, University of Florida, personal communication 1998). The seeds of *Bonamia* become dormant, but may not require dormancy to germinate, particularly if the seeds are planted immediately. Hartnett and Richardson (1989) observed that populations of this species have large seed banks of dormant seeds, mostly within 1 cm of the surface, distributed rather homogeneously, with no relation to the distribution of mature plants. The seedlings germinate throughout the summer until September. The necessity of fire for germination has not been studied; however, germination occurs on sites with sparse vegetation that have not burned recently (G. Romano, University of Florida, personal communication 1996). (USFWS, 1999)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Shrubland/chaparral (NatureServe, 2015)

Environmental Specificity

Adult: Moderate (inferred from NatureServe, 2015)

Habitat Narrative

Adult: *Bonamia grandiflora* is a scrub endemic of central Florida. All of its known populations occur within or near scrub or on the edge of scrub habitat in the white sands associated with the ancient Pleistocene dune systems of the central ridge system (Ward 1979). These sands are of the St. Lucie-Paola complex, highly porous, acidic (4.5 to 6.0) and containing few nutrients (Wunderlin et al. 1980). This substrate is associated with a sand pine scrub vegetation consisting of evergreen scrub oak (*Quercus myrtifolia* and *Q. germinata*) and sand pine (*Pinus clausa*) with openings between the trees and shrubs occupied by lichens and herbs. The openings are cleared by infrequent fires or by mechanical disturbance. *Bonamia grandiflora* is also known to live in disturbed areas near roadways and clearings caused by logging operations (50 FR 42068). This species is not found on altered soils such as the clay applied to logging roads (Miller 1989). As the scrub community reaches maturity, encroachment and shading from overstory pines and oaks cause the decline of this species as well as other associated endemics (Wunderlin et al. 1980). It seems that this species prefers an open canopy in full sunlight in order to avoid competition from the surrounding shrubs. For example, in Ocala NF, the *Bonamia* grows in a variety of growth stages of sand pine, but flowers profusely only in the open, sunny conditions of regeneration stands, and sparsely if at all in older stands. (USFWS, 1999)

Dispersal/Migration**Dependency on Other Individuals or Species for Dispersal**

Adult: Unknown

Dispersal/Migration Narrative

Adult: Dispersal occurs via biotic and abiotic factors - specific factors are unknown.

Population Information and Trends**Population Trends:**

Declining (NatureServe, 2015)

Species Trends:

Declining (USFWS, 2017)

Number of Populations:

66 (estimated) (USFWS, 2017)

Population Size:

1000 - 10,000 individuals (NatureServe, 2015)

Additional Population-level Information:

Turner et al.'s (2006) assessment included locality records over the past 20 years and more recent observations and it is not evident from this database whether Florida bonamia is still found at each of the 66 locations. Therefore, without a comprehensive range-wide survey it is not possible to evaluate the spatial distribution and trends in spatial distribution of this species. Nonetheless, it is likely that some of the historic locality records on private lands have been lost

due to habitat degradation (fire exclusion) and destruction. As a result, since its listing, the distribution of Florida bonamia has likely become more fragmented. (USFWS, 2017)

Population Narrative:

The status of Florida bonamia is largely unknown because repeated surveys have not been conducted at most known populations. However, available monitoring suggests that some populations may be in decline and others may be increasing, but this may be reflective of Florida bonamia's typical boom and subsequent decline following fire. Use of periodic prescribed fire appears to be essential in maintaining suitable habitat. Sixty-six locality records existed for Florida bonamia in 2006, but the number of extant populations is not known because recent range wide surveys have not been conducted. Twenty-five locality records occur on public lands. (USFWS, 2017)

Threats and Stressors

Stressor: Fire Suppression (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: The most pervasive threat to Florida bonamia on public land is habitat degradation due to fire suppression, although off-road vehicle use on the ONF is likely to result in adverse impacts. Florida bonamia on private lands are also threatened long-term with fire suppression, but habitat destruction is a more immediate concern in many locations. Recent range wide surveys have not been conducted for this species so evaluating threats due to fire suppression and habitat destruction is problematic because in many instances we do not know if previously identified populations still exist. Nonetheless, most land managing agencies in Florida are not able to use prescribed fire at the rates, frequency, and/or intensity needed to restore and maintain most of Florida's fire-adapted ecosystems (R. Mulholland, Florida Department of Environmental Protection, personal communication, 2007; Service 2006). Consequently, the difficulties land managing agencies currently face in implementing prescribed fires probably have resulted in the degradation of Florida bonamia habitat in some areas. Except for several privately owned conservation parcels, most other private landowners are unlikely to use habitat management techniques such as prescribed fire to maintain or enhance Florida bonamia habitat. At present, there are no incentives available that would encourage private landowners to undertake prescribed fire, especially for those who own relatively small parcels embedded in urban matrices. As a result, we believe that many locality records for Florida bonamia on nonconservation parcels in private ownership are threatened with habitat modification due to fire suppression. (USFWS, 2017)

Stressor: Urban Development (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Florida bonamia that occur on non-conservation private lands also are vulnerable to destruction due to urban development, such as construction of roads; installation of utilities and other infrastructure; and residential, commercial, and industrial construction. Florida bonamia on each private parcel is vulnerable to this threat at any time, however, we are not aware of any imminent loss of Florida bonamia due to development. (USFWS, 2017)

Stressor: Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Overutilization is not currently thought to be a significant risk factor to Florida bonamia; however, TNC reported two occasions of unauthorized plant removal on INC property since 1991 (TNC 2006). (USFWS, 2017)

Stressor: Disease or predation (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Florida bonamia may be affected by fungus, but no detailed investigations have been undertaken (Romano 1999). Insect herbivory has been observed, but it is not thought to be a significant risk to Florida bonamia (Romano 1999). (USFWS, 2017)

Stressor: Disease or predation (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Florida bonamia may be affected by fungus, but no detailed investigations have been undertaken (Romano 1999). Insect herbivory has been observed, but it is not thought to be a significant risk to Florida bonamia (Romano 1999). (USFWS, 2017)

Stressor: Inadequacy of existing regulatory mechanisms: Florida (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Existing regulatory mechanisms appear adequate to protect Florida bonamia on State and federally owned lands. Furthermore, we believe Florida bonamia on private conservation parcels are adequately protected because The Nature Conservancy would not authorize removal or destruction of Florida bonamia except for scientific or educational purposes. Even then, we anticipate that TNC would seek research permits from the Service to evaluate potential impacts resulting from proposed research or educational projects involving Florida bonamia. On private properties, Federal or State laws provide little protection for Florida bonamia. Since the majority of extant Florida bonamia populations occur on unprotected private lands, we conclude that existing regulatory mechanisms are inadequate to protect this species. e. Other natural or manmade factors affecting its continued existence: The 1999 South Florida Multi-species Recovery Plan (Service 1999) indicated that competition with non-native vegetation (e.g., cogon grass) may have been a management concern at ONF. Although ONF has an exotic vegetation management program in place, this threat is not entirely controlled and it is possible that unknown bonamia populations within the ONF may be affected by cogon grass or other exotic vegetation. We suspect that there are other locations containing Florida bonamia that also contain exotic vegetation, but we did not find current literature indicating this to be a significant management problem. (USFWS, 2017)

Recovery**Reclassification Criteria:**

Not applicable.

Delisting Criteria:

1. The species is secure in Ocala National Forest and low-intensity monitoring must continue after delisting (USFWS, 2008).
2. Secure and monitor at least three sites in Highlands county; three sites in Polk county; and at least two sites in other counties (USFWS, 2008).
3. Provide at least five years of demographic monitoring at each of the sites identified in numbers 1 and 2 (USFWS, 2008).

In South Florida: Delisting can be achieved when: (1) sites, within the historic range of *B. grandiflora*, are adequately protected from habitat loss, degradation, and fragmentation; (2) when these sites are managed to maintain the seral stage of xeric oak scrub communities to support *B. grandiflora*; and (3) when monitoring programs demonstrate that these sites support the appropriate numbers of self-sustaining populations, and those populations are stable throughout the historic range of the species. (USFWS, 1999)

Recovery Actions:

- Protect habitat through purchase and other means (including the Habitat Conservation Plan process for threatened animals in the Florida scrub habitat) (USFWS, 1996).
- Manage protected habitats (USFWS, 1996).
- Assess progress and plan post-recovery monitoring (USFWS, 1996).
- S1. Determine current distribution of *B. grandiflora*. Some portions of *B. grandiflora*'s range have been well surveyed (Ocala NF and the southern Lake Wales Ridge), yet a distribution has not been ascertained for this species. Lack of survey knowledge in much of its range makes defining distribution difficult. (USFWS, 1999)
- S2. Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- S3. Conduct research on life history characteristics of *B. grandiflora*. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species more specific biological information is needed.
- S4. Monitor existing populations of *B. grandiflora*. Develop monitoring protocol to assess population trends for *B. grandiflora*. Develop a quantitative description of the population structure of *B. grandiflora*. (USFWS, 1999)
- S5. Provide public information about *B. grandiflora*. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and

endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of *B. grandiflora* and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999) (USFWS, 1999)

- Habitat-level Recovery Actions: Prevent degradation of existing habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)
- Recommendation for Future Action from 2017 5-Year Review: Revise the recovery criteria to establish measureable goals for demographic monitoring, including but not limited to: the number of populations that should be monitored, the demographic parameters that should be measured, and the demographic performance levels/rates that should be met. (USFWS, 2017)
- Recommendation for Future Action from 2017 5-Year Review: A range wide survey should be conducted to determine the size and location of extant Florida bonamia populations and assessment of historic locality records. (USFWS, 2017)
- Recommendation for Future Action from 2017 5-Year Review: Demographic monitoring of Florida bonamia populations should be initiated on public lands. Level 2 monitoring (Menges and Gordon 1996) includes sufficient detail to evaluate trends in population status over time. (USFWS, 2017)
- Recommendation for Future Action from 2017 5-Year Review: Management activities should be implemented on public lands that contain Florida bonamia, including prescribed fire at return intervals and intensities necessary to restore and/or maintain the various xeric vegetative communities that support this species. (USFWS, 2017)
- Recommendation for Future Action from 2017 5-Year Review: An assessment of mechanical vegetation management (e.g., roller chopping, mowing, gyro-tracking, logging, and chain-saw felling) is needed to evaluate the response of Florida bonamia to various management alternatives. These data should be collected concurrently with level 2 monitoring. (USFWS, 2017)
- Recommendation for Future Action from 2017 5-Year Review: Future land acquisition or other conservation measures should be taken to protect large Florida bonamia populations on unprotected lands. Protection should target bonamia populations that are sufficiently large, or could be large if adequately managed, as to be self-sustaining and viable long-term. (USFWS, 2017)
- Recommendation for Future Action from 2017 5-Year Review: Given the relatively large number of unprotected Florida bonamia populations, efforts should be explored to encourage private landowners to conserve and manage property known to contain this species.

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SPECIES ACCOUNT: *Bonamia menziesii* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/10/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

A vine with twining branches up to 10 m (33 ft) long that are fuzzy when young. The leathery, oblong to oval leaves measure 3 to 9 cm (1.2 to 3.5 in) in length and 1 to 4-cm (0.4 to 1.6 in) in width. The upper leaf surface is usually hairless or covered with sparse hairs and the lower surface is covered with tomentose. The white to greenish funnel-shaped flowers are produced singly or in clusters of three on stalks with tiny bracts (modified leaves) at the base of each stalk. Stamens usually have glandular hairs at their bases. The flower has two styles, which are separate or partly fused. The fruits are tan or yellowish brown and contain one or two oval seeds imbedded in black pulp. This species is the only member of the genus that is endemic to the Hawaiian Islands and differs from other genera in the family by its two styles, longer stems and petioles, and rounder leaves (Wagner et al 1999; Austin 1990) (USFWS, 2016).

Taxonomy

A member of the Convolvulaceae (morning-glory) family (USFWS, 2016).

Historical Range

Historically, *Bonamia menziesii* was known from scattered locations on Kauai, the Koolau and Waianae Mountains of Oahu, several locations on Molokai, one location on west Maui, and eastern Hawaii (USFWS, 2016).

Current Range

Currently, this species is extant on Kauai, Oahu, Lanai, Maui, and Hawaii. *Bonamia menziesii* is known from many occurrences on these five islands with the largest number of extant individuals located on Kauai comprising several thousand individuals (USFWS, 2016).

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On March 18, 2003 (Revised March 30, 2016), the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Bonamia menziesii* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes nine detailed critical habitat units (CHUs), in Maui County, Hawaii (81 FR 17790-18110).

On September 18, 2012, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Bonamia menziesii* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 20 critical habitat units (CHUs), which encompass approximately 9,747 acres in Honolulu County, Hawaii (77 FR 57648-57862).

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, for *Bonamia menziesii* (68 FR 39623 - 39722).

On February 27, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Bonamia menziesii* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in Hawaii (68 FR 9116-9479).

Critical Habitat Designation

The critical habitat designation for *Bonamia menziesii* includes nine CHUs in Maui County, Hawaii with detailed unit information. There are also an unknown number of units on Lanai that contain this species (number of units is unknown because detailed unit descriptions for Lanai are not available) (81 FR 17790-18110).

Molokai—Lowland Dry—Unit 1 consists of 24 ac (10 ha) of privately owned land, in a small gulch northwest of Mahana, in west-central Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Molokai—Lowland Dry—Unit 1 is not known to be occupied by *Bonamia menziesii*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Hibiscus brackenridgei*, *Kokia cookei*, or *Sesbania tomentosa*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Dry—Unit 2 consists of 589 ac (238 ha) of State land at Kamiloloa on the southern slopes of Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Molokai—Lowland Dry—Unit 2 is not known to be occupied by *Bonamia menziesii*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Hibiscus brackenridgei*, *Kokia cookei*, or *Sesbania tomentosa*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Mesic—Unit 1 (and) *Palmeria dolei*—Unit 37—Lowland Mesic (and) *Pseudonestor xanthophrys*—Unit 37—Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Ctenitis squamigera*, *Cyanea dunbariae*, *C. mannii*, *C. profuga*, *Cyperus fauriei*, *Cyrtandra filipes*, *Gouania hillebrandii*, *Labordia triflora*, *Neraudia sericea*, *Santalum haleakalae* var. *lanaiense*, *Schiedea lydgatei*, *S. sarmentosa*, *Silene alexandri*, *S. lanceolata*, *Spermolepis hawaiiensis*, and *Zanthoxylum hawaiiense*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Lowland Mesic—Unit 1 is not known to be occupied by *Asplenium dielerectum*, *Bonamia menziesii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea procera*, *C. solanacea*, *Diplazium molokaiense*, *Festuca molokaiensis*, *Flueggea neowawraea*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Melicope mucronulata*, *M. munroi*, *M. reflexa*, *Phyllostegia haliakalae*, *P. mannii*, *P. pilosa*, *Sesbania tomentosa*, *Stenogyne bifida*, or *Vigna o-wahuensis*, or the forest birds, the akohekohe (*Palmeria*

dolei) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 2 consists of 1,851 ac (749 ha) of State land at Keokea on the southern slopes of east Maui. This unit is occupied by the plants *Bonamia menziesii*, *Canavalia pubescens*, and *Hibiscus brackenridgei*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 2 is not known to be occupied by *Alectryon macrococcus*, *Bidens micrantha* ssp. *kalealaha*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 3 consists of 188 ac (76 ha) of privately owned land, at Keauhou on the southern slopes of east Maui. This unit is occupied by the plant *Canavalia pubescens*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 3 is not known to be occupied by *Bidens micrantha* ssp. *kalealaha*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 4 consists of 1,266 ac (512 ha) of State land (including the Department of Land and Natural Resources) at Ahihi-Kinau Natural Area Reserve on the southern slopes of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Maui—Lowland Dry—Unit 4 is not currently occupied by *Bidens micrantha* ssp. *kalealaha*, *Bonamia menziesii*, *Canavalia pubescens*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*,

Nototrichium humile, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 5 (and) *Palmeria dolei*—Unit 29—Dry Cliff (and) *Pseudonestor xanthophrys*—Unit 29— Dry Cliff This area consists of 1,298 ac (525 ha) of State land, from Helu and across Olowalu to Ukumehame Gulch, on west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). They are occupied by the plant *Tetramolopium capillare*, and contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Dry Cliff—Unit 5 is not currently occupied by the plants *Bonamia menziesii*, *Diplazium molokaiense*, *Hesperomannia arbuscula*, *Isodendron pyrifolium*, *Kadua laxiflora*, or *Neraudia sericea*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 6 consists of 279 ac (113 ha) of State land along the east wall of Ukumehame Gulch on west Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). Although Maui—Dry Cliff— Unit 6 is not currently occupied by the plants *Bonamia menziesii*, *Diplazium molokaiense*, *Hesperomannia arbuscula*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Neraudia sericea*, or *Tetramolopium capillare*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 8 consists of 337 ac (137 ha) of State land along Kahakuloa ridge on the north side of west Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff— Unit 8 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their

small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat designation for *Bonamia menziesii* includes 20 CHUs in Honolulu County, Hawaii. The designated critical habitats include: Oahu - Lowland Dry - Unit 1, 2, 8, 9, 10, 11; Oahu--Lowland Mesic - Unit 1, 2, 3, 4, 5, 6, 7; Oahu - Dry cliff--Unit 1, 2, 3, 4, 6, 7a, 8 (77 FR 57648-57862).

Oahu—Lowland Dry—Unit 1 consists of 49 ac (20 ha) of State land and 53 ac (22 ha) of privately owned land in the Waianae Mountains, extending from Haili Gulch to Kawaipahai. This unit is occupied by the plants *Bidens amplexans*, *Hibiscus brackenridgei*, *Nototrichium humile*, and *Schiedea kealiae*, and includes the dry forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 4). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Lowland Dry—Unit 1 is not known to be occupied by the plants *Achyranthes splendens* var. *rotundata*, *Bonamia menziesii*, *Chamaesyce celastroides* var. *kaenana*, *Euphorbia haeleeleana*, *Gouania meyenii*, *G. vitifolia*, *Isodendron pyriformis*, *Melanthera tenuifolia*, *Neraudia angulata*, *Pleomele forbesii*, *Schiedea hookeri*, or *Spermolepis hawaiiensis*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Mesic—Unit 1 consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). This unit is occupied by the plants *Abutilon sandwicense*, *Alectryon macrococcus*, *Bonamia menziesii*, *Cenchrus agrimonoides*, *Chamaesyce herbstii*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Cyanea acuminata*, *C. calycina*, *C. grimesiana* ssp. *grimesiana*, *C. grimesiana* ssp. *obatae*, *C. longiflora*, *C. superba*, *Cyrtandra dentata*, *Delissea subcordata*, *Diellia falcata*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Euphorbia haeleeleana*, *Flueggea neowawraea*, *Hesperomannia arborescens*, *H. arbuscula*, *Hibiscus brackenridgei*, *Isodendron laurifolium*, *I. longifolium*, *Kadua degeneri*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *M. pallida*, *Neraudia angulata*, *Nototrichium humile*, *Phyllostegia kaalaensis*, *Platydesma cornuta* var. *decurrens*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Schiedea hookeri*, *S. kaalae*, *S. nuttallii*, *S. obovata*, and *Viola chamissoniana* ssp. *chamissoniana*, and includes the mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 4). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Lowland Mesic—Unit 1 is not known to be occupied by the plants *Chamaesyce celastroides* var. *kaenana*, *Cyanea pinnatifida*, *Cyperus pennatifolius*, *Diellia unisora*, *Diplazium molokaiense*, *Eugenia koolauensis*, *Gardenia mannii*, *Gouania meyenii*, *G. vitifolia*, *Kadua coriacea*, *K. parvula*, *Labordia cyrtandrae*, *Melicope saint-johnii*, *Phyllostegia hirsuta*, *P. mollis*, *P. parviflora*, *Plantago princeps*, *Sanicula maritima*, *Silene perlmannii*, *Solanum*

sandwicense, *Stenogyne kanehoana*, *Tetramolopium lepidotum* ssp. *lepidotum*, or *Urera kaalae*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 1 consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. This unit is on State land within the Pahole Natural Area Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). This unit is occupied by the plants *Alectryon macrococcus*, *Cenchrus agrimonoides*, *Chamaesyce herbstii*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Kadua degeneri*, *Plantago princeps* var. *princeps*, and *Schiedea obovata*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 1 is not currently occupied by *Abutilon sandwicense*, *Achyranthes splendens* var. *rotundata*, *Bonamia menziesii*, *Chamaesyce kuwaleana*, *Diellia falcata*, *D. unisora*, *Dubautia herbertobatae*, *Eragrostis fosbergii*, *Flueggea neowawraea*, *Gouania meyenii*, *G. vitifolia*, *Isodendron laurifolium*, *I. pyriform*, *Kadua parvula*, *Korthalsella degeneri*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *M. saint-johnii*, *Neraudia angulata*, *Nototrichium humile*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Platydesma cornuta* var. *decurrens*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Sanicula mariversa*, *Schiedea hookeri*, *S. trinervis*, *Silene lanceolata*, *S. perlmannii*, *Spermolepis hawaiiensis*, *Tetramolopium filiforme*, *T. lepidotum* ssp. *lepidotum*, or *Viola chamissoniana* ssp. *chamissoniana*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Dry—Unit 2 consists of 29 ac (12 ha) in the lowland dry ecosystem in the Waianae Mountains, on Federal land within Kaena Point State Park. This unit is occupied by the plants *Bonamia menziesii*, *Melanthera tenuifolia*, *Nototrichium humile*, and *Pleomele forbesii*, and includes the dry forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 4). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Lowland Dry—Unit 2 is not known to be occupied by the plants *Achyranthes splendens* var. *rotundata*, *Bidens amplexans*, *Chamaesyce celastroides* var. *kaenana*, *Euphorbia haeleeleana*, *Gouania meyenii*, *G. vitifolia*, *Hibiscus brackenridgei*, *Isodendron pyriform*, *Neraudia angulata*, *Schiedea hookeri*, *S. kealiae*, or *Spermolepis hawaiiensis*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Mesic—Unit 2 consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit is occupied by the plants *Abutilon sandwicense*, *Alectryon macrococcus*, *Cenchrus agrimonoides*, *Chamaesyce herbstii*, *Cyanea calycina*, *C. grimesiana* ssp. *obatae*, *Delissea subcordata*, *Diellia falcata*, *Gardenia mannii*, *Phyllostegia hirsuta*, *P. kaalaensis*, *P. mollis*, *Platydesma cornuta* var. *decurrens*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Schiedea hookeri*, *S. kaalae*, *Solanum sandwicense*, *Stenogyne kanehoana*, and *Urera kaalae*, and includes the mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 4). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Lowland Mesic—Unit 2 is not known to be occupied by the plants *Bonamia menziesii*, *Chamaesyce celastroides* var. *kaenana*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Cyanea acuminata*, *C. grimesiana* ssp. *grimesiana*, *C. longiflora*, *C. pinnatifida*, *C. superba*, *Cyperus pennatifolius*, *Cyrtandra dentata*, *Diellia unisora*, *Diplazium molokaiense*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Eugenia koolauensis*, *Euphorbia haeleeleana*, *Flueggea neowawraea*, *Gouania meyenii*, *G. vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Hibiscus brackenridgei*, *Isodendron laurifolium*, *I. longifolium*, *Kadua coriacea*, *K. degeneri*, *K. parvula*, *Labordia cyrtandrae*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *M. pallida*, *M. saint-johnii*, *Neraudia angulata*, *Nototrichium humile*, *Phyllostegia parviflora*, *Plantago princeps*, *Sanicula mariversa*, *Schiedea nuttallii*, *S. obovata*, *Silene perlmanii*, *Tetramolopium lepidotum* ssp. *lepidotum*, or *Viola chamissoniana* ssp. *chamissoniana*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 2 consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. This unit is almost entirely within the Makua Keaau Forest Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). Dry Cliff—Unit 2 is occupied by the plants *Abutilon sandwicense*, *Alectryon macrococcus*, *Dubautia herbstobatae*, *Gouania vitifolia*, *Kadua parvula*, *Lepidium arbuscula*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *Nototrichium humile*, *Peucedanum sandwicense*, *Platydesma cornuta* var. *decurrens*, *Pleomele forbesii*, *Sanicula mariversa*, *Schiedea hookeri*, *Tetramolopium filiforme*, and *Viola chamissoniana* ssp. *chamissoniana*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 2 is not currently occupied by *Achyranthes splendens* var. *rotundata*, *Bonamia menziesii*, *Cenchrus agrimonoides*, *Chamaesyce herbstii*, *C. kuwaleana*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia falcata*, *D. unisora*, *Eragrostis fosbergii*, *Flueggea neowawraea*, *Gouania meyenii*, *Isodendron laurifolium*, *I. pyriforme*, *Kadua degeneri*, *Korthalsella degeneri*, *Lipochaeta lobata* var. *leptophylla*, *Melicope saint-johnii*, *Neraudia angulata*, *Phyllostegia kaalaensis*, *Plantago princeps*, *Pteralyxia macrocarpa*, *Schiedea obovata*, *S. trinervis*, *Silene lanceolata*, *S. perlmanii*, *Spermolepis hawaiiensis*, or *Tetramolopium lepidotum*

ssp. *lepidotum*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Mesic—Unit 3 consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit is occupied by the plants *Alectryon macrococcus*, *Cenchrus agrimonioides*, *Delissea subcordata*, *Diellia falcata*, *D. unisora*, *Hesperomannia arbuscula*, *Melicope saint-johnii*, *Phyllostegia mollis*, *P. parviflora*, *Plantago princeps*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Schiedea kaalae*, *Silene perlmanii*, and *Urera kaalae*, and includes the mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Lowland Mesic—Unit 3 is not known to be occupied by the plants *Abutilon sandwicense*, *Bonamia menziesii*, *Chamaesyce celastroides* var. *kaenana*, *C. herbstii*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Cyanea acuminata*, *C. calycina*, *C. grimesiana* ssp. *grimesiana*, *C. grimesiana* ssp. *obatae*, *C. longiflora*, *C. pinnatifida*, *C. superba*, *Cyperus pennatifolius*, *Cyrtandra dentata*, *Diplazium molokaiense*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Eugenia koolauensis*, *Euphorbia haeleeleana*, *Flueggea neowawraea*, *Gardenia mannii*, *Gouania meyenii*, *G. vitifolia*, *Hesperomannia arborescens*, *Hibiscus brackenridgei*, *Isodendron laurifolium*, *I. longifolium*, *Kadua coriacea*, *K. degeneri*, *K. parvula*, *Labordia cyrtandrae*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *M. pallida*, *Neraudia angulata*, *Nototrichium humile*, *Phyllostegia hirsuta*, *P. kaalaensis*, *Platydesma cornuta* var. *decurrens*, *Sanicula mariversa*, *Schiedea hookeri*, *S. nuttallii*, *S. obovata*, *Solanum sandwicense*, *Stenogyne kanehoana*, *Tetramolopium lepidotum* ssp. *lepidotum*, or *Viola chamissoniana* ssp. *chamissoniana*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 3 consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. This unit is partially within the Waianae Kai Forest Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). This unit is occupied by the plants *Abutilon sandwicense*, *Alectryon macrococcus*, *Bonamia menziesii*, *Diellia falcata*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Flueggea neowawraea*, *Gouania meyenii*, *Isodendron laurifolium*, *Korthalsella degeneri*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *Neraudia angulata*, *Nototrichium humile*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Schiedea hookeri*, *Silene lanceolata*, *Tetramolopium filiforme*, and *Viola chamissoniana* ssp. *chamissoniana*. This unit also contains unoccupied habitat that is essential to the conservation of

these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 3 is not currently occupied by *Achyranthes splendens* var. *rotundata*, *Cenchrus agrimonoides*, *Chamaesyce herbstii*, *C. kuwaleana*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia unisora*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua degeneri*, *K. parvula*, *Melicope saint-johnii*, *Plantago princeps*, *Platydesma cornuta* var. *decurrens*, *Sanicula maritima*, *Schiedea obovata*, *S. trinervis*, *Silene perlmannii*, *Spermolepis hawaiiensis*, or *Tetramolopium lepidotum* ssp. *lepidotum*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Mesic—Unit 4 consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. This unit includes the lowland mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 4). Although Oahu—Lowland Mesic—Unit 4 is not known to be occupied by the plants *Alectryon macrococcus*, *Bonamia menziesii*, *Chamaesyce celastroides* var. *kaenana*, *Ctenitis squamigera*, *Cyanea acuminata*, *C. calycina*, *C. crispa*, *C. grimesiana* ssp. *grimesiana*, *C. lanceolata*, *C. longiflora*, *C. truncata*, *Cyrtandra dentata*, *C. polyantha*, *Delissea subcordata*, *Diellia erecta*, *D. falcata*, *Eugenia koolauensis*, *Gardenia mannii*, *Hesperomannia arborescens*, *Isodendron laurifolium*, *I. longifolium*, *Kadua coriacea*, *Labordia cyrtandrae*, *Lobelia monostachya*, *Melicope lydgatei*, *M. saint-johnii*, *Phyllostegia hirsuta*, *P. mollis*, *P. parviflora*, *Plantago princeps*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Schiedea kaalae*, *S. nuttallii*, *Solanum sandwicense*, *Tetraplasandra gymnocarpa*, or *T. lydgatei*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 4 consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. This unit is partially within the Waianae Kai Forest Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). This unit is occupied by the plants *Alectryon macrococcus*, *Chamaesyce kuwaleana*, and *Spermolepis hawaiiensis*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 4 is not currently occupied by *Abutilon sandwicense*, *Achyranthes splendens* var. *rotundata*, *Bonamia menziesii*, *Cenchrus agrimonoides*, *Chamaesyce herbstii*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia falcata*, *D. unisora*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Flueggea neowawraea*, *Gouania meyenii*, *G. vitifolia*, *Isodendron laurifolium*, *I. pyriformis*, *Kadua degeneri*, *K. parvula*, *Korthalsella degeneri*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *M. saintjohnii*, *Neraudia angulata*, *Nototrichium humile*, *Peucedanum sandwicense*, *Phyllostegia*

kaalaensis, *Plantago princeps*, *Platydesma cornuta* var. *decurrans*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Sanicula mariversa*, *Schiedea hookeri*, *S. obovata*, *S. trinervis*, *Silene lanceolata*, *S. perlmannii*, *Tetramolopium filiforme*, *T. lepidotum* ssp. *lepidotum*, or *Viola chamissoniana* ssp. *chamissoniana*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Dry—Unit 8 consists of 96 ac (40 ha) of privately owned land and 3 ac (1 ha) of State land as part of the old railroad right-of-way in the lowland dry ecosystem, at the Kalaeloa Barber's Point Harbor area. The area was occupied by *Chamaesyce skottsbergii* var. *skottsbergii* at the time the species was listed (see 47 FR 36846, August 24, 1982), although it is not currently known to be occupied by *C. skottsbergii* var. *skottsbergii*. The species was last observed on this site in 1989. However, even though the site is degraded, during two recent field surveys (November 2011 and June 2012), we verified that the area being designated contains the physical and biological features of the lowland dry ecosystem and the coral outcrop substrate that is essential for the conservation of *C. skottsbergii* var. *skottsbergii* (see Tables 4 and 5). Based on the field visits, the boundaries of the unit were revised to remove areas that were modified by construction and excavation activities, and do not contain essential features. This resulted in the reduction of the unit from the 292 ac (118 ha) that were originally proposed to the 99 ac (40 ha) that are included in this final rule. These physical and biological features are essential to the conservation of the species in this location because the conservation of the species requires reestablishment of populations of this species in areas where it once occurred. Based on our evaluation of the conservation needs for *Chamaesyce skottsbergii* var. *skottsbergii*, a plant requiring another individual for pollination (obligate-outcrosser) and living 10 years or less (short-lived perennial), we will need 7 to 8 populations containing a total of 10,000 mature individuals with at least 1,000 mature individuals per population in order to recover the species. The numbers of individuals and numbers of populations calculated for the 4 Lowland Dry units for akoko was based on our analysis (white paper) "Recovery Needs and Strategy for Akoko", June 20, 2012. This analysis incorporated data from the Recovery Plan for *C. skottsbergii* var. *skottsbergii* and *Achyranthes splendens* var. *rotundata* (1993), surveys/species reports from 1979, 1981, 1984, and 2012, the Revised Recovery Objective Guidelines as determined by the Hawaii and Pacific Plants Recovery Coordinating Committee (HPPRCC) 2011, and plant genetics information from Guerrant et al. (2004, pp. 419–441) and Neel and Cummings (2003). Currently, *Chamaesyce skottsbergii* var. *skottsbergii* is found in 2 occurrences in the lowland dry ecosystem on the Ewa Plain in southwestern Oahu, totaling approximately 200 wild individuals and 600 outplanted individuals (Guinther and Withrow 2008, pp. 6, 9–10; Whistler 2008, pp. 7–9; U.S. Navy et al. 2012, pp. 19–20). In our review of areas on the Ewa Plain where the features essential to the conservation of this species are still present, we were only able to find four sites that still had the essential features; were not already modified by construction, development, or excavation activities; were large enough to provide habitat for at least one self-sustaining population; and provided adequate distribution across the historical range of the species. To the extent that portions of this unit may not have been occupied at the time of listing, they are essential to the conservation of the species because, as discussed above, conservation of this species will require establishment of additional populations and this is one of the few suitable locations. Oahu—Lowland Dry—Unit 8 is one of four locations included in this final critical habitat designation that is essential to the conservation of *Chamaesyce skottsbergii* var.

skottsbergii. It was previously occupied by the species and still contains the features essential to its conservation, such as the unique coral outcrop substrate. Oahu—Lowland Dry—Unit 8 may be able to provide for two separate populations of *C. skottsbergii* var. *skottsbergii*. A designation limited to areas presently occupied by the species would be inadequate to ensure the conservation of the species because the one occupied unit (only Oahu—Lowland Dry—Unit 11, see below, is occupied by wild individuals; Oahu—Lowland Dry—Unit 9 contains outplanted, propagated individuals) would not provide enough area to support 7 to 8 populations needed for recovery, as determined in the “Recovery Needs and Strategy for *Chamaesyce skottsbergii* var. *skottsbergii* (Ewa Plains akoko)” (Service 2012, entire). There are no other geographic areas that are both undeveloped and contain the species-specific PCE of coral outcrop substrate. Oahu—Lowland Dry—Unit 8 is not known to be occupied by *Bidens amplexans*, one of the plants being listed in this rule as endangered. However, we have determined the lands within this unit are essential for the conservation of this lowland dry species, because they provide the habitat necessary for the reestablishment of wild populations within the historical ranges of the species (see Table 4). Due to their small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Additionally, Oahu—Lowland Dry—Unit 8 was not occupied by the endangered plants *Achyranthes splendens* var. *rotundata*, *Bonamia menziesii*, *Chamaesyce celastroides* var. *kaenana*, *Euphorbia haelealeana*, *Gouania meyenii*, *G. vitifolia*, *Hibiscus brackenridgei*, *Isodendron pyriformis*, *Melanthera tenuifolia*, *Neraudia angulata*, *Nototrichium humile*, *Schiedea hookeri*, *S. kealiae*, or *Spermolepis hawaiiensis* (see 51 FR 10518, March 26, 1986, and 68 FR 35950, June 17, 2003, for previous Federal actions), at the time they were listed, and is not currently known to be occupied by these 14 species. However, we have determined the lands within this unit are essential for the conservation of these lowland dry species, because they provide the habitat necessary for the reestablishment of wild populations within the historical ranges of the species (see Table 4). Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Mesic—Unit 5 consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. This unit includes the mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 4). Although Oahu—Lowland Mesic—Unit 5 is not known to be occupied by the plants *Alectryon macrococcus*, *Bonamia menziesii*, *Chamaesyce celastroides* var. *kaenana*, *Ctenitis squamigera*, *Cyanea acuminata*, *C. calycina*, *C. crispa*, *C. grimesiana* ssp. *grimesiana*, *C. lanceolata*, *C. longiflora*, *C. truncata*, *Cyrtandra dentata*, *C. polyantha*, *Delissea subcordata*, *Diellia erecta*, *D. falcata*, *Eugenia koolauensis*, *Gardenia mannii*, *Hesperomannia arborescens*, *Isodendron laurifolium*, *I. longifolium*, *Kadua coriacea*, *Labordia cyrtandrae*, *Lobelia monostachya*, *Melicope lydgatei*, *M. saint-johnii*, *Phyllostegia hirsuta*, *P. mollis*, *P. parviflora*, *Plantago princeps*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Schiedea kaalae*, *S. nuttallii*, *Solanum sandwicense*, *Tetraplasandra gymnocarpa*, or *T. lydgatei*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 6 consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). The unit is occupied by the plants *Cenchrus agrimonoides*, *Diellia unisora*, *Flueggea neowawraea*, *Lepidium arbuscula*, *Lobelia niihauensis*, *Melicope saintjohnii*, *Neraudia angulata*, *Plantago princeps*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, and *Tetramolopium lepidotum* ssp. *lepidotum*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 6 is not currently occupied by *Abutilon sandwicense*, *Achyranthes splendens* var. *rotundata*, *Alectryon macrococcus*, *Bonamia menziesii*, *Chamaesyce herbstii*, *C. kuwaleana*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia falcata*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Gouania meyenii*, *G. vitifolia*, *Isodendron laurifolium*, *I. pyrifolium*, *Kadua degeneri*, *K. parvula*, *Korthalsella degeneri*, *Lipochaeta lobata* var. *leptophylla*, *Melanthera tenuifolia*, *Melicope makahae*, *Nototrichium humile*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Platydesma cornuta* var. *decurrens*, *Sanicula mariversa*, *Schiedea hookeri*, *S. obovata*, *S. trinervis*, *Silene lanceolata*, *S. perlmanii*, *Spermolepis hawaiiensis*, *Tetramolopium filiforme*, or *Viola chamissoniana* ssp. *chamissoniana*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Dry—Unit 9 consists of 17 ac (7 ha) of City and County land, 3 ac (1 ha) of privately owned land, 1 ac (0.5 ha) of State land, and 16 ac (6 ha) of Federal (Pearl Harbor NWR) land in the lowland dry ecosystem at Kalaehoa. This unit was not occupied by *Chamaesyce skottsbergii* var. *skottsbergii* at the time the species was listed (see 47 FR 36846, August 24, 1982). As noted in the description of Oahu—Lowland Dry—Unit 8 above, we have determined that for *C. skottsbergii* var. *skottsbergii*, a plant requiring another individual for pollination (obligate-outcrosser) and living 10 years or less (short-lived perennial), we will need 7 to 8 populations containing at least a total of 10,000 mature individuals with at least 1,000 mature individuals per population in order to recover the species (HPPRCC 2011; Guerrant et al. 2004, pp. 419–441; Neel and Cummings 2003). Oahu—Lowland Dry—Unit 9 is one of the four locations included in this final critical habitat designation that is essential to the conservation of *C. skottsbergii* var. *skottsbergii*; please see discussion of the importance of these areas on the Ewa Plain, above, in the description of Oahu—Lowland Dry—Unit 8. This unit is currently occupied by recently outplanted individuals of *Chamaesyce skottsbergii* var. *skottsbergii*, and includes the dry forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland dry ecosystem, and the unique PCEs for the species *C. skottsbergii* var. *skottsbergii* (see Tables 4 and 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing populations. Oahu—Lowland Dry—Unit 9 may be able to provide for one separate population of *C. skottsbergii* var. *skottsbergii*. Oahu—Lowland Dry—Unit 9 is not known to be occupied by another plant being listed as endangered in this rule, *Bidens amplexans*. We have determined this area to be essential for the conservation and recovery of both of these lowland dry species because it provides the habitat necessary for the

reestablishment of wild populations within the historical ranges of the species (see Table 4). Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. A designation limited to areas presently occupied by the species would be inadequate because the one occupied unit (only Oahu—Lowland Dry—Unit 11, see below, is occupied by wild individuals; Oahu—Lowland Dry—Unit 9 contains outplanted, propagated individuals) would not provide enough area to support 7 to 8 populations needed for recovery, as determined in the “Recovery Needs and Strategy for *Chamaesyce skottsbergii* var. *skottsbergii* (Ewa Plains akoko)” (Service 2012, entire). There are no other geographic areas that are both undeveloped and contain the species-specific PCE of coral outcrop substrate. Additionally, Oahu—Lowland Dry—Unit 9 was not occupied by the endangered plants *Achyranthes splendens* var. *rotundata*, *Bonamia menziesii*, *Chamaesyce celastroides* var. *kaenana*, *Euphorbia haeleeleana*, *Gouania meyenii*, *G. vitifolia*, *Hibiscus brackenridgei*, *Isodendron pyriformis*, *Melanthera tenuifolia*, *Neraudia angulata*, *Nototrichium humile*, *Schiedea hookeri*, *S. kealiae*, or *Spermolepis hawaiiensis* (see 51 FR 10518, March 26, 1986 and 68 FR 35950, June 17, 2003), at the time they were listed, and is not currently known to be occupied by these 14 species. We have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species (see Table 4). Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Dry—Unit 10 consists of 43 ac (17 ha) of State land (DHHL) in the lowland dry ecosystem at Kalaeloa. This unit was not occupied by *Chamaesyce skottsbergii* var. *skottsbergii* at the time the species was listed (see 47 FR 36846, August 24, 1982); however, *C. skottsbergii* var. *skottsbergii* was observed in the area in 1998, but has not been re-observed since that time. As noted in the description of Oahu—Lowland Dry—Unit 8, above, we have determined that *C. skottsbergii* var. *skottsbergii*, a plant requiring another individual for pollination (obligate outcrosser) and living 10 years or less (short-lived perennial), we will need 7 to 8 populations containing a total of 10,000 mature individuals with at least 1,000 mature individuals per population in order to recover the species (HPPRCC 2011; Guerrant et al. 2004, pp. 419–441; Neel and Cummings 2003). Oahu—Lowland Dry—Unit 10 is one of the four locations included in this final critical habitat designation that is essential to the conservation of *C. skottsbergii* var. *skottsbergii*; please see discussion of the importance of these areas on the Ewa Plain, above, in the description of Oahu—Lowland Dry—Unit 8. This unit was previously occupied by *Chamaesyce skottsbergii* var. *skottsbergii* and still contains the features essential to its conservation, such as the unique coral outcrop substrate (see Tables 4 and 5). In the future, Oahu—Lowland Dry—Unit 10 may be able to provide for one separate population of *C. skottsbergii* var. *skottsbergii*. A designation limited to areas presently occupied by the species would be inadequate to ensure the conservation of the species, because the one occupied unit (Oahu—Lowland Dry—Unit 11) would not provide enough area to support 7 to 8 populations needed for recovery, as determined in the “Recovery Needs and Strategy for *Chamaesyce skottsbergii* var. *skottsbergii* (Ewa Plains akoko)” (Service 2012, entire). There are no other geographic areas that are both undeveloped and contain the species-specific PCE of coral outcrop substrate.

Oahu—Lowland Mesic—Unit 6 (and) Oceanic Hawaiian Damselfly—Unit 1—Lowland Mesic This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. This area is occupied by the plants *Cyanea*

acuminata, *C. crispa*, *C. truncata*, *Gardenia mannii*, *Pteralyxia macrocarpa*, and *Schiedea kaalae*; and the invertebrate, the oceanic Hawaiian damselfly. This area includes the lowland mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem, as well as unique PCEs for the damselfly (see Tables 4 and 5). Because the streams and upland foraging and cover areas required by the oceanic Hawaiian damselfly are dispersed in the lowland mesic ecosystem, the lowland mesic ecosystem's physical or biological features are essential to the damselfly because they provide for the proper ecological functioning of this ecosystem. This area also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although this area is not known to be occupied by the plants *Alectryon macrococcus*, *Bonamia menziesii*, *Chamaesyce celastroides* var. *kaenana*, *Ctenitis squamigera*, *Cyanea calycina*, *C. grimesiana* ssp. *grimesiana*, *C. lanceolata*, *C. longiflora*, *Cyrtandra dentata*, *C. polyantha*, *Delissea subcordata*, *Diellia erecta*, *D. falcata*, *Eugenia koolauensis*, *Hesperomannia arborescens*, *Isodendron laurifolium*, *I. longifolium*, *Kadua coriacea*, *Labordia cyrtandrae*, *Lobelia monostachya*, *Melicope lydgatei*, *M. saint-johnii*, *Phyllostegia hirsuta*, *P. mollis*, *P. parviflora*, *Plantago princeps*, *Pleomele forbesii*, *Schiedea nuttallii*, *Solanum sandwicense*, *Tetraplasandra gymnocarpa*, or *T. lydgatei*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 7a consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4), and is occupied by the plants *Flueggea neowawraea*, *Kadua parvula*, *Melicope saint-johnii*, *Plantago princeps*, *Platydesma cornuta* var. *decurrens*, *Pleomele forbesii*, *Silene perlmannii*, and *Viola chamissoniana* ssp. *chamissoniana*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 7a is not currently occupied by *Abutilon sandwicense*, *Achyranthes splendens* var. *rotundata*, *Alectryon macrococcus*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Chamaesyce herbstii*, *C. kuwaleana*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia falcata*, *D. unisora*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Gouania meyenii*, *G. vitifolia*, *Isodendron laurifolium*, *I. pyriformis*, *Kadua degeneri*, *Korthalsella degeneri*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *Neraudia angulata*, *Nototrichium humile*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Pteralyxia macrocarpa*, *Sanicula mariversa*, *Schiedea hookeri*, *S. obovata*, *S. trinervis*, *Silene lanceolata*, *Spermolepis hawaiiensis*, *Tetramolopium filiforme*, or *T. lepidotum* ssp. *lepidotum*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Dry Cliff—Unit 7b consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the

rim of Lualualei Valley at Palikea. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). Although Oahu—Dry Cliff—Unit 7b is not currently occupied by *Abutilon sandwicense*, *Achyranthes splendens* var. *rotundata*, *Alectryon macrococcus*, *Bonamia menziesii*, *Cenchrus agrimonoides*, *Chamaesyce herbstii*, *C. kuwaleana*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia falcata*, *D. unisora*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Flueggea neowawraea*, *Gouania meyenii*, *G. vitifolia*, *Isodendrion laurifolium*, *I. pyriformis*, *Kadua degeneri*, *K. parvula*, *Korthalsella degeneri*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *M. saintjohnii*, *Neraudia angulata*, *Nototrichium humile*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Plantago princeps*, *Platydesma cornuta* var. *decurrens*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Sanicula mariversa*, *Schiedea hookeri*, *S. obovata*, *S. trinervis*, *Silene lanceolata*, *S. perlmanii*, *Spermolepis hawaiiensis*, *Tetramolopium filiforme*, *T. lepidotum* ssp. *lepidotum*, or *Viola chamissoniana* ssp. *chamissoniana*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Dry—Unit 10 (43 acres) is not known to be occupied by another plant being listed as endangered in this rule, *Bidens amplexans*. However, we have determined this area to be essential for the conservation and recovery of this lowland dry species, because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species (see Table 4). Due to its small numbers of individuals or low population sizes, this species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Additionally, Oahu—Lowland Dry—Unit 10 was not occupied by the endangered plants *Achyranthes splendens* var. *rotundata*, *Bonamia menziesii*, *Chamaesyce celastroides* var. *kaenana*, *Euphorbia haeleeleana*, *Gouania meyenii*, *G. vitifolia*, *Hibiscus brackenridgei*, *Isodendrion pyriformis*, *Melanthera tenuifolia*, *Neraudia angulata*, *Nototrichium humile*, *Schiedea hookeri*, *S. kealiae*, or *Spermolepis hawaiiensis* (see 51 FR 10518, March 26, 1986, and 68 FR 35950, June 17, 2003), at the time they were listed, and is not currently known to be occupied by these 14 species. We have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species (see Table 4). Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. We are aware of the planned development of the Kalaeloa Solar One and Two alternative energy facilities (DHHL 2011, in litt.) on lands within, and adjacent to, this unit. The facilities, which are independently owned and operated, are being developed for the purpose of reducing Oahu's dependence on fossil-fuel for power generation. The January 2011 Draft Environmental Assessment prepared for this project states that no Federal funding or Federal authorizations will be required to develop this facility. We are also unaware of any Federal nexus for this project. Accordingly, since a critical habitat designation only triggers a consultation under section 7(a)(2) of the Act for activities that have a Federal nexus, the designation of this unit as critical habitat is not anticipated to have an impact on this project as proposed.

Oahu—Lowland Mesic—Unit 7 consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge. This unit is occupied by the plants *Bonamia menziesii*, *Cyanea acuminata*, *C. grimesiana* ssp. *grimesiana*, *C. lanceolata*, *Cyrtandra polyantha*, *Diellia erecta*, *Lobelia monostachya*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, and *Tetraplasandra lydgatei*, and includes the mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 4). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Lowland Mesic—Unit 7 is not known to be occupied by the plants *Alectryon macrococcus*, *Chamaesyce celastroides* var. *kaenana*, *Ctenitis squamigera*, *Cyanea calycina*, *C. crispa*, *C. longiflora*, *C. truncata*, *Cyrtandra dentata*, *Delissea subcordata*, *Diellia falcata*, *Eugenia koolauensis*, *Gardenia mannii*, *Hesperomannia arborescens*, *Isodendron laurifolium*, *I. longifolium*, *Kadua coriacea*, *Labordia cyrtandrae*, *Melicope lydgatei*, *M. saint-johnii*, *Phyllostegia hirsuta*, *P. mollis*, *P. parviflora*, *Plantago princeps*, *Schiedea kaalae*, *S. nuttallii*, *Solanum sandwicense*, or *Tetraplasandra gymnocarpa*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 8 consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve. A small portion of this area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). This unit is occupied by the plants *Abutilon sandwicense*, *Bonamia menziesii*, *Flueggea neowawraea*, *Lobelia niihauensis*, *Neraudia angulata*, *Nototrichium humile*, and *Pleomele forbesii*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 8 is not currently occupied by *Achyranthes splendens* var. *rotundata*, *Alectryon macrococcus*, *Cenchrus agrimonioides*, *Chamaesyce herbstii*, *C. kuwaleana*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia falcata*, *D. unisora*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Gouania meyenii*, *G. vitifolia*, *Isodendron laurifolium*, *I. pyrifolium*, *Kadua degeneri*, *K. parvula*, *Korthalsella degeneri*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Melanthera tenuifolia*, *Melicope makahae*, *M. saint-johnii*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Plantago princeps*, *Platydesma cornuta* var. *decurrens*, *Pteralyxia macrocarpa*, *Sanicula mariversa*, *Schiedea hookeri*, *S. obovata*, *S. trinervis*, *Silene lanceolata*, *S. perlmanii*, *Spermolepis hawaiiensis*, *Tetramolopium filiforme*, *T. lepidotum* ssp. *lepidotum*, or *Viola chamissoniana* ssp. *chamissoniana*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Dry—Unit 11 consists of 166 ac (67 ha) of federal land (U.S. Navy) in the lowland dry ecosystem at Kalaeloa. The area was occupied by *Chamaesyce skottsbergii* var. *skottsbergii* at the time the species was listed (47 FR 36846, August 24, 1982), and is currently occupied by *C. skottsbergii* var. *skottsbergii*. As noted in the description of Oahu—Lowland Dry—Unit 8, above, we have determined that for *C. skottsbergii* var. *skottsbergii*, a plant requiring another individual for pollination (obligate-outcrosser) and living 10 years or less (short-lived perennial), we will need 7 to 8 populations containing a total of 10,000 mature individuals with at least 1,000 mature individuals per population in order to recover the species (HPPRCC 2011; Guerrant et al. 2004, pp. 419- 441; Neel and Cummings 2003). Oahu— Lowland Dry—Unit 11 is one of the four locations included in this final critical habitat designation that is essential to the conservation of *C. skottsbergii* var. *skottsbergii*; please see discussion of the importance of these areas on the Ewa Plain, above, in the description of Oahu—Lowland Dry—Unit 8. Oahu—Lowland Dry—Unit 11 includes the dry forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland dry ecosystem, as well as unique PCEs for *Chamaesyce skottsbergii* var. *skottsbergii* (see Tables 4 and 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the habitat necessary for the expansion of the existing wild populations. A designation limited to areas presently occupied by the species would be inadequate to ensure the conservation of the species because this occupied unit (only Oahu—Lowland Dry—Unit 11 is occupied by wild individuals; Oahu— Lowland Dry—Unit 9 (see above) contains outplanted, propagated individuals, not wild plants) would not provide enough area to support 7 to 8 populations needed for recovery, as determined in the “Recovery Needs and Strategy for *Chamaesyce skottsbergii* var. *skottsbergii* (Ewa Plains akoko)” (Service 2012, entire). There are no other geographic areas that are both undeveloped and contain the species-specific PCE of coral outcrop substrate. In the future, Lowland Dry—Unit 11 may be able to provide for three or four separate populations of *C. skottsbergii* var. *skottsbergii*. Oahu—Lowland Dry—Unit 11 is not known to be occupied by another plant being listed as endangered in this rule, *Bidens amplexans*. However, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species (see Table 4). Due to its small numbers of individuals or low population sizes, this species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Additionally, Lowland Dry—Unit 11 was not occupied by the endangered plants *Achyranthes splendens* var. *rotundata*, *Bonamia menziesii*, *Chamaesyce celastroides* var. *kaenana*, *Euphorbia haelealeana*, *Gouania meyenii*, *G. vitifolia*, *Hibiscus brackenridgei*, *Isodendron pyriformis*, *Melanthera tenuifolia*, *Neraudia angulata*, *Nototrichium humile*, *Schiedea hookeri*, *S. kealiae*, or *Spermolepis hawaiiensis* (see 51 FR 10518, March 26, 1986, and 68 FR 35950, June 17, 2003) at the time they were listed, and is not currently known to be occupied by these 14 species. We have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species (see Table 4). Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. We are aware and supportive of the efforts underway by State and the Navy, in coordination with the Service, to develop a long-term preservation or conservation plan for *Chamaesyce skottsbergii* var. *skottsbergii* within this unit. These include the development of a State of Hawaii Habitat Conservation Plan and the conditional transfer of some of the Navy lands within this unit to the Hawaii Community Development Authority (HCDA). The State of Hawaii

Endangered Species Act already prohibits the take of individual listed plants by the State or any other nonFederal entity, without State review and authorization. If the lands are transferred by the Navy, the deed will require Grantees and successors to enter into a legally binding conservation and management plan approved by the Hawaii Department of Land and Natural Resources, to ensure protection of *C. skottsbergii* var. *skottsbergii* before conveying the property (U.S. Navy 2011, in litt.), based on the species being State and federally listed. The purpose of this agreement is to ensure the use or development of the transferred property does not adversely affect *C. skottsbergii* var. *skottsbergii*, as long as the species remains listed under the Act. If the Navy lands are transferred to HCDA, a portion of the lands may be used to develop a photovoltaic alternative energy project (HCDA 2012, in litt.; HDOFAW 2012, in litt.). The HCDA plans to use a portion of the revenue generated by commercial use of HCDA property to fund the conservation actions required under a conservation management plan (U.S. Navy 2011, in litt.). The Service is committed to working with the Navy and HCDA in the development of this conservation plan, to ensure it will provide for the long-term conservation of the plant and its habitat. Because of this close coordination, and because the deed restriction stipulates that *C. skottsbergii* var. *skottsbergii* will not be adversely affected, we believe the development of the photovoltaic alternative energy project, as proposed, will not be impacted by the designation of critical habitat in this unit, and it is our intent to work with our partners to facilitate this project.

The critical habitat designation for *Bonamia menziesii* includes one unit totaling 402 acres on the island of Hawaii. The critical habitat unit is Hawaii 10—*Bonamia menziesii*—a.

Hawaii 10—*Bonamia menziesii*—a [163 ha (402 ac)]: This unit contains no named natural features and lies completely within the Kiholo watershed just above the highway. This unit, in combination with Kamehameha Schools land adjacent to the unit, provides habitat for 1 population of 300 mature, reproducing individuals of *B. menziesii* and is currently unoccupied (although the adjacent, excluded Kamehameha Schools land is occupied by 6 to 8 individuals). This unit is essential to the conservation of *B. menziesii* because it is adjacent to excluded land that supports an extant colony of this species and includes habitat that is important for the expansion of that population.

The critical habitat designation for *Bonamia menziesii* includes two CHUs in Kauai County, Hawaii (68 FR 9116-9479).

Kauai 10—*Bonamia menziesii*—a: This unit is critical habitat for *Bonamia menziesii* and is 420 ha (1,038 ac) on State (Lihue-Koloa Forest Reserve) and private land. This unit contains Kahili Summit and portions of Kanaele Swamp. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Bonamia menziesii* and is currently occupied with 25 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. It provides habitat for the westernmost range of the species and wet habitat that is unique to the Kauai populations. The habitat features contained in this unit that are essential for this species include, but are not limited to, dry, mesic, or wet *Metrosideros polymorpha*-*Cheirodendron*-*Dicranopteris* forest. This unit provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Kauai 11—*Bonamia menziesii*—b: This unit is critical habitat for *Bonamia menziesii* and is 93 ha (229 ac) on State land (Alakai Wilderness Preserve) and contains a portion of Koaie Stream and Kipalau Valley. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Bonamia menziesii* and is currently occupied with one plant. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. It provides habitat for the westernmost range of the species and wet habitat that is unique to the Kauai populations. The habitat features contained in this unit that are essential for this species include, but are not limited to, dry, mesic, or wet *Metrosideros polymorpha*-*Cheirodendron*-*Dicranopteris* forest. This unit provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Bonamia menziesii* critical habitat consists of four components. Lowland dry (east Maui), Lowland mesic (Lanai and Molokai), Dry cliff (west Maui) and Wet cliff (west Maui) (81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*. Subcanopy: *Chamaesyce*, *Dodonaea*, *Leptecophylla*, *Osteomeles*, *Psydrax*, *Scaevola*, *Wikstroemia*. Understory: *Alyxia*, *Artemisia*, *Bidens*, *Chenopodium*, *Nephrolepis*, *Peperomia*, *Sicyos*.

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<914 m). Annual precipitation: 50–75 in (127–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freyinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Ecosystem: Dry Cliff. Elevation: unrestricted. Annual precipitation: < 75 in (<190 cm). Substrate: >65 degree slope, rocky talus. Canopy: None. Subcanopy: *Antidesma*, *Chamaesyce*, *Diospyros*, *Dodonaea*. Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Schiedea*.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. Understory: *Bryophytes*, *Ferns*, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Bonamia menziesii* critical habitat consists of three components (Lowland dry, Lowland mesic and Dry cliff). Species occurs within the indicated ecosystem in the Waianae Mountain caldera complex (Lowland dry, Lowland mesic and Dry cliff). Species occurs within indicated ecosystem in the Koolau Mountain caldera complex (Lowland mesic) (77 FR 57648-57862):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, little weathered lava. Canopy: Diospyros, Myoporum, Pleomele, Santalum, Sapindes. Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Plumbago, Sicyos, Sida, Waltheria.

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<914 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Ecosystem: Dry Cliff. Elevation: unrestricted. Annual precipitation: < 75 in (<190 cm). Substrate: >65 degree slope, rocky talus. Canopy: None. Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. Understory: Bidens, Eragrostis, Melanthera, Schiedea.

The habitat features contained in this unit that are essential for this species include, but are not limited to, dry forest.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Bonamia menziesii* critical habitat consists of two components (68 FR 9116-9479):

(i) Dry, mesic, or wet *Metrosideros polymorpha*-*Cheirodendron*-*Dicranopteris* forest and containing one or more of the following native plant species: *Antidesma platyphyllum*, *Alphitonia ponderosa*, *Acacia koa*, *Cyanea* spp., *Cyrtandra pickeringii*, *Cyrtandra limahuliensis*, *Dianella sandwicensis*, *Diospyros sandwicensis*, *Dodonaea viscosa*, *Dubautia knudsenii*, *Hedyotis terminalis*, *Isodendron longifolium*, *Labordia hirtella*, *Melicope anisata*, *Melicope barbiger*, *Myoporum sandwicense*, *Nestegis sandwicensis*, *Pisonia* spp., *Pittosporum* spp., *Pouteria sandwicensis*, *Psychotria mariniana*, *Psychotria hexandra*, *Psydrax odorata*, *Sapindus oahuensis*, *Scaevola procera*, or *Syzygium sandwicensis*; and

(ii) Elevations between 566 and 1,127 m (1,858 and 3,695 ft).

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia*

var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to

reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are

essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds.

Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for these species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites;

existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species and therefore are not included in the critical habitat designations.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (NatureServe, 2015)

Reproduction Narrative

Adult: Reproduction is sexual (NatureServe, 2015).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Dry to mesic forest, rarely in wet forest (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at 490 - 2,050 ft. elevation (USFWS, 2016)

Habitat Narrative

Adult: Inhabits dry to mesic forest, rarely in wet forest (NatureServe, 2015). *Bonamia menziesii* is found on steep slopes as well as on level ground in dry to mesic forest and sometimes in wet forest, between the elevations of 150 and 625 m (490 and 2,050 ft) (USFWS, 2016).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Oahu: declining; Kauai: unknown (USFWS, 2016)

Resiliency:

Low to moderate (inferred from USFWS, 2016)

Redundancy:

Moderate to high (inferred from USFWS, 2016)

Number of Populations:

Kauai: 12+; Oahu: 12; Lanai: 3; Maui: 4 - 6; Hawaii: 1 (USFWS, 2016)

Population Size:

Kauai: > 1,000; Oahu: < 60; Lanai: ~11; Maui: 10 - 15; Hawaii: 3+ (USFWS, 2016)

Population Narrative:

Total estimate probably fewer than 1000 plants. Twenty-five current (between 1982 and 1997), sixteen historical occurrences and two with status unknown (NatureServe, 2015). At least a dozen occurrences are known from Kalalau, upper Waioli Valley, scattered across the north coast from Limahuli, Hanakapiai to Milolii, Kawaiula Valley, Hipalau Valley, Paaiki Valley, Mount Kahili, and Hono O Na Pali Natural Area Reserve on State and private land, and Wahiawa drainage on private land totaling more than 1,000 individuals. There are 12 occurrences on Oahu that total fewer than 60 plants located both the Waianae and the Koolau Mountains (U.S. Army Garrison 1999a). On Lanai, *B. menziesii* is known from three scattered occurrences: about six individuals at Kaa, two individuals on Puhielele Ridge, and four individuals at Paomai, on private land. On Maui, one occurrence of a single individual is known from private land on the western slopes of West Maui, and three to five occurrences with nine to 14 individuals are located on private and State land on East Maui. On the island of Hawaii, a single occurrence of at least three individuals is located at Kaupulehu on private land (Hawaii Natural Heritage Program 1995; Lorence and Flynn 1991; S. Perlman and K. Wood, pers. comm. 1997). Recent survey data from the island of Oahu suggests the number of individuals and occurrences is decreasing on the island. Even though there are thought to be several thousand individuals on the island of Kauai, these populations are not managed or monitored so their status is unknown (USFWS, 2016).

Threats and Stressors

Stressor: Nonnative species (NatureServe, 2015; USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Threats are from non-native weed invasion, feral pigs and goats, black-Tailed Deer, and cattle (NatureServe, 2015). An alien beetle (*Physomerus grossipes*), which has recently become established on Oahu, is potentially a significant threat to *B. menziesii* (D. Orr, pers. comm. 1999) (USFWS, 2016).

Stressor: Fire (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: There is a risk of losing a significant proportion of this species from the island of Oahu since 10 individuals of *B. menziesii* are located in the high fire risk zone (USFWS, 2016).

Recovery

Conservation Measures and Best Management Practices:

- Surveys should be conducted to identify and assess the effects of the alien beetle on this species (USFW, 2016).
- The *Bonamia menziesii* plant on the Navy's Lualualei Naval Reservation has been fenced for protection from cattle. A program of alien plant removal within the enclosure is ongoing (J. Moribe, pers. comm. 1997). Most of the *B. menziesii* at Kanepuu Preserve on Lanai are found within fenced enclosures. In addition, the Nature Conservancy of Hawaii has implemented a fuel reduction treatment strategy for the Kanepuu Preserve on Lanai that includes mowing, at least yearly, portions of the seven distinct fenced units (C. Cory, pers. comm. 1999). The Kanepuu Preserve fire protection plan is updated each year and incorporates the participation of local, State, and private agencies (A. Remec, pers. comm. 1999). It is expected that these actions may enhance conservation of the *B. menziesii* plants found there (USFWS, 2016).
- *Bonamia menziesii* has been successfully propagated at the Lyon Arboretum's micropropagation laboratories, at the Waimea Arboretum, and the National Tropical Botanical Garden (Koob 1996; M. Chapin, pers. comm. 1997; G. Koob pers. comm. 1997; D. Orr, pers. comm. 1997). Currently, approximately 25 individuals exist in cultivation (Koob 1996; M. Chapin, pers. comm. 1997; D. Orr, pers. comm. 1997). Reintroduction of cultivated individuals to the wild has not been attempted (USFWS, 2016).

References

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U.S. Fish and Wildlife Service. 2016. Endangered and Threatened Wildlife and Plants

Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

Final Rule . 81 FR 17790-18110 (March 30, 2016).

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Endangered Status for 23 Species on Oahu and Designation of Critical Habitat for 124 Species

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U.S. Fish and Wildlife Service. 2003. Endangered and Threatened Wildlife and Plants

Final Designation or Nondesignation of Critical Habitat for 95 Plant Species From the Islands of Kauai and Niihau, HI

Final Rule. 68 FR 9116-9479 (February 27, 2003).

USFWS. 2016. Status of the Species and Critical Habitat: *Bonamia menziesii* (No Common Name). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016.

SPECIES ACCOUNT: *Brickellia mosieri* (Florida brickell-bush)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/6/2014; Southeast Region (R4) (USFWS, 2015)

Physical Description

Brickellia mosieri is a perennial herb. Mature plants are 0.3–1.1 meters (m) (1.0–3.5 feet (ft)) tall, slender, erect, and branching (Chafin 2000, page numbers not applicable). Leaves are 1–3 centimeters (cm) (0.4–1.2 inches (in)) long, alternate, narrow, linear, thick, usually spreading or curved downward, entire or slightly toothed, and resin dotted. The flower heads are in loose, open clusters at the ends of branches. Disk flowers are white in small, dense heads surrounded by hairy, slightly ribbed bracts; there are no ray flowers, although long-style branches (white, sometimes brown) may appear to be rays. (USFWS, 2013)

Taxonomy

Brickellia mosieri (Family: Asteraceae) was first described by Small in 1933 as *Kuhnia mosieri*. In 1970, Long called the species *Kuhnia eupatorioides* var. *floridana*, reducing it to a variety of a more widespread species occurring in the eastern United States. In 1971, Shinnars included all members of the genus *Kuhnia* in *Brickellia* and restored the plant to species status, calling it *Brickellia mosieri* (USFWS, 2013). Kartesz (1999) lists *B. mosieri* as a synonym of *Brickellia eupatorioides* var. *floridana*. (NatureServe, 2015).

Historical Range

Brickellia mosieri is endemic to the pine rocklands of the Miami Rock Ridge in Miami-Dade County. It was historically known from central and southern Miami-Dade County from approximately Coconut Grove to Florida City, a range of approximately 45.0 km (28.0 mi), along the Miami Rock Ridge. (USFWS, 2014)

Current Range

Brickellia mosieri is currently distributed from central and southern Miami-Dade County from SW 120 St. to Florida City, suggesting its historical range has contracted at least 13.6 km (8.5 mi), or more than 30 percent. (USFWS, 2014)

Critical Habitat Designated

Yes; 9/16/2015.

Legal Description

On August 17, 2015, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective September 16, 2015) for *Brickellia mosieri* (Florida brickell-bush) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six critical habitat units (CHUs), in Florida (80 FR 49846-49886).

Critical Habitat Designation

The critical habitat designation for *Brickellia mosieri* includes six CHUs (40 sub-units) in Miami-Dade County, Florida. This species critical habitat encompasses approximately 2,624 acres (ac) (1,062 hectares (ha)). Brief descriptions are presented below. Maps depicting the CH units are available in the Final Rule. (80 FR 49846-49886).

Unit BM1: Trinity Pineland and Surrounding Areas, Miami-Dade County, Florida: Unit BM1 consists of 18 ha (43 ac) in Miami-Dade County. Within Unit BM1, there are two subunits—BM1A (Countyowned) and BM1B (combination of State, County, and privately owned lands). The unit is comprised of State lands within Trinity Pineland County Park (4 ha (10 ac)); County lands primarily within A. D. “Doug” Barnes Park (6 ha (14 ac)); and parcels in private ownership (8 ha (19 ac)). This unit is bordered on the north by SW 24 Street, on the south by the Snapper Creek Expressway (State Road (SR) 878), on the east by SW 67 Avenue, and on the west by SW 87 Avenue.

Unit BM2: Nixon Smiley Pineland Preserve and Surrounding Areas, Miami-Dade County, Florida: Unit BM2 consists of approximately 108 ha (267 ac) of habitat in MiamiDade County. Within Unit BM2, there are seven subunits (BM2A–BM2G) comprising primarily conservation lands and including four larger areas plus three smaller areas. The unit is comprised of State lands within Camp Matecumbe, Tamiami Pineland Complex Addition, and Rockdale Pineland (49 ha (121 ac)); County/local lands primarily within Nixon Smiley Pineland Preserve, Tamiami #8 (Nixon Smiley Addition) Pineland, Pine Shore Pineland Preserve, Ron Ehman Park, and Rockdale Pineland Addition (59 ha (146 ac)); and small portions of parcels in private or other ownership (less than 1 ha (less than 1 ac)). This unit is bordered on the north by SW 104 Street, on the south by SW 152 Street (Coral Reef Drive), on the east by U.S. 1 (South Dixie Highway), and on the west by SW 177 Avenue (Krome Avenue).

Unit BM3: USDA Subtropical Horticultural Research Station and Surrounding Areas, Miami-Dade County, Florida: Unit BM3 consists of approximately 127 ha (315 ac) of habitat in MiamiDade County. Within Unit BM3, there are eight subunits (BM3A–BM3H), including two larger areas (U.S. Department of Agriculture (USDA) Subtropical Horticultural Research Station, and Deering Estate at Cutler) plus six smaller areas surrounding these. The unit is comprised of Federal lands within the USDA Subtropical Horticultural Research Station (59 ha (145 ac)); State lands within the R. Hardy Matheson Preserve, Ludlam Pineland, Deering Estate at Cutler, and Deering Estate South Addition (45 ha (112 ac)); County/local lands within Coral Reef Park, Ned Glenn Nature Preserve, and Bill Sadowski Park (15 ha (38 ac)); and parcels in private ownership (8 ha (19 ac)). This unit is bordered on the north by SW 112 Street, on the south by the intersection of Old Cutler Road and Franjo Road (County Road (CR) 977), on the east by the Atlantic Ocean, and on the west by U.S. 1 (South Dixie Highway).

Unit BM4: Richmond Pinelands and Surrounding Areas, Miami-Dade County, Florida: Unit BM4 consists of approximately 395 ha (975 ac) in Miami-Dade County. Within Unit BM4, there are eight subunits (BM4A–BM4H), most within the Richmond Pinelands complex (made up of Federal and County-owned lands, as well as land owned by the University of Miami). The unit is comprised of Federal lands owned by the USCG (Homeland Security), U.S. Army Corps of Engineers (ACOE; Department of Defense), U.S. Prison Bureau (Department of Justice), and the U.S. Department of Commerce/National Oceanic and Atmospheric Administration (NOAA) (75 ha (185 ac)); County/local lands within and adjacent to Larry and Penny Thompson Park, Martinez Pineland, Zoo Miami, and Eachus Pineland (239 ha (590 ac)); and parcels in private or other ownership (81 ha (200 ac)). This unit is bordered on the north by SW 152 Street (Coral Reef Drive), on the south by SW 200 St (Quail Drive/SR 994), on the east by U.S. 1 (South Dixie Highway), and on the west by SW 177 Avenue (Krome Avenue).

Unit BM5: Quail Roost Pineland and Surrounding Areas, Miami-Dade County, Florida: Unit BM5 consists of approximately 96 ha (238 ac) in Miami-Dade County. Within Unit BM5, there are 11 subunits (BM5A–BM5K), including 4 larger areas plus 7 smaller areas surrounding these. The unit is comprised of State lands within Quail Roost Pineland, Goulds Pineland and Addition, and Silver Palm Groves Pineland (39 ha (97 ac)); County/ local lands including Black Creek Forest, Rock Pit #46, and lands owned by the School Board of Miami-Dade County (15 ha (37 ac)); and parcels in private ownership (42 ha (104 ac)), including Porter-Russell Pineland owned by the Tropical Audubon Society. This unit is bordered on the north by SW 200 St (Quail Drive/SR 994), on the south by SW 248 Street, on the east by the Florida Turnpike, and on the west by SW 194 Avenue.

Unit BM6: Camp Owaissa Bauer and Surrounding Areas, Miami-Dade County, Florida: Unit BM6 consists of approximately 112 ha (276 ac) of habitat in MiamiDade County. Within Unit BM6, there are 12 subunits (BM6A–BM6L), composed of 1 larger area (Camp Owaissa Bauer and its addition) and 11 smaller areas to the south. The unit is comprised of State lands within Owaissa Bauer Pineland Addition, Ingram Pineland, West Biscayne Pineland, and Fuchs Hammock Addition (20 ha (50 ac)); County/local lands including Camp Owaissa Bauer, Pine Island Lake Park, Seminole Wayside Park, and Northrop Pineland (63 ha (156 ac)); and parcels in private ownership (28 ha (70 ac)), including the private conservation area, Pine Ridge Sanctuary. This unit is bordered on the north by SW 248 Street, on the south by SW 312 Street, on the east by SW 112 Avenue, and on the west by SW 217 Avenue.

Unit BM7: Navy Wells Pineland Preserve and Surrounding Areas, Miami-Dade County, Florida: Unit BM7 consists of approximately 206 ha (510 ac) of habitat in MiamiDade County. Within Unit BM7, there are eight subunits (BM7A–BM7H), including one larger area (Navy Wells Pineland Preserve) and seven smaller outlying areas. The unit is comprised of State lands within Palm Drive Pineland, Navy Wells Pineland #39, Navy Wells Pineland Preserve (portion), and Florida City Pineland (53 ha (132 ac)); County/ local lands including primarily Sunny Palms Pineland and Navy Wells Pineland Preserve (portion) (125 ha (309 ac)); and parcels in private ownership (28 ha (68 ac)). This unit is bordered on the north by SW 320 Street, on the south by SW 368 Street, on the east by U.S. 1 (South Dixie Highway), and on the west by SW 217 Avenue.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Brickellia mosieri* critical habitat consists of three components (80 FR 49846-49886):

(i) Areas of pine rockland habitat that contain: (A) Open canopy, semi-open subcanopy, and understory; (B) Substrate of oolitic limestone rock; and (C) A plant community of predominately native vegetation that may include, but is not limited to: (1) Canopy vegetation dominated by *Pinus elliottii* var. *densa* (South Florida slash pine); (2) Subcanopy vegetation that may include, but is not limited to, *Serenoa repens* (saw palmetto), *Sabal palmetto* (cabbage palm), *Coccothrinax argentata* (silver palm), *Myrica cerifera* (wax myrtle), *Myrsine floridana* (myrsine), *Metopium toxiferum* (poisonwood), *Byrsonima lucida* (locustberry), *Tetrazygia bicolor* (tetrazygia), *Guettarda scabra* (rough velvetseed), *Ardisia escallonioides* (marlberry), *Psidium longipes* (mangroveberry), *Sideroxylon salicifolium* (willow bustic), and *Rhus copallinum* (winged sumac); (3) Short-statured shrubs that may include, but are not limited to, *Quercus pumila* (running oak), *Randia aculeata* (white indigoberry), *Crossopetalum ilicifolium* (Christmas berry), *Morinda royoc* (redgal), and *Chiococca alba* (snowberry); and (4) Understory vegetation that may

include, but is not limited to: *Andropogon* spp.; *Schizachyrium gracile*, *S. rhizomatum*, and *S. sanguineum* (bluestems); *Aristida purpurascens* (arrowfeather threeawn); *Sorghastrum secundum* (lopsided Indiangrass); *Muhlenbergia capillaris* (hairawn muhly); *Rhynchospora floridensis* (Florida white-top sedge); *Tragia saxicola* (pineland noseburn); *Echites umbellata* (devil's potato); *Croton linearis* (pineland croton); *Chamaesyce* spp. (sandmats); *Chamaecrista deeringiana* (partridge pea); *Zamia integrifolia* (coontie); and *Anemia adiantifolia* (maidenhair pineland fern).

(ii) A disturbance regime that naturally or artificially duplicates natural ecological processes (e.g., fire, hurricanes, or other weather events) and that maintains the pine rockland habitat described in paragraph (2)(i) of this entry.

(iii) Habitats that are connected and of sufficient area to sustain viable populations of *Brickellia mosieri* in the pine rockland habitat described in paragraph (2)(i) of this entry.

Special Management Considerations or Protections

When designating critical habitat, the Service assesses whether the specific areas within the geographic area occupied by the species at the time of listing contain features which are essential to the conservation of the species and which may require special management considerations or protection. The features essential to the conservation of *Brickellia mosieri* and may require special management considerations or protection to reduce threats related to habitat loss, fragmentation, and modification primarily due to development; inadequate fire management; nonnative, invasive plants; and sea level rise. Destruction of the pinelands for economic development has reduced pine rockland habitat on the Miami Rock Ridge outside of ENP by over 98 percent, and remaining habitat in this area is highly fragmented. *Brickellia mosieri* occurs on a mix of private and publicly owned lands, only some of which are managed for conservation. Populations of the plants that occur on private land or non-conservation public land are vulnerable to habitat loss, while populations on conservation lands are vulnerable to the effects of habitat degradation if natural disturbance regimes are disrupted (e.g., through inadequate fire management). Prolonged lack of fire in pine rockland typically results in succession to rockland hammock, and displacement of native species by invasive, nonnative plants often occurs. Further development and degradation of pine rocklands increase fragmentation and decrease the conservation value of the remaining functioning pine rockland habitat. In addition, pine rocklands are expected to be further degraded and fragmented due to anticipated sea level rise, which would fully or partially inundate some pine rocklands along the coast and in the southern portion of Miami-Dade County (near Navy Wells Pineland Preserve), and cause increases in the salinity of the water table and soils resulting in vegetation shifts in additional pine rocklands across the Miami Rock Ridge. Many existing pine rockland fragments are also projected to be developed for housing as the human population grows and adjusts to changing sea levels. Special management considerations and protections that will address these threats include increased coordination and conservation of these plants and their habitat on Federal lands, and improved habitat restoration and management efforts (including fire management and nonnative plant treatments) of high-priority and high-elevation sites. (USFWS, 2013)

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 2014)

Breeding Season

Adult: August - October (USFWS, 2014)

Key Resources Needed for Breeding

Adult: Fire (USFWS, 2014)

Reproduction Narrative

Adult: Pollination occurs via insects and abiotic factors (EPA, 2016). Reproduction is sexual (Bradley and Gann 1999, p. 12). Flowering takes place primarily in the fall (August–October) (Bradley and Gann 1999, p. 12). Off-season flowering is usually the result of fire, and *B. mosieri* will flower within 1 to 2 months following a fire, regardless of the time of year (Possley 2013 pers. comm.) (USFWS, 2014).

Habitat Type

Adult: Terrestrial (EPA, 2016).

Habitat Vegetation or Surface Water Classification

Adult: Pine rockland (EPA, 2016)

Dependencies on Specific Environmental Elements

Adult: Periodic fire (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Scattered (USFWS, 2014)

Environmental Specificity

Adult: Very narrow

Habitat Narrative

Adult: Grows exclusively in pine rockland (EPA, 2016). Pine rockland is characterized by an open canopy of South Florida slash pine (*Pinus elliottii* var. *densa*). Subcanopy development is rare in well-maintained pine rocklands, with only occasional hardwoods, such as *Lysiloma latisiliquum* (wild tamarind) and *Quercus virginiana* (live oak) growing to tree size in Miami Rock Ridge pinelands (Snyder et al. 1990, p. 253). The shrub/ understory layer is a diverse mix of species including both temperate and tropical shrubs and palms. The pine rocklands where *Brickellia mosieri* occurs are characterized by an open shrub canopy of *Serenoa repens* (saw palmetto), *Myrica cerifera* (wax myrtle), *Metopium toxiferum* (poisonwood), and *Sideroxylon salicifolium* (willow bustic) as well as species with more restricted distribution within pine rocklands including *Sideroxylon reclinatum* ssp. *austrofloridense* (Everglades bully), *Callicarpa americana* (beauty berry), *Dodonaea angustifolia* (varnish leaf), and *Ilex cassine* (dahoon holly) (Snyder et al. 1990, p. 254; Bradley and Gann 1999, p. 12). Populations are typically sparse and contain a low density of plants even in well-maintained pine rockland habitat (Bradley and Gann 1999, p. 12) (USFWS, 2014). The environmental specificity of this species is very narrow, as it is known

only from pine rockland habitat in southern Florida, requiring fire to maintain the openings in which the plant occurs (NatureServe, 2015).

Dispersal/Migration

Dependency on Other Individuals or Species for Dispersal

Adult: Unknown (EPA, 2016)

Dispersal/Migration Narrative

Adult: Fruit dispersal occurs via unknown abiotic and biotic mechanisms (EPA, 2016). Wind is one likely dispersal vector (Gann 2013b, pers. comm.) (USFWS, 2014).

Population Information and Trends

Population Trends:

50% decline (USFWS, 2013)

Species Trends:

50 - 70% decline (NatureServe, 2015)

Number of Populations:

Unknown, presumed 17+ (USFWS, 2013)

Population Size:

2,150 - 3,700 (USFWS, 2013)

Population Narrative:

At least 9 known populations on private lands have been extirpated, plus at least 6 of 18 undated occurrences reported by Alan Herndon. Based on current estimates, the total population of *B. mosieri* has apparently declined by approximately 50 percent since 1999. The number of extant occurrences of this species is somewhat uncertain due to the lack of complete and recent survey information, however populations of *B. mosieri* are believed to occur on at least 17 (extant or presumed extant) sites. Based on the 17 populations considered to be extant, the current total population estimate is between 515 and 4,935 plants, although the actual number of individuals is probably closer to between 2,150 and 3,700. The current range of *Brickellia mosieri* spans a narrow band approximately 30.1 km (18.7 mi) wide and 26.9 km (16.7 mi) in length (USFWS, 2013). Even conservation areas are suffering due to lack of fire and exotic species invasion, and the short-term trend for this species is a 50 - 70 % decline (NatureServe, 2015).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: The pine rockland community of south Florida, to which the species endemic, is critically imperiled globally (FNAI 2012, p. 27). Since the 1800s, residential and commercial

development and agriculture have drastically reduced the habitat for these plants throughout pine rocklands in south Florida. Habitat loss continues to occur in its range, and most remaining suitable habitat has been negatively altered by human activity. Another human-related factor that can modify public and private lands alike is the potential for high levels of nutrients from agricultural and urban areas to enter into pine rockland systems. Such chemical alteration of pine rockland soil, which has naturally low amounts of phosphorus and nitrogen, can result in changes to vegetation composition and structure, at the expense of pine rockland endemics such as *Brickellia mosieri*. Effects of fragmentation on pollinators may include changes to the pollinator community as a result of limitation of pollinator-required resources (e.g., reduced availability of rendezvous plants, nesting and roosting sites, and nectar/pollen); these changes may include changes to pollinator community composition, species abundance and diversity, and pollinator behavior (Rathcke and Jules 1993, pp. 273–275; Kremen and Ricketts 2000, p. 1227; Harris and Johnson 2004, pp. 30–33). As a result, plants in fragmented habitats may experience lower visitation rates, which in turn may result in reduced seed production of the pollinated plant (which may lead to reduced seedling recruitment), reduced pollen dispersal, increased inbreeding, reduced genetic variability, and ultimately reduced population viability (Rathcke and Jules 1993, p. 275; Goverde et al. 2002, pp. 297–298; Harris and Johnson 2004, pp. 33–34). Exclusion of fire for approximately 25 years will likely result in gradual hammock development over that time period, leaving a system that is very fire resistant if additional pre-fire management (e.g., mechanical hardwood removal) is not undertaken. Now, natural fires are unlikely to occur or are likely to be suppressed in the remaining, highly fragmented pine rockland habitat. The suppression of natural fires has reduced the size of the areas that burn, and habitat fragmentation has prevented fire from moving across the landscape in a natural way. Without fire, successional climax from pine rockland to rockland hammock is rapid, and displacement of native species by invasive nonnative plants often occurs. Understory plants such as *Brickellia mosieri* are shaded out by hardwoods and nonnatives alike (USFWS, 2013).

Stressor: Nonnative plants (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Nonnative plants have significantly affected pine rocklands, and threaten all occurrences of *Brickellia mosieri* to some degree (Bradley and Gann 1999, pp. 15, 72; Bradley and Gann 2005, page numbers not applicable; Bradley 2007, pers. comm.; Bradley and van der Heiden 2013, pp. 12–16). As a result of human activities, at least 277 taxa of nonnative plants have invaded pine rocklands throughout south Florida (Service 1999, p. 3–175). Nonnative invasive plants compete with native plants for space, light, water, and nutrients, and make habitat conditions unsuitable for *Brickellia mosieri* which responds positively to open conditions (USFWS, 2014).

Stressor: Small isolated populations (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Only small and fragmented occurrences of this plant remains. The current range spans such a small area that all populations could be affected by a single event (e.g., hurricane). Although robust population viability analyses (including minimum viable population calculations)

have not been conducted for these plants, indications are that most existing populations for this plant are at best marginal (USFWS, 2013).

Stressor: Climate change (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Drier conditions and increased variability in precipitation associated with climate change are expected to hamper successful regeneration of forests and cause shifts in vegetation types through time (Wear and Greis 2012, p. 39). Although it has not been well studied, existing pine rocklands have probably been affected by reductions in the mean water table. Climate changes are also forecasted to extend fire seasons and the frequency of large fire events throughout the Coastal Plain (Wear and Greis 2012, p. 43). While restoring fire to pine rocklands is essential to the long-term viability of *Brickellia mosieri* populations, increases in the scale, frequency, or severity of wildfires could have negative effects on this species considering its general vulnerability due to small population size, restricted range, few colonies, and relative isolation (USFWS, 2013).

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- Not available - this species does not have a recovery plan.

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USFWS. 2013. Proposed Endangered Status for *Brickellia mosieri* (Florida Brickell-bush) and *Linum carteri* var. *carteri* (Carter's Small-flowered Flax). 78 FR 61273 - 61293 (October 3, 2013).

USFWS. 2015. Designation of Critical Habitat for *Brickellia mosieri* (Florida Brickell-bush) and *Linum carteri* var. *carteri* (Carter's Small-flowered Flax). Final Rule. 80 FR 49846-49886 (August 17, 2015).

USFWS. 2013. Proposed Designation of Critical Habitat for *Brickellia mosieri* (Florida Brickell-bush) and *Linum carteri* var. *carteri* (Carter's Small-flowered Flax). Proposed Rule. 78 FR 61293 - 61320 (October 3, 2013).

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Endangered Species Status for *Brickellia mosieri* (Florida Brickell-bush) and *Linum carteri* var. *carteri* (Carter's Small-flowered Flax). 79 Federal Register 171. September 4, 2014. Pages 52567 - 52575

EPA 2016. Chapter 1: Draft Chlorpyrifos Problem Formulation for ESA Assessment. Attachments 1-11, 1-12, 1-13, 1-14, 1-15, 1-20 and 1-21. <https://www.epa.gov/endangered-species/biological-evaluation-chapters-chlorpyrifos-esa-assessment#chapter 1>.

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Proposed Endangered Status for *Brickellia mosieri* (Florida Brickell-bush) and *Linum carteri* var. *carteri* (Carter's Small-flowered Flax). 78 Federal Register 192. October 3, 2013. Pages 61273 - 61293.

USFWS. 2014. Endangered and Threatened Wildlife and Plants

Endangered Species Status for *Brickellia mosieri* (Florida Brickell-bush) and *Linum carteri* var. *carteri* (Carter's Small-flowered Flax). 79 Federal Register 171. September 4, 2014. Pages 52567 - 52575.

SPECIES ACCOUNT: *Brighamia insignis* (Olulu)

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/25/1994; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Brighamia insignis, a member of the bellflower family (Campanulaceae), is an unbranched plant 1 to 5 m (3 to 16 ft) tall with a succulent stem that is bulbous at the bottom and tapers toward the top. The fleshy leaves, which measure 12 to 20 cm (5 to 8 in) long and 6.5 to 11 cm (2.5 to 4.5 in) wide, are arranged in a compact rosette at the apex of the stem. Fragrant yellow flowers are clustered in groups of three to eight in the leaf axils (the point between the leaf and the stem), with each flower on a stalk 1 to 3 cm (0.4 to 1.2 in) long. The hypanthium (basal portion of the flower) has 10 ribs and is topped with 5 oval or loosely triangular calyx lobes (partially fused sepals) 0.5 to 1 mm (0.02 to 0.04 in) long. The yellow petals are fused into a tube 7 to 14 cm (2.8 to 5.5 in) long and 3 to 4 mm (0.1 to 0.2 in) wide, which flares into five elliptic lobes. The fruit is a capsule 13 to 19 mm (0.5 to 0.7 in) long which contains numerous seeds. (USFWS, 1998)

Taxonomy

Asa Gray (in Mann 1868) described *Brighamia insignis* based upon alcohol-preserved flowers and fruits collected by William Tufts Brigham on Molokai and a dried specimen collected on Kauai or Niihau by Ezechiel Jules Remy. Brigham's bottled material, since lost, would today be considered to be *Brighamia rockii*. Other published names that Thomas C. Lammers (1989), in the currently accepted treatment of the genus, considers to be synonymous with *B. insignis* include *B. insignis* f. *citrina* (Forbes 1917a), *B. citrina* (St. John 1958), and *B. citrina* var. *napahiensis* (St. John 1969b). (USFWS, 1998)

Historical Range

Historically, *B. insignis* was known from the headland between Hoolulu and Waiahuakua Valleys along the Na Pali Coast on the island of Kauai, and from Kaali Spring on the island of Niihau (HHP 1994). (USFWS, 1998)

Current Range

Range includes Na Pali and Hapuu areas of Kauai, current reports on Niihau but no specimens collected. (NatureServe, 2015)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Brighamia insignis* on the islands of Kauai and Niihau, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Brighamia insignis* includes three units totaling 5,047 acres on the island of Kauai and one unit totaling 52,549 acres on the island of Niihau. The units are Kauai

6—*Brighamia insignis*—a, Kauai 7—*Brighamia insignis*—b, Kauai 11—*Brighamia insignis*—c, and Niihau 1—*Brighamia insignis*—a.

Kauai 6—*Brighamia insignis*—a: This unit is critical habitat for *Brighamia insignis* and is 63 ha (156 ac) on private land and contains a portion of Keopaweo Summit on the north side of Mount Haupu. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Brighamia insignis* and is currently occupied with one plant. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, rocky ledges with little soil or steep sea cliffs in lowland dry grasslands or shrublands with annual rainfall that is usually less than 170 cm (65 in). This unit provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Kauai 7—*Brighamia insignis*—b: This unit is critical habitat for *Brighamia insignis* and is 340 ha (843 ac) on private land. This unit contains the Haupu and Naluakeina Summits and Queen Victoria's Profile. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Brighamia insignis* and is currently occupied with one plant. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, rocky ledges with little soil or steep sea cliffs in lowland dry grasslands or shrublands with annual rainfall that is usually less than 170 cm (65 in). This unit provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Kauai 11—*Brighamia insignis*—c: This unit is critical habitat for *Brighamia insignis* and is 1,639 ha (4,051 ac) on State land (Hono o Na Pali NAR, Puu Ka Pele Forest Reserve, and Milolii, Nualolo Kai, and Na Pali Coast State Parks). This unit contains Alapii, Mukuaiki, and Puanaiea Points; Awaawapuhi, Honopu, Kalalau, Kawaiula, Makaha, Milolii, Nualolo, Paaiki, and Poopooiki Valleys; Hanakoa, Hoolulu, Kalalau, and Waiahuakua Streams; Kalalau Beach and Trail; Kanakou Summit and Nakeikionaiwi Pillar. The habitat features contained in this unit that are essential for this species include, but are not limited to, rocky ledges with little soil or steep sea cliffs in lowland dry grasslands or shrublands with annual rainfall that is usually less than 170 cm (65 in). This unit provides habitat for seven populations of 300 mature, reproducing individuals of the short-lived perennial *Brighamia insignis* and is currently occupied with between 40 and 60 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. This unit provides for seven populations within this multi-island species' historical range on Kauai that are some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Niihau 1—*Brighamia insignis*—a: This unit is critical habitat for *Brighamia insignis* and is 144 ha (357 ac) on private land. This unit contains Puu Alala and Mokouia Valley. The habitat features contained in this unit that are essential for this species include, but are not limited to, rocky ledges with little soil or steep sea cliffs in lowland dry grasslands or shrublands with annual rainfall that is usually less than 170 cm (65 in). This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Brighamia insignis* and is currently occupied with at least one plant. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. This unit provides for one population within this multi-island species' historical range on Niihau that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Rocky ledges with little soil or steep sea cliffs in lowland dry grasslands or shrublands with annual rainfall that is usually less than 170 cm (65 in) and containing one or more of the following native plant species: *Artemisia australis*, *Chamaesyce celastroides*, *Eragrostis variabilis*, *Heteropogon contortus*, *Hibiscus kokio*, *Hibiscus kokio* ssp. *saintjohnianus*, *Lepidium serra*, *Lipochaeta succulenta*, *Munroidendron racemosum*, or *Sida fallax*; and

(ii) Elevations between 0 and 748 m (0 and 2,453 ft).

Special Management Considerations or Protections

The following management actions are important: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (outcrossing) and asexual (vegetative) (USFWS, 1998)

Dependency on Other Individuals or Species

Adult: Pollination by sphingid moths is likely (David Lorence, NTBG, personal communication 1994). (USFWS, 1998)

Reproduction Narrative

Adult: Pollination by sphingid moths is likely (David Lorence, NTBG, personal communication 1994). Pollination failure is common, and may be due to a lack of pollinators or a reduction in genetic variability due to the few remaining individuals. The flower structure appears to favor outcrossing. Some vegetative cloning has been observed and flower and leaf size appear to be dependent on moisture availability (Takeuchi 1982, USFWS 1994a). (USFWS, 1998)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliff, savanna (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Moist, or rarely dry habitats (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations from sea level to 400 meters (USFWS, 1998)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1998)

Habitat Narrative

Adult: This species is found in moist, or rarely dry habitats. Usually on steep cliffs, sparsely vegetated with native shrubs and grasses. *Brigharnia insignis* grows from sea level to 400 meters (1,300 feet) on rocky ledges with little soil or steep sea cliffs in lowland dry grassland and shrubland. This habitat has annual rainfall that is usually less than 170 centimeters (65 inches). Associated native plant taxa include *Canthiurn odoratum* (alahee), *Charnaesyce celastroides* (akoko), *Eragrostis variabilis* (kawelu), and *Heteropogon contortus* (pili grass) (USFWS 1994a). (USFWS, 1998; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Seeds of this species are undoubtedly dispersed by gravity. Although they may be blown for short distances, they are not obviously adapted for wind dispersal, being ovoid to ellipsoid, smooth, and lacking any sort of wing or outgrowth (David Lorence, NTBG, personal communication 1994). (USFWS, 1998)

Population Information and Trends**Population Trends:**

Declining (USFWS, 2008)

Resiliency:

Very low (inferred from USFWS, 2008)

Representation:

Very low (inferred from USFWS, 2008)

Redundancy:

Very low (inferred from USFWS, 2008)

Number of Populations:

1 (USFWS, 2008)

Population Size:

0 (USFWS, 2017)

Population Narrative:

Brighamia insignis occurs on a steep cliff face and the only known wild individual was last observed in 2012 via helicopter (PEPP 2014; Walsh 2016; Walsh 2017, in litt.). (USFWS, 2017); This species has declined to only one naturally occurring wild individual, and the distribution has declined from four populations on two mountain ranges to only one on the Na Pali Coast. Three additional plants have been outplanted by Hawaii Division of Forestry and Wildlife (National Tropical Botanical Garden 2006a). Probably less than 100 plants. (USFWS, 2008; NatureServe, 2015);

Threats and Stressors

Stressor: Habitat degradation by animals (USFWS, 1998)

Exposure:

Response:

Consequence:

Narrative: The major threats to Brighamia insignis are predation and habitat degradation by feral goats and pigs. Other threats that affect B. insignis include: slugs and rats that eat seeds and leaves, carmine spider mites, and feral goats that are known to defoliate B. insignis. (USFWS, 2008)

Stressor: Small population size (USFWS, 1998)

Exposure:

Response:

Consequence:

Narrative: Brighamia insignis is threatened by stochastic extinction due to the small number of individuals and their restricted distribution. Small numbers may result in reduced reproductive vigor, and stochastic environmental disturbances, such as rock slides, are frequent in their cliff habitat (USFWS 1994a). Species like B. insignis that are very low in number and endemic to small portions of an island are inherently more vulnerable to extinction than widespread species because of the higher risks posed by genetic bottlenecks, random demographic fluctuations and localized catastrophes such as hurricanes. (USFWS, 1998; USFWS, 2008)

Stressor: Invasive plants (USFWS, 1998)

Exposure:

Response:

Consequence:

Narrative: Habitat degradation and competition from invasive plants such as Melinis minutiflora (molasses grass), Setaria gracilis (yellow foxtail), Sporobolus africanus (smutgrass),

lantana, *Psidium cattleianum* (strawberry guava), *Psidium guajava* (common guava), *Kahanchoe pinnata* (air plant), *Ageratum conyzoides* (maile hohono) and *Stachytarpheta* (NCN)) are threats to *B. insignis*. (USFWS, 1998)

Stressor: Fungal disease (USFWS, 1998)

Exposure:

Response:

Consequence:

Narrative: An unidentified fungal disease affected a number of cultivated *B. insignis*, causing a softening and collapse of the main stem tissue from the base (Factor C) (S. Perlman, National Tropical Botanical Garden, pers. comm. 2006). (USFWS, 2008)

Stressor: Pollination (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Pollination has been a problem for this species; it is presumed that the natural pollinator is a Sphingidae moth that now is either extinct or in extremely low numbers, which directly affects the amount of seed production for this species (Perlman 2006; K. Wood, pers. comm. 2006). (USFWS, 2008)

Stressor: Over-collection (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Some of the extirpated populations on the Na Pali Coast occurred near trails, which exposed the plants to overcollection and an increased likelihood of rock slides and invasive species introductions caused by hikers (Factor B) (USFWS 1995). (USFWS, 2008)

Stressor: Climate change loss or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Brighamia insignis* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.867 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2017)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1998)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)

3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1998)

2. Each population must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)

3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1998)

Recovery Actions:

- In order to prevent this taxon from going extinct, propagation efforts and the maintenance of adequate genetic stock ex situ should be undertaken immediately. (USFWS, 1998)
- It also crucial to protect the remaining wild individuals from goats and alien weed threats. (USFWS, 1998)
- Protect current populations, control threats and monitor. (USFWS, 1998)
- Expand current populations. (USFWS, 1998)
- Conduct research essential to conservation of the species. (USFWS, 1998)
- Establish new populations as needed to reach recovery objectives. (USFWS, 1998)
- Validate and revise recovery objectives. (USFWS, 1998)
- Devise and implement a public education program. (USFWS, 1998)
- Surveys and inventories—Survey for additional populations of *Brighamia insignis* in areas of potentially suitable habitat. (USFWS, 2017)
- Ungulate monitoring and control—Determine management needs of the immediate area of the one remaining wild individual and implement them to prevent extinction in the wild. (USFWS, 2017)
- Captive propagation for genetic storage and reintroduction—Continue to conduct research on outcrossing success, and collect seeds from living collections and handpollinations for adequate genetic representation. (USFWS, 2017)
- Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2017)
- Predator and herbivore monitoring and control—Implement effective control methods for rodents at the last known location. (USFWS, 2017)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides. (USFWS, 2017)

- Genetic research—Review the complete living collections to determine origin of progeny, as plants with genetic representation from the Waiahuakua Valley population would provide the best source to increase genetic diversity within the species, based on the existing genetic studies. (USFWS, 2017)
- Population biology research—Conduct a more detailed genetic study of propagules from the wild individual and those in cultivation to determine genetic diversity between populations and individuals to assist in determination of suitable material to use in hand-pollination. (USFWS, 2017)

Conservation Measures and Best Management Practices:

- Determine management needs of the immediate area of the one remaining naturally occurring wild individual and implement them to prevent complete extinction in the wild. (USFWS, 2008)
- Increase the number of individuals in cultivation and genetic storage through controlled breeding. (USFWS, 2008)
- Reintroduce populations in areas of suitable habitat that can be protected from goats and other ungulates, rats, and human disturbance. (USFWS, 2008)
- Review the complete living collections to determine where progeny derived from crosses with the Waiahuakua Valley population still exist, as these plants would provide the best source to increase the genetic diversity within the species, based on the existing genetics work. (USFWS, 2008)
- Conduct a more detailed genetic study of the individuals in the wild and in cultivation to determine micro-level distinctions between populations and individuals, to assist in determining suitable material to use of hand pollinated crosses. (USFWS, 2008)

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SPECIES ACCOUNT: *Brighamia rockii* (Pua `ala)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/08/1992; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Brighamia rockii, a member of the bellflower family (Campanulaceae), grows as an unbranched plant 1 to 5 m (3.3 to 16 ft) tall with a thickened, succulent stem that tapers from the base. The fleshy, oval leaves are widest at their tips and are arranged in a rosette at the top of the plant. They measure 6 to 22 cm (2.4 to 8.7 in) long and 5 to 15 cm (2 to 6 in) wide. The fragrant flowers are clustered in groups of three to eight in the leaf axils. Each flower cluster is on a stalk 3.5 to 7.5 cm (1.4 to 3.0 in) long, and each flower is on a stalk 6 to 12 mm (0.2 to 0.5 in) long. The green basal portion of the flower (hypanthium) has 10 ribs and is topped by 5 calyx lobes 2.5 to 8 mm (0.01 to 0.3 in) long. The petals are fused into a green to yellowish green tube 8 to 13 cm (3.1 to 5.1 in) long and 0.2 to 0.4 cm (0.1 to 0.2 in) wide that flares into five white, elliptic lobes 1.7 to 3.7 cm (0.7 to 1.5 in) long and 0.8 to 1.3 cm (0.3 to 0.5 in) wide. The fruit is a capsule 13 to 20 mm (0.5 to 0.8 in) long, 7 to 10 mm (0.3 to 0.4 in) wide, and 3 to 4 mm (0.1 to 0.2 in) thick containing numerous seeds about 1.1 to 1.2 mm (0.05 in) long. This species is a member of a unique endemic Hawaiian genus with only one other species, found on Kauai, from which it differs by the color of its petals, its longer calyx (fused sepals) lobes, and its shorter flower stalks (USFWS 1992). (USFWS, 1996)

Taxonomy

Genus endemic to hawaiian islands, species endemic to molokai. (NatureServe, 2015)

Historical Range

This long-lived perennial unbranched plant is endangered and occurred historically on the islands of Molokai, Maui, and Lanai. (USFWS, 2014)

Current Range

It is currently only found on Molokai. (USFWS, 2014)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Brighamia rockii* (Pua `ala) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 18 detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Brighamia rockii* includes 18 CHUs in Maui County, Hawaii with detailed unit information. There are also an unknown number of units on Lanai that contain this species (number of units is unknown because detailed unit descriptions for Lanai are not available) (81 FR 17790-18110).

Maui—Coastal—Unit 1 consists of 2 ac (1 ha) on Keopuka Rock on the northern coast of east Maui. This unit is State-owned, and is classified as a State Seabird Sanctuary. It is occupied by the plant *Peucedanum sandwicense* and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Coastal—Unit 1 is not known to be occupied by *Brighamia rockii*, *Cyperus pennatiformis*, *Ischaemum byrone*, or *Vigna o-wahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 2 consists of 16 ac (6 ha) of State land, and 9 ac (4 ha) of privately owned land, from Wahinepee Stream to Moiki Point on the northern coast of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). Although Maui—Coastal—Unit 2 is not currently occupied by *Brighamia rockii*, *Cyperus pennatiformis*, *Ischaemum byrone*, *Peucedanum sandwicense*, or *Vigna o-wahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the physical or biological features necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Molokai—Coastal—Unit 2 consists of 263 ac (106 ha) of State land, and 710 ac (287 ha) of privately owned land, from Ilio Point to Kaa Gulch, along the northwestern coast of Molokai. This unit is occupied by the plant *Marsilea villosa* and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 2 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 3 consists of 10 ac (4 ha) of privately owned land at Pauwalu Point on the northern coast of east Maui. This unit is occupied by the plant *Ischaemum byrone* and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations.

Although Maui—Coastal— Unit 3 is not known to be occupied by *Brighamia rockii*, *Cyperus pennatiformis*, *Peucedanum sandwicense*, or *Vigna o-wahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 4 consists of 40 ac (16 ha) of State land, and 35 ac (14 ha) of privately owned land, from Papiha Point to Honolulu Nui Bay on the northeastern coast of east Maui. This unit is occupied by the plant *Cyperus pennatiformis* and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Coastal—Unit 4 is not known to be occupied by *Brighamia rockii*, *Ischaemum byrnone*, *Peucedanum sandwicense*, or *Vigna owahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 5 consists of 26 ac (11 ha) of State land from Keakulikuli Point to Pailoa Bay on the northeastern coast of east Maui. This unit is occupied by the plant *Ischaemum byrnone* and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Coastal—Unit 5 is not known to be occupied by *Brighamia rockii*, *Cyperus pennatiformis*, *Peucedanum sandwicense*, or *Vigna o-wahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 5 consists of 1 ac (0.5 ha) on Huelo islet on the northern coast of Molokai. This area is State-owned, and is classified as a State Seabird Sanctuary. This unit is occupied by the plants *Brighamia rockii*, *Peucedanum sandwicense*, and *Pittosporum halophilum*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 5 is not known to be occupied by *Bidens wiebkii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrnone*, *Marsilea villosa*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low

population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 6 consists of 356 ac (144 ha) of State land at Kamanamana on the southern coast of East Maui. This unit is occupied by the plant *Vigna owahuensis* and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Coastal—Unit 6 is not known to be occupied by *Brighamia rockii*, *Cyperus pennatiformis*, *Ischaemum byrone*, or *Peucedanum sandwicense*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 6 consists of 190 ac (77 ha) of State land, and 1,685 ac (682 ha) of privately owned land, from Kaholaiki Bay to Halawa Bay, on the northeastern coast of Molokai. This unit is occupied by the plants *Bidens wiebkei*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, and *Ischaemum byrone*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 6 is not known to be occupied by *Brighamia rockii*, *Hibiscus brackenridgei*, *Marsilea villosa*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 7 consists of 30 ac (12 ha) of State land, and 15 ac (6 ha) of privately owned land, from Kailio Point to Waiuha Bay, on the southern coast of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). Although Maui—Coastal—Unit 7 is not currently occupied by *Brighamia rockii*, *Cyperus pennatiformis*, *Ischaemum byrone*, *Peucedanum sandwicense*, or *Vigna owahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 7 consists of 49 ac (20 ha) of privately owned land from Alanuihipaka Ridge to Kalanikaula, on the northeastern coast of Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). Although

Molokai—Coastal—Unit 7 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrnone*, *Marsilea villosa*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 8 consists of 493 ac (199 ha) of State land from Kiakeana Point to Manawainui on the southern coast of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). Although Maui—Coastal—Unit 8 is not currently occupied by *Brighamia rockii*, *Cyperus pennatifolius*, *Ischaemum byrnone*, *Peucedanum sandwicense*, or *Vigna owahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 9 consists of 170 ac (69 ha) of State land and 0.3 ac (0.1 ha) of privately owned land, from Poelua Bay to Mokolea Point on the northwestern coast of west Maui. This unit is occupied by the plants *Schenkia sebaeoides* and *Sesbania tomentosa*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Coastal—Unit 9 is not known to be occupied by *Brighamia rockii*, we have determined this area to be essential for the conservation and recovery of this coastal species because it provides the PCEs necessary for the reestablishment of wild populations within its historical range. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could approach recovery.

Maui—Coastal—Unit 10 consists of 147 ac (60 ha) of State land and 26 ac (10 ha) of privately owned land, from Kahakuloa Head to Waihee Point on the northeastern coast of west Maui. This unit is occupied by the plant *Schenkia sebaeoides*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Coastal—Unit 10 is not known to be occupied by *Brighamia rockii* or *Sesbania tomentosa*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within its historical range. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could approach recovery.

Maui—Coastal—Unit 11 consists of 6 ac (3 ha) of State land on Mokeehia Island on the northeastern coast of west Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). Although Maui—Coastal—Unit 11 is not currently occupied by *Brighamia rockii*, *Schenkia sebaeoides*, or *Sesbania tomentosa*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Wet Cliff—Unit 1 (and) *Palmeria dolei*—Unit 43—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 43—Wet Cliff This area consists of 1,395 ac (565 ha) of State land, and 212 ac (86 ha) of privately owned land, and encircles the plateau between Pelekunu and Wailau valleys, in north-central Molokai. These units are occupied by the plants *Brighamia rockii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea munroi*, and *Hibiscus arnottianus* ssp. *immaculatus*, and include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Wet Cliff—Unit 1 is not known to be occupied by *Cyanea grimesiana* ssp. *grimesiana*, *Hesperomannia arborescens*, *Phyllostegia hispida*, *Pteris lidgatei*, or *Stenogyne bifida*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Wet Cliff—Unit 2 (and) *Palmeria dolei*—Unit 44—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 44—Wet Cliff This area consists of 462 ac (187 ha) of State land, and 806 ac (326 ha) of privately owned land (partly within The Nature Conservancy's Pelekunu Preserve), along the rim of Pelekunu Valley from Kipapa Ridge to Mapulehu, in central Molokai. These units are occupied by the plants *Clermontia oblongifolia* ssp. *brevipes* and *Phyllostegia hispida*, and include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Wet Cliff—Unit 2 is not known to be occupied by *Brighamia rockii*, *Canavalia molokaiensis*, *Cyanea grimesiana* ssp. *grimesiana*, *C. munroi*, *Hesperomannia arborescens*, *Hibiscus arnottianus* ssp. *immaculatus*, *Pteris lidgatei*, or *Stenogyne bifida*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Wet Cliff—Unit 3 consists of 1,137 ac (460 ha) of State land, and 225 ac (91 ha) of privately owned land, along the rim of Wailau Valley from Mapulehu to Kahiwa Gulch, in eastern Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Molokai—Wet Cliff—Unit 3 is not known to be occupied by *Brighamia rockii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea grimesiana* ssp. *grimesiana*, *C. munroi*, *Hesperomannia arborescens*, *Hibiscus arnottianus* ssp. *immaculatus*, *Phyllostegia hispida*, *Pteris lidgatei*, or *Stenogyne bifida*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Brighamia rockii* critical habitat consists of three components. Coastal (east Maui, west Maui and Molokai), Dry cliff (Lanai) and Wet cliff (Molokai) (81 FR 17790-18110):

Ecosystem: Coastal. Elevation: <980 ft (<300 m). Annual precipitation: <20 in (<50 cm). Substrate: Well-drained, calcareous, talus slopes; dunes; weathered clay soils; ephemeral pools; mudflats. Canopy: *Hibiscus*, *Myoporum*, *Santalum*, *Scaevola*. Subcanopy: *Gossypium*, *Sida*, *Vitex*. Understory: *Eragrostis*, *Jacquemontia*, *Lyceum*, *Nama*, *Sesuvium*, *Sporobolus*, *Vigna*.

Ecosystem: Dry Cliff. Elevation: unrestricted. Annual precipitation: <75 in (<190 cm). Substrate: >65 degree slope, rocky talus. Canopy: None. Subcanopy: *Antidesma*, *Chamaesyce*, *Diospyros*, *Dodonaea*. Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Schiedea*.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. Understory: *Bryophytes*, *Ferns*, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight

plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; MauiWet

Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Breeding Season

Adult: August but may occur during other months (USFWS, 1996)

Reproduction Narrative

Adult: Recent observations of *Brighamia* by Geminill et al. (In Prep.) has provided the following information: the reproductive system is protandrous, meaning there is a temporal separation between the production of male and female gametes, in this case a separation of several days; only 5 percent of the flowers produce pollen; very few fruits are produced per inflorescence; there are 20-60 seeds per capsule; and plants in cultivation have flowers at an age of 9 months. This species was observed in flower during August 1987 (HHP 1994a). (USFWS, 1996)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliff, forest- hardwood, forest/woodland, shrubland/chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations from sea level to 470 meters (USFWS, 1996)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1996)

Habitat Narrative

Adult: This species is found on ledges on exposed steep moist coastal cliffs, with native grasses, shrubs and trees. The plants are found in rock crevices on steep sea cliffs, often within the spray zone, in Coastal Dry to Mesic Forests or Shrublands at an elevational zone from sea level to 470 meters (1,540 feet) with such associated species as ohia, *Canthium odoratum* (alahee),

Diospyros sandwicensis (lama), *Osteomeles anthyllidifolia* (ulei), and *Scaevola* (naupaka) (USFWS 1992). (USFWS, 1996; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Resiliency:

Very low (USFWS, 2014)

Redundancy:

Very low (USFWS, 2014)

Number of Populations:

3 (1 wild population and 2 outplanted populations; USFWS, 2018)

Population Size:

~205 individuals (45 in the wild population and ~160 in the outplanted populations; USFWS, 2018)

Population Narrative:

The previous 5-year review in 2014 reported three populations totaling 34 individuals on Molokai. Currently, there is one wild population at Waiehu totaling 45 individuals. The large majority of plants, however, are inaccessible. There are also two outplanted populations, one with seven individuals and another with 42 (PEPP 2017). (USFWS, 2018)

Threats and Stressors

Stressor: Climate change (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Climate change destruction or degradation of habitat – Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Brighamia rockii* is highly vulnerable to the impacts of climate change. Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2014); The assessment by Fortini et al. (2013) concluded that *Brighamia rockii* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.838 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). (USFWS, 2018)

Stressor: Habitat damage from animals (USFWS, 1996)

Exposure:

Response:

Consequence:

Narrative: Habitat damage (and possibly predation) by deer and goats poses a serious threat to *Brighamia rockii*. (USFWS, 1996)

Stressor: Non-native plant species (USFWS, 1996)

Exposure:

Response:

Consequence:

Narrative: Competition with alien plants is also a threat. (USFWS, 1996)

Stressor: Low reproductive rates (USFWS, 1996)

Exposure:

Response:

Consequence:

Narrative: Recent observations suggest that low reproductive rates in wild populations could be due to a combination of factors including low production of pollen, low establishment of seedlings and a lack of pollinators (Gemmill et al. In Prep.). (USFWS, 1996)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Molokai and at least one other island where they now occur or occurred historically. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1996)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1996)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Molokai and at least 1 other island where they now occur or occurred historically. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1996)
3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1996)

Recovery Actions:

- Implementation of immediate recovery actions needed to keep “on-the-brink” species (those that number fewer than 100 individuals in the wild) from going extinct. These actions include propagation and maintenance of genetic stock ex situ, and protection of remaining wild individuals from threats. (USFWS, 1996)
- Delineation of management units to conserve not only these taxa, but their habitats as well. These units should be managed to preserve as many native species (flora and fauna) as possible, through threat-control and forest-restoration programs. (USFWS, 1996)
- Augmentation of small populations and re-establishment of new populations within the historical range of the species. (USFWS, 1996)
- A research program is also recommended to study the growth and reproductive viability of each taxon, determine the parameters of viable populations of each taxon, study the reproductive strategy and pollinators of each taxon, and study possible pests and diseases. (USFWS, 1996)
- Surveys and inventories—Survey for additional populations of *Brighamia rockii* in areas of potentially suitable habitat. (USFWS, 2018)
- Ungulate monitoring and control—Construct and maintain fenced exclosures to protect individuals from the negative impacts of feral ungulates. Protect all occurrences against browsing and habitat disturbances from feral ungulates. (USFWS, 2018)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. Control invasive nonnative species that compete with the species around all populations. (USFWS, 2018)
- Captive propagation for genetic storage and reintroduction—Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species’ high vulnerability to climate change. Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. (USFWS, 2018)
- Climate change adaptation strategy—Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. (USFWS, 2018)
- Predator and herbivore monitoring and control—Implement effective control methods for rodents and slugs within the vicinity of all known *Brighamia rockii* populations. (USFWS, 2018)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from low numbers. (USFWS, 2018)

Conservation Measures and Best Management Practices:

- Survey geographical and historical range for a current assessment of the species’ status. (USFWS, 2014)
- Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species’ high vulnerability to climate change. (USFWS, 2014)
- Fence remaining populations to protect them from the impacts of feral ungulates. (USFWS, 2014)
- Eradicate invasive introduced plant species within ungulate exclosures and maintain the exclosures free of invasive introduced plants. (USFWS, 2014)

- Control slugs and rodents within the vicinity of all known *Brighamia rockii* populations. (USFWS, 2014)
- Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. (USFWS, 2014)
- Continue monitoring wild and outplanted individuals. (USFWS, 2014)
- Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2014)

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

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SPECIES ACCOUNT: *Buxus vahlii* (Vahl's boxwood)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/13/1985; Southeast Region (R4) (USFWS, 2015)

Physical Description

An evergreen shrub or small tree reaching 16 feet in height, with a stem diameter of 5 inches. The leaves are simple, opposite, and oblong to obovate (USFWS, 1987).

Taxonomy

A member of the boxwood family (Buxaceae). The type material was originally identified as *Crantzia laevigata* (USFWS, 1987).

Historical Range

Historical records of the species include only two locations within the karst region in Puerto Rico (USFWS, 1987).

Current Range

Vahl's boxwood is endemic to the islands of Puerto Rico and St. Croix, US Virgin Islands (USFWS, 2013).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from EPA, 2016), asexual (USFWS, 1987)

Breeding Season

Adult: December - April (EPA, 2016)

Key Resources Needed for Breeding

Adult: Unknown - possibly wind or insects (EPA, 2016)

Reproduction Narrative

Adult: Flowering occurs from December to April and fruiting occurs in July. Pollination occurs possibly via wind or insects (EPA, 2016) and reproductive biology consists of capsules with tiny seeds that depend on mechanical dispersal (USFWS, 2019). Floral morphology suggests self-pollination is possible (USFWS, 1987).

Habitat Type

Adult: Terrestrial (EPA, 2016)

Habitat Vegetation or Surface Water Classification

Adult: Subtropical dry forest, subtropical moist forest (EPA, 2016)

Geographic or Habitat Restraints or Barriers

Adult: 33 - 984 ft. elevation (EPA, 2016)

Environmental Specificity

Adult: Moderate (inferred from EPA, 2016)

Habitat Narrative

Adult: Occurs in the subtropical dry forest life zone and to a lesser extent in the subtropical moist forest life zone; within semi-evergreen forests of the subtropical moist forest zone in limestone hills of the Karst region. Karst region is characterized by undulating topography of relatively low relief, but with steep rounded hills, caves, sinkholes, and subterranean streams. At Hato Tejas site, forest has two canopy layers, an open understory, and sparse groundcover. Much of upper canopy is deciduous and lower canopy is evergreen; heavily shaded. The other site is Punta Higuero and it is largely deforested and occupied by coastal forest tree species as well as salt tolerant shrub and herbaceous species. More open habitat and exposure to salt spray and wind. Both populations are currently restricted to ravines. Soils usually derived from limestone and poorly developed and excessively drained, although volcanic alluvium has been incorporated into the bottomland soils. Occurs at elevations around 33 to 984 ft. (EPA, 2016).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Seed dispersal occurs via explosion (EPA, 2016).

Population Information and Trends**Population Trends:**

Increasing (USFWS, 2019)

Redundancy:

Moderate (inferred from USFWS, 2013)

Number of Populations:

10 (USFWS, 2019)

Population Size:

5,400 (USFWS, 2019)

Population Narrative:

The species status is overall increasing. Currently overall, the Service knows of ten populations with over 5,400 individuals estimated, including 100 trees identified on a new site in March, 2018. This reflects an increase since the time of listing and a 20% overall increase since 2013 (USFWS, 2013; 2019).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2013; 2019)

Exposure:

Response:

Consequence:

Narrative: The Rincón population is located on land owned by PREPA (a public corporation) adjacent to the long defunct BONUS nuclear reactor. However, there is no evidence that PREPA manages the area in any way. There is no fence or other access limitations. Breckon and Kolterman (1993) documented damage to this area and to plants of *B. vahlii* due to the apparent incursion of undocumented aliens and to presumably anthropogenic fires. In the case of Rincón, the boundaries of the property are not clearly defined and it is not possible to determine if part of the population lies within private land. The properties adjacent to this population have a great potential for urban and tourism development, which could result in further encroachment of the population and the modification of suitable habitat for the expansion of the population. For the Peñuelas-Ponce area the greatest threat is urban development (quarries, landfills, telecommunication towers, and residential housing and tourist development projects). All the populations within this area lie within private lands with no protection; the same applies to two of the St. Croix populations, as evidenced from the access road constructed through the center of the population. The native forest that harbors one of the populations at Ponce has been severely fragmented for housing lots (Omar Monsegur, Service, pers. obs. 2011). Furthermore, the general area that harbors suitable habitat for the species between Ponce and Peñuelas has been proposed for the construction of several infrastructure projects (Gasoducto del Sur and Vía Verde Gas Pipeline). In fact, one of the populations at Peñuelas lies within the boundaries of a rock quarry (Cantera Valdivieso; José Sustache, PRDNER, per. comm. 2011). Evidence of recent fires in the habitat and adjacent to known populations have been observed recently at Ponce (Omar A. Monsegur, Service, pers. obs. 2011) (USFWS, 2013; 2019).

Stressor: Other natural or manmade factors (USFWS, 2013; 2019)

Exposure:

Response:

Consequence:

Narrative: Vahl's boxwood may be further threatened by fires, hurricanes and climate change, although these are considered low and non-imminent threats to the species. Climate change is predicted to increase the frequency and strength of tropical storms, which could possibly impact the Rincón and Sandy Point "St. Croix" populations. The cumulative effect of coastal erosion due to severe hurricanes, plus the habitat modifications for urban and tourism development can further diminish the availability of suitable habitat, and therefore, limit the population expansion and colonization of new areas at Rincón and St. Croix. Hurricane Maria in 2017 devastated most habitats in Puerto Rico and St. Croix in 2017 and likely impacted this species. Human-induced fires may lead to destruction of the native vegetation seed bank and create favorable conditions for non-native plant species to out compete *Buxus vahlii*, particularly those populations occurring near forests where accidental or deliberate forest fires occur. In addition, the possibility of severe droughts may contribute to an increase in the quantity and frequency of fires on the Island. We have observed unusual shifts on dry and rainy seasons. In some cases these events have produced an overload of fuel (primary by exotic grasses) that when burned during the next dry season or drought produces severe damage to the native vegetation and seed bank (USFWS, 2013; 2019).

Stressor: Disease or predation (USFWS, 2019)

Exposure:**Response:****Consequence:**

Narrative: In 2013, the presence of the insect lobate lac scale *Paratachardina lobata*, was found in Bayamon and Rincon. Infestation in *Buxus vahlii* was more than 50% of the population. Although there is not enough evidence about the effect of this disease on the species, such pest may compromise the photosynthetic rate of the species and result in low reproductive output (reduced production of flowers and fruits).

Recovery**Reclassification Criteria:**

1. The two known populations at Hato Tejas (Bayamon) and Punta Higüero (Rincon) are placed under protective status (USFWS, 2013).
2. At least three new populations capable of self-perpetuation have been established within protected units of the Commonwealth Forest System in the karst region (e.g., Vega or Cambalache forests) (USFWS, 2013).

Delisting Criteria:

1. The five (5) existing population on private land (Rincon, Bayamon, Penuelas-Ponce, Aguadilla, and St Croix) show a stable or increasing trend, evidenced by natural recruitment and multiple age classes, and are protected via a conservation mechanism (USFWS, 2019).
2. Within the historic range and in protected suitable habitat, establish and manage four (4) additional population with a stable or increasing trend, evidenced by natural recruitment and multiple age classes (USFWS, 2019).
3. Threat reduction and management activities have been implemented to a degree that the species will remain viable into the foreseeable future (USFWS, 2019).

Recovery Actions:

- Prevent further habitat loss and population decline (USFWS, 1987).
- Continue to gather information on the distribution and abundance of *Buxus vahlii* in northern Puerto Rico (USFWS, 1987).
- Research (USFWS, 1987).
- Refine recovery goals (USFWS, 1987).
- Long-term protection and management of existing populations, including land acquisition, conservation easements, private landowner agreements and habitat restoration practices (USFWS, 2019).
- Establish four (4) new self-sustaining populations with genetics representation from each site within protected suitable habitat in Puerto Rico and USVI (USFWS, 2019).

Conservation Measures and Best Management Practices:

- The recovery of the species should focus on the protection of the known populations and its habitat. Conservation Agreements should be signed between the Service and private landowners to protect natural populations (USFWS, 2013).

- The land on which the Rincón population of *B. vahlii* occurs should be transferred from PREPA either to PRDNER or to the Puerto Rico Conservation Trust. Then, a management plan for the conservation of the species should be developed and implemented. The Service will start to advise PREPA on the benefits for the ecosystem and for the species by protecting this natural area (USFWS, 2013).
- The populations that are actively reproducing need to be identified and monitored to collect seed material for propagation purposes. A protocol to collect seed should be created and implemented to avoid altering the natural recruitment of the species (USFWS, 2013).
- The efforts by José R. Roman and Michael Morgan to germinate and to propagate the species need to be coordinated toward the recovery (ensuring that propagated material is used for the establishment and enhancement of populations) of the species (USFWS, 2013).
- The Bayamón, Peñuelas-Ponce, and St. Croix populations should be visited, and monitored on a regular basis; additional visits should be made after hurricanes, fires, or other major disturbances to determine their impacts on the populations (USFWS, 2013).
- The recovery plan should be revised to establish measurable criteria, including how many individuals constitute a self-sustainable population and how many populations would be needed to delist the species (USFWS, 2013).
- Studies should be conducted to determine the patterns of genetic variation within and among populations, in order to develop a plan to preserve the species germplasm (USFWS, 2013).
- Rincón has one of the most active “environmentalist” communities in Puerto Rico, which might well be recruited to assist in the species’ conservation. In fact, *B. vahlii* may well be the only endangered plant species with a major population located at Rincón, so it may be proposed as an iconic species for environmental education among school children and the general public at a local level (USFWS, 2013).

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SPECIES ACCOUNT: *Callicarpa ampla* (Capa rosa)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 4/22/1992

Physical Description

An evergreen shrub or small tree reaching up to 15 meters (in) in height, with stout, tetragonal or subterete branches, and internodes of up to 6.5 centimeters (cm) long. Young branches are tetragonal, purplish-black in color, white scurfy, and glabrescent. The leaves are simple, opposite, decussate, and extipulate, dark shiny green above and pale green with white scurfy and raised veins and midveins below. The leaves are membranaceous or rarely subcoriaceous, measuring 8-35 cm long, and 3.5-8 cm wide; the leaf blade is elliptic to oblong, with an acute to acuminate apex, and with margins entire or slightly sinuate or dentate. The inflorescence is an axillary, corymbose cyme about 11 cm long. The cymes are densely whitish scurfy, with peduncles of 1-6.5 cm long. The flowers are actinomorphic and hermaphroditic. The species has a four-lobed, campanulate to subentire, lepidote or puberulent calyx which is 0.6-1.8 millimeters (mm) long and 1.3- 1.4 mm wide. The white four-lobed corolla is broadly tubular, measuring about 1.8 mm long and 1.7 mm wide. The four stamens of the flower measure 5.2 mm long, and are exerted and epipetalous at the base of the corolla. The four-lobed and four-celled ovary is subglobose, measuring about 1 mm in diameter. The fruit is a fleshy four-seeded drupe, about 6 mm in diameter. The fruit is whitish when young and becomes purple when ripe (Little et al. 1974). (USFWS, 1993)

Historical Range

Not Available

Current Range

Known from the lower montane forests of Puerto Rico (Ewel and Whitmore 1973) and one from St. Thomas, U.S. Virgin Islands (Vivaldi and Woodbury). (USFWS, 1993). As of 2019, predominantly restricted to El Yunque National Forest (EYNF) in northeastern Puerto Rico. (USFWS, 2019).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Unknown (USFWS, 2015)

Reproduction Narrative

Adult: Little is known about the reproductive biology of this species. Although adults in all populations of *Callicarpa ampla* were seen in either flower or fruit during February of 1991, seedlings have been seen in only one locality (Garcia and Laboy 1991). Fruits are present in

Holdridge herbarium specimen number 245, collected in September of 1940 (Vivaldi and Woodbury 1981a) (USFWS, 1993).

Habitat Type

Adult: Palo colorado forest (USFWS, 1993)

Habitat Vegetation or Surface Water Classification

Adult: Palo colorado forest (USFWS, 1993)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1993)

Site Fidelity

Adult: High (inferred from USFWS, 1993)

Habitat Narrative

Adult: The Luquillo Mountains region is of volcanic origin and of a rough topography, with cliffs and rock exposures at high elevations. Six major rivers are born in the mountains and waterfalls are numerous. Nineteen soils belonging to four soil associations have been identified within the Caribbean National Forest (Silander et al. 1986), of which the Los Guineos-Guayabota-Rock land association constitutes the most extensive one (USDA 1977). This association contains acidic, shallow to deep, well drained to poorly drained steep soils. The Caribbean National Forest holds four vegetation types: tabonuco forest, palo colorado forest, palma de sierra forest, and dwarf or elfin forest. All the known localities of *Callicarpa ampla* and *Styrax portoricensis*, and some localities of *Ternstroemia luquillensis* and *Ternstroemia subsessilis* occur within the palo colorado vegetation type. Some localities of *Ternstroemia luquillensis* and *Ternstroemia subsessilis*, and all the localities of *Ilex sentenisi* occur in the dwarf forest vegetation type (USFWS, 1993). High ecological integrity and site fidelity as well as low tolerance ranges are inferred based on species specific habitat needs and low number of populations.

Dispersal/Migration**Motility/Mobility**

Adult: Low (Inferred from USFWS, 1993)

Dispersal

Adult: Low (Inferred from USFWS, 1993)

Dependency on Other Individuals or Species for Dispersal

Adult: Low/Slow (inferred from USFWS, 1993)

Population Information and Trends**Population Trends:**

Unknown (USFWS, 2015)

Species Trends:

Unknown (USFWS, 2015)

Resiliency:

Low (inferred from USFWS, 2015)

Representation:

Low (inferred from USFWS, 2015)

Redundancy:

Low (inferred from USFWS, 2015)

Number of Populations:

5 (USFWS, 2015)

Population Size:

~15 total individuals (USFWS< 2015)

Population Narrative:

Callicarpa ampla: When the recovery plan was approved in 1995, the number of individuals of this species was known to be approximately 14 distributed within five localities in the Palo Colorado Association Forest Type in the Luquillo Mountains (USFWS 1995). During the interagency assessment in 2011, a total of 15 individuals were identified in only two natural populations within El Yunque National Forest (Table 1). From two localities reported in the Recovery Plan in the Rio Blanco Ward, municipality of Naguabo, only one site with three individuals was located by USFS personnel in 2011 (Luis Rivera, USFS, 2011, pers. comm.). A previously reported site at Mameyes II Ward, municipality of Rio Grande, was not located, and in the Jimenez Ward, also in Rio Grande, only one of the two populations identified in the recovery plan was located. The Jimenez population consists of 12 individuals (27 stems). The site with three planted individuals at El Portal Visitor Center also was recorded by USFS during the assessment (Table 1). These individuals are the product of one air layer (asexual propagation) from the Rio Blanco Ward site in Naguabo (USFS 1985) that was not located in 2011 and two additional artificial air layers produced from the Jimenez Ward site near Sonadora Creek (Luis Rivera, USFS, 2011, pers. comm.). There is no long term monitoring of the natural populations, and the USFWS does not have accurate location for most of the historical populations of *C. ampla*. It is possible that some of the populations not found during the 2011 assessment may be extirpated (e.g., by landslides) (see factor D). The USFWS suspects that additional populations of these species may occur within the El Yunque National Forest, and probably in some remnants of native forest in the Carite and Guilarte Commonwealth Forests. However, if present we anticipate low number of individuals and little recruitment, similar to the originally known populations in El Yunque (USFWS, 2015).

Threats and Stressors

Stressor: Forest management (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat/Loss of individuals

Narrative: At the time of listing, forest management practices such as the establishment and maintenance of plantations, selective cutting, trails and roads construction and maintenance,

and shelter construction may have affected these trees. Furthermore, the proposed reconstruction and reopening of Road PR 191 was considered as a direct threat to some populations of these species. The destruction of the dwarf or elfin forests for the construction and/or expansion of communication facilities by the U.S. Navy and private entities were also considered a threat. Based on the available information, the core of the known populations of *L. sintenisii*, *S. portoricensis*, *C. ampla*, *T. subsessilis*, and *T. luquillensis* occur within the boundaries of El Yunque National Forest. Since the time of listing the USFWS has not documented any case of an individual of an endangered species being affected by forest management practices (management of plantations, trail maintenance or road construction). Moreover, the plans to reopen Road PR 191 have been abandoned due to the potential for further landslides that may compromise the project. Nonetheless, the USFS consults with the Service under Section 7 of the ESA when proposing actions within the forest to ensure that possible adverse effects to listed species are avoided or minimized before any such project is implemented. In addition, the USFS conduct environmental reviews documents under NEPA for all actions in the forest. These consultation mechanisms are effective tools to minimize possible effects of management activities on species and their habitats. Based on the above, we consider the present or threatened destruction, modification, or curtailment of the species habitat or range as low in magnitude and not imminent threat to these species (USFWS, 2015).

Stressor: Overutilization (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Despite the fact that plant collection in El Yunque National Forest is prohibited, when the five species were listed, collection was considered a threat due to the ornamental potential of these species. However, there is no evidence indicating that the species has been affected by these factors. Based on the above, we believe that overutilization for commercial, scientific or educational purposes is no longer a threat to these species (USFWS, 2015).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat/Loss of individuals

Narrative: Since the currently known populations of these species are mostly restricted to El Yunque National Forest, and there are appropriate Commonwealth and Federal laws and regulations protecting these five species, we believe that the inadequacy of existing regulatory mechanisms should no longer be considered a threat to them. However, historical collections indicate that suitable habitat may extend to private properties adjacent to El Yunque. In fact, some of the known populations that occur within El Yunque National Forest are located just along the boundaries of the forest. Thus, it is important to note that enforcement on private lands continues to be a challenge as accidental damage or extirpation of individuals has occurred with other federally listed species due to lack of knowledge of the species by private land owners and law enforcement officers (USFWS, 2015).

Stressor: Hurricanes (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat/Loss of individuals

Narrative: Due to the low number of populations and individuals, hurricanes were identified as a threat to *I. sintenisii*, *S. portoricensis*, *C. ampla*, *T. subsessilis* and *T. luquillensis* in the final rule. As endemic to the Caribbean, these tree species should be well adapted to tropical storms disturbance. However, the low number of populations and individuals pose a threat to the species by making them more susceptible to stochastic events such as hurricanes. In fact, it is not clear to what extent populations of these species may have been affected by Hurricane Hugo (which devastated El Yunque National Forest in 1989) or Hurricane Georges (in 1998). The heavy rains associated with tropical storms and hurricanes in the mountains of Puerto Rico often lead to landslides. Despite the low number of populations and individuals, the USFWS considers hurricanes, landslides and climate change as a moderate and non-imminent threat to these species (USFWS, 2015).

Stressor: Landslides (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat/Loss of individuals

Narrative: Natural landslides are common as part of the forest dynamics of El Yunque and it is expected that the frequency of this disturbance increases as a result of severe extreme rain events or droughts. Given the steep slopes on which most of these species grow, massive landslides may extirpate entire populations. The USFWS is aware that an area of road PR 191 that formerly connected the municipalities of Río Grande and Naguabo, and that run across the forest has historically been affected by landslides. This area was the site of some populations that were not located by the interagency group in 2011. Due to the severity of landslides, it was determined that it was not logistically and economically feasible to repair this road. Based on the 2011 surveys, *I. sintenisii* seems to be the only species that is not imminently threatened by hurricanes and landslides. The prime habitat for *I. sintenisii* is associated with dwarf forest vegetation. Due to the low agricultural value and inaccessibility of this habitat, this vegetation was not cleared during the peak of the deforestation of the island, and thus some of the highest parts of El Yunque remain as pristine forest. This explains the relative abundance of the species along the summits of Pico El Yunque and Pico del Este. Despite the low number of populations and individuals, the USFWS considers hurricanes, landslides and climate change as a moderate and non-imminent threat to these species (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat/Loss of individuals

Narrative: This species may be further threatened by climate change, which is predicted to increase the frequency and strength of tropical storms and can cause severe droughts (Hopkinson et al. 2008). Vulnerability to climate change impacts is a function of sensitivity to those changes (e.g., changes rain regime and moisture availability), exposure to those changes, and adaptive capacity (Glick et al. 2011). Despite the relative abundance and apparently stability of the populations of *I. sintenisii*, its habitat is considered rare in Puerto Rico. These areas (dwarf forest vegetation) are ecological islands that harbor unique vegetation and environmental conditions. Shifts of vegetation communities are expected as temperatures and moisture regimes are altered by climate change. Under this scenario populations of *I. sintenisii* as well as *S. portoricensis*, *C. ampla*, *T. subsessilis*, and *T. luquillensis* may be displaced or outcompeted by native or exotic species with wider environmental plasticity. Despite the low number of

populations and individuals, the USFWS considers hurricanes, landslides and climate change as a moderate and non-imminent threat to these species (USFWS, 2015).

Stressor: Genetic variation (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of viability

Narrative: Along with a decreasing population size, negative impacts of habitat fragmentation may result in erosion of genetic variation through the loss of alleles by random genetic drift (Honney and Jacquemyn 2007) and may also limit the ability of a species to respond to a changing environment (Booy et al. 2000). Given the extremely small population size and lack of connectivity between populations of *S. portoricensis*, *C. ampla*, *T. subsessilis* and *T. luquillensis* in Puerto Rico, it is highly likely that their genetic variability is extremely low. Based on the above, we consider the lack of genetic variation a high and imminent threat to *S. portoricensis*, *C. ampla*, *T. subsessilis* and *T. luquillensis*. Overall, we consider hurricanes, landslides, climate change and genetic variation as threats to *S. portoricensis*, *C. ampla*, *T. subsessilis* and *T. luquillensis*. Due to the small number of populations, the USFWS considers the above mentioned threats as high in magnitude and imminent for those species. In the case of *I. sintenisii*, the species is at least stable and probably improving, thus we consider the above mentioned threats as low and non-imminent (USFWS, 2015).

Recovery

Reclassification Criteria:

An agreement between the Fish and Wildlife Service and the USDA Forest Service concerning the protection of *Callicarpa ampla*, *Ilex sintenisii*, *Styrax portoricensis*, *Ternstroemia luquillensis*, and *Ternstroemia subsessilis* within the Caribbean. National Forest property has been prepared and implemented (USFWS, 1993).

An agreement between the Fish and Wildlife Service and the Department of Natural and Environmental Resources (DNER) concerning the protection of the three species in Commonwealth forests has been prepared and implemented, if the species is found within DNER properties (USFWS, 1993).

New populations (the number of which should be determined following the appropriate studies) capable of self perpetuation have been established within protected areas (USFWS, 1993).

Delisting Criteria:

1. Existing natural populations exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (addresses Factors E). (USFWS, 2019).
2. Establish or discover four (4) additional populations each of *Callicarpa ampla* within the current range at EYNF that exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (addresses Factors A and E). (USFWS, 2019).
3. Establish or discover two (2) new populations of *Callicarpa ampla* outside the current range but within the historical range (e.g., Carite, Guilarte or Toro Negro Commonwealth Forests) that

exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (addresses Factors A and E). (USFWS, 2019).

4. Threats have been addressed and/or managed to the extent that the species will remain viable into the foreseeable future (addresses Factor A and E). (USFWS, 2019).

Recovery Actions:

- Criterion 1 has been partially met. There is no formal agreement between the USFS and the USFWS for the implementation of a management plan to protect these five species. However, the El Yunque National Forest is managed by the USFS for conservation, and has an approved “Revised Land and Resource Management Plan” (1997), which is currently under revision. Moreover, Federal agencies are mandated to carry out programs for the conservation of endangered species under Section 7 of the Endangered Species Act (ESA) to ensure that any action authorized, funded or carried out by a Federal agency is not likely to jeopardize the continued existence of a federally listed species. Thus, the USFS continually consults with the USFWS to avoid and minimize impacts to listed species and their habitat at El Yunque National Forest. In addition, on July 26, 2005, the U.S. Congress enacted the Caribbean National Forest Act to designate approximately 10,000 acres of land in the El Yunque National Forest as wilderness and as a component of the National Wilderness Preservation System in accordance with the Wilderness Act (16 U.S.C. 1131 et seq.). This Act prohibits certain activities (e.g., timber harvest) within wilderness designated areas, although it does not preclude the installation and maintenance of facilities (e.g., data collection and remote transmission facilities) essential to the scientific and conservation purposes of the Forest Service. Therefore, the majority of the habitat upon which these species depend upon is essentially protected (USFWS, 2015).
- Criterion 2 has been partially met. Although there is no specific agreement between USFWS and the PRDNER concerning the protection of these three species in Commonwealth forests, there is an agreement between the two agencies under Section 6 of the Endangered Species Act, in which the PRDNER carries out conservation activities for the benefit of threatened and endangered species. Furthermore, these five species are listed by the PRDNER as endangered, and thus are protected by regulations of the Commonwealth of Puerto Rico (See factor D.). Therefore, special consideration is taken when considering actions within areas that harbor suitable habitat for these species (USFWS, 2015).
- Criterion 3 has been initiated. The Puerto Rico Conservation Trust (PRCT) is successfully propagating *Styrax portoricensis*. The USFWS has utilized some of this material and begun planting this species (approximately 50 individuals) at El Yunque National Forest. In addition, the PRDNER began planting *Styrax portoricensis* (approximately 5 individuals) in the Carite Commonwealth Forest. Furthermore, the USFS has propagated *Callicarpa ampla* by air layering (cloning by promoting rooting of branches using hormones), and has planted about three individuals at El Portal in El Yunque National Forest. However, little information is available about the reproductive biology and the ecology of these species. Further research and monitoring of reintroduced individuals is required to determine the success of these actions. There is no information about the propagation of any of the remaining three species (*Ilex sintenisii*, *Ternstroemia luquillensis* and *Ternstroemia subsessilis*) (USFWS, 2015).
- New in 2019: 1. Establish long-term conservation mechanisms (e.g., land conservation easements and conservation agreements) for private lands outside/bordering EYNF since

- these lands share similar vegetation and habitat characteristics. This new action should be included within Recovery Task 11. (USFWS, 2019).
- New in 2019 2: A protocol for the propagation and reintroduction of all five species should be developed in collaboration with partners (e.g., University of Puerto Rico, KEW, Fairchild Tropical Botanic Garden, PRDNER, Para La Naturaleza and Natural Resources Conservation Service). The protocol should address the feasibility of seed banking these species, and if deemed necessary, seed material should be stored at the Millennium Seed Bank (KEW) and USDA National Laboratory for Genetic Resources Preservation in Ft. Collins. This new action should be included within Recovery Task 33. (USFWS, 2019).
 - 2019 3. Studies in the species' population genetics should be conducted to determined patterns of genetic diversity across the species natural distribution, and to provide baseline information for sound management of these species. This new action should be included within Recovery Task 3. (USFWS, 2019).

Conservation Measures and Best Management Practices:

- 1. The USFS should establish a long term monitoring program for the populations of listed plants at El Yunque National Forest to determine population trends for these species. The guidelines for these monitoring should be included as part of the El Yunque National Forest Management Plan (USFWS, 2015).
- 2. Develop a comprehensive survey and assessment of the population of *I. sintenisii*. This survey must be standardized to ensure that the habitat (dwarf forest) is efficiently surveyed (USFWS, 2015).
- 3. Molecular studies should be conducted to determine the relationships within the genus *Ilex* in Puerto Rico (USFWS, 2015).
- 4. The USFS, PRDNER and the USFWS should develop an intensive survey program to inventory areas within and outside El Yunque National Forest with potential habitat for these species. This program should include training to field biologists to allow personnel to recognize listed species in the field (USFWS, 2015).
- 5. The populations that are actively producing seeds need to be identified and monitored to collect seed material for recovery purposes. A protocol to collect seed should be developed and implemented to avoid altering the natural recruitment of the species (USFWS, 2015).
- 6. Enhancement of natural populations should be considered a priority, particularly for *S. portoricensis*, *C. ampla*, *T. subsessilis* and *T. luquillensis*. The development of adequate propagation techniques is essential for the recovery of these species (USFWS, 2015).
- 7. Studies should be conducted to determine the patterns of genetic variation within and among populations, in order to develop a plan to preserve the species genetic variability (USFWS, 2015).
- 8. The recovery plan should be revised to establish measurable delisting criteria, including how many individuals constitute a self-sustainable population and how many populations would be needed to delist the species (USFWS, 2015).

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5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Southeast Region, Caribbean Ecological Services Field Office, Boquerón, Puerto Rico.

SPECIES ACCOUNT: *Callirhoe scabriuscula* (Texas poppy-mallow)

Species Taxonomic and Listing Information

Listing Status: Endangered; 2/12/1981; Southwest

Physical Description

A perennial herbaceous plant found in deep, loose, sandy soils near the Colorado River in west Texas. The fleshy taproots extend about 45 centimeters (cm) (18 inches (in)) deep before branching. During the winter, the plants form rosettes of 3 to 8 basal leaves that have 3 to 5 palmately-arranged lobes. Flower stalks emerge in the spring, reaching up to 45 cm (18 in) tall. The stems and leaves have a rough texture due to a covering of stellate pubescence (star-shaped hairs). Flowers have 5 reddish-purple petals, about 3.8 cm (1.5 in) long, arranged in the form of a cup, with dark maroon centers. This species is distinguished from others in the Genus by its linear involucellar bractlets, valvate calyx lobes that form an apiculate or acuminate point in bud (cover photograph), indehiscent mericarps, stiffly erect stems, and 6- to 8-rayed stellate hairs. (USFWS, 2019a)

Taxonomy

Robinson (1895–1897, p. 302) described *Callirhoe scabriuscula* as a new species in the Malvaceae (Mallow Family), based on a single specimen collected by Dr. Sutton Hayes. Robinson distinguished this from other species in the genus by its densely pubescent carpels with short beaks and involucl of 3 linear bractlets (figure 1.e.a). *Callirhoe leiocarpa* (tall poppymallow) and *C. involucrata* (winecup) occur near *C. scabriuscula*. These are distinguished by smaller flowers with white petal bases and the absence of stellate pubescence; additionally, *C. leiocarpa* is an annual species and lacks an involucl, and *C. involucrata* has a prostrate rather than erect habit. (USFWS, 2019a)

Historical Range

Historically known from Runnels County, Texas.

Current Range

In four counties in Texas: Runnels, Coke, Mitchell, and Scurry. (USFWS, 2019a)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: short-lived perennial (USFWS, 2019a)

Breeding Season

Adult: Flowers from late April to mid-June (USFWS, 2019a).

Key Resources Needed for Breeding

Adult: Insects for pollination (USFWS, 1985).

Reproduction Narrative

Adult: Texas poppy-mallow flowers from late April until mid-June (Amos 1979, pp. 8–10; USFWS 1985, pp. 7–9). Flowers open 2 to 3 hours after sunrise and close before sunset. If pollinated, flowers close within 30 to 90 minutes. Un-pollinated flowers continue to open for 6 to 8 days. Anthers of individual flowers mature prior to stigmas (figure 1.d), releasing their pollen about 36 hours before stigmas emerge. Less than 1 percent of flowers from which insects were excluded produced seeds. Conversely, 85 percent of open-pollinated flowers produced seeds; therefore, Texas poppy-mallow is a predominantly out-crossing species. Plants produced an average of 41.4 fruits per plant per year, and fruits averaged 19 seeds each; thus, individuals produced an average of 878 seeds per year. Three species of bees, *Diadasia afflicta*, *Melissodes intorta*, and *M. tepanica*, forage for nectar and pollen in Texas poppy-mallow flowers and use the staminal column as a landing and take-off platform; the foraging behaviors of these bees indicates that they are likely to be effective pollinators. *D. afflicta* and *M. intorta* are oligolectic species that forage primarily within the genus *Callirhoe*. Seeds mature and dehisce from 10 to 18 days after flowering and fertilization. Flowering ceases by late June, as the weather becomes increasingly hot and dry, and the stems die by late July. New rosettes emerge from the taproots in late August and September. (USFWS, 2019a)

Habitat Type

Adult: Terrestrial (USFWS, 2019a)

Habitat Vegetation or Surface Water Classification

Adult: Grasslands, shin oak shrublands, or open oak or mesquite woodlands (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Deep sandy soil blown from alluvial deposits along the Colorado River (USFWS, 2019a)

Habitat Narrative

Adult: Texas poppy-mallow occurs in deep, loose sands of the Tivoli and Brownfield Soil Series (USFWS 1985, pp. 3–4). These sands are carried by wind from alluvial formations in the Colorado River flood plain and deposited on the lee (north and east) side of the river (USDA Soil Conservation Service 1970, p. 26). The difference between Tivoli and Brownfield soils is that the former lacks a distinct B horizon, while the latter has a sandy clay subsoil at a depth of about 0.51–1.02 m (20–40 in). Dunes up to 9 m (30 ft) high and 61 m (200 ft) wide form to the lee of cultivated fields. These soils have very rapid rainfall infiltration rates, very little runoff, and low water holding capacity. Cruze (1991, pp. 12, 15) found 159 Texas poppy-mallow plants within an area of 225 m² (2,422 ft²) at the study site at EO3. About 80 percent of Texas poppy-mallow plants occurred on 1-m² (10.76 ft²) plots that had from 3 to 16 percent cover of forbs and grasses; 79 percent of plots were within this range of vegetative cover (p. 12). This demonstrates that occupied habitats have sparse vegetative cover. (USFWS, 2019a)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Cruze (1991) investigated the soil seed reserve of the Runnels County population mentioned above (EO3). She recovered 325 seeds from 6,583 soil samples totaling 1.7 m³ (60.0

ft3) of soil (pp. 6, 9). Seed distribution was uneven, with 91 percent of recovered seeds in the uppermost 5 cm of the soil; 85 percent of seeds were found within 1 m (3.28 ft) in horizontal distance of an established individual (pp. 9–11), indicating that seeds have very limited dispersal. Seed viability, tested with tetrazolium chloride, was 16.3 percent (p. 12); on this basis, the author concluded that seed viability declines rapidly in the soil (p. 19). (USFWS, 2019a)

Population Information and Trends

Population Trends:

Not available.

Species Trends:

Not available.

Number of Populations:

10 (USFWS, 2019a)

Population Size:

Approximately 2800 individuals (USFWS, 2019a)

Minimum Viable Population Size:

1,300 mature, reproductive individuals (USFWS, 2019a)

Population Narrative:

The Texas Natural Heritage Program conducted extensive surveys for Texas poppy-mallow from 1987 through 1989 at 143 sites in 37 counties (Poole (1990). This project documented 9 new populations at 6 sites in Runnels, Coke, and Mitchell counties, totaling 2,817 individuals, and reported an additional population discovered in Coke County in 1990 by an environmental consultant (Poole 1990, pp. 1, 3). All populations were found in areas of intact native vegetation on deep, loose, sandy soils of the Tivoli and Brownfield Series near the Colorado River (note that Likes and Heatly are alternate names for the Tivoli and Brownfield soil map units, respectively). The species has now been documented in four counties—Runnels, Coke, Mitchell, and Scurry (Amos 2008, 2019). The most recent censuses (TXNDD 2019) for all known EOs totals less than 3,000 individuals; however, we have no survey data more recent than 2001. All known populations of Texas poppy-mallow occur in Tivoli (Likes) and Brownfield (Heatly) fine sands (NRCS 2019c) in Runnels, Coke, Mitchells, and Scurry counties. Although we do not have geographic data for populations in Scurry County, Amos (2008, 2019) confirmed that at least one population extends from northern Mitchell County into southern Scurry County. The known populations span a linear distance of about 155 km (96 mi) from northwest to southeast. Within the counties mentioned, NRCS (2019c) classifies 16,987 ha (41,975 ac) as Tivoli (Likes) or Brownfield (Heatly) fine sands. (USFWS, 2019a)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 1981)

Exposure:

Response:

Consequence:

Narrative: Much of the natural habitat of *Callirhoe scabriuscula* has been disturbed. The present-range is limited to one Texas county, much of which is no longer suitable habitat for the plant. The actual area covered by the plant is very small. The range is dissected by a four-lane divided highway (Highway 67) and two frontage roads. All of the land on which the plants now occur is in private ownership. Cultivation, establishment of rural residences, and development of roads and a railway have reduced the range and the size of the populations. An imminent threat to all existing populations is commercial sand mining within the plant's habitat (USFWS, 1981).

Stressor: Overutilization (USFWS, 1981)

Exposure:

Response:

Consequence:

Narrative: If exact localities were published, the plant's conspicuous and showy blooms could cause it to be threatened by amateur gardeners wildflower enthusiasts, and commercial horticultural collecting. Since all the populations occur on privately owned land, taking of these attractive plants could not be prohibited (USFWS, 1981).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2019a)

Exposure:

Response:

Consequence:

Narrative: The ESA does provide some legal protection for federally-listed plants on land under federal jurisdiction; however, the known populations of Texas poppy-mallow occur almost entirely on privately-owned land (as well as a small amount of state highway ROW). Federally-listed plants occurring on private lands have limited protection under the ESA, unless they are protected by state laws; the State of Texas also provides very little protection to listed plant species on private lands. It is reasonable to assume that any undiscovered populations are also likely to be privately owned. Therefore, none of the species' populations and habitats are subject to federal protection unless there is a federal nexus, such as provisions of the Clean Water Act, or a federally-funded project, for example, a new highway or water treatment plant. Chapter 88 of the Texas Parks and Wildlife Code lists plant species as state-threatened or endangered once they are federally listed with these statuses. The State of Texas listed Texas poppy-mallow as endangered on April 29, 1983. The State prohibits taking and/or possession for commercial sale of all or any part of an endangered, threatened, or protected plant from public land. Texas Parks and Wildlife Department requires permits for the commercial use of listed plants collected from private land. Scientific permits are required for collection of endangered plants or plant parts from public lands for scientific or educational purposes. In addition to state endangered species regulations, other state laws may apply. For example, state law prohibits the destruction or removal of any plant species from state lands without a Texas Parks and Wildlife Department permit. (USFWS, 2019a)

Stressor: Demographic and genetic consequences of small population sizes (USFWS, 2019a)

Exposure:

Response:

Consequence:

Narrative: Small populations are less able to recover from losses caused by random fluctuations in recruitment (demographic stochasticity) or variations in rainfall (environmental stochasticity) (Shaffer and Stein 2000, pp. 308-310). In addition to population size, it is likely that population

density also influences population viability, since successful sexual outcrossing—necessary to maintain genetic diversity in populations—requires genetically distinct individuals to be in sufficiently close proximity for cross-pollination to occur. Small, reproductively isolated populations are also susceptible to the loss of genetic diversity, to genetic drift, and to inbreeding depression. The combined demographic and genetic consequences of small population sizes may reduce population recruitment, leading to an extinction vortex of even smaller populations, greater isolation, decreasing genetic diversity, and loss of viability. These factors may already have contributed to the restriction of Texas poppy-mallow to its current state of extreme endemism in the Tivoli (Likes) and Brownfield (Heatly) sands along the Colorado River of Texas. (USFWS, 2019a)

Recovery

Reclassification Criteria:

1. Texas poppy-mallow is documented in 10 or more protected, viable populations, with at least 3 viable populations in each of 3 recovery units. Populations and metapopulations are delineated by unpopulated gaps of at least 1 km (0.6 mi). However, viable populations that expand and merge with other populations may be counted as separate populations for the specific purpose of meeting this criterion. (USFWS, 2019b)
2. Viable populations have 1,600 or more mature individuals. Mature individuals have flowered at least once or are judged capable of flowering. Population surveys should be conducted during the peak of flowering and fruiting, from April through June. (USFWS, 2019b)
3. Protected populations occur on lands that are legally protected and managed to conserve the Region's native flora and fauna, including Texas poppy-mallow, its habitats, and its pollinators. Examples include, but are not limited to, conservation easements on private lands, lands owned and managed for conservation by non-profit organizations, publicly-owned land managed for conservation purposes, and legally binding long-term management agreements with private landowners. (USFWS, 2019b)

Delisting Criteria:

1. Periodic monitoring indicates that the downlisting criteria have been met, and that demographic trends have subsequently remained stable or have increased over a period of 25 years. Ideally, monitoring (censuses) of each protected population should be conducted during years of above-average April–May rainfall; trend detection should be based on the largest populations observed during each 5-year period. (USFWS, 2019b)

Recovery Actions:

- Manage presently known individuals and habitat for maintenance and expansion of existing wild populations.. A crucial step in recovery is to protect existing populations and the habitat upon which they depend. All populations are threatened by expansion of commercial sand mining and development. The land presently inhabited by the Texas poppy-mallow is under private ownership. The Endangered Species Act is most effective in protecting populations on Federal lands. Immediate protection of the habitat and cooperation with landowners is essential to recovery of the species. (USFWS, 1985)

- Sustain healthy populations in their natural habitat at existing sites. In order to develop management plans for sustaining healthy populations, it may be necessary to learn more about the Texas poppy-mallow. (USFWS, 1985)
- Search potential habitat for additional populations. Other windblown sand deposits similar to the habitat presently occupied by Texas poppy—mallow exist on the upper Colorado River between Ballinger and Colorado City (a distance of about 80 miles). These areas need to be thoroughly searched for new populations. Additionally, deep sands are extensive in Jones, Haskell, Knox, Foard, Hardeman, and adjacent counties north of the presently known populations. Suitable habitat may exist in some of these counties and they should also be searched for presence of the species structure. (USFWS, 1985)
- Establish additional populations within the historic range. If searches fail to locate enough new populations to ensure safety for the species, expanding present populations within the essential habitat and introducing the species into new areas within its historic range would diminish the risk of extinction. (USFWS, 1985)
- Develop public awareness, appreciation, and support for presentation of the Texas poppy-mallow. Education and cooperation of the public is a vital part of the recovery process. Enlist the support of public interest groups such as the Texas Organization for Endangered Species, The Nature Conservancy, and local garden clubs. The visibility of this support can be instrumental in shaping public opinion. Useful tools in this endeavor would include talks and slide presentations to local interest groups and articles on the Texas poppy-mallow in newspapers and nature magazines. (USFWS, 1985)
- Recommendation for Future Action (USFWS, 2019a): Revise the recovery plan and recovery criteria to incorporate updated guidance and specific, measurable recovery criteria (U.S. Fish and Wildlife Service 2017). Use the MVP level and population delimitation distances described in this review as components of recovery criteria that address resilience and redundancy. Adopt the provisional recovery units discussed in this review to develop recovery criteria that address the species' ecological and genetic representation.
- Recommendation for Future Action (USFWS, 2019a): Promote awareness and conservation of Texas poppy-mallow in Runnels, Coke, Mitchell, and Scurry counties.
- Recommendation for Future Action (USFWS, 2019a): Seek permission to survey and monitor populations on private land.
- Recommendation for Future Action (USFWS, 2019a): Conduct up-to-date censuses of the accessible populations and revise the TXNDD EO records.
- Recommendation for Future Action (USFWS, 2019a): Work cooperatively with private landowners who are interested in conserving and managing the species on their lands. Consider voluntary measures to confer long-term protection for populations on private lands, such as conservation agreements and conservation easements.
- Recommendation for Future Action (USFWS, 2019a): Propagate the species, using seeds in the Lady Bird Johnson Wildflower Center seed bank, to establish seed production plots, renew the seed bank, and reintroduce populations in appropriate sites that can be protected.
- Recommendation for Future Action (USFWS, 2019a): Recommendation for Future Action (USFWS, 2019a): Obtain support for conservation actions from the Cooperative Endangered Species Conservation Fund (Section 6) or other grant sources.

Conservation Measures and Best Management Practices:

- Not available.

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SPECIES ACCOUNT: *Calypttranthes thomasiana* (Thomas' Lidflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 2/18/1994; Southeast Region (R4) (USFWS, 2015)

Physical Description

An evergreen shrub or small tree that may reach 10 meters (30 feet) in height and 13 centimeters (5 inches) in diameter. Leaves are opposite, obovate to oblong, 2 to 4 centimeters long, blunt at the apex, and short pointed at the base. The leaves are coriaceous, with gland dots, shiny on the upper surface, and dull on the lower surface. The inflorescences are subaxillary and the cymes trichotomous. Flower-buds are obovoid, apiculate, and 3 millimeters long. Flowers have four small, spatulate petals. The fruit has not been described (Liogier 1994) (USFWS, 1997).

Taxonomy

It may be pointed out that the recovery plan for *Calypttranthes thomasiana* (USFWS, 1997) cites “no common name” but Thomas' Lidflower seems well established: Lidflower is the common name in English for other *Calypttranthes* species and Thomas is an appropriate geographical reference. This common name has been adopted by both the USDA PLANTS database and the IUCN Red List (USFWS, 2013).

Historical Range

At the time of listing, Thomas' Lidflower was reported from small populations from four islands: Vieques (PR), St. John and St. Thomas (USVI), and Virgin Gorda (BVI) (Clubbe et al. 2003) (USFWS, 2013).

Current Range

Currently, the species is known only from St. John and Virgin Gorda (USFWS, 2013). As of 2019: The known species occurrence is restricted to the USVI and BVI: St. John and St. Thomas (USVI), and Virgin Gorda and Tortola (BVI) (USFWS 2013). The species is estimated to be between 1,000 and 2,000 mature individuals and all sub-populations are suspected of having less than 1,000 mature individuals (IUCN 2018). In St John, the species is located within the Virgin Islands National Park managed by the U.S. National Park Service. (USFWS, 2019). In St. Thomas, the species was rediscovered by local plant experts and occurs at possibly two locations with an estimated population of 30 to 45 individuals between the two sites (IUCN 2018). (USFWS, 2019b).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Dependency on Other Individuals or Species

Adult: Unknown - possibly insects (EPA, 2016)

Reproduction Narrative

Adult: Insects are potential pollinators (EPA, 2016).

Habitat Type

Adult: Terrestrial (EPA, 2016)

Habitat Vegetation or Surface Water Classification

Adult: Subtropical moist forest (EPA, 2016)

Geographic or Habitat Restraints or Barriers

Adult: 984 - 1312 ft. elevation (EPA, 2016)

Environmental Specificity

Adult: Narrow (inferred from EPA, 2016)

Habitat Narrative

Adult: Occurs primarily within the subtropical moist forest life zone, perhaps extending into the subtropical dry forest zone. It has been reported to exist in the moist forest type at the Gorda Peak National Park in Virgin Gorda. In St. John, the species is found in the moist forest life zone but on the windward side of the Bordeaux Mountain where the effects of the wind make it a drier forest type. Rainfall ranges from 600 to 1,100 mm (24-44 in.) per year in the subtropical dry forest and from 1,100 to 2,200 mm (44-88 in.) per year in the subtropical moist forest. Soils are volcanic in origin and dominated by Cramer clay loam (St. John). Soils classified as Pandura-Very Stony Land Complex and is characterized by shallow, well-drained soils that are moderately permeable and acidic (Monte Pirata). Occurs between 984 and 1312 ft. elevation (EPA, 2016).

Dispersal/Migration**Dependency on Other Individuals or Species for Dispersal**

Adult: Bats (EPA, 2016)

Dispersal/Migration Narrative

Adult: Bats have been observed feeding on the fruits. Fruit dispersal also potentially occurs via abiotic factors (EPA, 2016).

Population Information and Trends**Population Trends:**

Decreasing (USFWS, 2013)

Species Trends:

Unknown (USFWS, 2013)

Resiliency:

Very low (inferred from USFWS, 2013)

Representation:

Low (inferred from USFWS, 2013)

Redundancy:

Very low (inferred from USFWS, 2013)

Number of Populations:

2 (USFWS, 2013)

Population Size:

59 (USFWS, 2013). At present time, between 1,000 and 2,000 mature individuals are known to occur in four sites: St Thomas, St. John, Virgin Gorda and Tortola (IUCN 2018). (USFWS, 2019).

Population Narrative:

The species status is unknown; the populations of Thomas' Lidflower have been poorly monitored and no information on population trends and demographic features are currently available. New information on the Thomas' Lidflower indicates that the species' population has decreased since the time of listing in 1994. Clubbe et al. (2003) cited that work in the BVI has documented a single locality on Virgin Gorda that comprises two subpopulations, one with 34 and another with 25 mature individuals, making a total population size for Virgin Gorda at 59 individuals within Gorda Peak National Park. With respect to the population from Vieques, recently, species' experts excluded the species from that island. Limited distribution suggests this species has low genetic variability (USFWS, 2013).

Threats and Stressors

Stressor: Exotic mammals (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Exotic mammals such as white-tailed deer (*Odocoileus virginianus*) and wild domestic mammal such as feral goats (*Capra aegagrus hircus*), pigs (*Sus scrofa*), and donkeys (*Equus asinus*) are found throughout the range of the Thomas' Lidflower on St. John and Virgin Gorda (Carlos Pacheco, USFWS, 2012, pers. obs.). Clubbe et al (2003) also mentioned loose cattle trampling through the Gorda Peak National Park may pose a threat to individuals in Virgin Gorda. It is expected that, due to their abundance, these exotic mammals are modifying the forest structure through overgrazing or altered seed dispersal mechanisms (Chakroff 2010). This may imply changes to microhabitat conditions that are necessary for seed germination and seedling recruitment of the specie (USFWS, 2013).

Stressor: Habitat destruction and modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: The Thomas' Lidflower population in Virgin Gorda lies within the Gorda Peak National Park. Clubbe et al (2003) cited that some developments are occurring close to the Park boundary that may negatively affect the species' habitat and could result in loss of mature individuals. The author also mentioned increase of visitation by hikers (locals and tourist) through the walking trails and human trampling through the Park to exploring new areas may result in losses of individuals in Virgin Gorda. Proctor (1992) stated that although Thomas' Lidflower had not been

found on St. Thomas since 1980, deforestation at the collection area for residential and tourist development may pose imminent threats to the survival of the species, if present (USFWS, 2013).

Stressor: Limited distribution (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Thomas' Lidflower is vulnerable to extinction due to its limited distribution and highly specialized ecological requirements. The low population number and restricted distribution (i.e., only 2 populations reported), coupled with habitat alteration or loss may also exacerbate its vulnerability to natural or anthropogenic events such as hurricanes, compromising the continued existence of this species (USFWS 1997). Given the extremely limited geographic distribution of Thomas' Lidflower, it is highly likely that its genetic variability is very low. This would result in a loss of alleles by random genetic drift, which would limit the species' ability to respond to changes in the environment (Honney and Jacquemyn, 2007) (USFWS, 2013).

Stressor: Invasive species (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: The most comprehensive forest inventory of the U.S. Virgin Islands indicate that three most common plant species are the invasive exotic plants, *Leucaena leucocephala*, *Tecoma stans* and *Megathyrsus maximus* (Chakaroff 2012). Any disturbance on vegetation along the road may create conditions favorable for the establishment of invasive species that may outcompete with native plants species changing vegetation structure. Invasive species (e.g. *Leucaena leucocephala* and *Megathyrsus maximus*) may spread and colonized the Thomas' Lidflower habitat, and it could alter fire regimes, microclimate, and nutrient cycling of the habitat that the species depend (USFWS, 2013).

Stressor: Climate change (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: As a species endemic to the Lesser Antillean, the Thomas' Lidflower should be adapted to hurricanes, but its occurrence at the highest elevations of St John and Virgin Gorda, where winds may be stronger, may place it at increased risk, especially as climate change is predicted to increase the frequency and strength of hurricanes. Hurricane winds often lead to tree defoliation, loss of small and large branches, and up-rooted resulting in damage to adjacent trees and understory plants when trees or branches fall, and ultraviolet damage to leaves of understory juveniles exposed to high light levels (Brokaw and Walker 1991). Additionally, high rainfall associated with tropical storms and hurricanes, sometimes about 24 inches (2 feet) of rain in a single storm event, can cause floods and interacting with topography and geologic substrate may induce mass wasting events, e.g. land, mud and debris slides (Lugo 2000). An expected effect of the climate change is the increase in intensity of hurricanes and tropical storm, followed by extended period of drought (IPCC 2012). This climate change may alter (modify) the surrounding vegetation around the populations of the Thomas' Lidflower. Hurricane effects followed by extended period of drought may result in changes in soil conditions and

microclimate and may allow other plants (native or non-native, herbaceous or woody) adapted to drier conditions to become established (Lugo 2000) (USFWS, 2013).

Recovery

Reclassification Criteria:

1. An agreement between the U.S. Fish and Wildlife Service and the U.S. Navy has been prepared and implemented for the protection of the known population on Vieques (USFWS, 2013). Criteria deemed obsolete in 2019. (USFWS, 2019).
2. An agreement between the U.S. Fish and Wildlife Service and the National Park Service has been prepared and implemented for the protection of the known population on St. John (USFWS, 2013).
3. New populations (the number of which should be determined following the appropriate studies) capable of self-perpetuation have been established in protected areas such as other areas on Vieques or St. John (USFWS, 2013).

Delisting Criteria:

1. The two (2) existing populations on the U.S. Virgin Islands, and two (2) existing populations on the British Virgin Islands show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factors A and E). (USFWS, 2019b).
2. Populations that exists on privately owned lands on St. Thomas are protected and managed through a conservation mechanisms (addresses Factor A). (USFWS, 2019b).
3. Establish two (2) new populations on lands protected by a conservation mechanism, and these populations show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factors A and E). (USFWS, 2019b).
4. Threat reduction and management activities have been implemented to a degree that the species will remain viable into the foreseeable future (addresses Factor C). (USFWS, 2019b).

Recovery Actions:

- Protect the existing population and its habitat through an agreement with the U.S. Navy and National Park Service (USFWS, 1997).
- Develop a management plan for the species in cooperation with these entities (USFWS, 1997). Refinement in 2019: The Service and the National Park Service should develop a plan with specific actions for the management and enhancement of existing populations within the Virgin Islands National Park. (USFWS, 2019, Recommended Action 7).
- Monitor known populations (USFWS, 1997). Refinement in 2019: The population should be monitored on a regular basis, and additional survey visits should be made after hurricanes, landslides, or other major disturbances. The known population at St. John should be monitored on a long term basis to determine the species' trends. (USFWS, 2019, recommended action #6).
- Enforce existing Commonwealth and Federal endangered species regulations (USFWS, 1997).

- Conduct research on the life history of the species and evaluate propagation techniques (USFWS, 1997). Refinement in 2019: Studies should be conducted on the species' phenology and reproductive biology. (USFWS, 2019, Recommended Action 3).
- Conduct propagation and enhance existing populations or establish new ones on protected lands (USFWS, 1997). Refinement in 2019: Propagation and reintroduction of the species should be conducted in order to strengthen the existing population. This action should be carefully evaluated by the Service taking into consideration if the species continues to be viable, existing threats to the species, genetic variations and if we can find ways to propagate without seeds. (USFWS, 2019, Recommended action 5).
- New in 2019: The status (distribution, abundance, possible threats) of Thomas' Lidflower in the U.S. and BVI should be ascertained. Mechanisms should be developed to share information on this and other Puerto Rican Bank species, and to coordinate conservation plans and activities. (USFWS, 2019, Recommended Action 1).
- New in 2019: Field surveys on Thomas' Lidflower should be conducted within historical sites and in non-traditional sites with suitable habitat to determine the existence of this species. (USFWS, 2019, Recommended action 2)
- New in 2019: Studies should be conducted to determine the patterns of genetic variation, in order to develop a plan to preserve the species' germplasm. (USFWS, 2019, Recommended Action 4).
- New in 2019: As new information becomes available, when individuals are documented, and the Service works further with partners like the National Park Service, the recovery plan should be revisited and possibly revised to establish measurable criteria, including how many individuals constitute a self-sustainable population and how many populations would be needed to delist the species. (USFWS, 2019, Recommended action 8).

Conservation Measures and Best Management Practices:

- The status (distribution, abundance, possible threats) of Thomas' Lidflower in the U.S. and BVI should be ascertained. Mechanisms should be developed to share information on this and other Puerto Rican Bank species, and to coordinate conservation plans and activities (USFWS, 2013).
- Field surveys on Thomas' Lidflower should be conducted within historical sites and in non-traditional sites with suitable habitat to determine the existence of this species (USFWS, 2013).
- Studies should be conducted on the species' phenology and reproductive biology (USFWS, 2013).
- Studies should be conducted to determine the patterns of genetic variation, in order to develop a plan to preserve the species' germplasm (USFWS, 2013).
- Propagation and reintroduction of the species should be conducted in order to strengthen the existing population. This action should be carefully evaluated by the Service taking into consideration if the species continues to be viable, existing threats to the species, genetic variations and if we can find ways to propagate without seeds (USFWS, 2013).
- The population should be monitored on a regular basis, and additional survey visits should be made after hurricanes, landslides, or other major disturbances. The known population at St. John should be monitored on a long term basis to determine the species' trends (USFWS, 2013).
- The Service and the National Park Service should develop a plan with specific actions for the management and enhancement of existing populations within the Virgin Islands National Park (USFWS, 2013).
- As new information becomes available, when individuals are documented, and the Service works further with partners like the National Park Service, the recovery plan should be revisited and possibly revised to establish measurable criteria, including how many individuals constitute a self-

sustainable population and how many populations would be needed to delist the species (USFWS, 2013).

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SPECIES ACCOUNT: *Calyptridium pulchellum* (Mariposa pussypaws)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/14/1998; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An annual herb that forms a basal rosette of leaves and slender, spreading, leafy stems, 1-2 dm long. Loose inflorescences (generally 2+ per rosette), made up of head-like clusters of rose-colored flowers bloom in the spring and summer. (NatureServe, 2015)

Taxonomy

U.S. FWS uses the name *Calyptridium pulchellum*. (NatureServe, 2015). *Calyptridium pulchellum* is an annual member of the Portulacaceae (purslane family). (USFWS, 2007)

Historical Range

No evidence exists that the historical range of *Calyptridium pulchellum* was ever wider than the current range. (USFWS, 2007)

Current Range

Mariposa, Madera, and Fresno counties, California; all are within a 20 mile stretch. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Spring and summer. (Nature Serve, 2015)

Reproduction Narrative

Adult: Loose inflorescences (generally 2+ per rosette), made up of head-like clusters of rose-colored flowers bloom in the spring and summer. (Nature Serve, 2015)

Habitat Type

Adult: Terrestrial (USFWS, 2007)

Habitat Vegetation or Surface Water Classification

Adult: Granite domes and gravelly openings (J. Clines, Sierra National Forest, in litt. 1998; CNDDDB 2006). (USFWS, 2007)

Dependencies on Specific Environmental Elements

Adult: Sparsely-vegetated (J. Clines, Sierra National Forest, in litt. 1998; CNDDDB 2006) and sandy soils (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Sparsely vegetated areas, 400-1100 m elevations (USFWS, 2007)

Spatial Arrangements of the Population

Adult: Colonial (inferred from USFWS, 2007)

Dependency on Other Individuals or Species for Habitat

Adult: Calyptridium pulchellum typically grows in association with the rare species Lupinus citrinus. (USFWS, 2007)

Habitat Narrative

Adult: Calyptridium pulchellum is an annual member of the Portulacaceae (purslane family) that grows in sparsely-vegetated areas such as granite domes and gravelly openings within foothill woodland communities (J. Clines, Sierra National Forest, in litt. 1998; CNDDDB 2006). (NatureServe, 2015). Occurrences range in elevation from a low of 442 meters (1,450 feet) in Mariposa County to a high of 1,097 meters (3,600 feet) in Fresno County (D. Hamon, Sierra National Forest, in litt. 1980; CNDDDB 2006). Populations, individuals, or colonies located within one-fourth of a mile of each other generally constitute a single occurrence (CNDDDB 2006). Calyptridium pulchellum typically grows in association with the rare species Lupinus citrinus. (USFW, 2007). Calyptridium pulchellum co-occurs with L. citrinus var. citrinus (orange lupine) at five locations and with L. citrinus var. deflexus (Mariposa lupine) at two locations. Mimulus layneae (Layne's monkeyflower) is the second most common associate, occurring with C. pulchellum at four sites. (USFWS, 2007)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

5 unknown, 2 declining, and 1 fluctuating (CNDDDB 2006). (USFWS, 2007)

Species Trends:

5 unknown, 2 declining, and 1 fluctuating (CNDDDB 2006). (USFWS, 2007)

Resiliency:

Low (inferred from USFWS, 2007)

Redundancy:

Low (inferred from USFWS, 2007)

Number of Populations:

9 or 10 (USFWS, 2007)

Population Size:

1680-1690 individuals (NatureServe, 2015)

Population Narrative:

Approximately 1680-1690 plants; the bulk is found in two occurrences; 874 (may be divided into 2 subpopulations) and 701 plants (NatureServe, 2015). *Calyptridium pulchellum* is reported from 9 or 10 occurrences in Mariposa, Madera, and Fresno Counties, occurring within a range of approximately 64 kilometers (40 miles) (CNDDDB 2006). Seven occurrences in three central California counties (one may be extirpated). Currently, the population trends for occurrences that have been reported to the California Natural Diversity Database are: 5 unknown, 2 declining, and 1 fluctuating (CNDDDB 2006). (NatureServe, 2015; USFWS, 2007).

Threats and Stressors

Stressor: Human populations (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: The human populations of Madera and Mariposa Counties are expected to increase by 49 percent and 20 percent, respectively, between 2000 and 2020 (Hickey et al. 2005). The region of Madera County covered by the Coarsegold Area Plan (Madera County 2006), which provides the framework in which development will occur, contains about 60,000 acres and at least 4 of the occurrences of *C. pulchellum*. The habitat for this species located near Coarsegold, in Madera County, will likely continue to be fragmented due to increased infrastructure associated with the need for housing and services for this area, and the construction of a gaming casino and hotel on the Chukchansi Tribal Lands (Madera County 2006). Activities associated with residential development such as landscaping, dirt bike riding, or foot traffic are a threat at Element Occurrence 3 near Ahwahnee and Element Occurrences 4 (if extant) and 5 (if extant) in Madera County, all of which are in residential subdivisions (CNDDDB 2006).(USFWS, 2007)

Stressor: Competition (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Competition from nonnative plants and native live oak potentially threatens *Calyptridium pulchellum* at four sites. (USFWS, 2007)

Stressor: Small population size

Exposure:

Response:

Consequence:

Narrative: small population size increases the susceptibility of a population to extirpation from random demographic, environmental and/or genetic events (Shaffer 1981, 1987; Lande 1988; Primack 2006; Groom et al. 2006). The combination of few populations, small range, and restricted habitat still renders *Calyptridium pulchellum* highly susceptible to extirpation due to random events, such as flood, drought, disease, or other factors (Shaffer 1981, 1987; Groom et al. 2006).

Recovery

Recovery Actions:

- There is no recovery plan for this species.

Conservation Measures and Best Management Practices:

- Protect the extant occurrences of *Calyptridium pulchellum* through mechanisms such as conservation easements. (USFWS, 2007)
- Complete and publish the draft recovery plan, and approve a final recovery plan. (USFWS, 2007)
- Map the potential habitat for *Calyptridium pulchellum* using the indicators mentioned in II.C.1.d. and survey for additional populations. (USFWS, 2007)
- Monitor the status and trend of *Calyptridium pulchellum* in order to estimate current population sizes, the number and distribution of populations, and whether the species is stable, increasing, or declining. (USFWS, 2007)

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SPECIES ACCOUNT: *Calystegia stebbinsii* (Stebbins' morning-glory)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/18/1996; Pacific Southwest (R8)

Physical Description

A leafy herbaceous perennial (persisting or living for several years with a period of growth each year) in the morning-glory family (Convolvulaceae). Its stems, which range up to 1 meter (3.3 feet) in length, generally lie flat on the ground. The leaves are palmately lobed (lobing radiating from a common point) with the two outermost lobes (major expansion or bulge) being divided again. The leaf lobes are narrow and lance-shaped. White flowers are on stalks 3 to 13 centimeters (1 to 5 inches) long and bear two leaf-like bracts. The fruit is a slender capsule. *Calystegia stebbinsii* flowers from May through June. *Calystegia occidentalis* (chaparral false bindweed) and *C. purpurata* ssp. *saxicola* (Pacific false bindweed) also occur on gabbro-derived soils in the Pine Hill area (Wilson 1986). *Calystegia stebbinsii* can be distinguished from other California morning-glories by its distinctively shaped leaves, each having 7 to 9 narrow lance-shaped lobes. (USFWS, 2002)

Taxonomy

Brummitt (1974) described *Calystegia stebbinsii* (Stebbins' morning-glory) from the type collection made by G. Ledyard Stebbins in 1970, 17 kilometers (10 miles) west of Placerville in El Dorado County, California. (USFWS, 2002)

Historical Range

In western El Dorado County that includes the Pine Hill formation (northern and southern portions). (USFWS, 2002)

Current Range

On the Pine Hill formation in western El Dorado County, California; a few known isolated occurrences in El Dorado, Nevada and/or Tuolumne Counties. (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: Lives for several years (USFWS, 2002).

Breeding Season

Adult: May through June (USFWS, 2002)

Key Resources Needed for Breeding

Adult: Insect pollinators; disturbance (USFWS, 2002)

Reproduction Narrative

Adult: The fruit is a slender capsule. *Calystegia stebbinsii* appears to emerge from a dormant seed bank or rootstock after disturbance. The plants grow and begin to flower in the year following germination or re-emergence. While an above-ground shoot may appear in the same spot for only several years, other portions of this plant's extensive root system might survive much longer (L. Eng in litt. 1999). Pollination studies showed that animal vectors were needed for successful seed set. Observations showed that *Calystegia stebbinsii* is only pollinated by insects. Eighty percent of all visits were made by Hymenoptera, the Halictidae (solitary bees) and Apidae (honey bees) being the most important families (Nosal 1997). Seed production ranged from an average of 20.6 seeds per square meter (1.9 seeds per square foot) at Grass Valley to 380 seeds per square meter (35.3 seeds per square foot) at Salmon Falls. (USFWS, 2002)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Barrens, Shrubland/ chaparral (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Seeds require heat or scarification for germination. (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Well-burned areas; shade intolerant (USFWS, 2002)

Spatial Arrangements of the Population

Adult: Discontinuously scattered (USFWS, 2002)

Environmental Specificity

Adult: Narrow/specialist (inferred from USFWS, 2002)

Habitat Narrative

Adult: *Calystegia stebbinsii* prefers mixed chaparral communities on gabbro-derived and serpentine-derived soils (NatureServe, 2015). Most occurrences of *C. stebbinsii* are discontinuously scattered within two population centers in the northern and southern portions of the Pine Hill formation. *Calystegia stebbinsii* produce fire adapted: seeds need heat or scarification for germination; plants grow well in burned-over areas, but are eliminated when surrounding chaparral grows tall enough to shade them. (NatureServe, 2015). *Calystegia stebbinsii* seems to be shade intolerant and does not occur beneath a closed canopy of vegetation (Baad and Hanna 1987). (USFWS, 2002)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends

Population Trends:

Unknown (USFWS, 2019)

Number of Populations:

3 known extant; 8 presumed extant; 3 possibly extirpated; 1 extirpated. (USFWS, 2019)

Population Size:

Greater than 9800 individuals (USFWS, 2019)

Population Narrative:

At the time of listing Stebbins' morning-glory occurred primarily on the Pine Hill formation an area of approximately 10,400 hectares (ha) (25,700 acres (ac)), in western El Dorado County, California, ranging in elevation from 138 to 628 m (453 to 2,060 ft). In addition, Stebbins' morning-glory had "a few known isolated occurrences in El Dorado, Nevada and/or Tuolumne Counties" (Service 1996). Today, the species continue to occur primarily at the Pine Hill Preserve, but Stebbins' morning-glory has a few known occurrences in Nevada County near Grass Valley. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2002)

Exposure:

Response:

Consequence:

Narrative: Historically, gold rush activities and clearing for agriculture reduced and fragmented habitat in western El Dorado County. More recently, vegetation on the Pine Hill formation has changed significantly due to commercial and residential development, road construction, and fragmentation. Commercial or residential developments have partially or completely destroyed occurrences of the species (California Natural Diversity Data Base 1998; California Department of Fish and Game 1990a, 1990b; G. Clark in litt. 1993). Proposed residential or commercial development within the Pine Hill formation threatens most of the remaining sites within the Pine Hill formation and adjacent serpentine in western El Dorado County, and either directly or indirectly will adversely affect most of the range of this species. Additionally, habitat fragments may be too small to support viable populations of animals serving as pollinators or seed dispersal agents for the species. Edge effects, which occur at the interfaces of any two or more habitat types, typically increase with habitat fragmentation and are more pronounced for natural communities bordered by human disturbances. (USFWS, 2002)

Stressor: Other species-specific threats (USFWS, 2002)

Exposure:

Response:

Consequence:

Narrative: *Calystegia stebbinsii* is threatened by altered periodicity of fire (either too frequent or fire suppression), competition with invasive alien vegetation, herbicide spraying, and unauthorized dumping. There is an increased risk of extinction due to environmental, demographic, or genetic random events due to habitat fragmentation (USFWS, 2002).

Stressor: Alteration of the natural fire regime (USFWS, 2019)

Exposure:**Response:****Consequence:**

Narrative: The primary overall threat is encroachment of native vegetation due to succession, even on lands in conservation ownership, in the absence of the natural fire regime. The long fire return interval due to fire suppression is preventing the formation of necessary clearings for Stebbins' morning-glory establishment and possibly the scarification of seeds needed for germination. (USFWS, 2019)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2019)

Exposure:**Response:****Consequence:**

Narrative: The State's authority to conserve rare wildlife and plants is comprised of four major pieces of legislation: the California Endangered Species Act, the Native Plant Protection Act, the California Environmental Quality Act, and the Natural Community Conservation Planning Act. The State may authorize permits for scientific, educational, or management purposes, and to allow take that is incidental to otherwise lawful activities. Landowners are exempt from the prohibition for plants to be taken in the process of habitat modification. Protection of listed species through California Environmental Quality Act is dependent upon the discretion of the lead agency involved. The National Environmental Policy Act (NEPA) does not require that adverse impacts be fully mitigated, only that impacts be assessed and the analysis disclosed to the public. More details about existing protections are provided in the 2019 5-Year Review. (USFWS, 2019)

Recovery**Reclassification Criteria:**

1. Secure and protect specified recovery areas from incompatible uses: (a) Cameron Park preserve north of Highway 50; (b) Cameron Park preserve south of Highway 50; (c) Salmon Falls/Martel Creek preserve; (d) occurrences in Nevada County; along with sufficient adjacent unoccupied habitat for fire management and a 150-meter (500-foot) buffer. (USFWS, 2002)
2. Management plan approved and implemented for recovery areas, including survival and recovery of the species as the objective for all populations recommended for protection and any adjacent areas identified as necessary for continued survival and recovery. (USFWS, 2002)
3. Monitoring in all recommended preserves shows: (a) Populations stable or increasing over one fire cycle (about 30 years) (subject to modification depending on results of fire management studies). (b) Habitat monitoring shows a mosaic of multiage -class stands and habitat fragmentation has not appreciably increased (less than 5 percent) within any preserve over current (2000) conditions. (c) Spatially and temporally, the establishment of occurrences must be greater than the extirpation of occurrences. (USFWS, 2002)
4. Other actions: (a) Ameliorate or eliminate threats; (b) Fire management studies; (c) Research on genetics of Nevada County population; (d) Seeds of disjunct populations stored in at least two Center for Plant Conservation certified facilities; (e) Research on propagation techniques if repatriation, enhancement, or restoration are determined to be necessary (f) Maintain metapopulation dynamics of at least 2 very large, 7 medium, and 4 small occurrences

throughout the northern and southern portions of the Pine Hill formation; and of at least 1 medium and 5 small occurrences near Grass Valley in Nevada County. (USFWS, 2002)

Delisting Criteria:

1. Management plan approved and implemented for recovery areas, including survival and recovery of the species as the objective: For all occurrences and any adjacent areas identified as necessary for continued survival and recovery. (USFWS, 2002)
2. Monitoring in all recommended preserves shows: (d) No population decline after downlisting during two additional fire cycles (about 60 years); if declining, determine cause and reverse trend. (e) Habitat monitoring continues to show a mosaic of multi-age class stands and habitat fragmentation has not appreciably increased (less than 5 percent) within any preserves over current (2000) conditions. (f) Spatially and temporally, the establishment of occurrences must continue to be greater than the extirpation of occurrences. (USFWS, 2002)
3. Other actions: (g) Ameliorate or eliminate threats. (USFWS, 2002)

Recovery Actions:

- 1. Develop and implement a cooperative program and participation plan. A cooperative program is needed to coordinate local public and private land use planning with State and Federal land use and recovery planning for gabbro species. A cooperative program needs to be developed focusing on western El Dorado County. A participation plan produced from this program will increase the chances of recovery for listed species. (USFWS, 2002)
- 2. Protect and secure existing populations. Natural lands that contain this species need to be protected in perpetuity. Protection of these lands includes identification and minimization of threats in perpetuity and application of appropriate and adaptive management (see Task 3) to ensure species survival and recovery. Natural lands that need protection can be categorized into two types: (1) blocks of land that contain occupied or potential habitat for two or more this species and (2) blocks of land that contain occupied or potential habitat for one this species. All potential preserve areas should be evaluated based on current mapping information and ground-truthed prior to purchase to confirm their value for recovery. (USFWS, 2002)
- 3. Manage Habitat Managing habitat is essential to the recovery of the listed species. Habitat management includes preparation and implementation of management plans for all areas inhabited by special status species being proposed for preservation, and periodic monitoring of populations in each of these areas. Within western El Dorado County, a multi-constituent committee should be formed to oversee the management of preserves located on the Pine Hill formation. The preserve management committee should include, at a minimum, representatives from the California Department of Fish and Game, U.S. Fish and Wildlife Service, Bureau of Land Management, El Dorado County, California Department of Forestry and Fire Protection, California Native Plant Society, American River Conservancy, and a private landowner representative. (USFWS, 2002)
- 4. Survey historical locations and other potential habitat where this species may occur. Recovery of listed species may often require relocating historic populations or locating new populations of these species. Historical locations should be surveyed to determine whether suitable habitat remains, the species persists at the sites, and/or the sites may be suitable for repatriation. Suitability of historical locations for repatriation would depend upon: (1) whether potential habitat exists, (2) the presence and magnitude of threats, and (3)

- whether the sites can be secured and managed for the long-term protection of the species. Surveys should also include other potential gabbro or serpentine habitat to determine whether undiscovered populations may exist. If new populations are discovered, they need to be protected and managed as discussed above. During the surveys, potential introduction sites should also be identified. (USFWS, 2002)
- 5. Conduct necessary biological research and use results to guide recovery/conservation efforts. - Develop propagation techniques for listed plant species for which enhancement, repatriation, or introductions would be appropriate. Geographic area research is outlined in the Recovery Plan. Species-specific research is described as follows: Habitat Survey Research: Nevada County on gabbro and serpentine soils. Reproduction and Demography Research: Including determining limiting life stages, seed production, and survival in soil to determine appropriate fire return period. Genetics research. Other Research Needs: Propagation techniques; fire management techniques; metapopulation analysis; determine efficacy of other types of disturbance regimes for species and habitat management; feasibility of habitat restoration/ enhancement. Management Actions Needed: Burning; general surveys; baseline monitoring; monitoring for trends of populations, success of management actions, and threats at all populations identified for protection; monitoring for habitat fragmentation, major shifts in vegetation type, and tracking of occurrence establishment, and extirpation; seed banking for disjunct populations. (USFWS, 2002)
 - 6. Undertake artificial enhancement, repatriation, or introduction efforts where necessary. Where it is deemed necessary, artificial enhancement, repatriation, or introduction efforts for sensitive plants should be undertaken. Prior to repatriation or introduction of sensitive plants, genetics studies are needed (see Task 5) to ensure that new populations will not disrupt unique local gene complexes. Plant repatriation or introduction efforts should be undertaken using collected seeds or plant propagules. (USFWS, 2002)
 - 7. Determine possible prescribed burning management strategies and incorporate the strategies into the management plans (Priority 1). Possible prescribed burning management strategies need to be evaluated, peer reviewed, and incorporated into management plans. (USFWS, 2002)
 - 8. Perform metapopulation-type analyses for this species (Priority 2). The results of a metapopulation-type analysis may be useful in clarifying uncertainties, data needs, and research, management priorities, and delisting criteria. Metapopulation-type analyses should be based on the results of monitoring and research. (USFWS, 2002)

Conservation Measures and Best Management Practices:

- Preserves must include sufficient habitat to allow for expansion or shifts in occupied habitat.
- In addition to securing and protecting habitat, maintenance of the metapopulation dynamics will be important for survival and recovery.
- Unless the metapopulation analysis shows otherwise, at least two very large occurrences each greater than 128 hectares (315 acres); seven medium occurrences each between 4 and 40 hectares (10 and 100 acres); and four small occurrences each smaller than 4 hectares (10 acres), are to be maintained at any given time throughout the northern and southern portions of the Pine Hill formation. In addition at least one medium and five small occurrences are to be maintained at any given time at the metapopulation near Grass Valley in Nevada County.
- In addition to securing and protecting habitat, directed surveys for *Calystegia stebbinsii* should be conducted on gabbro and serpentine soils in Nevada County. If plants (or additional populations) are

discovered in Nevada County, they should be secured through land acquisition, conservation easements, or other means. (USFWS, 2002)

- In addition, unoccupied habitat that might provide space for expansion of the populations and habitat for pollinators and seed dispersers must be protected along with sufficient adjacent unoccupied habitat for fire management, and a 150-meter (500-foot) buffer for fire safety. (USFWS, 2002)
- Dedicate more resources toward the investigation of best management approaches for the Pine Hill listed plant species, even at the cost of a temporary hiatus in land acquisition efforts. Investigation should be made into fire-related and non-fire related methods of disturbance to maintain listed plant species habitat. (USFWS, 2019)
- Once the best management strategy (in terms of technique, frequency, timing, and intensity) is determined at each site, implement these management practices to achieve and maintain a habitat mosaic that enables the attainment of recovery criteria for the species. (USFWS, 2019)

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SPECIES ACCOUNT: *Camissonia benitensis* (San Benito evening-primrose)

Species Taxonomic and Listing Information

Listing Status: Threatened; 2/12/1985; Pacific Southwest (R8) (USFWS, 2015); Proposed Delisting

Physical Description

A small, yellow-flowered, annual herb in the evening-primrose family (Onagraceae) (USFWS, 2009)

Taxonomy

Recognized as distinct by Peter Raven (1969) and J. Griffin (1984). Similar to non-serpentine *C. contorta* but differs in chromosome number, pollen morphology, leaf shape and pubescence. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Local endemic to serpentine alluvial terraces in the Clear Creek and San Carlos Creek drainages, California. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Self-fertilization (USFWS, 2009)

Lifespan

Adult: 1 year (annual) (USFWS, 2009)

Breeding Season

Adult: Mid-spring (USFWS, 2009)

Reproduction Narrative

Adult: *Camissonia benitensis* is autogamous (self-pollinating), and therefore does not require insects or other abiotic mechanisms for pollination. Germination occurs from February to March, flowering in mid-spring, and seed pods mature by early summer. An individual plant typically produces one capsule containing approximately 90-100 seeds. Maintaining a seedbank in the soil is an important survival mechanism for many short-lived annual species in years of poor conditions (Baskin and Baskin 1978). (USFWS, 2009)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Barrens, Forest/Woodland, Shrubland/chaparral, Woodland - Mixed (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Low rainfall; hot summers; elevations above 1,372 m (4,500 feet). (USFWS, 2009)

Spatial Arrangements of the Population

Adult: Colonial (inferred from USFWS, 2009)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from USFWS, 2009)

Habitat Narrative

Adult: All of the known occurrences of *Camissonia benitensis* are on serpentine alluvial flats, terraces, and debris flows (alluvial outwash) terraces and deposits near San Benito Mountain in San Benito County, California, and in western Fresno County, California. Physical characteristics desired for *C. benitensis* include alluvial terraces or areas adjacent to slopes (alluvial outwash) below an elevation of approximately 1,372 meters (4,500 feet). The habitat is flat to gently sloping (less than 3 degrees), on residual serpentine or serpentine alluvium, subject to frost heaving, and with minimal cover of surface gravel. Biotic characteristics include an association of annual plants, and no more than 25 percent of the terrace covered with chaparral. The habitat should be relatively stable with little soil erosion caused by natural processes (e.g., mass wasting), historical uses (e.g., mining activities), and current uses (e.g., recreational activities). The extent of stable habitat needs to include not only the current area occupied by *Camissonia benitensis*, but also sufficient surrounding habitat for maintaining stable soil and hydrologic processes, and for ensuring the species' ability to migrate within potentially suitable habitat at a site. A study of associated species identified six annual herbs that together are indicators for suitable habitat: *Cryptantha micromeres* (popcorn flower), *Erodium cicutarium* (filaree), *Eschscholzia californica* (California poppy), *Malacothrix floccifera* (wooly malacothrix), *Lotus subpinnatus* (deerweed), and *Vulpia microstachys* (Nuttall's fescue) (USFWS, 2006). The only non-native species is *Erodium cicutarium* (Taylor 1990 (USFWS, 2006). Low annual rainfall and hot summer temperatures limit the growing season for plants. (USFWS, 2009; USFWS, 2006)

Dispersal/Migration**Motility/Mobility**

Adult: High (inferred from USFWS, 2009)

Dispersal

Adult: Moderate (inferred from USFWS, 2009)

Dispersal/Migration Narrative

Adult: *Camissonia benitensis* may utilize both short-distance and long-distance seed dispersal mechanisms. The short stature of the plants when in fruit (5 to 10 centimeters or 2 to 4 inches) facilitates short-distance seed dispersal.. The distribution of occurrences over a large geographic

area in a number of watersheds are evidence of long-distance seed dispersal (Service 2006). (USFWS, 2009)

Population Information and Trends

Population Trends:

Slight increase

Resiliency:

Low (NatureServe, 2015)

Representation:

Low (inferred from USFWS, 2009)

Redundancy:

Low (inferred from USFWS, 2009)

Number of Populations:

69 (USFWS, 2009)

Population Size:

2500 - 10,000 individuals (NatureServe, 2015)

Minimum Viable Population Size:

100,000 to 1,000,000 (USFWS, 2009)

Population Narrative:

The known distribution of *Camissonia benitensis* comprises a total of 69 known populations, as summarized in Table 2 (R. O'Dell, Bureau, pers. comm. 2009d). Population numbers of *Camissonia benitensis* fluctuate from year to year, exhibiting a repetitive "boom-bust" population cycle occurring approximately every 2-3 years as described by O'Dell (2009b). In 1988, a record high number of 165,168 individuals of *Camissonia benitensis* were recorded. When population numbers from all sites were considered from 1983 to 2007, O'Dell (2009b) demonstrated that removal of this statistical outlier indicates that the population trend has slightly increased over time. Annual counts of *Camissonia benitensis* between 1983 and 2009 (a span of 26 years) reveal: of these years contained numbers above 1,000 individuals; 8 of the 20 years contained numbers over 10,000 individuals; and 1 of the 20 years contained numbers above 100,000 as illustrated in Table 3 (O'Dell, pers. comm. 2009b). For a long-lived perennial species, a population size of 1,000 individuals may be sufficient, but annual species may require larger populations (at least 100,000 to 1 million in climatically favorable years) to survive natural events that can eliminate occurrences and suitable habitat (Thomas 1990). (USFWS, 2009)

Threats and Stressors

Stressor: Off-highway Vehicle Recreation

Exposure:

Response:

Consequence:

Narrative: OHV use has been a substantial threat to *Camissonia benitensis* and its habitat (Bureau 1970, 1981, 1982, 1984, 1986, 1993, 1995, 2005a, and 2005c; Losos et al. 1993; Taylor 1990, 1991, 1993, and 1995). The CCMA attracts OHV recreationists in large numbers because its serpentine areas offer open slopes (barrens) for riding (Bureau 2005c), and visitor use in the CCMA has increased over the past decade. The silt-clay crust that forms on serpentine soils protects open, undisturbed slopes from erosion. When the crust is disturbed, sheet erosion, rilling, and gullying occur (Kruckeberg 1984). OHV recreation at the CCMA has caused disturbance of soil integrity, soil loss, compaction of soil, and destruction of plants (Bureau 2005c). In addition, recreation (e.g., camping, vehicle traffic, and OHV use) has disturbed alluvial terraces in Clear Creek Canyon (Bureau 2005c, Bureau 2006a). (USFWS, 2009)

Stressor: Soil Loss and Elevated Erosion Rates

Exposure:

Response:

Consequence:

Narrative: Erosion on both barren and vegetated slopes causes soil loss and other physical and chemical changes. These changes negatively affect the soil's texture, composition, and chemistry. They also can reduce the soil's water infiltration capacity and productivity, which in turn affects the ability of plants to grow in these soils. Riparian habitats (and the streamside terraces upon which *Camissonia benitensis* occurs) can be adversely affected by accelerated sediment deposition from wet-season use of the road system in the CCMA. (USFWS, 2009)

Stressor: Facilities Construction and Maintenance

Exposure:

Response:

Consequence:

Narrative: The Bureau established an administrative site in 1988 that lies to the north of the CCMA. Its purpose is to support ranger and law enforcement services and to facilitate asbestos (chrysotile) decontamination. The Bureau inadvertently constructed a residence within a *Camissonia benitensis* suboccurrence (suboccurrence 19110) at the administrative site, resulting in the direct loss of plants and habitat. (USFWS, 2009)

Stressor: Mining Activities

Exposure:

Response:

Consequence:

Narrative: Mining activity in the CCMA has decreased since the early 1900s, and the last commercial mining operation ceased its activities in 2002. Residual soil erosion problems from historic mines and their access roads may affect certain occurrences of *Camissonia benitensis*. The primary mining activity in the CCMA now consists of rock hounding for gems and minerals. In 1994, the Bureau estimated that 5 percent of the visitor use was comprised of rock hounders. The Service believes the impact of this activity on *Camissonia benitensis* and its habitat is minimal. (USFWS, 2009)

Stressor: Succession to Woody Shrub Community

Exposure:

Response:

Consequence:

Narrative: Several non-native plant species, including *Centaurea solstitialis* (yellow star-thistle) and *Taeniatherum caput-medusae* (medusahead) have been found in the Clear Creek watershed. Once established, these weeds are difficult to eradicate and therefore pose a potential threat to *Camissonia benitensis* habitat in certain areas. *Centaurea solstitialis* and non-native annual grasses occur on the Franciscan soils throughout the Clear Creek watershed where several *Camissonia benitensis* suboccurrences occur at the interfaces between Franciscan and serpentine soils (J.A. Delgado, pers. comm. 2002). Feral pigs (*Sus scrofa*) are also present in the Clear Creek watershed. As pigs root for bulbs and tubers, they churn the soil. Churning of the soil not only disrupts the existing native vegetation, but also facilitates establishment of non-native plant species. In spring 2002, feral pig damage was extensive throughout Clear Creek Canyon on partially vegetated alluvial terraces. Pigs affected several *Camissonia benitensis* suboccurrences after germination had occurred. (USFWS, 2009)

Stressor: Succession to Woody Shrub Community

Exposure:

Response:

Consequence:

Narrative: Woody plants have been encroaching on a number of alluvial terraces and may be reducing the amount of habitat available for *Camissonia benitensis* (Taylor 1990). Taylor (1990) speculated that seed of *Camissonia benitensis* is not likely to remain viable through an entire cycle of woody vegetation encroachment into occupied habitat. (USFWS, 2009)

Stressor: Stochastic Events

Exposure:

Response:

Consequence:

Narrative: Randomly-occurring events, such as prolonged drought, wildfire, flooding, and catastrophic erosion and sedimentation, have the potential to affect the continued existence of this species, but to an unknown extent. (USFWS, 2009)

Recovery

Reclassification Criteria:

1. Habitat condition within currently occupied or suitable habitat shows a substantial decline. (USFWS, 2006)
2. Population sizes decline over a 20-year period that includes multiple rainfall cycles (successive periods of drought and wet years). (USFWS, 2006)
3. The Bureau is unable to effect sufficient compliance with OHV restrictions in *Camissonia benitensis* habitat within the Clear Creek Management Area as the amended CCMA Management Plan is implemented. (USFWS, 2006)

Delisting Criteria:

1. Research has been completed and delisting criteria 2 through 4 have been refined as appropriate based on research findings. Factors that should be studied include: (a) Potential for restoration of serpentine terrace habitat and natural rate of habitat replacement (excluding human-caused activities); (b) Ecology of *Camissonia benitensis* seed banks; and (c) Population

viability modeling and estimation of habitat area and population levels necessary for dispersal, seed bank viability, and long-term persistence of the species. (USFWS, 2006)

2. Known occurrences and sufficient additional suitable habitat, within each watershed unit throughout its range, are protected from direct effects from OHV use and other recreational activities. Appropriate levels of compliance with use regulations by recreationists have prevented adverse impacts to *Camissonia benitensis* suboccurrences and habitat. (USFWS, 2006)

3. Currently occupied and suitable habitat for the species has been restored and maintained over an appropriate period of time, as informed by monitoring and research. Given current knowledge, we expect that the “appropriate period of time” will be no less than 20 years. Because the number of individuals in a suboccurrence fluctuates widely from year to year, more emphasis should be placed on maintaining the habitat that supports known suboccurrences. Disturbance and erosion rates should not be substantially elevated above natural levels, and *Camissonia benitensis* should persist in suitable habitat. (USFWS, 2006)

4. Population sizes have been maintained over a 20-year period during a normal rainfall cycle (i.e., includes periods of drought and wet years). (USFWS, 2006)

Recovery Actions:

- Protect known occurrences and suitable habitat for *Camissonia benitensis* throughout its range in the CCMA. Close use areas that occur in proximity to *Camissonia benitensis* and special status species habitats on Bureau lands. Maintain a weed control program for the CCMA. The Bureau has established a weed control program to ensure that highly invasive species, such as yellow star-thistle and medusahead, do not continue to spread in the CCMA. Ensure protection of *Camissonia benitensis* on non-Bureau lands by establishing private landowner contacts. Protecting the four known occurrences on private lands, and others as yet undiscovered, is important for the continued persistence of this species. (USFWS, 2006)
- Reduce soil erosion and stream sedimentation above natural levels in watersheds that support habitat for *Camissonia benitensis* in the Clear Creek Management Area. Establish an interagency technical team to assist in the development of a watershed management, protection, and restoration strategy, including soil erosion standards. Continue to identify and prioritize sites for restoration of *Camissonia benitensis* habitat. Continue to monitor effectiveness of habitat management. Use aerial and ground photography to monitor landscape scale changes over time. Compare photography to determine habitat conditions as related to user compliance. Monitor soil loss, erosion, and sediment loading conditions in the five watersheds in the CCMA. (USFWS, 2006)
- Continue improvement and implementation of the management and monitoring plan for *Camissonia benitensis*. Use technical specialists to provide review and assistance in development and implementation of the monitoring and research programs. Continue monitoring *Camissonia benitensis* occurrences. Conduct additional research on the ecology and life history of *Camissonia benitensis*. Search for new occurrences on alluvial outwash habitat. Revise management based on monitoring and research results. (USFWS, 2006)
- Establish an ex situ seed collection. (USFWS, 2006)
- Develop and implement a public awareness program for conserving *Camissonia benitensis* and its habitat. Install and maintain interpretive and informational signs near occurrences of

Camissonia benitensis, and implement other interpretive activities. Continue to work with OHV and other user groups to conserve the Clear Creek Management Area and other habitat. (USFWS, 2006)

Conservation Measures and Best Management Practices:

- The Service, the Bureau, and the County of San Benito (County) should coordinate to reroute Clear Creek Road out of Clear Creek Canyon. Even if the Bureau's efforts to reduce the adverse effects of authorized OHV use and eliminate unauthorized OHV use are fully successful, the presence of staging areas and Clear Creek Road will likely result in sediment movement into Clear Creek that would exceed natural levels. (USFWS, 2009)
- The Service should work with the Bureau to develop and implement an active program to determine the type of vegetation management that would promote the conservation of Camissonia benitensis. These measures could include reducing the amount of non-native weeds at various times of the year through mechanical or other means. (USFWS, 2009)
- The Service should work with the Bureau to develop and implement methods to monitor the abundance and other characteristics of the seed bank of Camissonia benitensis occurrences at the CCMA. Information from seed bank studies could be used along with information on the life history of this species and the requirements for suitable habitat to develop population models. Population modeling could allow us to compare the risk of extinction under natural rates of habitat replacement (terrace erosion and formation) with the risk of extinction under a range of rates of soil loss resulting from different scenarios of habitat management. This information would assist us and the Bureau in making and adjusting management decisions that will promote the long-term conservation of Camissonia benitensis. (USFWS, 2009)
- The Service, the Bureau, and the County should coordinate to develop and implement a program for applying dust suppressant to heavily-used routes which are under County jurisdiction. Under some conditions, encroachment by woody vegetation onto terraces that are otherwise suitable for Camissonia benitensis may reduce its ability to persist or preclude its establishment. If dust can be effectively suppressed, thereby reducing the hazards of asbestos contamination to firefighters, the Bureau may be more able to use prescribed fire as a management tool to maintain terraces in a condition that could potentially support Camissonia benitensis. (USFWS, 2009)

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California/Nevada Operations Office U.S. Fish and Wildlife Service Sacramento, California

SPECIES ACCOUNT: *Campanula robinsiae* (Brooksville bellflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/28/1989; Southeast Region (R4)

Physical Description

Campanula robinsiae is an annual herb, with stems 1-15 cm (0.5-6 in.) tall, very slender, simple or branched, faintly winged or 4-angled. The stems are glabrous except for a few trichomes in the angles (Morn 1987). The plant may be submerged for part of its life, which may affect its growth. Some stems root at the nodes (Morn 1987). The leaves are alternate, the blades varying in size and shape on different parts of the plant and from plant to plant (Morn 1987). Open flowers are solitary, 3-10 mm long, bell-shaped, "deep purple" (Morn 1987). Steven Leonard (under contract to The Nature Conservancy; report at Florida Natural Areas Inventory) discovered in 1983 that the plant has cleistogamous (closed, self-pollinating) flowers, which are quite small. This is the only North American *Campanula* with cleistogamous flowers (Morn 1987). The fruit is a subglobose capsule about 2 mm in diameter (Wunderlin et al. 1980a). The seeds are about 1 mm long, the smallest of any North American member of the genus (Shetler and Morn 1986; description adapted from Wunderlin et al. [1980a] and other sources as noted). Leonard observed only cleistogamous flowers on February 8 and 11, 1983, and did not see a chasmogamous flower until February 23 (letters from Leonard to Morn in Morn 1987). Flowering specimens have also been collected March 11, 1983; April 13, 1983; and April 26, 1958. Seed production proceeds while flowering continues. *Campanula robinsiae* may be confused with *Campanula floridana*, but the latter species has very different seeds and leaves that are "much firmer than those of *C. robinsiae*" (Morn 1987). (USFWS, 1993)

Taxonomy

Small (1926) formally published the species, but later (Small 1933) transferred the species to his new genus *Rotantha*, along with *Campanula floridana*, based on the shared character of their rotate corollas' (Small 1933). Later workers (Shetler 1963, Wunderlin et al. 1980a) determined that these two species are not closely related, so *Rotantha* is an artificial genus; the two species are retained in *Campanula* (USFWS, 1993).

Historical Range

All historically known sites of *C. robinsiae* occurred within approximately 2-3 square miles centered on Chinsegut Hill, which is located 5 miles north of Brooksville, in Hernando County, Florida. (USFWS, 2019)

Current Range

Hernando and Hillsborough Counties, Florida. (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from EPA, 2016); asexual (EPA, 2016)

Dependency on Other Individuals or Species

Adult: Insect and bird pollinators (EPA, 2016)

Breeding Season

Adult: March - April (EPA, 2016)

Key Resources Needed for Breeding

Adult: Insect and bird pollinators (EPA, 2016); rainfall (USFWS, 2010)

Reproduction Narrative

Adult: Flowering specimens have been collected March-April. Capable of self-pollination. Insects and birds are also potential pollinators. Seeds germinate in winter or spring. Seed production occurs while flowering continues (EPA, 2016). It was determined that water levels from rainfall rather than time of year may be a critical factor controlling germination (Williams 1998) (USFWS, 2010).

Habitat Type

Adult: Palustrine, terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Herbaceous wetland, forest (NatureServe, 2015)

Environmental Specificity

Adult: Moderate (inferred from NatureServe, 2015)

Habitat Narrative

Adult: *Campanula robinsiae* was originally found in a seepage area on the north facing slope of Chinsegut Hill surrounded by pasture used for animal husbandry. It has since been found within an oak/palm hydric hammock along the edge of an elongated maidencane (*Panicum hemitomom*) marsh at Burns Prairie (Laundry 1996). Typically this species is found along the margins of ponds and marshes with fluctuating water levels and moist seepage areas, both surrounded by pastures. *C. robinsiae* is associated with other wetland plants, such as mosquito fern (*Azolla carolinaiana*), hair sedge (*Bulbostylis* spp.), coinwort (*Centella asiatica*), button snakeroot (*Eryngium* spp.), pennywort (*Hydrocotyle* spp.), rush (*Juncus* spp.), pimpernel (*Anagallis minima*), pearlwort (*Sagina decumbens*), and maidencane (*Panicum hemitomom*). (USFWS, 2019)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Fruit dispersal potential occurs via abiotic factors and birds and mammals (EPA, 2016).

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Stable (USFWS, 2019)

Number of Populations:

6 (USFWS, 2019)

Population Size:

~8600 individuals (USFWS, 2019)

Population Narrative:

Although there are six extant populations (Burns Prairie, Croom- Bell Heaven, Croom- Power Line Road, and Hillsborough River State Park #1, #2, and #4) (Fig. 1), all on public land along wet prairies, pond margins, or seepage areas. There is one more population than when the last 5-Year Review was conducted in 2010. Three populations have been discovered and two are now considered historic due to habitat degradation and development. Populations are determined based on whether there was a hydrological connection and are considered extant if plants were found within the past 6 years. Most populations have been monitored yearly by Bok Tower Botanical Garden (BTG) since 2001. The species is only found in Hernando and Hillsborough Counties. The oldest remaining population in Hernando County is Burns Prairie, which was discovered in 1983. Most of the Burns Prairie population occurs on land owned by Florida Agricultural and Mechanical University (FAMU) and the southern extent is owned by the Florida Fish and Wildlife Conservation Commission (FWC). Less than 3 miles from Burns Prairie are two other populations that have not had plants in several years due to habitat degradation (Chinsegut Hill) and development (Young). In 2015, several plants were found in the Croom Tract of Withlacoochee State Park (WSF) in Hernando County along a power line road (Croom- Power Line Road). A year later, another population was found along a pond margin a tenth of a mile away (Croom- Bell Heaven) (Peterson, BTG pers. comm. 2018b). These populations are located approximately 5 miles southeast of the other Hernando County sites. Approximately 40 miles south of all other known sites are four populations within Hillsborough River State Park (HRSP #1-4). The HRSP populations were found starting in 2006 along pond margins and wetlands within HRSP, all within approximately 0.4 miles of each other. Surveyors have not found plants in one of the populations since 2009. These populations are much lower in elevation than the Hernando County sites. From 2016- 2018 three populations consistently had more than three hundred plants: Burns Prairie, Croom-Bell Heaven, and HRSP #2. Minimal to no habitat management is taking place for any of the populations. Without regular management, it is possible that the species will disappear from these sites. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: This species is threatened by habitat destruction and degradation on its six extant sites due to the lack of habitat management and development of the land surrounding protected sites. Previously, conversion of existing sites to residential and agriculture was determined to be

the primary threat and resulted in the need to list the species (USFWS 1994). Since all six known extant populations now occur on public land, the threat of conversion of known sites to residential land use has been significantly reduced. The lack of habitat management has resulted in the disappearance of the Chinsegut Hill and Young populations and may be affecting other populations, such as the introduction and Burns Prairie. At Chinsegut Hill and the Young site, *C. robinsiae* was likely outcompeted by dense vegetation due to lack of disturbance, which was previously created by mowing or trampling by cattle. In addition, at Chinsegut Hill, the death of an oak tree that provided shade to *C. robinsiae* likely affected moisture levels (Service 2010). It is important to consider overstory composition when managing habitat. The introduction at the Blackwater Creek Preserve failed due to lack of habitat management that would have allowed cattle to graze the site. In 2012, Burns Prairie lost its grazing cattle and the only management that has taken place is that overgrown competing vegetation was removed in 2015 (Peterson, BTG pers. comm. 2019a). It is possible that this population will disappear if grazing or other habitat management is not continued. More research is needed to determine which methods are effective at managing habitat. Development of the land surrounding protected lands may alter hydrology by increasing runoff to *C. robinsiae* sites. This runoff may also contain fertilizers and herbicides that may affect growth and germination of the plants. *C. robinsiae* occurs in the Central Region of Florida, which is projected to experience the greatest population growth in the state in the near future. By 2070, the percentage of developed land is expected to double from 25% in 2010 to almost 50% (Carr and Zwick 2016). Due to modeling efforts (Lewis 2010, 2011), unknown populations and suitable habitat for introductions likely exist on private land and may be at risk to development. It is likely that agricultural lands will be converted to residential land uses in the near future (Carr and Zwick 2016). This conversion may negatively affect *C. robinsiae* habitat because cattle may benefit the species by providing the disturbance necessary to reduce competition from other plants. (USFWS, 2019)

Recovery

Reclassification Criteria:

Not developed

Delisting Criteria:

Not developed - Plausible criteria for recovery might include securing at least 10 viable and self-sustaining populations of Brooksville bellflower in pond margin habitats, consisting of approximately 10,000 individuals during prolific years (USFWS, 1993).

Recovery Actions:

- Develop management and protection criteria for populations on current managed areas (includes collection of biological/systematic data and control of exotic plants) (USFWS, 1993).
- Acquire additional habitat, or protect habitat through conservation easements and/or regulation. Sufficient information is available to proceed immediately (USFWS, 1993).
- Conduct additional surveys for new populations of the species (USFWS, 1993).
- Augment existing cultivated populations, including establishment of a germ plasm bank (USFWS, 1993).
- Develop plans for possible (re)introduction of plants into suitable habitats (includes 10-year monitoring of existing and/or reintroduced populations) (USFWS, 1993).

- Enforce protective legislation (USFWS, 1993).

Conservation Measures and Best Management Practices:

- Revise the current recovery plan to include updated objective and measurable recovery criteria for reclassifying this species to threatened status and delisting that are related to reducing the threats identified in the recovery plan, as well as updated information on the species distribution and biology (USFWS, 2010).
- Support further research on: a. Effects of cattle grazing on this species. b. Life history needs. c. Microhabitat requirements of this species. d. Effect of severe changes in temperatures (freezing) on germination. e. Drought and fluctuating water levels and their effect on germination. f. Transplant experiments, long-term seed viability trials, and optimizing germination protocols (USFWS, 2010).
- Continue working with public land managers to increase management efforts to benefit *C. robinsiae*. No management plans have been developed for this species but are necessary. Minimal management has been taking place at some sites. Once disturbance has been removed from some sites, populations have disappeared. Burns Prairie especially needs additional management because competing vegetation has taken over since grazing cattle were removed from the site. (USFWS, 2019)
- Continue conducting surveys at known sites of occurrence and expand surveys to other suitable areas in Hillsborough and Hernando Counties. This information is necessary to determine where plants currently exist and to prioritize recovery actions such as reintroductions at suitable sites. BTG has continued conducting surveys at known sites of occurrence. This work has been made possible through annual grants from the State of Florida, Department of Agriculture and Consumer Services, Division of Plant Industry, which funds the basic operations of BTG's Rare Plant Conservation Program. Surveys have been expanded to other sites determined by a GIS model to have suitable habitat. However, due to either flood or drought conditions during the survey periods, no plants were found. One introduction took place in 2013, but no plants were found the following year due to overgrowth of competing vegetation. No plants have been found at the introduction site since. Habitat management is necessary to control competing vegetation. (USFWS, 2019)

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SPECIES ACCOUNT: *Canavalia molokaiensis* (`Awikiwiki)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/08/1992; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Canavalia molokaiensis, a member of the pea family (Fabaceae), is a perennial climbing herb with twining branches. Each leaf is made up of three lance-shaped or sometimes oval leaflets, which usually measure 3.5 to 8 cm (1.4 to 3 in) long and 1.3 to 5.4 cm (0.5 to 2.1 in) wide. Four to 15 flowers are arranged along a stalk 3 to 9 cm (1.2 to 3.5 in) long. The calyx (fused sepals), which is 20 to 28 mm (0.8 to 1.1 in) long, comprises a larger upper lip with two lobes and a smaller lower lip with three lobes. The five rose-purple petals vary from 36 to 47 mm (1.4 to 1.9 in) in length. The flattened pods, 12 to 16 cm (4.7 to 6.3 in) long and 2.3 to 3.5 cm (0.9 to 1.4 in) wide, enclose flattened, dark reddish-brown, oblong-elliptic seeds, which are 17 to 22 mm (0.7 to 0.9 in) long and about 12 to 14 mm (0.5 in) wide. (USFWS, 1996)

Taxonomy

Fosberg (1966) reduced several Hawaiian species of the genus to varieties, resulting in the name *C. galeata* var. *molokaiensis* for this taxon. In his revision of the Hawaiian taxa of the genus, St. John (1970) accepted *C. molokaiensis* and published two additional names, *C. peninsularis* and *C. stenophylla*, for Molokai plants. In the current treatment (Wagner and Herbst 1990), however, only *C. molokaiensis* is recognized. (USFWS, 1996)

Historical Range

Historically, *Canavalia molokaiensis* was known from East Molokai, at Kalaupapa, Pelekunu, and farther south in Kahuaawi Gulch and the region of Manawai (USFWS 1992). (USFWS, 1996)

Current Range

Known from Kalaupapa to Waialeia, Kaunakakai, and Kamakou in Molokai (USFWS 1992). (USFWS, 1996)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Canavalia molokaiensis* (`Awikiwiki) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Canavalia molokaiensis* includes six CHUs in Maui County, Hawaii (81 FR 17790-18110).

Molokai—Coastal—Unit 1 consists of 70 ac (28 ha) of privately owned land, and 54 ac (22 ha) of federally owned land (U.S. Coast Guard) at Laau Point, from Kahaiaawa to Keawakalani, along the western coast of Molokai. This unit is occupied by the plant *Marsilea villosa*, and includes the

mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 1 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 3 consists of 794 ac (321 ha) of State land, and 3 ac (1 ha) of federally owned land (Kalaupapa National Historical Park), from Kahu Point to Wainene, along the north-central coast of Molokai. This unit is occupied by the plants *Pittosporum halophilum*, *Schenkia sebaeoides*, and *Tetramolopium rockii*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 3 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Marsilea villosa*, *Peucedanum sandwicense*, or *Sesbania tomentosa*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 4 consists of 10 ac (4 ha) on Mokapu Island on the northern coast of Molokai. This area is State-owned, and is classified as a State Seabird Sanctuary. This unit is occupied by the plants *Peucedanum sandwicense* and *Pittosporum halophilum*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 4 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Marsilea villosa*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 6 consists of 190 ac (77 ha) of State land, and 1,685 ac (682 ha) of privately owned land, from Kaholaiki Bay to Halawa Bay, on the northeastern coast of Molokai. This unit is occupied by the plants *Bidens wiebkei*, *Canavalia molokaiensis*, *Hibiscus arnottianus*

ssp. *immaculatus*, and *Ischaemum byrone*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 6 is not known to be occupied by *Brighamia rockii*, *Hibiscus brackenridgei*, *Marsilea villosa*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Wet Cliff—Unit 2 (and) *Palmeria dolei*—Unit 44—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 44—Wet Cliff This area consists of 462 ac (187 ha) of State land, and 806 ac (326 ha) of privately owned land (partly within The Nature Conservancy's Pelekunu Preserve), along the rim of Pelekunu Valley from Kipapa Ridge to Mapulehu, in central Molokai. These units are occupied by the plants *Clermontia oblongifolia* ssp. *brevipes* and *Phyllostegia hispida*, and include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Wet Cliff—Unit 2 is not known to be occupied by *Brighamia rockii*, *Canavalia molokaiensis*, *Cyanea grimesiana* ssp. *grimesiana*, *C. munroi*, *Hesperomannia arborescens*, *Hibiscus arnottianus* ssp. *immaculatus*, *Pteris lidgatei*, or *Stenogyne bifida*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Wet Cliff—Unit 3 consists of 1,137 ac (460 ha) of State land, and 225 ac (91 ha) of privately owned land, along the rim of Wailau Valley from Mapulehu to Kahiwa Gulch, in eastern Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Molokai—Wet Cliff—Unit 3 is not known to be occupied by *Brighamia rockii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea grimesiana* ssp. *grimesiana*, *C. munroi*, *Hesperomannia arborescens*, *Hibiscus arnottianus* ssp. *immaculatus*, *Phyllostegia hispida*, *Pteris lidgatei*, or *Stenogyne bifida*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Canavalia molokaiensis* critical habitat consists of four components. Coastal (Molokai), Lowland mesic (Molokai), Lowland wet (Molokai) and Wet cliff (Molokai) (81 FR 17790-18110):

Ecosystem: Coastal. Elevation: <980 ft (<300 m). Annual precipitation: <20 in (<50 cm). Substrate: Well-drained, calcareous, talus slopes; dunes; weathered clay soils; ephemeral pools; mudflats. Canopy: Hibiscus, Myoporum, Santalum, Scaevola. Subcanopy: Gossypium, Sida, Vitex. Understory: Eragrostis, Jacquemontia, Lyceum, Nama, Sesuvium, Sporobolus, Vigna.

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepidia.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: Broussaisia, Cheirodendron, Leptecophylla, Metrosideros. Understory: Bryophytes, Ferns, Coprosma, Dubautia, Kadua, Peperomia.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be

currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium*

molokaiense, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: This species has been observed in flower during May 1982 (HHP 1990b) and December 1989 (HHP 1990c). Fruits and flowers were observed in March 1989 (HHP 1990d). (USFWS, 1996)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland, shrubland/chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 850 to 930 meters (2,790 to 3,050 feet) (USFWS, 1996)

Habitat Narrative

Adult: *Canavalia molokaiensis* is found in moist shrublands and forests on gulch slopes and in gulch bottoms. This species typically grows in exposed dry sites on steep slopes in mesic shrublands and forests at 850 to 930 meters (2,790 to 3,050 feet) elevation (USFWS 1992). Associated plant species include ohia, *Chamaesyce* (akoko), *Dodonaea viscosa* (aalii), *Styphelia tameiameia* (pukiawe), and *Wikstroemia* (akia) (USFWS 1992). (USFWS, 1996; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

6 (3 populations on Moloka'i and three that have not been visited within the last 10 years; USFWS, 2018)

Population Size:

18-33 (wild populations; USFWS, 2018)

Population Narrative:

In 2011, there were 10 populations of *Canavalia molokaiensis* totaling approximately 175 individuals on Moloka'i. Currently, there are three populations of 5 to 10 individuals each at Kalaupapa, Kūpā'ia, and Pua'ahala (Bakutis 2018, in litt.), and three individuals observed at Kua Gulch in 2013 (PEPP 2013). There are no new reports on the current status of other populations at Mokomoko Gulch (3 to 6 individuals) and Wai'ale'ia stream (10 individuals) since 2009 (Tangalin 2009, in litt.), or for two individuals at Wailau since 2005. (USFWS, 2018)

Threats and Stressors

Stressor: Habitat degradation from animals (USFWS, 1996; USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Feral ungulates, particularly goats and pigs, degrade the habitat of *Canavalia molokaiensis* extensively and pose an immediate threat to this species. Predation on a related species of *Canavalia* suggests that goats may possibly consume this species. At Mokomoko, Kua, and Waiehu, deer (*Axis axis*), goats (*Capra hircus*), and pigs (*Sus scrofa*) are very abundant, which contributes to habitat degradation and landslides. (USFWS, 1996; USFWS, 2011)

Stressor: Non-native plant species (USFWS, 1996; USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Competition with the alien plant, molasses grass, is also an immediate threat. Invasive introduced plant species that compete with natives and degrade *C. molokaiensis* habitat include *Ageratina adenophora* (sticky snake root), *Buddleia asiatica* (dog tail), *Clidemia hirta* (Koster's curse), *Cordyline fruticosa* (ti), *Bryophyllum pinnatum* (airplant), *Lantana camara* (lantana), *Melinis minutiflora* (molasses grass), *Psidium cattleianum* (strawberry guava), *Rubus rosifolius* (thimbleberry), and *Schinus terebinthifolius* (Christmasberry) (Hawaii Biodiversity and Mapping Program 2009; Perlman 2009; Tangalin 2009; Wood 2009). At Mokomoko, *Erigeron karvinskianus* (daisy fleabane), which blankets and outcompetes seedlings, is especially dense (Tangalin 2009). At Kupaia, the threats are introduced invasive plants including *Pinus* sp. (pine), *Melinis minutiflora*, *Casuarina* sp. (ironwood), and *Psidium cattleianum*. (USFWS, 1996; USFWS, 2011)

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2011); The assessment by Fortini et al. (2013) concluded that *Canavalia molokaiensis* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.761 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). (USFWS, 2018)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Molokai and at least one other island where they now occur or occurred historically. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1996)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1996)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Molokai and at least 1 other island where they now occur or occurred historically. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1996)
3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1996)

Recovery Actions:

- The highest priority for the recovery of the Molokai plant cluster taxa is the implementation of immediate recovery actions needed to keep “on-the-brink” species from going extinct. These actions include propagation and maintenance of genetic stock ex situ, and protection of remaining wild individuals from threats. (USFWS, 1996)
- Secondly, the plan proposes the delineation of management units to conserve not only these taxa, but their habitats as well. These units should be managed to preserve as many native species (flora and fauna) as possible, through threat-control and forest-restoration programs. (USFWS, 1996)
- The next step in the recovery of these species is augmentation of small populations and re-establishment of new populations within the historical range of the species. This includes selection of areas for augmentation and reestablishment, determination of the best methods for ex situ propagation and transplanting, selection of the best genetic stock for

- each area, propagation of suitable stock, preparation of sites for seeding and/or transplanting, and monitoring and maintenance of new individuals and populations as they are established. (USFWS, 1996)
- A research program is also recommended to study the growth and reproductive viability of each taxon, determine the parameters of viable populations of each taxon, study the reproductive strategy and pollinators of each taxon, and study possible pests and diseases. (USFWS, 1996)
 - Surveys and inventories—Survey for additional populations of *Canavalia molokaiensis* in areas of potentially suitable habitat. (USFWS, 2018)
 - Ungulate monitoring and control—Construct and maintain fenced exclosures to protect individuals from the negative impacts of feral ungulates. Protect all occurrences against browsing and habitat disturbances from feral ungulates. (USFWS, 2018)
 - Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. Control invasive nonnative species that compete with the species around all populations. (USFWS, 2018)
 - Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. (USFWS, 2018)
 - Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2018)
 - Climate change adaptation strategy—Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of this species. (USFWS, 2018)
 - Alliance and partnership development—Work with the Hawai'i Division of Forestry and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2018)

Conservation Measures and Best Management Practices:

- Continue protection from feral ungulates. (USFWS, 2011)
- Continue removal of invasive introduced plant species. (USFWS, 2011)
- Collect propagules for propagation and genetic storage. (USFWS, 2011)
- Propagate for reintroduction to augment existing populations. (USFWS, 2011)
- Establish additional populations within protected habitat. (USFWS, 2011)
- Work with Hawaii Division of Forestry and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2011)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2011)

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SPECIES ACCOUNT: *Canavalia napaliensis* (`Awikiwiki)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Canavalia napaliensis is a perennial climbing plant in the pea family (Fabaceae) having elliptical, papery leaflets 6 to 13 centimeters (cm) (2.4 to 5.0 inches (in)) long and 3.5 to 7.5 cm (1.4 to 3.0 in) wide. The upper surfaces of the leaves are sparsely pubescent, and the lower surfaces are densely pubescent. Flowers number 7.6 to 40.6 cm (3 to 16 in), pseudoracemes (multiple flowers in each bracket axil) are 1.9 cm (0.8 in) long, with dark purple corollas that are white spotted at the base. The flowers are 36 to 39 millimeters (mm) (1.4 to 1.5 in) long with wing petals 37 to 45 mm (1.5 to 2.0 in) long. The fruit pods are compressed, 14 to 20 cm (5.5 to 8.0 in) long by 3.0 to 3.8 cm (1.0 to 1.5 in) wide and densely silky pubescent. The seeds are reddish brown, oblong-elliptic, strongly compressed, 20 to 24 mm (0.8 to 1.0 in) long, and 14 to 16 mm (0.55 to 0.63 in) wide (Wagner and Herbst 1999). (USFWS, 2017)

Taxonomy

Genus found throughout tropical & subtropical Asia, Africa & America. Species endemic to Northwest Kauai. Wagner et al. have synonymized *C. makahaensis* & *C. nualoloensis* with this species. (NatureServe, 2015)

Historical Range

Canavalia napaliensis was historically known from 12 locations along the northwestern coast of Kauai, extending westward from Haena to Makaha Ridge (HBMP 2010). (USFWS, 2017)

Current Range

At the time of listing, five populations totaling between 106 and 206 individuals were reported from Haena to Kalalau Valley (Perlman 2007; HBMP 2007). Currently, this species is restricted to a small section of the Na Pali coast in eight populations totaling approximately 900 individuals. (USFWS, 2017)

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Canavalia napaliensis* (`Awikiwiki) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes five critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Canavalia napaliensis* includes five CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Lowland Mesic—Section 1: Lowland Mesic—Section 1 consists of 2,006 ac (812 ha) in the lowland mesic ecosystem, including mesic forest extending from Awaawapuhi Trail south to

Makaha Ridge, in the Na Pali Kona Forest Reserve and the Kuia NAR (Figure 1-A). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plants *Doryopteris angelica*, *Labordia helleri*, *Platydesma rostrata* and *Psychotria hobbdi*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these four species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic–Section 1 is not known to be occupied by the species *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Dubautia kenwoodii*, *Pittosporum napaliense*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

"Kauai—Lowland Mesic—Section 2: Lowland Mesic—Section 2 consists of 379 ac (154 ha) in the lowland mesic ecosystem, including mesic forest extending from Keanapuka to Kahuamaa Flat along the rim and cliffs of the Kalalau Valley, in the Na Pali Coast State Park (Figure 1-A, above). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plants *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Pittosporum napaliense*, and *Psychotria hobbdi*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these six species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic–Section 2 is not known to be occupied by the species *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Platydesma rostrata*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. "

"Kauai—Lowland Mesic—Section 3: Lowland Mesic—Section 3 consists of 124 ac (50 ha) in the lowland mesic ecosystem, including mesic forest extending from Manono Ridge, Pohakuao Valley, to Kanakuu, within the Na Pali Coast State Park (Figure 1-A, above). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plants *Canavalia napaliensis*, *Chamaesyce eleanoriae*, and *Charpentiera densiflora*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these three species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic–Section 3 is not known to be occupied by the species *Chamaesyce remyi* var. *remyi*, *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Pittosporum napaliense*, *Platydesma rostrata*,

Psychotria hobbdi, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. "

"Kauai—Lowland Mesic—Section 4: Lowland Mesic—Section 4 consists of 81 ac (33 ha) in the lowland mesic ecosystem, including mesic forest at the head of the Hanakapiai Valley, in the Na Pali Coast State Park (Figure 1-A, above). The entire section is State owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plant *Charpentieradensiflora* and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. Although Lowland Mesic—Section 4 is not known to be occupied by the species *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *Chamaesyce remyi* var. *remyi*, *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Pittosporum napaliense*, *Platydesmarostrata*, *Psychotria hobbdi*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery."

"Kauai—Lowland Mesic—Section 5: Lowland Mesic—Section 5 consists of 37 ac (15 ha) in the lowland mesic ecosystem, including mesic forest on the slopes of Mt. Haupū, on privately owned land (Figure 1-B). The entire section is within previously designated critical habitat, and falls within Critical Habitat Unit 7 of 50 CFR 17.99(a)(1), Map 23a. This section is occupied by the plants *Chamaesyce remyi* var. *remyi* and *Tetraplasandra bisattenuata*, and includes mesic forest and shrubland, the moisture regime, and subcanopy and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these two species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic—Section 5 is not known to be occupied by the species *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *Charpentieradensiflora*, *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Pittosporum napaliense*, *Platydesmarostrata*, and *Psychotria hobbdi*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. "

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Canavalia napaliensis* critical habitat consists of one component (Lowland mesic) (75 FR 18960-19165):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<914 m). Annual precipitation: 50–75 in (127–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to

address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland, shrubland/chaparral (NatureServe, 2015)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: *Canavalia napaliensis* occurs in open, dry sites and coastal strand, diverse lowland dryland-mesic forest to mixed mesophytic forest on talus slopes, and in shrubby, grassy gulch bottoms, at elevations between 6 to 695 meters (20 to 2,280 feet). Associated native species are: *Antidesma platyphyllum* (hame), *Chrysodracon aurea* (hala pepe), *Diospyros sandwicensis* (lama), *Dodonaea viscosa* (aalii), *Metrosideros* spp. (ohia), *Polyscias kawaiensis* (oheohe), *Pisonia* spp. (papala kepau), *Pittosporum kauaiense* (hoawa), *Planchonella sandwicensis* (alaa), *Psychotria mariniana* (kopiko), *Vitex rotundifolia* (beach vitex), and *Wikstroemia furcata* (akia) (Wagner and Herbst 1999; HBMP 2010; NTBG 2010, 2011, 2012, 2013, 2014). (USFWS, 2017)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends

Population Trends:

Long-term trends are unknown, but short-term trends indicate a relatively stable population (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

8 (USFWS, 2017)

Population Size:

~900 individuals [Na Pali (500 individuals), Makaha (100 individuals), Hikimoe (100 individuals), Haeleele (100 individuals) and four other scattered smaller populations totaling approximately 100 individuals; USFWS, 2017]

Population Narrative:

Long-term trends are unknown, but short-term trends indicate a relatively stable population. The original range of this species was probably much larger (Russell 2002). The number of plants remaining is probably under a thousand. Total number of environmental occurrences are 12, of those five are known extant occurrences found only on Kauai. Observation records range from 1986-2007 (HBMP 2007). (NatureServe, 2015); *Canavalia napaliensis* was historically known from 12 locations along the northwestern coast of Kauai, extending westward from Haena to Makaha Ridge (HBMP 2010). At the time of listing, five populations totaling between 106 and 206 individuals were reported from Haena to Kalalau Valley (Perlman 2007; HBMP 2007). Currently, this species is restricted to a small section of the Na Pali coast in eight populations totaling approximately 900 individuals. The populations include: Na Pali (500 individuals), Makaha (100 individuals), Hikimoe (100 individuals), Haeleele (100 individuals) and four other scattered smaller populations totaling approximately 100 individuals (Wood 2016, in litt.). Numbers have likely increased resulting from continued surveys of the area. (USFWS, 2017)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from non-native plants, goats, fire, hurricanes, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct

consumption of native vegetation; soil disturbance; dispersal of alien plant seeds, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Fire can destroy dormant seeds and plants, even in steep in inaccessible areas. Successive fires can remove habitat for native species by altering microclimate conditions favorable to alien plants.

Stressor: Predation and herbivory (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species present an immediate and significant threat to *Canavalia napaliensis* throughout its range due to documented browsing and trampling by pigs, goats, and deer and documented mechanical damage by rats and the black twig borer (*Xylosandrus compactus*) (USFWS, 2010).; Herbivory by rats has been noted as a threat to *Canavalia napaliensis* (HBMP 2010). Rats eat virtually every part of plants and at every stage: fleshy fruits, seeds, flowers, stems, leaves, shoot, seedlings, and roots (Russell 1980; Cuddihy and Stone 1990). The effects on plants range from reduced vigor and decreased reproduction to mortality of individuals and complete lack of recruitment. (USFWS, 2017)

Stressor: Ungulate modification and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Feral pigs (*Sus scrofa*), goats (*Capra hircus*), and black-tailed deer (*Odocoileus hemionus*) (Corn et al. 1978; HBMP 2010; NTBG 2010) modify and destroy habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil. (USFWS, 2017)

Stressor: Established ecosystem-altering invasive plant modification and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community. Invasive introduced plants impacting *Canavalia napaliensis* are *Adiantum hispidulum* (rough maidenhair fern), *Ageratum conyzoides* (maile honohono), *Andropogon glomeratus* (bushy beardgrass), *A. virginicus* (broomsedge), *Blechnum appendiculatum* (no common name (NCN)), *Clidemia hirta* (Koster's curse), *Cyperus meyenianus* (NCN), *Elephantopus mollis* (elephant's foot), *Erigeron karvinskianus* (daisy fleabane), *Hedychium gardnerianum* (kahili ginger), *Kalanchoe pinnata* (air plant), *Lantana camara* (lantana), *Melia azedarach* (chinaberry), *Melinis minutiflora* (molasses grass), *Oplismenus hirtellus* (basketgrass), *Plantago lanceolata* (narrow-leaved plantain), *Pluchea carolinensis* (sourbush), *Psidium guajava* (common guava), *Rubus rosifolius* (thimbleberry), *Setaria gracilis*

(yellow foxtail), and *Vulpia bromoides* (brome fescue) (Corn et al. 1978; HBMP 2010; NTBG 2010, 2011, 2012, 2013, 2014). (USFWS, 2017)

Stressor: Landslides and flooding destruction or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Landslides, including tree falls and erosion associated with them, can have a significant effect on small populations of *Canavalia napaliensis* (NTBG 2011, 2013; HBMP 2010). Landslides and erosion due to natural weathering destabilize substrates, damage and destroy individual plants, and alter hydrological patterns (Stearns 1985). (USFWS, 2017)

Stressor: Fire destruction or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: *Canavalia napaliensis* occurs in mesic and mesophytic forest areas that are more susceptible to fires (NTBG 2014). Fire kills most native trees and shrubs, and alters the native ecosystem, leading to invasion by nonnative grasses that contribute to the grass/fire cycle (D'Antonio and Vitousek 1992). (USFWS, 2017)

Stressor: Hurricanes (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden, 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013). (USFWS, 2017)

Stressor: Climate change loss or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Canavalia napaliensis* is highly vulnerable to the impacts of climate change, with a vulnerability

score of 0.711 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2017)

Stressor: Black twig borer herbivory (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Infestation by and damage or death caused by the black twig borer (*Xylosandrus compactus*) is a threat to *Canavalia napaliensis* (HBMP 2010). This insect pest burrows into branches, introduces a pathogenic fungus as a food source for its larvae, and lays its eggs (Davis 1970). In Hawaii, the black twig borer has many host plants, disperses easily, and is probably present at most elevations up to 762 meters (2,500 feet). (USFWS, 2017)

Stressor: Lack of adequate hunting regulations (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Nonnative feral ungulates pose a major ongoing threat to native species through destruction and modification of habitat, and by direct herbivory or predation. Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (i.e., sustained yield) in some areas, with one animal allowed per day; to other areas with as few as one animal allowed per year (DLNR 2010). All of the populations occur in State hunting areas. None of these populations are within fenced exclosures. Game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations are at risk (DLNR 2010). (USFWS, 2017)

Stressor: Lack of adequate biosecurity legislation (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Introduction of invasive nonnative plant species to the State of Hawaii and destruction of habitat and competition by nonnative plants are threats to *Canavalia napaliensis*. The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, is authorized to prevent the introduction or dissemination of animal and plant pests on all ships, aircraft, and their cargo and baggage arriving in the U.S. and its territories; however, pest species continue to enter the State. In addition, Federal import regulations do not address many species that could be pests in Hawaii (CGAPS 2009; Ikuma et al. 2002). (USFWS, 2017)

Stressor: Invasive species (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Established invasive plant species competition—Plant species including *Aleurites moluccana* (candlenut, kukui), *Cyclosorus dentatus* (downy wood fern), *Cordyline fruticosa* (ti), *Kalanchoe pinnata* (air plant), *Pluchea* spp. (marsh fleabane), and *Syzygium cumini* (Java plum) compete with *Canavalia napaliensis* for water, light, and nutrients (HBMP 2010; NTBG 2014). (USFWS, 2017)

Stressor: Stochastic events - Tsunami mortality and reduced viability (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Populations of *Canavalia napaliensis* near the shoreline are at very high risk of tsunamis. Even if plants survive the initial waves, salt water inundation can kill any salt-intolerant plants (USFWS 2011; Starr and Starr 2011, in. litt.). (USFWS, 2017)

Stressor: Stochastic events - reduced viability due to low numbers (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Small, isolated populations often exhibit reduced levels of genetic variability, which diminishes the species' capacity to adapt and respond to environmental changes, thereby lessening the probability of long-term persistence (Barrett and Kohn 1991; Newman and Pilson 1997; HBMP 2010). The problems associated with small population size and vulnerability to random demographic fluctuations or natural catastrophes are further magnified by synergistic interactions with other threats, such as anthropogenic impacts like habitat loss from human development or predation by nonnative species. Very small plant populations may experience reduced reproductive vigor due to ineffective pollination or inbreeding depression. (USFWS, 2017)

Recovery

Reclassification Criteria:

Reclassification criteria are not available.

Delisting Criteria:

Delisting criteria are not available.

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys. (USFWS, 2010)
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units. (USFWS, 2010)
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys. (USFWS, 2010)
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range. (USFWS, 2010)
- Conduct research on control methods for introduced slugs and avian malaria. (USFWS, 2010)

- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction. (USFWS, 2010)
- Identify threats and prioritize which ones to address first for the two birds. (USFWS, 2010)
- Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program. (USFWS, 2010)
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security. (USFWS, 2010)
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems. (USFWS, 2010)
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations. (USFWS, 2010)
- Surveys and inventories—Survey for populations of *Canavalia napaliensis* in areas of suitable habitat. (USFWS, 2017)
- Ungulate monitoring and control—Construct protective fences around all known populations and protect all occurrences against browsing and disturbances from feral ungulates. (USFWS, 2017)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. Control invasive nonnative plant species around all populations that compete with the species. (USFWS, 2017)
- Fire monitoring and control—Develop and implement a fire management plan for existing populations (USFWS, 2017).
- Predator and herbivore control—Implement rat control at current populations. (USFWS, 2017)
- Predator and herbivore control research—Develop and implement control methods for the black twig borer (*Xylosandrus compactus*). (USFWS, 2017)
- Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. (USFWS, 2017)
- Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2017)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from land slides and storms. (USFWS, 2017)
- Based on the recovery criteria above, consider development of a recovery plan. (USFWS, 2017)

Conservation Measures and Best Management Practices:

- Conservation measures are not available.

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SPECIES ACCOUNT: *Canavalia pubescens* (ʻAwikiwiki)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

A twining perennial vine. Leaves with 3 leaflets, usually hairy. Flowers usually 8-20 in pseudoracemes 3-5 cm long. Corollas dark red to pink, rarely white(?). (NatureServe, 2015)

Taxonomy

Genus found throughout tropical and subtropical Asia, Africa and America. Species endemic to Hawaiian islands. Wagner et al. have listed the following as synonyms of this taxon: *C. forbesii*, *C. haleakalaensis*, *C. Munroi*, *C. galeata* var. *pubescens*. (NatureServe, 2015)

Historical Range

Recorded from the islands of Niihau, Kauai, Maui, and Lanai in the state of Hawaii. (NatureServe, 2015)

Current Range

Recorded from the islands of Niihau, Kauai, Maui, and Lanai in the state of Hawaii. Current records (1983-1998) from Maui and Lanai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Canavalia pubescens* (ʻAwikiwiki) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Canavalia pubescens* includes three CHUs in Maui County, Hawaii with detailed unit information. There are also an unknown number of units on Lanai that contain this species (number of units is unknown because detailed unit descriptions for Lanai are not available) (81 FR 17790-18110).

Maui—Lowland Dry—Unit 1 consists of 11,465 ac (4,640 ha) of State land, 2,069 ac (837 ha) of federally owned land, and 3 ac (1 ha) of privately owned land, from Kanaio to Kahualau Gulch on the southern slopes of east Maui. This unit is occupied by the plants *Bonamia menziesii*, *Cenchrus agrimonioides*, *Flueggea neowawraea*, *Melicope adscendens*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 1 is not known to be occupied by *Alectryon macrococcus*, *Bidens micrantha* ssp. *kalealaha*, *Canavalia*

pubescens, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Sesbania tomentosa*, *Solanum incompletum*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 3 consists of 188 ac (76 ha) of privately owned land, at Keauhou on the southern slopes of east Maui. This unit is occupied by the plant *Canavalia pubescens*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 3 is not known to be occupied by *Bidens micrantha* ssp. *kalealaha*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 4 consists of 1,266 ac (512 ha) of State land (including the Department of Land and Natural Resources) at Ahihi-Kinohiwa Natural Area Reserve on the southern slopes of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Maui—Lowland Dry—Unit 4 is not currently occupied by *Bidens micrantha* ssp. *kalealaha*, *Bonamia menziesii*, *Canavalia pubescens*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Canavalia pubescens* critical habitat consists of two components. Coastal (Lanai) and Lowland dry (east Maui) (81 FR 17790-18110):

Ecosystem: Coastal. Elevation: <980 ft (<300 m). Annual precipitation: <20 in (<50 cm). Substrate: Well-drained, calcareous, talus slopes; dunes; weathered clay soils; ephemeral pools; mudflats.

Canopy: Hibiscus, Myoporum, Santalum, Scaevola. Subcanopy: Gossypium, Sida, Vitex.
Understory: Eragrostis, Jacquemontia, Lyceum, Nama, Sesuvium, Sporobolus, Vigna.

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm).
Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: Diospyros, Myoporum, Pleomele, Santalum. Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Sicyos.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative

ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland, grassland/herbaceous, shrubland/chaparral
(NatureServe, 2015)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: This species is found on dry grasslands, shrublands, and forests that are often at the coast or a short distance inland on rocky lands. On East Maui plants often occur on old lava flows.
(NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Long-term trends are unknown, whereas short-term trends indicate declines of 10-30%
(NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

7-10+ (NatureServe, 2015)

Population Size:

<200 plants (NatureServe, 2015)

Population Narrative:

Long-term population trends are unknown, whereas short-term trends indicate declines of 10-30%. The original range of this species was probably much larger (Russell 2002). Probably fewer than 200 plants. Estimated to have seven extant and 16 historical occurrences. USFWS estimates >10 populations. (NatureServe, 2015)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs, goats, axis deer, and cattle), nonnative plants, fire, drought, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Fire can destroy dormant seeds and plants, even in steep and inaccessible areas. Successive fires can remove habitat for native species by altering microclimate conditions favorable to alien plants. Drought destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, goats, axis deer, and cattle) is considered an ongoing threat to *Canavalia pubescens* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

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SPECIES ACCOUNT: *Cardamine micranthera* (Small-anthered bittercress)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/23/1989; Southeast Region (R4)

Physical Description

It is an erect slender perennial herb with fibrous roots and one (or rarely more) simple or branched stem(s) growing 2 to 4 decimeters tall. Basal leaves are 1 to 5 centimeters long (occasionally longer), 0.5 to 2.0 centimeters wide, crenate, with one (or rarely two) pairs of small lateral lobes or leaflets. The stem leaves are alternate and mostly unlobed, 1 to 1.5 centimeters long, crenate and cuneate. Flowering and fruiting occur in April and May. The flowers, subtended by leafy bracts, have four white petals, six stamens, and small, round anthers. The fruit is a silique, 0.8 to 1.2 centimeters long and approximately 1 millimeter in diameter, with a beak 1 to 1.2 millimeters long. The brown seeds are approximately 1 millimeter long. *Cardamine micranthera* can be distinguished from its most similar relative, *Cardamine rotundifolia*, by its much smaller, nearly orbicular (instead of oblong) anthers, smaller flowers, and more angulate and nonclasping leaves. In *Cardamine micranthera*, the anthers are about 0.5 millimeter long, and the petals are 1.2 to 2 millimeters wide. Stem leaves of *Cardamine micranthera* are typically broadly cuneate (rarely narrowly cuneate, oblique, or cordate) and never cordate-clasping. *Cardamine micranthera* is typically erect, or occasionally has decumbent stems, but these do not develop proliferating branches. *C. micranthera* has only one to two pairs of lateral leaflets (or none), with the terminal leaflet being nearly one-half the total length. *Cardamine micranthera* has pedicels 9 to 15 mm long and siliques 14 to 22 mm (pods only one and one-fourth to one and one-half times the length of the stalks). The beak of the fruit corresponds to the style in the flower and is that portion of the pod extending beyond the seed-bearing part. *Cardamine micranthera*'s beak is about 2 mm long and can be readily seen as a sharp, spindle-like tip on the pod (T. Wieboldt, personal communication, 1991). (USFWS, 1991)

Taxonomy

Cardamine micranthera was first described by R. C. Rollins (1940) from material collected in North Carolina in 1939. (USFWS, 1991)

Historical Range

Native to the Dan River drainage of the North Carolina and Virginia piedmont. Historically found in Stokes and Forsyth Counties (USFWS, 1991).

Current Range

Stokes County, North Carolina and Patrick County, Virginia. (USFWS, 2016)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from EPA, 2016)

Key Resources Needed for Breeding

Adult: Insect pollinators - possibly ants (EPA, 2016)

Reproduction Narrative

Adult: Produces flowers and fruits April to May. Insects are potential pollinators (EPA, 2016).
Ants have been observed visiting the flowers (USFWS, 1991).

Habitat Type

Adult: Palustrine, terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Riparian, forest (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Full to partial shade (NatureServe, 2015)

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Habitat Narrative

Adult: Seepages, wet rock crevices, streambanks, sandbars, and wet woods along small streams (Murdock and Weakley 1991). The environmental specificity of this specie is narrow; *C. micranthera* occupies moist soils of the upper Piedmont that are fully to partially shaded (Murdock and Weakley 1991). More specifically, it is typically found in wet, boggy soils of deciduous woodlands and moist to wet soils along the edge of small to intermediate sized streams (NCA 1996). Within the stream bed plants also inhabit sand and gravel bars and wet rock crevices (Murdock and Weakley 1991) (NatureServe, 2015). Occurs on soils of the Rion, Pacolet, and Wateree series, where slopes are 25 to 60 percent (EPA, 2016).

Dispersal/Migration**Dependency on Other Individuals or Species for Dispersal**

Adult: Unknown (EPA, 2016)

Dispersal/Migration Narrative

Adult: Seed dispersal occurs via water but other means are possible (EPA, 2016).

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Species Trends:

Declining (NatureServe, 2015)

Number of Populations:

32 (USFWS, 2016)

Population Size:

Annual fluctuation; < 23,000 (USFWS, 2016)

Population Narrative:

Little is known about the age of maturity and fecundity of this species; however the plant is a perennial and flowers and fruits annually. About 20 populations have excellent/good viability. Populations in North Carolina are believed to be in decline (NatureServe, 2015). Estimates of abundance for the 32 extant populations range from one plant to 8,000 - 10,000 plants. If the maximum estimates for each population are considered in aggregate, the global population contains fewer than 23,000 plants. However, population sizes are known to fluctuate widely from one year to the next (Boyer 1996) (USFWS, 2016).

Threats and Stressors

Stressor: Beaver dams (USFWS, 2002)

Exposure:

Response:

Consequence:

Narrative: Beaver dams have been observed to constitute a significant threat to *Cardamine micranthera* at some locations, with one knowledgeable observer regarding this as perhaps the most immediate threat to the species (Bridle 2009, pers. comm.). Bridle notes that beaver activity (especially in drought years) within main stream channels has flooded entire colonies of the species (USFWS, 2016).

Stressor: Habitat destruction and modification (USFWS, 2002)

Exposure:

Response:

Consequence:

Narrative: Habitat alteration remains the primary threat to *Cardamine micranthera*, with impoundment, channelization, conversion associated with agriculture or silviculture, flooding, and encroachment of exotic species as threats affecting the species. Cattle trampling and downstream beaver impoundments have also been noted as threatening *C. micranthera* habitat (USFWS, 2016).

Stressor: Inadequacy of regulatory mechanisms (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: State statutes primarily regulate collection and trade in listed species, and do not prohibit land owners from neglecting or otherwise impacting such species on their own properties or in conjunction with otherwise legal activities (USFWS, 2016).

Recovery

Reclassification Criteria:

Not defined (USFWS, 1991)

Delisting Criteria:

1. It has been documented that at least six populations are self-sustaining and that necessary management actions have been undertaken by the landowners or cooperating agencies to ensure their continued survival (USFWS, 1991).
2. All of the above populations and their habitat are protected from present and foreseeable human-related and natural threats that may interfere with the survival of any of the populations (USFWS, 1991).

Recovery Actions:

- Protect existing populations and essential habitat. Only nine populations of small-anthered bittercress are currently known to exist, all in the piedmont of North Carolina and Virginia. Until more is known about the species' biology and specific habitat requirements, and about the measures necessary to protect occupied sites, all existing populations should be protected. The long-term survival of six populations is believed to be essential to the recovery of the species as a whole. (USFWS, 1991)
- Determine and implement management necessary for long-term reproduction, establishment, maintenance, and vigor. Protection of the species' habitat is the obvious first step in ensuring its long-term survival, but this alone may not be sufficient. Since very little is known about this species, information on its population biology and ecology is necessary before effective management guidelines can be formulated and implemented.
- Develop a cultivated source of plants and provide for long-term seed storage. There are presently no cultivated sources of this species. Techniques for seed storage, germination, and maintenance of cultivated specimens must be developed. (USFWS, 1991)
- Enforce laws protecting the species and/or its habitat. The Endangered Species Act prohibits taking of *Cardamine micranthera* from Federal lands without a permit and regulates trade. Section 7 of the Act provides additional protection of the habitat from impacts related to federally funded or authorized projects. In addition, the 1988 amendments to the Act prohibit (1) the malicious damage or destruction of listed plants on Federal lands and (2) the removal, cutting, digging, damaging or destroying of such plants in knowing violation of any State law or regulation, including State criminal trespass law. The State of North Carolina prohibits taking of the species without a permit and the landowner's written permission and regulates trade in the species (North Carolina General Statute 19-B, 202.12-202.19). The State of Virginia prohibits taking and trade of listed species without a permit (Code of Virginia 39:3.1-1020 to 31-030). Federal and State enforcement agents whose jurisdiction includes the known range of small-anthered bittercress should be made aware of the threats to the species and be able to identify specimens. (USFWS, 1991)
- Develop materials to inform the public about the status of the species and the recovery plan objectives. Public support for the conservation of small-anthered bittercress could play an important part in encouraging landowner assistance and conservation efforts. Information materials should not identify the plant's locations so as not to increase the threat of taking or vandalism. Annually assess success of recovery efforts for the species. Review of new information, evaluation of ongoing actions, and redirection, if necessary, is essential for assuring that full recovery is achieved as quickly and efficiently as possible. (USFWS, 1991)

- Recommendation for Future Action from 2016 5-Year Review: Continue to pursue follow-up information from stream restoration project on Snow Creek (involving a portion of one population of this species) from appropriate state, federal and private parties. (USFWS, 1991)
- Recommendation for Future Action from 2016 5-Year Review: Communicate existing habitat protection priorities (VDCR 2007, Boyer 1996) to state agencies, local land trusts, and other conservation partners, to assess current and future options for protection. Encourage land protection strategies focused on headwater occurrences likely to serve as a seed source for recolonization of sites further downstream (Bridle 2009, pers. comm.). (USFWS, 1991)
- Recommendation for Future Action from 2016 5-Year Review: Identify sites which have experienced recent disturbance, and evaluate the effects of ongoing and prior habitat disturbance upon the species. (USFWS, 1991)
- Recommendation for Future Action from 2016 5-Year Review: Utilize information obtained from assessments of prior or ongoing habitat disturbance to devise and implement appropriate habitat management guidelines. (USFWS, 1991)
- Recommendation for Future Action from 2016 5-Year Review: 5. Conduct site visits to determine if Boyer's (1996) long-term monitoring transects can be relocated and resurrected. If so, reinitiate monitoring efforts to learn more about the longevity and relative stability of populations of this short-lived species. If Boyer's (1996) monitoring transects cannot be resurrected, work to establish comparable monitoring (using Boyer's protocol or modifications thereof) at priority sites using standardized monitoring methods. (USFWS, 1991)
- Recommendation for Future Action from 2016 5-Year Review: 6. Use monitoring data and other information to draft objective, measurable criteria for "self-sustaining" populations. (USFWS, 1991)
- Recommendation for Future Action from 2016 5-Year Review: 7. Determine the status of genetic material held in botanical gardens and other institutions, and work to ensure that the species is adequately represented in long-term storage. (USFWS, 1991)
- Recommendation for Future Action from 2016 5-Year Review: 8. Pursue development of habitat predictability models for this species, and iteratively refine and use these to search for new populations and guide land protection efforts. (USFWS, 1991)
- Recommendation for Future Action from 2016 5-Year Review: 9. Identify landowners, obtain permission to visit populations, and provide information to landowners about voluntary protection measures that may be implemented to protect the species (including best management practices, NHP Registry programs, conservation easements, and fee simple purchase by cooperating land protection agencies). (USFWS, 1991)

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SPECIES ACCOUNT: *Castilleja affinis* ssp. *neglecta* (Tiburon paintbrush)

Species Taxonomic and Listing Information

Listing Status: Endangered; 3/6/1995; Pacific Southwest (R8)

Physical Description

Castilleja affinis ssp. *neglecta* (Figure II- 5) is a semi-woody perennial of the snapdragon family (Scrophulariaceae), with erect, branched stems 30 to 60 centimeters (1 to 2 feet) tall and a sparse covering of soft, spreading hairs (Munz and Keck 1959). The lance-shaped leaves are 20 to 40 millimeters (0.8 to 1.6 inches) long and have 0 to 5 lobes (Hickman 1993). The conspicuous floral bracts are yellowish and sometimes red-tipped; the flowers are yellow to red and 18 to 20 millimeters (0.7 to 0.8 inch) long. (USFWS, 1998)

Taxonomy

Transferred to varietal rank by Egger (2008). Treated as *Castilleja affinis* ssp. *neglecta* by Kartesz (1999 Synthesis), by The Jepson Manual (Hickman, 1993) and by the U.S. Fish and Wildlife Service. Originally named as a species (*Castilleja neglecta*), and treated at that level by Kartesz (1994). Kartesz notes (pers. comm. to Larry Morse, 25Nov99) that his treatment of this as a subspecies is based on a 1992 personal communication with Chuang. (NatureServe, 2015)

Historical Range

Never widespread; in 1998, locations were on the Tiburon Peninsula in Main County, one population in Napa County, and one population in Santa Clara County (USFWS, 1998)

Current Range

Known from Marin, Napa, Santa Clara counties in California (USFWS, 2012)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 2012)

Dependency on Other Individuals or Species

Adult: The yellow flowers of *Castilleja affinis* ssp. *neglecta* are pollinated by hummingbirds (County of Santa Clara et al. 2010). (USFWS, 2012)

Breeding Season

Adult: April to June (USFWS, 1998)

Key Resources Needed for Breeding

Adult: Low temperatures and leaching (USFWS, 1998)

Reproduction Narrative

Adult: *Castilleja affinis* ssp. *neglecta* is a root parasite on other angiosperm (flowering plant) species. *Castilleja affinis* ssp. *neglecta* is a perennial, flowering from April to June (Munz and Keck 1959). The yellow flowers of *Castilleja affinis* ssp. *neglecta* are pollinated by hummingbirds (County of Santa Clara et al. 2010). Seed germination occurs in January or February and seems to be induced by leaching and low temperatures (5 to 15 degrees Celsius or 45 to 59 degrees Fahrenheit) (Martin 1989). The mean number of inflorescences per plant was 2.3, the mean number of capsules per inflorescence was 8.8, and the mean number of seeds per capsule was 82.3. Based on these figures, seed production for 1 year was calculated to be 1,666 seeds per plant (Martin 1989). The plant dies back to its woody base after seed dispersal and new growth occurs after the first winter rain. Heckard (1968) observed evidence that polyploidy leads to patterns of variation that can lead to hybridization while plants maintain differences in their appearance. (USFWS, 1998; USFWS, 2012)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Serpentine grasslands (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Leaching and low temperatures (USFWS, 1998)

Geographic or Habitat Restraints or Barriers

Adult: Grows at elevations between 75 and 400 meters (USFWS, 2012)

Spatial Arrangements of the Population

Adult: Scattered colonies (USFWS, 2012)

Site Fidelity

Adult: High (inferred from USFWS, 2012)

Dependency on Other Individuals or Species for Habitat

Adult: The primary advantage of the parasitic attachment in *Castilleja* and related plants in the figwort family is reportedly an increased water and mineral supply. Though the parasitic relationship is not obligate (hemiparasitic), benefits to species of *Castilleja* from the parasitic habit are manifested in increased vigor with more branching, greater height, and earlier flowering (Heckard 1962). Heckard (1962) showed that a host plant is beneficial to *Castilleja affinis* ssp. *neglecta* and increases the species' chance for survival. (USFWS, 1998)

Habitat Narrative

Adult: Three scattered colonies of the occurrences of *Castilleja affinis* ssp. *neglecta* in Marin County occur on the Tiburon peninsula. *Castilleja affinis* ssp. *neglecta* occurs in serpentine bunchgrass communities typically on north to west facing slopes. *Castilleja affinis* ssp. *neglecta* grows on open, rocky, serpentine slopes within the serpentine grassland communities, between about 75 and 400 meters in elevation in Napa, Marin, and Santa Clara Counties (Service 1998, Safford et al. 2005, LSA 2007, CDFG 2010). Seed germination occurs in January or February and seems to be induced by leaching and low temperatures (5 to 15 degrees Celsius or 45 to 59

degrees Fahrenheit) (Martin 1989). *Castilleja affinis* ssp. *neglecta* parasitic attachment increases water and mineral supply. Though the parasitic relationship is not obligate (hemiparasitic), benefits to species of *Castilleja* from the parasitic habit are manifested in increased vigor with more branching, greater height, and earlier flowering (Heckard 1962). Heckard (1962) showed that a host plant is beneficial to *Castilleja affinis* ssp. *neglecta* and increases the species' chance for survival. (USFWS, 1998; USFWS, 2012)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seed dispersal occurs from June to October. (USFWS, 2012)

Additional Life History Information

Adult: Seed dispersal occurs from June to October. (USFWS, 2012)

Population Information and Trends

Number of Populations:

8 (USFWS, 2012)

Population Size:

Approximately 2,000 plants (USFWS, 2012)

Population Narrative:

The distribution of *C. affinis* ssp. *neglecta* has never been widespread. Seven occurrences are described: five in Marin County (three of which occur on the Tiburon Peninsula), one near American Canyon in Napa County, and one in Santa Clara County (Service 1998, CDFG 2010). The CNDDDB reports one additional occurrence in Santa Clara County (CDFG 2010) and one occurrence from Stinson Beach in Marin County that was last observed at 1965 with the exact location and number of plants listed as unknown (CDFG 2010). The range of *C. affinis* ssp. *neglecta* is approximately 50 kilometers (30 miles) from east to west, and 112 kilometers (70 miles) from north to south (Service 1995). (USFWS, 2012)

Threats and Stressors

Stressor: Residential Development (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: When *Castilleja affinis* ssp. *neglecta* was listed as endangered in 1995, residential development was identified as a primary threat to Marin County populations. It remains a significant threat today. At the time of listing, the St. Hilary's church occurrence on the Tiburon peninsula was threatened by a proposed residential development. A portion of the land supporting this population was purchased by the Marin County Open Space District and Town of Tiburon in 1997 as an open space preserve (the Old St. Hilary's Open Space Preserve), however, a portion of the population remains on private land where residential development has been proposed on multiple occasions. Residential development on the Middle Ridge adjacent to

Tiburon paintbrush habitat is anticipated to occur in the near future (S. Anderson personal communication 2009). (USFWS, 2012)

Stressor: Mining/Landfill (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Both Santa Clara County occurrences of *Castilleja affinis* ssp. *neglecta* occur on private land associated with the Kirby Canyon Landfill. However, both are located in areas currently managed as mitigation sites for landfill impacts. Both occurrences are monitored and managed by the Kirby Canyon Butterfly Trust, but neither site is permanently protected (County of Santa Clara et al. 2010). At the time of listing, the Napa County occurrence was threatened by the potential expansion of the American Canyon Quarry. In 1999 private landowners donated land supporting 5 to 10 percent of the *Castilleja affinis* ssp. *neglecta* occurrence to the City of American Canyon in order to create the Newell Preserve; the Land Trust of Napa County holds a conservation easement on the preserve land (Napa County Land Trust website). Currently, there are no active plans for quarry expansion on the land that supports the majority of this occurrence and quarry reclamation which was initiated in 2007 is not anticipated to affect this occurrence (D. Barrella personal communication 2011). However, the quarry property is in an area zoned for agriculture and low density residential and could potentially be developed in the future. (USFWS, 2012)

Stressor: Recreation (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: At the time *Castilleja affinis* ssp. *neglecta* was listed, we cited pedestrian traffic associated with recreation activities as a Factor A threat for the Middle Ridge and Ring Mountain populations of *C. affinis* ssp. *neglecta* on the Tiburon peninsula. Currently, wayward trails continue to crisscross Ring Mountain Preserve resulting in a small reduction in available habitat. *C. affinis* ssp. *neglecta* is most likely to be negatively affected by hikers, cyclists, and equestrians if they stray from designated and social trails and trample plants or if new trails are established. *C. affinis* ssp. *neglecta* plants on the Middle Ridge of the Town of Tiburon faces threats from hikers and their dogs that trample plants and habitat despite posted signs warning sensitive plant habitat (E. Buxton personal communication 2009). (USFWS, 2012) Currently, visitors are only allowed to visit Newell Preserve in Napa County during docent-led tours. Therefore, trampling and habitat destruction from recreational hikers, dogs, cyclists, and equestrians is currently not a threat to this *Castilleja affinis* ssp. *neglecta* occurrence. However, a master plan is being developed for the preserve that will likely include allowing public access without docent supervision. (USFWS, 2012)

Stressor: Landslide/Erosion (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: At the time of listing, soil slumping was identified as a threat to the *Castilleja affinis* ssp. *neglecta* occurrence at Ring Mountain Preserve (Service 1995). The toe of the slope that supports the population was removed to accommodate residential development in Corte Madera

in the 1960s and soil from the slope slips onto the street below. Some Town of Tiburon Open space parcels are mapped as being prone to landslides and erosion occurs along some trails and watercourses on open space parcels, but neither appears to be a major threat to *C. affinis* ssp. *neglecta* at this time (LSA 2010). (USFWS, 2012)

Stressor: Grazing (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Cattle grazing was cited as a factor C threat to *Castilleja affinis* ssp. *neglecta* at the time of listing. Improper grazing may remain a potential threat to the species, however, grazing can also be used as a management tool to reduce biomass of non-native vegetation and may actually be beneficial to the species if managed appropriately (County of Santa Clara et al. 2010). (USFWS, 2012)

Stressor: Herbivory (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Mammal herbivory by mule deer (*Odocoileus hemionus*) and black-tailed jackrabbits (*Lepus californicus*) may pose a threat to *Castilleja affinis* ssp. *neglecta* on the Ring Mountain Preserve. Results from 2007 monitoring showed that approximately 25 percent of the inflorescence branches in the 53 plants evaluated were removed by herbivory (LSA 2007). However, side branches developed when tips of branches were removed, so this type of herbivory may not pose a substantial threat. Disturbance from feral pig (*Sus scrofa*) rooting poses a threat to the Paintbrush Hill occurrence in Santa Clara County (County of Santa Clara et al. 2010). Cameras placed at the Santa Clara occurrences have documented rabbits and deer in the area and sharp incisions on the plants suggest that rabbits may be eating some *C. affinis* ssp. *neglecta* flowers and fruit at this location (C. Niederer personal communication 2011). It is not known whether any diseases threaten the species. (USFWS, 2012)

Stressor: Non-native Invasive Plant Species (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Competition from non-native invasive plant species continues to pose a serious threat to *Castilleja affinis* ssp. *neglecta* on the Tiburon peninsula. At the Ring Mountain Preserve, the Marin County Open Space District has been working to eradicate or control non-native invasive species for several years. The Ring Mountain Preserve Sensitive Resource Monitoring Plan (LSA Associates, Inc. 2007) provides a list of non-native invasive species that currently occur on Ring Mountain and describes treatment recommendations. Similarly, the Town of Tiburon has an Open Space Resource Management Plan (LSA 2010) that addresses invasive species that affect the Middle Ridge occurrence of *C. affinis* ssp. *neglecta*. Bull thistle (*Cirsium vulgare*), French broom (*Genista monspessulana*), and wild oats (*Avena* spp.), are problematic on parcels supporting *C. affinis* ssp. *neglecta*. Weed abatement is an ongoing activity that will likely need to occur in perpetuity at these locations. (USFWS, 2012) Non-native invasive plant species occur to some extent in association with occurrences of *Castilleja affinis* ssp. *neglecta* outside the Tiburon peninsula as well. Point Reyes National Seashore is working to control an invasion of distaff

thistle (*Carthamus lanatus*) in the vicinity of the Nicasio Ridge occurrence of *C. affinis* ssp. *neglecta* within the GGNRA and hand removal of tocolote (*Centaurea melitensis*) is conducted on Nicasio Ridge once or twice a year as funding allows. At this time, however, these non-native species do not appear to pose a serious threat to the Nicasio Ridge *C. affinis* ssp. *neglecta* occurrence (M. Chasse personal communication 2011). Treatments for barbed goatgrass (*Aegilops triuncialis*) have taken place on the Kirby Canyon Butterfly Preserve that supports Paintbrush Hill occurrence of *C. affinis* ssp. *neglecta* in Santa Clara County (Niederer 2008) and a number of non-native species occur in low densities within the North Canyon occurrence in Santa Clara County (C. Niederer personal communication 2009). At these two locations, efforts to control non-native plant species are necessary to keep them in control, but at this 14 time cattle grazing and current efforts appear to have prevented severe encroachment of non-native species (C. Niederer personal communication 2009). (USFWS, 2012)

Stressor: Nitrogen Deposition (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Air pollution and the resultant deposition of reactive airborne nitrogen has become a significant threat to many native California plants, in particular to those that occur in nutrient poor soils such those in serpentine areas (Weiss 1999). Increased nitrogen deposition allows nutrient-poor serpentine soils to be invaded by non-native annual grasses that displace the native forbs (Weiss 1999). Nitrogen deposition is especially high near urban areas where combustion sources produce substantial concentrations of nitrogen oxides (Weiss 1999). All occurrences of *Castilleja affinis* ssp. *neglecta* occur within or adjacent to urban areas with elevated levels of nitrogen deposition with particularly high nitrogen deposition levels occurring in Santa Clara County near San Jose (Weiss 2006). (USFWS, 2012)

Stressor: Stochasticity (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: The limited number and small sizes of *Castilleja affinis* ssp. *neglecta* occurrences increase this species vulnerability to chance events such as fire, flood, drought, disease, and other natural and human-caused disasters (Brook et al. 2002). The occurrences of *C. affinis* ssp. *neglecta* on the Tiburon peninsula in particular are located in close proximity to dense, residential development placing them at risk of catastrophic events associated with human activity such as fire or vandalism. In addition, small populations are subject to inbreeding (mating between closely related individuals) resulting in a subsequent loss of genetic diversity (Spielman et al. 2004). Small populations are also more likely to experience extinction as a result of “stochastic” demographic fluctuations or other density-dependent effects (Avis 2004). (USFWS, 2012)

Stressor: Climate Change/Drought (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer

continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). However, climatic conditions for smaller sub-regions such as California remain uncertain (Pyke 2005). It is unknown at this time if climate change in California will result in a localized, relatively small cooling and drying trend, or a warmer trend with higher precipitation events (Pyke 2005). A modeling study completed by Loarie et al. (2008) provides an evaluation of potential trends to California's floristic communities under climate change scenarios. The models suggest that shifts in species ranges may break up local floras, resulting in new species combinations, with new patterns of competition and biotic interactions (Loarie et al. 2008). While it appears reasonable to assume that *Castilleja affinis* ssp. *neglecta* will be affected by climate change, we lack sufficient certainty regarding how and how soon climate change will affect the species. Because *C. affinis* ssp. *neglecta* is restricted to limited and patchily distributed serpentine soils, however, the species will likely have difficulty shifting its range to adjust to changing conditions. (USFWS, 2012)

Recovery

Reclassification Criteria:

1. Six (6) populations of *Castilleja affinis* ssp. *neglecta* are fully protected and managed with the primary intention of preserving the populations in perpetuity (USFWS, 1998)
2. Six (6) populations of *Castilleja affinis* ssp. *neglecta* are shown to be stable or increasing with evidence of recruitment over a minimum of 20 years that include the normal precipitation cycle (or longer if suggested by the results of demographic monitoring) (USFWS, 1998)
3. Seed collected from natural populations throughout the range of the species is stored at a minimum of two Center for Plant Conservation certified botanic gardens (USFWS, 1998)
4. Reliable seed germination and propagation techniques for the species are understood (USFWS, 1998)

Delisting Criteria:

1. Ten (10) populations throughout its range are shown to be fully protected and managed with the primary intention of preserving the populations in perpetuity. At least 2 of the 10 should occur in Santa Clara County. (USFWS, 1998)
2. Ten (10) populations of *Castilleja affinis* ssp. *neglecta* are shown to be stable or increasing with evidence of recruitment over a minimum of 20 years that include the normal precipitation cycle (or longer if suggested by the results of demographic monitoring) (USFWS, 1998)
3. Seed collected from natural populations throughout the range of the species is stored at a minimum of two Center for Plant Conservation certified botanic gardens (USFWS, 1998)
4. Reliable seed germination and propagation techniques for the species are understood (USFWS, 1998)

Recovery Actions:

- Protecting and managing the known populations. Protection and management of populations on public lands will involve working with Main Open Space District, the town of Tiburon, and the Golden Gate National Recreation Area to ensure the long-term survival of

the species on their lands. The populations, or portions of populations, occurring on private lands should be protected by land acquisition, conservation easements, or other mechanisms. Among populations on private land, protection of the only known population in Santa Clara County is a particularly high priority because it is geographically disjunct from other populations. In general, the largest possible block of serpentine habitat should be protected at each site. Protection should, at least, involve securing the populations themselves as well as a 150-meter (500-foot) buffer around each population, where possible, to reduce external influences and allow expansion of populations. In addition, other unoccupied habitat at the sites that might provide space for expansion of the populations and habitat for pollinators and seed dispersers must be protected.

Management plans emphasizing *Castilleja affinis* ssp. *neglecta* and other special status species in each location must be developed and implemented. The plans should include provisions for standardized monitoring of *Castilleja affinis* ssp. *neglecta* populations every other year to determine demographic trends. The plans should also include strategies to minimize known threats (e.g. foot traffic) at the sites as well as to identify new threats should they appear. Removal of nonnatives should be a high priority for management of sites on the Tiburon Peninsula such as those on Middle Ridge and in Main County Open Space near Old St. Hilary's Church. In addition, soil slumping at the Ring Mountain Preserve needs to be minimized. If new threats are identified or other new information becomes available, management plans need to be reevaluated and revised. For populations on public lands, any management plan developed should include an educational outreach program. (USFWS, 1998)

- Collection and banking of seed in Center for Plant Conservation certified botanic gardens. Seed banking guards against extinction of populations from chance catastrophic events and provides potential material for enhancement efforts in existing populations, repatriations, and/or introductions to new sites. In the absence of genetic data for *Castilleja affinis* ssp. *neglecta*, seed collection efforts should represent populations throughout the range of the species, including the Santa Clara County population that is at least 100 kilometers (62 miles) south of the other known populations (Elam in prep). Care should be taken to ensure that seed collection does not adversely affect the donor populations. (USFWS, 1998)
- Other potential serpentine habitat throughout the range of the species should be surveyed to determine if other populations exist. Santa Clara County, in particular, contains habitat that should be surveyed (e.g. to the south of the known occurrence and in Henry Coe State Park east of Anderson Reservoir) (California Department of Fish and Game 1997a). If new populations are discovered, they should be protected and managed as discussed above. During these surveys, potential introduction sites might also be identified. (USFWS, 1998)
- The effect of various vegetation management techniques (e.g. grazing, mowing, and burning) on *Castilleja affinis* ssp. *neglecta* needs to be evaluated, because (1) *Castilleja affinis* ssp. *neglecta* occurs approximately 100 to 250 meters (328 to 820 feet) from relatively good quality bay checkerspot butterfly habitat (N. McCarten, in litt., 1998) in Santa Clara County, and (2) bay checkerspot butterfly habitat benefits from vegetation management. Although cattle and deer grazing of *Castilleja affinis* ssp. *neglecta* has not been observed (N. McCarten, in litt., 1998), evaluation of these techniques will ensure that managers select management strategies that maintain bay checkerspot butterfly habitat while not adversely affecting *Castilleja affinis* ssp. *neglecta*. Research on the effects of grazing are also important in recovery efforts for *Castilleja affinis* ssp. *neglecta* because grazing is a concern at the Golden Gate National Recreation Area in Main County. In addition, because other *Castilleja* species appear to benefit from fire (R. Raiche. cited in

California Department of Fish and Game 1997b, small scale experimental burning (e.g. using burn boxes) may reveal another possible management strategy. Any experimental burning should initially be limited to a very small area (e.g. 1 square meter [10.8 square feet]). (USFWS, 1998)

- Other research needs include germination and propagation techniques, taxonomic, demographic, and genetic studies as well as mating system and pollination studies. Demographic studies should include field studies of *Castilleja affinis* ssp. *neglecta*'s hemiparasitic nature, the frequency of seed germination and seedling recruitment in nature, and identification of limiting life history stages. Martin (1989) observed no seedlings in the field during a 2-year study. Genetic studies should focus on whether, and to what extent, populations throughout the range of the species are genetically different from one another. These genetic data would be valuable guides as to which populations should be chosen as sources for enhancement of existing populations or introduction of new populations. (USFWS, 1998)

Conservation Measures and Best Management Practices:

- Control and eradicate non-native, invasive plant species: continue to control non-native plant species at Ring Mountain Preserve and Town of Tiburon Open Space parcels according to existing management plans. Amend the Town of Tiburon Open Space Management Plan to include the Old Saint Hilary's Church Open Space parcel. Develop and implement management plans for controlling non-native invasive plant species in the area supporting the two *Castilleja affinis* ssp. *neglecta* occurrences on GGNRA land in Marin County, on the Newell Preserve in Napa County, and for the mitigation lands supporting the two *C. affinis* ssp. *neglecta* occurrences in Santa Clara County. (USFWS, 2012)
- Locations that should be targeted for protection in cooperation with willing landowners: in Santa Clara County, establish a conservation easement on the 250 acre Bay checkerspot butterfly reserve that supports the Paintbrush Hill *C. affinis* ssp. *neglecta* occurrence and on the entire mitigation parcel that supports the North Canyon occurrence. In Napa County, pursue opportunities to acquire or incorporate land supporting *C. affinis* ssp. *neglecta* in the former quarry area into Newell Open Space Preserve. In Marin County, establish a conservation easement on all remaining undeveloped serpentine habitat in the Old St. Hilary's Church area as mitigation for any development that takes place on private parcels in this location. (USFWS, 2012)
- Monitoring: Continue to monitor *Castilleja affinis* ssp. *neglecta* on the Ring Mountain Preserve using the 24 established 1m² monitoring plots for three years using the same parameters as those used in 2007 thereafter, every two years as recommended by the 1998 Recovery Plan (Service 1998). Add a monitoring protocol for *Castilleja affinis* ssp. *neglecta* to the Town of Tiburon Open Space Management Plan. In Marin County on GGNRA land, continue monitoring *Castilleja affinis* ssp. *neglecta* at Nicasio Ridge and initiate monitoring at CNDDDB occurrence 6. Include monitoring of grazing effects at these locations. (USFWS, 2012)
- Seeds from *Castilleja affinis* ssp. *neglecta* should be collected from populations throughout the range and banked in Center for Plant Conservation certified gardens. (USFWS, 2012)
- Other serpentine habitats with the potential to support *Castilleja affinis* ssp. *neglecta* should be surveyed to determine whether undiscovered populations exist. New populations should be noted with the appropriate County, California Department of Fish and Game, the Service and the California Native Plant Society. (USFWS, 2012)

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SPECIES ACCOUNT: *Castilleja campestris* ssp. *succulenta* (Fleshy owl's-clover)

Species Taxonomic and Listing Information

Listing Status: Threatened; 03/26/1997; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A hemiparasitic annual herb, mostly 5-25 cm tall, with fleshy, somewhat brittle leaves. Produces dense inflorescences of yellow to white flowers subtended by green bracts. (NatureServe, 2015)

Taxonomy

Both Kartesz and the Fed. Reg. agree on the nomenclature of this element and now recognize it as part of the genus *Castilleja* (as opposed to *Orthocarpus*). (NatureServe, 2015)

Historical Range

The historical distribution between 1937 and 1986 was reported from 33 occurrences (Hoover 1937, 1968, CNDDB 2005), all in the Southern Sierra Foothills Vernal Pool Region (Keeler-Wolf et al. 1998). Sixteen of those occurrences, including the type locality, were in eastern Merced County. Six occurrences each were in Fresno and Madera Counties and five others were in Stanislaus County (CNDDB 2003). (USFWS, 2011)

Current Range

Found primarily in vernal pools along the lower rolling foothill grasslands in the eastern San Joaquin Valley of the Southern Sierra Foothills Vernal Pool Region. (USFWS, 2011)

Critical Habitat Designated

Yes; 2/10/2006.

Legal Description

On August 6, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Castilleja campestris* ssp. *succulenta* (Fleshy owl's-clover) (and other vernal pool species) under the Endangered Species Act of 1973, as amended (Act) (68 FR 46684 - 46867). On August 11, 2005, the Service issued a Final Rule that excluded some lands addressed in the 2003 rule from the final designation for economic reasons (70 FR 46924 - 46999). On February 10, 2006, the Service issued administrative revisions to the Final Rule (71 FR 7118-7316). The critical habitat designation for *Castilleja campestris* ssp. *succulenta* includes six critical habitat units (CHUs) in California.

Critical Habitat Designation

The critical habitat designation for *Castilleja campestris* ssp. *succulenta* includes six CHUs (some with multiple parts) in Fresno, Madera, Mariposa, Merced, San Joaquin, Stanislaus, and Tuolumne Counties, California. This species critical habitat encompasses approximately 175,873 acres (68 FR 46684 - 46867; 70 FR 46924-46999; 71 FR 7118-7316).

Unit 1: Sacramento and San Joaquin Counties, California. From USGS 1:24,000 scale quadrangles Clay and Lockeford.

Unit 2: Tuolumne and Stanislaus Counties, California. From USGS 1:24,000 scale quadrangles Keystone, La Grange, Cooperstown and Paulsell.

Unit 3: Mariposa and Merced Counties, California. (i) Unit 3A: Mariposa and Merced Counties, California. From USGS 1:24,000 scale quadrangles Merced Falls and Snelling.

Unit 3B: Mariposa and Merced Counties, California. From USGS 1:24,000 scale quadrangles Merced Falls, Snelling, Indian Gulch, Haystack Mountain, Yosemite Lake, Winton, Owen's Reservoir, Planada and Merced.

Unit 4: Madera and Merced Counties, California. (i) Unit 4A: Madera and Merced Counties, California. From USGS 1:24,000 scale quadrangle Raynor Creek.

Unit 4C: Madera and Fresno Counties, California. From USGS 1:24,000 scale quadrangles Millerton Lake West, Little Table Mountain, Daulton, Friant, Lanes Bridge and Gregg.

Unit 5: Fresno County, California. (i) Unit 5A: Fresno County, California. From USGS 1:24,000 scale quadrangles Friant and Round Mountain.

Unit 5B: Fresno County, California. From USGS 1:24,000 scale quadrangle Clovis.

Unit 6: Fresno County, California. (i) Unit 6A: Fresno County, California. From USGS 1:24,000 scale quadrangles Millerton Lake East and Academy.

Unit 6B: Madera County, California. From USGS 1:24,000 scale quadrangles North Fork and Millerton Lake East.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The primary constituent elements of critical habitat for *Castilleja campestris* ssp. *succulenta* (Fleshy owl's-clover) are the habitat components that provide:

(i) Topographic features characterized by isolated mound and intermound complex within a matrix of surrounding uplands that result in continuously, or intermittently, flowing surface water in the depressional features including swales connecting the pools described in paragraph (c)(8)(ii) of this section, providing for dispersal and promoting hydroperiods of adequate length in the pools; and

(ii) Depressional features including isolated vernal pools with underlying restrictive soil layers that become inundated during winter rains and that continuously hold water or whose soils are saturated for a period long enough to promote germination, flowering, and seed production of predominantly annual native wetland species and typically exclude both native and nonnative upland plant species in all but the driest years. As these features are inundated on a seasonal basis, they do not promote the development of obligate wetland vegetation habitats typical of permanently flooded emergent wetlands.

Special Management Considerations or Protections

Existing manmade features and structures, such as buildings, roads, railroads, airports, runways, other paved areas, lawns, and other urban landscaped areas do not contain one or more of the primary constituent elements. Federal actions limited to those areas, therefore, would not trigger a consultation under section 7 of the Act unless they may affect the species and/or primary constituent elements in adjacent critical habitat.

Life History**Food/Nutrient Resources****Lifespan**

Adult: 1 year (annuals) (USFWS, 2011)

Breeding Season

Adult: April and May (USFWS, 2011)

Reproduction Narrative

Adult: *Castilleja campestris* ssp. *succulenta* is an annual plant. Seeds of the *C. campestris* ssp. *succulenta* do not require the presence of a host to germinate, as they form root connections only after reaching a seedling stage.

Habitat Type

Adult: Vernal pools (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Small, seasonal pools. (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occur at elevations of 24 m (80 feet) to 700 m (2,300 feet). (USFWS, 2011)

Spatial Arrangements of the Population

Adult: Widely scattered (USFWS, 2011)

Habitat Narrative

Adult: *Castilleja campestris* ssp. *succulenta* is found primarily in vernal pools, and only in the lower rolling foothill areas of the eastern San Joaquin Valley in the Southern Sierra Foothills Vernal Pool Region (Service Recovery Plan 2005). Soil textures at those sites range from extremely stony loam to loamy clay. At the U.C. Merced site and the surrounding community planning area, 81.4% of the individual pools where this taxon was found were on Redding gravelly loam, 9.5% were on Corning gravelly sandy loam, 6.4% were on Corning gravelly loam, 1.7% were on Keyes gravelly loam, 0.7% was on Keyes gravelly clay loam, and 0.3% was on Pentz loam (EIP Associates 1999). Self-pollinating species of *Castilleja* typically occur as widely scattered individuals, rather than dense colonies (Atsatt 1970). Populations of *Castilleja campestris* ssp. *succulenta* have been reported from elevations of 24.0 m (80 feet) at the San Joaquin County site to 700.0 m (2,300 feet) at Kennedy Table in Madera County (CNDDB 2003). (USFWS, 2011; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Resiliency:**

Low (inferred from USFWS, 2011)

Representation:

Low (inferred from USFWS, 2011)

Redundancy:

Moderate (inferred from USFWS, 2011)

Number of Populations:

90 occurrences (USFWS, 2011)

Adaptability:

Low (inferred from USFWS, 2011)

Population Narrative:

At the time of the listing in 1997, there were 36 extant occurrences of *Castilleja campestris* ssp. *succulenta* and currently there are 90 presumed extant occurrences. The increase in occurrences is most likely a result of an increased number of surveys. Since the final listing rule, an additional threat to *Castilleja campestris* ssp. *succulenta* is that many of its populations are small in number. A small population size makes a population more vulnerable to extirpation from chance events. (USFWS, 2011)

Threats and Stressors

Stressor: Habitat degradation

Exposure:

Response:

Consequence:

Narrative: The 1997 final rule stated that nearly half of the extant *Castilleja campestris* ssp. *succulenta* occurrences are threatened by man-made activities such as urbanization, agricultural land conversion, discing, trampling due to overgrazing, mining, and a proposed road expansion project. The threats presented in the listing rule are still relevant. The habitat of this species has been reduced and fragmented throughout its range and vernal pools continue to be removed by the factors previously noted. Lands on the Central Valley floor are closer to existing cities and agricultural lands than the valley rim, which is steeper, less fertile and more removed from cities. As a result, valley floor vernal pools, along with open rangeland, have been and continue to be favored for urban and agricultural development. (USFWS, 2011)

Stressor: Stressor

Exposure:

Response:**Consequence:**

Narrative: According to a University of California, Berkeley study, the native plants unique to California are vulnerable to global climate change and that two-thirds of these endemics could suffer more than an 80% reduction in geographic range by the end of the century (U.C. Berkeley Press Release, June 2008). Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). It is unknown at this time if climate change in California specifically will result in a warmer trend with localized drying, higher precipitation events, or other effects. (USFWS, 2011)

Stressor: Small population size

Exposure:**Response:****Consequence:**

Narrative: Since the final listing rule, an additional threat to *Castilleja campestris* ssp. *succulenta* is that many of its populations are small in number. A small population size makes a population more vulnerable to extirpation from chance events as noted in the 2005 Recovery Plan. Among the 24 occurrences of *C. campestris* ssp. *succulenta* for which size estimates had been documented, ten consisted of fewer than 100 plants each at their peak size (J. Stebbins in litt. 2000b, CNDDDB 2003). According to the 2009 CNDDDB occurrences, 35 have population size estimates documented with approximately 16 occurrences with fewer than 100 plants and approximately 17 occurrences with more than 100 plants.

Stressor: Rainfall

Exposure:**Response:****Consequence:**

Narrative: This taxon is very cyclical and is somewhat scarce in normal or below normal rainfall years but large populations may be evident in wet years at the known sites (J. Stebbins, pers. comm. 2009). (USFWS, 2011)

Recovery**Reclassification Criteria:**

1. Habitat protection - Accomplish habitat protection that promotes vernal pool ecosystem function sufficient to contribute to population viability of the covered species. Suitable vernal pool habitat within each prioritized core area for the species is protected. Species occurrences distributed across the species geographic range and genetic range are protected. Protection of extreme edges of populations protects the genetic differences that occur there. Reintroductions must be carried out and meet success criteria established in the Recovery Plan. Additional occurrences identified through future site assessments, GIS and other analyses, and status surveys that are determined essential to the recovery are protected. Any newly found occurrences may count towards recovery goals if the occurrences are permanently protected as described in the Recovery Plan. Habitat protection results in protection of hydrology essential to vernal pool ecosystem function, and monitoring indicates that hydrology that contributes to population viability has been maintained through at least one multi-year period that includes

above average, average, and below average local rainfall as defined above, a multi-year drought, and a minimum of 5 years of post-drought monitoring. (USFWS, 2011)

2. Adaptive habitat management and monitoring: Habitat management and monitoring plans that ensure maintenance of vernal pool ecosystem function and population viability have been developed and implemented for all habitat protected. Mechanisms are in place to provide for long-term management and monitoring. Monitoring indicates ecosystem function has been maintained in the areas protected. Seed banking actions have been completed for species that would require it as insurance against risk of stochastic extirpations or that will require reintroductions or introductions to contribute to meeting recover criteria. (USFWS, 2011)

3. Status surveys, 5-year status reviews, and population monitoring show populations within each vernal pool region where the species occur are viable (e.g., evidence of reproduction and recruitment) and have been maintained (stable or increasing) for at least one multi-year period that includes above average, average, and below average local rainfall, a multi-year drought, and a minimum of 5 years of post-drought monitoring. Status surveys, status reviews, and habitat monitoring show that threats identified during and since the listing process have been ameliorated or eliminated. Site-specific threats identified through standardized site assessments and habitat management planning also must be ameliorated or eliminated. (USFWS, 2011)

4. Research actions necessary for recovery and conservation of the covered species have been identified (these are research actions that have not been specifically identified in the recovery actions but for which a process to develop them has been identified). Research actions (both specifically identified in the recovery actions and determined through the process) on species biology and ecology, habitat management and restoration, and methods to eliminate or ameliorate threats have been completed and incorporated into habitat protection, habitat management and monitoring, and species monitoring plans, and refinement of recovery criteria and actions. Research on genetic structure has been completed (for species where necessary – for reintroduction and introduction, seed banking) and results incorporated into habitat protection plans to ensure that within and among population genetic variation is fully represented by populations protected in the Habitat Protection section. Research necessary to determine appropriate parameters to measure population viability for each species has been completed. (USFWS, 2011)

5. Participation and outreach: recovery implementation team is established and functioning to oversee range-wide recovery efforts. Vernal pool regional working groups are established and functioning to oversee regional recovery efforts. Participation plans for each vernal pool region have been completed and implemented. Vernal pool regional working groups have developed and implemented outreach and incentive programs that develop partnerships. (USFWS, 2011)

Delisting Criteria:

Same as the reclassification criteria.

Recovery Actions:

- Conduct standardized vernal pool habitat site assessments for both the Southeastern Sacramento Valley and Southern Sierra Foothills vernal pool regions. (USFWS, 2011)
- Establish management and monitoring plans which include criteria for frequent surveys in order to capture the blooming period for this species. The *Castilleja campestris* ssp.

- succulenta population numbers vary widely from year to year depending on habitat conditions and rainfall (Vollmar 2002). Therefore, the Service should encourage bank owners and preserve managers to perform surveys on a frequent schedule in order to gather additional data which will increase knowledge. The additional information will be utilized for future 5-year reviews. (USFWS, 2011)
- The Vernal Pool Regional working group should formulate a plan to reach out and educate private landowners as to the value of federally-listed species on their lands, with a particular focus on plants. The Vernal Pool Regional group also should provide guidance to assist landowners on how to better manage their lands for the overall benefit of this species. (USFWS, 2011)
 - The Service should encourage collection of seeds and storage in approved seed banks from extant occurrences, in each core area, to aid in the establishment of a seed bank. (USFWS, 2011)
 - The Service should encourage County and local governments to consider developing Habitat Conservation Plans (HCPs) to include vernal pool species. Take of a federally listed invertebrate species would be permitted on private land, and any habitat acquisition to compensate for invertebrate species could include the *Castilleja campestris* ssp. *succulenta* if appropriate. Fresno County has been awarded Federal funds for the development of an HCP and additional funds may be available in the future for counties who apply for them. (USFWS, 2011)
 - Efforts to protect vernal pool species should include conservation efforts on a landscape scale (Vollmar 2002). Landscape Conservation Cooperatives provide Federal scientific and technical support for conservation on a landscape scale which is the entire range of an identified priority species. These cooperatives also have a role in helping partners identify common goals and priorities to target the right science for efficient and effective conservation. (USFWS, 2011)

Conservation Measures and Best Management Practices:

- Not available

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USFWS. 2015. Environmental Conservation Online System (ECOS) – Species Profile. <http://ecos.fws.gov/speciesProfile/>. Accessed April 2016.

USFWS 2011. Species Reviewed: *Castilleja campestris* ssp. *succulenta* (Fleshy Owl's-Clover) U.S. Fish and Wildlife Service Sacramento Fish and Wildlife Service Sacramento, California (5 yr review ref)

U.S. Fish and Wildlife Service. 2005. Endangered and Threatened Wildlife and Plants

Final Designation of Critical Habitat for Four Vernal Pool Crustaceans and Eleven Vernal Pool Plants in California and Southern Oregon

Evaluation of Economic Exclusions From August 2003 Final Designation. Final Rule. 70 FR 46924-46999 (August 11, 2005)

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Final Rule. 71 FR 7118 - 7316 (February 10, 2006)

U.S. Fish and Wildlife Service. 2003. Endangered and Threatened Wildlife and Plants

Final Rule. 68 FR 46684 - 46867 (August 6, 2003).

USFWS. 2011. Species Reviewed: *Castilleja campestris* ssp. *succulenta* (Fleshy Owl's-Clover) U.S. Fish and Wildlife Service Sacramento Fish and Wildlife Service Sacramento, California (5 yr review ref)

SPECIES ACCOUNT: *Castilleja cinerea* (Ash-grey paintbrush)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/14/1998; California/Nevada Region (R8)

Physical Description

A semi-parasitic perennial plant with several ascending to decumbent (reclining on the ground) grayish stems sprouting from the root-stem. These stems are 4-8 inches (in.) (10.2-20.3 centimeters (cm)) tall. The flower stalk is usually yellow-green (sometimes reddish-orange) with yellow hairs on the lower bracts. The calyx is almost equally divided into linear lobes; the corolla is yellowish (63 FR 49006). Ash-gray paintbrush is distinguished from other *Castilleja* in its range by short-haired stems and leaves, yellowish flowers, calyx lobes of equal length, and its perennial nature (63 FR 49006). (USFWS, 2008)

Taxonomy

At listing, ash-grey (Indian) paintbrush was considered to be in the Scrophulariaceae (figwort) family. Recent taxonomic studies have placed the genus *Castilleja* and other plant genera formerly in the Scrophulariaceae into the Orobanchaceae (broomrape) family (Olmstead et al. 2001). (USFWS, 2008)

Historical Range

See current range/distribution.

Current Range

Endemic to the San Bernardino Mountains, in San Bernardino County, California. (USFWS, 2013)

Critical Habitat Designated

Yes; 1/25/2008.

Legal Description

On December 26, 2007, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective January 25, 2008) for *Castilleja cinerea* (Ash-grey paintbrush) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 24 critical habitat units (CHUs), in California (72 FR 73092-73178).

Critical Habitat Designation

The critical habitat designation for *Castilleja cinerea* includes 24 CHUs in San Bernardino County, California. approximately 1,769 ac (722 ha) of Federal, State, and private land are being designated as critical habitat (72 FR 73092-73178). Units are grouped by pebble plain complexes (e.g., Arrastre/Union Flat) as identified in the USFS's 2002 Management Guide. Detailed coordinates and maps are provided in the Final Rule. The 24 units contain a total of 1,769 ac (722 ha).

Units CACI 1 and CACI 2. Arrastre/Union Flat, San Bernardino County, California. CACI 1 contains 69 ac (28 ha); CACI 2 contains 229 ac (93 ha); the landowner is the U.S. Forest Service. CACI 1 is USFS Pebble Plain Number 100; CACI 2 is USFS Pebble Plain Number 87.

Units CACI 3 and CACI 4. Big Bear Lake, San Bernardino County. CACI 3 contains 21 ac (9 ha); CACI 4 contains 6 ac (2 ha); the landowner is the U.S. Forest Service. CACI 3 is USFS Pebble Plain Number 248; CACI 4 is USFS Pebble Plain Number 254.

Units CACI 5 and CACI 6. Broom Flat, San Bernardino County, California. CACI 5 contains 58 ac (23 ha); CACI 6 contains 326 ac (132 ha);. The CACI 5 landowner is the U.S. Forest Service; the CACI 6 landowners are the U.S. Forest Service (255 ac) and a private landowner (71 ac). CACI 5 is USFS Pebble Plain Number 311; CACI 6 is USFS Pebble Plain Numbers 285 and 309.

Units CACI 7, CACI 8, CACI 9. Fawnskin, San Bernardino County, California. CACI 7 contains 15 ac (6 ha); CACI 8 contains 24 ac (10 ha); CACI 9 contains 2 ac (1 ha). The landowner is the U.S. Forest Service. CACI 7 is USFS Pebble Plain Number 301; CACI 8 is USFS Pebble Plain Number 302; CACI 9 is USFS Pebble Plain "Juniper Point".

Units CACI 10, CACI 11, CACI 12, CACI 15, and CACI 16. Gold Mountain and North Baldwin Lake, San Bernardino County, California. CACI 10 contains 62 ac (25 ha); CACI 11 contains 43 ac (17 ha); CACI 12 contains 0.3 ac (0.1 ha); CACI 15 contains 320 ac (129 ha); CACI 16 contains 4 ac (2 ha). The landowner for CACI 10, CACI 11, CACI 12, and CACI 15 is the U.S. Forest Service. The landowner for CACI 16 is the California Department of Fish and Game. CACI 10 is USFS Pebble Plain Number 188; CACI 11 is USFS Pebble Plain Number 192; CACI 12 is USFS Pebble Plain "South Baldwin Meadow"; CACI 15 is USFS Pebble Plain Number 128; CACI 16 is USFS Pebble Plain Number 168.

Units CACI 13 and CACI 14. Holcomb Valley, San Bernardino County, California. CACI 13 contains 28 ac (11 ha); CACI 14 contains 44 ac (18 ha). The CACI 13 landowners are the U.S. Forest Service (22 ac) and a private landowner (6 ac); the CACI 14 landowner is the U.S. Forest Service. CACI 13 is USFS Pebble Plain Numbers 98 and 109; CACI 14 is USFS Pebble Plain Number 153.

Units CACI 17 and CACI 18. Sawmill, San Bernardino County, California. CACI 17 contains 36 ac (14 ha); CACI 18 contains 5 ac (2 ha). The CACI 17 landowners are the U.S. Forest Service (15 ac) and a private landowner (21 ac). The CACI 18 landowner is a private landowner. CACI 17 is USFS Pebble Plain Number 236; CACI 18 is USFS Pebble Plain Number 224.

Unit CACI 19. Snow Valley, San Bernardino County, California. CACI 19 contains 26 ac (10 ha); the landowner is the U.S. Forest Service. CACI 19 is USFS Pebble Plain Number 270.

Unit CACI 20: South Baldwin Ridge/Erwin Lake, San Bernardino County, California. CACI 20 contains 23 ac (9 ha); the landowner is the U.S. Forest Service. CACI 20 is USFS Pebble Plain Number 212.

Units CACI 21, CACI 22, CACI 23, and CACI 24. Sugarloaf Ridge, San Bernardino County, California. CACI 21 contains 127 ac (51 ha); CACI 22 contains 34 ac (14 ha); CACI 23 contains 76 ac (31 ha); CACI 24 contains 190 ac (77 ha). The landowner for these units is the U.S. Forest Service. CACI 21 is USFS Pebble Plain Number 294; CACI 22 is USFS Pebble Plain Number 289; CACI 23 is USFS Pebble Plain Number 286; CACI 24 is USFS Pebble Plain Number 293.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Castilleja cinerea* critical habitat are those habitat components that provide (72 FR 73092-73178):

- (i) Pebble plains in dry meadow-like openings, or non-pebble plain dry meadow margin areas, within upper montane coniferous forest, pinyonjuniper woodlands, or Great Basin sagebrush in the San Bernardino Mountains of San Bernardino County, California; at elevations between 5,900 to 9,800 ft (1,830 to 2,990 m) that provide space for individual and population growth, reproduction and dispersal.
- (ii) Seasonally wet clay, or sandy clay soils, generally containing quartzite pebbles, subject to natural hydrological processes that include water hydrating the soil and freezing in winter and drying in summer causing lifting and churning of included pebbles, or seasonally wet silt or saline clay soils in non-pebble plain dry meadow margin areas that provide space for individual and population growth, reproduction and dispersal, adequate water, air, minerals, and other nutritional or physiological requirements to the species.
- (iii) The presence of one or more of its known host species such as *Eriogonum kennedyi* var. *austromontanum*, *E. kennedyi* var. *kennedyi*, and *E. wrightii* var. *subscaposum* in pebble plain habitat and species such as *Artemisia tridentata*, *A. nova*, and *E. wrightii* var. *subscaposum* in pebble plain and non-pebble plain meadow margin habitat that provide some of the physiological requirements for this species.

Special Management Considerations or Protections

Critical habitat does not include manmade structures (such as buildings, aqueducts, airports, roads, and other paved areas) and the land on which they are located existing on the effective date of this rule and not containing one or more of the primary constituent elements.

Threats to listed pebble plains plants throughout their range include land development, off-highway vehicle (OHV) use off of designated routes, road maintenance activities, ground disturbance that affects surface hydrology, mining activities, recreational activities, and nonnative plant species (63 FR 49006; September 14, 1998). Pebble plain habitat is also threatened by vegetation and fuels management, hazard tree removal, and wildfire suppression activities (Eliason 2006). However, of the above threats, land development remains the primary cause of habitat loss on private lands; while on Federal lands, OHV use off of designated routes has historically been, and continues to be, the most significant threat to pebble plains habitat. Increasing residential populations adjacent to pebble plains habitat on private and Federal lands has also resulted in degradation of habitat, as dispersed recreation and unauthorized OHV use increases (Eliason 2006). Also, while forest system road use and maintenance, mining activities, and dispersed recreation continue to have adverse ongoing effects to pebble plain habitat and the species it supports, the magnitude and severity of effects caused by these activities are relatively small compared to the effects of unauthorized motorized vehicle use (Eliason 2006). The primary constituent elements for the listed pebble plains plants may require special management considerations or protection to minimize impacts associated with, (1) vehicle use and road maintenance; (2) recreational activities; and (3) the presence of nonnative species (63 FR 49006, September 14, 1998; USFS 2002, p. 17; USFS 2005, pp. 207, 249, 293).

Life History

Food/Nutrient Resources**Reproductive Strategy**

Adult: Sexual (outcrossing) (USFWS, 2013)

Breeding Season

Adult: June through August. (USFWS, 2013)

Reproduction Narrative

Adult: Castilleja cinerea flowers from June through August (California Native Plant Society [CNPS] 2012). O'Brien has determined that Castilleja cinerea is outcrossing; covered flowers produced no seeds (O'Brien 1979, p. 69). (USFWS, 2013)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Barrens, Forest - Conifer, Forest/Woodland, Shrubland/chaparral, meadows (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 1800 and 2800 m on mountain slopes. (USFWS, 2013)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Dependency on Other Individuals or Species for Habitat

Adult: As a hemiparasitic plant, *C. cinerea* produces haustoria (modified structures on the plant's roots that penetrate the root tissues of a host plant) to obtain nutrients and water. Host plants include *Eriogonum kennedyi* var. *austromontanum*, *Eriogonum kennedyi* var. *kennedyi* (Kennedy's wild-buckwheat), *Eriogonum wrightii* var. *subscaposum* (short-stemmed bastardsage), *Artemisia tridentata* ssp. *tridentata* (big sagebrush), *Artemisia nova* (black sagebrush), and other *Artemisia* taxa (USFS 2005d, no page number). (USFWS, 2013)

Habitat Narrative

Adult: The primary habitat for *Castilleja cinerea* is pebble plains, so described because of the layer of orange quartzite pebbles that are pushed to the clay soil surface by frost heaving and thawing (Krantz 1983, p. 10). *Castilleja cinerea* is found in the San Bernardino Mountains at elevations between 1,800 and 3,300 meters (m) (5,905 to 10,827 feet (ft)) (Wetherwax et al. 2012, p. 960). Within the San Bernardino Mountains, *C. cinerea* occurs on various benches and on all mountain slope aspects including both south-facing and north-facing slopes (CNDDDB 2012; USFWS 2012). *Castilleja cinerea* occupies the meadow/forest ecotone (transitional area of vegetation between two different plant communities) of the San Bernardino Mountains and has been recorded in the following ecological communities: pebble plains, dry and wet forest meadows, mixed conifer forests, open pine forests, and pinyon-juniper woodlands (CNDDDB 2012). As a hemiparasitic plant, *C. cinerea* produces haustoria (modified structures on the plant's roots that penetrate the root tissues of a host plant) to obtain nutrients and water. Host

plants include *Eriogonum kennedyi* var. *austromontanum*, *Eriogonum kennedyi* var. *kennedyi* (Kennedy's wild-buckwheat), *Eriogonum wrightii* var. *subscaposum* (short-stemmed bastardsage), *Artemisia tridentata* ssp. *tridentata* (big sagebrush), *Artemisia nova* (black sagebrush), and other *Artemisia* taxa (USFS 2005d, no page number). (USFWS, 2013)

Dispersal/Migration

Motility/Mobility

Adult: Low (inferred from USFWS, 2013)

Dispersal/Migration Narrative

Adult: It is likely that seeds are shaken loose from the erect seed capsules and drop short distances from the parent plant, and then dispersed short distances by the wind as observed in *C. levisecta* (golden paintbrush), a prairie species from the Pacific Northwest (USFWS 2010, p. II-34). (USFWS, 2013)

Population Information and Trends

Population Trends:

Not available

Number of Populations:

47 occurrences (USFWS, 2013)

Population Narrative:

Low levels of gene transfer between obligate outcrossing populations within geographic areas (i.e., pebble plain complexes) that are subject to additional fragmentation. Of the 49 EOs described in the CNDDDB database for *C. cinerea* (CNDDDB 2012), we believe that two of these (EOs 42, 64), located just south of Big Bear Lake, are now extirpated (USFWS 2012).

Threats and Stressors

Stressor: Urban Development (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Much of the habitat of *Castilleja cinerea* historically found on private lands has been lost to residential and commercial development (USFS 2012c, p. 32). Urban development (primarily residences) and related recreational development on city, county or private lands within the Big Bear Lake and Baldwin Lake areas continue to represent an ongoing threat to *Castilleja cinerea* at seven of the pebble plain complexes. Threats and their effects on *C. cinerea* and other pebble plain and meadow plants were recently described in a biological assessment for ongoing activities within the SBNF (USFS 2012d, pp. 61–63, 76–78). (USFWS, 2013)

Stressor: Roads and Trails (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: In our final listing rule, we described impacts from this threat under the category of ORV activity, citing over 7 miles (mi) (11 kilometers (km)) of Forest Service roads and 10 mi (16 km) of unauthorized routes that directly impact pebble plain sites (USFWS 1998, p. 49013, citing Odell 1988, p. 4). Approximately 2.5 percent of the SBNF acreage consists of roads (USFS 2005e, Vol. 1, p. 114). The SBNF implements a Roads and Trails Management Program that incorporates roads, motorized trails, motorized interpretive trails, and non-motorized trails found within the SBNF (USFS 2012d, pp. 9–10). (USFWS, 2013)

Stressor: Road Construction, Use, and Maintenance (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Threats to *Castilleja cinerea* from roads and trails include both direct effects, such as habitat alteration, and indirect effects, including alteration of water flow and drainage patterns, sedimentation, deposition of particulates (dust), and effects related to wildfire (USFS 2012d, pp. 21–24). Roads, road construction, and road maintenance can also facilitate the introduction and establishment of nonnative plants by creating open, continually disturbed habitat as well as disrupt hydrological processes within pebble plains habitats. Nonnative plants can be transported along these road corridors by equipment and vehicles, and are often more easily established on exposed cut-and-fill slopes of roads than native plants (USFS 2005e, Vol. 1, p. 114). Open Forest Service roads present ongoing threats in the Baldwin Lake area (Sawmill pebble plain complex) and the Wildhorse Meadow area (Sugarloaf Ridge pebble plain complex) where *Castilleja cinerea* occurs, and the SBNF has installed fencing and signage to minimize impacts to the habitat, including effects related to crushing, uprooting, or burial of plants (USFS 2012d, pp. 77, 82). (USFWS, 2013)

Stressor: Recreational Use of Roads and Trails (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: The high frequency of ORV activity was described as the most significant and persistent threat in the final listing rule for *Castilleja cinerea* and other pebble plain plants and was reiterated as such in our 2008 5-year review (USFWS 1998, p. 49013; USFWS 2008, p. 5). Threats also result from the effects of non-motorized trails and mountain biking due to the proximity of *C. cinerea* and its habitat to urban areas (USFS 2012d, pp. 60–61). Associated with ORV activity is unauthorized collection of wood for fuel including removal of downed vegetation or trees. The SBNF has an active, personal use fuel-wood program in which the public can purchase permits for cutting wood from marked, downed logs in designated areas (USFS 2012d, p. 30). (USFWS, 2013)

Stressor: Alteration of Hydrology (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: The listing rule identified alteration of hydrological conditions as a threat to *Castilleja cinerea* habitat, noting that the majority of pebble plain complexes are directly impacted by vehicle routes that may lead to alterations in the surface hydrology (USFWS 1998, p. 49013). This threat is often the result of unauthorized ORV activities and direct and indirect impacts from

urbanization (USFS 2002, p. 25). Vehicle traffic within pebble plains habitats during the wet season is of particular concern because this activity creates deep ruts that change the hydrological patterns over the pebble plain (USFS 2002, p. 20). Alteration of hydrology can also result from land disturbance due to mining and fire suppression activities, which are discussed as separate threats to *C. cinerea* below. Our listing rule also highlighted activation or installation of wells within lower Holcomb Valley, Baldwin Lake (within the North Baldwin Lake complex) as a potential threat to pebble plains habitat through the alteration of hydrology in these areas (USFWS 1998, p. 49014). In an undisturbed condition, water generally flows evenly over the surface of pebble plains (Odell 1988, p. 19). However, disturbances to their surface can change hydrological patterns across these surfaces and can alter their soil composition through the erosion of clay sediments during rainfall events, leaving only large cobbles and pebbles (Neel and Chaney 1992, p. 1). These potential changes to soil morphology and composition can alter the vegetation structure and composition of the pebble plain, by creating favorable conditions for the invasion of both native and nonnative plant species that then out-compete *Castilleja cinerea* for space and resources, and further altering the soil composition by increasing the amount of organic debris (Derby 1979, pp. 72–73; USFS 2002, p. 15). (USFWS, 2013)

Stressor: Trampling of Habitat (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Moderate to heavy degradation of certain sites occupied by *Castilleja cinerea* from trampling by cattle has occurred in the past and some pebble plains and meadow complexes continue to be impacted by cattle, horses, and feral burros (USFWS 1998, p. 49016). However, we anticipated this threat would be reduced with the removal of feral burros from several pebble plain complexes under the provisions of the Big Bear Wild Burro Territory Management Plan (USFWS 1998, p. 49017). We also reported occasional trampling of *C. cinerea* from construction activities and trails near the Snow Valley Ski Area (USFWS 1998, p. 49016). (USFWS, 2013)

Stressor: Nonnative Plants (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: The Service identified exotic (nonnative) plants as a threat to *Castilleja cinerea* in the context of disturbances related to grazing, urban and rural development, and various recreational activities (USFWS 1998, p. 49017). These activities can threaten native plants by facilitating the establishment of nonnative species and resulting in the alteration of habitat through crowding or competition for resources (USFWS 1998, p. 49017). *Bromus tectorum* represents the primary species of concern for these pebble plain areas. This taxon, as well as *Erodium cicutarium* (filaree), represent very old invasions for the San Bernardino Mountains and are persistent threats within these complexes (Eliason 2012a, pers. comm.). More recent invasions of nonnative plant species within some of these pebble plain complexes include *Linaria dalmatica* (dalmatian toadflax), *Ranunculus testiculatus* (bur buttercup), and *Lepidium perfoliatum* (clasping pepperweed) (Eliason 2012a, pers. comm.). As with pebble plain habitat, ground disturbances by hikers, mountain bicyclists, and ORVs can create conditions favorable for the establishment and spread of nonnative plants into these areas. (USFWS, 2013)

Stressor: Mining (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: The Service indicated that mining activities had contributed to the decline of *Castilleja cinerea* due to effects from habitat destruction, degradation, and fragmentation of pebble plain habitats (USFWS 1998, p. 49013). We described mining as a secondary threat to habitat degradation (USFWS 1998, p. 49013). Mining claims on Forest Service lands were previously reported for five pebble plain complexes occupied by *Castilleja cinerea*: (1) Holcomb Valley (83 ac (33.6 ha)), (2) Fawnskin (24 ac (9.7 ha)), (3) Arrastre Flats (69 ac (28 ha)), (4) North Baldwin Lake (62 ac (25 ha)), and (5) Broom Flat (0.2 ac (0.08 ha)) (USFS 2002, pp. 42, 46, 48, 57, 65). These claims continue to represent a potential threat of ground disturbance for *C. cinerea*, specifically, gold prospecting activities or mining operations related to the ownership of mineral rights. (USFWS, 2013)

Stressor: Fire Suppression (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: Activities related to management of fire and fuels can also threaten *Castilleja cinerea* and its habitat. Though not recognized as a threat at the time of listing, fire suppression was known to impact one occurrence in 2008 when the previous status review was developed. However, fuelbreaks and vegetation treatment units are very rarely located in pebble plain habitat due to the scarcity of fuels (USFS 2005a, p. 255). Fire suppression activities typically include fire line construction; fire retardant and water drops; establishment of temporary fire camps, staging areas, parking sites, safety zones, and helipads; and post-fire rehabilitation (USFWS 2005, p. 27). Each of these activities can have negative impacts to *C. cinerea* and its habitat. (USFWS, 2013)

Stressor: Climate Change (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: Projected changes in April snow water equivalence across the Fawnskin, Holcomb Valley, and parts of Arrastre Flats pebble plains, under a low carbon emissions scenario (B1), indicate an 84 percent reduction in snow moisture; and a 92 percent reduction in snow moisture under a high emissions scenario (A2), between a baseline time period (1961 to 1990) and an end of century period (2070 to 2090). Similar reductions in snowpack are projected for the Bear Valley region and other parts of the SBNF. Projected changes in annual average in temperature for this region using the Cal-Adapt tool under the B1 scenario indicate a 3.9oF (2.1oC) increase in temperature, and 6.9oF (3.8oC) increase under the A2 scenario, between the baseline time period (1961 to 1990) and an end of century period (2070 to 2090). Although there is uncertainty in predictions of downscaled climate change models, these projected climate change effects could significantly alter the hydrology and vegetation that sustain and characterize pebble plain and other habitats occupied by *Castilleja cinerea*. (USFWS, 2013)

Recovery**Reclassification Criteria:**

Not applicable.

Delisting Criteria:

Not defined; a Recovery Plan is not available for this species.

Recovery Actions:

- Recommendation for Future Action from 2013 5-Year Review: Work with biologists at the SBNF to reduce impacts from recreational use of roads and trails through uncontrolled access to pebble plain habitat occupied by *Castilleja cinerea*. Prioritize protective measures being implemented (or planned) for controlling access to areas occupied by *Castilleja cinerea*. (USFWS, 2013)
- Recommendation for Future Action from 2013 5-Year Review: Reduce current and future impacts to *Castilleja cinerea* (and other federally listed pebble plain plants) from roads and trails through coordination with staff at SBNF. Identify and implement a priority strategy to identify roads and trails for decommissioning within pebble plain habitats. (USFWS, 2013)
- Recommendation for Future Action from 2013 5-Year Review: Conserve or preserve *Castilleja cinerea* occurrences on private lands. Continue to work with the State and local groups to purchase *C. cinerea* habitat from willing sellers, particularly within the Sawmill pebble plain complex. (USFWS, 2013)
- Recommendation for Future Action from 2013 5-Year Review: Develop a monitoring plan to provide early detection of downward trends in the populations of pebble plain plants, such as *Castilleja cinerea*, and quality of pebble plain and montane meadows habitats (adapted from USFS 2005b, p. 125). This monitoring plan should identify and prioritize surveys of plant populations, including abundance, and habitat conditions, in those areas most vulnerable to threats (e.g., pebble plain complexes with high levels of recreational activity) and should include remote sensing and mapping of unauthorized ORV trails. (USFWS, 2013)

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SPECIES ACCOUNT: *Castilleja grisea* (San Clemente Island indian paintbrush)

Species Taxonomic and Listing Information

Listing Status: Threatened; 9/12/1977; California/Nevada Region (R8) (USFWS, 2015); Proposed Delisting

Physical Description

A perennial plant which is grayish in color and with short cobweb-like hairs throughout. The stem is woody and highly branched. The flowers are brownish-green. (NatureServe, 2015)

Taxonomy

Not available

Historical Range

Known range on coastal bluffs, slopes, canyons, escarpments and terraces across the southern two-thirds of the island (Helenurm et al. 2005, pp. 1221, 1226; Junak 2006, p. 47; USFWS 2007, p. 14) (USFWS, 2012)

Current Range

Endemic to San Clemente Island, CA. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Bare rock/talus/scree, cliff, shrubland/chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Endemic to San Clemente Island (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Colonial (USFWS, 2012)

Habitat Narrative

Adult: *Castilleja grisea* is found in coastal scrub on steep canyon walls. The plants' presence in open habitat suggests that its restriction to cliffs and rocky habitats is an artifact of past goat predation or perhaps eradication by fire. (USFWS Endan. Pl. Sp. Status Report, Oct. 1979).

(NatureServe, 2015). One colony at the southern end of San Clemente Island has 500 to 600 plants located in a relatively flat open terrain. (USFWS, 2012; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Declining. (NatureServe, 2015)

Resiliency:

Low (inferred from USFWS, 2012)

Representation:

Low (inferred from USFWS, 2012)

Redundancy:

Low (inferred from USFWS, 2012)

Number of Populations:

29 (USFWS, 2012)

Population Size:

10,000 - 100,000 individuals (NatureServe, 2015)

Population Narrative:

Populations of *Castilleja grisea* have been declining. (NatureServe, 2015). In late 1890s this species was reported to flourish on the island. By 1978 a frequent visitor to the island reported that he had seen only three plants, all on the canyon walls (Mohlenbrock, 1983). A 2011 estimate from the Navy reported 11,733 individuals recorded since 2006 (Munson 2011, pers. comm., cited by USFWS 2012). Since listing and the removal of feral goats and pigs on San Clemente Island, the distribution of *Castilleja grisea* has expanded from 19 to 29 occurrences. (NatureServe, 2015; USFWS, 2012)

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Currently, the habitat of *Castilleja grisea* is threatened by destruction and modification caused by land use, erosion, nonnative plants, fire, and fire management (USFWS 2012, pp. 29078–29128). To help ameliorate these threats, the Navy is applying erosion control measures and developing an erosion control plan, implementing a Fire Management Plan, and an island-wide nonnative species control program (USFWS 2008, pp. 1–237). Though increased impacts

associated with military training could impact habitat occupied by *C. grisea*, 16 of 29 occurrences fall outside of heavily impacted training areas where the most intensive habitat disturbances occur (USFWS 2012, pp. 29078–29128). (USFWS, 2012)

Stressor: Human development (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Threats associated with movement of troops and vehicles continue to impact *Castilleja grisea* at 17 of 29 occurrences on San Clemente Island. (USFWS, 2012)

Stressor: Fire (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Fire continues to impact *Castilleja grisea* at 17 of 29 occurrences on San Clemente Island. The Navy is implementing a Fire Management Plan and an Integrated Natural Resources Management Plan to help minimize these threats (USFWS 2008, pp. 1–237). (USFWS, 2012)

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Climate change may also influence *C. grisea*, though the magnitude of this threat effect is largely unknown (USFWS 2012, pp. 29078–29128). (USFWS, 2012)

Recovery

Reclassification Criteria:

Not available

Delisting Criteria:

Not available

Recovery Actions:

- Identify present adverse impacts to biological resources and strive to eliminate them. (USFWS, 2012)
- Protect known resources from further degradation by: (a) removal of feral herbivores, carnivores, and selected exotic plant species; (b) control of erosion in sensitive locations; (c) direct military operations and adverse recreational uses away from biologically sensitive areas. (USFWS, 2012)
- Restore habitats by revegetation of disturbed areas using native species. (USFWS, 2012)
- Identify areas of San Clemente Island where habitat restoration and population increase of certain addressed taxa may be achieved through a careful survey of the island and research on habitat requirements of each taxon. (USFWS, 2012)
- Delist or upgrade the listing status of those taxa that achieve vigorous, self-sustaining population levels as the result of habitat stabilization, restoration, and preventing or minimizing adverse human related impacts. (USFWS, 2012)

- Monitor effectiveness of recovery effort by undertaking baseline quantitative studies and subsequent follow-up work (USFWS 1984, pp. 106–107). (USFWS, 2012)

Conservation Measures and Best Management Practices:

- Develop a systematic survey protocol for *Castilleja grisea* on San Clemente Island. These surveys should include confirmation of existing locations at greater regularity to better determine accurate population status and trend for the species. Additionally, these protocols should include the standardization of information collected such as habitat conditions, habitat type, number of plants, date collected, etc. (USFWS, 2012)
- Conduct research to determine the host plant(s) of *Castilleja grisea* and degree of dependence on host plants. (USFWS, 2012)
- Conduct studies to establish the fire tolerance and preferred fire regime of *Castilleja grisea*. (USFWS, 2012)
- Work with the Navy to better estimate fire frequency in areas occupied by *Castilleja grisea* on San Clemente Island. (USFWS, 2012)

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SPECIES ACCOUNT: *Castilleja levisecta* (Golden Paintbrush)

Species Taxonomic and Listing Information

Listing Status: Threatened; 7/11/1997; Pacific Region (R1); Proposed Delisting

Physical Description

Castilleja levisecta often has from 5 to 15 unbranched stems. The stems may be erect or spreading, in the latter case giving the appearance of being several plants, especially when in tall grass. Plants are up to 30 centimeters (12 inches) tall and are covered with soft, somewhat sticky hairs. The lower leaves are broader, with one to three pairs of short lateral lobes near the terminal third. The showy bracts are about the same width as the upper leaves, softly hairy and sticky, and are golden yellow. The bracts effectively hide the flowers. (USFWS, 2000)

Taxonomy

According to the Integrated Taxonomic Information System (2018), the genus *Castilleja* was formerly included within the Schrophulariaceae family, with current classification in the Orobanchaceae family. The taxonomic hierarchy for *C. levisecta* as determined by Flora of North America for the Integrated Taxonomic Information System is as follows: Kingdom: Plantae; Subkingdom: Viridiplantae; Infrakingdom: Streptophyta; Superdivision: Embryophyta; Division: Tracheophyta; Subdivision: Spermatophytina; Class: Magnoliopsida; Superorder: Asteranae; Order: Lamiales; Family: Orobanchaceae; Genus: *Castilleja* Mutis: ex L. f.; Species: *Castilleja levisecta* Greenm. (USFWS, 2019)

Historical Range

Historically, *C. levisecta* was reported from more than 30 sites in the Puget Trough of Washington and British Columbia, Canada, and as far south as the Willamette Valley of Oregon (Hitchcock et al., 1959, Sheehan and Sprague 1984, Gamon 1995; entire). (USFWS, 2019)

Current Range

C. levisecta occurs in the Puget Lowlands or Puget Trough Physiographic Province of Washington (as mapped by Franklin and Dyrness 1973) and lower Vancouver Island at elevations from sea level to about 100 meters (330 feet) above sea level. It has also been reestablished or introduced to a number of sites in Oregon since 2011. (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (USFWS, 2016)

Lifespan

Adult: 5-10 years (USFWS, 2016)

Dependency on Other Individuals or Species

Adult: Like most paintbrushes (Heckard 1962), this species is a hemi-parasite – its roots penetrate the roots of neighboring plant species and derive nutrients, carbohydrates, and other secondary compounds from these hosts (USFWS, 2016).

Breeding Season

Adult: Plants may flower as early as April with the major flush of flowering plants forming in May; with most flowering completed by July (USFWS, 2016).

Reproduction Narrative

Adult: *Castilleja levisecta* is a relatively short-lived perennial herb, with individual plants generally surviving 5 to 10 years (T. Thomas, USFWS, pers. comm. 2015). This species reproduces exclusively by seed; vegetative spread has never been reported. Plants may flower as early as April with the major flush of flowering plants forming in May; with most flowering completed by July. The fruit is a capsule, which matures in late summer, usually by August. The seed capsule generally dehisces by late summer, or early fall, distributing the abundant seed. Some capsules will persist into winter. By late summer the plants senesce, although some vegetative material may be present throughout the year, depending on the location. Like most paintbrushes (Heckard 1962), this species is a hemi-parasite – its roots penetrate the roots of neighboring plant species and derive nutrients, carbohydrates, and other secondary compounds from these hosts. The breeding system of *Castilleja levisecta* has not been thoroughly documented. Evans et al.(1984) reported that a species of bumblebee, *Bombus californicus*, was observed visiting *Castilleja levisecta*. Pollinator exclusion experiments showed that fruits can be produced in the absence of pollinator visitation, but fruit set was almost five times greater in unbagged inflorescences compared to inflorescences bagged to prevent visits from pollinators (Wentworth 1994). More recently, formal pollinator monitoring was conducted in 2011 to document all pollinators that visit *C. levisecta*. *Bombus* species (bumbees) were the most commonly observed pollinators (Bakker et al.2013); other types of pollinators included honey bees, solitary bees, flies, wasps, and a variety of butterflies (USFWS, 2016).

Habitat Type

Adult: Upland Prairie (USFWS, 2016)

Habitat Narrative

Adult: *Castilleja levisecta* occurs in upland prairies. Prairies may be generally flat in the glaciated portions of the species range; however, the species is also found on coastal bluffs in north Puget Sound, and on some grasslands characterized by mounded topography (T. Thomas, USFWS, pers. comm. 2015). The sites where *Castilleja levisecta* are found in the Willamette Valley, Oregon, are found on deeper, alluvial soils compared with the soil found at the Washington prairies within the species range. Low deciduous shrubs may be present as small to large thickets, although these shrub patches readily burn during prescribed fire events. With a fire return period of 2 to 5 years for prairies (Agee 1993, Hammond et al.2011), fire is thought to have historically played a key role in the maintenance of the upland prairie habitat occupied by this species by preventing the successional encroachment of woody shrubs and trees, and by creating bare soil areas to promote seed germination (T. Thomas, USFWS, pers. comm. 2015). In the absence of fire or other forms of management, most sites have been colonized by woody plants, primarily *Pseudotsuga menziesii*, and shrubs, including *Rosa nutkana* (wild rose), *Symphoricarpos albus* (snowberry) and *Cytisus scoparius*, an aggressive non-native, noxious

weed. The mainland population in Washington occurs in a gravelly, glacial outwash prairie (USFWS 2010). Most of the extant populations in Washington are on loamy sand or sandy loam soils derived from glacial origins. In the southern portion of its historic range in the Willamette Valley, populations occurred on clayey alluvial soils, in association with *Quercus garryana* (Oregon white oak) woodlands and savannah (Caplow 2004). Sites with a high abundance of native forbs and grasses have been determined to be the most suitable sites for reintroduction in Oregon (Lawrence and Kaye 2009), and likely this is the case throughout the species range (USFWS, 2016)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Although seed dispersal has not been directly observed, the seeds are probably shaken from the seed capsules and fall a short distance from the parent plant. The seeds are minute, and light and could possibly be dispersed short distances by the wind; however, we observe little natural reproduction on sites that have not received management (T. Thomas, USFWS, pers. comm. 2015) (USFWS, 2016).

Population Information and Trends

Number of Populations:

48 (USFWS, 2019)

Population Size:

approximately 561,000 flowering plants across all known sites (USFWS, 2019)

Minimum Viable Population Size:

Greater than 100 flowering plants (USFWS, 2019; p. 27)

Additional Population-level Information:

Sites assigned a Low condition are found in the north and south areas of the species' range, though driving stressors vary by region. In the north part of the species range, sites are relatively small and some have inconsistent management, leading to a decline in number of plants through time. In the central part of the species' range, no currently extant sites are in low condition, though two sites have been excluded from recovery planning due to hybridization. There are several sites that exhibit low condition in Willamette Valley, though this includes recent outplantings that have low plant counts because they are just starting to produce flowering plants. (USFWS, 2019)

Population Narrative:

Per 2018 monitoring data and communications with various experts, there are 48 confirmed extant sites with patches of documented flowering *C. levisecta* that were monitored in 2018, 11 of which contained wild patches of the species (Figure 2). Two of these 48 sites (Hill Road in Ebey's Landing Reserve on Whidbey Island and Peach Cove in Clackamas County, Oregon) were observed to contain flowering plants in 2018, but a monitoring count was not obtained. These 48 populations are distributed thusly: • Washington: In Washington, there are 19 extant sites with flowering plants. Nine of these 19 extant sites have had, or currently have, only wild plants on site. Five of these 19 sites are located in the South Puget Sound prairie landscape in central

Washington. In northwestern Washington, six sites are in the San Juan Islands, seven sites currently exist on Whidbey Island, and one site is on the state mainland near Dungeness Bay (see Table 2 of USFWS, 2019). • Oregon: There have been 26 sites with successful outplantings in the Willamette Valley. There are no wild populations left extant in Oregon (see Table 3 of USFWS, 2019). • British Columbia, Canada: Three extant sites contain patches of *C. levisecta* in British Columbia. Two of these extant sites have had, or currently have, only wild plants on site. One is a recent outplanting (see Table 4 of USFWS, 2019). (USFWS, 2019)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Continued development in the Puget Trough and the Willamette Valley is increasing habitat fragmentation (Lawrence and Kaye 2006), and loss of native grasslands. This trend is anticipated to continue or increase with regional population growth. However, this threat has been somewhat mitigated for *Castilleja levisecta* through land acquisition, protection of suitable prairie lands, and active management as a priority. The purchase and conservation of land has increased the amount of potential habitat available for the species. (USFWS, 2007)

Stressor: Herbivory (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Herbivory by deer, rabbits, and voles has been observed, sometimes resulting in serious damage at two populations (Forbes Point and Naas Preserve). At each site deep thatch and dense shrub cover has produced vole and rabbit habitat, respectively. At both of these populations, there have been years when the entire population was browsed, which leads to complete loss of that year's natural seed reproduction. A fence was constructed to exclude rabbits and voles from approximately one-half of the population at Forbes Point and the decline of the *C. levisecta* population slowed, but herbivory continues outside of the quarter hectare (0.62 acres) fenced enclosure. At the Naas Preserve, most flowering plants in the native populations are caged to prevent herbivory and all plants that have been augmented into this population are fenced to keep out deer, rabbits and voles. A minor threat is present at most locations from herbivory by butterfly larvae and other insects but no serious damage has been observed. Microbial interactions are largely unknown. (USFWS, 2007)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Outside of the protections afforded to the species through section 7 consultation for activities that are authorized, funded, or carried out by Federal agencies there is little additional protection given to the species through other means. The Endangered Species Act does not extend protection to listed plant species on private land. Although Washington State classifies plant species as endangered, threatened, or sensitive, the state does not provide protection to rare plants or the habitat upon which they depend. (USFWS, 2007)

Stressor: Fires and Erosion (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: An accidental fire occurred at the Ebey's Landing site during the growing season of 2002 and again during July 2007 when fireworks ignited the grass and forbs at this site. In each case the fire was extremely hot because the fuels on the site were abundant. Because the plant was flowering and no mature seed had formed for the year, the population was severely impacted by this event in both years that fire occurred. The fire intensity was hot enough to char the soil organic layers. Thus, the plants were killed by the fire, no seed was produced for the year, and the site was invaded by several species of invasive, nonnative plants. Up to one-half of the Castilleja plants were burned in each of these fires and the site has been dominated by nonnative species since the initial fire burned in 2002. Erosion at the same site has been a recurring problem and in 2004, a large section of the hillslope eroded from the site, carrying a large slab of soil and plants onto the beach and into the surf below. This erosion event removed an area of approximately 50 feet in width for the entire run of the slope. This type of random environmental event is not predictable in timing or in the amount of soil material that may be removed. However, because of the steepness of the slope at Ebey's Landing, erosion is expected to continue and this site may become extirpated at some time in the future. Between these two events (accidental fire and deep seated slope failure) this population has been reduced from several thousand flowering plants in 2000 to about 200 flowering plants in 2006, the last time a complete census of the site was made. (USFWS, 2007)

Recovery

Reclassification Criteria:

Not applicable.

Delisting Criteria:

Delisting will be considered when all of the following conditions have been met:

1. There are at least 20 stable populations distributed throughout the historic range of the species. To be deemed stable, a population must maintain a 5-year running average population size of at least 1,000 individuals. (USFWS, 2000)
2. At least 15 of these populations are located on protected sites. In order for a site to be deemed protected, it must be either owned and/or managed by a government agency or private conservation organization that identifies maintenance of the species as the primary management objective for the site, or the site must be protected by a permanent conservation easement or covenant that commits present and future landowners to the conservation of the species. (USFWS, 2000)
3. Genetic material, in the form of seeds adequately representing the geographic distribution or genetic diversity within the species, is stored in a facility approved by the Center for Plant Conservation. (USFWS, 2000)

4. Post-delisting monitoring of the condition of the species and the status of all individual populations is ready to begin. (USFWS, 2000)

5. Post-delisting procedures for the ecological management of habitats for all populations have been initiated. (USFWS, 2000)

Recovery Actions:

- 1. Maintain the current geographic distribution of the species through maintaining habitat integrity. Only 11 *Castilleja levisecta* populations are known to exist. A majority of these populations occur on small isolated fragments of remaining habitat and consist of relatively few individuals. Each of the 11 populations is subject to a number of current and potential threats, all of which compromise the integrity of the habitat. Since *C. levisecta* is adapted to specific habitat conditions, maintaining or restoring the integrity of the habitat is essential. (USFWS, 2000)
- 2. Identify and search potential habitat using standardized rare plant search methods developed by the U.S. Fish and Wildlife Service or other resource agencies. Although considerable inventory work has been undertaken for this species, the discovery in the last few years of previously unknown sites (two new occurrences and two new colonies within a previously known occurrence) suggests that other populations or colonies may yet be discovered. Comprehensive inventory is complicated because so much of the range of the species is privately owned, and because small remnant patches of habitat can be hidden from view from any point of public access. Although as yet undiscovered populations or colonies are likely to be small, they collectively have the potential to contribute substantially to the recovery effort. (USFWS, 2000)
- 3. Establish new populations of *Castilleja levisecta* within the historic range of the species. As noted above, the long term survival of *Castilleja levisecta* is likely to depend on the establishment of new populations. In order to accomplish this, a carefully prepared reintroduction plan is needed, along with research into the technical aspects of successfully growing the species. (USFWS, 2000)
- 4. Disseminate information about the species to appropriate audiences and landowners. Develop and conduct training programs to be provided to concerned agency personnel, as well as private landowners (Priority 3). Develop a brochure or fact sheet for public dissemination, and provide presentations as appropriate (Priority 3). Develop and disseminate species information to private landowners (Priority 3). (USFWS, 2000)
- 5. Promote State and county level legal protection for occurrences on non- Federal lands. Due to the limited number of known areas that harbor this species, and the limited number of known occurrences within those areas, it is important to secure the maximum legal protection available to all occurrences. (USFWS, 2000)
- 6. Establish a technical working group to periodically review the status of the species and assess the effectiveness of the management plans and other recovery tasks (Priority 3). Through periodic review, improvements to the overall recovery effort can be made, thereby accelerating recovery. (USFWS, 2000)
- 7. Collect seed adequately representing the genetic diversity within the species and store in a Center for Plant Conservation approved facility (Priority 3). The small number of known populations, area occupied, and the fact that many populations are few in number of individuals, make the species more vulnerable to random environmental and human-caused events. As a hedge against the loss of significant genetic material, seed representing the

diversity within the species should be collected and stored in a Center for Plant Conservation approved facility. The stored seed could also be used in efforts to establish new populations. (USFWS, 2000)

- Conservation measures to restore *Castilleja levisecta* (golden paintbrush) in the Willamette Valley: Some research has been conducted on the population biology, fire ecology, propagation and restoration of *Castilleja levisecta* (Dunwiddie et al. 2001, Gamon et al. 2001, Kaye 2001, Kaye and Lawrence 2003, Caplow 2004, Lawrence 2005). The results of these studies have been used to direct the management of the species at sites managed for upland prairies, and are critical to the future reintroduction and recovery of the species. A reintroduction plan has been prepared (Caplow 2004), as directed by the Golden Paintbrush Recovery Plan (U.S. Fish and Wildlife Service 2000b); reintroduction into likely historical habitat is the best hope for the species to recover in the prairies of Oregon and southwestern Washington. Recent research has considered the most appropriate seed sources and site characteristics for the reintroduction of *Castilleja levisecta* to the Willamette Valley (Lawrence 2005). The findings of this study are consistent with those recommended for the other prairie species addressed in this plan, in that the optimal sites for reintroduction were high quality prairies dominated by native perennial species with low abundance of non-native plant species. Furthermore, the study recommended against using genetic diversity, effective population size, or geographic distance in determining source material for reintroductions, instead suggesting that plant materials from Whidbey Island, Washington, had the greatest potential for successful reintroductions to the Willamette Valley (Lawrence 2005). Greenhouse trials and surveys of potential reintroduction sites in the Willamette Valley have recently been completed (Lawrence 2005). Seeds of this species have been banked at the Berry Botanic Garden in Portland, Oregon (Berry Botanic Garden 2005) and the University of Washington Botanic Garden. (USFWS, 2010)
- Recommendation for Future Action from 2007 5-Year Review: Upon completing this 5-year review of the status of *Castilleja levisecta* and its recovery plan, we recommend that surveyors monitoring the populations for *Castilleja levisecta* count only flowering plants. Counting vegetative individuals is difficult and impractical because small vegetative seedlings may be obscured by shrubs or tall grass and may not survive the growing season. To ensure monitoring is consistently applied across all ownerships and locations, the criterion used for monitoring the population should be modified to specify 1,000 flowering, rather than vegetative, plants as the threshold for a recovered population. (USFWS, 2007)
- Recommendation for Future Action from 2007 5-Year Review: Three items should be addressed when the Recovery Plan for *Castilleja levisecta* is revised: (1) modify how individual plants are counted during population monitoring by counting only flowering plants; (2) modify the number of populations that should be required to meet recovery based on our experience with restoring habitat and recovering *Castilleja levisecta*; and (3) reevaluate how we partition populations and determine if populations that are within close proximity to one another should be considered a single population using the current definition of "element occurrence". (USFWS, 2007)
- Recommendation for Future Action from 2007 5-Year Review: In addition to how we account for the number of plants in a population, we recommend that the number of populations that will be required to meet recovery of the species be reconsidered and modified. Currently, the Recovery Plan calls for at least 20 self-sustaining populations distributed throughout the species historic range. Because the species is reliant on regular management actions to sustain itself, it may be practical to focus on having fewer populations (for example, 15 protected populations) to meet the recovery needs of the

- species and to make sure these populations receive funding and regular management. It would still be required that a population would need to maintain a stable or positive trend for the number of plants in a population for a minimum of 5 years. (USFWS, 2007)
- Recommendation for Future Action from 2007 5-Year Review: It will be important to recognize the spatial relationship of populations. Closely situated populations should be counted as a single population and not be considered as separate populations. The standard definition for “element occurrence”, as it is used by the Washington Natural Heritage Program, is an area of land (or water) in which a species is, or was, present. Furthermore, the distance between occurrences of the element determines whether they are considered the same or separate occurrence. In addition to the distance criteria between populations, the pollination flight distance attributed to insects that are known to pollinate *Castilleja levisecta* and the availability of suitable habitat between two existing populations needs to be considered. The Recovery Plan should be revised to show our intent to apply the standard for element occurrence to *Castilleja levisecta*, which would combine some populations into single occurrences and would reduce the number of populations that we have currently, which would make each of the populations larger and more robust.

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SPECIES ACCOUNT: *Castilleja mollis* (Soft-leaved paintbrush)

Species Taxonomic and Listing Information

Listing Status: Endangered; 07/31/1997; California/Nevada Region (R8) (USFWS, 2015)

Physical Description

A shrubby, hemiparasitic, perennial herb with soft-woolly, grayish-green foliage. The highly branched plants are somewhat prostrate, usually reaching only 3+ dm high. Inflorescences (April-August) have yellow bracts (the bracts much more conspicuous than the flowers). (NatureServe, 2015)

Taxonomy

This species was described by Pennell as *Castilleja mollis* in 1947, based on material collected on Santa Rosa Island in 1939 (Ingram 1990, Heckard et al. 1991). Hoover (1970) and Munz and Keck (1973) included plants of coastal sand dunes of San Luis Obispo County in the description of this taxon. (USFWS, 2000). Upon review and in agreement with available systematic and floristic literature and consultation with species experts, we intend to propose amending part 17, subchapter B of chapter I, title 50 of the Code of Federal Regulations to reflect the transfer of *Castilleja* taxa including *C. mollis* from the family Scrophulariaceae to the family Orobanchaceae. (USFWS, 2007)

Historical Range

See current range/distribution.

Current Range

Confined to the California Channel Islands, perhaps only Santa Rosa Island but possibly San Miguel Island as well. Not seen on San Miguel Island since 1938, despite recent surveys (CNPS 2001). (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (hybridization) NatureServe, 2015)

Breeding Season

Adult: April to August (NatureServe, 2015)

Other Reproductive Information

Adult: This plant occasionally hybridizes with *Castilleja affinis*. (NatureServe, 2015)

Reproduction Narrative

Adult: This plant occasionally hybridizes with *Castilleja affinis*. Inflorescences (April-August) have yellow bracts (the bracts much more conspicuous than the flowers). (NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Sand/dune, Shrubland/chaparral (NatureServe, 2015)

Dependency on Other Individuals or Species for Habitat

Adult: Soft-leaved paintbrush is dependent on a host plant for water and dissolved resources. Some leaves have reduced chlorophyll and the plant compensates by parasitizing the roots of nearby vascular plants (Chuang and Heckard 1993). The most likely host is goldenbush (*Isocoma menziesii* var. *sedoides*) (E. Painter in litt. 1995, M. Wetherwax in litt. 1995). (USFWS, 2000)

Habitat Narrative

Adult: It is well established that *Castilleja mollis* requires the coastal scrub bluff community, which includes goldenbush, to establish and survive (USFWS, 2000). *Castilleja mollis* requires stabilized and partially stabilized coastal dunes (NatureServe, 2015). *Castilleja mollis* is dependent on a host plant for water and dissolved resources. Some leaves have reduced chlorophyll and the plant compensates by parasitizing the roots of nearby vascular plants (Chuang and Heckard 1993). The most likely host is goldenbush (*Isocoma menziesii* var. *sedoides*) (E. Painter in litt. 1995, M. Wetherwax in litt. 1995). (NatureServe, 2015; USFWS, 2000)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Decline of >10% (NatureServe, 2015)

Resiliency:

Very low (USFWS, 2007)

Representation:

Low (inferred from USFWS, 2007)

Redundancy:

Low (inferred from USFWS, 2007)

Population Growth Rate:

Slow decline (NatureServe, 2015)

Number of Populations:

2 (USFWS, 2007)

Population Size:

>1000 (NatureServe, 2015)

Population Narrative:

Population estimates are 1000 individuals in Jaw Gulch population and several thousand in Carrington Point population (USFWS 2000). There are only three occurrences at the California Natural Diversity Database for this species; one extant, two possibly extirpated. (NatureServe, 2015). Short term trends indicate a decline of approximately 10%. (NatureServe, 2015; USFWS, 2007)

Threats and Stressors

Stressor: Decline of plant host (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: We have information that indicates the direct dependency of *Castilleja mollis* on the coastal goldenbush scrub community (McEachern, pers. comm. 2006a). Before 1998, cattle grazing and ungulates rutting caused large gaps in the coastal goldenbush community. These gaps were then invaded by non-native grasses, inhibiting *Castilleja mollis* from making root connections with the goldenbush host plant. (USFWS, 2007)

Stressor: Non-native plants (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Competition with non-native plant taxa was also identified as a threat to *Castilleja mollis* in the final recovery plan (U.S. Fish and Wildlife Service 2000). *Castilleja mollis* is forced to compete with the invasive annual grasses for water and nutrients. This competition weakens the paintbrush, which may contribute to the failure of seedlings to make root connections with the goldenbush host plant (McEachern 2004a). (USFWS, 2007)

Stressor: Soil disturbance and trampling (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Although all cattle have been removed from Santa Rosa Island and deer numbers have decreased, elk numbers have increased since 2001 (see Figures 2 and 3). This is believed to be a continuing factor hindering *Castilleja mollis* recovery on the island (McEachern 2003). (USFWS, 2007)

Stressor: Habitat fragmentation (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Past habitat fragmentation that occurred as a result of grazing and trampling is still considered a major threat to the species. (USFWS, 2007)

Stressor: Predation (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: The listing rule also noted cattle herbivory as a problem for the species, but cattle were removed from Santa Rosa Island in 1998. Cattle removal and the reduction in the number of deer have, so far, not resulted in substantial improvements in *Castilleja mollis*. (USFWS, 2007)

Stressor: Soil disturbance and trampling (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Trends in the number of inflorescences and percent cover suggest that a large-scale event, such as weather, may also influence flowering and growth (McEachern, in litt. 2006b; McEachern, pers. comm. 2006c). (USFWS, 2007)

Stressor: Stochastic events (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Due to the small population size of this species, the listing rule noted that *Castilleja mollis* would be vulnerable to stochastic events (including variable weather patterns such as drought), reduced genetic integrity of the species, and depressed reproductive vigor (62 FR 40957). (USFWS, 2007)

Recovery

Reclassification Criteria:

1. Maintain the existing distribution with multiple colonies in each population on Santa Rosa Island. (USFWS, 2000)
2. Maintain stable or increasing population trends with evidence of natural recruitment for a period of 15 years that includes the normal precipitation cycle. (USFWS, 2000)
3. Damage from normative mammals significantly reduced. (USFWS, 2000)

Delisting Criteria:

1. Expansion of individuals into potential habitat within population boundaries. (USFWS, 2000)
2. No decline after downlisting for 10 years. (USFWS, 2000)

Recovery Actions:

- Provide protection and adaptive management of currently known (and in some cases historic) sites. (USFWS, 2007)

- Provide evidence that the populations at these sites are stable or increasing over a number of years, which is determined by the life history of the individual species. (USFWS, 2007)
- Support and intensify active control programs where herbivory or habitat alteration by alien animals exists. (USFWS, 2007)
- Develop and implement a plan to achieve the goals and standards of the Conservation Strategy. (USFWS, 2007)
- Seed is stored in Center for Plant Conservation cooperating facilities. (USFWS, 2007)
- Seed germination and propagation techniques are understood. (USFWS, 2007)
- Successful outplanting techniques are developed. (USFWS, 2007)
- Host plant and weed management plan are developed and implemented. (USFWS, 2007)
- Life history research is conducted that aids in the conservation and recovery of the species. (USFWS, 2007)
- Hybridization with *Castilleja affinis* is understood. (USFWS, 2007)
- If declining, determine the cause and reverse trend. (USFWS, 2007)

Conservation Measures and Best Management Practices:

- Because the removal of cattle and the reduction in deer have had a positive effect on seedling recruitment, the program to eliminate ungulates from the island by 2011 should continue as planned. (USFWS, 2007)
- During the time that the special use permits are in effect, if targeted hunting of deer and elk is no longer effective, the NPS should consider other actions to reduce the threats of these animals to the species. (USFWS, 2007)
- Based on the reports produced by the Scientific Panel, indeterminate threats, in addition to ungulate herbivory, scraping and general presence are contributing to the decline in the amount of inflorescence and percentage cover of *Castilleja mollis*. Therefore, other parameters that influence the species' ability to recover should be tracked at both locations where the species is found. In particular, the following monitoring actions are recommended: (a) monitor community species composition and cover to indicate whether the habitat is improving; (b) monitor rate of hybridization with *Castilleja affinis* to understand the level of threat this poses on recovering the species; (c) monitor damage to inflorescence, stems, and leaves caused by insects; (d) monitor the number of plants, or seedlings and juveniles within the populations; and (e) monitor the rate of erosion using soil depth/amount of litter. (USFWS, 2007)
- The following downlisting measures outlined in the recovery plan should be implemented: (1) seed storage in a Center for Plant Conservation facility, and (2) development and implementation of host plant and weed management actions. (USFWS, 2007)
- To secure several populations of *Castilleja mollis* containing a minimum of 2,000 plants each, efforts should focus on restoring coastal goldenbush scrub habitat so that there is reduced fragmentation within populations of *Castilleja mollis* on the island. (USFWS, 2007)

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SPECIES ACCOUNT: *Catesbaea melanocarpa* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 3/17/1999; Southeast Region (R4) (USFWS, 2015)

Physical Description

A branching shrub that may reach approximately 9.8 feet (ft.) (3.0 meters (m)) in height. Spines are borne at every internode (space between nodes) and are from 0.39 to 0.78 inches (in) (1.00 to 2.00 centimeters (cm)) long. Leaves are small, from 0.19 to 1.0 in (5.00 to 25.00 millimeters (mm)) long, and 0.07 to 0.58 in (2.00 to 15.00 mm) wide, often opposite. The flowers are white, solitary or paired, and almost lacking a stalk in the axils (angle formed by a leaf or branch with the stem). The petals are united in the form of a funnel and measure from 0.31 to 0.39 in (8.00 to 10.00 mm) long. The fruit is black, spherical, and 0.19 to 0.23 in (5.00 to 6.00 mm) in diameter. The two-celled fruit contains five to seven seeds in each cell (Proctor 1991) (USFWS, 2005).

Taxonomy

Catesbaea melanocarpa, of the family Rubiaceae, belongs to a genus that consists of ten or more species of spiny shrubs confined to the Antilles, but some may extend into the Bahamas and the Florida Keys. Some authors have noted that *C. melanocarpa* may be a synonym or variant of *C. parviflora* and have recommended further review (Howard 1989, Proctor 1991). Dr. Frank Axelrod (personal communication (pers. comm.) 2004) of the University of Puerto Rico, however, does not believe that *Catesbaea melanocarpa* is a variety of *C. parviflora* (USFWS, 2005). *C. melanocarpa* is now being referred to by the English common name, Tropical Thorn Lily, by species experts (Morgan and Zimmerman, UVI, poster presentation, 2016). No common name in Spanish has been published. (USFWS, 2018).

Historical Range

Catesbaea melanocarpa was historically known from Puerto Rico, St. Croix in the U.S. Virgin Islands (USVI), Barbuda, Antigua, and Guadeloupe (Proctor 1991) (USFWS, 2011).

Current Range

Catesbaea melanocarpa is currently known from seven areas: the Guánica Commonwealth Forest in Puerto Rico, two privately owned localities in Puerto Rico (Peñones de Melones and Encarnación), one privately-owned locality in St. Croix in the U.S. Virgin Islands, Barbuda, Antigua, and Guadeloupe (USFWS, 2011).

Critical Habitat Designated

Yes; 8/28/2007.

Legal Description

On August 28, 2007, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Catesbaea melanocarpa* (No Common Name) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in the Virgin Islands (72 FR 49212-49228).

Critical Habitat Designation

The critical habitat designation for *Catesbaea melanocarpa* includes one CHU in St. Croix, Virgin Islands. This species critical habitat encompasses approximately 10 acres (ac) (4.3 hectares (ha)) (72 FR 49212-49228).

Halfpenny Bay, St. Croix, U.S. Virgin Islands. (i) General description: The Halfpenny Bay unit consists of approximately 10.5 ac (4.3 ha) on privately owned property located about 2.48 mi (4 km) south of Christiansted, St. Croix, U.S. Virgin Islands. The designated unit is located east of South Shore Road, approximately 342 m (1,122 ft) south of Road 62, approximately 600 m (1,968 ft) north of the Halfpenny Bay coast, and 70 m (230 ft) west of a local road to Halfpenny Bay. This unit encompasses the habitat features essential to the conservation of *Catesbaea melanocarpa* within Estate Granard, Christiansted, St. Croix, and does not contain any manmade structures.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Catesbaea melanocarpa* critical habitat consists of two components (72 FR 49212-49228):

(i) Single-layered canopy forest with little ground cover and open forest floor that supports patches of dry vegetation with grasses, and

(ii) Well to excessively drained limestone and serpentine-derived soils (including soils of the San Germa'n, Nipe, and Rosario series and Glynn and Hogensborg series).

Special Management Considerations or Protections

When designating critical habitat, we assess whether the areas determined to be occupied at the time of listing contain the PCEs that may require special management considerations or protection. As discussed in this section and in the unit description below, we find that all of the PCEs in Halfpenny Bay may require special management considerations or protection due to threats to the species or its habitat from periodic but intense grazing, human-induced fires, and potential development for a tourist project (USFWS 2005, p. 8). Such management considerations and protections include fencing off forest patches to exclude cattle, developing fire-breaks adjacent to existing roads and farm boundaries during dry season, and establishing conservation agreements with landowners to protect habitat within the property.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from EPA, 2016)

Breeding Season

Adult: July (EPA, 2016)

Key Resources Needed for Breeding

Adult: Insect pollinators (EPA, 2016)

Reproduction Narrative

Adult: Flowering is observed in July and for several weeks onward. Green and mature fruit observed in July and for several weeks onward. Fruit is also observed in December. Insects are potential pollinators (EPA, 2016).

Habitat Type

Adult: Terrestrial (EPA, 2016)

Habitat Vegetation or Surface Water Classification

Adult: Subtropical dry forest (EPA, 2016)

Habitat Narrative

Adult: Occurs in the subtropical dry forest life zone, the driest life zone in Puerto Rico and U.S. Virgin Islands, this life zone receives a mean annual rainfall ranging from 24 to 40 inches (60 to 100 cm). In Puerto Rico, the vegetation is usually deciduous and forms a nearly continuous canopy with little groundcover. In St. Croix, the species is located on the dry coastal plain. Vegetation is made up of dry thicket scrub, dominated by grasses and patches of trees and shrubs. The site where species is found is an agricultural track that experiences periods of intense grazing. PCEs: 1) Single-layered canopy forest with little ground cover and open forest floor that supports patches of dry vegetation with grasses, and 2) well to excessively drained limestone and serpentine derived soils (including soils of the San German, Nipe, and Rosario series, and Glynn and Hogensborg series) (EPA, 2016).

Dispersal/Migration**Dependency on Other Individuals or Species for Dispersal**

Adult: Unknown (EPA, 2016)

Dispersal/Migration Narrative

Adult: Dispersal mechanisms are unknown (EPA, 2016)

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Stable (USFWS, 2011)

Resiliency:

Low (inferred from USFWS, 2011)

Redundancy:

Low (inferred from USFWS, 2011)

Number of Populations:

4 (USFWS, 2011). The total number of known population locations decreased from four (3 in PR and 1 in USVI) to three (2 in PR and 1 in USVI) with only one individual making up one of the populations in Puerto Rico. (USFWS, 2018).

Population Size:

132 (USFWS, 2011). The total number of individuals has increased from approximately 132 individuals (125 adult plants and 7 wild seedlings) in 2011 to approximately 547 individuals in 2018. Of these, 12 were grown in the UVI greenhouse, and 116 are wild seedlings counted only once in 2013 at Ha'Penny (and carried over here as an estimate). Based on survey data, 406 were found in Ha'Penny, St. Croix, 12 were found in Guanica, Puerto Rico, 1 was found in Penuelas, Puerto Rico, and none were found in Punta Melones, Puerto Rico. In total, 522 individuals are known in the US Virgin Islands, and 13 in Puerto Rico. (USFWS, 2018).

Population Narrative:

The species status is stable; no evident increase or decline within these populations was observed in 2010. The species is currently present in four localities within Puerto Rico and the U.S. Virgin Islands. Based on the data currently available for the Service, the number of individuals is estimated at 132 plants (adults and seedlings) (USFWS, 2011).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Deforestation for residential and tourist development may pose imminent threats to the survival of the species. In Puerto Rico, a single individual was reported on a privately-owned land known as Peñones de Melones. This locality was threatened with a proposed high density residential/tourist development. Visits by Service biologist Carlos Pacheco suggest that individuals may no longer exist in Peñones de Melones as deforestation and fires associated with human activity continue within this area. In St. Croix, approximately 100 individuals are present in a privately-owned land. This population is subject to impacts from grazing activities. Also, the development of a golf course has been proposed for the site (USFWS, 2011). Additional disturbances are caused by fire, illegal off-road racing, cattle, and hurricanes. (USFWS, 2018).

Stressor: Limited distribution (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Limited distribution of the species was also identified as an important factor affecting the species. Catastrophic natural events, such as hurricanes, may dramatically affect forest species composition and structure, felling large trees and creating numerous canopy gaps (USFWS, 2011).

Recovery**Reclassification Criteria:**

1. The habitat known to support the two extant populations (St. Croix and Peñones de Melones) is enhanced and protected through landowner conservation agreements or easement (USFWS, 2011).

2. Extant populations are enhanced through the planting of additional propagated individuals to augment the number of adult individuals to at least 250 (USFWS, 2011).
3. At least one population within each of the following previously occupied habitat is found and/or established: Guánica Commonwealth Forest (PR), Susúa Commonwealth Forest (PR), Barbuda, Antigua, and Guadalupe (USFWS, 2011).
4. Research is conducted on key biological and genetic issues, including effective propagation techniques, and number of individuals within a population and number of populations needed for the establishment of self-sustaining populations and a viable overall population (USFWS, 2011).

Delisting Criteria:

1. A number of viable populations (to be determined following the appropriate studies) are protected by long term conservation strategies (USFWS, 2011).
2. viable populations (the number of which should be determined following the appropriate studies) are established in previously unoccupied but suitable habitat at Sandy Point National Wildlife Refuge (USVI), Cabo Rojo National Wildlife Refuge (PR), La Tinaja in Sierra Bermeja (Laguna Cartagena National Wildlife Refuge, PR), and any other identified suitable conservation area within the dry forest zone (USFWS, 2011).
3. The numbers of populations, their sizes, genetic makeup and distribution needed to ensure self-sustainability are determined and achieved (USFWS, 2011).

Recovery Actions:

- Protect existing populations (St. Croix and Cabo Rojo) from current and future threats and/or limiting factors through landowner agreements and other conservation mechanisms (USFWS, 2005).
- Determine the distribution and population status of *Catesbaea melanocarpa* throughout its present and historic range, including Barbuda, Antigua, and Guadalupe (USFWS, 2005).
Refinement in 2019: Conduct a full population assessment, including developing maps (GIS) with spatial information of the species for each area and information on recruitment. Historic data and observation records should be compiled into a single electronic database to inform a full population assessment. (USFWS, 2018).
- Evaluate techniques and develop a plant propagation program for *Catesbaea melanocarpa* (USFWS, 2005). Refinement in 2019: Establish a sound propagation protocol and subsequent plant production program; identify additional suitable habitat and develop partnerships to aid in the reintroduction of the species within its historic range in identified suitable habitat. (USFWS, 2018).
- Enhance existing populations and establish new self-sustaining populations (number of which should be determined by viability analysis) within protected areas by introducing additional individuals developed through propagation. Introduction sites may include, but are not limited to, the Guánica Commonwealth Forest, Susúa Commonwealth Forest, Sandy Point National Wildlife Refuge, and Cabo Rojo National Wildlife Refuge (USFWS, 2005).
- Conduct additional scientific research on *Catesbaea melanocarpa* (USFWS, 2005).

- Facilitate the recovery of *Catesbaea melanocarpa* through public awareness and education (USFWS, 2005).
- Provide technical assistance to Barbuda, Antigua, and Guadalupe for the development of conservation measures for the species (USFWS, 2005).
- Refine recovery criteria (USFWS, 2005).
- New in 2018: Further studies to confirm the presence or absence of *C. melanocarpa* at potential sites in Puerto Rico including an updated status on the population at the Guánica Commonwealth Forest. (USFWS, 2018).
- New in 2018: Identify Territorial and Commonwealth agencies able to monitor current populations and inform those agencies of the status and threats to the species. (USFWS, 2018).

Conservation Measures and Best Management Practices:

- Initiate propagation efforts and establish new populations in protected areas (USFWS, 2011).

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SPECIES ACCOUNT: *Caulanthus californicus* (California jewelflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 07/19/1990; California/Nevada Region (R8) (USFWS, 2015)

Physical Description

Caulanthus californicus is a glabrous decumbent to erect often branched annual, with whitish petals and spherical seeds. Leaves are less than 11 millimeters (mm) (0.4 inch (in.)) in length and are shallowly cut to wavy-dentate and tapered. Calyx petals (outer whorl) are generally spreading, 4–10 mm (0.15–0.4 in.) in length, maroon, keeled, and darker in bud stage. Corolla petals (inner whorl) are 6–11 mm (0.2–0.4 in.) long and whitish, with wavy margins (Buck 1993). (USFWS, 2013)

Taxonomy

USFWS tracks as synonym 01 - *Caulanthus Californicus* (8/93). (NatureServe, 2015)

Historical Range

Originally in San Joaquin and adjacent valleys. Once fairly abundant in appropriate habitat in Fresno, Kern, King, Santa Barbara, San Luis Obispo and Tulare counties. (NatureServe, 2015)

Current Range

Appears to be currently extant in Fresno, Kings, Kern, and Santa Barbara Counties (CalFlora Occurrence Database website Feb. 2, 2000). Extirpated from Kings County, but present in San Luis Obispo County (CNPS Inventory, 2001). (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Dispersal/Migration

Population Information and Trends

Population Trends:

Decline (NatureServe, 2015)

Resiliency:

Low (inferred from USFWS, 2013)

Representation:

Low (inferred from USFWS, 2013)

Redundancy:

Low (inferred from USFWS, 2013)

Population Growth Rate:

Slowly declining (NatureServe, 2015)

Number of Populations:

34 (USFWS, 2013)

Population Narrative:

The long-term decline in population is primarily a result of loss of area and extent of occurrence (and resultant loss of population numbers; NatureServe, 2015). Additionally, the effects of soil nitrification, climate change, loss of pollinators, and loss in genetic diversity are emerging as new threats since the time of listing. (USFWS, 2013). Currently, the CNDDDB indicates that of the 34 occurrences listed as “presumed extant,” 26 occurrences have not been updated in 15 years. (USFWS, 2013)

Threats and Stressors

Stressor: Urbanization (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: At the time of listing the primary threats to *C. californicus* were the ongoing and threatened destruction and adverse modification of habitat due to agricultural land conversion and urbanization on the San Joaquin Valley floor (Service 1990). Non-urbanized or non-converted lands, which largely occurred in the neighboring foothills and valleys, were subject to livestock grazing, oil and gas exploration and development, off-road vehicle use, and mining (Service 1990). (USFWS, 2013)

Stressor: Agriculture (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: The CVP supplies water to more than 250 long-term water contractors in the Central Valley, Santa Clara Valley, and eastern San Francisco Bay Area. Agricultural conversions and related operations either directly or indirectly facilitated by the CVP include: conversion of native habitats to agricultural fields; conversion of land use to more water intensive purposes; disposal of agricultural drain water; application of pesticides; and other mowing and harvesting operations. Agricultural conversion and related operations have contributed to the loss and degradation of several habitat types, including grasslands and alkali scrub associated with declines of multiple listed species (Service 1998). (USFWS, 2013)

Stressor: Mining (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Mining presented a threat to *C. californicus* (Service 1990). On the Carrizo Plain National Monument (Monument), only valid leases, claims and other rights that existed as of the

date of the Proclamation, January 17, 2001, may see mineral development on federal lands within the Monument (BLM 2010). (USFWS, 2013)

Stressor: Oil and Gas Exploration and Development (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: At the time of listing, oil and gas exploration and development presented a threat to *C. californicus* (Service 1990). Adverse effects of oil and gas development on *C. californicus* include the loss of habitat, changes in habitat quality, destruction of individuals or populations and their seed bank, habitat fragmentation, and increased competition from nonnative plant species due to habitat degradation. (USFWS, 2013)

Stressor: Off-road Vehicle Use (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: At the time of listing, off-road vehicle use presented a threat to *C. californicus* (Service 1990). Off road vehicle use has been reported as a minor threat potentially affecting 7 occurrences on the Carrizo Plain National Monument where no off-road motorized or mechanized travel is legally permitted (BLM 2010). (USFWS, 2013)

Stressor: Solar Power Development (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: At the time of listing, solar power development did not present a threat to *C. californicus*. Solar power development projects pose potential threats to and may impact large amounts of habitat. These projects can destroy, fragment, or impact *C. californicus* habitat by: altering landscape topography, vegetation, and drainage patterns; and reducing habitat quality through interception of solar energy normally reaching the ground surface, affecting ambient air temperatures through habitat shading, and altering soil moisture regimes (Smith 1984; Smith et al. 1987 as cited in J.R. Single 2010). Moreover, recently proposed solar projects tend to be large contiguous blocks of disturbance in undeveloped habitat lands, ranging from hundreds to several thousand acres. (USFWS, 2013)

Stressor: Predation (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: At the time of listing, domestic livestock predation was thought to have extirpated colonies of *C. californicus* (Service 1990). On the Carrizo Plain, *C. californicus* is known to occur within and around the precincts or burrows of the endangered giant kangaroo rat (*Dipodomys ingens*). Giant kangaroo rats apparently seek out *C. californicus*, because stems of this species were clipped with equal frequency both on precincts (circular areas with a concentration of giant kangaroo rat burrows) and in interspaces of giant kangaroo rat burrows; however, directed research exploring interactions of plant and animal species in the community should be completed (Cypher 1994). (USFWS, 2013)

Stressor: Grazing (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Domestic livestock grazing has been used to reduce grass and forb competitors in endangered plant habitats; however, the use of domestic livestock grazing to benefit native plant species has had mixed results (Vesk and Westoby 2001; Floyd et al. 2003; Kimball and Schiffman 2003). Direct effects from cattle grazing are reported to be detrimental because cattle seek out and show preference for eating the plant (Service 1998). The habitat of *C. californicus* in Fresno County is grazed after the dispersal of its seeds in late spring and prior to the new growth of its basal rosettes in late winter. (USFWS, 2013)

Stressor: Competition from Nonnative Grasses (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: The southern San Joaquin Valley of California, as with much of western North America, has been invaded by nonnative plant species during the past 100 to 200 years. These include the following species: *Bromus rubens* (red brome), *Vulpia myuros* (mouse tail fescue), *Schismus arabicus* (Arabian grass), *Hordeum murinum* ssp. *glaucum* (known locally as foxtail and elsewhere as smooth barley), *Bromus diandrus* (ripgut brome), and *Bromus hordeaceus* (soft chess) (Biswell 1956; Germano et al. 2001). Individual invasive species could modify ecosystem properties (Gordon 1998). (USFWS, 2013)

Stressor: Competition from Nonnative Plant Species Due to Fire Retardant Application (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Another threat to California jewelflower is invasion and competition from nonnative plant species; this threat could be exacerbated by the application of fire retardant, which can act as a nutrient source for nonnative invasives. California jewelflower habitat includes slightly alkaline sandy loams; the low nitrogen levels of these soil conditions are unfavorable for nonnative, which in turn provides a competitive advantage to species, such as the jewelflower, which have adapted to the nutrient-poor environment. Nitrogen and phosphorus could be increased in the soil through the application of ammonium-based retardants. (USFWS, 2013)

Stressor: Nitrogen Deposition (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Nitrification of soil was not considered a threat at the time of listing *C. californicus*, but should currently be considered a threat. There is little information regarding *C. californicus* and soil nitrogen levels in which it occurs (B. Delgado, BLM pers. comm. 2011), however some adverse soil conditions (low nutrients, low water holding capacity) exert stress on plant species and can reduce competition, particularly for species that are not tolerant of the soil stress factors (R. O'Dell pers. comm. 2011). Human activities have increased nitrogen availability throughout

terrestrial systems (Suding et al. 2005). Three major producers of nitrogen emissions are transportation, agricultural production, and industrial activities including electricity production (Spiegel 2003). (USFWS, 2013)

Stressor: Pollinators (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: At the time of listing, the declines in the pollinators of all descriptions were not considered a threat to *C. californicus*. Since that time, the reduction to the population of the non-native honeybee (*Apis mellifera*), often referred to as colony collapse disorder, has been well documented. Native insects may pollinate the *C. californicus*, however a reduction in their abundance has been observed as well (United States 2007). (USFWS, 2013)

Stressor: Genetic Diversity (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Loss of genetic diversity was not considered a threat at the time of listing *C. californicus*. However, considering the reduction of the range of the *C. californicus* and fragmentation of habitat, lack of cross pollination between populations of the remaining localities may be a future threat. This may result in the loss of genetic diversity, which may reduce the adaptability of the plant to current and future environmental conditions and also increases the threat of inbreeding depression. Loss of genetic diversity and adaptability is likely to reduce the long-term survival of plant species (Huenneke 1991). (USFWS, 2013)

Stressor: Climate Change (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Climate change was not considered a threat to *C. californicus* at the time of listing; however, climate change is a potential threat to the species. Projected California temperature rise estimates range from an increase of 1.7° Celcius to 5.8° Celcius (3.0° Fahrenheit to 10.4° Fahrenheit) for years 2000 - 2100 (Cayan et al. 2006). Climate change has the potential to alter the timing and synchronicity of ecosystem processes. The interactions between flower production and insect availability for pollination may be altered (Field et al. 1999; Cayan et al. 2006). Changes in temperature and precipitation likely will alter the structure, composition, and productivity of vegetation communities and wildfire may become more frequent and intense (Lenihan et al. 2006). (USFWS, 2013)

Recovery

Reclassification Criteria:

1. Secure and protect specified recovery areas from incompatible uses on ninety-five percent of occupied habitat on public lands; 75 percent of population and occupied habitat in Santa Barbara Canyon. (USFWS, 2013)

2. Management Plan approved and implemented for recovery areas that include survival of the species as an objective for all protected areas identified as important to continued survival. (USFWS, 2013)

3. Population monitoring for specified recovery areas shows that the populations are stable or increasing through the normal precipitation cycle. (USFWS, 2013)

Delisting Criteria:

Delisting criteria is not available.

Recovery Actions:

- Surveys will be necessary to determine whether natural populations remain in all target areas. (USFWS, 1998)
- Unoccupied habitat within metapopulations also should be protected to facilitate movement of pollinators and seed dispersers. (USFWS, 1998)
- The top-priority action for recovery of California jewelflower is to protect the plants on private land in Santa Barbara Canyon. (USFWS, 1998)
- Buffer zones of 150 meters (500 feet) or more should be protected beyond the population margins to reduce external influences and to allow for population expansion. (USFWS, 1998)
- Additional tasks are required to achieve recovery goals. These tasks include developing management plans, surveying for additional populations, banking seed, conducting research, and modeling population demographics using matrix projection modeling. (USFWS, 1998)

Conservation Measures and Best Management Practices:

- Protection of extant populations and reintroductions as described in the 1998 Recovery Plan should be completed. Management on public lands should include provisions for suitable levels of sheep and cattle grazing. Protection of colonies on private lands or those to be re-established on private lands could result from partnering with landowners or offering conservation easements. (USFWS, 2013)
- Regular yearly surveys utilizing a standardized methodology should be conducted over the next five years at the Santa Barbara Canyon area in the Cuyama Valley in Santa Barbara County, at the Carrizo Plain National Monument in San Luis Obispo County, and at the Kreyenhagen Hills in Fresno County so that the determination of what constitutes a sustainable population can be defined and environmental variables affecting abundance, such as precipitation and temperature, can be monitored. (USFWS, 2013)
- Successful re-establishment of populations will require an adequate understanding of the biology of the species and a robust seed collection. Studies should be conducted that advance the understanding of the species' propagation requirements, knowledge of the physical and chemical elements of the soil required for successful re-establishment, the presence and role of mutualistic soil fungi, the species and role of pollinators, genetics, and seed dispersal mechanisms. Seeds should be collected from each of the three sites and banked at an appropriate depository. (USFWS, 2013)
- Threats such as loss and degradation of habitat should be eliminated, reduced, or ameliorated. The potential for habitat degradation due to nitrogen deposition and threats to pollinators from regional pesticide use should be analyzed and appropriate measures to ameliorate these threats should be implemented. (USFWS, 2013)

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SPECIES ACCOUNT: *Ceanothus ferrisiae* (Coyote ceanothus)

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/03/1995; California/Nevada Region (R8) (USFWS, 2015)

Physical Description

An evergreen shrub, 1-2 m tall. Leaves are < 3.2 cm long, rounded, tapering towards the base. The leaves are opposite and round with a dark green, hairless upper surface and a lighter green undersurface with minute hairs (Schmidt 1993). Leaf margins have short teeth or sometimes lack teeth; the leaf base is abruptly tapering or rounded. Small white flowers are borne in clusters 1.3 to 2.5 centimeters (0.5 to 1.0 inch) in length (McMinn 1933; Schmidt 1993). (NatureServe, 2015; USFWS, 2011)

Taxonomy

USFWS and CAHP tracks as synonym 01 - *Ceanthous ferrisiae* (9/93). (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Ceanothus ferrisiae are known from only three locations: Anderson Dam, Kirby Canyon, and Llagas Avenue north of Morgan Hill. All the locations are within 6 kilometers (4 miles) of each other in Santa Clara County (USFWS, 1998)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 2011)

Lifespan

Adult: 20 to 50 years (USFWS, 2011)

Breeding Season

Adult: January to March (USFWS, 2011)

Key Resources Needed for Breeding

Adult: Possibly fire; require multiple, large populations within close proximity to allow genetic migration to occur via pollination (USFWS, 2011)

Reproduction Narrative

Adult: *Ceanothus ferrisiae* is a perennial, flowering from January to May (Munz and Keck 1959). *Ceanothus* reach reproductive maturity after 5- 6 years. Will hybridize with other species or sub-

species in situations where only one plant exists or there is genetic incompatibility with surrounding plants of the same species. (USFWS, 2011). The role of fire in the ecology of this plant remains unclear. Fire appears to destroy all mature and older plants, and stimulate regeneration from soil seed banks. *C. ferrisae* require multiple, large populations within close proximity to allow genetic migration to occur via pollination. The average lifespan for this species is estimated to range from 20 to 50 years (Keeley 1975; T. Parker, pers. comm., 2010; D. Wilken, pers. comm., 2010). (USFWS, 2011)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Barrens, Shrubland/chaparral (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Possibly fire (USFWS, 2011)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations < 300 m (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Colonial (USFWS, 2011)

Environmental Specificity

Adult: Narrow/specialist (inferred from USFWS, 2011)

Dependency on Other Individuals or Species for Habitat

Adult: Rare species associated with *Ceanothus ferrisae* include the federally listed bay checkerspot butterfly (*Euphydryas editha bayensis*), Santa Clara Valley dudleya (*Dudleya setchellii*), and most beautiful jewelflower (*Streptanthus albidus* ssp. *peramoenus*) (Evens and San 2004). It is also associated with bigberry manzanita (*Arctostaphylos glauca*), California coffee berry (*Rhamnus californica*), California sagebrush (*Artemisia californica*), common yarrow (*Achillea millefolium*), foothill pine (*Pinus sabiniana*), leather oak (*Quercus durata*), and toyon (*Heteromeles arbutifolia*) (Corelli 1991; Evens and San 2004). Fire appears to destroy all mature and older plants, and stimulate regeneration from soil seed banks. (USFWS, 2011)

Habitat Narrative

Adult: *Ceanothus ferrisae* grows on arid slopes in mixed serpentine chaparral, valley, and foothill serpentine bunchgrass grasslands below 300 meters (about 1,000 feet) (Munz and Keck 1959; Hickman 1993). *C. ferrisae* is found in colonies at the Llagas Road location (CNDDDB, 2010). Rare species associated with *C. ferrisae* include the federally listed bay checkerspot butterfly (*Euphydryas editha bayensis*), Santa Clara Valley dudleya (*Dudleya setchellii*), and most beautiful jewelflower (*Streptanthus albidus* ssp. *peramoenus*) (Evens and San 2004). It is also associated with bigberry manzanita (*Arctostaphylos glauca*), California coffee berry (*Rhamnus californica*), California sagebrush (*Artemisia californica*), common yarrow (*Achillea millefolium*), foothill pine (*Pinus sabiniana*), leather oak (*Quercus durata*), and toyon (*Heteromeles arbutifolia*) (Corelli 1991; Evens and San 2004). (USFWS, 2011)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Declining (USFWS, 2011)

Resiliency:

Very low (inferred from USFWS, 2011)

Representation:

Low (inferred from USFWS, 2011)

Redundancy:

Low (inferred from USFWS, 2011)

Number of Populations:

4 (USFWS, 2011)

Population Size:

>100,000 (USFWS, 2011)

Minimum Viable Population Size:

5000 (USFWS, 2011)

Adaptability:

Low (inferred from USFWS, 2011)

Population Narrative:

Two of the four existing occurrences of *Ceanothus ferrisiae* have population sizes greater than 2,000 individuals (3,600 and > 100,000, respectively). Information available to the Service suggests a minimum population size of 5,000 may be necessary to maintain 95 percent fitness for plants (Reed 2005). A genetic Allee effect may be occurring as a result of limited availability of genetically suitable pollen mates in small populations of plants, thereby decreasing reproductive rates and increasing the risk of extinction (Berec et al. 2006; Wagenius et al. 2007). The survival and recovery of existing *C. ferrisiae* populations may be threatened by limited genetic diversity as a result of small or declining population size, habitat loss and fragmentation, and geographic isolation that may limit insect-mediated gene flow. (USFWS, 2011)

Threats and Stressors

Stressor: Habitat destruction (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Destruction and modification of habitat, and development on recreational and private lands continues to be a threat for *Ceanothus ferrisiae*. Construction of a commercial landfill at Kirby Canyon beginning in 1986 (prior to the listing of *C. ferrisiae* in 1995) may have resulted in the undocumented loss of thousands plants, as evidenced by the decline of this population from 5,000 in 1987 to about 100 individuals observed in 1992 (Freas, pers. comm. 1993; LSA Associates 1992). The remaining population is currently threatened by altered fire regime and lack of recruitment. Proximity to the commercial landfill and urban development may limit or prevent the use of fire for regeneration. The Llagas Road population exists on private land that is nearly surrounded by residential development. Future development could result in increased encroachment upon existing habitat necessary for expansion of the Llagas Road population to meet recovery goals. The proximity of urban development may limit or prevent the use of fire to regenerate this population as well. (USFWS, 2011)

Stressor: Cattle grazing (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Cattle have been grazing on the property for many years and may be negatively affecting the habitat and limiting recruitment for the Llagas Road population. The unprotected portion of the property where cattle grazing is permitted is nearly denuded of native chaparral vegetation with large areas of exposed soil and serpentine rocks evident (F. Gardipee pers. obs., 2010; T. Willsey, pers. obs., 2010; J. Hillman, pers. obs., 2010). The cattle have gained access into the existing conservation easement through broken fencing thereby allowing them to browse on inflorescences of young *C. ferrisiae* plants before seed production can occur (F. Gardipee pers. obs., 2010; T. Willsey, pers. obs., 2010; J. Hillman, pers. obs., 2010). Heavy browsing by cattle and wild ungulates was observed among young, reproductive-age, plants during the fall 2010 survey at all sites (F. Gardipee pers. obs., 2010; T. Willsey, pers. obs., 2010; J. Hillman pers. comm., 2010). (USFWS, 2011)

Stressor: Dam activities (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The population located at Anderson Dam is threatened by loss and modification of habitat as a result of activities associated with the dam, actions to protect against damage from potential seismic activity, and un-regulated land management practices. Anderson Dam was constructed upon unstable materials and is positioned on a seismically active fault line (SCVHP 2010). (USFWS, 2011)

Stressor: Predation (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Several insect species have been noted to infest *Ceanothus* species in California and predation in the form of herbivory by native ungulates and seed consumption by small mammals, insects, and birds is common (Deveny and Fox 2006). The western tent caterpillar (*Malacosoma californicum*) is known to construct large web-like tents on the branches of *Ceanothus* species (USDA 2006). Larvae feed on the leaves within the tent, often defoliating entire branches (USDA

2006). The western tussock moth (*Orgyia vetusta*) has been reported on *Ceanothus* species (USDA 2006). Large masses of cocoons may be observed on branches in late spring. Western tussock moth larvae feed on leaves and young growth, sometimes causing substantial defoliation and branch dieback. The western sycamore borer (*Synanthedon resplendens*) may attack *Ceanothus* species (USDA 2006). Adults emerge in May through early August and lay eggs within cracks, depressions, and injured tissues in the bark of old or slow-growing plants (USDA 2006). After hatching, larvae tunnel into the inner bark, creating winding tunnels that extend over 100 square centimeters (about 15.5 square inches). The amount of Herbivory may retard plant growth, destroy plants, and often reduces seed production (Boyd 2003; Deveny and Fox 2006). Black-tailed deer (*Odocoileus hemionus columbianus*) are primary browsers of *C. ferrisiae* (Deveny and Fox 2006). Herds of black-tailed deer make their home in the Anderson Dam area. Evidence of browsing on fresh shoots, inflorescences, and leaves of young *C. ferrisiae* plants was observed among all populations surveyed in mid-July and fall 2010 (F. Gardipee, pers. obs., 2010; T. Willsey, pers. obs., 2010; J. Hillman, pers. obs., 2010). Damage caused by western sycamore borers is generally considered to be insignificant (USDA 2006). (USFWS, 2011)

Stressor: Genetic Allee effect (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: A genetic Allee effect may occur as a result of limited availability of genetically suitable pollen mates in small populations of plants, thereby decreasing reproductive rates and increasing the risk of extinction (Berec et al. 2006; Wagenius et al. 2007). Habitat loss and fragmentation, small population size, and genetic isolation may increase the risk of a genetic Allee effect for self-incompatible species, such as *Ceanothus ferrisiae*, and ultimately result in a subsequent loss of long-term population viability (Willi et al. 2005; Berec et al. 2006; Leimu et al. 2006; Honnay and Jacquemyn 2007; Wagenius et al. 2007; Pickup and Young 2008). The subdivision of this population has resulted in possible isolation and reduced connectivity, thus increasing the risk of genetic Allee effects and decreased population viability. (USFWS, 2011)

Stressor: Fire management (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The proximity of *Ceanothus ferrisiae* to residential development may preclude or limit the use of fire that may be necessary for stand regeneration. Further research regarding the role of fire for *C. ferrisiae* is warranted to insure effective use of this management tool can be applied to benefit the long-term conservation of this species. (USFWS, 2011)

Stressor: Global climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, altered fire regimes, and increased summer continental drying (Field et al. 1999; Cayan et al. 2005; IPCC 2007). However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain.

However, climate change may exacerbate the effects of altered fire regimes on population viability of *Ceanothus* species endemic to California (Lawson et al. 2010). (USFWS, 2011)

Recovery

Reclassification Criteria:

1. Protection and management of the four known occurrences of *Ceanothus ferrisiae* by working with Santa Clara County, the SCVWD, and private landowners to ensure long-term survival of the species on their lands. (USFWS, 2011)
2. Survey of other potential serpentine habitats to identify potential habitat. (USFWS, 2011)
3. Seed collection and research. Collection and banking of seed in Center for Plant Conservation certified botanic gardens is prudent to guard against extinction of the species from catastrophic events and to provide potential material for enhancement efforts in existing populations, repatriations, and/or introductions to new sites. All known populations should be represented in seed collections. Care should be taken to ensure that seed collection does not adversely affect the donor populations. (USFWS, 2011)
4. Research on demography, fire ecology, and effects of grazing. Important research questions include how grazing impacts the reproduction, recruitment, and survival of the species, and why so little recruitment is observed in natural populations. (USFWS, 2011)
5. Establishment of new populations to meet recovery goal of eight populations representing the entire historic range. *Ceanothus ferrisiae* should not be considered for delisting unless eight populations, consisting of at least, 2,000 individuals, within its historic range and representing its entire historic range. (USFWS, 2011)

Delisting Criteria:

Delisting criteria are not available.

Recovery Actions:

- Recovery actions are not available.

Conservation Measures and Best Management Practices:

- Habitat conservation to support the survival and recovery of *Ceanothus ferrisiae* should be accomplished through land acquisition and establishment of conservation easements where possible. Protection of *C. ferrisiae* populations on private lands through additional conservation easements and land purchases, and restoration of additional populations within the historic range should be prioritized to minimize the likelihood of extinction. (USFWS, 2011)
- Research that will inform management decisions, conservation planning, and restoration efforts for *Ceanothus ferrisiae* should be conducted. (USFWS, 2011)
- Establishment of additional *Ceanothus ferrisiae* populations where appropriate serpentine chaparral habitat has been identified in the proposed SCVHP. Restoration efforts should target habitat sites that can support a minimum population of at least 5,000 individuals. (USFWS, 2011)
- Enhancement and regeneration of existing populations of *Ceanothus ferrisiae* to achieve minimum populations of 5,000 plants through various strategies. For example, implementation of an optimal fire regime (determined through research) to stimulate seedling production from the soil seed bank

may prove to be a successful strategy to increase small population sizes. Fire applied to small areas over several years may yield large, sustainable populations, consisting of a mosaic of age classes and genotypes, which may be less vulnerable to stochastic events and senescence. Translocation efforts may prove successful as well. (USFWS, 2011)

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SPECIES ACCOUNT: *Ceanothus ophiochilus* (Vail Lake ceanothus)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/13/1998; California/Nevada Region (R8) (USFWS, 2015)

Physical Description

A rounded shrub, usually 1.2-1.5 m (4-5 feet) tall. The flat, dull green leaves are opposite, with knob-like stipules, narrowly oblanceolate (broadest above the middle and tapering toward the base) to obovate (eggshaped) in shape, glabrous (smooth), with obscure veins and blades 3 to 7 mm long and 1 to 3 mm wide; fruits are 3 to 3.5 mm wide, and without horns (Wilken 2012, p. 1158). Flowers are pale blue, occasionally pink, in bloom from mid-February to March. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Ceanothus ophiochilus is a narrow, edaphic endemic plant found only within 20 acres in Southwestern Riverside County, California (Fish and Wildlife Service 1998). (NatureServe, 2015)

Critical Habitat Designated

Yes; 9/27/2007.

Legal Description

On September 27, 2007, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Ceanothus ophiochilus* (Vail Lake ceanothus) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in California (72 FR 54984-55010).

Critical Habitat Designation

The critical habitat designation for *Ceanothus ophiochilus* includes one CHU (2 sub-units) in Riverside County, California. This species critical habitat encompasses approximately 283 acres (ac) (115 hectares (ha)) (72 FR 54984-55010).

Unit 1: Western Riverside County Unit 1 is located near Vail Lake in southern Riverside County, California. The area was occupied at the time of listing and contains all of the primary constituent elements essential to the conservation of the species that may require special management considerations or protection for *Ceanothus ophiochilus*. Below, we present a brief description of subunit 1B, reasons why it meets the definition of critical habitat for *C. ophiochilus*, and our rationale for our final designation of critical habitat. Subunit 1B, Agua Tibia Mountains, Riverside County, California Subunit 1B (Agua Tibia Mountains) consists of 203 ac (82 ha) of land which is managed by the USFS. Subunit 1B contains two of the three CNDDDB element occurrences (2 and 3) of *Ceanothus ophiochilus*, both known at the time of listing. The PCEs within this subunit may require special management considerations or protection to address the threats posed by short-interval fires, competing nonnative species, impacts to ridge tops (PCE 1) from grading associated with the creation of fuel breaks and impacts to the associated vegetation community (PCE 3) resulting from unnatural fire regimes. Subunit 1B is entirely within the Agua Tibia Wilderness of

the Cleveland National Forest. Recently the USFS completed the LMP for the Four Southern California National Forests. Implementation of the LMP was analyzed by the Service to address potential impacts to *Ceanothus ophiochilus*. This analysis found that impacts to *C. ophiochilus* would be minor or negligible upon implementation of appropriate minimization measures due to the low impact nature of activities planned (e.g., dispersed recreation, non-motorized trails) (Service 2005 p. 129–132). However, the LMP does not identify specific management measures to address the threat posed by short interval fires and by competing nonnative species (Keeley 2006, p. 367; Merriam et al. 2007, p. vi, v, 48, 61). Because the USFS does not have a management plan specific to *C. ophiochilus* that provides the same or better level of protection from adverse modification or destruction than that provided through a consultation under section 7 of the Act, we have determined that exclusion of these lands from the final designation of critical habitat pursuant to section 4(b)(2) of the Act is not appropriate for these Federal lands (please see “Exclusions under Section 4(b)(2) of the Act” for a detailed discussion). Therefore, we are designating the USFS lands containing features essential to the conservation of *C. ophiochilus* as critical habitat for this species.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Ceanothus ophiochilus* critical habitat consists of three components (72 FR 54984-55010):

- (i) Flat to gently sloping north to northeast facing ridge tops with slopes in the range of 0 to 40 percent slope that provide the appropriate solar exposure for seedling establishment and growth.
- (ii) Soils formed from metavolcanic and ultra-basic parent materials and deeply weathered gabbro or pyroxenitic outcrops that provide nutrients and space for growth and reproduction. Specifically in the areas that *Ceanothus ophiochilus* is found, the soils are: (A) Ramona, Cienaba, Las Posas, and Vista series in the Agua Tibia Wilderness; and (B) Cajalco series in the vicinity of Vail Lake.
- (iii) Chamise chaparral or mixed chamise-ceanothus-arctostaphylos chaparral at elevations of 2,000 feet to 3,000 feet (610 meters to 914 meters) that provide the appropriate canopy cover and elevation requirements for growth and reproduction.

Special Management Considerations or Protections

As stated in the final listing rule, threats to *Ceanothus ophiochilus* include habitat destruction, alteration, fragmentation, and degradation from urban development, as well as hybridization and fire at too frequent intervals to allow for sufficient seed bank replenishment in the soil (63 FR 54956, October 13, 1998). Threats to *Fremontodendron mexicanum* as cited in the final listing rule include altered fire regimes, indirect impacts from nearby urbanization, and increased competition from nonnative species (63 FR 54965, October 13, 1998). These threats could impact the PCEs determined to be essential for conservation of *C. ophiochilus* and *F. mexicanum*. Urban development near *Ceanothus ophiochilus* critical habitat units may alter the habitat characteristics required by the species. Land grading in and around occurrences of *C. ophiochilus* may affect the topography of the habitat and change the soil composition (PCEs 1 and 2) rendering the habitat unsuitable for species growth and reproduction. Urban development may also encourage invasion by nonnative plant species, changing the vegetation community and/or

directly impacting the vegetation community (PCE 3). In addition, urban development near this species may increase the frequency of fire. All identified private land is covered by the Western Riverside County MSHCP (MSHCP), and those lands have been excluded from the final designation (see “Relationship of Critical Habitat to Habitat Conservation Plan Lands—Exclusions Under Section 4(b)(2) of the Act” section for a detailed discussion). No urban development is expected to directly impact the occurrences of *C. ophiochilus* on land owned by the USFS. Therefore, we do not believe threats from urban development would require special management considerations or protection of the PCEs on designated critical habitat for this species. The management of both fire frequency and the placement of fuel breaks is important for the conservation of *Ceanothus ophiochilus*, and special management considerations or protection of the PCEs for *C. ophiochilus* may be required on USFS lands to address potential threats posed by fire management activities. In the past, fuel breaks have been placed on the ridgelines (PCE 1) in *C. ophiochilus* habitat and have caused soil disturbance (PCE 2). Studies of fuel breaks in the Cleveland National Forest near the critical habitat designation have demonstrated an increase in the density of competing nonnative species (Merriam et al. 2007, p. 48), and it has been hypothesized that fuel breaks promote the introduction and spread of nonnative plants (Merriam et al. 2007, p. vi). These nonnative invasive plants alter local fuel conditions and change fire behavior and frequency (Merriam et al. 2007, p. 61). *Ceanothus ophiochilus* is very sensitive to short-interval fires, which may extirpate the species from a site entirely (Keeley 2006, p. 367). Soil disturbance, caused by the creation of fuel breaks, has also led to increased hybridization between *Ceanothus ophiochilus* and *C. crassifolius*. However, the degree to which hybridization is impacting *C. ophiochilus* and its habitat is not yet known.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (hybridization) (USFWS, 2013)

Breeding Season

Adult: Mid-February to March (NatureServe, 2015)

Key Resources Needed for Breeding

Adult: Fire (USFWS, 2013)

Reproduction Narrative

Adult: Flowers are pale blue, occasionally pink, in bloom from mid-February to March (NatureServe, 2015). Hybridization is common among *Ceanothus* species (Wilken 2012, p. 1153; Fross and Wilken 2006, pp. 132–133). *Ceanothus ophiochilus* generally requires a fire return interval between 10 to 20 years to adequately replenish the seed bank (Keeley and Davis 2007, p. 350). *Ceanothus ophiochilus* is an obligate seeder and therefore does not resprout following fire, but instead recovers through the germination of seeds stored in the soil (Boyd and Banks 1995, p. 28; Keeley 2006, p. 367). (USFWS, 2013)

Habitat Type

Adult: Terrestrial (NatureServe, 2013)

Habitat Vegetation or Surface Water Classification

Adult: Shrubland/chaparral

Dependencies on Specific Environmental Elements

Adult: Fire (USFWS, 2013)

Spatial Arrangements of the Population

Adult: Isolated patches (USFWS, 2013)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Habitat Narrative

Adult: *Ceanothus ophiochilus* is restricted to isolated patches of gabbro and pyroxenite-rich outcrops (Vail Lake), or within a mix of gabbro and sedimentary deposits (Agua Tibia Wilderness) (Boyd and Banks 1995, p. 15). It is generally found within chamise chaparral habitats on ridge tops and north- to northeast-facing slopes (USFWS, 2013). *Ceanothus ophiochilus* generally requires a firereturn interval between 10 to 20 years to adequately replenish the seed bank (Keeley and Davis 2007, p. 350). (USFWS, 2013)

Dispersal/Migration**Motility/Mobility**

Adult: Low (USFWS, 2013)

Dispersal/Migration Narrative

Adult: Many plant species with refractory seeds (i.e., seeds that need a fire-related stimulus, alone or in conjunction with other conditions; Keeley 1991, p. 87) have propagules that are not specialized for widespread dispersal and therefore have a relatively short dispersal distance (Keeley 1991, p. 105). *Ceanothus* plants have capsules that eject seeds and studies on two Sierra Nevada *Ceanothus* species, *C. cuneatus* and *C. leucodermis*, found that most seeds fall beneath the canopy vegetation (Evans et al. 1987, p. 288); even on open sites, few seeds (less than 2 percent) reached a distance of 29.5 ft (9 m) (Evans et al., 1987, pp. 288–289). (USFWS, 2013)

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Low (USFWS, 2013)

Representation:

Low (inferred from USFWS, 2013)

Redundancy:

Low (inferred from USFWS, 2013)

Number of Populations:

3 (USFWS, 2013)

Population Size:

~10,000

Population Narrative:

One population consists of about 3,000-5,000 individuals and occupies about 8 hectares; the remaining two populations comprise over 4,000 individuals in a 12 hectare area (Fish and Wildlife Service 1998). Known from only three occurrences near Vail Lake, California (Skinner 1997). (NatureServe, 2015).

Threats and Stressors

Stressor: Urban development (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: At the time of listing, the Service indicated that much of southwestern Riverside County was expected to become more urbanized based on development trends and planned developments on private lands in the Vail Lake area (USFWS 1998, p. 54961). In the 2008 5-year review, the Service reevaluated the proposed developments for this area and stated that the most recently proposed, large-scale development (Specific Plan No. 324) for this area had not been acted upon and the project was inactive (USFWS 2008, p. 8). However, the Service concluded that urban development in the Vail Lake area remained a significant threat to the Vail Lake occurrence of *Ceanothus ophiochilus* since no assurances of the conservation of this species have been made (USFWS 2008, p. 8). In summary, the Service believes that urban development represents a potential threat to *Ceanothus ophiochilus* at two of the three occurrences. (USFWS, 2013)

Stressor: Recreational activities (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Dispersed recreation (e.g., camping, hiking, mountain bike activity) is an occasional, ongoing use at the Agua Tibia Wilderness occurrences (USFS 2012b, p.41). The use of existing trails or the creation of new trails within the Agua Tibia Wilderness occurrences located on CNF lands represents a potential threat to *Ceanothus ophiochilus* primarily from soil compaction of habitat, although trampling of individual plants may also result from these activities. However, no designated USFS trails currently intersect with habitat occupied by *C. ophiochilus* (USFS 2012b, p. 41) and the recreational use, although allowed in or near the two Agua Tibia Wilderness occurrences within CNF by the public, is limited because access is controlled by adjacent private lands (USFS 2012b, pp. 40–41). (USFWS, 2013)

Stressor: Invasive non-native plants (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Invasive nonnative plants have been identified by the USFS as a threat to habitat quality for *Ceanothus ophiochilus*, particularly in those areas within the Agua Tibia Wilderness occurrences where recent wildland fire has exposed bare soils and created unclassified trails as a result of fire suppression activities (USFS 2005a, p. 259). Roads and road construction from grading of fuel breaks facilitate the introduction and establishment of invasive nonnative plants (discussed above) by creating open, continually disturbed habitat. Invasive nonnative plants can also be transported along these corridors by equipment and other vehicles, as well as recreational uses, and can become more readily established on exposed cut-and-fill slopes of roads than native plants (USFS 2005e, Volume 1, p. 114). Activities conducted by the USFS associated with the removal of invasive plants may have short-term adverse effects to *Ceanothus ophiochilus*. (USFWS, 2013)

Stressor: Wildland fire and fire Management (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: In the USFWS listing rule, the Service identified the change in fire cycle regimes (or fire frequency) as a threat to *Ceanothus ophiochilus* and other plants adapted to specific fire frequencies (USFWS 1998, p. 54964). Changes occurred from increased incidence of local accidental fires and less frequent natural fires resulting from human activity in fire prone areas (e.g., Vail Lake occurrence). The Service also highlighted fire management practices including grading of *C. ophiochilus* habitat for fire or implementation of fuel breaks as an important threat to this species for all three occurrences (Boyd 1991, pp. 2, 8; Boyd and Banks 1995, p. 16; USFWS 1998, p. 54961). Fire management and suppression activities including fire line construction, fire retardant and water drops, establishment of temporary fire camps, staging areas, parking sites, safety zones, helipads, and post-fire rehabilitation can affect *Ceanothus ophiochilus* habitat (USFWS 2005, p. 27). (USFWS, 2013)

Stressor: Hybridization and introgression (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: The Service identified hybridization and genetic introgression with *C. crassifolius* as a major threat to *C. ophiochilus* where the two species co-occur in our 2008 5-year review (USFWS 2008, p. 14). Without genetic evaluations and comprehensive surveys within the three occurrences, it is difficult to assess the nature and extent of hybrid individuals; thus, it is unclear if hybridization or introgression represents a current threat to *C. ophiochilus* at this time. Continued monitoring of disturbance to all three occurrences is needed in conjunction with additional genetic viability studies to better evaluate these two related threats to *C. ophiochilus*. (USFWS, 2013)

Stressor: Climate change (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Based on the best available information contained in model predictions for this general region of California, a change in temperature conditions resulting from climate change is considered a rangewide threat to *Ceanothus ophiochilus* due to predicted changes to its habitat.

Climate model predications also indicate a slight increase in fire risk to the geographical range of *C. ophiophilus*, which, when combined with anthropogenic facilitation, can produce a shortening of the fire return interval and affect its ability to recover and maintain its viability in the chaparral ecosystem. (USFWS, 2013)

Recovery

Reclassification Criteria:

Reclassification criteria are not available.

Delisting Criteria:

Delisting criteria are not available.

Recovery Actions:

- Recovery actions are not available.

Conservation Measures and Best Management Practices:

- Continue to work with the CNF to ensure that USFS guidelines and directives are being implemented for activities that might directly or indirectly impact *Ceanothus ophiophilus* habitat. This should include providing comment on biological assessments for proposed fire suppression activities and assistance in designing fuel breaks to protect populations of *C. ophiophilus*. (USFWS, 2013)
- Conserve or preserve *Ceanothus ophiophilus* occurrences on private lands, especially at Vail Lake. Pursue opportunities to purchase parcels through the Act's section 6 funding and other conservation partnership programs (i.e., Western Riverside County MSHCP) with willing sellers. (USFWS, 2013)
- Develop outreach or educational activities with the primary landowner adjacent to the Agua Tibia Wilderness–North occurrence to enlist their assistance in ensuring the survival and recovery of *Ceanothus ophiophilus*. (USFWS, 2013)
- Develop a monitoring plan for populations of *Ceanothus ophiophilus*, the quality of chamise chaparral habitats, and threats at the three *C. ophiophilus* occurrences. This monitoring plan should include surveys to detect abundance, habitat conditions, and potential threats to the taxon, particularly those related to the effects of fire and fire management activities. (USFWS, 2013)
- Determine the current level and pattern, extent, and impact of introgression of *Ceanothus ophiophilus* with *C. crassifolius* at all three occurrences. (USFWS, 2013)

References

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USFWS. 2013. *Ceanothus ophiochilus* (Vail Lake Ceanothus) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Carlsbad Fish and Wildlife Office, Carlsbad, California.

SPECIES ACCOUNT: *Ceanothus roderickii* (Pine Hill ceanothus)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/18/1996; California/Nevada Region (R8)

Physical Description

A prostrate evergreen shrub of the buckthorn family (Rhamnaceae) that generally grows to 3 meters (9.8 feet) in diameter. The smooth gray-brown branches radiate from a central axis and root when they come into contact with the ground. Its leaves are semi-erect with entire (smooth-edged) margins. Small whitish flowers tinged with blue appear from May through June. Its fruit is an inconspicuously horned, globe-shaped capsule. *Ceanothus roderickii* can be differentiated from its congeners (other species of the same genus, other related species) by a combination of its blue-tinged flowers, prostrate habit, and inconspicuously horned fruit. (USFWS, 2002)

Taxonomy

Walter Knight (1968) described *Ceanothus roderickii* as *Ceanothus rodericki*, naming it after Wayne Roderick, who first recognized the horticultural value of this endemic shrub. Due to an orthographic change, the correct spelling is *Ceanothus roderickii*. Knight (1968) considered *C. roderickii* to be most closely related to *C. cuneatus* (buckbrush), which also grows throughout the area. *Ceanothus roderickii* is suggested to resemble the sprawling *C. fresnensis* (Fresno mat), which grows a considerable distance to the south at higher elevations; plants of the two species grown in a regional park flowered at different times (Knight 1968). (USFWS, 2002)

Historical Range

Endemic to western El Dorado County, California. (USFWS, 2002)

Current Range

On the Pine Hill formation in western El Dorado County, California.(USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Dependency on Other Individuals or Species

Adult: The pollination of *Ceanothus roderickii* is primarily by insects from the orders Diptera (flies and gnats) and Hymenoptera (bees and wasps). (USFWS, 2002)

Breeding Season

Adult: May to June (USFWS, 2002)

Key Resources Needed for Breeding

Adult: Fire/heat (USFWS, 2002)

Reproduction Narrative

Adult: Flower/fruit development in this species is negatively affected by canopy shading (James 1996). Unlike most chaparral shrub species, Pine Hill ceanothus will not resprout from a caudex (woody axis comprising the stem and root) after a fire, and therefore, depends on nearby plants connected via branch layering for survival or the seedbank for re-establishment (Boyd 2007). There is reason to believe that seeds can survive at least 80 years in the seedbank (Ayres 2011; Boyd 2007). Hot/cold stratification, but not necessarily fire (Boyd 2007), seems to be required for germination (James 1996; Boyd 2007). Because juvenile plants do not begin flowering until 5-6 years after fire, populations need a fire-free period of at least six years to replenish the seed bank (Marsh and Ayres 2002; Ayres 2011), otherwise populations may be permanently lost. (USFWS, 2019)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Barrens, Shrubland/chaparral (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Combination of heat and cold (USFWS, 2002)

Geographic or Habitat Restraints or Barriers

Adult: Shading limits flower production (USFWS, 2002)

Spatial Arrangements of the Population

Adult: Scattered (USFWS, 2002)

Habitat Narrative

Adult: Ceanothus roderickii is found in openings in chaparral communities on gabbro- or serpentinite- derived soils (NatureServe, 2015). Most occurrences are discontinuously scattered within two population centers in the northern and southern portions of the Pine Hill formation. The seeds treated with a combination of heat and cold have the best germination rate. Canopy shading was shown to negatively affect flower and fruit production in C. roderickii. (USFWS, 2002)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Unknown (USFWS, 2019)

Number of Populations:

2 known extant ; 7 presumed extant (USFWS, 2019)

Population Size:

Greater than 55,000 individuals (USFWS, 2019)

Population Narrative:

It is restricted to one localized area of approximately 10 occurrences discontinuously scattered in the Pine Hill formation in the north, central, and south areas (USFWS, 2019)

Threats and Stressors

Stressor: Habitat loss (USFWS, 2002)

Exposure:

Response:

Consequence:

Narrative: Proposed residential or commercial development within the Pine Hill formation threatens most of the remaining sites within the Pine Hill formation and adjacent serpentine in western El Dorado County, and either directly or indirectly will adversely affect most of the range. (USFWS, 2002)

Stressor: Habitat fragmentation (USFWS, 2002)

Exposure:

Response:

Consequence:

Narrative: The subsequent induced growth from water acquisitions would affect all six species on the Pine Hill formation and adjacent serpentine, either by further fragmenting the habitat or by directly destroying habitat. Habitat fragmentation and edge effects significantly affect gabbro plants. Habitat fragments are more susceptible to being burned in their entirety, with shorter than natural intervals between fires, relative to larger tracts of habitat. If an entire preserve burns more often than the natural fire frequency, the seed bank of certain chaparral shrub species may not be adequate to replace the population. Fragmentation splits habitat into smaller, more isolated units and has two primary effects. First, habitat fragmentation may alter the physical environment, changing the amount of incoming solar radiation, water, wind, or nutrients for the remnant vegetation (Saunders et al. 1991). Second, most of these fragmented natural areas are subject to influences from external factors (e.g., additional development, lawn and garden watering, herbicide drift, and off-road vehicular use) that disrupt natural ecosystem processes. (USFWS, 2002)

Stressor: Fire management (USFWS, 2002)

Exposure:

Response:

Consequence:

Narrative: Changes in fire frequency threaten *Ceanothus roderickii*. *C. roderickii* occur within a fire-adapted plant community, either within chaparral or on the ecotone between chaparral and woodland. Before the advent of fire suppression policies, chaparral stands may have burned at a frequency of roughly 3 to 5 times per 100 years (Boyd 1985). Longer than normal fire frequencies lead to the loss of some plant species from the chaparral plant community. (USFWS, 2002)

Stressor: Hydrologic changes (USFWS, 2002)

Exposure:

Response:**Consequence:**

Narrative: El Dorado Irrigation District, is attempting to get additional water from the South Fork of the American River through purchase of PG&E's Hydroelectric Project 184 and a storage contract with the Bureau of Reclamation utilizing Folsom Reservoir. This water is most likely to be used for developments in the extreme western part of El Dorado County, where the gabbro soil plants are found (A. Howard in litt. 1999). (USFWS, 2002)

Stressor: Development (USFWS, 2002)

Exposure:**Response:****Consequence:**

Narrative: Mitigation for development often is by small "set asides" (small natural areas within the development), which increase habitat fragmentation, are difficult to manage for fire, and are subject to edge effect problems. Land development and multiple ownership complicate the planning and implementation of controlled burns at the appropriate fire frequency necessary for maintenance of chaparral. (USFWS, 2002)

Stressor: Road widening and maintenance (USFWS, 2002)

Exposure:**Response:****Consequence:**

Narrative: Road widening occurs near development within El Dorado County threatens the habitat of *Ceanothus roderickii* at one site (California Natural Diversity Data Base 1994). (USFWS, 2002)

Stressor: Recreation (USFWS, 2002)

Exposure:**Response:****Consequence:**

Narrative: Off-road vehicle use has adversely affected the habitat of *Ceanothus roderickii* at three sites in the northern part of the Pine Hill formation. Several hills are scarred with off-road vehicle tracks. Erosion promoted by scarring adversely modifies the habitat. (USFWS, 2002)

Stressor: Invasive plants (USFWS, 2019)

Exposure:**Response:****Consequence:**

Narrative: Invasive plants continue to present a minor threat to gabbro plant species. Populations within the Pine Hill Preserve are not significantly threatened by invasive plants and any small infestations identified are largely reduced or eliminated by mechanical means (BLM 2008). (USFWS, 2019)

Recovery**Reclassification Criteria:**

1. Secure and protect specified recovery areas from incompatible uses: (a) Cameron Park preserve north of Highway 50; (b) Cameron Park preserve south of Highway 50; (c) Pine Hill

preserve; Salmon Falls/Martel Creek preserve; (d) sufficient adjacent unoccupied habitat for fire management and a 150- meter (500-foot) buffer. (USFWS, 2002)

2. Management plan approved and implemented for recovery areas, including survival and recovery of the species as the objective: For preserves and any adjacent occupied or unoccupied habitat identified as necessary for continued survival and recovery (USFWS, 2002).

3. Monitoring in all recommended preserves shows: (a) populations stable or increasing over one fire cycle (about 30 years), (b) habitat monitoring of recommended preserves shows a mosaic of multiage class stands and habitat fragmentation has not appreciably increased (less than 5 percent) within any preserves over current (2000) conditions, (c) spatially and temporally, the establishment of occurrences must be greater than the extirpation of occurrences. (USFWS, 2002)

4. Other actions: (a) Ameliorate or eliminate threats; (b) Fire management studies; (c) Research on propagation techniques if repatriation, enhancement, or restoration are determined to be necessary; (d) Maintain metapopulation dynamics of at least 2 very large, 2 large, 6 medium, and 7 small occurrences throughout the range of the species. (USFWS, 2002)

Delisting Criteria:

1. Management plan approved and implemented for recovery areas, including survival and recovery of the species as the objective: For all occurrences and any adjacent areas identified as necessary for continued survival and recovery. (USFWS, 2002)

2. Monitoring in all recommended preserves shows: (a) no decline after downlisting during two additional fire cycles (about 60 years); if declining, determine cause and reverse trend, (b) habitat monitoring of recommended preserves shows a mosaic of multiage class stands and habitat fragmentation has not appreciably increased (less than 5 percent) within any preserves over current (2000) conditions, (c) spatially and temporally, the establishment of occurrences must be at least 10 percent greater than the extirpation of occurrences. (USFWS, 2002)

3. Ameliorate or eliminate threats; research on propagation techniques if repatriation, enhancement, or restoration are determined to be necessary. (USFWS, 2002)

Recovery Actions:

- 1. Develop and implement a cooperative program and participation plan. A cooperative program is needed to coordinate local public and private land use planning with State and Federal land use and recovery planning for gabbro species. A cooperative program needs to be developed focusing on western El Dorado County. A participation plan produced from this program will increase the chances of recovery for listed species. (USFWS, 2002)
- 2. Protect and secure existing populations. Natural lands that contain this species need to be protected in perpetuity. Protection of these lands includes identification and minimization of threats in perpetuity and application of appropriate and adaptive management (see Task 3) to ensure species survival and recovery. Natural lands that need protection can be categorized into two types: (1) blocks of land that contain occupied or potential habitat for two or more this species and (2) blocks of land that contain occupied or potential habitat for one this species. All potential preserve areas should be evaluated based on current mapping

information and ground-truthed prior to purchase to confirm their value for recovery. (USFWS, 2002)

- 3. Manage Habitat Managing habitat is essential to the recovery of the listed species. Habitat management includes preparation and implementation of management plans for all areas inhabited by special status species being proposed for preservation, and periodic monitoring of populations in each of these areas. Within western El Dorado County, a multi-constituent committee should be formed to oversee the management of preserves located on the Pine Hill formation. The preserve management committee should include, at a minimum, representatives from the California Department of Fish and Game, U.S. Fish and Wildlife Service, Bureau of Land Management, El Dorado County, California Department of Forestry and Fire Protection, California Native Plant Society, American River Conservancy, and a private landowner representative. (USFWS, 2002)
- 4. Survey historical locations and other potential habitat where this species may occur. Recovery of listed species may often require relocating historic populations or locating new populations of these species. Historical locations should be surveyed to determine whether suitable habitat remains, the species persists at the sites, and/or the sites may be suitable for repatriation. Suitability of historical locations for repatriation would depend upon: (1) whether potential habitat exists, (2) the presence and magnitude of threats, and (3) whether the sites can be secured and managed for the long-term protection of the species. Surveys should also include other potential gabbro or serpentine habitat to determine whether undiscovered populations may exist. If new populations are discovered, they need to be protected and managed as discussed above. During the surveys, potential introduction sites should also be identified. (USFWS, 2002)
- 5. Conduct necessary biological research and use results to guide recovery/conservation efforts. - Develop propagation techniques for listed plant species for which enhancement, repatriation, or introductions would be appropriate. Geographic area research is outlined in the Recovery Plan. Species-specific research is described as follows: Reproduction and Demography Research: Including determining limiting life stages, seed production, and survival in soil to determine appropriate fire return period. Systematics research and genetic studies if repatriation is determined to be necessary. Other Research Needs: Propagation techniques; fire management techniques; metapopulation analysis; determine efficacy of other types of disturbance regimes for species and habitat management; feasibility of habitat restoration/ enhancement. Management Actions Needed: Burning; general surveys; baseline monitoring; monitoring for trends of populations, success of management actions, and threats at all populations identified for protection; monitoring for habitat fragmentation, major shifts in vegetation type, and tracking of occurrence establishment, and extirpation. (USFWS, 2002)
- 6. Undertake artificial enhancement, repatriation, or introduction efforts where necessary. Where it is deemed necessary, artificial enhancement, repatriation, or introduction efforts for sensitive plants should be undertaken. Prior to repatriation or introduction of sensitive plants, genetics studies are needed (see Task 5) to ensure that new populations will not disrupt unique local gene complexes. Plant repatriation or introduction efforts should be undertaken using collected seeds or plant propagules. (USFWS, 2002)
- 7. Determine possible prescribed burning management strategies and incorporate the strategies into the management plans (Priority 1). Possible prescribed burning management strategies need to be evaluated, peer reviewed, and incorporated into management plans. (USFWS, 2002)

- 8. Perform metapopulation-type analyses for this species (Priority 2). The results of a metapopulation-type analysis may be useful in clarifying uncertainties, data needs, and research, management priorities, and delisting criteria. Metapopulation-type analyses should be based on the results of monitoring and research. (USFWS, 2002)

Conservation Measures and Best Management Practices:

- Dedicate more resources toward the investigation of best management approaches for the Pine Hill listed plant species, even at the cost of a temporary hiatus in land acquisition efforts. Investigation should be made into fire-related and non-fire related methods of disturbance to maintain listed plant species habitat. (USFWS, 2019)
- Once the best management strategy (in terms of technique, frequency, timing, and intensity) is determined at each site, implement these management practices to achieve and maintain a habitat mosaic that enables the attainment of recovery criteria for the species. (USFWS, 2019)

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SPECIES ACCOUNT: *Centaurium (= Zeltnera) namophilum* (Spring-loving centaury (= *Zeltnera namophila*))

Species Taxonomic and Listing Information

Listing Status: Threatened; 05/20/1985; California/Nevada Region (R8) (USFWS, 2015)

Physical Description

The species is an upright, annual herb that grows 17.5 in (45 cm) tall with many flowering branches bearing many flowers measuring approximately 0.3 to 0.5 in (7 to 12 mm) in diameter (Reveal, Broome and Beatley 1973). Flowers are deep rose-pink with a yellowish throat and five dark purple spots below where adjacent petals attach to the body of the flower (Reveal, Broome and Beatley 1973). (USFWS, 2009)

Taxonomy

As treated here (following Kartesz, 1994 checklist and 1999 Floristic Synthesis), *Centaurium exaltatum* and *C. namophilum* are considered distinct species. An alternative treatment maintains *C. namophilum* with two varieties (vars. *namophilum* and *nevadense*). According to Kartesz (pers. comm. to Larry Morse, 25Nov99), there are three significant references for this group: C. R. Broome's 1973 Ph.D. dissertation (Systematics of *Centaurium* (Gentianaceae) in Mexico and Central America, Duke Univ., Durham, N.C.); B.L. Turner's treatment in *Phytologia*, 1973; and Pringle's unpublished work for the Flora of North America (FNA). After review of these works, Kartesz concluded that these taxa are best recognized as separate species. However, some others (e.g., J.L. Reveal) disagree, and further taxonomic study is needed. Larry Morse, 23Dec99. (NatureServe, 2015)

Historical Range

Historically in the Death Valley region, California and Ash Meadows in Nye County, Nevada (NatureServe, 2015)

Current Range

Ash Meadows in Nye Co., Nevada (NatureServe, 2015)

Critical Habitat Designated

Yes; 5/20/1985.

Legal Description

On May 20, 1985, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Centaurium namophilum* (Spring-loving centaury) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Nevada (50 FR 20777-20794).

Critical Habitat Designation

The critical habitat designation for *Centaurium namophilum* includes one CHU in Nye County, Nevada (50 FR 20777-20794).

Nevada, Nye County, Ash Meadows.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Centaureum nanophilum* critical habitat consists of one component (50 FR 20777-20794):

Known primary constituent elements include moist to wet clay soils along banks of streams or in seepage areas.

Life History**Food/Nutrient Resources****Lifespan**

Adult: 1 year (USFWS, 2009)

Breeding Season

Adult: July to September (USFWS, 2009)

Reproduction Narrative

Adult: The spring-loving centaury is an upright, annual herb. that flowers from July to September (Pavlik and Manning 1986). One plant can produce thousands of seeds. (USFWS, 2009)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Desert (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 2,070 and 2,320 feet (630 to 707 m) above mean sea level (USFWS, 2009)

Dependency on Other Individuals or Species for Habitat

Adult: The wet meadow ecosystem occupied by spring-loving centaury is typically dominated by saltgrass (*Distichlis spicata*) with scattered velvet ash (*Fraxinus velutina*) and screwbean mesquite trees (*Prosopis pubescens*). (USFWS, 2009)

Habitat Narrative

Adult: The spring-loving centaury grows between 2,070 to 2,320 feet (630 to 707 m) above sea level within the Mojave Desert Ecoregion. The species is adapted to clay soils of the Ash Meadows area, and water availability is a limiting factor to this species' distribution (Pavlik and Manning 1986). It typically grows in wet saltgrass meadows near springs and streams and occasionally in low uplands at seeps (Reveal, Broome and Beatley 1973). The wet meadow ecosystem occupied by spring-loving centaury is typically dominated by saltgrass (*Distichlis spicata*) with scattered velvet ash (*Fraxinus velutina*) and screwbean mesquite trees (*Prosopis pubescens*). (USFWS, 2009)

Dispersal/Migration**Motility/Mobility**

Adult: Likely to be low (inferred from USFWS, 2009)

Dispersal/Migration Narrative

Adult: Given the small size of spring-loving centaury seeds, seed may be dispersed by small animals, wind, and water. Most seeds probably remain near the plant that produced it. (USFWS, 2009)

Population Information and Trends**Population Trends:**

Increasing (USFWS, 2009)

Resiliency:

High (USFWS, 2009)

Representation:

High (USFWS, 2009)

Redundancy:

Moderate (inferred from USFWS, 2009)

Population Growth Rate:

Moderately fast (inferred from USFWS, 2009)

Number of Populations:

19 (NatureServe, 2015)

Population Size:

~4,468,571 (USFWS, 2009)

Population Narrative:

The spring-loving centaury is adapted to disturbance with the relative proportion of energy devoted to seed production, enabling these ruderal species to quickly recover from disturbance (Grime 1977). Based on the life history, anecdotal observations, and assessment of biologists (C. Baldino, Ash Meadows National Wildlife Refuge, pers. comm. 2006a), it is reasonable to conclude the distribution of the spring-loving centaury has increased through colonization of previously disturbed sites since it was listed. They found the spring-loving centaury to be very widespread throughout the Refuge in habitats that included seasonally flooded wetlands to seasonally moist alkali meadows and the edges of some alkali scrub-shrub communities (Bio-West 2008, p. 26). On September 11th, 1997, there were 19 occurrences in Nevada. The total population is now estimated at 4,468,571 individuals on about 800 acres (Bio-West 2008, p. 28). (USFWS, 2009)

Threats and Stressors

Stressor: Habitat loss or degradation from groundwater pumping (USFWS, 2009)

Exposure:**Response:****Consequence:**

Narrative: At the time of listing, groundwater development was a major threat to the entire Ash Meadows ecosystem. Prior to listing, local groundwater pumping within Ash Meadows was responsible for declines in the wetlands in this area. The spring-loving centaury depends on the outflow of springs and near-surface water for its survival. (USFWS, 2009)

Stressor: Habitat loss from surface mining (USFWS, 2009)

Exposure:**Response:****Consequence:**

Narrative: Mining for clay minerals occurs in the Ash Meadows area. Surface disturbance and impacts to rare species that do not have Federal protection are permissible as long as operations comply with Federal and State laws. Currently, there are no active mines or mineral claims within known spring-loving centaury habitat (BLM 2007). New mineral claims and subsequent mining could cause direct loss of spring-loving centaury habitat, as well as indirect impacts by diverting water away from occupied habitat. (USFWS, 2009)

Stressor: Non-native species (USFWS, 2009)

Exposure:**Response:****Consequence:**

Narrative: Over 100 non-native species, approximately 16 percent of the total flora, occur on the Refuge (Service 2006). Of these, salt cedar (*Tamarix ramosissima*), Russian knapweed (*Acroptilon repens*), five hook bassia (*Bassia hyssopifolia*), Malta star thistle (*Centaurea melitensis*), yellow star thistle (*Centaurea solstitialis*), and hoary cress (*Cardaria draba*) are noxious weeds that could potentially threaten the spring-loving centaury (Service 2006). (USFWS, 2009)

Stressor: Climate change (USFWS, 2009)

Exposure:**Response:****Consequence:**

Narrative: The spring-loving centaury is a wetland dependent species. Current climatic modeling predicts the southwestern U.S. is likely to experience increased frequency of regional drought in response to elevated levels of atmospheric carbon dioxide (Seager et al. 2007). The springs and surface streams that support the spring-loving centaury are perennial and they originate from a regional aquifer that includes runoff from the Spring Mountains approximately 100 mi to the northeast (USGS 2005). Other climate predictions suggest the intensity of precipitation events may increase in response to elevated atmospheric carbon dioxide (IPCC 2007). The potential effects of climate change to the regional aquifer that supports Ash Meadow is unknown. (USFWS, 2009)

Recovery**Reclassification Criteria:**

1. All non-native animals and plant species must be eradicated for essential habitat. These non-native species currently include sailfin mollies, mosquito fish, largemouth bass, black bullheads, crayfish, turban snails, wild horses, salt cedar, and Russian olive. (USFWS, 2009)
2. Secure and protect the Ash Meadow aquifer so that all spring flows return to historical discharge rates, and the water level in Devils Hole is maintained at a minimum level of 1.4 feet below the copper washer. (USFWS, 2009)
3. Reestablish water to historic springbrook channels, which are free to barriers that eliminate genetic exchange between populations by preventing movement of native fishes throughout their historic ranges. (USFWS, 2009)
4. The essential habitat must be secure from detrimental human disturbance including mining, OHVs, and the introduction of non-native species (USFWS, 2009).

Delisting Criteria:

1. Criteria for downlisting from endangered to threatened apply in the delisting objectives. (USFWS, 2009)
2. Secure, protect, and maintain natural vegetation, corridors, and adjacent buffer areas for gene flow and dispersal of listed plant species within the essential habitat. (USFWS, 2009)
3. Native plant communities and aquatic communities have been reestablished to historic structure and composition within all essential habitats. (USFWS, 2009)
4. All of the listed species and the candidate plant species are present in all the sites that they have historically occupied as identified in the Recovery Plan. Within each critical habitat unit, the listed plant has a frequency value equal to or greater than the frequency value determined by Task 644 needed as an indicator of a self-sustaining plant population. (USFWS, 2009).

Recovery Actions:

- Recovery actions are not available.

Conservation Measures and Best Management Practices:

- Clarify or resolve the uncertainties regarding the significance of the remaining threats to spring-loving centaury, i.e., groundwater pumping and surface mining. (USFWS, 2009)
- The Service and BLM should continue to work toward the completion of the land and mineral withdrawals for public lands within the Refuge and the ACEC. (USFWS, 2009)
- Research on the role of fire in maintaining habitat for spring-loving centaury is needed, including both wild fire and prescribed burning. (USFWS, 2009)

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SPECIES ACCOUNT: *Cercocarpus traskiae* (Catalina Island mountain-mahogany)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/07/1997; California/Nevada Region (R8)

Physical Description

An evergreen shrub or small tree, 3-8 m tall, with leathery leaves, 2-6 cm long, that are densely covered with white-woolly hairs on the undersides. The petalless flowers (March-May) are also white-woolly. Fruits have a long, plume-like style. (NatureServe, 2015)

Taxonomy

Cercocarpus traskiae has hybridized locally with *C. betuloides* var. *blancheae*, which also occurs on the island. The hybrids have been characterized on morphological bases as well as on allozyme differences (Martin 1988, Rieseberg et al. 1989, Rieseberg 1991). Morphological assessments of hybridization have not always agreed with the results of random amplified polymorphic DNAs (RAPDs) and allozyme studies (Rieseberg and Swensen 1996). (USFWS, 2007)

Historical Range

See current range/distribution.

Current Range

Cercocarpus traskiae is still known to occur naturally only in Wild Boar Gully on the southwestern coast of Santa Catalina Island off the coast of southern California. (USFWS, 2007)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 2007)

Breeding Season

Adult: March to May (NatureServe, 2015)

Reproduction Narrative

Adult: *Cercocarpus traskiae* has hybridized locally with *C. betuloides* var. *blancheae*, which also occurs on the island. The petalless flowers appear from March to May and produce a single-seeded fruit. (USFWS, 2007; NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Shrubland/chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 131 and 231 meters (430 and 700 feet) (USFWS, 2007)

Environmental Specificity

Adult: Narrow/specialist (inferred from USFWS, 2007)

Site Fidelity

Adult: High (USFWS, 2007)

Habitat Narrative

Adult: The known natural population is found on soils derived from igneous, saussurite gabbro rock (Knapp 2006), which is restricted to the southwestern coast of Santa Catalina Island. *Cercocarpus traskiae* are found slopes of a steep-sided, narrow, dry arroyo within a coastal sage scrub community. Plants are typically found on steep slopes and near drainage bottoms between 131 and 231 meters (430 and 700 feet) in elevation (the highest elevation on the island is 648 meters [2,125 feet]) (62 FR 42692). (USFWS, 2007; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Stable (inferred from USFWS, 2007)

Resiliency:

Low (USFWS, 2007)

Representation:

Low (USFWS, 2007)

Redundancy:

Low (USFWS, 2007)

Population Growth Rate:

Very slow (USFWS, 2007)

Number of Populations:

1 (NatureServe, 2015)

Population Size:

~100 (USFWS, 2007)

Population Narrative:

Cercocarpus traskiae now has a population size of seven mature individuals. This is an increase in population size of one plant in the past 40 to 100 years. Twenty-seven of the 102 individuals reported in 2003 are saplings. (USFWS, 2007)

Threats and Stressors

Stressor: Introduced herbivores (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Large introduced herbivores have historically altered the flora and the landscape of Santa Catalina Island. Goats, pigs, bison, and deer were noted at the time of listing. The small size of the current *C. traskiae* population is attributed to the historical presence of goats, deer, and pigs (Rieseberg et al. 1989, Knapp 2006). Goats are known to consume coarse vegetation, including shrubs and trees. This results in reduced vegetation cover and less of a mulch layer (dead herbaceous vegetation) to hold moisture and slow erosion (Coblentz 1980). Lack of plant cover can result in the formation of gullied badlands (Thorne 1967). Pigs create a network of bare trails with compacted soils. The vegetation loses its tiered overlapping structure as shrubs become isolated by the trail network (Martin 1988). In addition to retaining soil moisture for adult plants, surface litter may hold seeds on the steep slopes. We did not elaborate on the threats from bison and deer in the final listing rule. However, these animals are generally found in the area where *C. traskiae* grows. Goats have been eliminated from the island, pigs are nearly gone, and the fenced enclosure in the Wild Boar Gully watershed has greatly decreased the threat from deer and bison. This has allowed the *C. traskiae* plants and other vegetation cover to increase. (USFWS, 2007)

Stressor: Predation (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: The fence erected in 1999 around the plants has reduced the incidence of direct browse damage to *Cercocarpus traskiae* (Knapp 2006). In addition to browsing impacts, the rooting activity of pigs was considered to be directly responsible for low numbers of *C. traskiae* plants (Rieseberg et al. 1989). Pigs uproot seedlings and churn up soil in some canyons (Thorne 1967). As noted above, the number of pigs has now been reduced to one to four animals (Knapp, pers. comm. 2007). A potential concern is that the fence does not completely exclude deer, because evidence of browsing on the *Cercocarpus* was seen in 2003. Seedling heights indicated that some browsing had taken place, and the California Department of Fish and Game was unwilling to issue a depredation permit to dispatch the deer (Knapp 2006). (USFWS, 2007)

Stressor: Fire (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: The listing rule identified fire as a potential threat. Since listing, the construction of the enclosure fence has excluded herbivores and resulted in local increases of vegetative cover. In general, it is not known to what extent the resulting increase of vegetative cover within the

fenced area poses a threat of increased fire frequency for *Cercocarpus traskiae*. Fire is likely infrequent on the island although lightning strikes are known. (USFWS, 2007)

Stressor: Hybridization (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Rieseberg and Gerber (1995) suspect that a critical factor leading to hybridization for a number of plants occurring on the Channel Islands has been habitat disturbance due to the introduction of non-native goats and pigs. We considered the potential for hybridization of *Cercocarpus traskiae* with the more common *C. betuloides* var. *blancheae* to be a threat in the listing rule. Genetic swamping of *C. traskiae* was suggested as a possible outcome of this hybridization. We also stated that Rieseberg et al. (1989) recommended elimination of mature hybrids as a means to preserve the species. Rieseberg and Swensen (1996) considered hybridization a significant threat where the frequency of interspecific mating is high and the population at risk is numerically smaller than the congener. (USFWS, 2007)

Stressor: Stochastic events (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: *Cercocarpus traskiae* now has a population size of seven mature individuals. This is an increase in population size of one plant in the past 40 to 100 years. The greater vulnerability to extinction of small populations is generally attributed to demographic fluctuations, environmental variation, and loss of genetic variability and related problems of inbreeding depression and genetic drift; and/or to natural catastrophes (Primack, 2006; Barrett and Kohn 1991). (USFWS, 2007)

Stressor: Age disparities between individual plants (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: There is a disparity in numbers of individuals of different age classes; i.e., plants are either very old or very young with few age classes in between. There is the potential for mature plants to die naturally before an adequate number of younger reproductive adults are present to maintain even the current genetic diversity and reproductive output. (USFWS, 2007)

Stressor: Genetic diversity (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Limitations on the reproductive partners among the seven mature plants could be another considerable threat to the species' survival and may indicate lower genetic diversity among the mature individuals. (USFWS, 2007)

Stressor: Nonnative plants (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Invasive non-native plants pose perhaps a greater threat than at the time of listing. The balance between effective control of invasive exotic non-natives and increased density of vegetation due to fencing is unknown. The invasive non-native plant management is focused on target species rather than vegetation cover. (USFWS, 2007)

Recovery**Reclassification Criteria:**

Reclassification criteria are not available.

Delisting Criteria:

Delisting criteria are not available.

Recovery Actions:

- Recovery actions are not available.

Conservation Measures and Best Management Practices:

- Establish an effective seed banking program for this species that includes maintenance of genetic diversity and plans to facilitate out-plantings, including ex-situ populations of the species to protect against detrimental stochastic events. (USFWS, 2007)
- Determine the incidence, nature, and management consequences of self-incompatibility in *Cercocarpus traskiae*. (USFWS, 2007)
- Determine the genetic identity of all of the *Cercocarpus* seedlings and saplings present in Wild Boar Gully, as well as that of plants recently deemed to be adults and plants at older outplantings. (USFWS, 2007)
- Determine the potential threat from continuing hybridization of *Cercocarpus traskiae* and co-occurring *C. betuloides* var. *blancheae* and implement management actions to alleviate the threat. (USFWS, 2007)
- Identify the micro-habitat requirements most conducive seedling production and establishment. (USFWS, 2007)
- Determine the best method for establishing additional populations that are self-sustaining and capable of participating in the evolutionary future of the species. Establish success criteria and remediation measures for these established populations. (USFWS, 2007)

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SPECIES ACCOUNT: *Cereus eriophorus* var. *fragrans* (Fragrant prickly-apple)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/2/1985; Southeast Region (R4)

Physical Description

Cereus eriophorus var. *fragrans* is a solitary tree cactus that may have from one to eight, spiny, cane-like, stout, and succulent stems. The columnar stems are 2.5 to 5.0 cm in diameter, and have 10 or 12 ridges alternated with deep, sharp grooves (Benson 1982). Stems may be erect, or for longer stems, the plant may recline over neighboring vegetation. The branching can be extensive, and the roots of this cactus are coarse, fibrous, and shallow (Small 1920). The spine-bearing regions (areoles) are aligned along its ridges about 2 cm apart. Each areole bears 9 to 13 spines, which are mostly grayish and yellowish at the tip, with one spine longer (2 to 4 cm) than the rest. *Cereus eriophorus* var. *fragrans* has initial flower buds that are 1 cm long, white, and exceedingly hairy. Buds often appear on the plant one to two months prior to flower growth. About 9 days after initiation of flower growth, the flower opens (Rae 1995). The flowers are fragrant, showy, solitary, and open only at night. The buds are 12 to 20 cm long when about to open and 7.5 to 10 cm in diameter when open. The ovary bears many lanceolate scales while the flower tube has only a few scattered scales. A tuft of long white hairs (10 to 15 mm long) protrudes from the axil beneath each scale. The sepals are narrowly linear, with green outer sepals and nearly white inner ones. There are numerous spatulate petals, white or pinkish, with unevenly toothed margins. The stamens are numerous and are composed of white filaments and yellow anthers. The style is elongate with 9 to 12 stigmas (FWS 1988). The fruits are attached at the narrower end. They average 4 to 6 cm in diameter and are a dull red. The fruit does not split and has long tufts of white hairs that remain persistent with the scale bases (Leon and Alain 1953). The fruits are swollen at the base and finely pitted; each contains approximately 1,500 black seeds that are about 3 mm long (Rae 1995). (USFWS, 1999)

Taxonomy

The type specimen was collected by John K. Small in 1917 along sand dunes approximately 6 miles (mi) south of Ft. Pierce, Florida, and treated as *Harrisia fragrans* (Britton and Rose 1920). It was separated from other species partly on the basis of having one longer spine than the other 9 to 13 spines per areole (Britton and Rose 1920). Austin (1984) followed the treatment of Lyman Benson (1982) in which *Harrisia* and other cacti were joined together in the genus *Cereus*. Since then, fragrant prickly-apple has consistently been referred to by its former name, *Harrisia*, in references to the flora of the United States and Florida (Chafin 2000; Gann et al. 2002; Flora of North America 2003; Wunderlin and Hansen 2003). The Integrated Taxonomic Information System (2010) was also checked while conducting this review and indicated that the accepted name is *Harrisia fragrans*. Because *Harrisia fragrans* is the name used in peer-reviewed literature and is accepted by the scientific community, we concur with this nomenclature. (USFWS, 2010)

Historical Range

Historically occurred on the east coast of Florida in St. Lucie, Indian River, Brevard, and Volusia Counties (USFWS, 2010)

Current Range

In Florida, in Volusia and St. Lucie Counties, projected to include Brevard and Indiana River Counties. (USFWS, 2010)

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexually and by regeneration by vegetative reproduction

Breeding Season

Adult: Plants flower from April to September with two distinct peaks. (USFWS, 2016)

Reproduction Narrative

Adult: Fragrant prickly-apple reproduces sexually and by regeneration by vegetative reproduction. Plants flower from April to September with two distinct peaks. The first peak is in the spring with flowering starting in April and reaching a peak in May. Some sporadic flowering occurs in the summer. In September and October, another minor peak in flowering occurs. Flowering is uncommon in the late fall, and no flowering occurs from January through March. Fruit set follows flowering with a major peak in May and a minor peak in September. A large standing crop of fruit remains on plants for approximately 8 months of the year. According to Rae (1995), mature plants are greater than 41 cm in length. The smallest plant to flower was 14.5 cm in stem length and the smallest plant to set fruit was 41 cm in length. In his study, 63 percent of the mature plants flowered. At two sites in the Savannas State Preserve, in St. Lucie County, 38 and 60 percent of flowers successfully produced fruits and 44 and 61 percent of mature plants successfully set fruit. A positive relationship was observed between total length of the stems and branches of a plant and the total annual production of fruit. The means of seed dispersal are uncertain, but there is evidence that birds consume the fruit of fragrant prickly-apple. Additionally, most individuals of this species are found within the drip line of other plants, suggesting avian seed dispersal. Rodents or gopher tortoises may also distribute the seeds. In addition to sexual reproduction, long stems will occasionally snap off of existing plants. After falling to the ground, stems may re-root at several places creating a small group of genetically identical plants (Rae 1994a). Vegetative growth of this perennial species is slowest from November to March. Growth accelerates in April and May, with the fastest growth occurring from July through September. The growth rate drops off rapidly after September (Rae 1994a, 1995). The fragrant prickly-apple is characterized as a long-lived species with late maturity, low fecundity, and low adult mortality (Rae and Ebert 2002). Larger plants tend to have higher fecundity and lower mortality rates (Rae and Ebert 2002); therefore, the larger individuals in the population are extremely important to overall population health (Rae and Ebert 2002). (USFWS, 2016)

Habitat Type

Adult: Sand pine scrub habitat

Habitat Narrative

Adult: Fragrant prickly-apple occurs in a clumped distribution and prefers early-successional sand pine scrub habitat (Rae 1994b, 1995). The known sites are limited to St. Lucie sand which is excessively well drained (Watts and Stankey 1980), where the water table is normally deeper than 3 m. Water capacity, fertility, and organic matter content are all very low. The most common plant species in this community include sandhill jointweed (*Polygonella fimbriata*), hairy jointweed (*P. ciliata*), tall jointweed (*P. gracilis*), sand live oak (*Quercus geminata*), myrtle oak (*Q. myrtifolia*), cabbage palm (*Sabal palmetto*), and pricklypear (*Opuntia humifusa*). Much of the Atlantic Coastal Ridge was cleared in the 1880s for pineapple plantations, but commercial pineapple cultivation was abandoned by 1920. The vegetative community has yet to regain its previous level of diversity or productivity. The vegetative succession has been arrested and the plant community has not succeeded to the climax sand pine habitat type (Rae 1994a, 1995). This cactus prefers partial shade, which is often provided by surrounding plants that shelter it from sun for a portion of the day (Rae 1994b). Surrounding vegetation is often used for support by fragrant prickly-apple for its long stems. Other plants may serve as nurse plants for the seedlings, protecting them from direct sun, but this has not been studied. As the plant grows, the nursery plant may die, leaving the cacti exposed to a greater intensity of sunlight. Overgrowth and shading by sand live oaks and other species may cause reproductive failure and premature death. Growth and productivity seems to be greater for plants in areas that are partially shaded. (USFWS, 2016)

Dispersal/Migration***Population Information and Trends*****Number of Populations:**

10 (USFWS, 2010)

Population Size:

Less than 3000 individuals (USFWS, 2010)

Population Narrative:

Fragrant prickly-apple was listed as endangered on November 1, 1985, following substantial losses of suitable habitat (50 FR 45621). At the time of listing, fragrant prickly-apple was only known from St. Lucie County (Service 1985). Historically, fragrant prickly-apple occurred in coastal hammock habitats on the east coast of Florida in St. Lucie, Indian River, Brevard, and Volusia Counties, although some accounts in other areas were erroneously reported due to misidentification with Simpson's prickly-apple (*Cereus gracilis* var. *simpsonii*) (Service 1985; Service 1999; Woodmansee et al. 2007). Fragrant prickly-apple was reportedly collected in Everglades National Park (ENP), but this is not confirmed (NPS 2007; Sadle 2009). Because Simpson's prickly-apple commonly occurs in ENP, there is much confusion over identification of these two species, there is no voucher specimen available in herbarium collections for confirmation, the fragrant prickly-apple is limited in distribution, and ENP lacks the habitats believed to support fragrant prickly-apple, it is thought that the species was misidentified (NPS 2007; Sadle 2009). The species is now known to occur on only 10 confirmed sites in Volusia and St. Lucie Counties, primarily on or around Savannas Preserve State Park (SPSP) where the site covers an area approximately 10.0 mi long and 0.5 mi wide and is bisected by the Florida East Coast railway (Bradley et al. 2002; Bradley and Gann 2002; Woodmansee et al. 2007; Florida

Natural Areas Inventory [FNAI] 2009). These cacti are often found to occur in distinct clusters (Bradley et al. 2002; Woodmansee et al. 2007). The occurrence of fragrant prickly-apple in Indian River County is yet unconfirmed because only a single sterile plant was observed on a coastal berm when surveys were conducted in 2006 (Woodmansee et al. 2007; FNAI 2009). Although only confirmed in Volusia and St. Lucie Counties, it is possible that the current range of the species includes Brevard and Indian River Counties, as these counties occur between confirmed locations and appropriate habitat is available (Woodmansee et al. 2007). (USFWS, 2016)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Continued habitat loss, fragmentation, and changes in land use threaten the existence of fragrant prickly-apple. Where plants occur on private sites, development has led to both direct destruction of habitat as a result of land clearing and habitat degradation from lack of management. For example, Woodmansee et al. (2007) suggested that the two extirpated sites in Brevard County were probably lost due to habitat alteration or destruction and severe freezes. Moore (2009) stated that another private site known to contain fragrant prickly-apple was to be sold for development a few years ago. After obtaining permission to salvage the cactus from the property, he returned to find that it had already been removed (Moore 2009). - Threats from development and habitat degradation on private sites are expected to continue and increase. Within the range of fragrant prickly-apple, the human population is predicted to grow from just below 500,000 to nearly 1,000,000 in Volusia County and from approximately 193,000 to more than 563,000 in St. Lucie County between 2005 and 2060 (Zwick and Carr 2006). - Even though 63 percent of the sites around SPSP containing fragrant pricklyapple are publicly owned and not at risk of being developed, the plants on these sites may still be vulnerable to habitat degradation from encroachment of exotic plant species and lack of fire or other mechanical treatment. If sites are not properly managed, ecosystem health may deteriorate. Because the sites are fragmented on a developed landscape, fire management may not always be feasible and encroachment by exotic plant species from neighboring properties is likely. Because population densities tend to vary over time, even those sites with high population densities may be vulnerable if not monitored carefully (Rae in litt. 2010). Therefore, habitat loss, degradation, and fragmentation due to increasing development and lack of management in coastal scrub habitat and the encroachment of exotic plants continue to threaten fragrant prickly-apple. (USFWS, 2010)

Stressor: Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: At the time of listing, overutilization was identified as a potential threat for fragrant prickly-apple, but indiscriminate collecting was not known to occur. Because it is limited in distribution and population sizes are relatively small, indiscriminate collecting could adversely affect the species. Like many other species of cacti, fragrant prickly-apple is vulnerable to unlawful exploitation and collection due to the activities of some collectors and hobbyists.

Enforcement is difficult due to insufficient resources and the remoteness of the plants. There is minor horticultural interest in this species (Bradley and Gann 2002). During the 5 years of monitoring that took place at SPSP, there was no evidence of poaching (Bradley and Gann 2002). However, the salvage of a fragrant prickly-apple from a property slated to be sold for development was planned but never occurred because the plant was mysteriously removed before the rescue could be implemented (Moore 2009). The Service believes that there is a continuing threat from overutilization for commercial or recreational purposes. (USFWS, 2010)

Stressor: Disease or predation (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: When the fragrant prickly-apple was listed as endangered, disease and predation were not known to be threats. However, insects may damage cacti. Moore (2009) noted that young seedlings were damaged when unidentified caterpillars ate the sprouts. A native scale insect, *Diaspis echinocacti*, has been found to destroy stems of the fragrant pricklyapple in SPSP; however, it does not appear to kill the host plant (Bradley et al. 2002a; Bradley and Gann 2002). Root parasitism may occur when fragrant 10 prickly-apple grows in association with tallow wood (*Ximenia Americana*) or graytwig (*Schoepfia chrysophylloides*) but has not been directly observed (Bradley and Gann 2002). Fragrant prickly-apple may also be parasitized by love-vine. There is evidence that birds eat the fruit and serve as a mechanism to disperse seeds (Service 1999). It is also thought that rodents or gopher tortoises may distribute seeds (Service 1999). These occurrences of predation and parasitism are not known to constitute serious threats to the fragrant prickly-apple. (USFWS, 2010)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The ESA provides limited protection for the species and its habitat. Existing Federal regulations prohibit the removal or destruction of listed plant species on Federal lands. The fragrant prickly-apple is also listed by the Florida Department of Agriculture and Consumer Services (FDACS) as endangered (5B-40.0055 Regulated Plant Index), but this legislation does not provide any direct habitat protection. State regulations require both written permission from the owner or legal representative and a permit issued by FDACS to collect or remove plants listed as endangered on the Florida Regulated Plant Index. Title 62D2.013 of the Florida Administrative Code prohibits the removal, destruction, or damage of plants from FDEP, Division of Recreation and Park properties. This regulation provides protection for much of the population where it occurs on SPSP. - Existing regulatory mechanisms do not appear to be adequate, as several properties with fragrant prickly-apple on private lands have been developed. Fragrant prickly-apple was potentially impacted in 2005 when heavy equipment was used to push debris into habitat where the species was presumed to occur along the railroad right-of-way (Kaufmann 2005). Multiple portions of potential habitat along the railroad tracks are being purchased and used to dump dredged material from the Intracoastal Waterway along the Indian River. - Because this plant occurs in habitat along the Atlantic coastal ridge, which is desirable for development and other uses due to its elevation, it remains vulnerable to development pressures where it occurs on private property. Where the species occurs on public land, there is protection from development but not necessarily from habitat degradation. (USFWS, 2010)

Stressor: Prescribed fire (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Land management practices such as prescribed fire are important to maintaining the scrub ecosystem. However, the fragrant prickly-apple is intolerant of fire (Bradley and Gann 2002). Because it is thought that the species was historically located along the perimeter of scrub habitat in xeric hammocks, it may not have been affected as frequently by fires that were occurring in adjacent scrub (Bradley and Gann 2002). (USFWS, 2010)

Stressor: Invasive nonnative plant species (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: A large source of habitat degradation is the establishment of invasive plant 11 species such as Brazilian pepper (*Schinus terebinthifolius*), rosary pea (*Abrus precatorius*), white cypress pine (*Callitris glaucophylla*), golden trumpet (*Allamanda cathartica*), cathedral bells (*Kalanchoe pinnata*), chandelier plant (*K. tubiflora*), swamp mahogany (*Eucalyptus robusta*), guinea grass (*Panicum maximum*), and Crow's foot grass (*Dactyloctenium aegyptium*) (Bradley and Gann 2002; Bradley et al. 2002b). These invasive species may impact fragrant prickly-apple growth, reproductive potential, and recruitment by competing for space and nutrients and blocking sunlight (Bradley and Gann 2002). The species frequently grows beneath the canopy of these invasives to take advantage of partial shade and also can be crushed beneath falling limbs or trees not able to withstand hurricane winds (Bradley and Hines 2007). However, herbicides used to control overgrowth, if not properly applied, also pose a threat to the fragrant prickly-apple. Bradley and Hines (2007) noted mortality as a result of off-target herbicide application at SPSP. (USFWS, 2010)

Stressor: Feral hogs, tortoise, and inadequate land management (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Degradation to habitat can also occur from damage by feral hogs (Engeman et al. 2003, 2004). Bradley and Hines (2007) recorded an incident in which feral hog damage killed a fragrant prickly-apple plant. Gopher tortoises may also bury small cacti at the mouth of burrows (Bradley and Gann 2002). Vegetation restoration and management programs are costly, and the availability of funding is never assured; therefore, habitat modification from inadequate management even on protected lands remains an imminent, though moderate, threat. (USFWS, 2010)

Stressor: Climatic events (USFWS 2010)

Exposure:

Response:

Consequence:

Narrative: The species' restriction to specialized habitat, its limited distribution, and its limited reproductive capacity also renders it vulnerable to random natural events, such as freezes and hurricanes. Sea level rise may also threaten cacti on sites with low elevation, such as those at

Canaveral National Seashore (Woodmansee et al. 2007). Woodmansee et al. (2007) suggested that freezing temperatures may have led to the extirpation of the species at one location in Brevard County. Although the species did well through the Category 1 hurricane in 2000 and the Category 2 and 3 storms in 2004 and 2005 (Bradley and Gann 2002; Woodmansee et al. 2007), specific conditions such as storm surge and amount of debris dumping following the event vary greatly with each hurricane and may render sites with few plants vulnerable to destruction. Hurricanes have the potential to adversely affect fragrant prickly-apple populations in other ways. High winds can bring surrounding vegetation crashing down on top of individual cacti, injuring or killing them. Bradley and Hines (2007) found that mortality rates more than tripled at SPSP as a result of hurricane impacts. One colony that was particularly affected was located beneath invasive white cypress pine trees which were not equipped to handle hurricane winds and either fell or lost numerous branches that crushed the cacti below (Bradley and Hines 2007). However, hurricanes also open hammock canopies, allowing light to penetrate and stimulating flowering activity, thus providing conditions that may be favorable to cactus regeneration (Bradley and Gann 2002; Woodmansee et al. 2007). (USFWS, 2010)

Recovery

Reclassification Criteria:

Not defined; 1999 Recovery Plan provided only "stabilization" criteria. (USFWS, 1999)

Delisting Criteria:

1. When at least 15 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)
2. When populations (as defined in criterion 1) in coastal sand pine scrub habitat are distributed across the historical range of the species. (Factors A and E) (USFWS, 2019)
3. When populations (as defined in criterion 1) must be protected via a conservation mechanism and managed (e.g., appropriate burn intervals) such that enough suitable habitat is present for the species to remain viable for the foreseeable future. (Factors A, B, D, and E) (USFWS, 2019)

Recovery Actions:

- 1. Determine distribution of *C. e. var. fragrans*. Known *C. e. var. fragrans* populations occur on well-drained soils indicative of xeric upland plant communities. Much of the xeric upland habitat of Indian River and St. Lucie counties remains botanically unsurveyed and threatened with destruction. Efforts to survey and assess the xeric vegetative communities for *C. e. var. fragrans* are needed to ensure the survival of this species. (USFWS, 1999)
- 2. Protect and enhance existing populations. Of the three populations known, one occurs on private land in residential areas and two occur in Florida's Savannas State Preserve. Additional protection at each of these sites is needed. (USFWS, 1999)
- 3. Conduct research on the biology of *C. e. var. fragrans*. Much of the basic biology and ecology of this species remains poorly understood. If we are to effectively recover the species, more specific biological information will be needed. (USFWS, 1999)
- 4. Monitor *C. e. var. fragrans* populations. Maintain an inventory of naturally reproducing populations to help determine habitat characteristics and natural environmental changes affecting *C. e. var. fragrans*. (USFWS, 1999)

- 5. Provide public information about the fragrant prickly-apple cactus. It is important, and perhaps crucial, to the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and landowners be appropriately informed about this species. Informing the conservation organizations such as the Cactus and Succulent Society is appropriate, but care is needed to avoid unnecessarily revealing localities and to avoid stimulating demand for the species. Efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of *C. e. var. fragrans* and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- 6. Establish delisting criteria. Once reclassification is achieved, research and monitoring results may provide data necessary to develop delisting criteria. (USFS, 1999)
- Habitat-level Recovery Actions: - Protect, manage and enhance habitat. None of the habitat for *C. e. var. fragrans* on private land is secure at this time. Efforts to protect these sites are essential since many of the remaining plants occur on private land. - Monitor habitat and ecological processes. Little is known regarding response of *C. e. var. fragrans* to land management actions used in coastal xeric communities. The effects of fire, vegetative cutting, or other measures must be monitored to determine biological and ecological consequences. - Continue public information efforts about xeric vegetative communities and their unique biota. Educational efforts, especially those conducted by private conservation organizations, have been successful in providing important information about xeric plant communities to the public. (USFWS, 1999)

Conservation Measures and Best Management Practices:

- Surveys: • Continue monitoring the SPSP and Volusia County populations on an annual basis and after stochastic events, such as fires. 13 • Conduct additional surveys on other parts of Hutchinson Island South in St. Lucie County, Sebastian Inlet State Park in Brevard and Indian River Counties, spoil islands in Indian River and St. Lucie Counties, Pelican Island National Wildlife Refuge and the southern end of Pine Island in Indian River County, and other potential locations within the historic range. • Re-survey the Pine Island location to confirm the identity of the plant in question. (USFWS, 2010)
- Management: • Continue management actions to remove invasive species with particular care in using mechanical means and herbicide application that may damage cacti; control public access to these areas to avoid human disturbance and to improve habitat conditions. • Continue application of prescribed fire to habitats that support the species while maximizing the number of burn units rather than applying fire to large expanses of habitat. • Consider reducing the canopy in areas where cacti are impacted by too much shade. • Restore coastal hammocks along the eastern slope of the Atlantic Coastal Ridge. • Where unable to restore coastal hammocks, maintain the threeawn (*Aristida gyrans*)/ Sabal palm (*Sabal palmetto*) habitat that fragrant prickly-apple now occupies for the long-term existence of the species. • Control public access and eliminate dumping in areas where fragrant prickly-apple occurs. • Focus conservation efforts on marginal and small sites to preserve the genetic diversity of the species. • Evaluate the feasibility of acquiring private property in Brevard County for reintroduction of the species, identify suitable habitat for additional reintroduction sites in protected areas, and establish reintroduced populations. • Increase the genetic diversity of the species at existing and reintroduced locations. (USFWS, 2010)

- Research: • Conduct demographic studies using a metapopulation approach to understand spatial and temporal variation. Incorporate surveys to evaluate flower and fruit production. • Develop a model to evaluate long-term population growth in relationship to microhabitat conditions (i.e., shade, partial shade, and sun). • Develop mechanisms to improve seedling survival and continue to study seed germination to determine habitat preferences of the species. Evaluate the role of nurse plants that provide shade in the early development of seedlings. • Conduct research on recruitment, mortality, seed bank characteristics, and soil moisture. • Conduct parallel studies on the other two similar cacti in Florida, Simpson's pricklyapple and Aboriginal pricklyapple (*Harrisia aboriginum*), to gain additional insight into fragrant prickly-apple biology and to delineate these species. • Continue genetic research and appropriately apply these results to listing status of all *Harrisia* species in Florida. • Conduct a population-level genetic study using microsatellite markers to determine genetic variation within the species and gene flow in and among sites and to better understand the reproductive mode at low population densities. • Conduct research on the response of fragrant prickly-apple to fire and fire prescriptions necessary to benefit the species. • Identify pollinators and evaluate impacts to insect pollinators from aerial mosquito spraying. • Continue propagation efforts and collect germ plasm from the remaining sites not currently represented in the CPC's National Collection of Endangered Plants, primarily from the Volusia County population. • Evaluate the effects of climate change on the species, including those that result from precipitation pattern changes and temperature rise. (USFWS, 2010)
- Other: • Pursue conservation agreements/implement management recommendations and/or acquire land and investigate incentives to encourage land managers to manage habitat for ecosystem health and listed species. • Acquire private inholdings within the SPSP when willing sellers are identified. • Consider acquiring the Pine Island tract in Indian River County and determine the status of Fairchild Tropical Botanic Garden's ex situ population of plants from this site. • Promote partnerships to share information, conduct collaborative research on coastal scrub habitat conservation, and provide land managers and the interested public with information about the ecosystem, threats, recovery actions, and associated rare biota. • Consider nomenclatural changes to officially designate the name of the fragrant pricklyapple as *Harrisia fragrans*. • Conduct an ad hoc meeting to compile new information, discuss recovery actions, share land management strategies, and set and prioritize 5- and 10-year goals. • Seek opportunities to include the media in conservation efforts to provide information about this species to the public. (USFWS, 2010)

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SPECIES ACCOUNT: *Chamaecrista glandulosa* var. *mirabilis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 4/5/1990; Southeast Region (R4) (USFWS, 2015)

Physical Description

A prostrate, ascending, or erect shrub which may reach up to 1 meter in height. The branches are slender, straight, and wire-like. Leaves are alternate, evenly one-pinnate, 1 to 3 centimeters long, 0.5 to 1 centimeter wide, with some scattered whitish hairs. The stipules are persistent, striate, and about 2 millimeters long. The leaflets are membranaceous, usually in 18 pairs, 3 to 6 millimeters long and 0.5 to 1.5 millimeters wide. The petioles have one to two stipitate glands. The flowers are solitary, with a pedicel about as long as the leaves. The corolla is yellow, about 2 centimeters in diameter, with one petal much larger than the others. Mature fruits (legumes) are glabrous, linear, 2.5 to 4 centimeters long, 3 to 4 millimeters wide, flat, elastically dehiscent, and 12 to 15 seeded (Vivaldi and Woodbury 1980). (USFWS, 1994)

Taxonomy

A member of the Fabaceae family, was first collected by Dr. Agustin Stahl in the mid-nineteenth century. In 1899, Mr. Edward Heller collected the species in Vega Baja. *Chamaecrista glandulosa* var. *mirabilis* has been placed by various authors in the genus *Cassia* as a species (*Cassia mirabilis*) and in the genus *Chamaecrista* both as a species and a variety (*Chamaecrista glandulosa* var. *mirabilis*). Liogier (1988), in the "Descriptive Flora of Puerto Rico and Adjacent Islands," place the taxon as a variety in the genus *Chamaecrista*. (USFWS, 1994)

Historical Range

It is known from the coastal white or siliceous sands in north central Puerto Rico in areas adjacent to the Tortuguero Lagoon Natural Reserve. The species is commonly considered as endemic to mainland Puerto Rico (Axelrod 2011) (USFWS, 2015).

Current Range

Chamaecrista glandulosa var. *mirabilis* occurs in the north central coastal plain of Puerto Rico (USFWS, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual and asexual (USFWS, 2015)

Dependency on Other Individuals or Species

Adult: Hymenoptera spp. (EPA, 2016)

Breeding Season

Adult: Year round (inferred from EPA, 2016)

Reproduction Narrative

Adult: Flowering and fruiting occurs for most of the year, with peaks in February and March. Hymenopterans are pollinators (EPA, 2016). López-Colon et al. (2007) found that the species does not depend on autogamy for pollination. Moreover, López-Colon et al. (2007) reported various pollinators for the species (i.e., Hymenopterans), suggesting that the species reproduction is dependent on interaction with pollinators (USFWS, 2015).

Habitat Type

Adult: Terrestrial (EPA, 2016)

Habitat Vegetation or Surface Water Classification

Adult: Subtropical moist forest (EPA, 2016)

Dependencies on Specific Environmental Elements

Adult: 44 - 88 in. annual rainfall (EPA, 2016)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2015)

Habitat Narrative

Adult: Vegetation surrounding lagoon is dry evergreen or littoral forest. Species is found growing on almost pure sands without any organic layer, frequently in open areas. It occurs near sea level in the north central coastal plain within the subtropical moist forest life zone, where rainfall ranges from 1,100 to 2,200 mm (44-88 in) per year. It grows on occurring on white silica sands derived from outcrops of granodiorite. They belong to the Algarrobo-Corozo-Arecibo soil association. Soils are deep, excessively drained, low in nutrients, and acidic (EPA, 2016). *Chamaecrista glandulosa* var. *mirabilis* is limited to coastal habitats consisting on white siliceous sands adjacent to wetland areas (USFWS, 2015).

Dispersal/Migration**Dependency on Other Individuals or Species for Dispersal**

Adult: Unknown (EPA, 2016)

Dispersal/Migration Narrative

Adult: Dispersal mechanisms are unknown (EPA, 2015).

Population Information and Trends**Population Trends:**

Unknown (USFWS, 2015)

Species Trends:

Unknown (USFWS, 2015)

Resiliency:

Very low (inferred from USFWS, 2015)

Redundancy:

Low (inferred from USFWS, 2015)

Number of Populations:

4 (USFWS, 2015)

Population Size:

Unknown (USFWS, 2015)

Population Narrative:

In the absence of a long term monitoring and uncertainty about population trends, the Service deems the status of the population as uncertain. There are no accurate estimates on the current number of individuals and populations trends of *C. glandulosa* var. *mirabilis*. There are 4 known populations within northern Puerto Rico (USFWS, 2015).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: The northern coast of Puerto Rico between San Juan and Arecibo represents perhaps the most developed and disturbed area on the Island. This zone includes areas that harbors suitable habitat for the species. A variety of development activities (e.g., residential, commercial, highways, etc.) are ongoing, and protected areas on the northern coast are few and most are small. ATV and mountain bikes tracks have been found along the habitat. Human-induced fires could modify the landscape by promoting nonnative trees and grasses, and by diminishing the seed bank of native species (Brandeis and Woodall 2008). In some cases, fires may maintain extensive areas of young forest and grasslands, slowing the recovery (regeneration) of ecosystems, and therefore, impairing the delivery of ecosystem services (Brandeis and Woodall 2008) (USFWS, 2015).

Stressor: Limited distribution (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Other than the Tortuguero Lagoon Natural Reserve, there is no other natural reserve that includes siliceous sands habitat. Therefore, the limited distribution of *C. glandulosa* var. *mirabilis* and its substrate (suitable habitat), makes the species vulnerable to habitat destruction and modification (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Climate change is predicted to increase the frequency and strength of tropical storms and also to lead to a gradual rise in sea level. Vulnerability to climate change impacts is a function of sensitivity and exposure to those changes, and the adaptive capacity of the species (Glick et al. 2011). Therefore, shifts of vegetation communities are expected as temperatures and moisture regimes are altered by climate change. Under this scenario, the populations of *C. glandulosa* var. *mirabilis* may be displaced or outcompeted by native or exotic species with wider environmental plasticity. Even a small rise in sea level could represent a very serious threat to the taxon. Sea level rise will also compromise natural recruitment by affecting seed germination and/or the survival of seedlings. Due to its limited range and limited substrate availability, flooding and climate change could likely have an adverse impact on the species as there may not be other areas that harbors suitable habitat for the displacement or colonization by the species (USFWS, 2015).

Stressor: Invasive species (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: In 2013, the USFWS documented areas that harbor habitat for the taxon, are being lost due to changes in the structure of the vegetation. For example, areas that were open white sands with herbaceous vegetation in the 1990s are currently covered by tree species (i.e., *Anacardium occidentale* and *Chrysobalanus icaco*). *Chrysobalanus icaco* is a native species characteristic of coastal vegetation (including sand dunes). However, *A. occidentale* is native to northern South America and Brazil, and is showing an invasive pattern within *C. glandulosa* var. *mirabilis* habitat in Tortuguero Lagoon. *Melaleuca quiquenervia* is another exotic tree species that is already established on the reserve and poses a risk for the ecosystem (Hamilton 2013) (USFWS, 2015).

Recovery**Reclassification Criteria:**

Not available

Delisting Criteria:

1. The known populations are given protected status (USFWS, 2015).
2. At least 3 new populations capable of self-perpetuation are established within protected areas. These should be minimum requirements, and could be expanded upon if the regenerative or propagative potential of natural and ex situ populations proves to be insufficient. On the other hand, if new populations of the species are discovered, it may be preferable to place greater emphasis on protection, rather than on propagation, in order to achieve a minimum number of plants (USFWS, 2015).

Recovery Actions:

- Monitor existing populations (USFWS, 1994).
- Provide protection, through acquisition or conservation easements, for existing populations (USFWS, 1994).

- Conduct research on aspects of the life history of the species and evaluate propagation techniques (USFWS, 1994).
- Conduct propagation and enhance existing populations or establish new ones (USFWS, 1994).

Conservation Measures and Best Management Practices:

- The recovery of the species should focus primarily on the protection of natural known populations and its habitat. Studies and surveys should be conducted to locate and determine the current status of additional wild populations (USFWS, 2015).
- Efforts should be made to identify existing fragments of siliceous sands and to ensure their preservation and ecological restoration (i.e., through USFWS funded projects via the Coastal Program and Partners for Fish and Wildlife Program) should also be undertaken if appropriate sites are found (USFWS, 2015).
- A long term monitoring program should be established to determine population trends of the known populations (USFWS, 2015).
- Since the population dynamics of the species are poorly known, and we do not have enough information to determine what constitutes a viable population. Additional studies should be conducted on the species' phenology, reproductive biology and population structure (USFWS, 2015).
- Studies should be conducted on the patterns of genetic variation, in order to develop a plan to preserve the species' germplasm (USFWS, 2015).
- A signage and outreach program should be implemented to educate the users of the Tortuguero Lagoon Natural Reserve about the species and its habitat (USFWS, 2015).

References

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SPECIES ACCOUNT: *Chamaecrista lineata keyensis* (Big Pine partridge pea)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/31/2016; Southeast Region (R4) (USFWS, 2016)

Physical Description

Chamaecrista lineata var. *keyensis* is a small, prostrate to ascending, perennial, herbaceous shrub that is 10–80 centimeters (cm) (3.9–31.5 inches (in)) tall, with yellow flowers and pinnately compound leaves (each leaf consists of a main stem with multiple leaflets lined up along on each side). It has one to several branched stems arising from a contorted rootstock. New branches are covered in soft, fuzzy hairs. The leaves are 1.7–4.0 cm (0.7–1.6 in) long, with 5 to 9 pairs of leaflets. Flowers consist of five sepals 9–20 mm (0.4–0.8 in) long that are fused together near their bases; five yellow petals 11–15 mm (0.4–0.6 in) long, with one slightly larger than the others; 10 reddish-purple stamens; and a single, elongate style. The fruit is an elongate pod, roughly similar to that of a pea, 33–45 mm (1.3–1.8 in) long and 4.5–5.0 mm (0.19–0.17 in) wide, with a soft fuzzy texture, which turns gray with age and eventually split open to release seeds (Irwin and Barneby 1982, p. 757; Small 1933, pp. 662–663) (USFWS, 2015).

Taxonomy

John Loomis Blodgett was the first to collect *Chamaecrista lineata* var. *keyensis*, sometime between 1838 and 1852, on Big Pine Key (Bradley and Gann 1999, p. 17). Pollard (1894, p. 217) assigned the plants on Big Pine Key to the existing taxon *Cassia grammica*. John K. Small (1903, p. 587; 1913, p. 58) followed this usage, but used the genus *Chamaecrista* (considered a subgenus within *Cassia* or a genus unto itself variously by many authors). In 1917, Pennell (p. 344) recognized the Big Pine Key plant as a distinct endemic species, naming it *Chamaecrista keyensis*. This name was retained by Small (1933, p. 663) in his *Manual of the Southeastern Flora*. In an exhaustive study of *Cassia* and *Chamaecrista*, Irwin and Barneby (1982, p. 757) assigned plants in Florida and parts of the West Indies to the existing taxon *Chamaecrista lineata*, and assigned the Big Pine Key plants to var. *keyensis*, retaining them as endemic to the Florida Keys. Isely (1990, p. 33), Wunderlin (1998, p. 348), and Wunderlin and Hansen (2003, p. 441) have followed this treatment. The online *Atlas of Florida Vascular Plants* (Wunderlin and Hansen 2014, p. 1) uses *Chamaecrista lineata* var. *keyensis*. The *Integrated Taxonomic Information System* (2015, p. 1) uses the name *Chamaecrista lineata* var. *keyensis* and indicates that this taxonomy is accepted. Based upon the best available scientific information, *Chamaecrista lineata* var. *keyensis* is a distinct taxon, endemic to the lower Keys in Monroe County, Florida. Synonyms are *Cassia keyensis* (Pennell) J.F. Macbr and *Chamaecrista keyensis* Pennell. *Chamaecrista lineata* var. *keyensis* is related to, and superficially resembles, *Chamaecrista fasciculata*, the partridge pea, a common species which occurs throughout Florida. (USFWS, 2015)

Historical Range

Chamaecrista lineata var. *keyensis* is endemic to the lower Florida Keys in Monroe County, Florida. Historical records exist for occurrences on five islands: Big Pine Key, No Name Key, Ramrod Key, Cudjoe Key, and Sugarloaf Key (Hodges and Bradley 2006, pp. 20–21) (USFWS, 2015).

Current Range

Florida, Monroe County, on Big Pine Key and Cudjoe Key. (USFWS, 2015)

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual

Dependency on Other Individuals or Species

Adult: Pollinators

Key Resources Needed for Breeding

Adult: Open canopy

Reproduction Narrative

Adult: Requires pollinators.

Habitat Type

Adult: Pine rockland vegetation; roadsides; cleared lots adjacent to pine rockland (USFWS, 2015).

Dependencies on Specific Environmental Elements

Adult: Most likely to be found in canopy openings and requires full sun to partial shade (USFWS, 2013).

Geographic or Habitat Restraints or Barriers

Adult: Closed canopy, hardwood cover (USFWS, 2013)

Environmental Specificity

Adult: very

Habitat Narrative

Adult: Big Pine partridge pea occurs primarily in pine rockland vegetation. Some populations can be found on roadsides (Hodges and Bradley 2005, p. 22) or in cleared lots adjacent to pine rockland. Pine rocklands in the lower Florida Keys are dominated by a canopy of *Pinus elliottii* var. *densa* (South Florida slash pine). The subcanopy is composed of *Thrinax morrisii* (brittle thatch palm), *Psidium longipes* (longstalked stopper), *Metopium toxiferum* (poisonwood), *Byrsonima lucida* (locustberry), *Pithecellobium keyense* (blackbead), and *Coccothrinax argentata* (silver palm) (Bradley 2006, p. 25). Ross and Ruiz (1996, p. 5) found that it occurs primarily in areas where hardwoods are relatively unimportant, and where understory and overstory palms are important. Bradley (2006, p. 26) also found that it preferred open sunny areas, but in contrast to Ross and Ruiz (1996, p. 5) found a negative correlation with palm cover. Big Pine

partridge pea is most likely to be found in canopy openings and requires full sun to partial shade (Muir and Liu 2003, p. 3). It is capable of colonizing disturbed areas within pine rockland habitat, such as dirt roads. It does not persist in damp soil or depressions (Muir and Liu 2003, p. 3). Pine rockland is maintained by relatively frequent fires, which keep the understory woody plants at shrub height (Snyder et al. 1990, pp. 257-263; Carlson et al. 1993, p. 915; Bergh and Wisby 1996, p. 1; Liu et al. 2005a, p. 210; 2005b, p. 71). In the absence of fire, many areas become wooded, eventually succeeding to rockland hammock (i.e., hardwood forest) (Snyder et al. 1990, p. 260). As with other pineland plants, Big Pine partridge pea is shade intolerant, and requires periodic burning to reduce competition from woody vegetation (e.g., shading, leaf litter accumulation) (Carlson et al. 1993, p. 922; Liu et al. 2005a, p. 210; 2005b, p. 71) (USFWS, 2013). *Chamaecrista lineata* var. *keyensis* occurs in pine rocklands of the lower Florida Keys, and adjacent disturbed sites, including roadsides (USFWS, 2016).

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Declining (USFWS, 2013; USFWS, 2015)

Species Trends:

Declining (USFWS, 2013; USFWS, 2015)

Number of Populations:

2 extant occurrences (USFWS, 2015)

Population Size:

>300,000 individuals (USFWS, 2015)

Population Narrative:

The population size of Big Pine partridge pea is apparently much smaller than it was historically. In addition to a reduction in the amount of available habitat, there has also been a reduction in density. Total population size within the Big Pine Key public pine rockland study area (1,181 acres [478 ha]) was estimated to be 816,833 to 1,709,994 in 2005 (pre-Hurricane Wilma, 297 plots) and 178,543 to 458,227 in 2007 (post-Wilma, 285 plots) (Bradley and Saha 2009, p. 12). Since 82 percent of the pine rockland on Big Pine Key is publicly owned, this estimate likely accounts for the majority of the population. Big Pine partridge pea density and percent cover was significantly higher in 2005 compared to 2007 in all plots combined, as well as, separately for northern and southern plots. In 2005, a total of 1,540 plants were counted in 297 plots, whereas in 2007 only 584 plants were counted in 285 plots. In surveys collected immediately after Hurricane Wilma, island-wide population sizes were 38 percent lower than in plots sampled prior to the hurricane (Bradley 2006, p. 35). Mortality rates varied geographically. Small areas of pine rockland were not flooded at all, while in many areas salt water pooled for several days. Bradley (2006, p. 13) sampled 60 plots both before and after the hurricane. These plots were all at the northeast end of the island in a low-lying area. Only 6.25 percent of the plants that were found prior to the hurricane were found after the storm, indicating a major population decline. Similarly, at TNCs Terrestriis Preserve, counts of Big Pine partridge pea declined greatly between 2003 and 2006 in all three study units (Slapcinsky and Gordon 2007, p.

9) (USFWS, 2013). Population data for *Chamaecrista lineata* var. *keyensis* have been collected periodically on Big Pine Key since 1955. Because of the size of Big Pine Key, sample study plots were used, as opposed to a complete search of all potential habitat. Multiple indicators show that the population on Big Pine Key has declined over the past 60 years (Bradley 2006, p. 35). Dickson (1955) and Alexander and Dickson (1972) reported densities of *C. lineata* var. *keyensis* from plots they established on Big Pine Key in 1951 and 1969, respectively. Dickson (1955) reports a mean density of 10,764 plants/ha (26,599 plants/ac). Alexander and Dickson (1972) report a mean density of 27,871 plants/ha (68,872 plants/ac). In 2005, Bradley (2006, p. 35) recorded 2,339 plants/ha (5,780 plants/ac), 23.4 percent and 9.0 percent of the 1955 and 1972 estimates, respectively. Hurricane Wilma, which passed over Big Pine Key on October 24, 2005, generated storm surge in the lower Keys of up to 10 feet (Bradley 2006, p. 11; Hodges 2010, p. 4). In 2007, density had dropped to 820 plant/ha (2,026 plants/ac) and had not fully rebounded after 9 years (Bradley et al. 2015, pp. 21–22). By 2013, density had fallen to 657 plants/ha (1,624 plants/ac) (Bradley et al. 2015, p. 21). In summary, the data from 2005 to 2013 demonstrate a 63.8 percent decline in the density of *C. lineata* var. *keyensis* on Big Pine Key (Bradley et al. 2015, p. 48). A second indicator, the frequency which *Chamaecrista lineata* var. *keyensis* occurred in sample plots on Big Pine Key from data collected in 2005, 2007, and 2013, also show a decline. *Chamaecrista lineata* var. *keyensis* was present in 37 percent of plots in 2005, and 19 percent of plots in 2013, respectively. This represents a 49 percent reduction in the species frequency in study plots (Bradley et al. 2015, p. 48). A third indicator, total population size for *Chamaecrista lineata* var. *keyensis* on publicly owned pine rocklands on Big Pine Key (478 ha (1,181 ac)), was estimated to be 866,659 plants in 2005 (pre-Hurricane Wilma), 391,944 in 2007 (2 years post-Wilma), and 313,914 in 2013 (8 years post-Wilma). This represents a population decrease of 64 percent (Bradley et al. 2015, p. 21). The most recent estimate (2013) of the *Chamaecrista lineata* var. *keyensis* population on Big Pine Key is 313,914 plants (Bradley et al. 2015, p. 21). Since 82 percent of the pine rocklands on Big Pine Key are publicly owned, this estimate likely accounts for the majority of the population. The most recent estimate of the population on Cudjoe Key is 150 plants (Hodges and Bradley 2006, p. 21). The decline in *Chamaecrista lineata* var. *keyensis* can be largely attributed to loss of pine rocklands habitat to development and modification of this habitat due to inadequate fire management. Folk (1991, p. 188) estimated that pine rocklands historically covered 1,049 ha (2,592 ac), about 44 percent of Big Pine Key. Pine rocklands now cover approximately 582 ha (1,438 ac) of Big Pine Key, 56 percent of the historical estimate by Folk (1991) (Bradley 2006, p. 4). Hurricanes and associated storm surge have also impacted population levels (USFWS, 2013).

Threats and Stressors

Stressor: Fire suppression (USFWS, 2015; USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Fire is required to maintain the pine rockland community (Snyder et al. 1990, pp. 257-263; Carlson et al. 1993, p. 915; Bergh and Wisby 1996, p. 1; Liu et al. 2005a, p. 210; Liu et al. 2005b, p. 71). With fire suppression, hardwoods eventually invade pine rocklands and shade out understory species like Big Pine partridge pea. Fire suppression reduces the size of the areas that do burn, and habitat fragmentation prevents fire from moving across the landscape. Accordingly, in the absence of fire, pine rockland communities tend toward becoming tropical hardwood hammock communities. Complete implementation of a prescribed fire program in the lower Keys

has been hampered by an incomplete understanding of the fire ecology in the area, and by public opposition to burning (USFWS, 2015; USFWS, 2013).

Stressor: Pesticide application (USFWS, 2015; USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Application of pesticides to control mosquitoes may be impacting populations of Big Pine partridge pea by limiting pollinator populations. The flowering season of the species overlaps with the peak of mosquito activity and pesticide application to control mosquitoes in June and July (Liu 2003, p. 7). Liu (2003, p. 14) found declines in the population of one genus of pollinator after spraying events. There were no declines with the second known pollinator genus (Liu 2003, p. 14). Reduced pollinator visits likely accounted for lower fruit production (Liu 2003, pp. 16-17). The pesticide application on Big Pine Key will continue to impact pollinator populations and thus the population of Big Pine partridge pea. At present, even with reduced pollinator populations, the species still has a strong reproductive output (Liu et al. 2005a, pp. 205-216). Liu and Koptur (2003, p. 1186) recommended limiting pesticide applications to control mosquitoes to no more than weekly. However, at this time, the likelihood of implementing this reduction is unlikely (USFWS, 2015; USFWS, 2013).

Stressor: Exotic plants (USFWS, 2015; USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Exotic plants have significantly affected pine rocklands. At least 277 taxa of exotic plants are now known from pine rocklands in south Florida (Service 1999, p. 3-175). Bradley (2006, pp. 25-26) found that 12.1 percent of pine rockland plots on Big Pine Key had exotic plants, and that Big Pine partridge pea had a significant negative correlation with exotic species richness in sample plots. The most frequent exotic plant species recorded were *Schinus terebinthifolius* (Brazilian pepper), *Fimbristylis cymosa* (hurricane sedge), *Swietenia mahagoni* (West Indian mahogany), and *Stenotaphrum secundatum* (St. Augustine grass). Some of these may compete directly with Big Pine partridge pea for space and resources, while others have a profound effect on community structure and responses to fire. Brazilian pepper is the most widespread and one of the most invasive species. If left uncontrolled in a fire-suppressed pineland, it will form a dense monospecific canopy almost completely eliminating native vegetation. It will also affect the characteristics of a fire when one does occur. Fires that once burned fairly coolly with mostly pine needle duff for fuel may now burn much hotter and affect the vegetation that develops following fire. For instance, under some post-fire circumstances, *Pteridium aquilinum* var. *caudatum* (dense bracken fern) thickets develop (Ross and Ruiz 1996, p. 4). Therefore, in the presence of exotic species, additional factors must be accounted for in order to manage fire for the benefit of Big Pine partridge pea. At present, Brazilian pepper is largely under control in intact pine rockland on NKDR lands and the Terrestris Preserve (USFWS, 2015; USFWS, 2013).

Stressor: Sea level rise (USFWS, 2015; USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Climate change is likely to increase the occurrence of saltwater intrusion into coastal aquifers as sea level rises and that sea-level rise is projected to extend areas of salinisation of groundwater and estuaries, resulting in a decrease of freshwater availability for humans and ecosystems in coastal areas (IPCCC 2008, pp. 3, 103). From the 1930s to 1950s, increased salinity of coastal waters contributed to the decline of cabbage palm forests in southwest Florida (Williams et al. 1999, pp. 2056-2059), expansion of mangroves into adjacent marshes in the Everglades (Ross et al. 2000, pp. 9, 12-13), and loss of pine rockland in the Keys (Ross et al. 1994, pp. 144, 151-155). Hydrology has a strong influence on plant distribution in these and other coastal areas (IPCC 2008, p. 57). Such communities typically grade from salt to brackish to freshwater species. Human developments will also likely be significant factors influencing whether natural communities can move and persist (IPCC 2008, p. 57; CCSP 2008, p. 7-6). In the Keys, not only are elevation differences between such communities very slight (Ross et al. 1994, p. 146), but the horizontal distances are small as well. Sea level rise poses a significant threat to the species and its habitat. There has been a 15 cm (5.9 inch [in]) rise in sea level over a 70-year period in the vicinity of Big Pine Key (Ross et al. 1994, p. 145). The pine rockland community in the Keys has undergone a reduction due to sea level rise (Ross et al. 1994, p. 149). For example, the pine rockland area on Sugarloaf Key covered 217 acres (88 ha) prior to 1935, and was reduced to 114 acres (46 ha) by 1935 and 74 acres (30 ha) by 1991 (Ross et al. 1994, p. 149). The loss of pine rockland communities was correlated with elevated ground- and soil-water salinity, and loss of upland plant diversity was inferred (Ross et al. 1994, pp. 150-151). In areas affected by sea level rise, communities of halophytic plants replaced pine rockland communities (Ross et al. 1994, p. 152). Sea level rise of the same order likely occurred among the nearby Big Pine and Cudjoe Keys, but the effects have yet to be quantified on those keys. Based on IPCC and other predictions of sea level rise, Clough (2008, p. 23) concluded that a significant proportion of upland habitat will be lost on Big Pine Key by 2100 (USFWS, 2015; USFWS, 2013).

Stressor: Stochastic events (USFWS, 2015; USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Hurricanes and tropical storms are an additional threat, particularly to the extent that they yield storm surges with salt-water overwash. Hurricane storm surges can inundate landscapes with saltwater for varying durations. Klimstra (1986, p. 3) stated, The effects of salt water on pinelands is well established as a consequence of hurricane Betsy, September 8, 1965. After 20 years the site where waters were entrapped for several hours has not yet fully recovered from complete loss of *Pinus*, *Ernodea*, *Randia*, *Pisonia*, and *Metopium* seedlings. The small area of occupancy and somewhat patchy distribution of Big Pine partridge pea renders it susceptible to extinction through such stochastic events. Hurricane Wilma in 2005 resulted in substantial reductions in population size and distribution. The surge reduced the population by as much as 95 percent in some areas (Bradley 2006, p. 13). The long term impacts of this hurricane are uncertain. However, slash pine needle-fall (litter) appears to provide for fire advancement in pine rockland communities. Because large areas of slash pine are dead since Hurricane Wilma, and may remain so, fire may no longer occur and provide important functions that enable the persistence of Big Pine partridge pea and other flora in these communities (USFWS, 2015; USFWS, 2013).

Recovery

Reclassification Criteria:

Not defined.

Delisting Criteria:

Not defined.

Recovery Actions:

- Not defined.

Conservation Measures and Best Management Practices:

- Increase prescribed fires across all pine rockland areas in NKDR and other portions of Big Pine Key, Cudjoe Key, and on islands that formerly has populations of this taxon. (USFWS, 2013)
- Limit pesticide applications to control mosquitoes to once a week to allow pollinator populations time to recover between applications events. Assess and reduce the use of truck-delivered adulticides (permethrins) from roadsides with NKDR lands adjacent. (USFWS, 2013)
- Consider management tools that mimic fire by opening up the pine rockland canopy (e.g., limb cutting, selective thinning). (USFWS, 2013)
- Continue exotic plant control programs in pine rockland habitat. Exotic plants densities in most pine rocklands areas on Pig Pine Key are currently low; management should continue to prevent spread of aggressive exotics. (USFWS, 2013)
- Big Pine partridge pea should be outplanted to islands where it formerly occurred (Muir and Liu 2003, p. 6). Bradley and Saha (2009, p. 4) surveyed No Name and Little Pine Keys in 2007 and 2008. However, Big Pine partridge pea was found to remain extirpated. If it is not found on those islands, outplantings should occur in open understory areas on both islands, which are part of the species historic range. (USFWS, 2013)
- Engage stakeholders to protect the small population on Cudjoe Key that resides strictly along a roadside. Notify Monroe County road maintenance and law enforcement personnel about the location and specific problems that need to be prevented. (USFWS, 2013)

References

USFWS. 2015. Endangered Species Status for *Chamaecrista Lineata* Var. *Keyensis* (Big Pine Partridge Pea), *Chamaesyce Deltoidea* Ssp. *Serpyllum* (Wedge Spurge), and *Linum Arenicola* (Sand Flax), and Threatened Species Status for *Argythamnia Blodgettii* (Blodgett's Silverbush)

Proposed Rule. 80 FR 58536 - 58567 (September 29, 2015).

USFWS 2013. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for *Chamaecrista lineata keyensis* (Big Pine Partridge Pea). U.S. Fish and Wildlife Service, Region 4 (Southeast Region), March 26, 2013

22 p.

USFWS. 2015. Endangered and Threatened Wildlife and Plants

Endangered Species Status for *Chamaecrista Lineata* Var. *Keyensis* (Big Pine Partridge Pea), *Chamaesyce Deltoidea* Ssp. *Serpyllum* (Wedge Spurge), and *Linum Arenicola* (Sand Flax), and Threatened Species Status for *Argythamnia Blodgettii* (Blodgett's Silverbush)

Proposed Rule. FR Vol. 80, No. 188. Pages 58536-58567

USFWS. 2013. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for *Chamaecrista lineata keyensis* (Big Pine Partridge Pea). U.S. Fish and Wildlife Service, Region 4 (Southeast Region), March 26, 2013

SPECIES ACCOUNT: *Chamaesyce deltoidea pinetorum* (Pineland sandmat)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/6/2017; Southeast Region (R4) (USFWS, 2017)

Physical Description

Chamaesyce deltoidea ssp. *pinetorum* is an ascending to erect perennial herb. The stems are hairy and often reddish. The leaf blades range from kidney-shaped or triangle-shaped and elliptic to oval. The fruit is a 2-mm broad, pubescent capsule. The seeds are 1 mm long, transversely wrinkled, and yellowish in color. Fruit production is year-round, with a peak in the fall. (USFWS, 2017)

Taxonomy

Chamaesyce deltoidea ssp. *pinetorum* was first described by Small in 1905, based on specimens collected in eastern Miami-Dade County. Initially, Small referred to these specimens as *C. pinetorum* but recognized that it was closely related to *Chamaesyce deltoidea*. Herndon (1993, included *C. pinetorum* within the *C. deltoidea* complex, which is composed of three other taxa, two occurring farther north on the Miami Rock Ridge, and one occurring on Big Pine Key in the lower Florida Keys (Monroe County). The three taxa on the Miami Rock Ridge have distinct, but adjacent, ranges. Subsequently, Herndon (1993) has placed all four taxa at the same taxonomic level, treating each as a distinct subspecies under *Chamaesyce deltoidea* (*C. deltoidea* ssp. *pinetorum*, *C. deltoidea* ssp. *serpyllum*, *C. deltoidea* ssp. *adhaerens*, and *C. deltoidea* ssp. *deltoidea*). *Chamaesyce deltoidea* ssp. *deltoidea* and *C. deltoidea* ssp. *adhaerens* occur north of known *C. deltoidea* ssp. *pinetorum* populations, while *Chamaesyce deltoidea* ssp. *serpyllum* is endemic to Big Pine Key. Wunderlin and Hansen (2016) follow Herndon's treatment in using *C. deltoidea* ssp. *pinetorum*. Some modern authors place the genus *Chamaesyce* into the genus *Euphorbia* sensu lato. If placed into the genus *Euphorbia*, the correct name of pineland sandmat is *Euphorbia deltoidea* ssp. *pinetorum*. The online Atlas of Florida Vascular Plants uses the name *Chamaesyce deltoidea* ssp. *pinetorum* (Small) Herndon (Wunderlin and Hansen 2016, p. 1). NatureServe (2016, p. 1) and FDACS (Coile and Garland 2003, p. 11) indicate that *C. deltoidea* ssp. *pinetorum* is accepted. However, the Integrated Taxonomic Information System (ITIS 2016, p. 1) accepts *Euphorbia deltoidea* ssp. *pinetorum* as the scientific name for the subspecies (Gann 2015, p. 168). We have carefully reviewed all taxonomic data to determine that *C. deltoidea* ssp. *pinetorum* is a valid taxon. (USFWS, 2017)

Historical Range

Chamaesyce deltoidea ssp. *pinetorum* occurred historically only with the southern portion of the Miami Rock Ridge, from Homestead to the Long Pine Key region of Everglades National Park, a range of approximately 42 mi (67.6 km). (USFWS, 2017)

Current Range

The current range of *Chamaesyce deltoidea* ssp. *pinetorum* is similar to the historical range, although 98 percent of the pine rocklands (the species' only habitat) outside of the Everglades National Park has been lost to development. (USFWS, 2017)

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (USFWS, 2017)

Lifespan

Adult: Somewhat long-lived; 88 percent of plants survived more than 3 years. Extensive root system (USFWS, 2017)

Dependency on Other Individuals or Species

Adult: Pollinators may include bees, flies, ants, and wasps (USFWS, 2017)

Breeding Season

Adult: year-round

Other Reproductive Information

Adult: This species is known to flower and fruit year round. Peaks in fruiting for *C. deltoidea* ssp. *pinetorum* occur in the fall and are stimulated by fire. (USFWS, 2017)

Reproduction Narrative

Adult: Reproduction is sexual, but little is known about the reproductive biology and ecology of the subspecies. Some of the plants recorded as dead during surveys may have instead been in a cryptic phase. Pollinators are unknown; some other species of *Chamaesyce* are completely reliant on insects for pollination and seed production, while others are self-pollinating. Pollinators may include bees, flies, ants, and wasps. (USFWS, 2017)

Habitat Type

Adult: Pine rockland in pockets of clayey marl or on oolitic limestone

Dependencies on Specific Environmental Elements

Adult: Fire is an important element in maintaining the pine rockland habitat.

Tolerance Ranges/Thresholds

Adult: The plants can stand partial inundation with fresh water for a portion of the year, but do not tolerate salinity. (USFWS, 2017)

Habitat Narrative

Adult: *Chamaesyce deltoidea* ssp. *pinetorum* occurs in pine rocklands. Pine rocklands are maintained by regular fire, and are prone to annual flooding for several months during the wet season. However, *C. deltoidea* ssp. *pinetorum* generally occurs in higher elevation pine rocklands at Long Pine Key in Everglades National Park, in areas rarely subject to flooding. See detailed description of Pine Rockland habitat in Additional Habitat Information (USFWS, 2017)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Dispersal is unknown for *Chamaesyce deltoidea* ssp. *pinetorum*; however, many seed capsules in similar *Chamaesyce* species are explosively dehiscent, a form of dispersal that flings seeds far from the parent plant. *Chamaesyce deltoidea* ssp. *pinetorum* is thought to have a similar, but reduced, level of dispersal (USFWS, 2017)

Population Information and Trends**Number of Populations:**

20 extant occurrences; 9 on public conservation lands owned by Miami-Dade County and the NPS.

Population Size:

14,500 to 146,000 individuals (USFWS, 2017)

Population Narrative:

The total population size of *Chamaesyce deltoidea* ssp. *pinetorum* is estimated to be 14,500-146,000 individuals, with the majority of the population occurring on Long Pine Key. However, while *Chamaesyce deltoidea* ssp. *pinetorum* is most abundant within Everglades National Park, pine rockland fragments outside of the Everglades represent about half the subspecies' extant range. (USFWS, 2017)

Threats and Stressors

Stressor: Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range

Exposure:

Response:

Consequence:

Narrative: Habitat loss, fragmentation and degradation, and associated pressures from increased human population are major threats this species. These threats are expected to increase as remaining pine rocklands and other habitats are lost to development, placing these plants at greater risk. This species may be impacted when pine rocklands are converted to other uses or when lack of fire causes the conversion to hardwood hammocks or other unsuitable habitats. On public lands, including National Park Service lands and Miami-Dade County-owned lands, implementation of prescribed fire has not been sufficient because of legal constraints (permitting requirements) and inadequate funding. Any populations of this species found on private property could be destroyed due to development. Although efforts are being made to conserve natural areas and apply prescribed fire, most pine rocklands remain in poor fire condition, and the long-term effects of large-scale and wide-ranging habitat modification, destruction, and curtailment will last into the future, while ongoing habitat loss due to population growth, development, and agricultural conversion continues to pose a threat to this species outside of conservation lands.

Stressor: Inadequacy of Existing Regulatory Mechanisms

Exposure:

Response:

Consequence:

Narrative: This species is found on Federal, State and County lands. NPS regulations provide protection at Everglades National Park and Big Cypress National Preserve. These two sites continue to support the largest and best managed populations. State regulations provide protection against trade, but allow private landowners or their agents to clear or remove species on the Florida Regulated Plant Index. State Park regulations provide protection for plants within Florida State Parks. The Natural Forest Communities program in Miami is designed to protect rare and important upland (non-wetlands) habitats in south Florida; however, this regulatory strategy has several limitations that reduce its ability to protect this plant and its habitat. Although many populations of this species are afforded some level of protection because they are on public conservation lands, especially Federal lands, existing regulatory mechanisms vary in strength and scope, and do not provide substantive protection of habitat at this time. They have not led to a sufficient reduction of threats posed to these plants by a wide array of sources. (USFWS, 2017)

Stressor: Other Natural or Manmade Factors Affecting Its Continued Existence

Exposure:

Response:

Consequence:

Narrative: Threats from other natural or manmade factors to this species include nonnative, invasive plants; management practices (such as mowing); recreation (including off-road vehicle use), effects from small population size and isolation; limited geographic range; and stochastic events including hurricanes, storm surges, and wildfires. Additionally, this plant is particularly vulnerable to the effects of climate change, including sea level rise, as changes in the water table, increased soil salinity from partial inundation, and storm surge will likely result in vegetation shifts in the decades prior to the fully anticipated sea level rise. Some of these threats (e.g., nonnative species) may be reduced on public lands due to active programs by Federal, State, and County land managers. Many of the remaining populations of this plant are small and geographically isolated, and genetic variability is likely low, increasing the inherent risk due to overall low resilience of these plants. The threats act together to impact populations of this species. (USFWS, 2017)

Recovery

Reclassification Criteria:

Not defined.

Delisting Criteria:

Not defined.

Recovery Actions:

- Not defined.

Conservation Measures and Best Management Practices:

- Conserve pine rocklands and suitable habitat through purchase or conservation easements (Wendelberger 2003, p. 182).
- Remove exotic plants or hardwoods. Use manual labor, herbicides, and prescribed fire, and once cleared, use proper management to reduce costs of control and to maintain the site free of exotics

(Bradley and Gann 1999, p 26.). Control seed sources in small, fragmented areas surrounded by urban development (Bradley and Gann 1999, p. 26).

- Implement regular, prescribed burns to create or maintain suitable habitat conditions. In general, a mosaic of burns should be used, and the recommended burning regime is 3 to 7 years with summer burns generally preferred to winter burns (Bradley and Gann 1999, p. 26). Where fire has been suppressed for long periods of time, reintroduce fire in a step-wise manner (Bradley and Gann 1999, p. 26; Wendelberger 2003, p. 182). Include a monitoring program to determine effectiveness of the fire prescription (Bradley and Gann 1999, p. 26).
- Monitor and manage pine rockland fragments in Miami-Dade County.
- Continue monitoring rare plants at Long Pine Key (Gann et al. 2006, p. 2). It is important to determine effects (positive or negative) from Everglades restoration and other hydrologic manipulations and changes.
- Resurvey known locations and compare those data with current location data to better understand the stability and size of the population (Wendelberger 2003, p. 183; Maschinski et al. 2005, p. 163).
- Consider ex situ collections (Maschinski et al. 2005, p. 163).
- Assess the need for studies to determine current level of genetic variation remaining in extant occurrences.
- Assess the need to augment the population (Wendelberger 2003, p. 183).

References

USFWS. 2017. Endangered Species Status for *Dalea carthagenensis* var. *floridana* (Florida Prairie-clover), and Threatened Species Status for *Sideroxylon reclinatum* ssp. *austrofloridense* (Everglades Bully), *Digitaria pauciflora* (Florida Pineland Crabgrass), and *Chamaesyce deltoidea* ssp. *pinetorum* (Pineland Sandmat). Final Rule. 82 FR 46691-46715 (October 6, 2017).

USFWS. 2016. Proposed Threatened Species Status for *Sideroxylon reclinatum* ssp. *austrofloridense* (Everglades Bully), *Digitaria pauciflora* (Florida Pineland Crabgrass), and *Chamaesyce deltoidea* ssp. *pinetorum* (Pineland Sandmat) and Endangered Species Status for *Dalea carthagenensis* var. *floridana* (Florida Prairie-Clover). Proposed Rule. 81 FR 70282 - 70308 (October 11, 2016).

USFWS. 2017. Endangered Species Status for *Dalea carthagenensis* var. *floridana* (Florida Prairie-clover), and Threatened Species Status for *Sideroxylon reclinatum* ssp. *austrofloridense* (Everglades Bully), *Digitaria pauciflora* (Florida Pineland Crabgrass), and *Chamaesyce deltoidea* ssp. *pinetorum* (Pineland Sandmat). Final Rule. 82 FR 46691-46715 (October 6, 2017).

USFWS 2013. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form For *Chamaesyce deltoidea* *pinetorum* (Pineland Sandmat). U.S. Fish and Wildlife Service Region 4 (Southwest Region), 03/26/2013. 18 p.

SPECIES ACCOUNT: *Chamaesyce deltoidea serpyllum* (Wedge spurge)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/31/2016; Southeast Region (R4) (USFWS, 2016)

Physical Description

Wedge spurge is a small, prostrate perennial herb. The stems are slender and numerous, radiating out from the tap root. The leaves are more or less triangular. The flowers are cyathia, the specialized inflorescences characteristic of the genus *Euphorbia* and its close relatives. Reproduction is sexual. Some species of *Chamaesyce* are completely reliant on insects for pollination and seed production while others are self pollinating (Bradley and Gann 1999, p. 32). Pollinators may include bees, flies, ants, and wasps (Ehrenfeld 1979, pp. 95-97). No studies of reproductive biology or ecology have been conducted and these topics are poorly known for *Chamaesyce* in general. (USFWS, 2015; USFWS, 2013).

Taxonomy

John K. Small collected plants on Big Pine Key and first described *C. deltoidea* ssp. *serpyllum* as *C. serpyllum*. The taxon was later found to be related to the *C. deltoidea* complex, and subsequently ascribed to it. That complex includes several additional taxa found in the pine rockland flora of Miami-Dade County (Bradley and Gann 1999, p. 31). *Chamaesyce* is distinguished by having the main stem abortive just above the cotyledons. Synonyms include: *Chamaesyce serpyllum* Small and *Euphorbia deltoidea* Engelm. ex Chapman var. *serpyllum* (Small) Oudejans (U.S. Department of Agriculture, Natural Resources Conservation Service 2011, p. 1) (USFWS, 2015; USFWS, 2013).

Historical Range

Florida: Big Pine Key, Monroe County. (USFWS, 2015)

Current Range

Florida: Big Pine Key, Monroe County. The current range of is on Big Pine Key. Small groups of plants are scattered widely across the island (USFWS, 2015).

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (USFWS, 2013; USFWS, 2015)

Dependency on Other Individuals or Species

Adult: Pollinators may include bees, flies, ants, and wasps (Ehrenfeld 1979, pp. 95-97) (USFWS, 2015)

Reproduction Narrative

Adult: Some species of *Chamaesyce* are completely reliant on insects for pollination and seed production while others are self pollinating (Bradley and Gann 1999, p. 32). No studies of reproductive biology or ecology have been conducted and these topics are poorly known for *Chamaesyce* in general (USFWS, 2013).

Habitat Type

Adult: Pine rocklands (USFWS, 2015).

Dependencies on Specific Environmental Elements

Adult: Pine rockland is maintained by relatively frequent fires (every 2-3 years to a maximum of 15 years), which maintain the understory woody plants at shrub height (Snyder et al. 1990, pp. 257-263; Carlson et al. 1993, p. 915; Bergh and Wisby 1996, p. 1; Liu et al. 2005a, p. 210, Liu et al. 2005b, p. 71). In the absence of fire, many areas become wooded, eventually succeeding to rockland hammock (i.e., hardwood forest) (Snyder et al. 1990, p. 260) (USFWS, 2013).

Environmental Specificity

Adult: High

Habitat Narrative

Adult: *Chamaesyce deltoidea* ssp. *serpyllum* occurs in pine rocklands and adjacent disturbed sites on Big Pine Key, including roadsides. It most often grows directly from crevices in the oolitic limestone substrate (Bradley and Gann 1999, p. 31). Pine rocklands are described in detail for *Chamaecrista lineata* var. *keyensis*, above. Within pine rocklands, *Chamaesyce deltoidea* ssp. *serpyllum* is associated with areas of relatively higher elevation, extensive exposed rock substrate, where the understory is open, hardwood and palm density is low, and native herbaceous species cover and richness are high (Bradley and Saha 2009, p. 26; Ross and Ruiz 1996, p. 6; Bradley 2006, p. 27). Roadsides dominated mostly by native herbs and grasses where exotic lawn grasses are not established are a potentially important habitat for *C. deltoidea* ssp. *serpyllum* (Bradley 2006, p. 37). (USFWS, 2015). Wedge spurge is historically known only from pine rockland vegetation on Big Pine Key (Bradley and Gann 1999, p. 31). Pine rocklands in the lower Florida Keys are dominated by a canopy of *Pinus elliottii* var. *densa* (South Florida slash pine). The subcanopy is composed of *Thrinax morrisii* (brittle thatch palm), *Psidium longipes* (longstalked stopper), *Metopium toxiferum* (poisonwood), *Byrsonima lucida* (locustberry), *Pithecellobium keyense* (blackbead), and *Coccothrinax argentata* (silver palm) (Bradley 2006, p. 25). There is also a rich herbaceous layer composed of grasses and herbs. Limestone bedrock and exposed calcareous rubble are prominent features associated with pine rockland communities (Snyder et al. 1990, pp. 235-236; Ross and Ruiz 1996, p. 4). In addition to the more common associates, wedge spurge can grow in association with other rare taxa, including *Linum arenicola* (sand flax), and *Chamaecrista lineata* var. *keyensis* (Big Pine partridge pea) (Bradley and Gann 1999, p. 32) (USFWS, 2013).

Dispersal/Migration**Motility/Mobility**

Adult: Low

Population Information and Trends

Population Size:

368,557 (USFWS, 2015)

Population Narrative:

Total population size for *Chamaesyce deltoidea* ssp. *serpyllum* on publicly owned pine rocklands on Big Pine Key (478 ha (1,181 acres)) was estimated to be 352,993 plants in 2005 (preHurricane Wilma), 343,255 in 2007 (post-Wilma), and 368,557 in 2013. This represents a slight (4.4 percent) increase in the known population size of from 2005 to 2013 (Bradley et al. 2013, p. 21) (USFWS, 2015).

Threats and Stressors

Stressor: Fire suppression (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: At present, fire suppression may be one of the greatest threats to wedge spurge. While fires may have occurred at least once per decade in the past, the fire frequency since about 1950 has been sharply reduced throughout the island, despite occasional prescribed burns conducted by the Service and TNC (Bergh and Wisby 1996, p. 1). While fire suppression has occurred mostly adjacent to developed areas, all pine rockland areas on Big Pine Key have suffered from lack of fire, including pine rockland within the NKDR. Because of this drop in burn frequency, habitat characteristics have changed. Fire is required to maintain the pine rockland community (Snyder et al. 1990, pp. 257-263; Carlson et al. 1993, p. 915; Bergh and Wisby 1996, p. 1; Liu et al. 2005a, p. 210; Liu et al. 2005b, p. 71). With fire suppression, hardwoods eventually invade pine rocklands and shade out understory species like wedge spurge. Fire suppression reduces the size of the areas that burn, and habitat fragmentation prevents fire from moving across the landscape. Accordingly, in the absence of fire, pine rockland communities tend toward becoming tropical hardwood hammock communities. In many areas, pine rockland communities have been succeeded by tropical hardwood hammock flora (USFWS, 2013).

Stressor: Sea level rise (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Sea level rise is a significant threat to the species and its habitat. There has been a 15 centimeter (5.9 inch) rise in sea level over a 70-year period in the vicinity of Big Pine Key (Ross et al. 1994, p. 145). The pine rockland community in the Keys has undergone a reduction due to sea level rise (Ross et al. 1994, p. 149). For example, the pine rockland area on Sugarloaf Key covered 217 acres (88 ha) prior to 1935, and was reduced to 114 acres (46 ha) by 1935 and 74 acres (30 ha) by 1991 (Ross et al. 1994, p. 149). The loss of pine rockland communities and upland plant diversity was correlated with elevated ground- and soil-water salinity (Ross et al. 1994, pp. 150-151). In areas affected by sea level rise, communities of halophytic plants replaced pine rockland communities (Ross et al. 1994, p. 152). Based on IPCC and other predictions of sea level rise, Clough (2008, p. 23) concluded that a significant proportion of upland habitat will be lost on Big Pine Key by 2100 (USFWS, 2013).

Stressor: Nonnative invasive plants (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: Exotic plants have detrimental impacts on pine rocklands. Some of these are a threat to wedge spurge because they alter community structure and composition or even form dense monocultures in habitats otherwise used by wedge spurge. Some exotic species invade pine rocklands and edge habitats that are otherwise suitable for wedge spurge. Some of these may compete directly with wedge spurge for space and resources, while others have a profound effect on community structure and responses to fire. When habitats are infested by invasive exotics, lack of control (particularly if in conjunction with fire suppression) may result in dense foliage and high fuel loads. If left uncontrolled in a fire-suppressed pineland, invasive species such as Brazilian pepper may form a dense monospecific canopy almost completely eliminating native vegetation. They will also affect the characteristics of a fire when it occurs, and or the structure and composition of plant communities after fire occurs. This results in additional threats to wedge spurge. Where exotic plants are present, the known benefits of prescribed fire for wedge spurge are less certain to occur. When there are fires in infested areas, instead of being relatively cool fires that consume light fuels (e.g., pine needle litter) as in the past, they may burn much hotter and have detrimental effects on the vegetation that develops following fire (USFWS, 2013).

Stressor: Catastrophic events (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: Hurricanes and tropical storms are an additional threat, particularly to the extent that they yield storm surges with salt-water overwash. Hurricane storm surges can inundate landscapes with saltwater for varying durations. Klimstra (1986, p. 3) stated that the effect of salt water on pinelands is well established as a consequence of hurricane Betsy, September 8, 1965. After 20 years the site where waters were entrapped for several hours has not yet fully recovered from complete loss of *Pinus*, *Ernodea*, *Randia*, *Pisonia*, and *Metopium* seedlings. The small area of occupancy and somewhat patchy distribution of wedge spurge renders it susceptible to extinction through such stochastic events. In 2005, Hurricane Wilma resulted in a storm surge that covered most of Big Pine Key with seawater (USFWS, 2013).

Stressor: Demographic and genetic factors (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: The small area, few occurrences, and somewhat patchy distribution of wedge spurge renders it susceptible to extinction risks associated with stochastic demographic, genetic, and environmental events, including catastrophic storms. Further reduction of population size would likely enhance threats associated with genetics and demographic stochasticity (Caughley 1994, p. 217) (USFWS, 2013).

Recovery**Reclassification Criteria:**

Not defined.

Delisting Criteria:

Not defined.

Recovery Actions:

- Not defined.

Conservation Measures and Best Management Practices:

- Increase prescribed fires. Prescribed fires should be conducted across all pine rockland areas in NKDR and other portions of Big Pine Key. NKDR has revised its Comprehensive Conservation Plan; this plan calls for a revised Fire Management Plan. (USFWS, 2013)
- Mechanical treatments to control understory can be effective in preparing for prescribed fires. These techniques will probably be most beneficial in pine rockland areas that have undergone long periods of fire suppression. There are many such areas in the southern half of Big Pine Key. (USFWS, 2013)
- Conduct further research into fuel reduction and fire-wedge spurge interactions, including the effects of mechanical treatments. (USFWS, 2013)
- Establish and maintain fire breaks; quantify before the outcome is determined. (USFWS, 2013)
- Given the large impact of Hurricane Wilma, monitor wedge spurge and community characteristics that are positively correlated with wedge spurge occurrences on multiple spatial scales. (USFWS, 2013)
- Continue exotic plant control programs in pine rockland habitat. Exotic plant densities in most pine rockland areas on Big Pine Key are currently low, and management should continue to prevent spread of invasive exotic plants. (USFWS, 2013)
- NKDR should institute an integrated program of adaptive management in order to prioritize and optimize efforts and objectives pertaining to pine rockland viability, fire regimes, and fuel reduction relative to wedge spurge and other endemic plants. (USFWS, 2013)
- Develop sea level rise and hurricane impact models, and encourage the integration of these models in management efforts in order to enhance their effectiveness. (USFWS, 2013)
- Conduct studies on reproductive biology and ecology of wedge spurge. (USFWS, 2013)
- Consider the need to establish and maintain an ex situ collection of wedge spurge in the future to reduce its vulnerability to catastrophic events, if the trend in population continues to decline. (USFWS, 2013)

References

USFWS. 2015. Endangered Species Status for *Chamaecrista Lineata* Var. *Keyensis* (Big Pine Partridge Pea), *Chamaesyce Deltoidea* Ssp. *Serpyllum* (Wedge Spurge), and *Linum Arenicola* (Sand Flax), and Threatened Species Status for *Argythamnia Blodgettii* (Blodgett's Silverbush)

Proposed Rule. 80 FR 58536 - 58567 (September 29, 2010).

USFWS 2013. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for *Chamaesyce deltoidea serpyllum* (Wedge Spurge). U.S. Fish and Wildlife Service, Region 4 (Southeast Region), March 26, 2013

Proposed Rule. 80 FE 58536 - 58567 (September 29, 2015).

USFWS. 2015. Endangered and Threatened Wildlife and Plants

Endangered Species Status for *Chamaecrista Lineata* Var. *Keyensis* (Big Pine Partridge Pea), *Chamaesyce Deltoidea* Ssp. *Serpyllum* (Wedge Spurge), and *Linum Arenicola* (Sand Flax), and Threatened Species Status for *Argythamnia Blodgettii* (Blodgett's Silverbush)

Proposed Rule. Vol. 80, No. 188. Pages 58536-58567.

USFWS. 2013. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for *Chamaesyce deltoidea serpyllum* (Wedge Spurge). U.S. Fish and Wildlife Service, Region 4 (Southeast Region), March 26, 2013

SPECIES ACCOUNT: *Cordylanthus tenuis ssp. capillaris* (Pennell's bird's-beak)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/06/1995; California/Nevada (Region 8)

Physical Description

A branching herbaceous annual of the broomrape family (Orobanchaceae). The plant grows 30 to 60 centimeters (12 to 24 inches) tall, with yellow-green hairless herbage that becomes purplish with age. The leaves are entire (with smooth edges), or those of the primary stem three-parted, and threadlike. The floral bracts are three-parted up to two-thirds of their length, with fine marginal hairs on bracts and calyx (collective term for the sepals or outermost whorl of flower parts). The tubular corolla (collective term for all the petals) is 1.5 centimeters (0.6 inch) long (Chuang and Heckard 1986), and gamet-brown laterally, paler dorsally (Pennell 1950). Each capsule contains 10 to 16 seeds (Chuang and Heckard 1986). (USFWS, 1998; USFWS, 2019b)

Taxonomy

Cordylanthus capillaris (Pennell's bird's-beak) was first described by Pennell (1950). Chuang and Heckard (1986) reclassified the *Cordylanthus* genus and considered Pennell's bird's-beak to be a subspecies: *C. tenuis ssp. capillaris*. At the time of listing, the genus was considered within the snapdragon family (Scrophulariaceae). Presently, the genus *Cordylanthus* is considered within the broomrape family (Orobanchaceae) (Olmstead et al. 2001). (USFWS, 2011)

Historical Range

Known only from the Outer North Coast Ranges floristic province of Sonoma County, California, a range of a few square miles (vicinity of unincorporated Camp Meeker area). (USFWS, 2019b)

Current Range

Known only from the Outer North Coast Ranges floristic province of Sonoma County, California, a range of a few square miles (vicinity of unincorporated Camp Meeker area). (USFWS, 2019b)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (self-incompatible) (USFWS, 2011)

Lifespan

Adult: 1 year (USFWS, 2011)

Dependency on Other Individuals or Species

Adult: Members of the *Cordylanthus* genus require bees for effective pollination (Chuang and Heckard 1986).

Breeding Season

Adult: June to July (USFWS, 2011)

Reproduction Narrative

Adult: Pennell's bird's-beak is an herbaceous annual of the broomrape family (Orobanchaceae) (Olmstead et al. 2001) and it flowers from June through July (Chuang and Heckard 1986).

Members of the *Cordylanthus* genus require bees for effective pollination (Chuang and Heckard 1986). The fruit are capsules containing 10 to 16 seeds (Chuang and Heckard 1986). *C. tenuis* ssp. *capillaris* were found to be self-incompatible (Chuang and Heckard 1986).

Habitat Type

Adult: Terrestrial (USFWS, 2011)

Habitat Vegetation or Surface Water Classification

Adult: Chaparral communities (USFWS, 2011)

Geographic or Habitat Restraints or Barriers

Adult: Restricted to elevations from 45 to 245 meters (148 to 804 feet) (USFWS, 2011)

Spatial Arrangements of the Population

Adult: Colonies (USFWS, 2011)

Habitat Narrative

Adult: *Cordylanthus tenuis* ssp. *capillaris* grows only on serpentine soils among chaparral and closed pine forests (Chuang and Heckard 1986) and are found in colonies. Occurrences range in elevation above mean sea level from 45 to 245 meters (148 to 804 feet) (Calflora 2011, CNPS 2011). *Cordylanthus tenuis* ssp. *capillaris* is associated with Sargent's cypress (*Cupressus sargentii*), Baker's manzanita, and coffeeberry (*Rhamnus californica*) (Chuang and Heckard 1986). (USFWS, 2011)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Unknown (USFWS, 2019a)

Number of Populations:

4 (USFWS, 2019a)

Population Size:

Unknown; fluctuates from well over 10,000 to a few individuals at each location (USFWS, 2019a)

Population Narrative:

In 2011, Pennell's bird's-beak was recognized to occur in five separate locations (USFWS 2011). Currently, Pennell's bird's-beak is known from four locations (CNDDDB 2018). California Natural Diversity Database lists occurrence #1 as mainly within the Harrison Grade Ecological Reserve, owned and managed by CDFW. The fifth occurrence is combined with occurrence #4. Two occurrences (#2 and #4) are within what is now the Bohemia Ecological Preserve. This property is protected under a conservation easement, which is owned and managed by Land Paths since 2012 (E. Mullen, pers. comm. 2018). Occurrence #3 is located on the privately owned Twin Valley Ranch near Porter Creek, about 11 kilometers (6.8 miles) northeast of occurrence #2. However, this site has not been surveyed in the past 20 years. While the status of this population remains unknown, it is assumed to be extant. Anecdotal reports suggest many Pennell's bird's-beak populations exist on private property outside of the before mentioned occurrences in areas where botanical surveys have not been done (G. Cooley, pers. comm. 2018). Biologists with CDFW have observed Pennell's bird's-beak on private properties outside of the reserve boundaries at the Harrison Grade Ecological Reserve (J. Bjerke, in litt. 2018b). The full extent of the population remains unknown. (USFWS, 2019a)

Threats and Stressors

Stressor: Development (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: At the time of listing, development and associated road construction on the private lands containing occurrence 1, which would result in loss, modification, and destruction of *Cordylanthus tenuis* ssp. *capillaris* habitat, were considered potential threats. Development plans had included the donation of 87 hectares (including *C. tenuis* ssp. *capillaris* habitat) to the county for use as a park (Service 1998). However, although some roads were constructed, the development never took place, and the land was subsequently sold. Habitat for *Cordylanthus tenuis* ssp. *capillaris* along Bohemian Highway has been significantly reduced within the past 23 years (Herrick, in litt. 2011). Parts of the talus and bank have been removed and a windrow has been planted in areas known to be previously colonized by *C. tenuis* ssp. *capillaris* (Herrick, in litt. 2011). (USFWS, 2011)

Stressor: Vineyards (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Presently, within the past 5 to 10 years along Stoetz Lane parcels of land have been converted vineyards. The conversion to vineyards of potential *C. tenuis* ssp. *capillaris* habitat continues to threaten populations at CNDDDB occurrence 2 (Herrick, in litt. 2011). (USFWS, 2011)

Stressor: Timber harvest (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: CNDDDB Occurrence 1 is located on property where timber harvesting has occurred since the time of listing (G. Hale, Sonoma Land Trust, in litt. 2011). Similarly, timber harvesting has occurred on the property where Occurrence 6 is located, and may continue in the future (Robertson 2011, Zito 2011). Timber harvesting can cause significant changes in the species richness and diversity in the herbaceous plant layer (Battles et al. 2001, Macdonald and Fenniak 2007). Although some effects of canopy removal can be short-lived, many other effects persist over a much longer timeframe (e.g., disturbance-mediated limitations to dispersal) (Gilliam 2007). Such effects could be detrimental to populations of *C. tenuis* ssp. *capillaris*. Roadside maintenance such as mowing has been reported at occurrence 4, and cattle grazing was reported at occurrence 5 (CNDDDB 2011). (USFWS, 2011)

Stressor: Mowing and grazing (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Mowing and grazing before the plants flower, typically June through July (Chuang and Heckard 1986) would prevent the generation of seeds. As an annual herbaceous plant species, *C. tenuis* ssp. *capillaris* relies on seed banks to maintain population levels. Horses and deer were reported to browse on *Cordylanthus tenuis* ssp. *capillaris*. The site of occurrence 5 has been used for cattle grazing (CNDDDB 2011). In general, however, the number of plants damaged by grazing continues to be unknown. (USFWS, 2011)

Stressor: Diseases (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Due to the hemiparasitic nature of *Cordylanthus tenuis* ssp. *capillaris*, diseases to potential host species may threaten *C. tenuis* ssp. *capillaris* populations. *Phytophthora cinnamomi* is a pathogen causing mortality in a number of native forests and chaparral communities in northern California (Swiecki, in litt. 2008, p. 2). *Phytophthora ramorum* is another pathogen known to cause sudden oak death in at least four coastal California oak species (Garbelotto et al., 2001; Rizzo and Garbelotto 2003). The Service lacks adequate information to determine the potential effects of these pathogens on *Cordylanthus tenuis* ssp. *capillaris*. (USFWS, 2011)

Stressor: Increasing human populations (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Increasing human populations in central California coastal counties were reported to place a great strain on undeveloped wild-lands, such as those found on the serpentine soils (Service 1995). Listed factors include pedestrian and off-road vehicle traffic, hiking and bicycle trails, and unauthorized garbage dumping. These factors can lead to increased erosion, the establishment of non-native, invasive plants, and the fragmentation of the native plant populations (Service 1995). In turn the native plant populations are increasingly susceptible to natural factors that can negatively affect viability, such as fire and disease (Brigham and Schwartz 2010). The limited number and isolated conditions of the *Cordylanthus tenuis* ssp. *capillaris*

populations, resulting from these natural and manmade factors, can render the species susceptible to stochastic extinction (Brigham and Schwartz 2010). (USFWS, 2011)

Stressor: Roadside maintenance (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Roadside maintenance, such as mowing and spraying, and vehicular traffic were mentioned as threats to *Cordylanthus tenuis* ssp. *capillaris* in the 1995 listing (Service 1995). Unauthorized dumping of articles ranging from appliances to bottles also was mentioned as factors affecting *C. tenuis* ssp. *capillaris* (Service 1995). Whereas light road grading was thought to facilitate establishment of *C. tenuis* ssp. *capillaris*, heavy road disturbance may increase the invasion of non-native plant species (Service 1995). (USFWS, 2011)

Stressor: Habitat fragmentation (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Leimu et al. (2006), in meta-analyses of plant studies published between 1987 and 2005, determined that the negative effects of habitat fragmentation (e.g., reduced genetic variation, increased demographic stochasticity) are more common among self-incompatible and rare plant species. *Cordylanthus tenuis* ssp. *capillaris* is not only rare, but also self-incompatible (Chuang and Heckard 1986). Although natural selection pressures have acted over time to create a niche for *C. tenuis* ssp. *capillaris* on serpentine soils, the fragmented nature of serpentine habitats can leave rare plants dependent upon them susceptible to vagaries of stochastic events. Indeed, populations of *C. tenuis* ssp. *capillaris* vary among years (CNDDDB 2011), and the causes for annual variations are not readily apparent. (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to particular species at this time. (USFWS, 2011)

Stressor: Ozone (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Ozone due to photochemical smog is another potential threat to *Cordylanthus tenuis* ssp. *capillaris*. Several studies have documented harmful effects of increased nitrogen deposition, such as increased foliar injury and growth reduction (e.g., Miller 1992; Grantz and

Yang 1996; Bytnerowicz 2002), yet no information exists specifically for *C. tenuis* ssp. *capillaris*. (USFWS, 2011)

Recovery

Reclassification Criteria:

1. The two confirmed populations of *Cordylanthus tenuis* ssp. *capillaris* (Harrison Grade and Bohemian Highway) are (1) fully protected and managed with the primary intention of preserving the populations in perpetuity; and (2) shown to be stable or increasing over a minimum of 20 years that include the normal precipitation cycle (or longer if suggested by the results of demographic monitoring). (USFWS, 1998)
2. Seed collected from both remaining natural populations is stored at a minimum of two Center for Plant Conservation certified botanic gardens. (USFWS, 1998)
3. Reliable seed germination and propagation techniques for the species are understood. (USFWS, 1998)

Delisting Criteria:

- A/1: Areas of occupied habitat are secured or established and voluntarily protected in perpetuity for at least ten known sites large enough to incorporate the seasonal and spatial variation of new colonies. Protected areas are at least 12 hectares (30 acres), unless future research indicates otherwise. (USFWS, 2019b)
- A/2: The breadth of current genetic variation is represented at protected sites. (USFWS, 2019b)
- A/3: No damage is recorded over the course of 20 years due to trampling or vandalism. (USFWS, 2019b)
- E/1: Plants that are nonnative to serpentine habitats are monitored and controlled at a level that allows for the increase, establishment, and persistence of Pennell's bird's-beak in protected areas on suitable habitat. (USFWS, 2019b)

Recovery Actions:

- 1. Establish or protect additional populations of Pennell's bird's-beak. 1.1 Conduct botanical field surveys to discover additional populations. (Priority 1). 1.2 Protect additional populations through voluntary conservation agreements or land acquisitions. (Priority 1). 1.3 Collect and introduce Pennell's bird's-beak seeds in areas of appropriate habitat on protected lands. (Priority 1). 1.4 Survey reintroduction sites annually to determine abundance and extent. (Priority 2). (USFWS, 2019b)
- 2. Conduct research to increase understanding of Pennell's bird's-beak life history and annual establishment. 2.1 Conduct research to determine the full range (area and extent) of the species. (Priority 3). 2.2 Conduct demographic surveys and long-term monitoring that includes, but is not limited to, habitat surveys, genetic research, host-parasite dynamics, and annual establishment. (Priority 1). 2.3 Investigate and monitor potential management methods to maximize population success. Adapt and modify management as necessary. (Priority 2). (USFWS, 2019b)

- 3. Conduct genetic research to determine if genetically distinct populations exist outside of protected areas. (Priority 3). (USFWS, 2019b)
- 4. Monitor and manage Pennell's bird's-beak populations on protected lands. 4.1 At locations where the plant is protected, establish management plans to ensure the quality of existing habitat is maintained and/or degraded habitat is restored. (Priority 2). 4.2 Conduct regular patrols to deter illegal dumping in habitat. If needed, mitigate the effects of illegal dumping on habitat. (Priority 3). 4.3 Store seeds in at least two Center for Plant Conservation certified facilities. Unless storage techniques and/or research show otherwise, replenish seed stock every 10 years to ensure seed viability. (Priority 2). 4.4 Establish a Service-approved monitoring plan to cover a minimum of 5 years post-delisting. The plan will be ready for implementation at the time of delisting to ensure the ongoing conservation of the species and the continued effectiveness of management actions. Adequate funding must be dedicated in order to implement the delisting management plan. (Priority 3). (USFWS, 2019b)
- Until research shows otherwise, recovery should target securing populations containing a minimum of 2,000 plants each (but preferably more). The probability of population persistence over the long-term is expected to be higher for larger populations because large size decreases the likelihood of reduced viability or population extirpations due to random demographic or genetic events (Barrett and Kohn 1991, Ellstrand and Elam 1993). (USFWS, 1998)
- Protecting and managing populations at the two remaining locations by working with the California Department of Fish and Game and private landowners to ensure long-term survival of the species. Populations on private land should be protected by land acquisition, conservation easements, or other means. In general, the largest possible block of serpentine habitat should be protected at each site. Protection should, at least, involve securing the populations themselves as well as a 150- meter (500-foot) buffer around each population, where possible, to reduce external influences and allow expansion of populations. In addition, other unoccupied habitat at the sites that might provide space for expansion of the populations and habitat for pollinators and seed dispersers must be protected. Management plans emphasizing *Cordylanthus tenuis* ssp. *capillaris* and other special status species in these locations must be developed and implemented. The plans should include provisions for standardized annual monitoring of *Cordylanthus tenuis* ssp. *capillaris* populations to determine demographic trends. The plans should also include strategies to minimize known threats at the sites as well as to identify new threats as they may appear. In particular, threats from off road vehicle use, dumping, and roadside maintenance must be eliminated. If new threats (e.g. invasion of non-natives) are identified or other new information becomes available, management plans need to be reevaluated and revised. (USFWS, 1998)
- Collection and banking of seed in Center for Plant Conservation certified botanic gardens is also a high priority recovery action for *Cordylanthus tenuis* ssp. *capillaris*. Seed banking is prudent to guard against extinction of the species from chance catastrophic events and to provide potential material for enhancement efforts in existing populations, repatriations, and/or introductions to new sites. In the absence of genetic data for *Cordylanthus tenuis* ssp. *capillaris*, seed banking should include collections from all known populations. Care should be taken to ensure that seed collection does not adversely affect the donor populations. (USFWS, 1998)

- Other suitable serpentine habitat should be surveyed to determine whether undiscovered populations exist. If new populations are discovered, they should be protected and managed as discussed above. During these surveys, potential introduction sites might also be identified. (USFWS, 1998)
- Research on seed germination and propagation techniques that take into account the hemiparasitic nature of the plant, the use of burning as a management strategy, and basic research on demography (including soil seed bank) and reproduction (including mating system and pollination). Demographic research would be valuable to identify limiting life history stages. (USFWS, 1998)
- Recommended Future Action from 2011 5-Year Review: Protect known occurrences from threats by acquiring the private lands from willing sellers where *Cordylanthus tenuis* ssp. *capillaris* is known to occur. (USFWS, 2011)
- Recommended Future Action from 2011 5-Year Review: Design and implement a comprehensive survey method for *Cordylanthus tenuis* ssp. *capillaris*. Survey designs should incorporate geographic information systems (G.I.S.) technology to identify additional suitable sites for *C. tenuis* ssp. *capillaris*. (USFWS, 2011)
- Recommended Future Action from 2011 5-Year Review: Work with land owners and land managers to gain access to known and potential suitable sites for *Cordylanthus tenuis* ssp. *capillaris* populations. Annual population surveys of known occurrences should be reported to the CNDDDB. (USFWS, 2011)
- Recommended Future Action from 2011 5-Year Review: Scientific studies should be conducted to identify ideal host species. Chuang and Heckard (1971) have inferred suitable host species for *Cordylanthus tenuis* ssp. *capillaris*, yet individual plant fitness varies with host plant relationships. Studies remain to identify decisively the optimal host species. (USFWS, 2011)
- Recommended Future Action from 2011 5-Year Review: Ascertain the importance of habitat disturbance to *Cordylanthus tenuis* ssp. *capillaris*. Current occurrences are openings among chaparral and conifer woodlands. Management strategies should evaluate the effectiveness of timber removal and fire ecology for the propagation of the species. (USFWS, 2011)
- Recommended Future Action from 2019 5-Year Review: Survey to identify potential habitat. A comprehensive and systematic survey of serpentine habitats for the presence of Pennell's bird's-beak has yet to be conducted. A new occurrence was discovered in 1997 during surveys for a different serpentine plant (CNDDDB 2018). Anecdotal reports suggest additional populations might exist on private property. By identifying these areas and working with local landowners, additional occurrences might be protected in perpetuity. (USFWS, 2019a)
- Recommended Future Action from 2019 5-Year Review: Conduct research to better understand Pennell's bird's-beak life history, demographics, annual establishment, etc. Very little is known about the demographics and life history of Pennell's bird's-beak. Future research should be focused on informing conservation and management decisions. Current occurrences indicate that site disturbance might promote colonization, yet the role of disturbance mechanisms such as fire and flooding is unknown. Conducting long-term 4 demographic surveys and monitoring that include habitat surveys, genetic research, host-parasite dynamics and annual establishment would further recovery goals. (USFWS, 2019a)

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SPECIES ACCOUNT: *Cornutia obovata* (Palo de nigua)

Species Taxonomic and Listing Information

Listing Status: Endangered; 4/7/1988; Southeast Region (R4) (USFWS, 2015)

Physical Description

An evergreen tree which reaches 10 to 15 meters in height and 25 centimeters in diameter. The leaves are opposite, simple, obovate, blunt or rounded at the apex. The lower surface of leaves is finely hairy with minute, golden, shiny glandular dots. Leaves may be from 5 to 14 centimeters long and from 4 to 8 centimeters wide. Three or four prominent, ascending, curved veins are present on either side of the mid—vein. Twigs are four-sided, finely hairy and brownish when young. The flower cluster is a terminal panicle, 8 to 30 centimeters in length. Flowers are perfect and zygomorphic. The corolla is bluish or purplish, finely hairy outside with long hairs inside. Fruits are a purplish drupe which contains 3 to 4 seeds (Vivaldi and Woodbury 1981a, Little et al. 1974)(USFWS, 1992).

Taxonomy

Cornutia obovata is a member of the family Verbenaceae (USFWS, 1992).

Historical Range

Cornutia obovata is considered as endemic to the main island of Puerto Rico. *Cornutia obovata* was first collected in 1885 by the German collector Paul Sintenis on the area of Monte Torrecilla in the municipality of Barranquitas in central Puerto Rico (USFWS, 2014).

Current Range

C. obovata currently exists within the following natural areas: Monte Torrecilla, Susúa Commonwealth Forest, Río Abajo Commonwealth Forest, Sumidero Tres Pueblos, and the Arecibo Observatory (USFWS, 2014).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Vegetative (USFWS, 1992); sexual (inferred from EPA, 2016)

Breeding Season

Adult: May - July (EPA, 2016)

Key Resources Needed for Breeding

Adult: Insect and bird pollinators (EPA, 2016)

Reproduction Narrative

Adult: Abundant flowering is observed in June and July; flowering also observed in late May. Observed in September and October. It is pollinated by insects and birds (EPA, 2016). The importance of vegetative reproduction has not been studied; however, field observations indicate that sprouting following cutting or breakage occurs rapidly (USFWS, 1992).

Habitat Type

Adult: Terrestrial (EPA, 2016)

Habitat Vegetation or Surface Water Classification

Adult: Subtropical moist forest, subtropical wet forest, lower montane forest (EPA, 2016)

Geographic or Habitat Restraints or Barriers

Adult: ~730 to 3,300 ft. elevation (USFWS, 2014)

Habitat Narrative

Adult: Occurs in subtropical moist forest and subtropical wet forest life zones in northern and south-central Puerto Rico. Barranquitas in the central mountains, Rio Abajo Commonwealth Forest, and Arecibo Observatory. Most populations occur in semi-evergreen and evergreen seasonal forests of the limestone hills of northern Puerto Rico. Also found in lower montane forest (Mont Torrecilla). Susua population occurs on serpentine-derived soils of the El Cacique-La Taina Complex. Arecibo population is on soils derived from Rock- outcrop-Tanama complex and the Soller-rock outcrop complex. The Barranquitas population is on soils from igneous bedrock of the Humatas clay series. Soils are shallow, well-drained, alkaline, and interspersed between outcrops of hard limestone. Volcanic derived soils that are moderately deep to deep, and moderately acid clays in the Barranquitas area. Also reported historically in serpentine soils, but none of the currently known populations are on serpentine soils (EPA, 2016). Elevations at all sites range from 730-3,300 ft. (USFWS, 2014).

Dispersal/Migration**Dependency on Other Individuals or Species for Dispersal**

Adult: Unknown (EPA, 2016)

Dispersal/Migration Narrative

Adult: Dispersal mechanisms are unknown (EPA, 2016).

Population Information and Trends**Population Trends:**

Unknown (USFWS, 2014)

Species Trends:

Unknown (USFWS, 2014)

Resiliency:

Very low (inferred from EPA, 2016)

Representation:

Very low (inferred from USFWS, 2014)

Redundancy:

Low (inferred from EPA, 2016)

Number of Populations:

7 (EPA, 2016)

Population Size:

~19 (USFWS, 2014)

Population Narrative:

There are 6 populations in the limestone hill area and 1 population in the central mountains (EPA, 2016). The species status is uncertain; little monitoring has been conducted on the natural populations of the species. About 19 individuals currently exist. There is no long-term monitoring of these natural populations, so population trends are unknown (USFWS, 2014).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: The largest natural population, and type locality at Monte Torrecilla (located on private land), remains threatened by future expansion or maintenance of communication facilities (USFWS, 2014).

Stressor: Stochastic events and climate change (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: The low number of populations and individuals pose a threat to the species by making it susceptible to stochastic events such as hurricanes. The effects of landslides are exacerbated for small relic populations as is the case of *C. obovata*. Moreover, the frequency of landslides may increase, as landslides are triggered by severe rain events, whose frequency and severity is expected to increase due to climate change (Hopkinson et al. 2008). For example, given the steep topography of Monte Torrecilla, a massive landslide may extirpate the largest known population of *C. obovata*. Vulnerability to climate change impacts is a function of sensitivity and exposure to those changes, and the adaptive capacity of the species (Glick et al. 2011). Therefore, shifts of vegetation communities are expected as temperatures and moisture regimes are altered by climate change. Under this scenario, the populations of *C. obovata* may be displaced or outcompeted by native or exotic species with wider environmental plasticity. Climate change may also compromise natural recruitment by affecting seed germination and/or the survival of seedlings (USFWS, 2014).

Stressor: Genetic variation (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Along with reduced population size, negative impacts of habitat fragmentation may result in erosion of genetic variation through the loss of alleles by random genetic drift (Honney and Jacquemyn 2007). These factors may limit the ability of a species to respond to a changing environment (Booy et al. 2000). Given the extremely small population size and low number of known natural populations of *C. obovata*, it is likely that their genetic variability is low. As previously indicated, only the population at Monte Torrecilla is composed by 9 individuals, the remaining sites are comprised by 1-5 individuals (USFWS, 2014).

Stressor: Lack of natural recruitment (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Lack of natural recruitment represents one of the major threats to *C. obovata* as there is no evidence of seedlings on the wild despite the production of fruits (Geraldo Hernández, PRDNER, pers. comm. 2013). According to Santiago (2011) germination under nursery conditions seem to be low, suggesting the possibility of selfing on the wild populations. Without natural recruitment or successful augmentation from captive propagated individuals, populations (natural and reintroduced) of *C. obovata* are likely to become extirpated as older individuals naturally die. Despite future efforts to enhance natural populations by planting seedlings and saplings, it is unknown if planted individuals will develop into mature plants capable of reproduction (USFWS, 2014).

Recovery**Reclassification Criteria:**

Not available

Delisting Criteria:

1. The privately owned populations are given protected status (USFWS, 2014).
2. At least three new self-sustaining populations in Commonwealth Forest units such as Río Abajo or Guajataca have been established (USFWS, 2014).

Recovery Actions:

- Monitor existing populations (USFWS, 1992).
- Protect privately-owned populations sites (USFWS, 1992).
- Conduct research on the life history of the species and evaluate methods of propagation (USFWS, 1992).
- Propagate and produce seedlings and saplings for enhancement of existing populations and the establishment of new ones (USFWS, 1992).

Conservation Measures and Best Management Practices:

- Studies should be conducted on the species phenology and reproductive biology to address other limiting factors affecting the species (e.g., lack of pollinators or seed dispersers) (USFWS, 2014).

- The population at Monte Torrecilla should be monitored to collect seed material for recovery purposes. A protocol to collect seed material should be developed and implemented to avoid impacting the natural recruitment of the species (USFWS, 2014).
- All known populations should be marked and monitored on a regular basis, and additional visits should be made after hurricanes or other major disturbances to determine any possible adverse effects on the populations (USFWS, 2014).
- Studies should be conducted of the patterns of genetic variation, in order to develop a plan to preserve the species' germplasm (USFWS, 2014).
- The very small wild populations should urgently be enhanced, using seeds or vegetative propagation (e.g., air layering, tissue culture, etc.) if necessary, taking into account the species' patterns of genetic variation (USFWS, 2014).

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SPECIES ACCOUNT: *Coryphantha minima* (Nellie cory cactus)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/7/1979; Southeast Region (R2) (USFWS, 2016)

Physical Description

E. minima has ovoid to cylindrical, tuberculate, solitary or branching stems from to 1.0 to 4.0 cm (0.4 to 1.6 in) tall and 0.6 to 2.5 cm (0.2 to 1.0 in) wide; when cultivated, the plants often form caespitose clusters with numerous stems. Dense, appressed, peg-like spines, from 15 to 27 per areole, obscure the stems. The flowers have pink to reddish-purple perianths from 1.5 to 2.7 cm (0.6 to 1.1 in) wide. The fruits are green to yellowish, from 1.5 to 7.0 mm (0.06 to 0.3 in) long, and the dark brown to black, pitted seeds are up to 1.0 mm (0.04 in) long. (USFWS, 2012)

Taxonomy

First reported by Baird (1931). There is debate over the systematics of the cactus family. Recognized scientific names for *Escobaria minima* include: *Coryphantha minima* Baird (Baird 1931; Benson 1982; Zimmerman and Parfitt 2011b; Tropicos 2011b; U.S. Fish and Wildlife Service 2011b); *Coryphantha nelliae* Croizat (Croizat 1934); *Escobaria minima* (Baird) D.R. Hunt (Hunt 1978; Anderson 2001; Poole, et al. 2007; Integrated Taxonomic Information System 2011b; Natural Resources Conservation Service 2011b); *Escobaria nelliae* (Croizat) Backeb (Backeberg 1961) and *Mammillaria nelliae* (Croizat) Croizat (Croizat 1942). Common names used for *Escobaria minima* include: Birdfoot cactus (Poole et al. 2007); Dwarf cory cactus (Poole et al. 2007); Least cory cactus (Poole et al. 2007); Nellie cory cactus (Poole et al. 2007; Center for Plant Conservation 2011b; Natural Resources Conservation Service 2011b; U.S. Fish and Wildlife Service 2011b); Nellie's cory cactus (Poole et al. 2007); Nellie's cory-cactus (Anderson 2001); and Nellie's pincushion cactus (Zimmerman and Parfitt 2011b). The Service will continue to classify this species as *Escobaria minima*. Further systematic revisions are expected in the *E. viridiflorus* complex, particularly as genetic studies provide new tools to reveal the phylogeny of the cactus family. (USFWS, 2012)

Historical Range

Near Marathon, in Brewster County, Texas (USFWS, 2012).

Current Range

Near Marathon, in Brewster County, Texas (USFWS, 2012).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 2012)

Lifespan

Adult: Not available, but clearly perennial (USFWS, 2019)

Breeding Season

Adult: April - May (USFWS, 2012)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 2012)

Reproduction Narrative

Adult: Weniger (1979a, 1979b) observed that *E. minima* flowered in April and May and the fruits ripened by mid-summer. The species is insect pollinated and reproduce entirely by sexually-produced seeds. It begins flowering at three to four years of age. *E. minima* plants produce up to four fruits per year containing 80 to 100 seeds each (USFWS, 2012).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Creosote bush-mesquite shrub, Chihuahuan Desert scrub (USFWS, 2012)

Geographic or Habitat Restraints or Barriers

Adult: 1,200 - 1,350 m elevation (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Caespitose clusters (USFWS, 2012)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2012 and NatureServe, 2015)

Habitat Narrative

Adult: Inhabits rock crevices on novaculite outcrops (a hard, fine-grained, silica-rich rock), in full sun, among sparse Chihuahuan Desert scrub at 1,200-1,350 m elevation (NatureServe, 2015). Within the Caballos formation, *E. minima* grows in novaculite cracks and fragments, often in association with *Selaginella peruviana* (club-moss) (Weniger 1979a, 1979b; U.S. Fish and Wildlife Service 1984a, 1984b; Poole et al. 2007). The vegetation map of Frye et al. (1984) classifies the vegetation of the Caballos novaculite outcrops and of the surrounding valley floors as creosote bush - mesquite shrub (*Larrea tridentata* – *Prosopis glandulosa*) and tobosa - blackgrama grasslands (*Hilaria mutica* – *Bouteloua eriopoda*), respectively. Poole et al. (2007) describe the specific habitats of the endemic plants of the Caballos novaculite as sparse Chihuahuan Desert scrub or sparsely vegetated desert or semi-desert grasslands or shrublands. *E. minima* plants typically occur as dense, caespitose clusters (USFWS, 2012).

Dispersal/Migration**Dispersal**

Adult: Low (inferred from USFWS, 2012)

Dispersal/Migration Narrative

Adult: The seeds apparently fall near the parent plants as fruits decompose and are dispersed by the surface flow of rain water (USFWS, 2012).

Population Information and Trends

Population Trends:

Not available

Number of Populations:

2 (NatureServe, 2015)

Population Size:

> 1 million (USFWS, 2012)

Minimum Viable Population Size:

Unable to determine (USFWS, 2019)

Population Narrative:

Known from only 1 site, 2 populations (NatureServe, 2015). McKinney (2000) estimated that total populations of *E. minima* were more than 1,000,000 (USFWS, 2012).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Livestock grazing, wildfires, herbicide usage, and mining are potential and/or minor threats (USFWS, 2012).

Stressor: Collection (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: The evidence of the threat of illicit and unscrupulous collection to *E. minima* is clear; the species has been extirpated from its type location on a publicly-accessible highway ROW – a site well-known to cactus collectors for decades. This cactus species is offered for sale over the internet (B & T World Seeds 2011a, 2011b; High Country Gardens 2011a, 2011b), presumably cultivated legally and ethically from propagated seed or tissue culture rather than seeds or plants collected from the wild. There is no information on the current extent of illicit collection from the remaining wild populations. The restricted access to these remote sites and the vastness of the landscape may provide the best possible protection from this threat (USFWS, 2012).

Stressor: Herbivory (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Herbivory by insects, rodents, and perhaps other animals constitutes a potential threat to *E. minima* (USFWS, 2012).

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Changes in temperature and rainfall amounts and patterns could alter the species competitive advantages in the unique micro-habitats it occupies. Regardless of how these changes may affect its autecology, the altered synecology may be far more significant. For example, this species might benefit from higher winter temperatures that extend its growing season. Conversely, it might face new threats from a migration of tropical cactus parasites and pathogens into their habitat (USFWS, 2012).

Recovery

Reclassification Criteria:

The downlisting criteria for Nellie's cory cactus are based on the minimum conditions that justify reclassification of the species. We will consider reclassifying Nellie's cory cactus to threatened status when: (USFWS, 2019)

1. Ten or more viable metapopulations are legally protected and managed for the purpose of conserving Nellie's cory cactus and its habitats. Examples include, but are not limited to, conservation easements on private lands, lands owned and managed for conservation by non-profit organizations, and legally-binding long-term management agreements with private landowners. (USFWS, 2019)
2. The 10 or more protected metapopulations described in the previous criterion must each have a minimum viable population size of 1,300 or more mature individuals. (USFWS, 2019)

Delisting Criteria:

Nellie's cory cactus will be considered for delisting when: (USFWS, 2019)

1. Periodic monitoring indicates that the minimum viable population levels of 1,300 mature individuals within each of 10 protected metapopulations (the criteria for downlisting to threatened) have remained stable or have increased over a period of 25 years. Monitoring (censuses) of each protected metapopulation must be conducted at least once every five years. (USFWS, 2019)

Recovery Actions:

- Develop a cooperative agreement with private landowners for the protection and management of the Nellie cory cactus population (USFWS, 1984).
- Initiate and support studies on the population biology and ecology of the Nellie cory cactus (USFWS, 1984).
- Develop a comprehensive trade management plan for all cacti (USFWS, 1984).

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SPECIES ACCOUNT: *Coryphantha ramillosa* (Bunched cory cactus)

Species Taxonomic and Listing Information

Listing Status: Threatened; 12/06/1979; Southwest Region (R2) (USFWS, 2016)

Physical Description

The stems of *Coryphantha ramillosa* are dark grayish green, solitary or rarely with a few branches, 6—9 cm (2.4—3.6 in.) long, and 6—9.5 cm (2.4—3.7 in.) in diameter. There are 3—6 central spines per areole: 1 inner, and 2—5 but usually 3 outer. The inner central spine is 25—140 mm (1—1.6 in.) long, and the outer central spines, 17—38.5 mm (.7—1.5 in.) long. The lull white to pale gray radial spines are 12—30 cm (.5—1.2 in.) long. The flowers are 38—65 mm (1.5—2.6 in.) long and 30—50 mm (1.2—2 in.) in diameter. The fruits are 1—2.5 cm (.4—1 in.) long. The seeds are finely raised—reticulate, reniform, reddish—brown, and 1.14—1.5 mm (.06 in.) long (USFWS, 1989). The longer, curving, twisting spines and purplish flowers of *C. ramillosa* distinguished it from the yellow-flowered *C. scheeri* and *C. scolymoides* (Weniger 1979, p. 2). *C. ramillosa* has flattened, overlapping tubercles, relatively few stems, sulca extending from the apex to the base of the tubercles, entire outer perianth segments, and ovoid fruits less than 2 cm long, while *C. macromeris* has cylindrical, widely-spaced tubercles, large numbers of stems, sulca extending only half of the tubercle length, frilled outer perianth segments, and elongate fruits over 3 cm long (Weniger 1979, p. 2; Heil et al. 1985, p. 29). (USFWS, 2018)

Taxonomy

A.R. Davis, of Marathon, Texas, first observed bunched cory cactus at the head of Reagan Canyon in 1936. Cutak (1942) described *Coryphantha ramillosa* based on specimens Davis collected in 1939 (A.R. Davis s.n., MO #12L12260). Weniger (1970) published the species invalidly as *Mammillaria ramillosa* (USFWS 1989, p. 3). *Coryphantha ramillosa* has consistently been recognized as a distinct, valid species. However, since the easternmost populations in Coahuila, Mexico, are now recognized as a distinct subspecies, *santarosa*, the listed entity, bunched cory cactus, is recognized as subspecies *ramillosa*. (USFWS, 2018)

Historical Range

The bunched cory cactus is known only from Brewster and Terrell Counties, Texas and central Coahuila, Mexico. Presumably the present and historic ranges of the bunched cory cactus are similar (USFWS, 1989).

Current Range

As a subspecies, bunched cory cactus is now somewhat more narrowly endemic to a portion of northern Coahuila, Mexico, and portions of Brewster and Terrell Counties in the Big Bend region of Texas. (USFWS, 2018)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (USFWS, 1989)

Dependency on Other Individuals or Species

Adult: Halictidae sweat bee (USFWS, 1989)

Breeding Season

Adult: mid-September to October (USFWS, 2018)

Key Resources Needed for Breeding

Adult: Rocks (USFWS, 1989)

Other Reproductive Information

Adult: Although the breeding system of bunched cory cactus has not been documented, Zimmerman (1985, p. 137) stated that most *Coryphantha* species are obligate outcrossers. Schmalzel et al. (1999, p. 20) learned from local observers who were familiar with bunched cory cactus that it flowers from mid-September to October, following rain; the flowers open for 2 or 3 days; populations can flower more than once per season; fruits mature in about 6 to 8 weeks; and fruits persist 1 to 2 months. Stems expand and contract according to the amount of water they contain, confounding direct growth measurements. Consequently, Schmalzel et al. (1999, p. 33) estimated growth by painting the spine clusters of young tubercles and observing tubercle production at intervals for two years. They observed that flowers arose only from tubercles produced during the same season. Based on their estimates of size-age relationships, plants become reproductive at about 9 years, corresponding to a diameter of 40 mm (p. 35). They were unable to observe pollinators, seed dispersal, or seedling recruitment (p. 37). (USFWS, 2018)

Reproduction Narrative

Adult: The bunched cory cactus begins blooming at an age of 5 years. Reports of flowering time vary: Weniger (1979) states April to May, Warnock (1970) states June, and Heil et al. (1985) state July to August. The major pollinator is thought to be a green sweat bee in the family Halictidae. Fruits form from October through December (Heil et al., 1985). In its natural habitat and in cultivation virtually 100 percent of the flowers produce fruits. However, such high fruit set is only likely when plant densities are such that cross pollination is assured (A. Zimmerman, Chihuahuan Desert Research Institute, pers. comm., 1986). There are about 75 seeds per fruit. The best place for seedling survival is under rocks or deep in the cracks of rocks where the seeds are protected from dessication and predation (USFWS, 1989).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Chihuahuan Desert Scrubland (USFWS, 1989)

Geographic or Habitat Restraints or Barriers

Adult: 2,500 - 3,500 ft. elevation (USFWS, 1989)

Spatial Arrangements of the Population

Adult: Scattered (USFWS, 1989)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 1989)

Habitat Narrative

Adult: It occupies limestone gravel, alluvial soil on foothills and ridges. It is found on the Bouquillas and Santa Elena limestone formation; distributed along cracks in rock ledges at edges of canyons and on hilltops (NatureServe, 2015). It is found primarily as widely scattered populations or individuals. The bunched cory cactus grows in the Chihuahuan Desert Scrubland (Brown and Lowe, 1980). The elevation range for bunched cory cactus is between 750 and 1,050 meters (2,500—3,500 ft.). In the northern part of its range, the species is mostly confined to rocky, well—drained, and full sunlit sites on steep canyon sides and hill summits along the canyons of the Rio Grande (USFWS, 1989).

Dispersal/Migration**Dispersal**

Adult: Low (inferred from USFWS, 1989)

Dispersal/Migration Narrative

Adult: The fruits ripen in December and the seeds are distributed by rodents and ants (USFWS, 1989).

Population Information and Trends**Population Trends:**

Not available

Number of Populations:

7+ (NatureServe, 2015)

Population Size:

Estimated to be > 10,000 individuals (USFWS, 2018)

Minimum Viable Population Size:

Not yet calculated (USFWS, 2018)

Population Narrative:

Schmalzel et al. 1999 obtained permission to conduct surveys of private ranches in Terrell County with the help of Mr. Jim Talbot, a resident of Sanderson, Texas. They confirmed 17 new population sites; Talbot reported three additional sites that the investigators were not able to verify (pp. 21-28). They found 228 bunched cory cactus individuals along 2 km (1.24 mi) of Red House Canyon. Assuming that this density is representative of all populated sites, they estimated the total population would be 10,260 over a span of 90 km in Red House, Lion, Sanderson, Cook, Isinglass, Washboard, and Cedar canyons, and one unnamed canyon (pp. 15-16). Since other populations occur at Reagan, Big, and Rio Grande canyons, as well as a mesa near Seminole Canyon, 10,000 is a conservative estimate of the U.S. population within 30 km

(18.6 mi) of the mouth of Sanderson Canyon (p. 16). However, in contradiction of earlier reports by Weniger (1979, pp. 5,7), the species has never been documented at Black Gap Wildlife Management Area (BGWMA) (Bonnie McKinney, cited in Schmalzel et al. 1999, pp. 27-28), and surveys of Maravillas Canyon (BGWMA) and Mariscal Mountain (BBNP) by Schmalzel's team did not detect bunched cory cactus. They concluded that bunched cory cactus is not rare and should not be listed as threatened under ESA (p. 39). (USFWS, 2018)

Threats and Stressors

Stressor: Habitat or Range destruction, modification, or curtailment (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Intensive range management practices, such as root-plowing and seeding with buffelgrass or other introduced, invasive grasses remains a potential threat, but has not been reported and is unlikely to occur due to the steep terrain and marginal capacity of the habitats for forage production. Some bunched cory cactus individuals may have been trampled at BIBE, due to their proximity to an archeological site (Schmalzel et al. 1999, p. 19). We have no evidence that trampling or habitat destruction has occurred due to increased recreational activity along the Rio Grande scenic river. (USFWS, 2018)

Stressor: Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: From a total of about 75 individuals along transects at BIBE, two disappeared; due to their proximity to visitor access they may have been stolen by poachers (Schmalzel et al. 1999, p. 19). We have no additional evidence of the current extent of illegal collection of this species. Since cactus collection continues to be a popular activity, and rare species collected from the wild are especially valuable to some collectors, bunched cory cactus will probably remain vulnerable to a persistent, low-grade threat of illegal collection. (USFWS, 2018)

Stressor: Disease or predation (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Schmalzel et al. (1999, pp. 19-20) did not observe signs of mammalian herbivory in populations of bunched cory cactus where goats, javelina, and aoudad were abundant. However, they did observe insect frass on stems, indicating the presence of insect parasites (p. 19). Insect parasites cause populations collapses of other small cactuses, such as Tobusch fishhook cactus (USFWS 2017, pp. 27-28, 31, 39-40), and may also cause significant mortality of bunched cory cactus. (USFWS, 2018)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: The ESA does provide some legal protection for federally-listed plants on land under federal jurisdiction, including the populations of bunched cory cactus at BIBE. Beginning in 2007, USFWS and the U.S. Department of Homeland Security (DHS) interacted extensively regarding the proposed construction of a border wall along the Rio Grande in south and west Texas. A provision of the REAL ID Act of 2005 gives the Secretary of Homeland Security authority to waive other federal laws, including the ESA, in order to expedite construction of border barriers. Hence, the border wall project was exempt from consultation with USFWS under section 7 of the ESA. Nevertheless, DHS and USFWS have coordinated to establish best management practices for the federally listed plants and animals in the project impact area (U.S. Department of Homeland Security 2008). Additional border wall construction has been proposed by the current Administration. If implemented, the border wall and related infrastructure may affect populations and habitats of bunched cory cactus that occur along the Rio Grande. In particular, the only protected population of bunched cory cactus, at BIBE, is near the Rio Grande and could be adversely affected by new construction in that area. Chapter 88 of the Texas Parks and Wildlife Code lists plant species as state-threatened or endangered once they are federally-listed with these statuses. Bunched cory cactus was listed as threatened by the State of Texas on April 29, 1983. The State prohibits taking and/or possession for commercial sale of all or any part of an endangered, threatened, or protected plant from public land. TPWD requires permits for the commercial use of listed plants collected from private land. Scientific permits are required for collection of endangered plants or plant parts from public lands for scientific or educational purposes. In addition to State endangered species regulations, other State laws may apply. State law prohibits the destruction or removal of any plant species from State lands, including BGWMA, without a TPWD permit. (USFWS, 2018)

Stressor: Demographic and genetic consequences of small population sizes (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Small, isolated plant populations are often vulnerable to genetic drift, loss of genetic diversity, and inbreeding depression. However, the population genetics of bunched cory cactus has not been investigated; we have no evidence of the extent of the actual impacts of these potential threats. (USFWS, 2018)

Stressor: Climate change (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: We do not know whether the climate changes that have already occurred have affected the populations or distribution of bunched cory cactus, nor can we predict how the species might be affected by the type and degree of climate changes forecast by the range of models. While many species have adapted to previous climate changes by migrating in latitude or elevation, it is unlikely that this species could migrate, without facilitation, fast enough to match the projected rate of climate change. Changes in temperature and rainfall amounts and patterns could have multiple effects that alter the species' fitness in opposing ways. For example, hotter summers could increase mortality from drought, but warmer winters could reduce mortality from freezing. Regardless of how these changes may affect its autecology, the altered synecology may be more significant. For example, bunched cory cactus might benefit from more frequent or more severe droughts if it tolerates extended drought better than other plants that compete

with it. Conversely, extended drought could reduce pollinator populations, resulting in pollen limitation and reduced reproductive output. At present, we cannot predict how the infinitely complex aggregation of climate changes will affect the synecology of bunched cory cactus populations and habitat. Therefore, we will continue to monitor the species' status and will adapt our recovery and management strategies when necessary to address the changing conditions. (USFWS, 2018)

Recovery

Reclassification Criteria:

Not available

Delisting Criteria:

1. Identify at least three sites where the species can be protected and then carry out protective management measures. One site should be on private land in northeastern Brewster or southwestern Tyrrell County, one site should be in Big Bend National Park, and one site should be in Mexico. Each site should initially contain at least 500 plants and should have enough available habitat to permit population expansion and growth (USFWS, 1989).

2. Monitoring and habitat surveys indicate that a total of a least 10,000 plants is being sustained at the protected and managed sites (USFWS, 1989).

Recovery Actions:

- Remove threats to the bunched cory cactus by enforcement of existing regulations and management for protection. Because of the rarity of the bunched cory cactus the populations must be protected by the enforcement of existing Federal, and State regulations and by management to remove threats to the species. (USFWS, 1989)
- Gather information for use in management. A thorough understanding of the population biology and ecology of the bunched cory cactus is needed to help manage healthy natural populations. (USFWS, 1989)
- Develop a comprehensive trade management plan for all cacti. Studies are needed to determine which species are in trade, the overall trend of trade in listed cacti, and the feasibility of reducing collecting pressure on wild populations by promoting a commercial artificial propagation program. Strategies for effective law enforcement under ESA, CITES, Lacey Act, and State laws need to be developed. The trade study should be national in scope and address all cacti. The results will be used to develop policy and a comprehensive trade management plan for all cacti. (USFWS, 1989)
- Refine propagation techniques to provide nursery stocks and seeds to reduce collecting pressure. The collecting pressure on natural populations could possibly be reduced by refining commercial propagation techniques. This task will be undertaken if findings of the trade management plan indicate that increased commercial propagation is an advisable means of reducing collecting pressure on natural populations. (USFWS, 1989)
- Establish populations at the botanical gardens of research institutions. Even though plants in botanical gardens cannot substitute for healthy populations in natural habitats, a living collection could still contribute significantly to the overall recovery effort. Much information on ecological requirements and reproductive potential could be obtained most easily from a living collection. In addition, a permanent well documented and accessible living collection, together with appropriate seed banking, could provide an important source of material for

non—destructive research, maintenance of wild populations, and public awareness. An adequate living collection would remove the necessity of repeatedly returning to wild populations to collect plants for various recovery projects. (USFWS, 1989)

- Develop public awareness, appreciation, and support for preservation of the bunched cory cactus . Public education is a vital part of the recovery process. The cooperation of the public is essential for the ultimate success of many recovery measures. (USFWS, 1989)
- Recommended Actions from 2018 5-Year Review: To ascertain the degree to which the recovery criteria of bunched cory cactus have been met, we recommend the following: • Develop efficient, quantitative, verifiable methods to estimate population sizes and trends using representative samples of potential habitats and valid statistical analyses. • Recruit Mexican botanists and support studies of the size and geographic distribution of populations in Coahuila and Nuevo León. (USFWS, 2018)
- Recommended Actions from 2018 5-Year Review: The most important recovery actions during the next five years include, but are not limited to, the following: • Revise the recovery plan and recovery criteria to incorporate updated guidance and specific, measurable recovery criteria, including the length of the monitoring period needed to detect demographic trends. Revise the population size criterion to the provisional minimum viable population level of 1,000 to 1,500 mature, reproductive individuals per metapopulation. • Continue to improve the potential habitat model as we learn more about the ecological requirements. • Explore the potential to conserve populations of bunched cory cactus on private lands in Brewster and Terrell counties, Texas through private landowner agreements or other appropriate measures. • Communicate with Mexican agencies, non-profit conservation organizations, and academic institutions to promote the conservation and management of *Coryphantha ramillosa* subspecies in Mexico. • Investigate the population genetics to determine the genetic structure, genetic diversity and extent of inbreeding, evidence of gene flow, and other parameters that will be useful in the conservation and recovery of bunched cory cactus. (USFWS, 2018)

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SPECIES ACCOUNT: *Coryphantha robbinsiorum* (Cochise pincushion cactus)

Species Taxonomic and Listing Information

Listing Status: Threatened; 01/09/1986; Southwest Region (R2) (USFWS, 2016)

Physical Description

A spiny succulent with a solitary round stem, 3-5 cm tall. Pale green-yellow flowers appear in March-April, followed in July and August by orange-red fruits (NatureServe, 2015).

Taxonomy

The Cochise pincushion cactus was originally named *Cochiseia robbinsorum* by W.H. Earle (1976). The genus *Cochiseia* was rejected almost immediately. Dr. A.D. Zimmerman (1978) assigned the species to the genus *Coryphantha*, which is currently the most frequently accepted placement. The only other synonym for the species is *Escobaria robbinsorum*, which is subject to an unresolved controversy (USFWS, 1993).

Historical Range

The Cochise pincushion cactus is known from the San Bernardino Valley, southwestern Cochise County, Arizona, and northern Sonora, Mexico (Lopresti 1984) (USFWS, 1993).

Current Range

It occurs in Cochise Co., Arizona and Sonora, Mexico (NatureServe, 2015). It is restricted to three small limestone hills in Cochise County, Arizona, along the U.S./Mexico border (USFWS, 2007).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from NatureServe, 2015)

Breeding Season

Adult: March - April (USFWS, 2016)

Key Resources Needed for Breeding

Adult: Bee pollinators (USFWS, 1993)

Reproduction Narrative

Adult: Lower reproduction rate than most cacti - estimated average annual production is 3 fruits with 20 seeds per plant (NatureServe, 2015). Flowering begins in mid-March extending to mid-April (USFWS, 2016). Zimmerman (1985) noted the small bees *Perdita opuntiae*, *Ashmeadiella*

opuntiae, and (rarely) *Dialictus* sp. visiting the flowers of *Coryphantha robbinsorum* (USFWS, 1993).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Semidesert grassland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Full sunlight (USFWS, 2007)

Geographic or Habitat Restraints or Barriers

Adult: 1,280 - 1,544 m elevation (USFWS, 2016); dense vegetation (inferred from USFWS, 2016)

Spatial Arrangements of the Population

Adult: Scattered with a few dense clumps (USFWS, 2007)

Habitat Narrative

Adult: Inhabits grey limestone hills within a semidesert grassland, with small shrubs, other succulents, and grama grasses (NatureServe, 2015). Found only on one type of high-calcium limestone outcrop in the Mexican Highland vegetation community at elevations of 1,280-1,433 meters (4,200 feet). Soils are thin with a soil crust of lichens, mosses, and algae, and bedrock is very near the surface at occupied sites. Plants tend to be in the open, not underneath other plants. Overall vegetation at occupied sites is sparse (USFWS, 2016). The soils are low in nutrients, with a pH of 7.9 to 8.0. Plants require well-drained substrates and grow in full sunlight. Within their limited habitat (10-16 sq. km), the plants are found scattered, with a few dense clumps ranging from 100-1,000 individuals (Zimmerman 1985) (USFWS, 2007).

Dispersal/Migration**Dispersal**

Adult: Moderate (inferred from USFWS, 1993)

Dispersal/Migration Narrative

Adult: Zimmerman (1985) speculates that seeds are disseminated by rock wrens (*Salpinctes obsoletus*), cactus wrens (*Campylorhynchus brunneicapillus*), mockingbirds (*Mimus polyglottos*), black-throated sparrows (*Amphispiza bilineata*), thrashers (*Toxostoma* sp.), and house finches (*Carpodacus mexicanus*). The bright red, fleshy fruits probably attract the birds. He notes that his unpublished study of rock wrens in a population of *Coryphantha robbinsorum* showed that these birds fly from one *Coryphantha* population to another during their daily activities (USFWS, 1993).

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Declining (USFWS, 2007)

Resiliency:

Very low (inferred from USFWS, 2016)

Redundancy:

Very low (inferred from (NatureServe, 2015)

Number of Populations:

2 (NatureServe, 2015)

Population Narrative:

It occupies 8.8 acres of rangeland (in U.S.?). This species is known only from 1 population in southeastern Arizona and 1 in adjacent Sonora, Mexico (NatureServe, 2015). The known range is very small and limited (USFWS, 2016). Population numbers appear to be declining based on current data (USFWS, 2007).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Threats include grazing by livestock and wildlife, and oil/mineral exploration activities. Changes in grazing patterns by the local landowner have minimized the potential effects from livestock grazing. Impacts to populations from mining activities have not been a significant factor. However, each of these activities continues to be a potential threat to populations of Cochise pincushion cacti. Impacts from these threats could increase if land ownership changes or incentives for oil and mineral exploration increase. A new threat that has been escalating over the past 10 years is related to illegal immigration and drug smuggling, and associated law enforcement activities. Plants can be trampled or otherwise damaged or injured. Cochise pincushion cactus habitat is destroyed or altered by foot and vehicle traffic, and there is the potential for the increased incidence of fire. Impacts from border activities have been documented within areas occupied by the Cochise pincushion cactus, but increased law enforcement efforts have, at least temporarily, reduced illegal traffic in the area (USFWS, 2007).

Stressor: Invasive plants (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: An additional threat comes in the form of invasive plant species, especially grasses. Of particular note is the spreading threat to Sonoran and Chihuahuan desert ecosystems resulting from the invasion of buffelgrass (*Pennisetum ciliare*). Buffelgrass can compete for resources with Cochise pincushion cactus, and it also increases the frequency and intensity of fire on the landscape as compared to natural conditions. Such a change in the fire regime could increase Cochise pincushion cactus mortality and alter important habitat microclimates. The recent development of a cold-tolerant strain of buffelgrass by the Agricultural Research Service (2005)

increases the potential for this species to invade areas occupied by the Cochise pincushion cactus. Lehmann's lovegrass (*Eragrostis lehmanniana*) is another invasive grass species in southeastern Arizona (USFWS, 2007).

Stressor: Collection (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: The desirability of this species, coupled with its limited distribution, increases the potential for significant impacts to populations if illegal collection were to occur. No evidence of illegal collection within known populations has been observed. However, collection remains a real threat to this species due to its limited numbers and distribution. Cochise pincushion cacti are available commercially on a limited basis, but if interest in this species increases or commercial availability decreases, pressure to collect plants from the wild may increase. The unique, rare nature of this species increases its desirability among collectors (USFWS, 2007).

Stressor: Insect depredation (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Depredation by insects was documented in the Cochise pincushion cactus long-term monitoring plots in 1994. As a result, mortality of individual plants during that year nearly doubled from the highest mortality previously recorded (see Figure 2). The documentation of this significant depredation event points to the potential for the distribution of this species to be driven by density-dependent insect depredation. As the density of Cochise pincushion cacti increases in a local population, it becomes more vulnerable to insect depredation. At some point, densities may become high enough that conditions favor a significant insect depredation event. Density of cacti is reduced, as is the subsequent depredation by insects. This cycle may repeat itself over time within each of the local populations of Cochise pincushion cactus. As a result, there may be a number of high-density populations within the landscape; however, the density of these populations would eventually be reduced by insect depredation. Low-density populations will gradually increase in density during favorable environmental conditions until they reach a point that favors insect depredation events. In order to determine if this cycle of depredation is indeed a natural component of the population dynamics of the Cochise pincushion cactus, monitoring techniques must be modified to sample the population across its range. Depredation may be a significant driver of the distribution and density of this species. Depredation effects would be amplified in populations suffering from other stressors such as drought (USFWS, 2007).

Stressor: Drought (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Ongoing, long-term drought is occurring within the range of the Cochise pincushion cactus. Drought increases mortality of adults and juveniles and reduces reproduction in populations of this species. Because of the limited number of individual plants and the limited distribution of this species, drought effects may significantly affect its ability to persist on the landscape. A return to normal winter and monsoon precipitation patterns is needed to decrease

this threat. The declining trend in numbers of cacti within monitoring plots is likely evidence of the effects of drought on known populations (USFWS, 2007).

Stressor: Pesticides (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Application of pesticides within or adjacent to the range of the Cochise pincushion cactus could adversely affect these insects and associated ecosystem functions. The potential application of pesticides is most likely associated with rangeland grasshopper control. The application of pesticides remains a potential threat to insects that benefit the Cochise pincushion cactus (USFWS, 2007).

Recovery

Reclassification Criteria:

Not available

Delisting Criteria:

Recovery of this species will require permanent protection and management of the habitat, trade protection through retention of the species on the Highly Safeguarded List of the Arizona Native Plant Law and CITES list following delisting, and demonstration through ten years of monitoring that viable populations are being maintained (USFWS, 1993).

Recovery Actions:

- Conduct biological studies necessary for effective management of the species (USFWS, 1993).
- Develop and implement a habitat management plan in cooperation with the private landowner and Arizona State Land Department (USFWS, 1993).
- Study the population biology of Cochise pincushion cactus to determine the effects of management (USFWS, 1993).
- Protect Cochise pincushion cactus from loss of individuals and habitat (USFWS, 1993).
- Establish an ex situ conservation and research program (USFWS, 1993).
- Define the range and distribution of Cochise pincushion cactus (USFWS, 1993).

Conservation Measures and Best Management Practices:

- Modify the current monitoring protocol to expand the area monitored within the known range of the species. Design the protocol to more effectively evaluate the status of the species across the landscape. Monitoring should be designed to investigate possible density-dependent depredation issues and identify the distribution of both high-density and low-density populations (USFWS, 2007).
- Update the recovery plan with quantifiable criteria for delisting. For example, a goal of establishing 15,000 plants in 50 populations (Recovery Criteria #2) may not be realistic based on current information of the density and distribution of this species (USFWS, 2007).
- In conjunction with #2, evaluate the existing recovery actions outlined in the existing recovery plan and decide which are still appropriate for the species' recovery, based on current information (USFWS, 2007).

- Evaluate the results of Dr. Tom Van Devender's 2007 work on this species in Mexico and increase monitoring efforts in Mexico, if appropriate (USFWS, 2007).
- Continue to coordinate with and involve the landowners/lessees and SBNWR in recovery actions related to the Cochise pincushion cactus (USFWS, 2007).
- Evaluate the genetics of this species to determine variation within and among populations. This information is useful in determining if population augmentation or establishment of new populations is warranted (USFWS, 2007).

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USFWS 2007. Cochise Pincushion Cactus (*Coryphantha robbinsorum*) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Arizona Ecological Services Office Phoenix, Arizona

Recovery of this species will require permanent protection and management of the habitat, trade protection through retention of the species on the Highly Safeguarded List of the Arizona Native Plant Law and CITES list following delisting, and demonstration through ten years of monitoring that viable populations are being maintained (USFWS, 1993).

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SPECIES ACCOUNT: *Coryphantha scheeri* var. *robustispina* (Pima pineapple cactus)

Species Taxonomic and Listing Information

Commonly-used Acronym: PPC

Listing Status: Endangered; 10/25/1993; Southwest Region (R2)

Physical Description

Individuals of *C. scheeri* var. *robustispina* are small, hemispheric to cylindrical, stem succulent perennials of the Cactaceae (cactus family). Individual stems reach 5 to 46 centimeters (cm) (1.9 to 18.1 inches (in)) in height and 5 to 21 cm (1.9 to 8.3 in) in diameter, are comprised primarily of tough, fleshy pulp, and are protected by a leathery outer skin. Stems may be singular or form clumps. The surface of the stems is covered in 2 to 3 cm (0.8 to 1.2 in) long rounded projections called tubercles, each of which is grooved along the upper surface and contains one to several extra-floral nectaries (place that secretes nectar to attract pollinators) along the groove. At the tip of each tubercle, arising from small bumps called areoles, are groupings of 7 to 20 straw-colored spines that darken with age (Roller 1996a, p. 9; Parfitt and Gibson 2004, p. 226). There is an average of two thick central spines, one of which is generally hooked and averages 1.7 millimeters (mm) (0.07 in) thick and 3 cm (1.2 in) long (Baker and Butterworth 2013, p. 996). There are 6 to 16 thinner radial spines about 1.1 to 3.5 cm (1.43 to 1.38 in). The young areoles are densely covered with deciduous wool. The stems of *C. scheeri* ssp. *robustispina* arise from taproots that are deeper than most Sonoran Desert cacti at about 15 cm deep. Lateral roots are found between 2 and 5 cm below the soil surface and extend approximately 1 m (3.28 ft) in length. The flowers of *C. scheeri* ssp. *robustispina* average 6.5 cm (2.6 in) long with pale yellow tepals (petals and sepals) that are variously tinged with red pigments. Flowers generally open early to mid-July following summer rains; fruit matures a few weeks later. The pale green fruits are narrowly ellipsoid, 3.2 to 5.7 cm (1.25 to 2.25 in) long and 1.3 to 1.9 cm (0.5 to 0.75 in) wide, with a soft rind and juicy sweet pulp surrounding a mass of brown to black seeds. (USFWS, 2018a)

Taxonomy

Arthur Schott originally described the taxon as *Mammillaria robustispina* from a collection he made from near El Sásabe, Sonora, Mexico (holotype MO 2017438) and the name was published by George Engelmann in 1856 (*M. robustispina* Schott ex Engelmann). Britton and Rose (1923, pp. 33-34) transferred the species to *Coryphantha* (*C. robustispina*). The name of the taxon was recombined by Benson (1982, p. 820) to *C. scheeri* var. *robustispina* and then again to *C. robustispina* (Schott ex Engelm.) Britton & Rose ssp. *robustispina* by Taylor (1998, pp. 17-18). According to Taylor, the species name *C. robustispina* has priority over the epithet *C. scheeri*. This view is accepted by Anderson (2001, p. 196). Within the 2018 Recovery Plan, however, we refer to the taxon as *C. scheeri* var. *robustispina*, the name in use when the taxon was listed as endangered under the Act in 1993 and how the taxon has been referred to in Service documents since that time. A morphometric study in 2004 suggested that a taxonomic cline exists between all *C. robustispina* occurring between Arizona and Texas and therefore no varieties are valid (Schmalzel et al. 2004, p. 553). Three varieties; *robustispina*, *uncinata* and *scheeri*, have been investigated recently and were shown to be geographically isolated (Baker 2005, p. 6),

significantly different morphologically (Baker 2003, p. 17), and significantly different genetically (Butterworth 2010, p. 14; Baker and Butterworth 2013, p. 996), warranting subspecific division. We accept this varietal differentiation in this document. (USFWS, 2018a)

Historical Range

See Current Range. There is no indication that the historical range of the taxon differs widely from the current known distribution. (USFWS, 2018a)

Current Range

Found across roughly 152,920 ha (377,873 ac) of land within the Altar and Santa Cruz Valleys in Pima and Santa Cruz Counties, Arizona, including some lands that connect the two valleys. (USFWS, 2018a)

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Obligate outcrosser

Lifespan

Adult: Variable, can be 30 or more years (USFWS, 2018a)

Dependency on Other Individuals or Species

Adult: Pollinators

Breeding Season

Adult: Early to mid-July or five to seven days after the first summer rains of at least 3 mm and continues through the monsoon season. (USFWS, 2018a)

Other Reproductive Information

Adult: Flower buds begin to appear in mid-May and the timing is related to photoperiod and rainfall (Roller 1996a, p. 58). Flowering usually occurs in early to mid-July or five to seven days after the first summer rains of at least 3 mm and continues through the monsoon season (Kearney and Peebles 1951, p. 577; Roller 1996a, p. 58; Kidder 2014, entire). Flowers persist for a single day, yet the timing of flowering may assist with pollination, as there are few cactus species which bloom at this same time, resulting in a greater potential for pollination success (McDonald and McPherson 2005, p. 531). Schmalzel (2014, p. 4) suggests that plants do not reach maturity and begin to flower until they are more than 12 years of age and likely between 20 and 25 years of age. (USFWS, 2018a)

Reproduction Narrative

Adult: Pollinators of *C. scheeri* var. *robustispina* are fairly well known. Flowers of the taxon are morphology typical for the subgenus *Cactoideae* and exhibit characteristics considered generalized with respect to pollination, that is, the pollen being easily accessible to many

different types of pollinators. Known pollinators include both native insects and the nonnative European honeybees (*Apis mellifera*) (Roller 1996a, p. 63). *Coryphantha scheeri* var. *robustispina* become isolated from potential pollination after 600 m (1,968.5 ft) and since the taxon is not able to self-pollinate (Service 2000a, p. 4), they are likely to be genetically isolated or inbred after 900 m (2,953 ft; McDonald 2005, p. 30). Pups (offsets of the parent cactus that are genetically identical) produced vegetatively will not increase genetic diversity of the population. (USFWS, 2018a)

Habitat Type

Adult: Semi-desert grasslands, desert scrub and the transition area between the two vegetation types.

Dependencies on Specific Environmental Elements

Adult: Open and transitional areas; deep, silty and gravelly, alluvial soils (USFWS, 2018a)

Tolerance Ranges/Thresholds

Adult: Found at elevations between 728 and 1,280 m (2,388 and 4,200 ft) (USFWS, 2018a)

Habitat Narrative

Adult: *Coryphantha scheeri* var. *robustispina* is typically found in open areas within the Sonoran Desert-scrub and desert-grassland vegetation types and in areas transitional between these vegetation communities. Routson (2003, p. 3) found that individuals of *C. scheeri* var. *robustispina* within the Altar Valley occurred most frequently in disclimax (displaced climax due to disturbance) desert-grassland among woody vegetation on well-drained soils. Many studies describe the subshrubs *Zinnia* species (desert zinnia), *Gutierrezia sarothrae* (snakeweed), *Isocoma tenuisectus* (burroweed), and *Eriogonum* spp. (buckwheat) as common associates. Schmalzel (2000c, p. 2) noted greater rates of mortality among *C. scheeri* var. *robustispina* occurring under the canopies of *Prosopis velutina* (velvet mesquite). Similarly, Kidder (2014, entire) found occupied sites were characterized by overall high incoming solar radiation (Kidder 2015, p. 110). McPherson (2002, p. 3), however, found individuals occur more frequently under the canopy of perennial plants than at a distance of at least 1 m (3.28 ft) from the canopy edge. (USFWS, 2018a)

Dispersal/Migration**Motility/Mobility**

Adult: Low

Dispersal

Adult: Rabbits and rodents act as seed disperses.

Dependency on Other Individuals or Species for Dispersal

Adult: Rabbits and rodents for seed dispersal (USFWS, 2018a)

Dispersal/Migration Narrative

Adult: Fruit and seed dispersal for the taxon is probably facilitated, for the most part, by rodents and, perhaps less so, by ants. It has also been hypothesized that jack rabbits (*Lepus* spp.) may play a key role in fruit and seed dispersal (Westland 2005, p. 33; Schmalzel and McGibbon 2010,

p. 11). In 2001, Westland (2005, p. 33) examined jackrabbit dung and discovered intact *C. scheeri* var. *robustispina* seeds within. They noted that dung increased around plants at the time fruits are maturing. A study conducted by Baker and Routson beginning in 2002 documented that ants were mostly associated with extrafloral nectaries, however there were multiple cases of ants eating the fruits and transporting seeds (Baker 2013, p. 21). This study also documented the presence of a single seed in jackrabbit feces, which supports the jackrabbit dispersal hypothesis (Baker 2013, p. 33). In a study of antelope jackrabbit (*Lepus alleni*) habitat structure and vegetation characteristics, Altemus (2016, p. 10) did not detect a spatial association between the jackrabbits and the presence of *C. scheeri* var. *robustispina*, but suggested further study was warranted, as this was a habitat selection study for the herbivore and did not emphasize the distribution of fruits. Additionally, Harris' antelope squirrels (*Ammospermophilus harrisi*), (USFWS, 2018a)

Additional Life History Information

Adult: Ample seed production, however, does not necessarily equate to persistent seedbanks or recruitment (e.g. see Godinez-Alvarez et al. 2003, p. 183; Aragon and Lasso 2018, p. 1). One field study reported the results of two trials where 200 or more *C. scheeri* var. *robustispina* seeds were planted in close proximity to in situ *C. scheeri* var. *robustispina* adult plants and germination was followed (Schmalzel 2002, p. 7). In the first trial, 16 of 220 seeds germinated in the first year and none in the second. In the second trial, 35 of 200 seeds germinated; 30 in the first year and 5 in the second year of study (Schmalzel 2002, p. 7). In another study, field germination testing from 5 study sites found that *C. scheeri* var. *robustispina* seeds had high germination rates of 88 percent (Roller 1996a, p. 75). Observations from laboratory and shadehouse over a 22-month period showed continuous germination indicating that there is no set dormancy period for the seeds (Roller 1996a, p. 72). (USFWS, 2018a)

Population Information and Trends

Population Size:

Roughly 8000 individuals and 152,920 ha (377,873 ac) of habitat (USFWS, 2018b)

Additional Population-level Information:

Between 1995 and 2007, 45 individual *C. scheeri* var. *robustispina* were monitored in an enclosure on Coronado National Forest land in the Santa Cruz Valley. In 2010, no living plants were found (Coronado National Forest 2010, entire), however, in a partial survey of this area in 2015, some *C. scheeri* var. *robustispina* were found both within and outside of this enclosure (Service 2015b, entire). Similarly, plants are monitored regularly on the Pima County and Palo Alto Pima Pineapple Cactus Conservation Bank properties. On one portion of the County-owned Conservation Bank property in 2006, 67 plants were mapped; when last counted in 2014, 13 of the original 67 plants remained alive and 11 new plants had been found (Pima County 2015, p. 1). Within or adjacent to the Palo Alto Conservation Bank property, 49 plants were found in 2001; as of September, 2015, 9 of the original individuals remained alive and 11 new plants were discovered, for a total of 24 known *C. scheeri* var. *robustispina* (Westland 2015, p. 2). (USFWS, 2018a)

Population Narrative:

We are aware of roughly 8,000 individuals and 152,920 ha (377,873 ac) of habitat within the Altar and Santa Cruz Valleys in Pima and Santa Cruz Counties, Arizona, including acreage of

some lands that connect the two valleys. Maintaining linkages for pollinators and lands dominated by native plants are important for the survival of the taxon. Long-term monitoring plots of *Coryphantha scheeri* var. *robustispina* indicate overall decreases in the number of individuals monitored over time. Attempts at transplanting individuals out of the path of development has resulted in a mix of successes and failures. We are aware of at least 1,837 individuals and tens of thousands of acres of habitat that have been lost, primarily due to development. (USFWS, 2018b)

Threats and Stressors

Stressor: Habitat loss due to commercial development (2018a)

Exposure:

Response:

Consequence:

Narrative: The primary habitats of *C. scheeri* var. *robustispina* are open areas on flat ridge tops or areas with less than 10 percent slope, which are also areas very well suited for human development. Urban and suburban development in the areas south and west of Tucson, Green Valley, and Nogales, Arizona, and mining in the Sierrita Mountains and Green Valley, threats first recognized in the 1980s (Phillips et al. 1981, p. 11; Mills 1991, p. 7; Reichenbacher 1985, p. 21; Service 2000a, p. 7), are responsible for complete and permanent modification of lands that previously supported *C. scheeri* var. *robustispina* and its pollinators. By 2000, the Service estimated that 43 percent of the total habitat surveyed to date had been modified or destroyed due to urbanization (Service 2001a, p. 6). For example, 143 ha (353 ac) of habitat and 47 individual plants were lost to a single housing development project in 1998 (Service 1998c, p. 16). In 2014, 197 ha (487 ac) of suitable *C. scheeri* var. *robustispina* habitat and 99 individual plants were lost to a single infrastructure development project (Service 2014a, p. 33). (USFWS, 2018a)

Stressor: Habitat loss due to nonnative plant invasion and altered fire regimes (USFWS, 2018a)

Exposure:

Response:

Consequence:

Narrative: *Coryphantha scheeri* var. *robustispina* occur in both the desert-grassland and desert-scrubland plant communities, especially in the ecotone of the two (Roller 1996a, p. 9). Invasive nonnative grasses in both communities compete with native plants for water and nutrients, reduce community composition and structure, and alter fire frequency and intensity. Historically, low severity fires that occurred every 10 to 20 years in grasslands, or every 250 years in deserts, likely posed no threat to the long-term survival of *C. scheeri* var. *robustispina* individuals. When invaded by invasive nonnative grasses, fire frequency and intensity increase, leading to the deterioration of both natural grassland and desert communities. Invasive nonnative grasses produce more fine fuels than native vegetation, allowing for a more uniform and higher intensity burn compared with the discontinuous fuels of some native grasslands and deserts, thus reducing the number of microsite refuges safe from fire. *Coryphantha scheeri* var. *robustispina* is not fire adapted, but may survive fires through refugia (e.g. older soils or spaces between native plants), chance, shrinking into the ground, reproducing through basal resprouting, or possibly recolonization from a surviving seedbank, barring adequate rainfall to allow for survival. Further research into the relationship of fire, drought, nonnative species, soil types, and *C. scheeri* var. *robustispina* and their seedbanks would help to better understand the tolerance of this taxon to wildland and prescription fires. Research into desert-scrubland and desert-grassland restoration

(e.g. removal of nonnative grasses and the establishment of native plants) is also essential, as this is a large-scale problem currently without large-scale solutions. (USFWS, 2018a)

Stressor: Effects of Livestock Grazing (USFWS, 2018a)

Exposure:

Response:

Consequence:

Narrative: Some livestock grazing practices that occurred in the past have resulted in enduring landscape-level impacts, because recovery in dryland ecosystems is slow or stagnant. Historically overgrazed lands have altered microclimate and hydrology, increased soil compaction and erosion, reduced structural complexity and abundance of the vegetation community, and species composition; all of which may impact the current suitability of habitat for *C. scheeri* var. *robustispina* in certain areas of its range. In general, poorly managed livestock grazing may negatively impact *C. scheeri* var. *robustispina* seedlings and adult plants through soil erosion, soil compaction, hydrologic and micro-climatic changes, and invasion or expansion of invasive nonnative grasses. Low to moderate intensity grazing however, may also aid *C. scheeri* var. *robustispina* through the creation of open areas temporarily free of competition and with reduced fuels (Service 2000a, p. 9). Additional research into the relationships between livestock use and *C. scheeri* var. *robustispina* is needed to determine both the benefits of grazing and the threshold at which disturbance no longer benefits the taxon. In addition, research is needed into restoration of native species and fire regimes on desert grasslands and desertscrub. (USFWS, 2018a)

Stressor: Recreation and Border Activity (USFWS, 2018a)

Exposure:

Response:

Consequence:

Narrative: Off-road vehicle use and illegal border activity contribute to the overall degradation of *C. scheeri* var. *robustispina* habitat. In addition, individual *C. scheeri* var. *robustispina* have been run over by off-road vehicles. Although these activities could impact individual *C. scheeri* var. *robustispina*, off-road vehicles and illegal border activity are not likely significant sources of mortality for the taxon as a whole. (USFWS, 2018a)

Stressor: Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2018a)

Exposure:

Response:

Consequence:

Narrative: Illegal collection of *C. scheeri* var. *robustispina* is difficult to detect and only one incident has been reported in recent years. Although illegal collection could impact *C. scheeri* var. *robustispina*, it is not as significant a threat for the taxon as previously thought. The determination to not designate critical habitat for the species has helped reduce this threat by not making maps publically available, and continued outreach and education related to the issue of illegal collection remain important tools in the conservation of this taxon. (USFWS, 2018a)

Stressor: Disease or Predation (USFWS, 2018a)

Exposure:

Response:

Consequence:

Narrative: In general, cacti are susceptible to attacks from numerous types of insects, and *C. scheeri* var. *robustispina* is no exception. The interior flesh of cacti provides both a nesting area and food source for beetles, weevils, and other insects. Once an infestation has occurred, cacti can die from the feeding and tunneling activities of insects or from the introduction of fungus or disease. Plants already stressed from prolonged drought are more susceptible to insect attack and disease, as drought may cause physiological stress responses in plants, such as limiting their photosynthesis and cell. Predation by mammals and insects occurs on both adult *C. scheeri* var. *robustispina* and seedlings. Primary insect predators of *C. scheeri* var. *robustispina* are the native *Gerstaeckeria* sp. (cactus weevil), the native *Moneilema* sp. (cactus beetle), and the native *Cactobrosis* sp. (pyralid moth). Ants have been documented on *C. scheeri* var. *robustispina* and will consume seed, however they are not specialists of *C. scheeri* var. *robustispina*. O'Dowd and Hay (1980, p. 539) suggest that ants may also aid in reducing the seedbank of competing plant species. Predation of *Coryphantha scheeri* var. *robustispina* by mammals is well-documented. Harris' antelope squirrel), antelope jackrabbits and desert cottontails are known to eat stem material of *C. scheeri* var. *robustispina*, especially when other food sources are scarce, such as in times of drought. Researchers have documented *C. scheeri* var. *robustispina* mortality caused by javelina (*Pecari tajacu*). These and other animals can also impact cacti by digging under stems, or, at least for larger animals, knocking over or trampling stems. In summary, there are many insect and mammalian predators to *C. scheeri* var. *robustispina* adults and seedlings. Predation increases during times of drought and following damage to a cacti's protective spines, such as post-fire. Many individual *C. scheeri* var. *robustispina* die or become disposed to death annually from predation which has been recorded on numerous occasions over the past decade. (USFWS, 2018a)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2018a)

Exposure:

Response:

Consequence:

Narrative: Because most *C. scheeri* var. *robustispina* occur on private and State Trust lands, they and their habitats are not subject to Federal protection unless there is a Federal nexus to a proposed action. Habitat loss due to urbanization remains a substantial threat to *C. scheeri* var. *robustispina* on these lands. Although best management practices may be implemented with regard to development, nonnative plant invasion and associated alteration of fire regimes, recreation, border issues, and the presence of livestock, management is not continuous across the range of the species and *C. scheeri* var. *robustispina* remain vulnerable to these threats and stressors. There are no regulations in place that address stressors to *C. scheeri* var. *robustispina* and its habitat from predation, drought and climate change, or small population size. (USFWS, 2018a)

Stressor: Drought and Climate Change (USFWS, 2018a)

Exposure:

Response:

Consequence:

Narrative: Cacti are vulnerable to disturbance because they grow slowly, their germination and establishment occurs with low frequency, and they have little capability to recover from disturbance (Portilla 2011, p. 509). Disturbance can reduce recruitment, survival, fecundity, and population growth; disturbance coupled with drought, however, can exacerbate negative

impacts on cacti. In summary, since the late 1990s, the southwestern United States has been experiencing drought conditions and increasing high temperatures. Climatic predictions suggest continued less frequent, but perhaps more intense, summer precipitation, reduced winter precipitation, and increasing temperatures in this region. Drought and increased temperatures increase *C. scheeri* var. *robustispina* stress, reduce defenses to predation and disease, and reduce reproduction, among other impacts. These impacts will continue to affect *C. scheeri* var. *robustispina* and its habitat throughout its range into the foreseeable future. (USFWS, 2018a)

Stressor: Small Population Size and Isolation (USFWS, 2018a)

Exposure:

Response:

Consequence:

Narrative: High species diversity within the vegetative community is important to the survival of *C. scheeri* var. *robustispina*, as this cactus is not abundant enough to sustain its main pollinators. A key pollinator for *C. scheeri* var. *robustispina* is *Diadasia rinconis*, a cactus specialist bee which requires species of *Cylindropuntia*, *Opuntia*, and *Ferocactus* to survive. *C. scheeri* var. *robustispina* is a sparsely distributed plant that requires habitat connectivity and proximity to other plants for effective pollination. Large scale threats and stressors such as habitat degradation and regional drought increase the potential for isolation and genetic loss. Current information indicates that roughly 98 percent of all known *C. scheeri* var. *robustispina* occur within 900 m (2,952.8 ft) of one another. Should development or other threats or stressors remove or cause the deterioration of corridors and connectivity, this could result in genetic isolation and inbreeding. (USFWS, 2018a)

Recovery

Reclassification Criteria:

1. Threats and Habitat Criterion: At least 8,094 hectares (ha) (20,000 acres [ac]) of *C. scheeri* var. *robustispina* habitat per recovery unit are documented to be of optimal quality and remain that way through successful resource management, land conservation, and restoration techniques such as in situ germination. At least 24,281 ha (60,000 ac) of *C. scheeri* var. *robustispina* habitat per recovery unit are documented to be of good quality and remain that way in perpetuity. Habitat is considered optimal quality when it: is protected for conservation purposes; is managed in a manner that promotes the long-term survival of *C. scheeri* var. *robustispina*; has less than 20 percent cover of *C. ciliaris*, *E. lehmanniana*, or other invasive nonnative plant species that alter ecosystem function; contains contiguous habitat and corridors for pollinators; and the *C. scheeri* var. *robustispina* population is observed to be stable or increasing. Habitat is considered good quality when the cover of *C. ciliaris*, *E. lehmanniana*, or other nonnative plants that alter ecosystem function remains between 20 and 35 percent; the land is managed in such a way that promotes the continued existence or expansion of long-term survival of *C. scheeri* var. *robustispina*. Collectively, this represents approximately 42 percent of the known range of *C. scheeri* var. *robustispina*. Additional acres of lesser quality *C. scheeri* var. *robustispina* also exist throughout the range of the species; some of which occurs on lands where ongoing efforts may continue to improve habitat quality. (USFWS, 2018a)

2. Conserve, protect, and restore mature *C. scheeri* var. *robustispina* individuals, their seedbanks (approximately 10 meters), and habitat for pollinators (approximately 900 meter radius) in each recovery unit through resource management, land conservation, and restoration techniques

such as in situ germination. Quantitative monitoring, using a standardized monitoring protocol, of established plots across a variety of land ownerships and land management scenarios, with landowner support, is conducted within each of the two recovery units every 3 to 5 years. Plots demonstrate that the population is stable or increasing a minimum of 10 years over a 15-year period. (USFWS, 2018a)

Delisting Criteria:

The first two criteria for downlisting must be met or surpassed, and monitoring must demonstrate that the population is increasing for a minimum of 20 years over a 30-year period. The additional time necessary to achieve delisting ensures continued population viability. Additionally, it will allow land managers to continue to reduce threats to *C. scheeri* var. *robustispina* from nonnative species invasion achieved during downlisting and track the long-term effectiveness of management. The additional time will also allow land managers to develop methods to reduce anticipated cost and effort needed to maintain habitat and population viability absent the protections of the Act. (USFWS, 2018a)

Recovery Actions:

- Conserve existing and newly discovered *C. scheeri* var. *robustispina* and associated habitat, including unoccupied areas that provide habitat and connectivity for pollinators. Promote urban planning for compact urban development, increase open space preservation and management (e.g. restrictions on trash dumping, off road vehicle use, placement of pedestrian trails, etc.), and connective habitat corridors. Engage in land acquisition to reduce habitat fragmentation and increase connectivity. Develop conservation easements for the protection of *C. scheeri* var. *robustispina* on private lands. Develop and monitor conservation mitigation banking to promote the protection of *C. scheeri* var. *robustispina* habitat. (USFWS, 2018a)
- Restore quality *C. scheeri* var. *robustispina* habitat in the U.S. and Mexico. Develop and implement land management plans that support and promote the taxon, including through the reduction of nonnative plant species and unnatural fire regimes, soil erosion, soil compaction, and headcutting. Work toward a better understanding of transplanting and seeding requirements for *C. scheeri* var. *robustispina* which could be implemented in appropriate habitat. (USFWS, 2018a)
- Develop range-wide standardized long-term monitoring of individuals in established plots, as well as their habitats, threats, and stressors. Monitor individuals in established plots across the range of the taxon using a tested standard protocol to enable an understanding of the long-term trend of the species, its habitat, threats, and stressors. Check the effectiveness of management actions by monitoring individuals subjected to natural and prescribed fire, mechanical site disturbance, various grazing regimes, various restoration techniques, and other management considerations. Monitor in situ grown and transplanted individuals for effectiveness of sowing, planting, and transplanting protocols. (USFWS, 2018a)
- Encourage scientific study to improve our understanding of *C. scheeri* var. *robustispina* biology, ecology, abundance, status, threats, stressors, viability, propagation, restoration of individuals and of habitats, distribution, and genetics in the United States and Mexico. Identify information gaps, compatible land uses, threats, stressors, and appropriate management actions that lead to the conservation of the taxon. Conduct surveys in appropriate habitat, using a tested standard protocol, to better understand the geographic range and habitat requirements of the taxon. Investigate the feasibility of alternative survey

methodologies, such as the use of detection dogs, drones, and distance sampling. Conduct research related to the biology, ecology, abundance, status, threats, stressors, viability, propagation, restoration of individuals and of habitat, and genetics of the taxon. (USFWS, 2018a)

- Maintain plants in captivity at botanic gardens and seeds at seed storage facilities; encourage research into propagation, in situ seed planting, and transplanting methods. Promote the propagation and planting of individuals ex situ at botanic gardens for conservation and public education purposes. Maintain seed from plants across the geographic range of the taxon for conservation purposes. Develop effective approaches to in situ conservation. (USFWS, 2018a)
- Develop public outreach, collaborative partnerships, and agreements with private landowners in the United States and Mexico that encourage *C. scheeri* var. *robustispina* conservation. Increase public outreach regarding threats, stressors, and conservation measures relating to *C. scheeri* var. *robustispina* in both the United States and Mexico. Develop collaborative partnerships and agreements with private landowners that result in management plans or that otherwise encourage *C. scheeri* var. *robustispina* conservation in the United States and Mexico. Develop a recovery implementation team comprised of species experts, agency and non-government agency partners, landowners, and stakeholders to meet regularly, review progress, discuss problems, and revise this plan as needed. (USFWS, 2018a)

References

USFWS. 2018a. Recovery plan for Pima pineapple cactus (*Coryphantha scheeri* var. *robustispina*). U.S. Fish and Wildlife Service, Southwest Region, Tucson, Arizona. 76 pp + 2 Appendices.

USFWS. 2018a. Recovery plan for Pima pineapple cactus (*Coryphantha scheeri* var. *robustispina*). U.S. Fish and Wildlife Service, Southwest Region, Tucson, Arizona. 76 pp + 2 Appendices.

USFWS. 2018b. Pima pineapple cactus (*Coryphantha scheeri* var. *robustispina*), 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Tucson, Arizona. 2 pp.
https://ecos.fws.gov/docs/five_year_review/doc5814.pdf

SPECIES ACCOUNT: *Coryphantha sneedii* var. *leei* (Lee pincushion cactus)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/26/1979; Southwest Region (R2)

Physical Description

Both the Sneed and Lee pincushion cacti are many branched, forming tight clumps of up to 100 or more stems. Individual stems are cylindroid or spherical to club-shaped, 2.5-7.5 cm long (1.0-2.9 inches) and 1-3 cm in diameter (0.4- 1.2 inches) with tubercles up to 3mm long (0.12 inches). The tubercles are persistent and hard after fall of the spines. The spines hide the stem. The central spines are acicular, white, tipped with pink and brown, 3-14 cm long (1.2-5.5 inches) and about 6-17 per areole. The radial spines are white, 3-12 mm long (0.2-0.47 inches) and 35-90 per areole. The flowers are about 1.2 cm tall (0.5 inches) and of equal diameter, not opening widely; they are brownish-pink to pale rose with pink filaments and bright orange anthers. The fruits are greyish-green, or greenish tinged with brown, or rarely pinkish when ripe. They are clavate up to 1.5 cm long (0.6 inches) and 6 mm in diameter (0.24 inches). The seeds are reddish-brown, 0.7-1 mm long (.027-.039 inches), and 1.25-1.5 mm broad (.049-.059 inches) (Benson, 1982). In the Lee pincushion cactus, the spines are deflexed on medium and small stems, slanting from the top of the tubercle toward the main portion of the stem; the flowers are dull medium brownish-pink; the seeds are 1 mm long (.039 inches) and 1.5 mm broad (.059 inches) (Benson, 1982).(USFWS, 1986)

Taxonomy

In the recent taxonomic publications (Kartesz 1999; Baker and Johnson 2000; Anderson 2001), both varieties of *Coryphantha sneedii* are placed in the genus *Escobaria* Britton and Rose. Baker and Johnson (2000) note that this genus is sometimes considered a subgenus of *Coryphantha*. Anderson (2001) uses the genus *Escobaria* in his book "The Cactus Family," stating that the International Cactaceae Systematics Group has accepted this genus. (USFWS, 2015)

Historical Range

Coryphantha sneedii var. *leei* is known only from the Guadalupe Mountains in New Mexico (Eddy County), within, and immediately adjacent to, Carlsbad Caverns National Park. At the time of listing, it was known to only occur in "several canyons" (Weniger 1969). (USFWS, 2015)

Current Range

Occurs in the Guadalupe Mountains (Eddy County) of New Mexico (NatureServe, 2015). This subspecies includes individuals from six canyons scattered in populations of low abundance over approximately 22 kilometers (14 miles) of the Guadalupe Mountains including BLM lands (Carlsbad District). (USFWS, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources**Reproductive Strategy**

Adult: Asexual: vegetative (USFWS, 1986; see dispersal narrative); sexual (inferred from USFWS, 1986)

Breeding Season

Adult: March - April (USFWS, 1986)

Key Resources Needed for Breeding

Adult: Winter and spring moisture, soils seed bank (USFWS, 1986)

Reproduction Narrative

Adult: Most Lee pincushion cacti bloom after 3 - 4 years. Plants bud in late March or early April; fruit formation is from August to November. Winter and spring moisture is important for bud set. Each fruit produces about 26 seeds and a flowering stem produces about 6 fruits. A typical plant may produce over 1,000 seeds per year. Since seeds can remain viable for up to 10 years, the soil probably contains a sizeable seed bank (USFWS, 1986).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 1,220-1,800 m elevation (NatureServe, 2015)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: It is restricted to the Tansil Limestone Formation and grows only on north-facing limestone ledges, slopes and ridgetops, at 1,220-1,800 m elevation; precipitation averages 30 cm/year, in interior chaparral communities. The limestones are generally hard, resistant to erosion, and support a sparse vegetation of low shrubs, some rosette-forming perennials, many cacti, and both annual and perennial herbs (USFWS, 1986; NatureServe, 2015).

Dispersal/Migration**Dispersal**

Adult: Low (inferred from USFWS, 1986)

Dispersal/Migration Narrative

Adult: Only about 10% of all stems are of the non-flowering type, and these are broken off by animals or shifting rocks and may root, establishing new plants. Most fruits are eaten by insects or rodents who probably scatter a few seeds in the process. Birds have also been observed to feed on the fruits and should at least occasionally serve as dispersal agents. If a fruit is not

eaten, weathering breaks down the fruit wall causing the seeds to be dispersed by wind or rain (USFWS, 1986).

Population Information and Trends

Population Trends:

Not available

Number of Populations:

6 (USFWS, 2015)

Population Size:

1,000 - 2,000 (USFWS, 1986)

Population Narrative:

Presently, *Coryphantha sneedii* var. *leei* is known from very limited portions of six canyons in the Guadalupe Mountains (USFWS, 2015). There are an estimated 1,000 - 2,000 plants (Heil and Brack, 1985a) (USFWS, 1986).

Threats and Stressors

Stressor: Fire (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Presently, the threat of wild and prescribed fires in or around occupied *Coryphantha sneedii* var. *leei* habitat could prove problematic to its survival. Most of the park has burned since 1941 (NPS 2005, map, p. 6). While lightning ignitions probably took place frequently in the Guadalupe Mountains, most fires were likely quite localized and less intense prior to fire suppression (NPS 2005). Fire suppression in many ecosystems creates more uniform fuel loads that support more landscape-scale high intensity fires (NPS 2005). Specific impacts of wild and prescribed fire on *Coryphantha sneedii* var. *leei* are inconclusive (USFWS, 2015).

Stressor: Longhorn cactus beetle (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: There has been one observation of adult *Moneilema armatum* (longhorn cactus beetle) on *C. sneedii* var. *leei*, eating portions of this cactus. It is unknown what impact, if any, longhorn beetles have on this species (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Growing seasons are becoming longer and warmer in many regions (Parmesan 2007) including the southwest (Cayan et al. 2001; Easterling 2002; Lenart et al. 2007; Enquist and Gory 2008). Earlier soil moisture stress would result in decreased flowering and reproduction, and

because this cactus has a limited distribution, we would predict a substantial population reduction with a long-term warming trend. Munson et al. (2014) predicts declines in vegetative cover including cacti in Chihuahuan Desert habitats due to climate change. *Coryphantha* spp. are likely to have experienced and rebounded from periods of drought in the past. However, should substantial climate change materialize with increased severity and frequency of drought, it would likely reduce the long-term survivorship of this species (USFWS, 2015).

Recovery

Reclassification Criteria:

Not applicable. (USFWS, 1986)

Delisting Criteria:

The Lee pincushion cactus will be considered for delisting when:

1. All core populations demonstrate stable or increasing trends in abundance over a 20-year period. This will be based on periodic demographic trend monitoring and analysis implemented under the recovery actions. (USFWS, 2019)
- 2a. Maintain a minimum of three geographically separated core populations for each species over a 20-year period. (USFWS, 2019)
- 2b. A minimum of one new core population will be discovered (use Criterion 1) or established outside the current range and wholly separated geographically from the other core populations, and remain occupied for 10 years out of the 20-year survey period. (USFWS, 2019)
- 3a. Maintain genetic diversity within all core populations as measured by the fixation indices inbreeding coefficient (FIS) at or within one standard deviation of the FIS of a closely related species with similar reproductive strategies and demonstrated acceptable viability. (USFWS, 2019)
- 3b. Maintain presence in 80 percent of subpopulations over 20-year monitoring period and outside of the core populations, with any subpopulation extirpations compensated by a newly identified or colonized subpopulation. (USFWS, 2019)
4. Develop and implement a Habitat Management Plan (HMP) for Sneed and Lee pincushion cacti conservation. (USFWS, 2019)
5. A Service approved post-delisting monitoring plan will be implemented. (USFWS, 2019)

Recovery Actions:

- Remove threats of collecting by enforcement of existing regulations. Because of the rarity of the Lee pincushion cactus, the populations must be protected by enforcement of existing international, Federal, and State regulations. Determine the extent and impacts of collecting. Develop and implement a law enforcement strategy. Publicize successful law enforcement actions. (USFWS, 1986)
- Manage existing habitat for protection of the cactus. Habitat management for the Lee pincushion cactus should be done through existing agency management procedures and

- through cooperation with private landowners. The following should be accomplished. Agencies should remain informed of the location and status of Lee pincushion cactus populations. Develop and implement habitat management plans for all populations on public lands. Seek cooperation of landowners to protect and maintain populations on private lands. (USFWS, 1986)
- Gather information for use in management. In-depth knowledge of the plant's growth, distribution, population biology and ecology is needed to understand habitat requirements. The knowledge gained can be used to help sustain and manage healthy natural populations. Study population biology and ecology. Develop techniques to artificially propagate and transplant the Lee pincushion cactus. Inventory known populations and search for new populations in the Franklin and Guadalupe Mountains. (USFWS, 1986)
 - Develop a comprehensive trade management plan for all cacti. Studies are needed to determine what species are in trade, the overall trend of trade in listed cacti, and the feasibility of reducing collecting pressure on wild populations by promoting a commercial, artificial propagation program. Strategies for effective implementation of law enforcement responsibilities under ESA, CITES, Lacey Act, and State laws need to be developed. These studies should be national in scope and address all cacti. The results will be used to develop policy and a comprehensive trade management plan for all cacti. (USFWS, 1986)
 - Develop public awareness, appreciation and support for preservation of the Lee pincushion cactus. Education of the public is a vital part of the recovery process. The cooperation of the public is essential to the ultimate success of the foregoing recovery measures. (USFWS, 1986)
 - Recommendations for Future Actions from 2015 5-Year Review:
 - Determine if the genus associated with this species needs to be changed from *Coryphantha* to *Escobaria* on all future Service documents.
 - Revise the recovery plan for these species to incorporate new information on taxonomy, biology, ecology, and threats with management recommendations. Objective and measurable recovery criteria for down and de listing of the species should be developed which address all listing factors relevant to this species.
 - Develop a *Coryphantha sneedii* var. *leei* and *C. sneedii* var. *sneedii* multi-agency working group to share and disseminate information regarding this listed species to promote education, protection, and recovery.
 - Develop standardized survey and monitoring protocols for these species to be conducted annually by well trained personnel. Continue monitoring of known sites as well as adding new sites to provide a robust dataset for long-term trend analysis. Incorporate fire and climate change factors into long-term monitoring data collection.
 - Develop a mitigation banking requirement (a system whereby project proponents pay for plants to be preserved in an area suitable for their preservation as mitigation for losses incurred during projects).
 - Implement and monitor new transplant projects with experimental manipulations (watering, shading, planting depth, etc.) and controls to determine required establishment needs.
 - Provide legally grown seeds and plants of *Coryphantha sneedii* var. *leei* and *C. sneedii* var. *sneedii*, as the known populations allow, to the commercial succulent trade, but law enforcement must remain vigilant against the theft of cacti throughout its range.
 - Provide viable *Coryphantha sneedii* var. *leei* and *C. sneedii* var. *sneedii* seeds to a seed bank operating under the Center for Plant Conservation guidelines.
 - Collect data on seed dispersal and growth past the germination stage, timing of seed set, and seedling establishment to more clearly define the vulnerable life history stages of these species.
 - Determine microhabitat needs of these species ("nurse" plants, pollinators, precipitation needs- amount and timing, slope and aspect requirements,

disturbance patterns, etc.) to further quantify potential habitat for a transplant and mitigation site. (USFWS, 2015)

References

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SPECIES ACCOUNT: *Coryphantha sneedii* var. *sneedii* (Sneed pincushion cactus)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/07/1979; Southwest Region (R2)

Physical Description

Both the Sneed and Lee pincushion cacti are many branched, forming tight clumps of up to 100 or more stems. Individual stems are cylindroid or spherical to club-shaped, 2.5-7.5 cm long (1.0-2.9 inches) and 1-3 cm in diameter (0.4- 1.2 inches) with tubercles up to 3mm long (0.12 inches). The tubercles are persistent and hard after fall of the spines. The spines hide the stem. The central spines are acicular, white, tipped with pink and brown, 3-14 cm long (1.2-5.5 inches) and about 6-17 per areole. The radial spines are white, 3-12 mm long (0.2-0.47 inches) and 35-90 per areole. The flowers are about 1.2 cm tall (0.5 inches) and of equal diameter, not opening widely; they are brownish-pink to pale rose with pink filaments and bright orange anthers. The fruits are greyish-green, or greenish tinged with brown, or rarely pinkish when ripe. They are clavate up to 1.5 cm long (0.6 inches) and 6 mm in diameter (0.24 inches). The seeds are reddish-brown, 0.7-1 mm long (.027-.039 inches), and 1.25-1.5 mm broad (.049-.059 inches) (Benson, 1982). In the Sneed pincushion cactus, the stems have spines that are not deflexed but spread parallel to the stem surface; the flowers are pale, or medium to rose, magenta; the seeds are 0.75 mm long (.03 inches), and 1.25 mm broad (.049 inches) (Benson, 1982). (USFWS, 1986)

Taxonomy

In the recent taxonomic publications (Kartesz 1999; Baker and Johnson 2000; Anderson 2001), both varieties of *Coryphantha sneedii* are placed in the genus *Escobaria* Britton and Rose. Baker and Johnson (2000) note that this genus is sometimes considered a subgenus of *Coryphantha*. Anderson (2001) uses the genus *Escobaria* in his book "The Cactus Family," stating that the International Cactaceae Systematics Group has accepted this genus. Further elucidation of the taxonomic relationships of the *C. sneedii* complex, including *Escobaria guadalupensis*, is needed in order to understand the distribution and abundance of *C. sneedii* var. *sneedii* (USFWS, 2015).

Historical Range

Coryphantha sneedii var. *sneedii* is a regional endemic along the Texas/New Mexico border (USFWS, 2015). It was historically known only from the Anthony Gap area of the Franklin mountains in Dona Ana County, New Mexico. (USFWS, 1986)

Current Range

It occurs in western Texas and nearby southern New Mexico (between El Paso and Las Cruces) (NatureServe, 2015). It possibly occurs in the Guadalupe Mountains; in Dona Ana and Eddy Counties, New Mexico, and El Paso County in Texas (USFWS, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources**Reproductive Strategy**

Adult: Asexual: vegetative (USFWS, 1986); sexual (inferred from USFWS, 1986)

Breeding Season

Adult: March - April, sometimes July - August (USFWS, 1986)

Key Resources Needed for Breeding

Adult: Rocks (USFWS, 1986; NatureServe, 2015)

Reproduction Narrative

Adult: A second blooming season has rarely been observed in July and August usually following summer rains. The best seedling survival is under rocks or deep in the cracks of rocks where seedlings are protected (USFWS, 1986; NatureServe, 2015). One type of stem remains small and probably serves to start new plants when they break off. Most Sneed pincushion cacti bloom after 3 - 4 years. Plants bud from March to April with the principal blooming period in April and fruit formation from August to November. Fruits from Slaughter Canyon averaged about 18 seeds per fruit. With about 11 flowering stems per plant, about 140 seeds per plant are produced each year (USFWS, 1986).

Habitat Type

Adult: Terrestrial (USFWS, 1986; NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Desert and desert grassland (USFWS, 1986; NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 1,220-1,800 m elevation (USFWS, 1986; NatureServe, 2015)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 1986; NatureServe, 2015)

Habitat Narrative

Adult: It is restricted to limestone ledges and the rocky slopes of limestone mountains in desert and desert grassland habitats; 1,220-1,800 m elevation; precipitation 19.7 - 40.0 cm/year; and grows in cracks on vertical cliffs or ledges. The limestones are generally hard, resistant to erosion, and support a sparse vegetation of low shrubs, some rosette-forming perennials, many cacti, and both annual and perennial herbs (USFWS, 1986; NatureServe, 2015).

Dispersal/Migration**Dispersal**

Adult: Low to moderate (inferred from USFWS, 1986)

Dispersal/Migration Narrative

Adult: The fruits have a prune-like odor when ripe and attract rodents which are likely dispersal agents. Birds have been noted to feed on the fruits and should serve as dispersal agents. Some fruits crumble with age, and water disperses the seeds (USFWS, 1986).

Population Information and Trends

Population Trends:

Not available

Number of Populations:

20 (USFWS, 1986)

Population Size:

Possibly > 100,000 (USFWS, 1986)

Population Narrative:

There are 20 documented localities for this taxon. Heil and Brack (1985a) have estimated the total number of sneed pincushion cacti in Carlsbad Caverns National Park to exceed 100,000. This figure needs verification through quantitative sampling (USFWS, 1986).

Threats and Stressors

Stressor: Fire (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Most of the park has burned since 1941 (NPS 2005, map, p. 6). While lightning ignitions probably took place frequently in the Guadalupe Mountains, most fires were likely quite localized and less intense prior to fire suppression (NPS 2005). Fire suppression in many ecosystems creates more uniform fuel loads that support more landscape-scale high intensity fires (NPS 2005). However, specific impacts of wild and prescribed fire on *C. sneedii* var. *sneedii* are still inconclusive (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Growing seasons are becoming longer and warmer in many regions (Parmesan 2007) including the southwest (Cayan et al. 2001; Easterling 2002; Lenart et al. 2007; Enquist and Gory 2008). Earlier soil moisture stress would result in decreased flowering and reproduction, and because this cactus has a limited distribution, we would predict a substantial population reduction with a long-term warming trend. Munson et al. (2014) predicts declines in vegetative cover including cacti in Chihuahuan Desert habitats due to climate change. *Coryphantha* spp. are likely to have experienced and rebounded from periods of drought in the past. However, should substantial climate change materialize with increased severity and frequency of drought, it would likely reduce the long-term survivorship of this species (USFWS, 2015).

Recovery

Reclassification Criteria:

Downlisting of the Sneed pincushion cactus to threatened can be initiated when:

1. Six or more secure populations are established with at least three each near the eastern (Guadalupe Mountains) and western (Franklin Mountains and southern Organ Mountains) limits of the plant's known range. Populations will be considered secure when land managing agencies, organizations or individuals have developed and implemented habitat management plans for the Sneed pincushion cactus. At a minimum, the plans should contain methods for securing populations against present and future potential threats, methods for accurately quantifying population sizes, and methods for monitoring populations to determine their stability, growth, or decline. (USFWS, 1986)
2. When the known number of plants in these six secure populations totals 20,000. (USFWS, 1986)

Delisting Criteria:

The Sneed pincushion cactus will be considered for delisting when:

1. All core populations demonstrate stable or increasing trends in abundance over a 20-year period. This will be based on periodic demographic trend monitoring and analysis implemented under the recovery actions. (USFWS, 2019)
2. Maintain a minimum of three geographically separated core populations for each species over a 20-year period. (USFWS, 2019)
- 3a. Maintain genetic diversity within all core populations as measured by the fixation indices inbreeding coefficient (FIS) at or within one standard deviation of the FIS of a closely related species with similar reproductive strategies and demonstrated acceptable viability. (USFWS, 2019)
- 3b. Maintain presence in 80 percent of subpopulations over 20-year monitoring period and outside of the core populations, with any subpopulation extirpations compensated by a newly identified or colonized subpopulation. (USFWS, 2019)
4. Develop and implement a Habitat Management Plan (HMP) for Sneed pincushion cacti conservation. (USFWS, 2019)
5. A Service approved post-delisting monitoring plan will be implemented. (USFWS, 2019)

Recovery Actions:

- Remove threats of collecting by enforcement of existing regulations. Because of the rarity of the Sneed pincushion cactus, the populations must be protected by enforcement of existing international, Federal, and State regulations. Determine the extent and impacts of collecting. Develop and implement a law enforcement strategy. Publicize successful law enforcement actions. (USFWS, 1986)
- Manage existing habitat for protection of the cactus. Habitat management for the Sneed pincushion cactus should be done through existing agency management procedures and

- through cooperation with private landowners. The following should be accomplished. Agencies should remain informed of the location and status of Sneed pincushion cactus populations. Develop and implement habitat management plans for all populations on public lands. Seek cooperation of landowners to protect and maintain populations on private lands. (USFWS, 1986)
- Gather information for use in management. In-depth knowledge of the plant's growth, distribution, population biology and ecology is needed to understand habitat requirements. The knowledge gained can be used to help sustain and manage healthy natural populations. Study population biology and ecology. Inventory known populations and search for new populations in the Franklin and Guadalupe Mountains. (USFWS, 1986)
 - Develop a comprehensive trade management plan for all cacti. Studies are needed to determine what species are in trade, the overall trend of trade in listed cacti, and the feasibility of reducing collecting pressure on wild populations by promoting a commercial, artificial propagation program. Strategies for effective implementation of law enforcement responsibilities under ESA, CITES, Lacey Act, and State laws need to be developed. These studies should be national in scope and address all cacti. The results will be used to develop policy and a comprehensive trade management plan for all cacti. (USFWS, 1986)
 - Develop public awareness, appreciation and support for preservation of the Sneed pincushion cactus. Education of the public is a vital part of the recovery process. The cooperation of the public is essential to the ultimate success of the foregoing recovery measures. (USFWS, 1986)
 - Recommendations for Future Actions from 2015 5-Year Review:
 - Determine if the genus associated with this species needs to be changed from *Coryphantha* to *Escobaria* on all future Service documents.
 - Revise the recovery plan for these species to incorporate new information on taxonomy, biology, ecology, and threats with management recommendations. Objective and measurable recovery criteria for down and de listing of the species should be developed which address all listing factors relevant to this species.
 - Develop a *Coryphantha sneedii* var. *leei* and *C. sneedii* var. *sneedii* multi-agency working group to share and disseminate information regarding this listed species to promote education, protection, and recovery.
 - Develop standardized survey and monitoring protocols for these species to be conducted annually by well trained personnel. Continue monitoring of known sites as well as adding new sites to provide a robust dataset for long-term trend analysis. Incorporate fire and climate change factors into long-term monitoring data collection.
 - Develop a mitigation banking requirement (a system whereby project proponents pay for plants to be preserved in an area suitable for their preservation as mitigation for losses incurred during projects).
 - Implement and monitor new transplant projects with experimental manipulations (watering, shading, planting depth, etc.) and controls to determine required establishment needs.
 - Provide legally grown seeds and plants of *Coryphantha sneedii* var. *leei* and *C. sneedii* var. *sneedii*, as the known populations allow, to the commercial succulent trade, but law enforcement must remain vigilant against the theft of cacti throughout its range.
 - Provide viable *Coryphantha sneedii* var. *leei* and *C. sneedii* var. *sneedii* seeds to a seed bank operating under the Center for Plant Conservation guidelines.
 - Collect data on seed dispersal and growth past the germination stage, timing of seed set, and seedling establishment to more clearly define the vulnerable life history stages of these species.
 - Determine microhabitat needs of these species ("nurse" plants, pollinators, precipitation needs- amount and timing, slope and aspect requirements, disturbance patterns, etc.) to further quantify potential habitat for a transplant and mitigation site. (USFWS, 2015)

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https://ecos.fws.gov/docs/recovery_plan/860321b.pdf

SPECIES ACCOUNT: *Crescentia portoricensis* (Higuero de sierra)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/4/1987; Southeast Region (R4) (USFWS, 2015)

Physical Description

A vine-like shrub or small tree which may reach up to 6 meters (20 feet) in height and 8 centimeters (3 inches) in diameter. The bark is gray and the branches long and slender. The glabrous leaves vary from 5 to 15 centimeters (2 to 6 inches) in length and 2 to 8 centimeters (3/4 to 3 inches) in width and are whorled in groups of 3 to 5 at the nodes. The leaves are simple, widest above the middle, entire, leathery, dark shiny—green above, with a rounded or blunt apex and a tapered base. The petiole is from 1 to 2 centimeters (1/4 to 5/8 inch) long (Little et al., 1974, Vivaldi and Woodbury 1981) - The perfect flowers are solitary at the axil of the leaves or along the branches. The calyx is leathery, tubular, 2-lobed, and about 2 centimeters (3/4 inch) long. The corolla is yellowish— white with the 5 united petals forming a bell-shaped tube approximately 4 centimeters (1 and 1/2 inches) long. The four stamens are attached to the base of the petals. The fruit is dark green when mature, cylindric, hard and leathery, indehiscent, approximately 10 centimeters (4 inches) long and 3 centimeters (1 and 1/4 inches) wide (Little et al. 1974, Vivaldi and Woodbury 1981). (USFWS, 1991)

Taxonomy

A member of the Bignoniaceae family (USFWS, 1991).

Historical Range

This species is endemic to Puerto Rico and found only in the Maricao Commonwealth Forest and the Susua Commonwealth Forest (USFWS, 1991).

Current Range

Presently known from only 7 sites in Puerto Rico: five within the Maricao Commonwealth Forest and two within the nearby Susua Commonwealth Forest (USFWS, 1991). Specific locations include Quebrada Piedras and Río Seco in the Maricao Commonwealth Forest, and Quebrada Peces in the Susúa Commonwealth Forest. Within the Susúa Forest, Breckon et al. (1992) reported three main populations comprised by 10 localities along three water bodies (Quebrada Grande, Río Loco and Quebrada Peces), all tributaries of the Río Loco drainage. Three populations within the Maricao Commonwealth Forest are located in the Rio Maricao watershed, steep slopes along the Quebrada Seca river, and along a small tributary of the Rio Lajas river below El Salto de Curet. Additional MCF populations are found along the Quebrada Piedras, Rio Bonelli, Rio Cupeyes and Rio Postrero (USFWS, 2017).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Vegetative (USFWS, 1991)

Key Resources Needed for Breeding

Adult: Likely bat pollinators (EPA, 2016)

Other Reproductive Information

Adult: Breckon and Kolterman (1993) stated that the species is in danger of hybridization with the introduced *Crescentia cujete*. These authors reported a natural population of *C. linearifolia* (native to Puerto Rico) located along State Road PR 116 in the Lajas Valley that was apparently hybridizing with *C. cujete*. They mentioned that trees that appear to be “pure” *C. linearifolia* are infrequent in the population; the majority of the trees are apparently hybrids. *Crescentia cujete* is probably native to Mexico and north Central America. Cancel (2010) recorded individuals of *C. cujete* within the Susúa Commonwealth forests in the proximity of a population of *C. portoricensis*. Nonetheless, Cancel (2010) did not find evidence of hybridization in any of the wild *C. portoricensis* populations he studied. However, he recorded evidence of hybridization in several ex situ collections of *C. portoricensis* (i.e., Quebradillas and Caguas Botanical Garden). (USFWS, 2017).

Reproduction Narrative

Adult: Produces fruits year round and is probably pollinated by bats (EPA, 2016). Sprouting has been observed in some individuals but the importance of this vegetative reproduction is unknown (USFWS, 1991). All surveys have found no evidence of natural seedling establishment which indicates that the species is apparently depending on asexual reproduction (Breckon et al. 1992; Breckon and Kolterman 1993; Breckon and Kolterman 1994; and Breckon and Kolterman 1996; Cancel 2010). Breckon et al. (1992) and Breckon and Kolterman (1993) observed evidence of asexual or vegetative reproduction, which occurred when the terminal portion of the arching branches came in contact with the ground and layering (producing roots). In particular, Breckon and Kolterman (1994) observed that a portion of the plant tagged as #168 in the Susúa Commonwealth Forest, had separated from the parent plant, had rooted, and was in good condition. (USFWS, 2017).

Habitat Type

Adult: Terrestrial (EPA, 2016)

Habitat Vegetation or Surface Water Classification

Adult: Subtropical moist and wet forest, riparian (EPA, 2016)

Geographic or Habitat Restraints or Barriers

Adult: ~820 to 2624 ft. elevation (EPA, 2016)

Habitat Narrative

Adult: Subtropical moist and wet forest life zones. Found along banks of streams, usually within a meter of the water's edge. Topography is mountainous with steep slopes and ravines. Vegetation in the forests is semi-evergreen to deciduous. Serpentine-derived soils, area has serpentine outcrops interspersed with Nipe and Rosario clay soils (derived from serpentine). Occurs around 820 to 2624 ft. elevation (EPA, 2016).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seeds are dispersed by water (flooding of streams) (EPA, 2016).

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Very low (inferred from USFWS, 1991)

Redundancy:

Low (USFWS, 1991)

Number of Populations:

7 (USFWS, 1991). During his research, Cancel (2010) reported at least 532 individuals of *C. portoricensis* within eleven populations (USFWS, 2017).

Population Size:

~100 (USFWS, 1991). Several new populations have been found and the number of known individuals has increased to more than 500. The current number of known individuals has increased to over 500 plants within these Commonwealth forests. More recently, José Sustache (2015; PRDNER botanist) reported about 15 individuals within a previously unreported area adjacent to Cabañas del Monte del Estado in Maricao. We currently estimate at least 547 individuals of *C. portoricensis* in the wild (including individuals located by Jose Sustache). (USFWS, 2017).

Population Narrative:

It is found in only two areas of southwestern Puerto Rico. A total of approximately 100 individuals occur in the 7 populations known (USFWS, 1991).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 1991). As of 2019: the majority of the suitable habitat for the species is protected and managed for conservation, and the impacts by forest management do not occur on a regular basis and are limited to maintenance of existing trails and recreational areas. Therefore, destruction, modification or curtailment of their habitat (Factor A) is considered a low and non-imminent threat for this species. (USFWS, 2019)

Exposure:**Response:****Consequence:**

Narrative: Historically, the most important factors affecting the abundance and distribution of *Crescentia portoricensis* have been both the direct and indirect effects of deforestation. Much of the Susua Forest and parts of the Maricao Forest were cut for cultivation, grazing, charcoal production, and wood prior to their designation as public forests. Land use practices in upland areas resulted in increased flash flooding and erosion of stream banks, the habitat for this species. Small intake dams, trails, and recreational use of the more accessible areas also threaten

the species (USFWS, 1991). This includes road construction and activity, particularly along State Road PR 362. (USFWS, 2017).

Stressor: Flash floods (USFWS, 1991)

Exposure:

Response:

Consequence:

Narrative: The “Quebrada Peces” population in Susúa, composed of only six known individuals, although within a protected Commonwealth Forest, is located close to a heavily traveled access road to the Forest. All known individuals are located on steep stream banks and are exposed to the threat of elimination by erosion and flash flooding. The Maricao populations are also subject to a variety of threats. Here the species is found along drainage areas subject to flash floods which may uproot plants (USFWS, 1991).

Stressor: Erosion (USFWS, 2017).

Exposure:

Response:

Consequence:

Narrative: All populations are threatened with increased erosion by deforestation and poor management practices occurring upstream outside the forest. According to Cancel (2010), erosion may explain why the numbers of individuals in the Río Lajas and Quebrada Seca in Maricao, and Arroyo del Tanque in Susúa have decreased as compared to the data provided by Breckon and Kolterman from 1991 to 1995. Moreover, the loss of individuals in the Río Maricao could be explained by the construction of a small dam in the river and the effect of hurricanes. Based on the monitoring of this population by Breckon and Kolterman (1992), and by Cancel (2010), there was a decline in number of individuals likely due to river overflow and erosion of the river bank during hurricanes events (i.e., Hurricane Georges in 1998). Despite documentation of additional populations, loss of individuals due to erosion along river margins and landslides may have a major detrimental effect on the species, particularly since recruitment is not documented on these populations. (USFWS, 2017).

Stressor: *Rattus rattus* predation (USFWS, 2017). Considered the most significant threat as of 2019. (USFWS, 2019).

Exposure:

Response:

Consequence:

Narrative: Breckon et al. (1992) found several fruits of *C. portoricensis* that had been gnawed on, and in some cases the contents had been eaten; presumably by the introduced rat, *Rattus rattus*. Breckon et al. (1992) recommended further studies to determine if rat predation of fruits accounted for the absence of seedlings in the wild. Cancel (2010) also found evidence of rat predation in the *C. portoricensis* population at Quebrada Peces, Susúa commonwealth Forest. The predated fruit found by Cancel was green and was still hanging on the plant at the time of his observation. Evidence of predation was also observed in 2010 by Service biologist O. Monsegur, along the headwaters of Río Maricao (Maricao Commonwealth Forest). A ripe fruit was found submerged in the river with clear rodent teeth marks around the pericarp, with intact seed material that was set for germination and showed 80% germination. Although other *Crescentia* spp. have been reported to be dispersed by rodents (Kubitzki and Ziburski 1994), the existing evidence of predation and the lack of natural recruitment of the species, lead us to concur with

Breckon et al. (1992), who suggested that exotic rats (*Rattus rattus*) might be negatively impacting *C. portoricensis*. It is likely that the majority of the fruits are eaten before the seed material has fully developed and any seed (embryo) left by rodents might be immature and not able to germinate. (USFWS, 2017). There is evidence that the absence of recruitment is being caused by rats preying on (Factor C) and/or damaging the fruits and seeds of *higiiero de sierra* (USFWS 2017). It is likely that the majority of the fruits are eaten before the seed material has fully developed and any seed (embryo) left by rodents might be immature and not able to germinate. (USFWS, 2019).

Stressor: Genetic diversity and hybridization (USFWS, 2017).

Exposure:

Response:

Consequence:

Narrative: Along with a small population size, negative impacts of habitat fragmentation may result in erosion of genetic variation through the loss of alleles by random genetic drift (Honnay and Jacquemyn 2007), which may also limit the ability of a species to respond to a changing environment (Booy et al. 2000). This may be due to the founder effect or a genetic bottleneck during the history of the species. This might well be the case of *C. portoricensis* following the massive deforestation island wide in Puerto Rico, and that reached its peak prior to the designation of the Maricao and Susúa forests as conservation areas (Cancel 2010). Species with low fruit set and no evidence of natural recruitment as the case of *C. portoricensis* were likely adversely affected by this deforestation. Thus, another factor that would be expected to contribute to a low genetic diversity in *C. portoricensis* is its apparent reliance on asexual reproduction. A preponderance of asexual reproduction on this species would be expected to be reflected in genetic differences of individuals among different river drainages (Cancel 2010). Moreover, in the absence of natural recruitment, where seedlings are a result of crosspollination among adult individuals, the clones produced through asexual reproduction are expected to reduce the genetic variability of the species. Additionally, it is known that species of the genus *Crescentia* hybridize with related species (Gentry 1980), but Cancel (2010) did not find evidence of hybridization in any of the wild populations he studied. Nonetheless, Cancel (2010) reported plants of *C. portoricensis* with fruits of intermediate size and shape, suggesting hybridization on cultivated material in the municipality of Quebradillas. Hybridization of *C. portoricensis* also has been documented in the nursery of Para La Naturaleza (O. Monsegur, USFWS, pers. obs., 2009). Hybridization with other species of the genus should be avoided both in situ and ex situ, to safeguard the integrity of this narrow endemic species. (USFWS, 2017).

Stressor: Natural recruitment (USFWS, 2017).

Exposure:

Response:

Consequence:

Narrative: Neither Breckon et al. (1992), Cancel (2010), nor any Service biologist has documented evidence of seedlings in the wild despite the evidence of high germination rates (about 80%) of seed material collected from wild populations when propagated in nursery conditions. Factors such as the lack of a native seed disperser and/or appropriate microhabitat conditions for germination may explain the absence of natural recruitment in the wild. Nonetheless, the Maricao and Susúa Commonwealth Forests harbor very good stands of native vegetation, including some remnants of pristine forest, suggesting that ecological conditions are suitable. However, available evidence strongly suggests that predation of fruits by rats is a major factor

preventing the establishment of seedlings of *C. portoricensis* (see Factor C), and thus compromise the long term recovery of the species. (USFWS, 2017).

Recovery

Reclassification Criteria:

Existing populations and their habitats are protected and at least four new populations are established in protected areas (USFWS, 1991). At least four new populations capable of self-perpetuation have been established within suitable protected areas such as Commonwealth forests. The plan specifies that these four populations should be considered a minimum requirement, and should be expanded upon if the regenerative or propagative potential of natural and ex situ populations proves to be insufficient. (USFWS, 2017).

The plan also specifies that if new populations of the species are discovered, it may be preferable to place greater emphasis on protection, rather than on propagation, to achieve a minimum number of plants. (USFWS, 2017).

Delisting Criteria:

1. Existing eleven (11) populations of higiiro de sierra within the Maricao and Susua Commonwealth Forests are enhanced and managed such that they show a stable or increasing population trend, evidenced by natural recruitment, and multiple age classes (addresses Factor A, C, and E). (USFWS, 2019).
2. Threats reduction and management activities (e.g., control of predation by rats, best management practices during forest management activities) have been implemented to a degree that the species will remain viable for the foreseeable future (addresses Factor A, C, and E). (USFWS, 2019).

Recovery Actions:

- Monitor existing populations (USFWS, 1991).
- Provide protection for existing populations and their habitat (USFWS, 1991).
- Conduct research on the life history of the species, evaluate methods of propagation, and locate introduction sites (USFWS, 1991).
- Propagate and produce seedlings for enhancement of existing populations and for the establishment of new populations at identified sites (USFWS, 1991). Added in 2017: The populations that are actively producing fruits should be monitored to collect seed material for recovery purposes. (USFWS, 2017). Added in 2019: Develop a protocol for the propagation and reintroduction of higiiro de sierra in collaboration with partners. The protocol should address avoiding hybridization and insect pests. This revised action supplements Task 4: Establishment of new populations. (USFWS, 2019).
- 2017 Recommendation 1. Develop a plan for the long term monitoring of the known populations of *C. portoricensis* in order to establish population trends and to record any evidence of natural recruitment. (USFWS, 2017).
- 2017 Recommendation 2. Conduct further studies to address possible adverse effects of fruit predation by rats (*Rattus rattus*), and to determine if rats provides some mechanism for seed dispersal or if they damage the seed embryo. (USFWS, 2017). Refinement in 2019: Research should be conducted focused on the potential factors that affect higiiro de sierra

recruitment in the wild in order to assess the need to control rats in the wild or the need for other actions to enhance recruitment. This new action should be included within Task 3: Research. (USFWS, 2019).

- 2017 Recommendation 3. Studies should be conducted to determine the patterns of genetic variation within and among populations in order to develop a plan to preserve the species genetic variability and to manage populations effectively. (USFWS, 2017).
Refinement in 2019: Assess Higuero de Sierra genetic structure along its known range that may inform the need for specific propagation efforts and the need for long-term seed banking. This new action should be included within Task 3: Research. (USFWS, 2019).
- 2017 Recommendation 4. Further studies should be conducted on the species reproductive biology to address other limiting factors (e.g., lack of pollinators or seed dispersers). (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Although there is no documentation that *Crescentia portoricensis* has been taken for horticultural purposes, it may be recognized as having ornamental potential in the future. Propagation has been attempted by cuttings and seed by the Fairchild Tropical Garden of Miami, Florida. Germination of the many small seeds collected in August 1989, has been successful, however, it is not known yet whether ex situ propagation could provide a source of material for reintroduction of the species in Puerto Rico (C. Lippincott pers. comm.) (USFWS, 1991).
- The Puerto Rico Department of Natural Resources has constructed barriers along the Susua Forest access road in order to discourage parking. In addition, the Department has installed a fence at the entrance to the “Quebrada Feces” in order to reduce visitation to the area (USFWS, 1991).

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SPECIES ACCOUNT: *Crotalaria avonensis* (Avon Park harebells)

Species Taxonomic and Listing Information

Listing Status: Endangered; 5/27/1993; Southeast Region (R4) (USFWS, 2015)

Physical Description

Avon Park harebells (*Crotalaria avonensis*) is a spreading, perennial herb with one to three moderately hairy, flowering stems that may grow 2 to 10 cm above the surface. It has a large taproot, up to 14 mm thick and 40 cm long. The leaves of this plant are 8 to 19 mm long, broadly elliptic or round, somewhat succulent, and coated with white or yellowish-white hairs. The stems terminate in flowering racemes. Flowering is from March until June. The flower, shaped like a typical pea flower, has a yellow corolla 8 to 9 mm long. The seed pods are inflated and 14 to 25 mm long. These pods are tan to grey or maroon, and can be nearly as long as the upright stems that hold them in place. The pods contain up to 18 seeds, chestnut to maroon in color and 3.4 to 3.8 mm long by 2.4 to 2.6 mm wide. The plant generally appears to resemble clusters of fuzzy grayish leaves hugging the ground and sometimes appears bushy (DeLaney and Wunderlin 1989). (USFWS, 1999)

Taxonomy

C. avonensis is a member of the pea family (Fabaceae/Leguminosae). This small herb with large seed pods was not named until 1989, evidently because very few specimens had ever been collected and they had not been examined by taxonomists. This species is most closely related to *C. rotundifolia*, a variable species that ranges from Virginia to Panama (DeLaney and Wunderlin 1989). *Crotalaria* is a very large, mostly tropical genus that includes a number of robust annual weeds, all with inflated “rattlebox” seed pods. It has been suggested that this endemic is a relic of the Miocene on the southern Lake Wales Ridge (DeLaney and Wunderlin 1989). (USFWS, 1999)

Historical Range

See Current Range.

Current Range

Avon Park harebells is one of the most narrowly distributed of the Lake Wales Ridge endemics, having only been identified at three sites in Polk and Highlands counties. Its distribution includes the Avon Park Lakes acquisition area and the Saddleblanket Lakes State Preserve in Polk County, and the Carter Creek acquisition area in Highlands County. (USFWS, 1999)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated

Breeding Season

Adult: Flowering begins in mid-March and continues until June. (USFWS, 1999)

Other Reproductive Information

Adult: Flowering begins in mid-March and continues profusely until June. After flowering, this deciduous plant enters a vegetative phase, forming clusters of stems that give a clumped or rosette appearance. They are then dormant from late fall or early winter until March (DeLaney and Wunderlin 1989). Demographic information on pollinators, seed dispersers, and seed viability is lacking for this species. (USFWS, 1999)

Reproduction Narrative

Adult: Avon Park harebells are pollinated by insects, but visitation rates are very low. The plant is reproductively challenged, with less than 10 percent of flowers producing fruits. Seeds contribute to a persistent seed bank lasting at least three years. Seedlings have moderate survival and commonly begin flowering after 6-8 years (Menges et al. 2016). (USFWS, 2019)

Habitat Type

Adult: Scrub flatwoods rosemary scrub and pine scrub

Habitat Narrative

Adult: This species inhabits scrub communities found on the Lake Wales Ridge where it typically grows in full sun, on bare white sand, or in association with clumps of *Cladonia* lichens. However, it may also occur in the partial shade of other plants (DeLaney and Wunderlin 1989). It may also grow along trails, open edges, or previously disturbed roadbeds. The soils associated with this species have been classified as Archbold and Satellite sands (The Nature Conservancy 1991). Like other small scrub endemics, it appears to depend on bare patches of sand to become established. (USFWS, 1999)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: No information available (USFWS, 1999)

Population Information and Trends**Number of Populations:**

2 (USFWS, 2019)

Population Narrative:

Historically and currently, the species is known from just two populations. One population occurs partially in the unprotected Avon Park Lakes subdivision and continues to decline as vacant lots supporting the plant are developed (Menges et al. 2016). Part of this population is protected at a second site, The Nature Conservancy's Saddle Blanket Scrub Preserve. The second population is at the Florida Fish and Wildlife Conservation Commission's (FWC) Carter Creek unit of the Lake Wales Ridge Wildlife Management Area (LWRWEA). The unprotected Avon Park Lakes site hosts the largest number of plants, likely consisting of thousands. The Saddle Blanket site supported 531 plants in 2006 (Service 2007). The size of the Carter Creek population is unknown, but likely is in the thousands, based on Menges et al. (2016). Avon Park harebells has

been reintroduced at two conservation sites which have to date been successful in establishing plants that have flowered and produced seed. The FNAI 2015 Element Tracking Summary (FNAI 2015) identifies 6 occurrences, 2 of these are protected at Saddle Blanket Preserve, and represent portions of the larger Avon Park Lakes population. Two others are FWC protected areas that represent the Carter Creek population. The final two occurrences represent unprotected portions of the Avon Park Lakes population. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat destruction or modification

Exposure:

Response:

Consequence:

Narrative: This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 million persons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

Stressor: Lack of adequate fire management

Exposure:

Response:

Consequence:

Narrative: Fire is necessary to maintain the scrub habitats upon which this species depends. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time (Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species. (USFWS, 2019)

Stressor: Limited geographic range

Exposure:

Response:

Consequence:

Narrative: This species occurs within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

Recovery**Reclassification Criteria:**

Not developed. (USFWS, 1999)

Delisting Criteria:

1. At least 20 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)
2. Populations (as defined in criterion 1) in yellow sand scrub and scrubby flatwoods habitats are distributed across the known range of the species. (USFWS, 2019)
3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

Recovery Actions:

- Determine current distribution of *C. avonensis*. This species' known distribution is isolated to Polk and Highlands counties. Additional surveys of scrub habitat with appropriate soils should be conducted in these two counties. A geographic information systems database should be developed to map existing populations and to assess the species' status and trends over time. The database should contain information on locations, population sizes, and status. This information should also be used for project review and in land acquisition activities. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or residential development. The remaining habitat is fragmented into small parcels and in many cases, isolated. (USFWS, 1999)
- Conduct research on life history characteristics. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species, more specific biological information is needed. (USFWS, 1999)

- Develop standardized monitoring. Standardized monitoring needs to be developed for this and other listed scrub species to determine the effect of management actions. (USFWS, 1999)
- Provide public information about *C. avonensis*. It is important that governmental agencies, conservation organizations, and private land owners be appropriately informed about this species. (USFWS, 1999)
- Establish reclassification criteria. Once the population is stabilized, research and monitoring results may provide data necessary to develop reclassification criteria. (USFWS, 1999)
- Habitat-Level Recovery Actions: Prevent degradation of existing habitat. Provide public information about scrub and its unique biota. (USFWS, 1999)

References

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USFWS. 2019. Amendment 1. Recovery Plan for *Conradina brevifolia* (short-leaved rosemary), *Crotalaria avonensis* (Avon Park harebells), *Dicerandra christmanii* (Garrett's mint), *Dicerandra frutescens* (scrub mint), *Eryngium cuneifolium* (snakeroot), *Hypericum cumulicola* (Highlands scrub hypericum), *Liatris ohlingerae* (scrub blazing star), *Polygala lewtonii* (Lewton's polygala), *Polygonella basiramia* (wireweed), *Polygonella myriophylla* (sandlace), *Warea carteri* (Carter's mustard), and *Ziziphus celata* (Florida ziziphus). U.S. Fish and Wildlife Service, Atlanta, Georgia. 23 pp. September 24, 2019.

SPECIES ACCOUNT: *Cryptantha crassipes* (Terlingua Creek cat's-eye)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/30/1991; Southwest Region (R2) (USFWS, 2016)

Physical Description

A silvery-gray perennial herb with erect stems, 1.5-2.5 dm tall, growing out of a mound of basal leaves. Flowers (late March-early June) are white with yellow throats (NatureServe, 2015).

Taxonomy

Cryptantha crassipes belongs to the Borage (Boraginaceae) family (USFWS, 1993).

Historical Range

See current range/distribution.

Current Range

Only occurs in in southern Brewster Co., Tex. in gypseous clays (NatureServe, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (USFWS, 1993)

Lifespan

Adult: Unknown; long-lived perennial (USFWS, 1993)

Breeding Season

Adult: March - June (USFWS, 1993)

Key Resources Needed for Breeding

Adult: Insect pollinators, likely bees (USFWS, 1993)

Reproduction Narrative

Adult: This species is long-lived perennial nature with apparently low and/or erratic recruitment. Flowering can begin as early as late March and continue until early June. Recent study by Hughes (1992) has confirmed heterostyly, and he found the two forms in approximately a 1:1 ratio. Such heterostyly suggests that the species is an obligate outcrosser, thus requiring some sort of pollinator. Although the exact identity of the pollinator(s) is not known, preliminary studies indicate that the agents are small bees (Hughes 1992). How long individual plants live is not known (USFWS, 1993).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Trans-Pecos shrub savannah (USFWS, 1993)

Geographic or Habitat Restraints or Barriers

Adult: 3,150 - 3450 ft. elevation (USFWS, 1993)

Environmental Specificity

Adult: Very narrow (inferred from NatureServe, 2015 and USFWS, 1993)

Habitat Narrative

Adult: Low hills and gentle slopes composed of a platy, yellowish limestone formation with a high level of clay and gypsum. These areas are nearly devoid of vegetation due to the gypsum soils and the very dry nature of the site. (NatureServe, 2015). The Terlingua Creek cat's-eye grows on xeric, barren, gypsiferous, low rounded hills and gentle slopes composed of small platelets of silty limestone in the Trans-Pecos shrub savannah. Site elevations vary from 3,150 to 3,450 feet. Vegetation cover is less than 10% (USFWS, 1993).

Dispersal/Migration**Dispersal**

Adult: Low to moderate (inferred from USFWS, 1993)

Dispersal/Migration Narrative

Adult: Dispersal is probably carried out by water, insects, or small mammals (USFWS, 1993).

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Unknown (USFWS, 1993)

Resiliency:

Very low (inferred from USFWS, 1993)

Redundancy:

Very low (inferred from USFWS, 1993)

Number of Populations:

1 (inferred from USFWS, 1993)

Population Size:

< 5,000 (USFWS, 1993)

Population Narrative:

It is known from 10 sites within a six-mile (10 kilometer) radius in west Texas. Less than 5000 plants are known. It is not known whether populations are stable, increasing, or declining (USFWS, 1993).

Threats and Stressors

Stressor: Habit destruction and modification (USFWS, 1993)

Exposure:

Response:

Consequence:

Narrative: Ranch tracks and numerous subdivision roads have been blazed across the area, probably destroying some plants in their path and fragmenting the habitat and some populations. These routes have also opened the way for modern recreational use (off—road vehicles ((ORVs)), mountain bikes, hiking and horseback riding groups). Although road maintenance is minimal and few tracks have been observed in the habitat, the area lacks any fencing or gates to confine wheeled vehicles. Tracks and roads take scores of years to disappear in this extremely arid environment. A significant portion of the known individual plants are on various 5, 10, and 20 acre (2, 4, and 8 hectare) tracts sold by a local resort developer. The potential for habitat destruction, if owners develop these tracts, is a threat to some plants.

Stressor: Stochastic events (USFWS, 1993)

Exposure:

Response:

Consequence:

Narrative: *Cryptantha crassipes* is particularly vulnerable to impacts and threats because of its narrow habitat specificity, extremely limited distribution, and low numbers of individuals. The species is found only on an uncommon rock formation, which is scattered within the geologic mosaic of the Big Bend region. The small occupied area and low numbers make the species vulnerable to chance extinction events from disease, natural or man-caused catastrophes, genetic drift (loss of genetic variability and thence adaptability), etc. In addition, the habitat is quite arid, which in many growing seasons may limit the species from reaching its full reproductive potential. If numbers fall below critical levels, populations may no longer be able to survive cycles with several seasons that do not allow successful reproduction (USFWS, 1993).

Stressor: Loss of pollinators (USFWS, 1993)

Exposure:

Response:

Consequence:

Narrative: Pollinators are potentially very important. The species is likely an obligate outcrosser reliant on insects that are probably also narrow endemics (known only from a limited geographic area). Conditions or activities that harm these pollinators could secondarily harm *Cryptantha crassipes* (USFWS, 1993).

Recovery

Reclassification Criteria:

Not available

Delisting Criteria:

Develop and implement management plans that insure the long-term protection and stability of a minimum of three population centers. There should be a total of at least 20 viable populations across the three population centers with each population comprised of no fewer than 1000 plants and being capable of long-term, self-perpetuating reproduction (USFWS, 1993).

Recovery Actions:

- Establish protected sites and develop management plans (USFWS, 1993).
- Maintain reserve seed bank/cultivated populations (USFWS, 1993).
- Gather biological information necessary for management decisions (USFWS, 1993).
- Search for new populations (USFWS, 1993).
- Develop plans for augmentation and/or establishment of new populations, if feasible, at suitable sites (USFWS, 1993).

Conservation Measures and Best Management Practices:

- The only conservation measure initiated so far is seed storage collection. The National Seed Storage Lab in Fort Collins, Colorado contains 200 field—collected seeds and the Desert Botanical Garden in Phoenix, Arizona retains 820 field collected seeds (USFWS, 1993).
- Barry Hughes, a graduate student at Sul Ross State University, has begun studies on the reproductive biology of *Cryptantha crassipes*, about which little is known. He has reported germination rates of about 75% and 40—50% in two trials and has developed some simple techniques to increase success in transplanting seedlings (Hughes, pers. comm., 1993) during cultivation studies (USFWS, 1993).
- The Desert Botanical Garden in Phoenix, Arizona, working with the Center for Plant Conservation, has performed two germination experiments to determine the best growing medium for germination and seedling growth (Pritchett-Kozak and Ecker 1992) (USFWS, 1993).

References

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NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

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SPECIES ACCOUNT: *Cucurbita okeechobeensis* ssp. *okeechobeensis* (Okeechobee gourd)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/11/1993; Southeast Region (R4) (USFWS, 2015)

Physical Description

A vigorous annual vine. Stems are nearly smooth. Leaves are alternate and paired, and have with long helical tendrils. The leaf blades have 5-7 shallow lobes. Flowers are cream-colored to nearly white, 6-7 cm long, narrowly bell-shaped. (NatureServe, 2015)

Taxonomy

Small (1922, 1930) originally described the gourds he found in the pond apple forest surrounding Lake Okeechobee as *Pepo okeechobeensis*. Bailey (1930) transferred the Okeechobee gourd to the genus *Cucurbita*, which includes pumpkins and squashes. Bailey (1943) subsequently described two new gourd species, *C. martinezii* and *C. lundelliana*. These two gourds were proven to be closely related to the Okeechobee gourd. Closely related gourds with cream-colored corollas (all others in the genus *Cucurbita* are bright yellow) are found in Florida and in Mexico, near the Gulf Coast. The Florida plants were described as the Okeechobee gourd (Bailey 1930) and the Mexican plants were designated (Bailey 1943) as the Martinez gourd (*C. martinezii*). However, Robinson and Puchalski (1980) showed through isozyme analysis that there was only a single allelic difference between the two varieties. The (ESA) does not allow Federal listing of disjunct populations of widespread plant species. Since the Mexican gourds are moderately abundant, and considering the findings of Robinson, the FWS originally opposed listing of the Okeechobee gourd. A later study by Walters and Decker-Walters (1991), also using isozyme analysis, showed a difference of just one allele. However, they calculated an estimated time since divergence of about 450,000 years between the Martinez and Okeechobee gourds, and concluded that they should be considered distinct at the subspecies level. Walters and Decker-Walters (1993) rearranged the nomenclature, designating the Florida gourds as *Cucurbita okeechobeensis* (Small) Bailey ssp. *okeechobeensis*, and assigning the Mexican gourds to the subspecies *C. okeechobeensis* ssp. *martinezii* (Bailey) Andres and Nabhan ex T. Walters and Decker Walters. The FWS concurred with this finding, and because the ESA allows protection of distinct subspecies, the Okeechobee gourd was subsequently listed as endangered. (USFWS, 1999)

Historical Range

Historically found on the southern shore of Lake Okeechobee, in Palm Beach County, Florida, and formerly in the Everglades area of Florida. (USFWS, 1999)

Current Range

In Florida, on the shore of Lake Okeechobee in Glades and Palm Baech Counties, along the middle St. Johns river in Volusia County. (USFWS, 1999)

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Key Resources Needed for Breeding**

Adult: Insect pollinators (EPA, 2016)

Reproduction Narrative

Adult: Pollination occurs via insects (EPA, 2016). Based on closely related gourds, a variety of insects are likely to be available, including bees, flies, and squash beetles. Typically, male flowers greatly outnumber female flowers and where pollinators are rare, decreased fruit set may be observed (M. Minno, Eco Cognizant, Inc., personal communication 1998) (USFWS, 1999).

Habitat Type

Adult: Wetland (EPA, 2016); terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forested wetland, temporary pool, field (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Low water levels (USFWS, 2009)

Habitat Narrative

Adult: Originally found in swampy forests and hammocks on muck soils. Today, this species is restricted to disturbed areas that are not cultivated, such as ditch banks and wet road shoulders. It is sensitive to changes in hydrology and freezing. (NatureServe, 2015). Occurs at Lake Okeechobee and the other along the St. Johns River; limited to areas along the shoreline and a few islands in the lake and along the St. Johns River. Inhabits open organic soils exposed by low water levels (EPA, 2016). The gourd is ephemeral by nature, often only growing when habitat conditions are favorable, and its growth habit of climbing amongst the tree canopy precludes the ability to count individual plants. This subspecies employs a strategy of growing on open organic soils exposed by low water levels with little to no competition, producing numerous seeds with somewhat long viability, and experiencing vegetative decline when competition increases or water levels rise (Moyroud 2009b) (USFWS, 2009). The gourd readily climbs any plant that will provide a trellis; in both Lake Okeechobee and the St. Johns River, the Okeechobee gourd grows on elderberry (*Sambucus canadensis*) and buttonbush (*Cephalanthus occidentalis*). Around Lake Okeechobee, the gourd is frequently associated with alligator nests. These disturbed sites provide areas where competition is reduced and elevated areas that promote the growth of elderberry, button bush, and other erect bushes and shrubs. Around Lake Okeechobee, the gourd relies on pond apple trees to support its vines above rising water levels during the wet season.

Dispersal/Migration**Dispersal**

Adult: Unknown (USFWS, 1999)

Dependency on Other Individuals or Species for Dispersal

Adult: Possibly marsh rabbits (USFWS, 1999)

Dispersal/Migration Narrative

Adult: Seeds are dispersed by birds and mammals (EPA, 2016). High lake levels facilitate dispersal. Although the exact mechanism for seed dispersal of the Okeechobee gourd is unknown, Walters et al. (1992) suggest that Okeechobee gourds disperse by floating in water bodies (in canals and along the shore of islands in Lake Okeechobee); however, no information is available regarding the distances seeds may disperse. Walters et al. (1992) also indicate that marsh rabbits are the main terrestrial disperser of gourd seeds, but others suggest that rabbits are only a predator of these seeds and are unlikely to be significant seed dispersers (M. Minno, Eco-Cognizant, Inc., personal communication 1998) (USFWS, 1999).

Population Information and Trends**Population Trends:**

> 95% decline (NatureServe, 2015)

Species Trends:

Declining (USFWS, 2009)

Number of Populations:

2 (USFWS, 2009)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

At least 50 gourds were found at one site by Walters and Decker-Walters in 1990-1991. In winter and early spring of 1990-1991 Walters and Decker-Walters found the Okeechobee gourd at 11 sites along the lake shores (Martin, 1992). The estimated population size is up to 1,000 individuals. The species has already lost 95% of its former range (J.K. Small, 1930) (NatureServe, 2015). The species status is declining; fires destroyed no plants were found on the spoil islands that once supported substantial populations. The Okeechobee gourd is only found in Florida in two natural populations, one on Lake Okeechobee and the other along the St. Johns River. Very little genetic variation was observed within any of the three populations evaluated, and differences between populations were minor with nothing to differentiate between the Lake Okeechobee and St. Johns River populations of the Okeechobee gourd (Decker-Walters 2002c) (USFWS, 2009).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Continued habitat degradation and loss threaten the existence of Okeechobee gourd. Decker-Walters (2002c) stated that factors that reduce the availability of habitat (e.g., lack of fluctuation in water levels and aggressive weeds) pose a large threat to the subspecies. In

addition, several factors related to human values (e.g., water storage, flood control, navigation) and ecological values (e.g., waterfowl, fisheries, littoral zone vegetation, water quality, snail kite recovery, and others) that affect management decisions can potentially conflict (Service 1999). At this time, the habitat seems stable along the St. Johns River; however, proposed water withdrawals for alternative public water supplies may affect suitability for the Okeechobee gourd (Minno 2009). Permanent inundation of suitable soils prevents germination of gourd seeds, and changes in water level management that would reduce the likelihood of low water can threaten the subspecies. Within the range of Okeechobee gourd in the Lake Okeechobee region, the human population is predicted to grow from nearly 11,000 to over 17,000 in Glades County between 2005 and 2060 and from approximately 1,270,000 to over 2,700,000 in Palm Beach County (Zwick and Carr 2006). Population growth is expected to increase water demands and recreational pressure on the lake. Within the range of the St. Johns River gourd population, the number of residents in Volusia County is projected to increase over the same time period from nearly 500,000 to over 940,000 and nearly triple in Lake County from just over 260,000 to more than 700,000 (Zwick and Carr 2006) (USFWS, 2009).

Stressor: Competition (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Okeechobee gourd plants are not strong competitors and are often outcompeted by more aggressive plant species (Decker-Walters 2002c). Weed competitors include moonflower, common reed (*Phragmites australis*), Virginia saltmarsh mallow (*Kosteletzkya virginica*), camphorweed (*Pluchea* sp.), melaleuca (*Melaleuca quinquenervia*), *Sesbania* sp., and *Polygonum* spp. (Decker-Walters 2002a; 2002c) (USFWS, 2009).

Stressor: Herbicide usage (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Although necessary for control of exotic plants, herbicide use also poses a threat to the Okeechobee gourd. The occurrences at one of the sites along the St. Johns River were destroyed in 2005 where herbicide was sprayed, and the site is no longer suitable (Minno and Minno 2005). Herbicides are routinely sprayed around Lake Okeechobee to keep waterways free of aquatic vegetation (USFWS, 2009).

Stressor: Disease (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Minno and Minno (1998) reported finding powdery mildew fungus (*Sphaerotheca fuliginea*), a hyperparasitic fungus (*Ampelomyces quisqualis*), mites (e.g., *Bevipalpus* sp., *Propioseius meridionalis*, and *Galendromus mcgregori*), melonworm (*Diaphania hyalinata*), pickleworm (*Diaphania nitidalis*), sowbugs, grasshoppers, leaf-footed bugs, and scales (*Saissetia neglecta*) on leaves of the Okeechobee gourd along the St. Johns River. Little damage to the plants was observed except as a result of the powdery mildew fungus, melonworm, and pickleworm in which older leaves were killed and infected fruit was aborted (Minno and Minno 1998). During the 2002 survey on Lake Okeechobee's Torrey Island, Okeechobee gourd plants

appeared productive but unhealthy, and plants tested positive for several viruses, including cucumber mosaic virus, squash mosaic virus, and watermelon mosaic virus (Decker-Walters 2002a). Signs of viral infection (leaf puckering) were also seen on one of the FWC spoil islands, but few vines from the St. Johns River population exhibited signs of viral infection (Decker-Walters 2002a). The author believed that the Lake Okeechobee population may be affected by more diseases and insects as a result of local agricultural activities in the area, such as the production of squash, but suggested that reproduction may not be substantially affected (Decker-Walters 2002a) (USFWS, 2009).

Stressor: Predation (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Insect predation was observed on Okeechobee gourd plants on one of the FWC spoil islands on Lake Okeechobee in 2002 (e.g., striped cucumber beetle [*Acalymma vittatum*], pickleworm, and melonworm) (Decker-Walters 2002a). Extensive herbivory by marsh rabbits (*Sylvilagus palustris*) was observed on one of the FWC spoil islands on Lake Okeechobee and appeared to have devastated the plants on this island; the other spoil island seemed to be unaffected by herbivory (Decker-Walters 2002c). Decker-Walters (2002c) suggested that rabbits, as well as wild pigs (*Sus scrofa*), present a threat to the subspecies through predation of seeds. Plants in the St. Johns River population were healthier in 2002 and exhibited no signs of insect damage (Decker-Walters 2002a) (USFWS, 2009).

Stressor: Small population size (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Small populations are susceptible to inbreeding depression, which compounds the effects of other threats, such as reduced resistance to herbivore damage and viral infections (Stephenson et al. 2004). Because Okeechobee gourds are ephemeral in nature, they tend to appear and disappear from sites, depending upon growing conditions (Service 1999). No stable core population remains south of the lake to ensure survival as a result of poor growing conditions (e.g., the permanent inundation of suitable soils as a result of water-level regulation) (Service 1999). Even during natural environmental fluctuations, the subspecies may be more vulnerable to localized extinction because of small population sizes (Nee 2009). The presence of the large core population in the pond-apple forest around the lake in the past may have maintained viability of the ephemeral populations on the islands by providing a source for seeds (Nee 2009). Fewer individuals occur along the St. Johns River, making this small population more susceptible to catastrophic events than the lake population (Decker-Walters 2002a). Growing near water and in swamps helps to buffer plants from winter freezes which can kill exposed stems and leaves (Minno 2009). Because plants of the St. Johns River population survive mostly from stems growing along the ground or through dense vegetation, they may be more susceptible to the effects of freezes (Minno 2009) (USFWS, 2009).

Recovery

Reclassification Criteria:

1. The Okeechobee gourd is protected at all known sites within Lake Okeechobee (USFWS, 1999).
2. Plants on Kreamer, Torry and Ritta Islands and the southern Rim Canal of Lake Okeechobee produce fruit at each of these locations at least every other year (their [i.e., fruit] absence for a period of two or more consecutive years will violate this requirement) (USFWS, 1999).
3. The distribution of fruiting plants is expanded within Lake Okeechobee either by the discovery of additional sites or by translocation (USFWS, 1999).
4. One or two sites are established outside of the southeastern quadrant of Lake Okeechobee (outside of Palm Beach County) (USFWS, 1999).
5. A stable, self-sustaining population of the Okeechobee gourd is established within the South Florida Ecosystem outside of Lake Okeechobee (USFWS, 1999).
6. Measures of vitality are developed and monitored at each of the sites described above (USFWS, 1999).
7. Based on the results of research on the viability of seeds following prolonged submergence and the survival of plants under rising water stages, the water regulation schedule for Lake Okeechobee is found not to jeopardize the continued existence of the Okeechobee gourd (USFWS, 1999).

Delisting Criteria:

1. At least 20 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (addresses Factor A) (USFWS, 2019)
2. Populations (as defined in criterion 1) occur in marsh and swamp habitats and are distributed across the historical range of the species. (addresses Factors A and E) (USFWS, 2019)
3. Populations (as defined in criterion 1) must be protected via a conservation mechanism or managed such that enough suitable habitat is present for the species to remain viable for the foreseeable future. (addresses Factors A and E) (USFWS, 2019)

Recovery Actions:

- Maintain information on the distribution and status of the Okeechobee gourd. Conduct regularly scheduled surveys. Individuals should be encouraged to provide information on sightings of the Okeechobee gourd. (USFWS, 1999).
- Protect and enhance existing populations. Ensure that spraying for control of aquatic vegetation does not harm or kill Okeechobee gourd plants. Assess the effect of Melaleuca and Brazilian pepper control efforts (both cut-and-squirt and aerial spraying methods); use techniques to avoid direct impact on Okeechobee gourd plants. Use provisions of section 7 of the ESA to protect the Okeechobee gourd. Augment natural populations of the Okeechobee gourd. (USFWS, 1999).
- Initiate research on the life history and genetics of the Okeechobee gourd. Test experimentally the viability of Okeechobee gourd seeds kept submerged for long periods (1 to 3 years). Characterize the range of soil conditions where the Okeechobee gourd

currently grows and provide detailed mapping of soil types in southeastern Lake Okeechobee. Through field surveys, determine dates of germination under natural conditions. Test experimentally the effect of seasonally rising water level on the survival of young plants. After information is available from the research studies described above and the annual field surveys, conduct population viability and risk assessment studies particularly with respect to water regulation schedule alternatives for Lake Okeechobee. Investigate the role of animals in dispersing seeds of the Okeechobee gourd. Document the potential ecological relationship between the American alligator and the Okeechobee gourd. Investigate the genetic distance between the two known populations of the Okeechobee gourd. (USFWS, 1999)

- Monitor existing populations of the Okeechobee gourd. Determine the most effective approach to monitor the condition of the Okeechobee gourd. After determining the most effective methods and indices, conduct monitoring on an annual basis. (USFWS, 1999)
- Increase public awareness about the Okeechobee gourd. Public awareness can be addressed through a variety of strategies, including, but not limited to, classroom programs, newspaper and magazine articles, public information displays at boat ramps in Lake Okeechobee, and outreach to fishing and airboating clubs. (USFWS, 1999)
- Habitat-level Recovery Actions: Prevent degradation of existing Okeechobee gourd habitat. Restore areas to suitable habitat. Research the acute and long-term tolerance of the Okeechobee gourd and other wetland plants to herbicides commonly used to control nuisance species of aquatic vegetation. Monitor habitat/ecological processes. Increase public awareness of ecological relationships, environmental stressors, and restoration activities in the South Florida Ecosystem. (USFWS, 1999)

Conservation Measures and Best Management Practices:

- Conduct regular surveys to monitor growth and reproduction, especially from late November through mid-February when many trees are leafless and fruit are easy to see (USFWS, 2009).
- Monitor the spoil islands of Lake Okeechobee to evaluate how the plants respond in a restricted environment with other competitive colonizers and observe the establishment of the seed bank (USFWS, 2009).
- Monitor future translocation sites (USFWS, 2009).
- Continue research to evaluate temporal changes in the prevalence of the three viruses found and to determine the extent to which the fitness of Okeechobee gourd populations is being negatively impacted (USFWS, 2009).
- Conduct experiments on dry fruits from plants grown under controlled conditions (e.g., in the greenhouse) to explore the buoyancy of dried-fruit seeds in greater detail (USFWS, 2009).
- Continue to assess dormancy mechanisms and test viability limits through longer immersion periods of seeds (USFWS, 2009).
- Conduct buried seed experiments in Lake Okeechobee or St. Johns River soils (USFWS, 2009).
- Directly evaluate each gourd population for viral loads, determine the percentage of progeny that may carry the squash mosaic virus, and conduct off-site viral-inoculation experiments of progeny to evaluate degree of tolerance and reproductive impacts (USFWS, 2009).
- Re-evaluate the relationships amongst subspecies of *Cucurbita okeechobeensis* using modern molecular techniques and new morphological characteristics (USFWS, 2009).
- Continue research on fluctuations in abundance of the gourd in response to water conditions, particularly extended periods of high water, to determine the level of risk to the long-term survival of the subspecies (USFWS, 2009).

- Research the acute and long-term tolerance of the Okeechobee gourd and other wetland plants to herbicides commonly used to control nuisance species of aquatic vegetation (USFWS, 2009).
- Conduct population viability and risk assessment studies, particularly with respect to water regulation schedule alternatives for Lake Okeechobee (USFWS, 2009).
- Eradicate exotic weeds (e.g., *Ipomoea alba*) in locations that support gourds and take care when planting native trees to prevent introduction of these weeds (USFWS, 2009).
- Use controlled burns to open up areas of overly dense herbaceous and/or shrubby vegetation in lake littoral zones and marshes (USFWS, 2009).
- Prevent cultural (i.e., human caused) eutrophication of lakes and marshes (USFWS, 2009).
- Avoid disruptive changes to the riparian habitat along the St. Johns River where the population occurs (USFWS, 2009).
- Ensure that water-level regulation is compatible with management needs of the Okeechobee gourd (USFWS, 2009).
- Ensure aquatic vegetation management practices are compatible with recovery of the subspecies (USFWS, 2009).
- Consider Okeechobee gourd and the creation of habitat in planning phases of Everglades restoration (USFWS, 2009).
- Restore habitat by planting pond apple and cypress where appropriate (USFWS, 2009).
- Establish a translocation protocol, locate potential sites, and translocate plants to identified sites (USFWS, 2009).
- Ensure that the St. Johns River and Lake Okeechobee populations are not grown together in collections to avoid hybridization. If hybridization is suspected, hybrid material should not be used for reintroduction (USFWS, 2009).
- Develop recovery criteria for the Okeechobee gourd population along the St. Johns River (USFWS, 2009).

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SPECIES ACCOUNT: *Cyanea (=Delissea) rivularis* (Haha, Oha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Delissea rivularis, a member of the bellflower family, is a shrub, unbranched or branched near the base, with hairy stems 4 to 5 m (13 to 16 ft) long. The leaves are arranged in a rosette at the tips of the stems. The elliptic to lance-shaped leaves are 20 to 30 cm (8 to 12 in) long and 3 to 8 cm (1.2 to 3.2 in) wide, with minutely toothed margins. Both leaf surfaces are covered with hairs. Six to 12 flowers are arranged on an inflorescence stalk 4 to 8 cm (1.6 to 3.2 in) long, each having an individual stalk 10 to 15 mm (0.4 to 0.6 in) in length. The curved, hairy flowers are white with blue longitudinal stripes, 30 to 40 mm (1.2 to 1.6 in) long, with one dorsal knob. The fruit is a spherical, dark purple berry 10 to 15 mm (0.4 to 0.6 in) in diameter. (USFWS, 1998)

Taxonomy

In his 2005 treatment of the genus *Delissea*, Thomas Lammers reclassified this species as *Cyanea rivularis*, with no change in the range or distribution of the species (Lammers 2005). The species will be referred to as *Cyanea rivularis* in the remainder of this review. (USFWS, 2010)

Historical Range

Historically, *Delissea rivularis* was found at Waiakealoha waterfall (location unknown), Waialae Valley, Hanakoa Valley, and Kaholuamano on the island of Kauai. (USFWS, 1998)

Current Range

Known in Kauai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Cyanea (=Delissea) rivularis* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Cyanea (=Delissea) rivularis* includes one unit totaling 2,100 acres in Kauai County, Hawaii. The unit is Kauai 11—*Delissea rivularis*—a.

Kauai 11—*Delissea rivularis*—a: This unit is critical habitat for *Delissea rivularis* and is 851 ha (2,102 ac) on State land (Alakai Wilderness Preserve, Halelea Forest Reserve, Hono o Na Pali NAR, and Na Pali Coast State Park). This unit contains Keanapuka, Moaalele, Pihea, and Waiahuakua Summits. This unit provides habitat for three populations of 300 mature, reproducing individuals of the shortlived perennial *Delissea rivularis* and is currently occupied with 40 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for

this species include, but are not limited to, steep slopes near streams in *Metrosideros polymorpha* *Cheirodendron trigynum* montane wet or mesic forest. Although we do not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is of an appropriate size so that each potential recovery population on Kauai within the unit is geographically separated enough to avoid destruction by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Within this unit, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Steep slopes near streams in *Metrosideros polymorpha* *Cheirodendron trigynum* montane wet or mesic forest and containing one or more of the following native plant species: *Boehmeria grandis*, *Broussaisia arguta*, *Carex* spp., *Coprosma* spp., *Diplazium sandwichianum*, *Dubautia knudsenii*, *Hedyotis foggiana*, *Ilex anomala*, *Machaerina angustifolia*, *Melicope anisata*, *Melicope clusiifolia*, *Pipturus* spp., *Psychotria hexandra*, or *Sadleria* spp.; and

(ii) Elevations between 823 and 1,307 m (2,701 and 4,286 ft).

Special Management Considerations or Protections

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial and palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Riparian, forest- hardwood, forest/woodland (NatureServe, 2015)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1998)

Habitat Narrative

Adult: *Delissea rivularis* is found on steep slopes in ohia-olapa montane wet or mesic forest, near streams. Associated native species include kanawao, *Athyrium* sp., *Carex* sp., *Coprosma* sp. (pilo), and *Sadleria* sp. (amau) (USFWS 1996). (USFWS, 1998)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Resiliency:

Very low (inferred from USFWS, 2010)

Redundancy:

Very low (inferred from USFWS, 2010)

Number of Populations:

3 (USFWS, 2010; USFWS, 2017))

Population Size:

9 wild individuals and 60 outplanted individuals (USFWS, 2017)

Population Narrative:

Known populations continue to decline. In 1994, there were 20 individuals at Hanakoa, currently there are fewer than 10 (HMBP 2010; Tangalin 2008; PEPP 2016). In 1998, there were 30 individuals at upper Hanakapiai, but by 2013, fewer than 10 remained (HBMP 2010; PEPP 2012, 2013, NTBG 2016a-c). In 2000, there was one individual at Kawaikoi; however, this individual could not be relocated in 2013 (PEPP 2013). An individual observed at Blue Hole has not been seen since 1988. The 2016 IUCN review estimates three “subpopulations” (considered by USFWS as populations) totaling nine individuals. With continued decline, the wild individuals could soon be extirpated, as indicated by the Plant Extinction Prevention Program (PEPP) reports (PEPP 2011, 2012, 2013, 2014, 2015, 2016). (USFWS, 2017)

Threats and Stressors

Stressor: Invasive plants (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species compete with and crowd out *Cyanea rivularis*. These include *Clidemia hirta* (Koster’s curse), *Hedychium gardnerianum* (Kahili ginger), *Erigeron karvinskianus* (daisy fleabane), *Kalanchoe pinnata* (airplant), *Cyperus meyenianus* (NCN), *Paspalum urvillei* (vasey grass), *Rubus argutus* (prickly Florida blackberry), *R. rosifolius*

(thimbleberry), and *Juncus planifolius* (bog rush) (Perlman 2008; Tangalin 2008; Wood 2008). (USFWS, 2010)

Stressor: Feral ungulates (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Other threats are from feral ungulates (pigs) that modify the landscape and increase soil erosion (Perlman 2008). (USFWS, 2010)

Stressor: Landslide (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: In Hanakoa, a collapsed ledge killed a couple of individuals and other individuals were damaged by a small landslide (Tangalin 2008). (USFWS, 2010)

Stressor: Herbivory by rats and slugs (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The bark of *Cyanea rivularis* individuals in Hanakoa was scarred from chewing by rats or slugs (Tangalin 2008). (USFWS, 2010)

Stressor: Climate change (USFWS, 2010; USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to *Cyanea rivularis*. However, current climate change models do not allow us to predict specifically what those effects, and their extent, would be for this species. (USFWS, 2010); Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment identified how vulnerable 63 species of *Cyanea* are to climate change, but did not specifically assess *Cyanea rivularis* due to lack of data due to rarity. As the average vulnerability score for the 63 assessed species of *Cyanea* is 0.627 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change), it is likely that *Cyanea rivularis* has similar vulnerability to climate change. Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2017)

Stressor: Small population size (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: *Cyanea rivularis* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few

populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding and disease outbreaks. (USFWS, 2010)

Stressor: Hurricanes (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Hurricanes were accidentally not highlighted in the last five year review. In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event, and 70 percent of all listed plant species on Kauai are only found on Kauai. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013). (USFWS, 2017)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Kauai where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Kauai where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1998)

Recovery Actions:

- In order to prevent this taxon from going extinct, propagation efforts and the maintenance of adequate genetic stock ex situ should be continued. Additional wild seeds should be collected periodically until the cryopreservation method of long-term storage is perfected. This will insure that viable seed stock is available for outplanting. (USFWS, 1998)
- A long-range management plan to control alien plant species in the upper Hanakoa Valley, upper Hanakapiai drainage and on State land within the Hono O Na Pali Natural Area Reserve needs to be developed. Once an active management plan for control of alien plants in these areas is in place, site selection and outplanting should occur to prevent wild stocks from declining further. (USFWS, 1998)
- A management plan to control rats should be developed. This should include the use of the currently approved Diphacinone bait blocks and ultimately a more broad-scale method such as aerial dispersal of rodenticide. (USFWS, 1998)
- Surveys and inventories—Continue to survey for populations of *Cyanea rivularis* in areas of potentially suitable habitat. Identify protected sites for reintroduction and augmentation. (USFWS, 2017)
- Predator and herbivore monitoring and control—Determine and implement effective control methods for slugs. Implement effective control methods for rodents. (USFWS, 2017)
- Ungulate monitoring and control—Protect all occurrences against browsing and disturbances from feral ungulates. Construct and maintain fenced exclosures around all populations. Placement of small-scale fencing around the few remaining wild individuals is critical to prevent extinction. (USFWS, 2017)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. Control invasive nonnative plant species around all populations that compete with the species. (USFWS, 2017)
- Captive propagation genetic storage and reintroduction—Continue to collect material for storage and propagation for reintroduction from wild plants without representation. Maintain viable ex situ collections. (USFWS, 2017)
- Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. Work with Hawaii DOFAW to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2017)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides. Create erosion protection to prevent landslides at known populations, if possible. (USFWS, 2017)

Conservation Measures and Best Management Practices:

- Conduct rat and slug control around known plants. (USFWS, 2010)
- Fence areas where this species grows to protect against ungulate damage. (USFWS, 2010)
- Create erosion protection to prevent landslides, if possible. (USFWS, 2010)
- Collect material for genetic storage and propagation for reintroduction. (USFWS, 2010)
- Identify protected sites for reintroduction and augmentation. (USFWS, 2010)
- Work with Hawaii Division of Forestry and Wildlife to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2010)
- Update the listed entity on 50 CFR 17 to match the currently recognized taxonomy. (USFWS, 2010)

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SPECIES ACCOUNT: *Cyanea (=Rollandia) crispa* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/28/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

Cyanea crispa is a short-lived perennial in the Campanulaceae (bellflower family). It is an unbranched shrub with leaves that are 30.0 to 75.0 cm (12 to 30 in) long and 9.0 to 16.0 cm (3.5 to 6.5 in) wide, which are clustered at the ends of succulent stems that are 0.3 to 1.3 m (1.0 to 4.3 ft) long. The flowers are 4.0 to 6.0 cm (1.6 to 2.4 in) long with a magenta color and dark longitudinal stripes. The globe-shaped berries are about 1.0 cm (2.54 in) long. *C. crispa* is distinguished from other species in this endemic Hawaiian genus by its leaf shape, distinct calyx lobes, length of the flowers, and stalks of flower clusters (Wagner et al.1999).

Taxonomy

Cyanea crispa is a short-lived perennial in the Campanulaceae (bellflower family). It is an unbranched shrub with leaves that are 30.0 to 75.0 cm (12 to 30 in) long and 9.0 to 16.0 cm (3.5 to 6.5 in) wide, which are clustered at the ends of succulent stems that are 0.3 to 1.3 m (1.0 to 4.3 ft) long. The flowers are 4.0 to 6.0 cm (1.6 to 2.4 in) long with a magenta color and dark longitudinal stripes. The globe-shaped berries are about 1.0 cm (2.54 in) long. *C. crispa* is distinguished from other species in this endemic Hawaiian genus by its leaf shape, distinct calyx lobes, length of the flowers, and stalks of flower clusters (Wagner et al.1999).

Historical Range

Historically, *Cyanea crispa* was known from scattered locations throughout the upper elevations of the Koolau Mountains of Oahu from Kaipapau Valley to Waialae Iki Ridge.

Current Range

This species is now known from 11 occurrences with a total of 65 individuals at Aihualama (1 individual), Kaipapau (3), Kapakahi (1), Kawaipapa (1), Maakua (2), Makua (10), Maunawili (1), Pia (20), Pukele (6), upper Kawaiiki (5), and Wailupe (15) (HINHP Database 2001). The known occurrences of *C. crispa* are in decline, and those that remain occur in small clusters that are widely dispersed (Service 1998a).

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea (=Rollandia) crispa* (Haha) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Cyanea (=Rollandia) crispa* (77 FR 57648-57862). The critical habitat designation includes 19 critical habitat units, which encompass approximately 31,995 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Cyanea (=Rollandia) crispa* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs

necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Cyanea* (=Rollandia) *crispa* includes 19 critical habitat units, covering three ecosystem types, which encompass approximately 31,995 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 4, 5, 6, 7; Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; Oahu—Wet Cliff—Units 6, 7, 8.

Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Hauula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikeekee, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet—Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac

(0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet— Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu— Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamo Ridge.

Oahu—Wet Cliff—Unit 6 [151 ac (61 ha)]. This area consists of 151 ac (61 ha) in the wet cliff ecosystem on State land on the windward side of the Koolau Mountains in Kaipapau Gulch, entirely within the Kaipapau Forest Reserve. Oahu—Wet Cliff—Unit 7 [144 ac (58 ha)]. This area consists of 144 ac (58 ha) in the wet cliff ecosystem in State land on the windward side of the Koolau Mountains in Hauula Gulch, entirely within the Hauula Forest Reserve. Oahu—Wet Cliff—Unit 8 [4,649 ac (1,881 ha)]. This area consists of 1,479 ac (598 ha) of State land, 1,281 ac (519 ha) of City and County of Honolulu land, 5 ac (2 ha) of Federal land, and 1,884 ac (762 ha) of privately owned land, in the wet cliff ecosystem along the summit of the Koolau Mountains, overlapping portions of Sacred Falls State Park, the Waiahole FR (Waiahole and Iolekaa sections), the Kaneohe and Honolulu Watershed FRs, and the Nuana Pali State Wayside.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea* (=Rollandia) *crispa* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Cyanea* (=Rollandia) *crispa* occurs within the Lowland mesic, Lowland wet and Wet cliff ecosystems in the Koolau Mountain caldera complex:

Oahu—Lowland Mesic—Units 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (E) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (E) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Oahu—Wet Cliff—Units 6, 7, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: >65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E)

Subcanopy: Broussaisia, Cheirodendron, Leptecophylla, Metrosideros. (E) Understory: Bryophytes, Ferns, Coprosma, Dubautia, Kadua, Peperomia.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Cyanea (=Rollandia) crispa* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: *C. crispa* was observed flower in April and fruiting in June and September. Little else is known about its flowering cycle, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors (Service 1998a; 59 FR 14482).

Habitat Type

Adult: Wet forest

Habitat Narrative

Adult: – *Cyanea crispa* is found in a variety of habitats ranging from steep slopes in open mesic forests to gentle slopes or moist gullies in closed wet forests and along stream banks at elevations between 56 and 959 m (184 and 3,146 ft). Associated native plant species include *Antidesma platyphylla*, *Boehmeria grandis*, *Broussaisia argutus*, *Christella cyatheoides*, *Cibotium chamissoi*, *Cyrtandra* spp., *Diospyros* sp., *Dubautia* sp., *Metrosideros polymorpha*, *Perrottetia sandwicensis*, *Pipturus albidus*, *Pisonia umbellifera*, *Psychotria* sp., or *Touchardia latifolia* (HINHP Database 2001; Service 1998a).

Dispersal/Migration

Population Information and Trends

Threats and Stressors

Stressor:

Exposure:

Response:

Consequence:

Narrative: The major threats to *Cyanea crispa* are habitat alteration and predation by feral pigs; competition with non-native plant species; predation by rats; and extinction due to naturally occurring stochastic events and/or reduced reproductive vigor, both resulting from the small number of remaining individuals, their limited gene pool, and their restricted distribution. The

non-native plant species *Arthrostemma ciliatum*, *Clidemia hirta*, *Psidium cattleianum*, *Psidium guajava*, *Pterolepis glomerata*, *Rubus rosifolius*, *Schinus terebinthifolius*, *Setaria palmifolia*, and *Zingiber zerumbet* threaten *C. crispa* by altering its habitat and competing with it for nutrients, light, and space. The types of stochastic events most likely to affect *C. crispa* are landslides, hurricanes, or flooding (Service 1998a; 59 FR 14482).

Recovery

Conservation Measures and Best Management Practices:

- A State-wide management plan should be developed and implemented for the long-term conservation of all known occurrences of *Cyanea crispa*. This plan should also include broader landscape actions that are needed for the recovery of this plant throughout its range. The recovery plan for this species identifies the following important conservation actions. Fences should be constructed around the known occurrences of *C. crispa* to exclude feral pigs. Control or removal of pigs from these areas and the broader landscape will alleviate impacts to native ecosystems and will promote nature regeneration. Non-native plant species should be removed from the fenced areas and from the general vicinity of all known occurrences of *C. crispa*. Rats are a serious threat to most occurrences of *C. crispa* and should be controlled in the vicinity of each known occurrence and over the broader landscape. This should include use of currently-approved rodenticide bait blocks and, when approved, aerial dispersal of rodenticide (Service 1998a). Occurrences of *C. crispa* with only a few remaining individuals should be given priority for implementation of conservation actions.
- Ongoing Conservation Actions *Cyanea crispa* is being propagated at the Lyon Arboretum, the Army Environmental nursery and the National Tropical Botanical Garden. In addition, seeds are being stored at the Lyon Arboretum seed storage facility (Service 2002). The Hawaii Division of Forestry and Wildlife has been controlling pigs in Hidden Valley, however site visits have revealed abundant pig sign with many individuals of *C. crispa* defoliated or dead (Service 1998a). The Service is currently not aware of any other conservation efforts for this species.

References

USFWS 2016. Status of the Species and Critical Habitat: *Cyanea crispa* (Haha). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016.

U.S. Fish and Wildlife Service. 2012. Endangered and Threatened Wildlife and Plants

Endangered Status for 23 Species on Oahu and Designation of Critical Habitat for 124 Species. Final Rule. 77 FR 57648-57862 (September 18, 2012)

SPECIES ACCOUNT: *Cyanea acuminata* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

Cyanea acuminata is a short-lived perennial and a member of the Campanulaceae (bellflower family). It is an unbranched shrub 0.3 to 2 m (1 to 6.6 ft) tall with inversely lance-shaped to narrowly egg-shaped or elliptic leaves 11.0 to 32.0 cm (4.3 to 12.6 in) long and 3.0 to 9.0 cm (1.2 to 3.5 in) wide. The flowers are 3.0 to 3.5 cm (1.2 to 1.4 in) long, white, and occasionally have a purplish tinge. The globe-shaped berries are yellow to yellowish orange. *C. acuminata* is distinguished from others in this endemic Hawaiian genus by the color of the petals and fruit and length of the calyx lobes, flowering stalk, and leaf stalks (Wagner et al.1999).

Historical Range

Historically, *Cyanea acuminata* was known from 31 scattered occurrences in the Koolau Mountains of Oahu. Currently, between 172 and 208 plants are known from 18 occurrences in both the Koolau and Waianae Mountains at East Makaleha (2 individuals), Halemano (6), Kaala (18), Kaalaea (30), Kahana near Puu Kaaumakua (3-4), Kahuku Cabin (1), Kaipapau (40 to 50), Kaluanui and Maakua (12), Kawaiiki (1), Konahuanui (20 to 40), Makaua (3), Pia (4), Poamoho (12-17), Pukele (1), Puu Keahiakahoe (3), Puu O Kona (1), south Kaukonahua (5), and Waahila (10) (HINHP Database 2001). The number of occurrences and the range of *C. acuminata* are declining (U.S. Army 2003a).

Current Range

Current range: Oahu. Historically no additional range.

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea acuminata* (Haha) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Cyanea acuminata* (77 FR 57648-57862). The critical habitat designation includes 32 critical habitat units, which encompass approximately 39,247 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Cyanea acuminata* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Cyanea acuminata* includes 32 critical habitat units, covering four ecosystem types, which encompass approximately 39,247 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—

Units 1, 2, 3, 4, 5, 6, 7; Oahu—Lowland Wet—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; Oahu—Montane Wet—Unit 1; Oahu—Wet Cliff—Units 1, 2, 3, 4, 5, 6, 7, 8 .

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

Oahu—Lowland Wet—Unit 1 [541 ac (219 ha)]. This area consists of 428 ac (173 ha) of State land and 112 ac (46 ha) of City and County of Honolulu land in the lowland wet ecosystem on the windward side of the Waianae Mountains, and partially within the Mokuleia and Waianae Kai Forest Reserves. Oahu—Lowland Wet—Unit 2 [20 ac (8 ha)]. This area consists of 19 ac (8 ha) of State land in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puuhapapa. Oahu—Lowland Wet—Unit 3 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puukanehoa. Oahu—Lowland Wet—Unit 4 [27 ac (11 ha)]. This area consists of 27 ac (11 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains on State land at Puukaua. Oahu—Lowland Wet—Unit 5 [74 ac (30 ha)]. This area consists of 74 ac (30 ha) of State land in the lowland wet ecosystem, on the windward side of the Waianae Mountains at Palikea. Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihihi, Waialele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Hauula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikēēē, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land,

4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet—Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet—Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu—Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamo Ridge.

Oahu—Montane Wet—Unit 1 [370 ac (150 ha)]. This area consists of 18 ac (7 ha) of City and County of Honolulu land, 352 ac (142 ha) of State land, and less than 1 ac (less than one ha) of privately-owned land in the montane wet ecosystem at the summit of the Waianae Mountains at Kaala, and partially within the Mokuleia Forest Reserve and the Kaala Natural Area Reserve.

Oahu—Wet Cliff—Unit 1 [235 ac (95 ha)]. This area consists of 167 ac (68 ha) of State land, 68 ac (28 ha) of City and County of Honolulu land, and less than 1 ac (less than 1 ha) of privately owned land in the wet cliff ecosystem in the Waianae Mountains, near the summit of Kaala, and partially within the Mokuleia and Waianae Kai FRs and the Kaala Natural Area Reserve. Oahu—Wet Cliff—Unit 2 [3 ac (1 ha)]. This area consists of 3 ac (1 ha) of State land in the wet cliff ecosystem in the Waianae Mountains at Puuhapapa, within a small area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Oahu—Wet Cliff—Unit 3 [16 ac (6 ha)]. This area consists of 16 ac (6 ha) in the wet cliff ecosystem on State land in the Waianae Mountains at Puukanehoa, partially within an area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Oahu—Wet Cliff—Unit 4 [23 ac (9 ha)]. This area consists of 23 ac (9 ha) in the wet cliff ecosystem on State land in the Waianae Mountains at Puukaua, partially overlapping an area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and recently acquired by the State. Oahu—Wet Cliff—Unit 5 [31 ac (13 ha)]. This area consists of 31 ac (13 ha) of State land in the wet cliff ecosystem in the Waianae Mountains, at Palikea and north

of Palikea. Oahu—Wet Cliff—Unit 6 [151 ac (61 ha)]. This area consists of 151 ac (61 ha) in the wet cliff ecosystem on State land on the windward side of the Koolau Mountains in Kaipapau Gulch, entirely within the Kaipapau Forest Reserve. Oahu—Wet Cliff—Unit 7 [144 ac (58 ha)]. This area consists of 144 ac (58 ha) in the wet cliff ecosystem in State land on the windward side of the Koolau Mountains in Hauula Gulch, entirely within the Hauula Forest Reserve. Oahu—Wet Cliff—Unit 8 [4,649 ac (1,881 ha)]. This area consists of 1,479 ac (598 ha) of State land, 1,281 ac (519 ha) of City and County of Honolulu land, 5 ac (2 ha) of Federal land, and 1,884 ac (762 ha) of privately owned land, in the wet cliff ecosystem along the summit of the Koolau Mountains, overlapping portions of Sacred Falls State Park, the Waiahole FR (Waiahole and Iolekaa sections), the Kaneohe and Honolulu Watershed FRs, and the Nuana Pali State Wayside.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea acuminata* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Cyanea acuminata* occurs within the Lowland mesic, Lowland wet and Wet cliff ecosystems in the Waianae Mountain caldera complex and the Koolau Mountain caldera complex, and occurs within the Montane wet ecosystem in the Waianae Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Oahu—Lowland Wet—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (F) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Oahu—Montane Wet—Unit 1. (A) Elevation: 3,300–6,600 ft (1,000-2,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Well-developed soils, montane bogs. (D) Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. (E) Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. (F) Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Oahu—Wet Cliff—Units 1, 2, 3, 4, 5, 6, 7, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: >65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. (F) Understory: Bryophytes, Ferns, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Cyanea acuminata* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes,

landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: *Cyanea acuminata* has been observed fruiting in February and November. Little else is known about its flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors (Service 1998a).

Habitat Type

Adult: Slopes and stream banks in wet or mesic forest or shrubland

Habitat Narrative

Adult: Wet forests in gulch bottoms, on gulch slopes and on ridgecrests. (NatureServe, 2015). *Cyanea acuminata* typically grows on slopes, ridges, or stream banks between 216 and 1,208 m (708 and 3,962 ft) in elevation. The plants are found in *Metrosideros polymorpha*-*Dicranopteris linearis*, *Acacia koa*-*M. polymorpha* wet or mesic forest or shrubland, or *Diospyros sandwicensis*-*M. polymorpha* lowland mesic forest with one or more of the following associated native species: *Antidesma* sp., *Broussaisia arguta*, *Chamaesyce* sp., *Charpentiera* sp., *Cyrtandra* spp., *Diplazium sandwichianum*, *Dryopteris sandwicensis*, *Dubautia laxa*, *Freycinetia arborea*, *Hibiscus* sp., *Hedyotis* sp., *Ilex anomala*, *Labordia* sp., *Machaerina* sp., *Melicope* spp., *Perrottetia sandwicensis*, *Phyllostegia* sp., *Pipturus albidus*, *Pisonia* sp., *Psychotria* sp., *Sadleria* sp., *Syzygium sandwicensis*, *Touchardia latifolia*, and *Wikstroemia* sp. (HINHP Database 2001; Wagner et al. 1999).

Dispersal/Migration

Population Information and Trends

Resiliency:

Fragility unknown. (NatureServe, 2015)

Representation:

Fragility unknown. (NatureServe, 2015)

Redundancy:

Fragility unknown. (NatureServe, 2015)

Number of Populations:

6 - 20 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Adaptability:

Fragility unknown. (NatureServe, 2015)

Population Narrative:

Fragility unknown. Fewer than 100 plants currently known. Estimated less than 3000 total plants. 14 current (between 1982 and 1997) and 17 historical occurrences. (NatureServe, 2015)

Threats and Stressors**Stressor:****Exposure:****Response:****Consequence:**

Narrative: The major threats to *Cyanea acuminata* are habitat degradation and destruction by feral pigs and goats; potential impacts from military activities; predation by slugs; predation by rats; and competition with the non-native plant species such as *Ageratina adenophora*; *Aleurites moluccana*, *Clidemia hirta*, *Cordyline fruticosa*, *Dioscorea* sp., *Erigeron karvinskianus*, *Musa* sp., *Passiflora suberosa*, *Psidium cattleianum*, *Rubus argutus*, and *Schinus terebinthifolius*. In addition, *C. acuminata* is threatened by the risk of extinction from naturally occurring stochastic events (such as landslides, hurricanes, or flooding) and from reduced reproductive vigor, both due to the small number of remaining individuals (HINHP Database 2001; Service 1998a; 61 FR 53089).

Recovery**Conservation Measures and Best Management Practices:**

- A State-wide management plan should be developed and implemented for the long-term conservation of all known occurrences of *Cyanea acuminata*. This plan should also include broader landscape actions that are needed for the recovery of this plant throughout its range. The recovery plan for this species identifies the following important conservation actions. Fences should be constructed around the known populations of *C. acuminata* to exclude feral pigs. Feral pigs should be controlled or removed from these areas to alleviate their impact on native ecosystems and promote germination of *C. acuminata* over a greater landscape. Where fences are not feasible due to topography, other means of ungulate control should be extensively employed. Occurrences that have only a few remaining individuals should be give priority for remove non-native plants and fence construction. Rats should be controlled in the vicinity of known occurrences and over the broader landscape needed to sustain this plant. This should include the use of the approved rodenticides and, when approved, aerial dispersal of rodenticide. Ongoing Conservation Actions: This species is in genetic storage at the Lyon Arboretum and the National Tropical Botanical Garden (Service 2002). The Service is currently not aware of any other conservation efforts for this species.

References

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SPECIES ACCOUNT: *Cyanea asarifolia* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/25/1994; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Cyanea asarifolia, a member of the bellflower family, is a sparingly branched shrub 0.3 to 1 m (1 to 3.3 ft) tall. The heart-shaped leaves are 8.5 to 10.5 cm (3.3 to 4.1 in) long and 7 to 8 cm (2.8 to 3.1 in) wide with leaf stalks 12 to 15 cm (4.7 to 5.9 in) long. Thirty to 40 flowers are clustered on a stalk 25 to 30 mm (1 to 1.2 in) long, each having an individual stalk 7 to 10 mm (0.3 to 0.4 in) in length. The slightly curved flowers are white with purple stripes, 20 to 22 mm (0.8 to 0.9 in) long, and about 3.5 mm (0.1 in) wide with spreading lobes. The five anthers have tufts of white hairs at the tips. The nearly spherical fruit is a dark purple berry about 1 cm (0.4 in) long. (USFWS, 1995)

Taxonomy

Recently, St. John (1987d, St. John and Takeuchi 1987) placed the genus *Cyanea* in synonymy with *Dehissea*, resulting in the new combination *Delissea asarifolia*, but Lammers (1990) retains both genera in the currently accepted treatment of the family. (USFWS, 1995)

Current Range

This species is restricted to Kauai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designate critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Cyanea asarifolia* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Cyanea asarifolia* includes two units totaling 3,848 acres in Kauai County, Hawaii. The units are Kauai 4—*Cyanea asarifolia*—a and Kauai 10—*Cyanea asarifolia*—b.

Kauai 4—*Cyanea asarifolia*—a: This unit is critical habitat for *Cyanea asarifolia* and is 656 ha (1,619 ac) on State (Kealia and Moloaa Forest Reserves) and private land. This unit contains Ke Ana Kolea, Mount Namahana, and Anahola, Kekoiki, Leleiwi, and Puu Awa Summits. This unit provides habitat for three populations of 300 mature, reproducing individuals of the short-lived perennial *Cyanea asarifolia* and is currently unoccupied. This unit provides habitat that is essential to the establishment of additional populations on Kauai in order to reach recovery goals. The habitat features contained in this unit that are essential for this species include, but are not limited to, pockets of soil on sheer, wet rock cliffs and waterfalls in lowland wet forests. This unit is geographically separated from the other unit designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 10—*Cyanea asarifolia*—b: This unit is critical habitat for *Cyanea asarifolia* and is 903 ha (2,232 ac) on State (Lihue-Koloa Forest Reserve) and private land. This unit contains Iole, Kalalea, Kamanu, and Palikea Summits. This unit provides habitat for seven populations of 300 mature, reproducing individuals of the short-lived perennial *Cyanea asarifolia* and is currently occupied with 4 or 5 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, pockets of soil on sheer wet rock cliffs and waterfalls in lowland wet forests. This unit is geographically separated from the other unit designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Pockets of soil on sheer wet rock cliffs and waterfalls in lowland wet forests and containing one or more of the following native plant species: *Bidens* spp., *Dubautia plantaginea*, *Hedyotis centranthoides*, *Hedyotis elatior*, *Lysimachia filifolia*, *Machaerina angustifolia*, *Metrosideros polymorpha*, or *Panicum lineale*; and

(ii) Elevations between 182 and 1,212 m (597 and 3,976 ft).

Special Management Considerations or Protections

The following management actions are important: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliff (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Wet regions (NatureServe, 2015)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1995)

Habitat Narrative

Adult: This species typically grows in pockets of soil on sheer rock cliffs in lowland wet forests at an elevation of approximately 330 meters (1,080 feet). Associated plant taxa include ferns, *Hedyotis elatior* (manono), ohia, *Touchardia latifolia* (olona), and *Urera giabra* (opuhe) (USFWS 1994a). (USFWS, 1995)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2009)

Representation:

Very low (inferred from USFWS, 2009)

Redundancy:

Very low (inferred from USFWS, 2009)

Number of Populations:

3 (USFWS, 2016)

Population Size:

134 (USFWS, 2016)

Population Narrative:

Currently only one wild population containing 20 to 30 individuals is known. (USFWS, 2009); In 2009 a second population was found, and the two known populations totaled 58 individuals (PEPP 2009). By 2012, it was estimated these two populations totaled over 100 individuals, and the species was downgraded from the PEPP list (plants with fewer than 50 individuals in the wild) to POP (taxa that have more than 50 individuals but remain extremely vulnerable; PEPP 2014). Currently, those two populations only have 20 and 54 individuals. However, in 2017 a third population was discovered, also in the Blue Hole area, with 60 individuals (Kishida 2017, in litt.). Fruit are collected and the known populations are monitored for weeds. (USFWS, 2017)

Threats and Stressors

Stressor: Hurricanes and rock slides (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The major threats to this species remain the risk of extinction from naturally occurring events, such as hurricanes and rock slides. (USFWS, 2009)

Stressor: Small population size (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Reduced reproductive vigor remains a threat due to the small number of existing individuals. (USFWS, 2009)

Stressor: Predation (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Predation by introduced slugs and rodents [black rats (*Rattus rattus*) and mice (*Mus musculus*)]. (USFWS, 2009)

Stressor: Invasive introduced plants (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Competition from invasive introduced plant species is a threat to *C. asarifolia*. (USFWS, 2009)

Stressor: Habitat degradation (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Habitat degradation by feral pigs (*Sus scrofa*) continues to be a threat. (USFWS, 2009)

Stressor: Invertebrate predation or herbivory (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: An observation of nonnative snails (that consume seedlings and leaves) was made at one population (PEPP 2014). (USFWS, 2017)

Stressor: Landslides and flooding destruction or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Flooding is a threat to some individuals (NTBG 2010; PEPP 2014). (USFWS, 2017)

Stressor: Climate change loss or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Cyanea asarifolia* is highly vulnerable to the impacts of climate change with a vulnerability score of 0.532 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2017)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Kauai and at least one other island where they now occur or occurred historically. (USFWS, 1995)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1995)
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1995)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Kauai and at least one other island where they now occur or occurred historically. (USFWS, 1995)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1995)
3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1995)

Recovery Actions:

- propagation efforts and the maintenance of adequate genetic stock ex situ should be undertaken immediately, as well as the protection of remaining wild individuals from feral pigs, slugs and rodents. (USFWS, 1995)
- The plan begins with the protection and management of current habitats of the Kauai cluster taxa. Current threats are addressed through fencing and/or hunting to control ungulates; control of alien plants; protection from fire; control of rodents and slugs; control of insects pests and disease; protection from human disturbance; collection, storage and maintenance of genetic material; and, a comprehensive monitoring program. (USFWS, 1995)

- A research program is also recommended to study the growth and reproductive viability of each taxon, determine the parameters of viable populations of each taxon, study the reproductive strategy and pollinators of each taxon, study possible pests and diseases, and use the results of such research to improve management practices. (USFWS, 1995)
- A program of augmentation of very small populations and re establishment of new populations within the historical range of the species is also needed. (USFWS, 1995)
- A public education program is also needed to increase public awareness and support for plant recovery efforts. (USFWS, 1995)
- Finally, the recovery objectives should be refined and revised as new information becomes available. (USFWS, 1995)
- Surveys and inventories—Survey the geographical and historic range of *Cyanea asarifolia* for additional populations. (USFWS, 2017)
- Ungulate monitoring and control—Construct enclosure fences or determine other methods to protect individuals from the negative impacts of feral pigs to prevent imminent extinction. Protect all occurrences against disturbances from feral ungulates. (USFWS, 2017)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. (USFWS, 2017)
- Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. (USFWS, 2017)
- Reintroduction and translocation—Establish new populations within historic range or suitable habitat where threats have been controlled. (USFWS, 2017)
- Predator and herbivore monitoring and control—Determine and implement adequate slug control methods. (USFWS, 2017)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides. (USFWS, 2017)
- Genetic research—Conduct a genetic analysis of the species to determine variability within extant wild individuals. (USFWS, 2017)
- Population biology research—Study *Cyanea asarifolia* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. (USFWS, 2017)

Conservation Measures and Best Management Practices:

- Collect fruit from all wild individuals and any reintroduced individuals that set seed to add to the genetic diversity of the ex situ material. (USFWS, 2009)
- Construct enclosure fences to protect individuals from the negative impacts of feral pigs. (USFWS, 2009)
- Enhance current natural populations to increase numbers of individuals. (USFWS, 2009)
- Establish new populations within historical range or suitable habitat where threats have been controlled. (USFWS, 2009)
- Determine and implement adequate rat and slug control methods. (USFWS, 2009)
- Survey the geographical and historical range of *Cyanea asarifolia* for additional populations. (USFWS, 2009)
- Assess genetic variability within extant populations. (USFWS, 2009)

- Study *Cyanea asarifolia* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. (USFWS, 2009)

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SPECIES ACCOUNT: *Cyanea asplenifolia* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (Region 1) (USFWS, 2017)

Physical Description

A shrub, 1.3-2 m tall with unbranched or sparingly branched stems. Leaves deeply cut and fern-like. Racemes axillary. Corollas tubular, gently curved. (NatureServe, 2015)

Taxonomy

A member of the bellflower family (Campanulaceae) (USFWS, 2016).

Historical Range

This species was known historically from Waihee Valley and Kaanapali on west Maui, and Halehaku ridge on east Maui (Lammers 1999, p. 445; HBMP 2010). (USFWS, 2016)

Current Range

Endemic to the island of Maui in the state of Hawaii. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea asplenifolia* (Haha) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes nine detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Cyanea asplenifolia* includes nine CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Lowland Mesic—Unit 1 consists of 1,147 ac (464 ha) of State land, 241 ac (97 ha) of privately owned land, and 494 ac (200 ha) of federally owned land (Haleakala National Park), from Manawainui Valley to Kukuiula on the eastern slopes of east Maui. This unit is occupied by the plants *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, and *Huperzia mannii*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Mesic—Unit 1 is not known to be occupied by *Ctenitis squamigera* or *Solanum incompletum*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 1 (and) *Palmeria dolei*—Unit 2—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 2— Lowland Wet This area consists of 6,616 ac (2,677 ha) of State land, 7,425 ac (3,005 ha) of privately owned land, and 2,038 ac (825 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Kipahulu Valley on the northern and eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia samuelii*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *M. ovalis*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 1 is not known to be occupied by the plants *Clermontia oblongifolia* ssp. *mauiensis*, *C. peleana*, *Mucuna sloanei* var. *persericea*, *Phyllostegia haliakalae*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 2 (and) *Palmeria dolei*—Unit 3—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 3— Lowland Wet (and) *Newcombia cumingi*—Unit 1—Lowland Wet This area consists of 65 ac (26 ha) of State land at Moomoku, on the northwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. Although Maui—Lowland Wet—Unit 2 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendrion pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), or by the Newcomb's tree snail (*Newcombia cumingi*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 3 (and) *Palmeria dolei*—Unit 4—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 4— Lowland Wet This area consists of 1,247 ac (505 ha) of State land at Honanana Gulch on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta*, *Cyanea asplenifolia*, and *Pteris lidgatei*. These units also contain unoccupied habitat that is essential to the conservation of these species

by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 3 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 4 (and) *Palmeria dolei*—Unit 5—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 5— Lowland Wet This area consists of 864 ac (350 ha) of State land at Kahakuloa Valley on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta* and *Cyanea asplenifolia*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 4 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 5 (and) *Palmeria dolei*—Unit 6—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 6— Lowland Wet This area consists of 30 ac (12 ha) of State land at Iao Valley on the eastern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 5 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation

and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 6 (and) *Palmeria dolei*—Unit 7—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 7— Lowland Wet This area consists of 136 ac (55 ha) of State land at Honokowai and Wahikuli valleys on the western slopes of west Maui. These units include the mixed hermland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 6 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendrion pyriformium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 7 (and) *Palmeria dolei*—Unit 8—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 8— Lowland Wet This area consists of 898 ac (364 ha) of State land at Olowalu Valley, on the southern slopes of west Maui. These units include the mixed hermland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Alectryon macrococcus*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 7 is not currently occupied by the plants *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendrion pyriformium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 8 (and) *Palmeria dolei*—Unit 9—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 9— Lowland Wet This area consists of 230 ac (93 ha) of State land at upper Ukumehame Gulch, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 8 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformum*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea asplenifolia* critical habitat consists of two components. Lowland mesic (east Maui) and Lowland wet (east Maui and west Maui) (81 FR 17790-18110):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight

plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet

Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylothea* ssp. *pentamera*, *B. campylothea* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Lowland wet and lowland mesic ecosystem (see population narrative)

Environmental Specificity

Adult: Very narrow to moderate. (NatureServe, 2015)

Habitat Narrative

Adult: *Cyanea asplenifolia* is found on moist to wet forests on gulch slopes. (NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Decline of 10-50% (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2016)

Redundancy:

Low (inferred from NatureServe, 2016)

Number of Populations:

8 (USFWS, 2016)

Population Size:

~200 (USFWS, 2016)

Population Narrative:

Short-term population trends indicate a decline of 10-50% (NatureServe, 2015). On west Maui, in the lowland wet ecosystem, there are 3 occurrences totaling 14 individuals in the Puu Kukui Preserve and two occurrences totaling 5 individuals in the West Maui NAR. On east Maui, *C. asplenifolia* is found in 1 occurrence each in the lowland mesic ecosystem in Haleakala National Park (53 individuals) and Kipahulu FR (140 individuals), and 1 occurrence in the lowland wet ecosystem in the Makawao FR (5 individuals) (TNC 2007; Oppenheimer 2008b, in litt, 2010b, in litt.; PEPP 2008, p. 48; Welton and Haus 2008, p. 12; NTBG 2009c, pp. 3–5; HBMP 2010; Welton 2010a, in litt.). Currently, *C. asplenifolia* is known from 8 occurrences totaling fewer than 200 individuals (USFWS, 2016).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs, goats, axis deer, and cattle), nonnative plants, fire, landslides, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Fire can destroy dormant seeds and plants, even in steep and inaccessible areas. Successive fires can remove habitat for native species by altering microclimate conditions favorable to alien plants. Landslides destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:**Consequence:**

Narrative: Predation and herbivory by nonnative animal species (pigs, goats, axis deer, and cattle) is considered an ongoing threat to *Cyanea asplenifolia* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Recovery**Reclassification Criteria:**

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

References

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

Final Rule . 81 FR 17790-18110 (March 30, 2016).

USFWS. 2013. Determination of Endangered Status for 38 Species on Molokai, Lanai, and Maui

Final Rule. 78 Federal Register 102, May 28, 2013. Pages 32014 - 32065.

SPECIES ACCOUNT: *Cyanea calycina* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/18/2012; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Cyanea calycina (Haha), an unbranched shrub in the bellflower family (Campanulaceae). (USFWS, 2012)

Taxonomy

Kartesz's Synthesis (1999) and the Hawaii Heritage Program follow a treatment recognizing *Cyanea calycina* as a species, distinct from *C. lancolata*. Formerly treated as a member of the genus *Rollandia*, however, Tom Lammers (Lammers et al. 1993) have merged all of the species of this endemic Hawaiian genus under *Cyanea*. (NatureServe, 2015)

Current Range

Cyanea calycina (Haha) is found in both the Waianae and Koolau Mountains of Oahu. (USFWS, 2012)

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On September 18, 2012, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea calycina* (Haha) under the Endangered Species Act of 1973, as amended (Act) (77 FR 57648-57862). The critical habitat designation includes 32 critical habitat units, which encompass approximately 39,247 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Cyanea calycina* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Cyanea calycina* includes 32 critical habitat units, covering four ecosystems type, which encompasses approximately 39,247 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7 Oahu— Lowland Wet—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; Oahu—Montane Wet—Unit 1; Oahu—Wet Cliff—Units 1, 2, 3, 4, 5, 6, 7, 8.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the

lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

Oahu—Lowland Wet—Unit 1 [541 ac (219 ha)]. This area consists of 428 ac (173 ha) of State land and 112 ac (46 ha) of City and County of Honolulu land in the lowland wet ecosystem on the windward side of the Waianae Mountains, and partially within the Mokuleia and Waianae Kai Forest Reserves. Oahu—Lowland Wet—Unit 2 [20 ac (8 ha)]. This area consists of 19 ac (8 ha) of State land in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puuhapapa. Oahu—Lowland Wet—Unit 3 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puukanehoa. Oahu—Lowland Wet—Unit 4 [27 ac (11 ha)]. This area consists of 27 ac (11 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains on State land at Puukaua. Oahu—Lowland Wet—Unit 5 [74 ac (30 ha)]. This area consists of 74 ac (30 ha) of State land in the lowland wet ecosystem, on the windward side of the Waianae Mountains at Palikea. Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Hauula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikēēē, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet—Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward

side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet—Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu—Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamoa Ridge.

Oahu—Montane Wet—Unit 1 [370 ac (150 ha)]. This area consists of 18 ac (7 ha) of City and County of Honolulu land, 352 ac (142 ha) of State land, and less than 1 ac (less than one ha) of privately-owned land in the montane wet ecosystem at the summit of the Waianae Mountains at Kaala, and partially within the Mokuleia Forest Reserve and the Kaala Natural Area Reserve.

Oahu—Wet Cliff—Unit 1 [235 ac (95 ha)]. This area consists of 167 ac (68 ha) of State land, 68 ac (28 ha) of City and County of Honolulu land, and less than 1 ac (less than 1 ha) of privately owned land in the wet cliff ecosystem in the Waianae Mountains, near the summit of Kaala, and partially within the Mokuleia and Waianae Kai FRs and the Kaala Natural Area Reserve. Oahu—Wet Cliff—Unit 2 [3 ac (1 ha)]. This area consists of 3 ac (1 ha) of State land in the wet cliff ecosystem in the Waianae Mountains at Puuhapapa, within a small area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Oahu—Wet Cliff—Unit 3 [16 ac (6 ha)]. This area consists of 16 ac (6 ha) in the wet cliff ecosystem on State land in the Waianae Mountains at Puukanehoa, partially within an area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Oahu—Wet Cliff—Unit 4 [23 ac (9 ha)]. This area consists of 23 ac (9 ha) in the wet cliff ecosystem on State land in the Waianae Mountains at Puukaua, partially overlapping an area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and recently acquired by the State. Oahu—Wet Cliff—Unit 5 [31 ac (13 ha)]. This area consists of 31 ac (13 ha) of State land in the wet cliff ecosystem in the Waianae Mountains, at Palikea and north of Palikea. Oahu—Wet Cliff—Unit 6 [151 ac (61 ha)]. This area consists of 151 ac (61 ha) in the wet cliff ecosystem on State land on the windward side of the Koolau Mountains in Kaipapau Gulch, entirely within the Kaipapau Forest Reserve. Oahu—Wet Cliff—Unit 7 [144 ac (58 ha)]. This area consists of 144 ac (58 ha) in the wet cliff ecosystem in State land on the windward side of the Koolau Mountains in Hauula Gulch, entirely within the Hauula Forest Reserve. Oahu—Wet Cliff—Unit 8 [4,649 ac (1,881 ha)]. This area consists of 1,479 ac (598 ha) of State land, 1,281 ac (519 ha) of City and County of Honolulu land, 5 ac (2 ha) of Federal land, and 1,884 ac (762 ha) of privately owned land, in the wet cliff ecosystem along the summit of the Koolau Mountains, overlapping portions of Sacred Falls State Park, the Waiahole FR (Waiahole and Iolekaa sections), the Kaneohe and Honolulu Watershed FRs, and the Nuana Pali State Wayside.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea calycina* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Cyanea calycina* occurs within the Lowland mesic, Lowland wet and Wet cliff ecosystems in the Waianae Mountain caldera complex and the Koolau Mountain caldera complex. *Cyanea calycina* also occurs within the Montane wet ecosystem in the Waianae Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (E) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

7 Oahu—Lowland Wet—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. (E) Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. (E) Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

Oahu—Montane Wet—Unit 1. (A) Elevation: 3,300–6,600 ft (1,000-2,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Well-developed soils, montane bogs. (D) Canopy: Acacia, Charpentiera, Cheiropendron, Metrosideros. (E) Subcanopy: Broussaisia, Cibotium, Eurya, Ilex, Myrsine. (E) Understory: Ferns, Carex, Coprosma, Leptecophylla, Oreobolus, Rhynchospora, Vaccinium.

Oahu—Wet Cliff—Units 1, 2, 3, 4, 5, 6, 7, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: >65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: Broussaisia, Cheiropendron, Leptecophylla, Metrosideros. (E) Understory: Bryophytes, Ferns, Coprosma, Dubautia, Kadua, Peperomia.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Cyanea calycina* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 1,800 and 3,920 feet (USFWS, 2012)

Environmental Specificity

Adult: Very narrow to moderate. (NatureServe, 2015)

Habitat Narrative

Adult: *Cyanea calycina* (Haha), an unbranched shrub in the bellflower family (Campanulaceae), is found in both the Waianae and Koolau Mountains of Oahu in the lowland mesic, lowland wet, montane wet, and wet cliff ecosystems (Lammers 1999, p. 483; Wagner and Herbst 2003, p. 17; TNC 2007; HBMP 2008). In the Waianae Mountains, *C. calycina* occurs in *Acacia-Metrosideros-Dicranopteris* (koa- ohia-uluhe) forests at elevations between 1,800 and 3,920 ft (550 and 1,195 m), and in the Koolau Mountains this species occurs in wet *Metrosideros-Dicranopteris* forest and shrubland at elevations between 1,830 and 3,000 ft (558 and 900 m) (HBMP 2008). (USFWS, 2012)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Population Growth Rate:

Unknown (NatureServe, 2015)

Number of Populations:

40 occurrences (USFWS, 2012)

Population Size:

300-350 (USFWS, 2012)

Population Narrative:

Currently, *C. calycina* is found from Pahole in the northern portion of the Waianae Mountains south along the summit to Palawai, in 18 occurrences totaling at least 170 individuals (U.S. Army 2006; HBMP 2008). Currently, 22 occurrences totaling between 155 and 169 individuals are known, from the most northern point at Kamananui Gulch along the summit ridges south to Konahuanui (U.S. Army 2006; HBMP 2008). The combined 40 occurrences total 325 to 339 individuals. (USFWS, 2012)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative plants, animals (pigs and goats), fire, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Fire can destroy dormant seeds as well as the plants themselves, even in steep or inaccessible areas. Successive fires that burn farther and farther into native habitat destroy native plants, and remove habitat for native species by altering microclimate conditions favorable to alien plants. The projected effects of climate change will likely exacerbate the effects of the other threats to the species (USFWS, 2012).

Stressor: Predation and herbivory (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, goats, rats, and slugs) is considered an ongoing threat to *Cyanea calycina* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2012).

Stressor: Trampling by humans (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: *Cyanea calycina* faces the threat of trampling. Visitors on foot, horseback, and motorbikes may pose threats to *C. calycina* directly due to trampling and other direct damage, and indirectly due to being a source of fire ignition in areas in the southern Waianae Mountains. Human impacts, such as trampling by hikers, has been documented as a threat to *C. calycina* in the northern Waianae Mountains, between Kaala and Puu Kalena summits (USFWS, 2012).

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

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Final Rule. 77 Federal Register 181. Pages 57648-57862.

USFWS. 2012. Endangered Status for 23 Species on Oahu and Designation of Critical Habitat for 124 Species

Final Rule. 77 Federal Register 181, September 18, 2012. Pages 57648 - 57862.

SPECIES ACCOUNT: *Cyanea copelandii* ssp. *copelandii* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/04/1994; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Cyanea copelandii subsp. *copelandii* is a small epiphytic shrub that grows 1-6.7 ft (0.3-2 m) tall (Lammers 1990). Rooting at the nodes, its weak stems clamber on rocks and tree trunks. Oblance-shaped leaf blades 4.9-10.6 in (10-27 cm) long and 1.4-3.3 in (3.5-8.5 cm) wide are dark green on the upper surface and hairy on the lower surface. Leaf blade margins have small teeth and the base of the blade is attached to a leafstalk that is 1-3.9 in (2.5-10 cm) long. Clusters of 5 to 12 flowers are attached to a main flower cluster stalk (peduncle) 0.8-1.8 in (2-4.5 cm) long. Each flower is then attached to a flower stalk (pedicel) 0.2-0.6 in (0.4-1.6 cm) long. The calyx and the petals are fused at the base into a tube 0.2-0.4 in (0.6-1 cm) long. Calyx lobes are small and triangular, 0.08-0.2 in (2-4 mm) long. The petals, 1.5-1.7 in (3.7-4.2 cm) long, are yellowish but appear rose because of long dark red hairs that cover the surface. Five spreading petal lobes are fused into a tube. Berries are ob-oval, 0.3-0.6 in (0.7-1.5 cm) long and dark orange. (USFWS, 1996)

Historical Range

Known only from a few historical specimens from the district of Puna on the island of Hawaii. (NatureServe, 2015)

Current Range

No current range; last collected in 1957. (NatureServe, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 1996)

Dependency on Other Individuals or Species

Adult: Honeycreeper pollinates flowers (NatureServe, 2015)

Reproduction Narrative

Adult: This taxon was observed in fruit and flower during December 1914 (HHP 1991f1). The loss of Hawaiian honeycreepers has likely resulted in elimination of the bird pollinator for this plant. (USFWS, 1996)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 2,200 and 5,232 feet (USFWS, 1996)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1996)

Habitat Narrative

Adult: The habitat of *Cyanea copelandii* subsp. *copelandii* is montane wet forest dominated by *Cibotium* spp., at elevations between 2,200 to 5,232 ft (660 to 1,600 m) (Lammers 1990). The Hawaiian Heritage Program (1991f) gives 2,200 to 2,900 ft (660 to 880 m) as the elevational range of this taxon. *Cibotium* is the only genus recorded as an associate of this taxon (HHP 1991f). (USFWS, 1996)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

None (USFWS, 2012)

Representation:

None (USFWS, 2012)

Redundancy:

None (USFWS, 2012)

Number of Populations:

0 (USFWS, 2012)

Population Size:

0 (USFWS, 2012)

Population Narrative:

In 2010, there were no known individuals or populations of *Cyanea copelandii* subsp. *copelandii* (USFWS 2010). (USFWS, 2012)

Threats and Stressors

Stressor: Ungulates (NatureServe, 2015)

Exposure:**Response:****Consequence:**

Narrative: The greatest threat to *Cyanea copelandii* ssp. *copelandii* is grazing by feral ungulates and its rarity (USFWS 1996). (NatureServe, 2015)

Stressor: Predation (NatureServe, 2015)

Exposure:**Response:****Consequence:**

Narrative: Possible predation of fruit and seeds by black rats and the loss of its avian pollinator, the Hawaiian Honeycreeper also threaten this species reproduction success (USFWS 1996).

Stressor: Small population size (USFWS, 2012)

Exposure:**Response:****Consequence:**

Narrative: Low numbers – increased likelihood of stochastic extinction due to changes in demography, the environment, genetics, or other factors (USFWS 1994, 1996; Plant Extinction Prevention Program 2010). (USFWS, 2012)

Stressor: Climate change (USFWS, 2012)

Exposure:**Response:****Consequence:**

Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2012)

Recovery**Reclassification Criteria:**

1. A total of five to seven populations of each taxon should be documented on the Big Island and at least one other island where it now occurs or occurred historically, if it is not endemic to the Big Island. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1996)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1996)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on the Big Island and at least 1 other island where they now occur or occurred historically, if it is not endemic to the Big Island. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 individuals per population for short-lived perennials. (USFWS, 1996)
3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1996)

Recovery Actions:

- This taxon should be located in the wild, and seeds and/or tissue collected for propagation and maintenance of ex situ genetic stock. (USFWS, 1996)
- Additional populations will need to be established and, along with the extant population, protected from ungulates and other threats. (USFWS, 1996)

Conservation Measures and Best Management Practices:

- A thorough survey of the areas where the last known *Cyanea copelandii* subsp. *copelandii* occurred should be undertaken, focusing on the southeastern slope of Mauna Loa, near Glenwood. (USFWS, 2012)
- If the species is rediscovered, genetic material for ex situ maintenance should be collected, and the existing population protected. (USFWS, 2012)
- If the species is rediscovered, work with Hawaii Division of Forestry and Wildlife to initiate planning and contribute to implementation of ecosystem-level restoration and management for sites to reintroduce this species. (USFWS, 2012)

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SPECIES ACCOUNT: *Cyanea copelandii* ssp. *haleakalaensis* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/03/1999; Pacific Region (R1) (USFWS, 2016)

Physical Description

A liana-like shrub 0.3-2 m tall. Flowers appear to be pale rose in color (NatureServe, 2015).

Taxonomy

A member of the bellflower family. In 1987, St. John (1987b) merged the two genera *Cyanea* and *Delissea*, formally recognizing only *Delissea*, the genus with priority. This change resulted in the combination *D. haleakalaensis*. Lammers retains both genera in the currently accepted treatment of the Hawaiian members of the family, and in 1988 he recognized *C. haleakalaensis* as a subspecies of *C. copelandii*, publishing the new combination *C. copelandii* ssp. *haleakalaensis* (Lammers 1988, 1999) (USFWS, 2002).

Historical Range

It is endemic to East Maui (USFWS, 2011). Historically (prior to 1970), *Cyanea copelandii* ssp. *haleakalaensis* was reported from the windward side of Haleakala and from Waikamoi to Kipahulu Valley on the island of Maui (USFWS, 2002).

Current Range

Currently (since 1970), this taxon is known from three populations within the East Maui Watershed Partnership in Haiku Uka, the ridge above Kuhiwa Valley, and Kipahulu Valley within Haleakala National Park and Hanawi Natural Area Reserve (Lammers 1999; U.S. Fish and Wildlife Service 1999b, 2002b, Warshauer 1998; Hawaii Natural Heritage Program Database 2001; Geographic Decision Systems International 2001; Medeiros et al. 1998) (USFWS, 2002).

Critical Habitat Designated

Yes; 5/14/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea copelandii* ssp. *haleakalaensis* (Haha) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 11 detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Cyanea copelandii* ssp. *haleakalaensis* includes 11 CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Lowland Mesic—Unit 1 consists of 1,147 ac (464 ha) of State land, 241 ac (97 ha) of privately owned land, and 494 ac (200 ha) of federally owned land (Haleakala National Park), from Manawainui Valley to Kukuiula on the eastern slopes of east Maui. This unit is occupied by the plants *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, and *Huperzia mannii*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic

ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Mesic—Unit 1 is not known to be occupied by *Ctenitis squamigera* or *Solanum incompletum*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 1 (and) *Palmeria dolei*—Unit 2—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 2—Lowland Wet This area consists of 6,616 ac (2,677 ha) of State land, 7,425 ac (3,005 ha) of privately owned land, and 2,038 ac (825 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Kipahulu Valley on the northern and eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia samuelii*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *M. ovalis*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 1 is not known to be occupied by the plants *Clermontia oblongifolia* ssp. *mauiensis*, *C. peleana*, *Mucuna sloanei* var. *persericea*, *Phyllostegia haliakalae*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 1 (and) *Palmeria dolei*—Unit 10—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 10—Montane Wet This area consists of 1,313 ac (531 ha) of State land and 798 ac (323 ha) of privately owned land, at Haiku Uka on the northern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Cyanea duvalliorum*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *Phyllostegia pilosa*, and by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 1 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary

for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 11—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 11— Montane Wet This area consists of 4,075 ac (1,649 ha) of State land, 9,633 ac (3,898 ha) of privately owned land, and 875 ac (354 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Puukaukanu and upper Waihoi Valley, on the northern and northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Geranium hanaense*, *G. multiflorum*, and *Wikstroemia villosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 2 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea glabra*, *C. maritae*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, and *Schiedea jacobii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 3 (and) *Palmeria dolei*—Unit 12—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 12— Montane Wet This area consists of 2,228 ac (902 ha) of federally owned land (Haleakala National Park) in Kipahulu Valley, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. maritae*, and *Melicope ovalis*, and by the forest bird, kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 3 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea duvalliorum*, *C. glabra*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest bird, the akohekohe (*Palmeria dolei*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small

numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 4 (and) *Palmeria dolei*—Unit 13—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 13— Montane Wet This area consists of 180 ac (73 ha) of State land and 1,653 ac (669 ha) of federally owned land (Haleakala National Park), in Kaapahu Valley on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *Cyrtandra ferripilosa*, and *Huperzia mannii*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 4 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea duvalliorum*, *C. glabra*, *C. mceldowneyi*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 5 (and) *Palmeria dolei*—Unit 14—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 14— Montane Wet This area consists of 222 ac (90 ha) of State land, and 165 ac (67 ha) of federally owned land (Haleakala National Park), near Kaumakani on the eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units area occupied by the plant *Bidens campylotheca* ssp. *pentamera*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 5 is not currently occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 1 (and) *Palmeria dolei*—Unit 30—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 30— Wet Cliff This area consists of 290 ac (117 ha) of privately owned land along the wall of Keanae Valley on the northern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff— Unit 1 is not currently occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *Cyanea horrida*, *Melicope ovalis*, *Phyllostegia bracteata*, *P. haliakalae*, or *Plantago princeps*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 2 (and) *Palmeria dolei*—Unit 31—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 31— Wet Cliff This area consists of 475 ac (192 ha) of State land, 20 ac (8 ha) of privately owned land, and 912 ac (369 ha) of federally owned land (Haleakala National Park), from Kalapawili Ridge along Kipahulu Valley and north to Puuhoolio, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plants *Bidens campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *Melicope ovalis*, *Phyllostegia bracteata*, and *Plantago princeps*. These units also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 2 is not known to be occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Cyanea horrida*, or *Phyllostegia haliakalae*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 3 (and) *Palmeria dolei*—Unit 32—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 32— Wet Cliff This area consists of 5 ac (2 ha) of State land and 433 ac (175 ha) federally owned land (Haleakala National Park) along the south rim of Kipahulu Valley on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff— Unit 3 is not currently occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. horrida*, *Melicope ovalis*, *Phyllostegia bracteata*, *P. haliakalae*, or *Plantago princeps*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 4 (and) *Palmeria dolei*—Unit 33—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 33—Wet Cliff This area consists of 184 ac (75 ha) of State land along the north wall of Waihoi Valley, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plant *Bidens campylotheca* ssp. *pentamera* and *B. campylotheca* ssp. *waihoiensis*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 4 is not known to be occupied by the plants *Cyanea copelandii* ssp. *haleakalaensis*, *C. horrida*, *Melicope ovalis*, *Phyllostegia bracteata*, *P. haliakalae*, or *Plantago princeps*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea copelandii* ssp. *haleakalaensis* critical habitat consists of four components. Lowland mesic (east Maui), Lowland wet (east Maui), Montane wet (east Maui) and Wet cliff (east Maui) (81 FR 17790-18110):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: *Ferns*, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. Understory: *Bryophytes*, *Ferns*, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the

conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through

6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Lifespan**

Adult: < 10 years (USFWS, 2011)

Breeding Season

Adult: Unknown (USFWS, 2002)

Key Resources Needed for Breeding

Adult: Unknown (USFWS, 2002)

Reproduction Narrative

Adult: It is a short-lived perennial (fewer than ten years) (USFWS, 2011). Flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown (U.S. Fish and Wildlife Service 1999b, 2002b) (USFWS, 2002).

Habitat Type

Adult: Terrestrial (NatureServe, 2015); riparian (USFWS, 2002)

Habitat Vegetation or Surface Water Classification

Adult: Montane and mesic koa and ohia forest, wet scree (USFWS, 2002)

Geographic or Habitat Restraints or Barriers

Adult: 2,015 - 4,625 ft. elevation (USFWS, 2002)

Habitat Narrative

Adult: Inhabits wet forests (NatureServe, 2015). *Cyanea copelandii* ssp. *haleakalaensis* is found on stream banks and wet scree (a sloping mass of rocks at the base of a cliff) slopes and forest understory in montane wet or mesic forest dominated by *Acacia koa* (koa) and/or *Metrosideros polymorpha* (ohia) at elevations between 615 and 1,410 meters (2,015 to 4,625 feet) (USFWS, 2002).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: The fruits of *Cyanea copelandii* subsp. *haleakalaensis* are able to float and disperse via stream flow (Oppenheimer 2009) (USFWS, 2011).

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Very low (inferred from USFWS, 2011)

Redundancy:

High (inferred from USFWS, 2011)

Number of Populations:

25 (USFWS, 2011)

Population Size:

300-500 (USFWS, 2018)

Population Narrative:

Currently, there are 25 widely distributed populations containing more than 300 individuals in East Maui (Bily et al. 2008) (USFWS, 2011).; Additional, new occurrences of *Cyanea copelandii* subsp. *haleakalaensis* were found at Kūhiwa Valley (about 10 individuals), Kawaipapa (at least one individual), and at 'Ohe'o (Kīpahulu; large patches) (Oppenheimer 2018, in litt.). Including those populations last monitored in 2007 (Wailua Iki and east Makaīwa), the total number of individuals remains around 300 to 500 (Bruegmann et al. 2016; Oppenheimer 2018, in litt.). (USFWS, 2018)

Threats and Stressors

Stressor: Nonnative species (USFWS, 2011)

Exposure:

Response:**Consequence:**

Narrative: Feral pigs (*Sus scrofa*) degrade habitat at most sites, although little pig damage was observed at the Wailua Nui region. Invasive introduced plant species that degrade habitat and compete with *Cyanea copelandii* subsp. *haleakalaensis* include *Ageratina adenophora* (sticky snakeroot), *Axonopus fissifolius* (carpetgrass), *Clidemia hirta* (Koster's curse), *Cortaderia jubata* (pampas grass), *Hedychium flavescens* (yellow ginger), *H. gardnerianum* (Kahili ginger), *Hypochoeris radicata* (hairy cat's ear), *Juncus planifolius* (rush), *Paspalum conjugatum* (Hilo grass), *P. urvillei* (vasey grass), *Pluchea carolinensis* (sourbush), *Prunella vulgaris* (selfheal), *Psidium cattleianum* (strawberry guava), *Rhynchospora caduca* (beak rush), *Rubus argutus* (blackberry), *Setaria palmifolia* (palmgrass), *Rubus rosifolius* (thimbleberry), and *Tibouchina herbacea* (glorybush) (Oppenheimer 2009; Perlman 2009; Wood 2009) (USFWS, 2011).

Stressor: Stochastic events (USFWS, 2011)

Exposure:**Response:****Consequence:**

Narrative: Flooding and landslides are also a threat to *Cyanea copelandii* subsp. *haleakalaensis* (Oppenheimer 2009) (USFWS, 2011).

Stressor: Predation (USFWS, 2011)

Exposure:**Response:****Consequence:**

Narrative: Seed predation by rats (*Rattus* spp.) and consumption of leaves and stems by slugs (unidentified species) and mongoose (*Herpestes javanicus*) are threats to *Cyanea copelandii* subsp. *haleakalaensis* (Perlman 2009; USFWS 2002; Wood 2009) (USFWS, 2011).

Stressor: Climate change (USFWS, 2011; USFWS, 2018))

Exposure:**Response:****Consequence:**

Narrative: Climate change may pose a threat to this subspecies. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai'i using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) was conducted at the species level and concluded that *Cyanea copelandii* is vulnerable to the impacts of climate change, with a vulnerability score of 0.447 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2018)

Stressor: Lack of adequate hunting regulations (USFWS, 2018)

Exposure:**Response:****Consequence:**

Narrative: Three populations of *Cyanea copelandii* subsp. *haleakalaensis* occur in state hunting areas (Puohokamoa, Waiokamilo to Wailua Iki, and Kawaiipapa). Nonnative feral ungulates pose a

major ongoing threat to all native species, including *C. copelandii* subsp. *haleakalaensis*, through destruction and modification of habitat, and through direct herbivory or predation. Feral pigs have been noted as a threat to the species. Public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations are at risk (DLNR 2010). (USFWS, 2018)

Stressor: Lack of adequate biosecurity legislation (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Invasion of the State of Hawai'i by invasive nonnative plant species, and destruction of habitat and competition by nonnative plants are threats to *Cyanea copelandii* subsp. *haleakalaensis*. The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, is authorized to prevent the introduction or dissemination of animal and plant pests on all ships, aircraft, and their cargo and baggage arriving in the U.S. and its territories; however, pest species continue to enter the State. In addition, Federal import regulations do not address many species that could be pests in Hawai'i (CGAPS 2009; Ikuma et al. 2002). (USFWS, 2018)

Stressor: Invasive species (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Established invasive plant species competition—Nonnative plant species, particularly *Clidemia hirta* (*clidemia*), compete with *Cyanea copelandii* subsp. *haleakalaensis* for water, light, and nutrients (HNP 2012). *Clidemia hirta* is widespread and naturalized in forests throughout Hawai'i. (USFWS, 2018)

Stressor: Reduced viability due to low numbers (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Small, isolated populations often exhibit reduced levels of genetic variability, which diminishes the species' capacity to adapt and respond to environmental changes, thereby lessening the probability of long-term persistence (Barrett and Kohn 1991; Newman and Pilson 1997). The problems associated with small population size and vulnerability to random demographic fluctuations or natural catastrophes are further magnified by synergistic interactions with other threats, such as anthropogenic impacts like habitat loss from human development or predation by nonnative species. Very small plant populations may experience reduced reproductive vigor due to ineffective pollination or inbreeding depression. Small numbers are noted as a cause of loss of reproductive vigor of *Cyanea copelandii* subsp. *haleakalaensis* (Bruegmann et al. 2016). (USFWS, 2018)

Recovery

Reclassification Criteria:

1. A total of five to seven populations should be documented on islands where it now occurs or occurred historically (USFWS, 2002).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 2002).
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 2002).

Delisting Criteria:

1. A total of 8 to 10 populations should be documented on islands where it now occurs or occurred historically (USFWS, 2002).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 2002).
3. Each population should persist at this level for a minimum of five consecutive years (USFWS, 2002).

Recovery Actions:

- Protect habitat and control threats (USFWS, 2002).
- Expand existing wild populations (USFWS, 2002).
- Conduct essential research (USFWS, 2002).
- Develop and maintain monitoring plans (USFWS, 2002).
- Reestablish wild populations within the historic range (USFWS, 2002).
- Validate and revise recovery criteria (USFWS, 2002).
- Construct exclosures to protect populations against feral ungulates (USFWS, 2002).
- Maintain adequate genetic stock (USFWS, 2002).
- Control competing alien plant species (USFWS, 2002).
- Enhance wild populations and establish new populations (USFWS, 2002).
- Surveys and inventories—Continue to survey for additional populations of *Cyanea copelandii* subsp. *haleakalaensis* in areas of potentially suitable habitat. (USFWS, 2018)
- Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect individuals from the negative impacts of feral ungulates. Protect all occurrences against browsing and habitat disturbances from feral ungulates. (USFWS, 2018)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. Control invasive nonnative species that compete with the species around all populations. (USFWS, 2018)
- Climate change adaptation strategy—Assess the modeled effects of climate change on this subspecies, and determine future landscape needed for the recovery of the subspecies. (USFWS, 2018)
- Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. (USFWS, 2018)

- Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range, and outside of Haleakalā National Park, that is being managed for known threats to this subspecies. (USFWS, 2018)
- Predator and herbivore monitoring and control—Implement effective control methods for rodents at the last known location. Develop and implement an effective method of slug control (USFWS, 2018)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and flooding. (USFWS, 2018)

Conservation Measures and Best Management Practices:

- Fence all populations to provide protection against the negative impacts of feral ungulates (USFWS, 2011).
- Maintain adequate genetic stock for populations outside the National Park, as well as those in the Park boundaries (USFWS, 2011).
- Control invasive introduced plant species in all populations (USFWS, 2011).
- Control rats in the vicinity of these populations (USFWS, 2011).
- Develop and implement an effective method of slug control (USFWS, 2011).
- Propagate for reintroduction augmentation (USFWS, 2011).
- Conduct a thorough survey throughout the current and historical range of the species to determine the current status (USFWS, 2011).
- Work with Hawaii Division of Forestry and Wildlife, National Park Service, East Maui Watershed Partnership Program, and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2011).

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

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SPECIES ACCOUNT: *Cyanea dolichopoda* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/14/2010; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Cyanea dolichopoda (haha) is a shrub in the bellflower family (Campanulaceae). Shrub, 1 m tall, erect, with stem unbranched. Leaf blades ovate or oblong, 6.5-10 cm long, 3.7-5.8 cm wide, bases cordate, often markedly asymmetric. Petioles 9-16 cm long, slender. Inflorescences (not fully expanded) spreading or pendent, 8-11-flowered. Corollas (in bud) pinkish. (NatureServe, 2015; USFWS, 2016)

Current Range

Cyanea dolichopoda was first collected in 1990 at Blue Hole, Kauai. The only mature individual and two seedlings could not be relocated after Hurricane Iniki in 1992. Currently, there are no known individuals. (USFWS, 2017)

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea dolichopoda* (`Akoko) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Cyanea dolichopoda* includes three CHUs in Kauai County, Hawaii. Note: This species may no longer occur naturally in the wild, therefore there is no known occupied critical habitat for this species. The critical habitat units for this species have been determined to be essential to the conservation of the species because the area provides for the reestablishment of populations within the species' historical range (75 FR 18960-19165).

Kauai—Wet Cliff—Section 1: Wet Cliff—Section 1 consists of 190 ac (77 ha) in the wet cliff ecosystem, including cliffs along the rim of Kalalau Valley from Alealeau to Pihea, on Stateowned land in the Na Pali Coast State Park and the Hono o Na Pali NAR (Figure 6-A). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70b, and is occupied by the plant *Chamaesyce remyi* var. *remyi*. This section includes the wet cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the wet cliff ecosystem (Table 3). Although Wet Cliff—Section 1 is not known to be occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyanea dolichopoda*, *Cyrtandra oenobarbara*, *C. paliku*, *Dubautia plantaginea* ssp. *magnifolia*, *Lysimachia iniki*, *L. pendens*, *L. venosa*, and *Platydesma rostrata*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Wet Cliff—Section 2: Wet Cliff—Section 2 consists of 784 ac (317 ha) in the wet cliff ecosystem, and includes the cliffs at the headwaters of the Wailua River or “Blue Hole,” on State (778 ac, 315 ha) and privately owned (6 ac, 3 ha) land in the LihueKoloa Forest Reserve (Figure 6-B). There are 489 ac (198 ha) within previously designated critical habitat and 296 ac (120 ha) of newly designated critical habitat on State-owned land. The portion of the section that is in previously designated critical habitat falls within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36b. The newly designated portion of the section comprises Critical Habitat Unit 18 of 50 CFR 17.99(a)(1), Map 217a. This section is occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyrtandra oenobarba*, *Dubautia plantaginea* ssp. *magnifolia*, *Lysimachia iniki*, *L. pendens*, and *Platydesma rostrata*. The section includes the wet cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the wet cliff ecosystem (Table 3). Although Wet Cliff—Section 2 is not known to be occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyanea dolichopoda*, *Cyrtandra paliku*, and *Lysimachia venosa*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Wet Cliff—Section 3: Wet Cliff—Section 3 consists of 61 ac (24 ha) in the wet cliff ecosystem, including cliffs below Kekoiki, on State (8 ac, 3 ha) and privately owned (53 ac, 22 ha) land in the Halelea, Moloaa and Kealia forest reserves (Figure 6-C). There are 23 ac (9 ha) of newly designated critical habitat on privately owned land within this section. That portion of the section that falls within previously designated critical habitat is within Critical Habitat Unit 4 of 50 CFR 17.99(a)(1), Map 5a. The newly designated portion of the section comprises Critical Habitat Unit 19 of 50 CFR 17.99(a)(1), Map 217b. This section is occupied by the plant *Cyrtandra paliku*, and includes the wet cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the wet cliff ecosystem (Table 3). Although Wet Cliff—Section 3 is not known to be occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Cyanea dolichopoda*, *Cyrtandra oenobarba*, *Dubautia plantaginea* ssp. *magnifolia*, *Lysimachia iniki*, *L. pendens*, *L. venosa*, and *Platydesma rostrata*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea dolichopoda* critical habitat consists of one component (Wet cliff) (75 FR 18960-19165):

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. Understory: *Bryophytes*, *Ferns*, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry

Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History

Food/Nutrient Resources

Habitat Type

Adult: Terrestrial (inferred from NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliffs (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: High rainfall (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at approximately 2,300 feet (USFWS, 2010)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 2010)

Habitat Narrative

Adult: *Cyanea dolichopoda* occurs in a deep and extremely wet valley head surrounded on three sides by vertical cliffs 900 meters (m) (2,953 feet (ft)) high and laced with waterfalls. The vegetation is an unusual mix of shrubland and low-statured rainforest on saturated rocky ground. The canopy is just 1 to 3 m (3.3 to 9.9 ft) tall, and the ground layer is rich in ferns and fern allies (Lammers and Lorence 1993). The canopy is *Metrosideros polymorpha* (ohia) lowland wet shrubland with the associated native species *Cyanea asarifolia* (haha), *Cyrtandra* sp. (haiwale), *Kadua elatior* (awiwi), *Lysimachia filifolia* (NCN), *Pipturus albidus* (mamake), *Touchardia latifolia* (olona) (NTBG 1990; Lammers and Lorence 1993). (USFWS, 2017)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Redundancy:

Very low (inferred from NatureServe, 2015)

Number of Populations:

1 (NatureServe, 2015)

Population Narrative:

In June 1990, a single mature individual and a few seedlings of an undescribed species of *Cyanea* was discovered on the south side of Blue Hole, a relatively inaccessible site located at the headwaters of the Wailua River, at about 700 m (2,297 ft) elevation (NTBG 1990; Lammers and Lorence 1993). The species was named *Cyanea dolichopoda*. In October 1992, six weeks after Hurricane Iniki, a survey revealed that all known individuals of this species had been destroyed. It is likely that additional plants survive on cliffs surrounding Blue Hole, although the vertical aspect and great height of the cliffs makes them difficult to explore (Lammers and Lorence 1993; Perlman 2007, as cited in USFWS 2010a). Numerous surveys have been conducted at the holotype region, along with nearby locations, but no individuals have ever been located (Wood 2015). (USFWS, 2017)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from non-native plants, hurricanes, landslides, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Landslides destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities.

Stressor: Predation and herbivory (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species present an immediate and significant threat to *Cyanea dolichopoda* throughout its range due to , and documented mechanical damage by nonnative invertebrates (USFWS, 2010).

Stressor: Small populations (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: *Cyanea dolichopoda* has not been confirmed to persist in the wild. This species is not in storage or propagation, but individuals familiar with this species believe it may possibly remain extant and that much of its suitable habitat (lowland mesic, lowland wet, and wet cliff) on Kauai remains to be surveyed (USFWS, 2010).

Stressor: Established ecosystem-altering invasive plant modification and destruction of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community. Invasive introduced plants impacting *Cyanea dolichopoda* are *Erigeron karvinskianus* (daisy fleabane), *Psidium* spp. (guava), and *Toona ciliata* (Australian red cedar) (KRCF 2014). (USFWS, 2017)

Stressor: Lack of adequate hunting regulations (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Nonnative feral ungulates pose a major ongoing threat to native species through destruction and modification of habitat, and by direct herbivory or predation. Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (i.e., sustained yield) in some areas, with one animal allowed per day; to other areas with as few as one animal allowed per year (DLNR 2010). Public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation. The only known population of *Cyanea dolichopoda* occurred in a State hunting area in Lihue-Koloa Forest Reserve (mammal hunting area). This area is not fenced. (USFWS, 2017)

Stressor: Lack of adequate biosecurity legislation (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Invasion of the State of Hawaii by invasive nonnative plant species, and destruction of habitat and competition by nonnative plants are threats to *Cyanea dolichopoda*. The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, is authorized to prevent the introduction or dissemination of animal and plant pests on all ships, aircraft, and their cargo and baggage arriving in the U.S. and its territories; however, pest species continue to enter the State. In addition, Federal import regulations do not address many species that could be pests in Hawaii (CGAPS 2009; Ikuma et al. 2002). (USFWS, 2017)

Recovery

Reclassification Criteria:

To meet the interim stage of recovery of *Cyanea dolichopoda*, 600 mature individuals are needed in one population and all major threats must be controlled around the population designated for recovery at this stage. There should also be demonstrated regeneration of

seedlings and growth to at least sapling stage for woody species and documented replacement regeneration within each of the target populations. The population must be adequately represented in an ex situ collection as defined in the Center for Plant Conservation's guidelines (Guerrant et al. 2004). Adequate monitoring must be in place and conducted to assess individual plant survival, population trends, trends of major limiting factors, and response of major limiting factors to management. (USFWS, 2017)

In addition to achieving 5 to 10 populations with 1,000 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats. (USFWS, 2017)

Delisting Criteria:

In addition to achieving 5 to 10 populations with 1,000 mature individuals per population and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis. (USFWS, 2017)

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys. (USFWS, 2010)
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units. (USFWS, 2010)
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys. (USFWS, 2010)
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range. (USFWS, 2010)

- Conduct research on control methods for introduced slugs and avian malaria. (USFWS, 2010)
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction. (USFWS, 2010)
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security. (USFWS, 2010)
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems. (USFWS, 2010)
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations. (USFWS, 2010)
- Surveys and inventories—Survey suitable habitat to find new populations. Consider utilizing Unmanned Aerial Vehicles to survey inaccessible cliff habitat to confirm extirpation from the Blue Hole known location. (USFWS, 2017)
- Ungulate monitoring and control—Fence any populations found to protect them from the impacts of feral ungulates. Control feral ungulates within fenced exclosures. (USFWS, 2017)
- Invasive plant monitoring and control—Control invasive plant species around any populations found. (USFWS, 2017)
- Captive propagation for genetic storage and reintroduction—Collect material for genetic storage and propagation for reintroduction from any individuals found. (USFWS, 2017)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms. (USFWS, 2017)
- Based on the recovery criteria above, consider development of a recovery plan. (USFWS, 2017)

Conservation Measures and Best Management Practices:

- Not available.

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SPECIES ACCOUNT: *Cyanea dunbarii* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Cyanea dunbarii is a branched shrub 1.5 to 2 m (4.9 to 6.6 ft) tall. The oval to broadly elliptic leaves are 10 to 22 cm (3.9 to 8.7 in) long and 6 to 14 cm (2.4 to 5.5 in) wide, with irregularly lobed or cleft margins. The flowers are arranged in groups of six to eight on a stalk, which is 3 to 7 cm (1.2 to 2.8 in) long. The corolla is white, tinged or striped with pale lilac and 30 to 38 mm (1.2 to 1.5 in) long. The corolla is slightly curved, with spreading lobes three-fourths as long as the tube. This species is distinguished from others in this endemic Hawaiian genus by the lack of prickles on the stems and the irregularly lobed and cleft leaf margins (Lammers 1990). (USFWS, 1998)

Taxonomy

A member of the bellflower family (Campanulaceae) (USFWS, 1998).

Historical Range

Historically known from Waihanau and Waialaie valleys on Molokai. (NatureServe, 2015)

Current Range

This species is current known from Mokokoko Gulch on Molokai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/18/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea dunbarii* (aka *Cyanea dunbariae*) (Haha) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes five detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Cyanea dunbarii* includes five CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Molokai—Lowland Mesic—Unit 1 (and) *Palmeria dolei*—Unit 37—Lowland Mesic (and) *Pseudonestor xanthophrys*—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waihanu Gulch to Mapulehu, in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Ctenitis squamigera*, *Cyanea dunbariae*, *C. mannii*, *C. profuga*, *Cyperus fauriei*, *Cyrtandra filipes*, *Gouania hillebrandii*, *Labordia triflora*, *Neraudia sericea*, *Santalum haleakalae* var. *lanaiense*, *Schiedea lydgatei*, *S. sarmentosa*, *Silene alexandri*, *S. lanceolata*, *Spermolepis hawaiiensis*, and *Zanthoxylum hawaiiense*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied

habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Mesic—Unit 1 is not known to be occupied by *Asplenium dielirectum*, *Bonamia menziesii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea procera*, *C. solanacea*, *Diplazium molokaiense*, *Festuca molokaiensis*, *Flueggea neowawraea*, *Isodendrion pyriformis*, *Kadua laxiflora*, *Melicope mucronulata*, *M. munroi*, *M. reflexa*, *Phyllostegia haliakalae*, *P. mannii*, *P. pilosa*, *Sesbania tomentosa*, *Stenogyne bifida*, or *Vigna o-wahuensis*, or the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 1 (and) *Palmeria dolei*—Unit 38—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 38— Lowland Wet This area consists of 2,195 ac (888 ha) of State land, and 754 ac (305 ha) of privately owned land (partly within The Nature Conservancy's Pelekunu Preserve), from Pelekunu Valley to Wailau Valley, in north-central Molokai. These units are occupied by the plant *Cyrtandra filipes*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Wet—Unit 1 is not known to be occupied by *Asplenium dielirectum*, *Bidens wiebkii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Lysimachia maxima*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 2 (and) *Palmeria dolei*—Unit 39—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 39— Lowland Wet This area consists of 1,356 ac (549 ha) of State land and 594 ac (241 ha) of privately owned land, from Kahanui to Pelekunu Valley, in north-central Molokai. These units are occupied by the plant *Lysimachia maxima*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Wet—Unit 2 is not known to be occupied by *Asplenium dielirectum*, *Bidens wiebkii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Cyrtandra filipes*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary

for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 3 consists of 94 ac (38 ha) of State land, and 3,125 ac (1,265 ha) of privately owned land, from Waiahookalo gulch to Moaula stream and Puniuohua, on eastern Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Molokai—Lowland Wet—Unit 3 is not known to be occupied by *Asplenium dielerectum*, *Bidens wiebkei*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Cyrtandra filipes*, *Lysimachia maxima*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Mesic—Unit 1 (and) *Palmeria dolei*—Unit 42—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 42—Montane Mesic This area consists of 257 ac (104 ha) of State land, and 559 ac (226 ha) of privately owned land from Kamiloloa to Makolelau in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Bidens wiebkei*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Montane Mesic—Unit 1 is not known to be occupied by *Asplenium dielerectum*, *Cyanea dunbariae*, *C. mannii*, *C. procera*, *C. solanacea*, *Cyperus fauriei*, *Kadua laxiflora*, *Melicope mucronulata*, *Neraudia sericea*, *Plantago princeps*, or *Stenogyne bifida*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwiku* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea dunbarii* critical habitat consists of three components. Lowland mesic (Molokai), Lowland wet (Molokai) and Montane mesic (Molokai) (81 FR 17790-18110):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*,

Melanthera, Osteomeles, Pleomele, Psydrax. Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: Acacia, Ilex, Metrosideros, Myrsine, Nestegis, Nothocestrum, Pisonia, Pittosporum, Psychotria, Sophora, Zanthoxylum. Subcanopy: Alyxia, Charpentiera, Coprosma, Dodonaea, Kadua, Labordia, Leptecophylla, Phyllostegia, Vaccinium. Understory: Ferns, Carex, Peperomia.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire,

drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 1998)

Reproduction Narrative

Adult: Cyanea dunbarii was observed in flower, with immature fruit, in September (Hawaii Heritage Program (HHP) 1 993b). (USFWS, 1998)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 600 to 1,220 meters (USFWS, 1998)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1998)

Habitat Narrative

Adult: This species inhabits moist and wet forests on gulch slopes and gulch bottoms in hardwood forests (NatureServe, 2015). Cyanea dunbarii is found in mesic to wet Dicranopteris linearis (uluhe)-Metrosideros polymorpha (ohia) forest on moderate to steep slopes along a stream (HHP 1993a3; USEWS 1996a). Associated species include Perrottetia sandwicensis (olomea), Pipturus albidus (mamaki), Clermontia kakeana (haha), Cheirodendron trigynum (olapa), and Freycinetia arborea (ieie) (USEWS 1996a). This species typically grows on the sides of deep gulches in ohia-dominated mesic to wet forests at elevations of about 600 to 1,220 meters (1,980 to 4,000 feet) (USFWS 1992). (USFWS, 1998)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2014)

Redundancy:

Very low (inferred from USFWS, 2014)

Number of Populations:

2 (USFWS, 2014; USFWS, 2018)

Population Size:

1 wild individuals, 28 outplanted individuals (USFWS, 2018)

Population Narrative:

There are two known populations of *Cyanea dunbariae*, both on the island of Molokai. The population at Mokomoko or Kapuna springs has declined to four individuals (Plant Extinction Prevention Program [PEPP] 2013). (USFWS, 2014); The population of four individuals reported in the last 5-year review had as many as 10 individuals at the time of designation of critical habitat in 2016; however, currently this population has declined to only one individual (PEPP 2017a). (USFWS, 2018)

Threats and Stressors

Stressor: Habitat alteration by pigs and deer (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: Alteration of habitat, especially the side gulch, is occurring due to the activities of feral pigs and axis deer and (USFWS 2008). (NatureServe, 2015)

Stressor: Predation (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: These plants are also threatened by slug and rat predation and bird damage (USFWS 2008). Rats (*Rattus* spp.) are a potential threat since they are in the area and are known to eat stems and fruits of other species of *Cyanea* (Cuddihy and Stone 1990). Axis deer (*Axis axis*) and pigs (*Sus scrofa*) are potential threats to this species, since they occur in areas adjacent to the only known population (USEWS 1996a; Ed Misaki, TNCH. personal communication 1991). Slugs (including *Milax gagates*) are widespread in Hawaii and a serious threat to many native plant taxa. Slugs feed preferentially on plants with fleshy leaves, stems, and fruits, including all taxa in the family Campanulaceae in Hawaii (Loyal Mehrhoff USEWS, in litt. 1995). (USFWS, 1998; NatureServe, 2015)

Stressor: Non-native plants (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: Non-native invasive plants that alter the habitat and compete with *C. dunbariae* include *Buddleia asiatica* (butterfly bush), *Commelina diffusa* (dayflower), *Erigeron karvinskianus* (daisy fleabane), *Hedychium* sp. (ginger), *Kalanchoe pinnata* (airplant), *Musa* sp. (banana), *Ricinus communis* (castor bean), *Psidium cattleianum* (strawberry guava), *Psidium guajava* (common guava), and *Rubus rosifolius* (thimbleberry) (USFWS 2008). (NatureServe, 2015)

Stressor: Small population size (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: Due to extremely small population size, natural disasters such as hurricanes, landslides, and droughts can be devastating (USFWS 2008). (NatureServe, 2015)

Stressor: Climate change (USFWS, 2014; USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Cyanea dunbariae* is highly vulnerable to the impacts of climate change. Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2014); The assessment by Fortini et al. (2013) concluded that *Cyanea dunbariae* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.727 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2018)

Stressor: Landslides and flooding destruction or degradation of habitat (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Landslides have been reported as a threat to *Cyanea dunbariae*. The only known individuals of this species occur in a steep, rocky area along a stream. Landslides, including tree falls and erosion associated with them, can have a significant effect on small populations by destabilizing substrate, altering hydrological patterns, and by damaging and destroying individual plants (PEPP 2014; Stearns 1985). (USFWS, 2018)

Stressor: Lack of adequate hunting regulations (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: The only known wild population of *Cyanea dunbariae* on Moloka'i occurs in a State hunting area in the Moloka'i Forest Reserve (FR). Nonnative feral ungulates pose a major ongoing threat to native species through destruction and modification of habitat, and through direct herbivory or predation. In addition, public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations are at risk (DLNR 2010). Only one reintroduced population is protected within an enclosure. (USFWS, 2018)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Molokai. (USFWS, 1998)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Molokai. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1998)

Recovery Actions:

- Immediate actions necessary for the prevention of extinction of these taxa include controlling or excluding ungulates (where possible); alien plant control; protection from fire; population and plant community monitoring and management; ex situ propagation (such as in a nursery or arboretum); and augmentation of populations, as appropriate. (USFWS, 1998)
- Long-term activities necessary for the perpetuation of these taxa in their natural habitats additionally include baseline and long-term research; public education; maintenance of fenced areas, fire breaks and fuel breaks; long-term monitoring and management of populations and communities; and re-establishment of populations within the historic ranges of some taxa. (USFWS, 1998)
- Further research regarding current range, reproduction and reproductive status, pollinators, life history, limiting factors, habitat requirements, and minimum viable population sizes is needed to facilitate appropriate management decisions regarding the long-term perpetuation of each of these taxa. (USFWS, 1998)
- Surveys and inventories—Survey for additional populations of *Cyanea dunbariae* in areas of potentially suitable habitat. (USFWS, 2018)
- Ungulate monitoring and control—Continue to construct fenced exclosures to protect individuals from the negative impacts of feral ungulates. Protect all occurrences against browsing and habitat disturbances from feral ungulates to prevent extinction. (USFWS, 2018)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. Control invasive nonnative species that compete with the species around all populations. (USFWS, 2018)
- Captive propagation for genetic storage and reintroduction—Continue to conduct research on seed storage techniques to increase seed viability for adequate genetic representation. Continue propagation efforts for maintenance of genetic stock. (USFWS, 2018)
- Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2018)

- Predator and herbivore monitoring and control—Implement effective control methods for rodents at the last known location. Research and implement effective control methods for slugs.(USFWS, 2018)
- Stochastic events—Build resiliency and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides. (USFWS, 2018)
- Climate change adaptation strategy—Assess the modeled effects of climate change on this species, and determine future landscape needed for the recovery of the species. (USFWS, 2018)
- Alliance and partnership development—Continue to work with partners in planning and implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2018)

Conservation Measures and Best Management Practices:

- Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' high vulnerability to climate change. (USFWS, 2014)
- Continue augmenting current natural populations to increase numbers of individuals. (USFWS, 2014)
- Eradicate invasive introduced plants within ungulate exclosures and maintain the exclosures free of invasive introduced plants. (USFWS, 2014)
- Maintain existing exclosures and monitor for potential incursions. (USFWS, 2014)
- Continue monitoring all individuals at both Mokomoko and Kalamaula. (USFWS, 2014)
- Control slugs and rodents within the vicinity of all known *C. dunbariae* populations. (USFWS, 2014)
- Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and flooding. (USFWS, 2014)
- Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. (USFWS, 2014)
- Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2014)

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

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SPECIES ACCOUNT: *Cyanea duvalliorum* (haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (Region 1) (USFWS, 2016b)

Physical Description

Cyanea duvalliorum (haha), a short-lived perennial tree in the bellflower family (Campanulaceae). (USFWS, 2016)

Current Range

Found only in the east Maui mountains (Lammers 2004). (USFWS, 2016a)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea duvalliorum* (Haha) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Cyanea duvalliorum* includes six CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Lowland Wet—Unit 1 (and) *Palmeria dolei*—Unit 2—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 2— Lowland Wet This area consists of 6,616 ac (2,677 ha) of State land, 7,425 ac (3,005 ha) of privately owned land, and 2,038 ac (825 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Kipahulu Valley on the northern and eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia samuelii*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *M. ovalis*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 1 is not known to be occupied by the plants *Clermontia oblongifolia* ssp. *mauiensis*, *C. peleana*, *Mucuna sloanei* var. *persericea*, *Phyllostegia haliakalae*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 1 (and) *Palmeria dolei*—Unit 10—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 10— Montane Wet This area consists of 1,313 ac (531 ha) of State land and 798 ac (323 ha) of privately owned land, at Haiku Uka on the northern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Cyanea duvalliorum*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *Phyllostegia pilosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 1 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 11—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 11— Montane Wet This area consists of 4,075 ac (1,649 ha) of State land, 9,633 ac (3,898 ha) of privately owned land, and 875 ac (354 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Puukaukanu and upper Waihoi Valley, on the northern and northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Geranium hanaense*, *G. multiflorum*, and *Wikstroemia villosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 2 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea glabra*, *C. maritae*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, and *Schiedea jacobii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 3 (and) *Palmeria dolei*—Unit 12—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 12— Montane Wet This area consists of 2,228 ac (902 ha) of federally owned

land (Haleakala National Park) in Kipahulu Valley, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. maritae*, and *Melicope ovalis*, and by the forest bird, *kiwikiu* (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 3 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea duvalliorum*, *C. glabra*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest bird, the *akohekohe* (*Palmeria dolei*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 4 (and) *Palmeria dolei*—Unit 13—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 13— Montane Wet This area consists of 180 ac (73 ha) of State land and 1,653 ac (669 ha) of federally owned land (Haleakala National Park), in Kaapahu Valley on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *Cyrtandra ferripilosa*, and *Huperzia mannii*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 4 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea duvalliorum*, *C. glabra*, *C. mceldowneyi*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 5 (and) *Palmeria dolei*—Unit 14—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 14— Montane Wet This area consists of 222 ac (90 ha) of State land, and 165 ac (67 ha) of federally owned land (Haleakala National Park), near Kaumakani on the eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological

features in the montane wet ecosystem (see Table 5). These units area occupied by the plant *Bidens campylotheca* ssp. *pentamera*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 5 is not currently occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea duvalliorum* critical habitat consists of two components. Lowland wet (east Maui) and Montane wet (east Maui) (81 FR 17790-18110):

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m).. Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The

125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant

species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Habitat Narrative

Adult: Lowland wet and montane wet ecosystems in the East Maui mountains (USFWS 2012).
(NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

2 (NatureServe, 2015)

Population Size:

71 wild, 135 outplanted (NatureServe, 2015)

Population Narrative:

Currently there are 2 occurrences with an approximate total of 71 individuals in the montane wet ecosystem near Makawao FR, with an additional 135 individuals outplanted in Waikamoi Preserve (TNC 2007; NTBG 2009d, p. 2; Oppenheimer 2010a, in litt.). (USFWS, 2016a)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs), nonnative plants, flooding, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Flooding destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, rats, and slugs) is considered an ongoing threat to *Cyanea duvalliorum* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

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SPECIES ACCOUNT: *Cyanea eleeleensis* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Cyanea eleeleensis is a shrub in the bell flower family (Campanulaceae), 1.8 meters (6.0 feet) tall with glabrous (hairless) stems. Leaves are oblanceolate (longer than wide, with widest point above the middle), 38.5 to 40.5 centimeters (cm) (15 to 16 inches (in)) long and 11.5 cm (4.5 in) wide, with the upper surface green and the lower surface pale green. The inflorescence is 11- to 20-flowered and densely short-pubescent. Calyx lobes are triangular, 4 to 5 millimeters (mm) (0.16 to 0.2 inches (in)) long, and 3 mm (0.12 in) wide. The corolla is bilabiate (two-lipped) and tubed, 46 to 47 mm (1.8 to 1.9 in) long, purple with lighter longitudinal stripes, with a ventral (front or inward) lip cut to its middle into three linear lobes. Berries are subglobose (almost spherical), 12 mm (0.5 in) long, 14 mm (0.6 in) in diameter, purple, and crowned by persistent calyx lobes. Seeds are unknown (Lammers 1992). (USFWS, 2017)

Taxonomy

A member of the bellflower family (Campanulaceae) (USFWS, 2010).

Historical Range

This species was discovered in Wainiha Valley on the island of Kauai in 1977, in one population noted as “fewer than 10” individuals (Lammers 1992, p. 129; K. Wood, pers. comm. 2000; HBMP 2007) (USFWS, 2010).

Current Range

Individuals of this species were not observed in extensive surveys conducted in August 2001, June 2002, March 2013, October 2013, April 2014, July 2014, and September 2014, in areas at or adjacent to the original location, and in nearby gulches (Wood 2006, pers. comm.; Wood 2012; Wood 2015). Much of the suitable habitat for this species on Kauai has not been surveyed; however, the latest analysis for this species conducted by IUCN has assessed it as regionally extinct (Bruegmann et al. 2016). (USFWS, 2017)

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea eleeleensis* (Haha) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Cyanea eleeleensis* includes six CHUs in Kauai County, Hawaii. Note: This species may no longer occur naturally in the wild, therefore there is no known occupied critical habitat for this species. The critical habitat units for this species have been

determined to be essential to the conservation of the species because the area provides for the reestablishment of populations within the species' historical range (75 FR 18960-19165).

Kauai—Lowland Wet—Section 1: Lowland Wet—Section 1 consists of 1,164 ac (471 ha) in the lowland wet ecosystem (117 ac (47.4 ha) on State land; 1,047 ac (424 ha) on private land), including wet forest extending from Kulanalilia into Limahuli Valley to Honoonapali, in the Halelea Forest Reserve (Figure 2-A). The section includes 1,099 ac (445 ha) of State and privately owned land within previously designated critical habitat and 65 ac (26 ha) of newly designated critical habitat on private land. The area that falls within designated critical habitat lies within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and newly designated Critical Habitat Unit 20, Map 217c. This section is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Labordia helleri*, and *Phyllostegia renovans*. This section also contains unoccupied habitat that is essential to the conservation of these four species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 1 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Melicope paniculata*, *M. puberula*, *Platydesma rostrata*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 2: Lowland Wet—Section 2 consists of 172 ac (70 ha) in the lowland wet ecosystem, including wet forest extending from Alealau to Pohakea, within the Hono o Na Pali NAR and the Na Pali Coast State Park (Figure 2-A, above). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plant *Melicope puberula*. This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 2 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope paniculata*, *Phyllostegia renovans*, *Platydesma rostrata*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 3: Lowland Wet—Section 3 consists of 756 ac (306 ha) in the lowland wet ecosystem, including wet forest in upper Wainiha Valley, on privately owned land in the Halelea Forest Reserve (Figure 2-B). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by

the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyrtandra oenobarba*, *Melicope puberula*, *Phyllostegia renovans*, and *Stenogyne kealiae*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet–Section 3 is not known to be occupied by the species *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope paniculata*, *Platydesma rostrata*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 4: Lowland Wet–Section 4 consists of 591 ac (239 ha) in the lowland wet ecosystem, including wet forest at the head of Lumahai Valley, on State (10 ac, 4.1 ha) and privately owned (581 ac, 235 ha) land in the Halelea Forest Reserve (Figure 2-B, above). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyrtandra oenobarba*, *Melicope paniculata*, *Phyllostegia renovans*, and *Platydesma rostrata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet–Section 4 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope puberula*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population numbers of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 5: Lowland Wet–Section 5 consists of 1,541 ac (624 ha) in the lowland wet ecosystem, including wet forest extending from the headwaters of the Wailua River at “Blue Hole” south to Iole, on State (442 ac, 179 ha) and privately owned (1,099 ac, 445 ha) land in the Lihue-Koloa Forest Reserve (Figure 2-C). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36a, and is occupied by the plants *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Melicope paniculata*, *Phyllostegia renovans*, and *Platydesma rostrata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet–Section 5 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C.*

kuhihewa, *Labordia helleri*, *Melicope puberula*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 6: Lowland Wet—Section 6 consists of 789 ac (319 ha) in the lowland wet ecosystem, including wet forest extending from Kapalaoa to Kanaele Bog and Lauahihaihai in the Wahiawa Mountains, on State (134 ac, 54 ha) and privately owned (655 ac, 265 ha) land in the Lihue-Koloa Forest Reserve (Figure 2-D). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36a, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Platydesma rostrata*, and *Tetraplasandra bisattenuata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 6 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuuhihewa*, *Labordia helleri*, *Melicope paniculata*, *M. puberula*, *Phyllostegia renovans*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea eleeleensis* critical habitat consists of one component (Lowland wet) (75 FR 18960-19165):

Ecosystem: Lowland Wet. Elevation: <3,000 ft (<914 m). Annual precipitation: >75 in (>190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepidia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in

the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon

which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Wet forest (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Lowland wet ecosystem (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: Occurs ~699 ft. elevation (USFWS, 2010)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: This species is found in wet forests. (NatureServe, 2015) It is reported from the lowland wet ecosystem (Lammers 1992, p. 129; TNCH 2007). It was found growing in a shaded gulch in wet forest, surrounded by steep, precipitous cliffs of Pali Eleele, at an elevation of 699 ft (213 m) (HBMP 2007; Lammers 1992, p. 129) (USFWS, 2010).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Resiliency:

Very low (inferred from NatureServe, 2015)

Redundancy:

Very low (inferred from NatureServe, 2015)

Population Growth Rate:

Unknown (NatureServe, 2015)

Number of Populations:

1 (NatureServe, 2015)

Population Size:

0 (USFWS, 2017)

Population Narrative:

Known from one population totaling less than 10 individuals in 1977. Known only from the type specimen collected in 1977. Unknown if still extant. Survey conducted in 2004 but was not found. (NatureServe, 2015) Collections for genetic storage and ex situ (off site) propagation were not made at the time of the 1977 discovery. Since its discovery in 1977, subsequent surveys for this species have not been conducted in the original (type) location. Although individuals of this species were not observed in surveys conducted in August 2001 and June 2002 in areas adjacent to the original location, much of the suitable habitat (Metrosideros lowland wet forest) for this species on Kauai has not been surveyed. If surveys are conducted, additional individuals are likely to be found (S. Perlman and K. Wood, pers. comm. 2007) (USFWS, 2010).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from non-native plants, pigs, hurricanes, landslides, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Landslides destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities.

Stressor: Predation and herbivory - Ungulate, Rodent, Slug (USFWS, 2010; USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species present an immediate and significant threat to *Cyanea eleleensis* throughout its range due to documented browsing and trampling by pigs, goats, and deer, and documented mechanical damage by rats and nonnative invertebrates (USFWS, 2010).; Herbivory by pigs has been noted as a threat to this species (Wood 2000, in. litt.; DLNR 2005). Herbivory by rats (*Rattus* spp.) has been 11 noted as a threat to

Cyanea eleeleensis (DLNR 2005). Rats eat virtually every part of plants and at every stage: fleshy fruits, seeds, flowers, stems, leaves, shoots, seedlings, and roots (Russell 1980; Cuddihy and Stone 1990). The effects on plants range from reduced vigor and decreased reproduction to mortality of individuals and complete lack of recruitment. Herbivory by slugs has been reported as a threat to many *Cyanea* species (Wood 2000, in. litt.; DLNR 2005; U.S. Army Garrison 2005). (USFWS, 2017)

Stressor: Small populations (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: *Cyanea eleeleensis* has not been confirmed to persist in the wild. This species is not in storage or propagation, but individuals familiar with this species believe it may possibly remain extant and that much of its suitable habitat (lowland mesic, lowland wet, and wet cliff) on Kauai remains to be surveyed (USFWS, 2010).

Stressor: Ungulate degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Feral pigs (*Sus scrofa*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil. Feral pigs are reported in the area where *Cyanea eleeleensis* was last observed (Wood 2000, in. litt.; DLNR 2005; Bruegmann et al. 2016). (USFWS, 2017)

Stressor: Landslides and flooding destruction or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Landslides can have a significant effect on small populations or individuals of *Cyanea eleeleensis*. Landslides and erosion due to natural weathering destabilize substrates, damage and destroy individuals plants, and alter hydrological patterns (Wood 2000, in. litt.; Bruegmann et al. 2016). (USFWS, 2017)

Stressor: Hurricanes—Loss and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not

predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013). (USFWS, 2017)

Stressor: Lack of adequate biosecurity legislation (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Invasion of the State of Hawaii by invasive nonnative plant species, and destruction of habitat and competition by nonnative plants are threats to *Cyanea eleleensis*. Pest species have caused the extinction of native species, the destruction of native forests, and the spread of disease. The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, is authorized to prevent the introduction or dissemination of animal and plant pests on all ships, aircraft, and their cargo and baggage arriving in the U.S. and its territories; however, pest species continue to enter the State. In addition, Federal import regulations do not address many species that could be pests in Hawaii (CGAPS 2009; Ikuma et al. 2002). (USFWS, 2017)

Stressor: Invasive species—Established invasive plant species competition (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Nonnative plant species are a high and imminent threat to *Cyanea eleleensis* though very little is known about the specific nonnative plant threats in its only known location in Wainiha Valley (Wood 2000, in. litt.; DLNR 2005, Bruegmann et al. 2016). Nonnative plants compete for water, light, and nutrients. (USFWS, 2017)

Stressor: Stochastic events—Reduced viability due to low numbers (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Small, isolated populations often exhibit reduced levels of genetic variability, which diminishes the species' capacity to adapt and respond to environmental changes, thereby lessening the probability of long-term persistence (Barrett and Kohn 1991; Newman and Pilson 1997; HBMP 2010). The problems associated with small population size and vulnerability to random demographic fluctuations or natural catastrophes are further magnified by synergistic interactions with other threats, such as anthropogenic impacts like habitat loss from human development or predation by nonnative species. Very small plant populations may experience reduced reproductive vigor due to ineffective pollination or inbreeding depression (Wood 2000, in. litt.; DLNR 2005). (USFWS, 2017)

Recovery

Reclassification Criteria:

5 to 10 populations with 1,000 mature individuals per population (USFWS, 2017)

1,200 mature individuals are needed in one population and all major threats must be controlled around the population designated for recovery at this stage. There should also be demonstrated regeneration of seedlings and growth to at least sapling stage for woody species and documented replacement regeneration within each of the target populations. The population must be adequately represented in an ex situ collection as defined in the Center for Plant Conservation's guidelines (Guerrant et al. 2004). Adequate monitoring must be in place and conducted to assess individual plant survival, population trends, trends of major limiting factors, and response of major limiting factors to management. (USFWS, 2017)

all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years (USFWS, 2017)

Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. (USFWS, 2017)

Delisting Criteria:

In addition to achieving 5 to 10 populations with 1,000 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. (USFWS, 2017)

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys. (USFWS, 2010)
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units. (USFWS, 2010)
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys. (USFWS, 2010)
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range. (USFWS, 2010)
- Conduct research on control methods for introduced slugs and avian malaria. (USFWS, 2010)
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction. (USFWS, 2010)
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security. (USFWS, 2010)

- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems. (USFWS, 2010)
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations. (USFWS, 2010)
- Surveys and inventories—Survey suitable habitat to find new populations. (USFWS, 2017)
- Ungulate monitoring and control—Fence any populations found to protect them from the impacts of feral ungulates. Control feral ungulates within fenced exclosures. (USFWS, 2017)
- Invasive plant monitoring and control—Control invasive plant species around any populations found. (USFWS, 2017)
- Predator and herbivore monitoring and control—Implement effective measures to control rodents around any populations found. (USFWS, 2017)
- Predator and herbivore control research—Develop and implement adequate slug control methods. (USFWS, 2017)
- Captive propagation for genetic storage and reintroduction—Collect material for genetic storage and propagation for reintroduction from any individuals found. (USFWS, 2017)
- Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species if any individuals are found. (USFWS, 2017)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms. (USFWS, 2017)
- Based on the recovery criteria above, consider development of a recovery plan. (USFWS, 2017)

Conservation Measures and Best Management Practices:

- Not available.

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SPECIES ACCOUNT: *Cyanea gibsonii* (= *C. macrostegia* ssp. *g.*) (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/20/1991; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Cyanea macrostegia ssp. *gibsonii*, a member of the bellflower family (Campanulaceae), is a palm-like tree 1 to 7 m (3.3 to 23 ft) tall. The leaves are elliptic or oblong, about 20 to 80 cm (7.9 to 31.5 in) long and 6.5 to 20 cm (2.6 to 7.9 in) wide; the upper surface is usually smooth, while the lower is covered with fine hairs. The leaf stem is often covered with small prickles throughout its length. The inflorescences are horizontal and clustered among the leaves, each bearing 5 to 15 curved flowers that are blackish-purple externally and white or pale lilac within. The fruit is a yellowish-orange berry about 1.5 to 3 cm (0.6 to 1.2 in) long. The following combination of characters separates this taxon from the other members of the genus on Lana'i: calyx lobes oblong, narrowly oblong, or ovate in shape; and the calyx and corolla both more than 0.5 cm (0.2 in) wide (Lammers in Wagner et al. 1990, Rock 1919, Wimmer 1943). (USFWS, 1994)

Taxonomy

Cyanea macrostegia ssp. *gibsonii* was originally described by William Hillebrand as *Cyanea gibsonii* based on his 1870 collection from Lana'i "on the highest wooded ridge" (Lana'ihale) (Hillebrand 1888). Lammers (1988) reclassified *Cyanea gibsonii* to subspecific status within *Cyanea macrostegia* due to similarities between the taxa also noted by other botanists (Rock 1919, Wimmer 1943). (USFWS, 1994); We proposed a taxonomic change for this species in 2012 and accepted the new name *Cyanea gibsonii* in the final critical habitat rule for 135 species on Moloka'i, Lāna'i, Maui, and Kaho'olawe on March 30, 2016 (81 FR 17790). (USFWS, 2018)

Current Range

This species current range is restricted to Lanai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea macrostegia* ssp. *gibsonii* (Haha) under the Endangered Species Act of 1973, as amended (Act) (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Cyanea macrostegia* ssp. *gibsonii* includes an unknown number of CHUs in Maui County, Hawaii. The number of CHUs is unknown because all CHUs reside on Lanai and there is not detailed CHU information for Lanai (81 FR 17790-18110).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea macrostegia* ssp. *gibsonii* critical habitat consists of two components. Montane wet (Lanai) and Wet cliff (Lanai) (81 FR 17790-18110):

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: *Ferns*, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. Understory: *Bryophytes*, *Ferns*, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the

critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: *Cyanea macrostegia* ssp. *gibsonii* was seen flowering in the month of July (Rock 1919); however, details of its flowering period are not known. (USFWS, 1994)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland, shrubland/chaparral (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Wet environment (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 760 and 970 meters (USFWS, 1994)

Environmental Specificity

Adult: Low, with few key requirements (USFWS, 1994)

Habitat Narrative

Adult: *Cyanea macrostegia* ssp. *gibsonii* is found in wet forests and shrublands in gulch bottoms or on gulch sides. The habitat of *Cyanea macrostegia* ssp. *gibsonii* is the Lowland Wet Forest community. It has been observed to grow on flat to moderate or steep slopes, usually on lower gulch slopes or gulch bottoms, often at edges of streambanks, probably due to vulnerability to ungulate damage at more accessible locations. Sites are sunny to shady, mesic to wet with clay or other soil substrate. *C. macrostegia* ssp. *gibsonii* has been reported from elevations of 760-970 meters (2490-3180 feet). Associated vegetation includes native ferns, shrubs, trees in wet *Metrosideros* forest or *Diolooterygium*-*Metrosideros* shrubland (sometimes with *Dicranopteris*), *Perrottetia*, *Scaevola chamissoniana*, *PiDturus*, *Antidesma*, *Freycinetia*, *Psychotria*, *Cyrtandra*, *Dicranopteris*, *Broussaisia*, *Cheirodendron*, *Clermontia*, *Dubautia*, *Hedyotis*, *Ilex*, *Labordia*, *Melicope*, *Pneumatopteris*, and *Sadleria*, and the alien *Rubus rosifolius*. (USFWS, 1994; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2014)

Redundancy:

Very low (inferred from USFWS, 2014)

Number of Populations:

3 (USFWS, 2014; USFWS, 2018))

Population Size:

24 wild (USFWS, 2018)

Population Narrative:

In 2013, there were three populations of *Cyanea macrostegia* subsp. *gibsonii* containing approximately ten mature wild individuals (Plant Extinction Prevention Program [PEPP] 2013). The number of individuals has decreased from the estimated range of 14 to 24 wild individuals reported in the previous 5-year review (USFWS 2008). (USFWS, 2014); In the previous 5-year review for 2014 there were three populations of *Cyanea gibsonii* that totaled only 10 individuals. Since that time, with continuing surveys, some new individuals and a population (two subpopulations) were discovered. There are no remaining individuals of the three observed at Wai'opa in 2006 (PEPP 2016). At Hauola, three of the four individuals were reported to have died (PEPP 2017a). At Lāna'ihale, there are four new individuals, and 10 individuals with four that are likely clones (PEPP 2017a, 2018). Two new small subpopulations have been located at Wai'alalā-Pu'uali'i that total approximately eight individuals (Oppenheimer 2018, in litt.; PEPP 2016). In summary, there are three populations totaling as many as 23 individuals. (USFWS, 2018)

Threats and Stressors

Stressor: Climate change (USFWS, 2014; USFWS, 2018))

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Cyanea gibsonii* is highly vulnerable to the impacts of climate change. Furthermore, *C. gibsonii* was identified as a "wink-out" species, defined as a species that is projected to lose more than 99 percent of its current climate envelope (areas that contain the full range of climate conditions under which the species is known to occur) by 2100. Therefore, additional management actions are urgently needed to conserve this taxon into the future. (USFWS, 2014); The assessment by Fortini et al. (2013) concluded that *Cyanea gibsonii* is extremely vulnerable to the impacts of climate change, with a vulnerability score of 0.914 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this assessment classified *C. gibsonii* as a "wink-out" species. "Wink-out" species are those species with no future climate envelope. No projected suitable climate areas exist for the species to persist in the future. Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2018)

Stressor: Drought and reduced viability (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Drought mortality and reduced viability – In 2010, drought was reported as a threat to *C. gibsonii* (PEPP 2011, 2012). (USFWS, 2014)

Stressor: Browsing and habitat disturbance by deer (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Browsing and habitat disturbance by axis deer. Deer have not yet fully invaded the current habitat of this taxon, though they have directly (through browsing and trampling) and indirectly (through opening up avenues for invasion of alien plants by their trampling) contributed to the taxon's decline. Browsing and habitat disturbance by axis deer promise to eliminate *Cyanea macrostegia* ssp. *gibsonii* if drastic management efforts are not undertaken. (USFWS, 1994)

Stressor: Alien plant species (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Encroaching alien plant species. Kahili ginger (*Hedychium gardnerianum*) was observed overgrowing the only plant found at one of the Kaiholena sites in 1989 CR. Hobdy, personal communication 1992). Even small pockets of virtually undisturbed forest in the heads of gulches on the upper slopes of Lana' ihale are being invaded by *Psidium cattleianum*, *Myrica fava*, *Leptospermum scoparium*, *Pluchea symphytifolia*, *Melinis minutiflora*, *Rubus rosifolius*, *Paspalum conjugatum*, and other alien species. These alien species have become pervasive on adjacent ridges since the forest floor is bombarded by alien propagules, and natural openings, or openings created by habitat disturbance by axis deer, provide ample sites for these aliens to obtain a foothold. Continuing disturbance by axis deer exacerbates the alien plant invasion problem. (USFWS, 1994)

Stressor: Small population size (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: The very small number of extant individuals. With at most only 75-80 individuals in many small populations, the limited local gene pools may depress reproductive vigor. (USFWS, 1994)

Stressor: Loss of pollinators (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: The probable loss of appropriate pollinators. Since native birds may have been the pollinators of *Cyanea macrostegia* ssp. *gibsonii*, their decline is very likely to pose a major, though undocumented, threat. (USFWS, 1994)

Recovery

Reclassification Criteria:

1. A total of five to seven populations are documented on Lanai and at least one other island where they now occur or occurred historically. (USFWS, 1994)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1994)

3. Each of these populations must persist at this level for at least 5 consecutive years before downlisting is considered. (USFWS, 1994)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Lanai and at least one other island where they now occur or occurred historically. (USFWS, 1994)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum or 300 mature individuals per population for short-lived perennials. (USFWS, 1994)

3. Each population should persist at this level for at least 5 consecutive years before delisting is considered. (USFWS, 1994)

Recovery Actions:

- Protect habitat of current populations and manage threats. (USFWS, 1994)
- Conduct research essential to conservation of the species. (USFWS, 1994)
- Expand current populations. (USFWS, 1994)
- Establish new populations as needed to reach recovery objectives. (USFWS, 1994)
- Validate and revise recovery objectives. (USFWS, 1994)
- Surveys and inventories—Continue to survey for additional populations of *Cyanea gibsonii* in areas of potentially suitable habitat. (USFWS, 2018)
- Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect individuals from the negative impacts of feral ungulates. Protect all occurrences against browsing and habitat disturbances from feral ungulates to prevent imminent extinction. (USFWS, 2018)
- Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species around all populations. Continue to control invasive nonnative species that compete with the species around all populations. (USFWS, 2018)
- Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2018)
- Predator and herbivore monitoring and control—Implement effective control methods for rodents and slugs within the vicinity of all known *Cyanea gibsonii* populations. (USFWS, 2018)
- Population biology viability monitoring and analysis—Continue monitoring wild individuals. (USFWS, 2018)
- Stochastic events—Build resiliency and redundancy—Continue to augment populations by reintroduction into protected habitat. (USFWS, 2018)
- Climate change adaptation strategy—Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. As this species is likely to

“wink out” by 2100, ensure that adequate genetic storage is maintained as viable material. (USFWS, 2018)

- Alliance and partnership development—Continue to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2018)

Conservation Measures and Best Management Practices:

- Survey geographical and historical range for a current assessment of the species’ status. (USFWS, 2014)
- Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species’ vulnerability to climate change. (USFWS, 2014)
- Fence remaining populations to protect them from the impacts of feral ungulates. (USFWS, 2014)
- Eradicate invasive introduced plant species within ungulate exclosures and maintain the exclosures free of invasive introduced plants. (USFWS, 2014)
- Control slugs (unidentified species) and rodents within the vicinity of all known *C. gibsonii* populations. (USFWS, 2014)
- Continue monitoring wild individuals. (USFWS, 2014)
- Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. As a species likely to wink out by 2100, ensure that adequate genetic storage is maintained as viable material. (USFWS, 2014)
- Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2014)

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SPECIES ACCOUNT: *Cyanea glabra* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/03/1999; Pacific Region (R1) (USFWS, 2016)

Physical Description

Branched shrubs, of unknown height. Flowers are white, often tinged pale lilac (NatureServe, 2015).

Taxonomy

A member of the bellflower family (Campanulaceae). In 1981, St. John elevated *C. knudsenii* var. *glabra* to full species status as *C. glabra* (St. John 1981). Lammers, in the most recent treatment of the Hawaiian members of the family, upheld the species name, and included as a synonym *C. holophylla* var. *obovata*, a taxon originally collected on West Maui by William Hillebrand and later formally named by Joseph Rock (Rock 1919). Other synonyms of *Cyanea glabra* include *C. scabra* var. *variabilis*, *Delissea glabra*, *D. holophylla* var. *obovata*, and *D. scabra* var. *variabilis* (Lammers 1999; Rock 1919) (USFWS, 2002).

Historical Range

Historically (prior to 1970), *Cyanea glabra* has been reported from West Maui and on Haleakala, East Maui (USFWS, 2002).

Current Range

On West Maui, *Cyanea glabra* occurs in both forks of Kauaula Valley (USFWS, 2011).

Critical Habitat Designated

Yes; 5/14/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea glabra* (Haha) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 16 detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Cyanea glabra* includes 16 CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Lowland Wet—Unit 2 (and) *Palmeria dolei*—Unit 3—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 3—Lowland Wet (and) *Newcombia cumingi*—Unit 1—Lowland Wet This area consists of 65 ac (26 ha) of State land at Moomoku, on the northwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. Although Maui—Lowland Wet—Unit 2 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C.*

kunthiana, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauensis*, or *Wikstroemia villosa*, by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), or by the Newcomb's tree snail (*Newcombia cumingi*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 3 (and) *Palmeria dolei*—Unit 4—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 4— Lowland Wet This area consists of 1,247 ac (505 ha) of State land at Honanana Gulch on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta*, *Cyanea asplenifolia*, and *Pteris lidgatei*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 3 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielarectum*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Remya mauensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 4 (and) *Palmeria dolei*—Unit 5—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 5— Lowland Wet This area consists of 864 ac (350 ha) of State land at Kahakuloa Valley on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta* and *Cyanea asplenifolia*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 4 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielarectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of

these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 5 (and) *Palmeria dolei*—Unit 6—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 6— Lowland Wet This area consists of 30 ac (12 ha) of State land at Iao Valley on the eastern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 5 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 6 (and) *Palmeria dolei*—Unit 7—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 7— Lowland Wet This area consists of 136 ac (55 ha) of State land at Honokowai and Wahikuli valleys on the western slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 6 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 7 (and) *Palmeria dolei*—Unit 8—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 8— Lowland Wet This area consists of 898 ac (364 ha) of State land at Olowalu Valley, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species

identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Alectryon macrococcus*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 7 is not currently occupied by the plants *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwiku* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 8 (and) *Palmeria dolei*—Unit 9—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 9— Lowland Wet This area consists of 230 ac (93 ha) of State land at upper Ukumehame Gulch, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 8 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwiku* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 1 (and) *Palmeria dolei*—Unit 10—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 10— Montane Wet This area consists of 1,313 ac (531 ha) of State land and 798 ac (323 ha) of privately owned land, at Haiku Uka on the northern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Cyanea duvalliorum*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *Phyllostegia pilosa*, and by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwiku* (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 1 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp.

haleakalaensis, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 11—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 11— Montane Wet This area consists of 4,075 ac (1,649 ha) of State land, 9,633 ac (3,898 ha) of privately owned land, and 875 ac (354 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Puukaukanu and upper Waihoi Valley, on the northern and northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Geranium hanaense*, *G. multiflorum*, and *Wikstroemia villosa*, and by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 2 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea glabra*, *C. maritae*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, and *Schiedea jacobii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 3 (and) *Palmeria dolei*—Unit 12—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 12— Montane Wet This area consists of 2,228 ac (902 ha) of federally owned land (Haleakala National Park) in Kipahulu Valley, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. maritae*, and *Melicope ovalis*, and by the forest bird, *kiwikiu* (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 3 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea duvalliorum*, *C. glabra*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P.*

mannii, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest bird, the akohekohe (*Palmeria dolei*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 4 (and) *Palmeria dolei*—Unit 13—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 13— Montane Wet This area consists of 180 ac (73 ha) of State land and 1,653 ac (669 ha) of federally owned land (Haleakala National Park), in Kaapahu Valley on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *Cyrtandra ferripilosa*, and *Huperzia mannii*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 4 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea duvalliorum*, *C. glabra*, *C. mceldowneyi*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 5 (and) *Palmeria dolei*—Unit 14—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 14— Montane Wet This area consists of 222 ac (90 ha) of State land, and 165 ac (67 ha) of federally owned land (Haleakala National Park), near Kaumakani on the eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plant *Bidens campylotheca* ssp. *pentamera*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 5 is not currently occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the

reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 1 (and) *Palmeria dolei*—Unit 18—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 18— Montane Mesic This area consists of 6,593 ac (2,668 ha) of State land, 707 ac (286 ha) of privately owned land, and 3,672 ac (1,486 ha) of federally owned land (Haleakala National Park), from Kealahou to Puualae, nearly circumscribing the summit of Haleakala on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Asplenium dielirectum*, *A. peruvianum* var. *insulare*, *Clermontia lindseyana*, *Cyanea horrida*, *C. obtusa*, *Cyrtandra ferripilosa*, *C. oxybapha*, *Diplazium molokaiense*, *Geranium arboreum*, *G. multiflorum*, *Huperzia mannii*, *Melicope adscendens*, and *Neraudia sericea*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 1 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Cyanea glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. mceldowneyi*, *Phyllostegia bracteata*, *P. mannii*, *Santalum haleakalae* var. *lanaiense*, *Wikstroemia villosa*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 6 (and) *Palmeria dolei*—Unit 35—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 35— Wet Cliff This area consists of 1,858 ac (752 ha) of State land, and 253 ac (102 ha) of privately owned land, at the summit ridges of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plants *Alectryon macrococcus*, *B. conjuncta*, *Ctenitis squamigera*, *Cyrtandra munroi*, *Remya mauiensis*, and *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 6 is not known to be occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Bonamia menziesii*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendrion pyriformum*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, or *Tetramolopium capillare*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 7 (and) *Palmeria dolei*—Unit 36—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 36—Wet Cliff This area consists of 556 ac (225 ha) of State land along Honokowai ridge on the northwestern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units are occupied by the plants *Cyrtandra filipes* and *C. munroi*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 7 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 8 consists of 337 ac (137 ha) of State land along Kahakuloa ridge on the north side of west Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff—Unit 8 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea glabra* critical habitat consists of four components. Lowland wet (west Maui), Montane wet (east Maui), Montane mesic (east Maui) and Wet cliff (west Maui) (81 FR 17790-18110):

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m).. Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*,

Cheirodendron, Metrosideros. Subcanopy: Broussaisia, Cibotium, Eurya, Ilex, Myrsine.
Understory: Ferns, Carex, Coprosma, Leptecophylla, Oreobolus, Rhynchospora, Vaccinium.

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: Acacia, Ilex, Metrosideros, Myrsine, Nestegis, Nothocestrum, Pisonia, Pittosporum, Psychotria, Sophora, Zanthoxylum. Subcanopy: Alyxia, Charpentiera, Coprosma, Dodonaea, Kadua, Labordia, Leptecophylla, Phyllostegia, Vaccinium. Understory: Ferns, Carex, Peperomia.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: Broussaisia, Cheirodendron, Leptecophylla, Metrosideros. Understory: Bryophytes, Ferns, Coprosma, Dubautia, Kadua, Peperomia.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire,

drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Lifespan

Adult: < 10 years (USFWS, 2011)

Breeding Season

Adult: Unknown (USFWS, 2002)

Key Resources Needed for Breeding

Adult: Unknown (USFWS, 2002)

Reproduction Narrative

Adult: *Cyanea glabra* is a short-lived perennial (fewer than ten years) (USFWS, 2011). Flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown (U.S. Fish and Wildlife Service 1999b, 2002b) (USFWS, 2002).

Habitat Type

Adult: Terrestrial (NatureServe, 2015); riparian (USFWS, 2002)

Habitat Vegetation or Surface Water Classification

Adult: Ohia and koa wet forest (USFWS, 2011)

Geographic or Habitat Restraints or Barriers

Adult: 1,360 - 5,150 ft. elevation (USFWS, 2002)

Habitat Narrative

Adult: Inhabits wet forests on gulch slopes (NatureServe, 2015). On West Maui in the Kauaula Valley, the habitat is *Metrosideros polymorpha* (ohia) wet forest. The habitat in which *Cyanea glabra* occurs on East Maui is wet forest with *Metrosideros polymorpha* and *Acacia koa* (koa) forming the canopy with an understory of uluhe mat ferns dissected by riparian vegetation. (USFWS, 2011). *Cyanea glabra* is found on soil and rock stream banks at elevations between 415 and 1,570 meters (1,360 to 5,150 feet) (USFWS, 2002).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Very low (inferred from USFWS, 2011; see current range/distribution)

Number of Populations:

1 (USFWS, 2018)

Population Size:

300 wild, 1 outplanted (USFWS, 2018)

Population Narrative:

In the 2011 5-year review, there were no known populations of *Cyanea glabra* on Maui because of uncertain taxonomic identity of some individuals. Since that time, plants from west Maui previously identified as *C. glabra* were studied closely and were found to represent a new species, which was then described as *C. kauaulaensis* (Oppenheimer and Lorence 2012). Plants on east Maui at Kīpahulu and Kaʻāpahu are now recognized as *C. maritae* (Lammers 2004). In 2007, a new population of *C. glabra* was found on east Maui along West Wailua Iki stream, consisting of “100s” of individuals (Oppenheimer 2018, in litt.). Currently, this population is estimated to total about 300 individuals (Oppenheimer 2018, in litt.). (USFWS, 2018)

Threats and Stressors

Stressor: Nonnative species (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Pigs (*Sus scrofa*) and flooding are threats to *Cyanea glabra* habitat on East Maui (USFWS 2002). Invasive introduced plants which compete with this species and degrade the habitat include *Ageratina adenophora* (sticky snakeroot), *A. riparia* (spreading mist flower), *Buddleia asiatica* (dog tail), *Clidemia hirta* (Koster’s curse), *Coffea arabica* (coffee), *Cordyline fruticosa* (ti), *Erigeron karvinskianus* (daisy fleabane), *Hedychium gardnerianum* (Kahili ginger), *Oplismenus hirtellus* (basketgrass), *Rubus argutus* (blackberry) *R. rosifolius* (thimbleberry), and *Tibouchina herbacea* (glory bush) (Perlman 2009; Wood 2009). On West Maui, invasive introduced plants include *Coffea arabica* (coffee) and *Erigeron karvinskianus* (daisy fleabane). In Waihoi, they include *Hedychium coronarium* (white ginger) and *Miconia calvescens* (miconia) (H. Oppenheimer, pers. comm. 2009) (USFWS, 2011).

Stressor: Predation (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Seed predation by rats (*Rattus rattus*), and eating of leaves and stems by slugs (various species) and two-spotted leafhoppers (*Sophonia rufofascia*) are primary threats to this rare species (Perlman 2009; USFWS 2002) (USFWS, 2011).

Stressor: Climate change (USFWS, 2011; USFWS, 2018))

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaiʻi using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Cyanea glabra* is vulnerable to the impacts of climate change, with a vulnerability score of 0.504 (on a scale of 0 being not

vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2018)

Stressor: Stochastic events (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: In addition to all of the other threats, species like *Cyanea glabra* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding and disease outbreaks. The extent of these natural processes on this single island endemic are exacerbated by anthropogenic threats, such as habitat loss for human development or predation by introduced species (USFWS 2002) (USFWS, 2011).

Recovery

Reclassification Criteria:

1. A total of five to seven populations should be documented on islands where it now occurs or occurred historically (USFWS, 2002).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 2002).
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 2002).

Delisting Criteria:

1. A total of 8 to 10 populations should be documented on islands where it now occurs or occurred historically (USFWS, 2002).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 2002).
3. Each population should persist at this level for a minimum of five consecutive years (USFWS, 2002).

Recovery Actions:

- Protect habitat and control threats (USFWS, 2002).
- Expand existing wild populations (USFWS, 2002).
- Conduct essential research (USFWS, 2002).
- Develop and maintain monitoring plans (USFWS, 2002).
- Reestablish wild populations within the historic range (USFWS, 2002).
- Validate and revise recovery criteria (USFWS, 2002).

- Construct exclosures to protect the single remaining wild population against feral ungulates (USFWS, 2002).
- Maintain adequate genetic stock (USFWS, 2002).
- Control competing alien plant species (USFWS, 2002).
- Enhance wild populations and establish new populations (USFWS, 2002).
- Reduce threats from rodent and slug predation (USFWS, 2002).
- Conduct research into, and implement, control methods for the two-spotted leafhopper (USFWS, 2002).
- Surveys and inventories—Survey for additional populations of *Cyanea glabra* in areas of potentially suitable habitat. (USFWS, 2018)
- Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect individuals from the negative impacts of feral ungulates. Protect all occurrences against browsing and habitat disturbances from feral ungulates to prevent imminent extinction. (USFWS, 2018)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. Control invasive nonnative species that compete with the species around all populations. (USFWS, 2018)
- Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock. (USFWS, 2018)
- Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2018)
- Predator and herbivore monitoring and control—Implement effective control methods for rodents at the last known location. Develop and implement effective control methods for slugs. Develop and implement effective control methods for the two-spotted leaf hopper. (USFWS, 2018)
- Stochastic events—Build resiliency and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and flooding. (USFWS, 2018)
- Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for recovery of the species. (USFWS, 2018)
- Alliance and partnership development—Continue to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2018)

Conservation Measures and Best Management Practices:

- Survey Waihoi Valley to relocate plants documented in 1970s (USFWS, 2011).
- Determine taxonomic status of all populations that may be *Cyanea glabra* (USFWS, 2011).
- Collect propagules for reintroduction and genetic storage when true *Cyanea glabra* are found (USFWS, 2011).
- Fence wild populations to exclude ungulates in any discovered populations (USFWS, 2011).
- Control rats within any discovered populations (USFWS, 2011).
- Reintroduce populations within protected suitable habitat (USFWS, 2011).
- Develop and implement an effective control method for slugs (USFWS, 2011).
- Develop and implement effective control methods for the two-spotted leaf hopper (USFWS, 2011).
- Control invasive introduced plants competing with any *Cyanea glabra* found (USFWS, 2011).

- Work with Haleakala National Park, East Maui Watershed Partnership, and other land managers to initiate planning and contribute to implementation of ecosystem level restoration and management to benefit this species (USFWS, 2011).
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2011).

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SPECIES ACCOUNT: *Cyanea grimesiana* ssp. *grimesiana* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

A shrub 1 to 3.2 m tall, unbranched or sparingly branched. The leaves are deeply cut, and fern-like. Flowers are purplish or greenish to yellowish white, often suffused or striped with magenta. (NatureServe, 2015)

Taxonomy

A member of the bellflower family (Campanulaceae) (USFWS, 1999). Due to taxonomic changes, the taxon originally listed as endangered in 1996 as *Cyanea grimesiana* subsp. *grimesiana* currently includes (1) *Cyanea grimesiana* subsp. *grimesiana*, (2) *Cyanea munroi*, (3) *Cyanea magnicalyx*, (4) *Cyanea mauensis*, (5) *Cyanea cylindrocalyx*, and (6) *Cyanea grimesiana* subsp. *obatae* (Lammers 2004) (USFWS, 2011).

Historical Range

Numerous historical occurrences were reported from the Koolau Mountains prior to 1969 (Hawaii Biodiversity and Mapping Program 2009) (USFWS, 2011). Historically, *Cyanea grimesiana* ssp. *grimesiana* was known from at least 40 populations located in the Waianae and Koolau Mountains on Oahu, Wailau Valley and Puu Kahea on Molokai, central and northern Lanai, and scattered locations on Maui (USFWS 1996a; Heidi Bornhorst, formerly with TNCH, and S. Perlman, in litt. 1992) (USFWS, 1999).

Current Range

Known from Oahu and Molokai. The taxon was last observed on Molokai in 1991 (USFWS, 2012; NatureServe, 2015). On Oahu, *Cyanea grimesiana* subsp. *grimesiana* occurs in the Waianae Mountains (USFWS, 2011).

Critical Habitat Designated

Yes; 3/18/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea grimesiana* ssp. *grimesiana* (Haha) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea grimesiana* ssp. *grimesiana* (Haha) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Cyanea grimesiana* ssp. *grimesiana* (77 FR 57648-57862). The critical habitat designation includes 23 critical habitat units, which encompass approximately 33,624 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Cyanea grimesiana* ssp. *grimesiana* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs

necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Cyanea grimesiana* ssp. *grimesiana* includes six CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Molokai—Lowland Wet—Unit 1 (and) *Palmeria dolei*—Unit 38—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 38— Lowland Wet This area consists of 2,195 ac (888 ha) of State land, and 754 ac (305 ha) of privately owned land (partly within The Nature Conservancy's Pelekunu Preserve), from Pelekunu Valley to Wailau Valley, in north-central Molokai. These units are occupied by the plant *Cyrtandra filipes*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Wet—Unit 1 is not known to be occupied by *Asplenium dielerectum*, *Bidens wiebkei*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Lysimachia maxima*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 2 (and) *Palmeria dolei*—Unit 39—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 39— Lowland Wet This area consists of 1,356 ac (549 ha) of State land and 594 ac (241 ha) of privately owned land, from Kahanui to Pelekunu Valley, in north-central Molokai. These units are occupied by the plant *Lysimachia maxima*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Wet—Unit 2 is not known to be occupied by *Asplenium dielerectum*, *Bidens wiebkei*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Cyrtandra filipes*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 3 consists of 94 ac (38 ha) of State land, and 3,125 ac (1,265 ha) of privately owned land, from Waiahookalo gulch to Moaula stream and Puniuhua, on eastern

Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Molokai—Lowland Wet—Unit 3 is not known to be occupied by *Asplenium dielarectum*, *Bidens wiebkei*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Cyrtandra filipes*, *Lysimachia maxima*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Wet Cliff—Unit 1 (and) *Palmeria dolei*—Unit 43—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 43—Wet Cliff This area consists of 1,395 ac (565 ha) of State land, and 212 ac (86 ha) of privately owned land, and encircles the plateau between Pelekunu and Wailau valleys, in north-central Molokai. These units are occupied by the plants *Brighamia rockii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea munroi*, and *Hibiscus arnottianus* ssp. *immaculatus*, and include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Wet Cliff—Unit 1 is not known to be occupied by *Cyanea grimesiana* ssp. *grimesiana*, *Hesperomannia arborescens*, *Phyllostegia hispida*, *Pteris lidgatei*, or *Stenogyne bifida*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Wet Cliff—Unit 2 (and) *Palmeria dolei*—Unit 44—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 44—Wet Cliff This area consists of 462 ac (187 ha) of State land, and 806 ac (326 ha) of privately owned land (partly within The Nature Conservancy's Pelekunu Preserve), along the rim of Pelekunu Valley from Kipapa Ridge to Mapulehu, in central Molokai. These units are occupied by the plants *Clermontia oblongifolia* ssp. *brevipes* and *Phyllostegia hispida*, and include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Wet Cliff—Unit 2 is not known to be occupied by *Brighamia rockii*, *Canavalia molokaiensis*, *Cyanea grimesiana* ssp. *grimesiana*, *C. munroi*, *Hesperomannia arborescens*, *Hibiscus arnottianus* ssp. *immaculatus*, *Pteris lidgatei*, or *Stenogyne bifida*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable

habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Wet Cliff—Unit 3 consists of 1,137 ac (460 ha) of State land, and 225 ac (91 ha) of privately owned land, along the rim of Wailau Valley from Mapulehu to Kahiwa Gulch, in eastern Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Molokai—Wet Cliff—Unit 3 is not known to be occupied by *Brighamia rockii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea grimesiana* ssp. *grimesiana*, *C. munroi*, *Hesperomannia arborescens*, *Hibiscus arnottianus* ssp. *immaculatus*, *Phyllostegia hispida*, *Pteris lidgatei*, or *Stenogyne bifida*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat designation for *Cyanea grimesiana* ssp. *grimesiana* includes 23 critical habitat units, covering two ecosystem types, which encompasses approximately 33,624 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7; Oahu—Lowland Wet—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

Oahu—Lowland Wet—Unit 1 [541 ac (219 ha)]. This area consists of 428 ac (173 ha) of State land and 112 ac (46 ha) of City and County of Honolulu land in the lowland wet ecosystem on the windward side of the Waianae Mountains, and partially within the Mokuleia and Waianae Kai

Forest Reserves. Oahu—Lowland Wet—Unit 2 [20 ac (8 ha)]. This area consists of 19 ac (8 ha) of State land in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puuhapapa. Oahu—Lowland Wet—Unit 3 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puukanehoa. Oahu—Lowland Wet—Unit 4 [27 ac (11 ha)]. This area consists of 27 ac (11 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains on State land at Puukaua. Oahu—Lowland Wet—Unit 5 [74 ac (30 ha)]. This area consists of 74 ac (30 ha) of State land in the lowland wet ecosystem, on the windward side of the Waianae Mountains at Palikea. Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihihi, Wailele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Haula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikēē, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet—Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet—Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu—Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamoa Ridge.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea grimesiana* ssp. *grimesiana* critical habitat consists of two components. Lowland wet (Molokai) and Wet cliff (Molokai) (81 FR 17790-18110):

Ecosystem: Lowland Wet. Elevation: *Cyanea grimesiana*. Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. Understory: *Bryophytes*, *Ferns*, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea grimesiana* ssp. *grimesiana* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Cyanea grimesiana* ssp. *grimesiana* occurs within the Lowland mesic and Lowland wet ecosystems in the Waianae Mountain caldera complex and the Koolau Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (E) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Oahu—Lowland Wet—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (E) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight

plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; MauiWet

Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Cyanea grimesiana* ssp. *grimesiana* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 1999)

Lifespan

Adult: < 10 years (USFWS, 2011)

Breeding Season

Adult: July - August (USFWS, 1999)

Reproduction Narrative

Adult: *Cyanea grimesiana* subsp. *grimesiana* is a short-lived perennial (fewer than 10 years) (USFWS, 2011). Little is known about the life history of this plant. On Molokai, flowering plants have been reported in July and August (USFWS, 1999).

Habitat Type

Adult: Terrestrial (NatureServe, 2015); riparian (USFWS, 1999)

Habitat Vegetation or Surface Water Classification

Adult: Koa-ohia-uluhe lowland mesic forest; koa-ohia mesic forest (USFWS, 2011)

Geographic or Habitat Restraints or Barriers

Adult: 1,150 - 3,100 ft. elevation (USFWS, 1999)

Habitat Narrative

Adult: Inhabits moist forests in gulch bottoms and gulch slopes. (NatureServe, 2015). In the Waianae Mountains of Oahu, the habitat of *Cyanea grimesiana* subsp. *grimesiana* is *Acacia koa* (*koa*) – *Metrosideros polymorpha* (*ohia*) – *Dicranopteris linearis* (*uluhe*) lowland mesic forest (Puu Pane), with associated native species. In the Koolau Mountains of Oahu, the habitat where *Cyanea grimesiana* subsp. *grimesiana* occurs is *Acacia koa* – *Metrosideros polymorpha* mesic forest (USFWS, 2011). *Cyanea grimesiana* ssp. *grimesiana* is typically found in mesic forest often dominated by *ohia* or *ohia* and *koa*, or on rocky or steep slopes of stream banks, at elevations between 350 and 945 meters (1,150 and 3,100 feet) (USFWS, 1999).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Number of Populations:

4 (NatureServe, 2015)

Population Size:

0 wild individuals, <50 outplanted individuals (USFWS, 2018)

Minimum Viable Population Size:

Three populations with a minimum of 50 mature plants each (USFWS, 2011)

Population Narrative:

One population of three individuals and a single seedling was seen in 2000 in Mt. Kaala Natural Area Reserve, Puu Pane, on the north facing slopes of Mt. Kaala, in the Waianae Mountains at 671 meters (2,200 feet) elevation (Perlman 2009a; USFWS 1999). Another population of *Cyanea grimesiana* was reported from North Haleauau Gulch on the Schofield Barracks Military Reservation, last seen in 1992. In the back of Makaha Valley, in 2005, Steve Perlman of the National Tropical Botanical Garden, Ane Bakutis of the Plant Extinction Prevention Program, and Amy Tsuneyoshi of the Honolulu Board of Water Supply saw one individual without flowers or fruits at 689 meters (2,260 feet) elevation (Perlman 2009a). To be considered stable, a minimum of three populations should be documented on islands where they now occur or occurred historically. For the species to be considered stable, each of these populations must be naturally reproducing and increasing in number, with a minimum of 50 mature individuals per population. There are currently no known wild individuals and 3 outplanted individuals (USFWS, 2011). On Oahu there are five to six individuals in four occurrences in the Waianae and Koolau Mountains" (U.S. Army 2006; HBMP 2008 cited by USFWS 2012; NatureServe, 2015).; As

discussed in the previous review in 2011, this subspecies is found in the Ko'olau Mountains of Oahu, and historically on Moloka'i. Those individuals in the Waianae Mountains of Oahu have been determined to be *C. grimesiana* subsp. *obatae*. Currently, on O'ahu, there are no wild individuals of *C. grimesiana* subsp. *grimesiana* remaining at its last known location (PEPP 2013). The occurrence on Moloka'i has not been observed since 2004, and was searched for but not relocated in 2009 (Lammers 2004; PEPP 2009). (USFWS, 2018)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs, goats, and axis deer), nonnative plants, fire, landslides, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Fire can destroy dormant seeds and plants, even in steep and inaccessible areas. Successive fires can remove habitat for native species by altering microclimate conditions favorable to alien plants. Landslides destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, goats, axis deer, rats, and slugs) is considered an ongoing threat to *Cyanea grimesiana grimesiana* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor: Small populations (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: *Cyanea grimesiana grimesiana* faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). *Cyanea grimesiana grimesiana* has not been observed since 1991 on Molokai (USFWS, 2013).

Stressor: Climate change loss or degradation of habitat (USFWS, 2018)

Exposure:**Response:****Consequence:**

Narrative: Climate change may pose a threat to this subspecies. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai'i using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) was conducted at the species level and concluded that *Cyanea grimesiana* is vulnerable to the impacts of climate change, with a vulnerability score of 0.497 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions will be needed to conserve this taxon into the future. (USFWS, 2018)

Stressor: Lack of adequate hunting regulations (USFWS, 2018)

Exposure:**Response:****Consequence:**

Narrative: The last known population of *Cyanea grimesiana* subsp. *grimesiana* on Moloka'i occurred in a state hunting area in the Moloka'i Forest Reserve. The last known population of this subspecies on Oahu occurred on private land between two State hunting areas. Nonnative feral ungulates pose a major ongoing threat to native species through destruction and modification of habitat, and through direct herbivory or predation. The last known populations on O'ahu and Moloka'i were not fenced and feral pigs have been noted as a threat to the species. Public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations are at risk (DLNR 2010). (USFWS, 2018)

Recovery**Reclassification Criteria:**

- 1) A total of five to seven populations should be documented on islands where they now occur or occurred historically (USFWS, 1999).
- 2) Each of these populations must be naturally reproducing, stable or increasing in number, and secure with 300 minimum numbers of mature individuals per population (for short-lived perennials) (USFWS, 1999).
- 3) Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1999).

Delisting Criteria:

- 1) A total of 8 to 10 populations should be documented on islands where they now occur or occurred historically (USFWS, 1999).
- 2) Each of these populations must be naturally reproducing, stable or increasing in number, and secure with 300 minimum numbers of mature individuals per population (for short-lived perennials) (USFWS, 1999).

3) Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1999).

Recovery Actions:

- Protect habitat and control threats (USFWS, 1999).
- Expand existing wild populations (USFWS, 1999).
- Conduct essential research (USFWS, 1999).
- Develop and maintain monitoring plans (USFWS, 1999).
- Reestablish wild populations within the historic range (USFWS, 1999).
- Validate and revise recovery criteria (USFWS, 1999).
- Construct exclosures to protect populations against feral and wild ungulates (USFWS, 1999).
- Control competing alien plant species (USFWS, 1999).
- Maintain adequate genetic stock (USFWS, 1999).
- Enhance wild populations and establish new populations (USFWS, 1999).
- Protect endangered plants from fire (USFWS, 1999).
- Surveys and inventories—Survey for additional populations of *Cyanea grimesiana* subsp. *grimesiana* in historical locations and appropriate remaining habitat for new occurrences. (USFWS, 2018)
- Ungulate monitoring and control—Construct and maintain fenced exclosures to protect reintroduced individuals from the negative impacts of feral ungulates. Protect all occurrences against browsing and habitat disturbances from feral ungulates to prevent imminent extinction. (USFWS, 2018)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. Control invasive nonnative species that compete with the species around all populations. (USFWS, 2018)
- Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. (USFWS, 2018)
- Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this subspecies. (USFWS, 2018)
- Stochastic events—Reduced viability due to low numbers—Continue seed collection, seed storage, propagation, out planting efforts for this subspecies. (USFWS, 2018)
- Predator and herbivore monitoring and control—Implement effective control methods for rodents and slugs at the last known location and at reintroduced populations. (USFWS, 2018)
- Habitat and natural process management and restoration—Strategic planning—Work with Hawai'i Division of Forestry and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this subspecies. (USFWS, 2018)
- Climate change adaptation strategy—Assess the modeled effects of climate change on this subspecies and use to determine future landscape needed for the recovery of the subspecies. (USFWS, 2018)

Conservation Measures and Best Management Practices:

- Monitor known populations and collect any available seed for genetic storage and reintroduction (USFWS, 2011).

- Maintain or build fences around existing populations to protect them from the negative impacts of ungulates (USFWS, 2011).
- Control invasive introduced species around known populations (USFWS, 2011).
- Develop and implement methods to control rats and slugs (USFWS, 2011).
- Propagate to augment the existing populations (USFWS, 2011).
- Establish additional populations within protected suitable habitat (USFWS, 2011).
- Survey historical locations and appropriate remaining habitat for new individuals (USFWS, 2011).
- Work with Hawaii Division of Forestry and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2011).
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2011).

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SPECIES ACCOUNT: *Cyanea grimesiana* ssp. *obatae* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

It is a single-stemmed or sparingly branched shrub 1 to 3.2 m (3.3 to 10.5 ft) tall, with leaves clustered at the stem tips. The wide, deeply lobed, pinnate leaves are 27 to 58 cm (10.6 to 22.8 in) long and 14 to 32-cm (5.5 to 12.6 in) wide. The tubular flowers are purple or green to yellow-white and 5.5 to 8.0-cm (2.2 to 3.1 in) long. The elliptical orange berries are 1.8 to 3.0-cm (0.7 to 1.2 in) long. *Cyanea grimesiana* ssp. *obatae* can be distinguished from the two other subspecies of *C. grimesiana* by its short, narrow calyx lobes that are not fused and do not overlap (Wagner et al 1999; Makua Implementation Team 2003) (USFWS, 2016).

Taxonomy

A member of the Campanulaceae (bellflower family). The genus *Cyanea* is one of the largest Hawaiian plant genera and incorporates a high proportion of rare taxa, including 28 endangered taxa, 1 threatened taxon, 8 candidates for listing, and 17 species of concern (Service 2006a, Hawaii Biodiversity and Mapping Program 2006) (USFWS, 2016).

Historical Range

Distribution *Cyanea grimesiana* ssp. *obatae* is a species endemic to Oahu. Survey data indicate *C. grimesiana* ssp. *obatae* historically was known from an area extending for about 6.5 km (4 mi) in the southern Waianae Mountains (59 FR 32932) (USFWS, 2016).

Current Range

Currently occurs in the Waianae Mountains of Oahu (NatureServe, 2015). Many of the occurrences that have been monitored over the last 15 to 20 years have either died out or have greatly declined in numbers; most of the known occurrences have been recently discovered. One naturally occurring plant was recently discovered at Makaha, which represents a new occurrence for this subspecies. A new, naturally occurring plant was also recently discovered in the Central Kaluaa population unit (USFWS, 2016).

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea grimesiana* ssp. *obatae* (Haha) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Cyanea grimesiana* ssp. *obatae* (77 FR 57648-57862). The critical habitat designation includes 17 critical habitat units, which encompass approximately 8,022 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Cyanea grimesiana* ssp. *obatae* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs

necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Cyanea grimesiana* ssp. *obatae* includes 17 critical habitat units, covering three ecosystem types, which encompass approximately 8,022 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7; Oahu—Lowland Wet—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Oahu—Lowland Wet—Unit 1 [541 ac (219 ha)]. This area consists of 428 ac (173 ha) of State land and 112 ac (46 ha) of City and County of Honolulu land in the lowland wet ecosystem on the windward side of the Waianae Mountains, and partially within the Mokuleia and Waianae Kai Forest Reserves. Oahu—Lowland Wet—Unit 2 [20 ac (8 ha)]. This area consists of 19 ac (8 ha) of State land in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puuhapapa. Oahu—Lowland Wet—Unit 3 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puukanehoa. Oahu—Lowland Wet—Unit 4 [27 ac (11 ha)]. This area consists of 27 ac (11 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains on State land at Puukaua. Oahu—Lowland Wet—Unit 5 [74 ac (30 ha)]. This area consists of 74 ac (30 ha) of State land in the lowland wet ecosystem, on the windward side of the Waianae Mountains at Palikea.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38

ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac(105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea grimesiana* ssp. *obatae* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Cyanea grimesiana* ssp. *obatae* occurs within the lowland wet, Dry cliff and lowland mesic ecosystems in the Waianae Mountain caldera complex :

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (E) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Oahu—Lowland Wet—Units 1, 2, 3, 4, 5. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (E) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Oahu—Dry Cliff—Units 1, 2, 3, 4, 5, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: *Antidesma*, *Chamaesyce*, *Diospyros*, *Dodonaea*. (E) Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Schiedea*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Cyanea grimesiana* ssp. *obatae* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: self-pollination, cross-pollination (USFWS, 2016)

Lifespan

Adult: < 10 years, based on genus (USFWS, 2016)

Breeding Season

Adult: Year round (USFWS, 2016)

Key Resources Needed for Breeding

Adult: Presumably birds (USFWS, 2016)

Reproduction Narrative

Adult: This subspecies may produce flowers and fruits year round, depending on rainfall. The long tubular flowers and orange berries of this taxon suggest pollination and seed dispersal by birds may be common; however, the plants are capable of self-pollination and isolated plants have been found with viable seeds. *Cyanea grimesiana* ssp. *obatae* presumably lives less than 10 years like other *Cyanea* of similar size (Makua Implementation Team 2003) (USFWS, 2016).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Diverse mesic to wet lowland forest (USFWS, 2016)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at 1,325 - 3,528 ft. elevation (USFWS, 2016)

Habitat Narrative

Adult: Inhabits moist forests, in gulch bottoms or lower gulch slopes (NatureServe, 2015). *Cyanea grimesiana* ssp. *obatae* typically grows on steep, moist, shaded slopes in diverse mesic to wet lowland forests at elevations between 404 and 1,075 m (1,325 and 3,528 ft). It often grows on steep, vertical embankments in rock or a mix of rock and soil (USFWS, 2016).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Significant increase since 1994 (USFWS, 2016)

Resiliency:

Very low (inferred from NatureServe, 2015; see current range/distribution)

Representation:

Low (USFWS, 2016)

Redundancy:

Low (inferred from USFWS, 2016)

Number of Populations:

6 (USFWS, 2016)

Population Size:

254 (USFWS, 2016)

Minimum Viable Population Size:

100 mature, reproducing individuals (USFWS, 2016)

Additional Population-level Information:

76% of individuals are from propagated stock (USFWS, 2016)

Population Narrative:

At the time of listing in 1994, there were approximately 18 known individuals in three occurrences (59 FR 32932). Currently, there are 254 total individuals in six population units, located on State and private lands (Table SB 9) (U.S. Army Garrison 2005b; 68 FR 35950). None of the currently known population units of this subspecies contain 100 mature, reproducing individuals (the minimum number required for stabilized population as defined in the Makua Implementation Plan). Demographic data for this species indicate that about 76 percent of all currently existing individuals of *Cyanea grimesiana* ssp. *obatae* are augmentations or reintroductions from greenhouse-propagated stock. Augmentations have been outplanted at five separate locations, including all three stabilization population units; four locations are on land owned by The Nature Conservancy of Hawaii and one location is on State land. This subspecies is easy to propagate and outplant. Plants produce ample viable seed but the genetic base is limited owing to the low number of founder individuals (USFWS, 2016).

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Threats include alien plants and feral ungulates (NatureServe, 2015). Occurrences of *Cyanea grimesiana* ssp. *obatae* are vulnerable to extirpation from habitat degradation by feral ungulates; competition with various non-native plants; wildfire; and military activities (USFWS, 2016).

Stressor: Predation (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Recruitment is limited by rats and slugs, which attack plants of all size classes. Major rat damage has occurred to five mature plants in West Makaleha population unit, and slugs prey on plants of all size/age classes. Slugs likely attack all members of this genus, as suggested by investigations of the related *Cyanea superba* ssp. *superba*. Slug predation killed half of 14 outplants at the North Branch of South Ekahanui population unit, and the remaining plants are in

poor condition most likely due to the stress of predation (U.S. Army Garrison 2005b) (USFWS, 2016).

Stressor: Stochastic events (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Reduced reproductive vigor due to small population size and limited distribution as well as direct destruction of individual plants by rat or slug predation, erosion, landslides, and rockslides is a threat (59 FR 32932; 68 FR 35950; Service 1995a, 1998). This subspecies tends to fluctuate widely in population size and has a recent history of decline; any catastrophic disturbance during a major low point could extirpate one or more population units or result in subspecies extinction in the wild (Makua Implementation Team 2003). The science of conservation biology has documented a general pattern of population collapse for a wide range of plant and animal species (Dennis et al 1991; Schemske et al 1994; Morris et al 1999; Menges 2000). According to this pattern, *C. grimesiana* ssp. *obatae* already is in a phase of “quasi-extinction” with numbers that have declined to the point where demographic stochasticity alone can result in extirpation (USFWS, 2016).

Stressor: Loss of pollinators (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: The long-billed, nectar-feeding native Hawaiian birds that were the presumed pollinators of *C. grimesiana* ssp. *obata* have been almost totally extirpated from the Waianae Mountains. Although this subspecies is capable of self-pollination, the loss of its natural pollinators has likely resulted in decreased genetic variability (Makua Implementation Team 2003) (USFWS, 2016).

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. We anticipate high spatial resolution climate outputs by 2013 (USFWS, 2012).

Recovery

Reclassification Criteria:

1. A total of five to seven populations should be documented on Oahu and at least one other island where they now occur or occurred historically (USFWS, 1998).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1998).

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1998).

Delisting Criteria:

1. A total of 8 to 10 populations should be documented on Oahu and at least one other island where they now occur or occurred historically (USFWS, 1998).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1998).

3. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1998).

Recovery Actions:

- Protect habitat and control threats (USFWS, 1998).
- Expand existing wild populations (USFWS, 1998).
- Conduct essential research (USFWS, 1998).
- Develop and maintain monitoring plans (USFWS, 1998).
- Reestablish wild populations within historic range (USFWS, 1998).
- Validate and revise recovery criteria (USFWS, 1998).
- Construct enclosures to protect populations against feral pigs (USFWS, 1998).
- Control competing alien plant species within enclosures (USFWS, 1998).
- Reduce threat from rats (USFWS, 1998).

Conservation Measures and Best Management Practices:

- The fence at the Palikea (South Palawai) population unit needs to be expanded to increase the area for future outplantings. The Makaha plant is not within the management subunit that will be fenced in 2007; it is scheduled for fencing in 2009. The number of *C. grimesiana* ssp. *obatae* founders represented at reintroduction sites needs to be increased and equalized. Research on slug control in forest settings is needed to find ways to reduce invertebrate threats to *C. grimesiana* ssp. *obatae* and associated native plants (USFWS, 2016).
- The Makua Implementation Team (2003) has developed stabilization protocols for *Cyanea grimesiana* ssp. *obatae*, which are incorporated in the Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). All population units (except Makaha) are protected by fenced enclosures. Reintroductions within the North Branch of South Ekahanui population unit are within the management unit fence, although the naturally occurring site (now extirpated) is not. The Army and the State have been augmenting occurrences in the Pahole to West Makaleha population unit, and The Nature Conservancy of Hawaii has been augmenting occurrences in the Palikea (South Palawai) population unit. Rat control grids (toxicant bait stations and snap traps) are maintained during the *C. grimesiana* ssp. *obatae* fruiting season at all population units except Pahole and Palikea Gulch. This subspecies is located in occurrences over four management units where it will also benefit from population unit and/or ecosystem-level protection: Pahole, West Makaleha, Kaluaa and Waieli, and Palikea (USFWS, 2016).
- The Army recently assisted The Nature Conservancy in an “aggressive” outplanting that involved reintroduction of relatively small plants at the Central Kaluaa population unit (U.S. Army Garrison 2005b). Smaller plants require a shorter growing time in the nursery, are easier to transport, and

can be planted in more locations such as steep slopes where wild plants are known to occur. However, the mortality of these small outplants was greater than that of larger outplants. This aggressive approach of outplanting smaller individuals may be justified for this subspecies because of the large amount of seed available (U.S. Army Garrison 2005b). In addition, this subspecies is represented in several ex situ collections, which in 2005 included 11 cuttings in a nursery (Harold L. Lyon Arboretum), 51 mature fruit in storage or awaiting processing at a nursery (Army Environmental Division, Oahu), 4,465 ungerminated seeds in a nursery (Harold L. Lyon Arboretum), 215,000 seeds in seed storage (Lyon Arboretum Seed Storage Facility), and 642 seedlings in a nursery (Harold L. Lyon Arboretum) (Service 2005b) (USFWS, 2016).

- Captive propagation for genetic storage and reintroduction: Continue to collect seeds from tagged individuals, keeping close track of the maternal source for use in ex situ propagation. Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation (USFWS, 2012).
- Reintroduction / translocation implementation – Continue to reintroduce the species back into its known historical range (USFWS, 2012).
- Ungulate exclosures: Continue to construct fenced exclosures around existing and reintroduced populations to provide protection from feral ungulates. Monitor fenced exclosures for evidence of breaching by feral ungulates (USFWS, 2012).
- Ungulate control – Continue to protect all populations against disturbances from feral ungulates (USFWS, 2012).
- Ecosystem-altering invasive plant species control – Continue to control invasive introduced plant species around all populations (USFWS, 2012).
- Predator / herbivore control – Continue to implement effective control methods for rodents (USFWS, 2012).
- Surveys / inventories – Conduct thorough surveys of appropriate habitat in historical locations to determine the current status of *Cyanea grimesiana* subsp. *obatae* (USFWS, 2012).
- Threats research: Conduct studies to develop and implement control methods for slugs around all known populations. Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2012).
- Fire protection – Develop and implement a fire management plan for all populations of *Cyanea grimesiana* subsp. *obatae* (USFWS, 2012).
- Invertebrate control research – Conduct studies to determine the effects of the twospotted leaf hopper on populations of *Cyanea grimesiana* subsp. *obatae*. If research identifies that control is necessary, develop and implement effective control techniques (USFWS, 2012).
- Population viability monitoring – Study *Cyanea grimesiana* subsp. *obatae* populations with regard to population size and structure, geographical distribution, flowering cycles, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2012).
- Alliance and partnership development – Work with the U.S. Army and other land managers to continue planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2012).

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SPECIES ACCOUNT: *Cyanea hamatiflora* ssp. *carlsonii* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/04/1994; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Cyanea hamatiflora Rock subsp. *carlsonii* (Rock) Lammers is a palm-like tree that grows 9.8-26 ft (3-8 m) tall and has tan sap (Lammers 1990). The leaf blades are 20-31 in (50-80 cm) long and 3-5.5 in (8-14 cm) wide and are without a leaf stalk. Five to 10 flowers are in clusters at the end of a main cluster stalk (peduncle) 0.6-1.2 in (1.5-3 cm) long. Each flower is subtended by a stalk (pedicel) 0.2-0.5 in (0.5-1.2 cm) long. The sepals and the petals are fused at the base into an oboval tube (hypanthium) 0.5-1.2 in (1.2-3 cm) long and 0.2-0.5 in (0.6-1.2 cm) wide. The calyx has five narrowly oblong lobes 1.2-1.8 in (3-4.5 cm) long and 0.2 in (0.5 cm) wide. Magenta petals are fused into a tube 2.3-3.1 in (6-8 cm) long and 0.2-0.4 in (0.6-1.1 cm) wide, which is down-curved. The top of the tube is 1-lipped with five down-curved lobes. Berries are red and oboval, 1.2-1.8 in (3-4.5 cm) long and 0.8-1.0 in (2-2.7 cm) wide. (USFWS, 1996)

Taxonomy

The species is composed of two subspecies: *Cyanea hamatiflora* subsp. *carlsonii* is an endangered taxon endemic to the Big Island; *Cyanea hamatiflora* subsp. *hamatiflora* occurs only on East Maui and is relatively common. *C. h.* subsp. *carlsonii* is distinguished from other taxa in the genus by calyx lobes that are longer and wider (Lammers 1990). (USFWS, 1996)

Historical Range

Cyanea hamatiflora subsp. *carlsonii*, known only from the westside of the Big Island, is a fairly recent discovery by Rock and Carlson (1957). (USFWS, 1996)

Current Range

This species current range is restricted to the Kona region of Hawaii. (NatureServe, 2015)

Critical Habitat Designated

Yes; 7/2/2003.

Legal Description

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Cyanea hamatiflora* ssp. *Carlsonii* on the island of Hawaii (68 FR 39623 - 39722).

Critical Habitat Designation

The critical habitat designation for *Cyanea hamatiflora* ssp. *Carlsonii* includes four units totaling 4,744 acres in Hawaii county, Hawaii. The units are Hawaii 11—*Cyanea hamatiflora* ssp. *carlsonii*—a, Hawaii 14—*Cyanea hamatiflora* ssp. *carlsonii*—b, Hawaii 15—*Cyanea hamatiflora* ssp. *carlsonii*—c, Hawaii 16—*Cyanea hamatiflora* ssp. *carlsonii*—d. Two of the units, “Hawaii 11—*Cyanea hamatiflora* ssp. *carlsonii*—a” and “Hawaii 16—*Cyanea hamatiflora* ssp. *carlsonii*—d” currently are occupied. These two units are each essential to the conservation of *C. hamatiflora* ssp. *carlsonii* because each supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable.

Each of the two currently unoccupied units is essential to the conservation of the species because each supports habitat that is necessary for the establishment of additional populations in order to reach recovery goals. The four critical habitat units are geographically separated in order to avoid destruction of habitat for all populations by one naturally occurring catastrophic event. The designation of these four units provides habitat for a total of eight populations of *C. hamatiflora* ssp. *carlsonii*, each with 300 mature, reproducing individuals.

Hawaii 11—*Cyanea hamatiflora* ssp. *carlsonii*—a [92 ha (227 ac)]: This unit contains no named natural features and lies completely within the Waiaha watershed. The unit, which is completely within the Honuaua Forest Reserve, provides habitat for 1 population of 300 individuals and is currently occupied by about 14 individuals. This unit provides the northernmost critical habitat within the species' historical range.

Hawaii 14—*Cyanea hamatiflora* ssp. *carlsonii*—b [597 ha (1,475 ac)]: This unit contains no named natural features and lies completely within the Kiilae watershed. The unit, which is completely within the Kona Unit of Hakalau Forest NWR, provides habitat for 2 populations of 300 individuals and is currently unoccupied.

Hawaii 15—*Cyanea hamatiflora* ssp. *carlsonii*—c [1,045 ha (2,583 ac)]: This unit contains no named natural features, lies completely within the Kiilae watershed, and contains portions of the South Kona Forest Reserve. The unit provides habitat for 4 populations of 300 individuals and is currently unoccupied.

Hawaii 16—*Cyanea hamatiflora* ssp. *carlsonii*—d [186 ha (459 ac)]: This unit contains no named natural features, it lies completely within the Kiilae watershed, and is completely within Kipahoe NAR. The unit provides habitat for 1 population of 300 individuals is currently occupied by 1 individual. This unit provides the southernmost critical habitat within the species' historical range.

Primary Constituent Elements/Physical or Biological Features

Habitat features that are essential for this species include, but are not limited to, mesic montane forest dominated by *Metrosideros polymorpha* or *Acacia koa*.

Special Management Considerations or Protections

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for this species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species;

monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: This taxon was observed in flower during December 1980 (HHP1991g1) and August 1995 (C. Corn, DOFAW, pers. comm., 1996). Seeds were collected by Hawaii Division of Forestry and Wildlife (DOFAW) in October 1991 and November 1995. (USFWS, 1996)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 4,000 and 5,700 feet (USFWS, 1996)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1996)

Habitat Narrative

Adult: This species is found in wet forests on old volcanic substrates. The habitat of *Cyanea hamatiflora* subsp. *carlsonii* is mesic montane forest dominated by *Metrosideros polymorpha* at elevations between 4,000 to 5,700 ft (1,220 to 1,740 m) (Lammers 1990, HHP 1991g1-g2). Associated native plants include *A'lyoporum sandwicense* A. Gray (naio), *Hedyotis* (pilo), and *Zanthoxylum* (a'e). (USFWS, 1996; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Low (inferred from USFWS, 2015)

Redundancy:

Low (inferred from USFWS, 2015)

Number of Populations:

3 (USFWS, 2015)

Population Size:

4-6 wild, 41 to 2,606 reintroduced (USFWS, 2015)

Population Narrative:

Overall, the numbers of individuals have decreased from the 17 wild individuals reported in the previous 5-year review, to approximately four to six wild individuals in two populations in 2014. There are three reintroduced populations containing approximately 41 to 2,606 individuals. (USFWS, 2015)

Threats and Stressors

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Climate change destruction or degradation of habitat – Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *C. hamatiflora* is minimally vulnerable to the impacts of climate change. (USFWS, 2015)

Stressor: Non-native invasive plants (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The major threats to *Cyanea hamatiflora* ssp. *carlsonii* are competition from invasive introduced plant species, particularly pasture grasses at the Olelomoana population and *Passiflora mollissima* (banana poka) at Honuaula. These invasive species compete with individuals of *C. hamatiflora* ssp. *carlsonii* for nutrients, water and light (USFWS 1996; Plant Extinction Prevention 2007). (USFWS, 2009)

Stressor: Grazing, trampling, and browsing by ungulates (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Grazing and trampling by cattle (*Bos taurus*) continues to be a major threat to the two populations (USFWS 1994). Habitat destruction and damage to the individual plants by feral pigs (*Sus scrofa*) are a concern for the Honuaula population (Plant Extinction Prevention Program 2007). Browsing and trampling of the surrounding habitat by feral goats (*Capra hircus*) is also a potential threat (USFWS 1991, 1996, 2008). (USFWS, 2009)

Stressor: Small population size (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Extinction due to random environmental events and/or reduced reproductive vigor due to the small number of existing populations and individuals are a concern for *Cyanea hamatiflora* ssp. *carlsonii*. The Olelomoana population occurs on private lands and is unfenced (Plant Extinction Prevention 2007). Species like *C. hamatiflora* ssp. *carlsonii* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding and disease outbreaks. When considered on their own, the natural processes associated with being a single island endemic do not affect *C. hamatiflora* ssp. *carlsonii* to such a degree that it is threatened or endangered with extinction in the foreseeable future, but these natural processes can exacerbate the threat from anthropogenic factors, such as habitat loss from or predation by introduced species (USFWS 1996). (USFWS, 2009)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on the Big Island and at least one other island where it now occurs or occurred historically, if it is not endemic to the Big Island. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1996)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1996)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on the Big Island and at least 1 other island where they now occur or occurred historically, if it is not endemic to the Big Island. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 individuals per population for short-lived perennials. (USFWS, 1996)
3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1996)

Recovery Actions:

- Current populations need to be protected from ungulates, and banana poka and other alien species controlled, to the extent possible, within the taxon's habitat. Propagation and outplanting efforts should be encouraged and continued. (USFWS, 1996)

Conservation Measures and Best Management Practices:

- Continue collection of genetic resources for storage, future propagation and reintroducing into protected suitable habitat within historical range. (USFWS, 2009)
- Control introduced invasive plant species around wild and outplanted plants. (USFWS, 2009)
- Construct large-scale fences around all naturally occurring and reintroduced individuals to exclude feral ungulates. (USFWS, 2009)
- Control rats around wild and outplanted individuals. (USFWS, 2009)
- Collect fruit from any reintroduced individuals that set seed to add to the genetic diversity of the ex situ material. (USFWS, 2009)
- Initiate planning and contribute to implementation of ecosystem level restoration and management to benefit this species. (USFWS, 2009)
- Assess the genetic variability within the two extant populations. (USFWS, 2009)
- Study *Cyanea hamatiflora* ssp. *carlsonii* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. (USFWS, 2009)
- Survey geographical and historical range for a current assessment of the species' status. (USFWS, 2015)
- Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. (USFWS, 2015)
- Maintain existing fences and fence remaining populations to protect them from the impacts of feral ungulates. (USFWS, 2015)
- Eradicate invasive introduced plants within ungulate exclosures and maintain exclosures free of invasive plants. (USFWS, 2015)
- Continue monitoring wild and reintroduced individuals. (USFWS, 2015)
- Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2015)

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SPECIES ACCOUNT: *Cyanea hamatiflora* ssp. *hamatiflora* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/03/1999; Pacific Region (R1) (USFWS, 2016)

Physical Description

A perennial palm-like tree 3 - 8 meters tall. Slightly curved, tubed flowers are magenta (NatureServe, 2015).

Taxonomy

A member of the bellflower family. In 1987, St. John (St. John 1987b) merged the two genera *Cyanea* and *Delissea*, formally recognizing only *Delissea*, the genus with priority. This change resulted in the combination *D. hamatiflora*. In 1988, Lammers upheld *Cyanea* as a separate genus and combined *C. carlsonii* with this species, resulting in two subspecies: *C. hamatiflora* ssp. *carlsonii* and the nominative *C. hamatiflora* ssp. *hamatiflora* (Lammers 1988, 1999) (USFWS, 2002).

Historical Range

Historically (prior to 1970), *Cyanea hamatiflora* ssp. *hamatiflora* was known from the windward (northeastern) side of Haleakala, stretching from Puu o Kaka'e to Manawainui on the island of Maui (USFWS, 2002).

Current Range

Currently known from windward slopes of Haleakala, East Maui (NatureServe, 2015).

Critical Habitat Designated

Yes; 5/14/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea hamatiflora* ssp. *hamatiflora* (Haha) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Cyanea hamatiflora* ssp. *hamatiflora* includes six CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Lowland Wet—Unit 1 (and) *Palmeria dolei*—Unit 2—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 2— Lowland Wet This area consists of 6,616 ac (2,677 ha) of State land, 7,425 ac (3,005 ha) of privately owned land, and 2,038 ac (825 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Kipahulu Valley on the northern and eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *waihoi*ensis, *Clermontia samuelii*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakala*ensis, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. maritae*, *C.*

mceldowneyi, *Huperzia mannii*, *Melicope balloui*, and *M. ovalis*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 1 is not known to be occupied by the plants *Clermontia oblongifolia* ssp. *mauiensis*, *C. peleana*, *Mucuna sloanei* var. *persericea*, *Phyllostegia haliakalae*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 11—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 11—Montane Wet This area consists of 4,075 ac (1,649 ha) of State land, 9,633 ac (3,898 ha) of privately owned land, and 875 ac (354 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Puukaukanu and upper Waihoi Valley, on the northern and northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Geranium hanaense*, *G. multiflorum*, and *Wikstroemia villosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 2 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea glabra*, *C. maritae*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, and *Schiedea jacobii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 3 (and) *Palmeria dolei*—Unit 12—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 12—Montane Wet This area consists of 2,228 ac (902 ha) of federally owned land (Haleakala National Park) in Kipahulu Valley, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. maritae*, and *Melicope ovalis*, and by the forest bird, kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 3 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Clermontia oblongifolia* ssp.

mauiensis, *C. samuelii*, *Cyanea duvalliorum*, *C. glabra*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest bird, the akohekohe (*Palmeria dolei*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 4 (and) *Palmeria dolei*—Unit 13—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 13— Montane Wet This area consists of 180 ac (73 ha) of State land and 1,653 ac (669 ha) of federally owned land (Haleakala National Park), in Kaapahu Valley on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *Cyrtandra ferripilosa*, and *Huperzia mannii*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 4 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea duvalliorum*, *C. glabra*, *C. mceldowneyi*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 5 (and) *Palmeria dolei*—Unit 14—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 14— Montane Wet This area consists of 222 ac (90 ha) of State land, and 165 ac (67 ha) of federally owned land (Haleakala National Park), near Kaumakani on the eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units area occupied by the plant *Bidens campylotheca* ssp. *pentamera*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 5 is not currently occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*,

or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 1 (and) *Palmeria dolei*—Unit 18—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 18— Montane Mesic This area consists of 6,593 ac (2,668 ha) of State land, 707 ac (286 ha) of privately owned land, and 3,672 ac (1,486 ha) of federally owned land (Haleakala National Park), from Kealahou to Puualae, nearly circumscribing the summit of Haleakala on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Asplenium dielirectum*, *A. peruvianum* var. *insulare*, *Clermontia lindseyana*, *Cyanea horrida*, *C. obtusa*, *Cyrtandra ferripilosa*, *C. oxybapha*, *Diplazium molokaiense*, *Geranium arboreum*, *G. multiflorum*, *Huperzia mannii*, *Melicope adscendens*, and *Neraudia sericea*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 1 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Cyanea glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. mceldowneyi*, *Phyllostegia bracteata*, *P. mannii*, *Santalum haleakalae* var. *lanaiense*, *Wikstroemia villosa*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea hamatiflora* ssp. *hamatiflora* critical habitat consists of three components. Lowland wet (east Maui), Montane wet (east Maui) and Montane mesic (east Maui) (81 FR 17790-18110):

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: *Acacia*, *Ilex*,

Metrosideros, Myrsine, Nestegis, Nothocestrum, Pisonia, Pittosporum, Psychotria, Sophora, Zanthoxylum. Subcanopy: Alyxia, Charpentiera, Coprosma, Dodonaea, Kadua, Labordia, Leptecophylla, Phyllostegia, Vaccinium. Understory: Ferns, Carex, Peperomia.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special

management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylothea* ssp. *pentamera*, *B. campylothea* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Lifespan**

Adult: < 10 years (USFWS, 2014)

Breeding Season

Adult: Unknown (USFWS, 2002)

Other Reproductive Information

Adult: Unknown (USFWS, 2002)

Reproduction Narrative

Adult: It is a short-lived perennial (fewer than 10 years) (USFWS, 2014). Flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown (U.S. Fish and Wildlife Service 1999b, 2002b) (USFWS, 2002).

Habitat Type

Adult: Terrestrial (USFWS, 2002)

Habitat Vegetation or Surface Water Classification

Adult: Koa and ohia montane wet forest (USFWS, 2002)

Geographic or Habitat Restraints or Barriers

Adult: 2,510 - 5,100 ft. elevation (USFWS, 2002)

Habitat Narrative

Adult: Typical habitat for this taxon is montane wet forest dominated by *Metrosideros polymorpha* (ohia), with a *Cibotium* spp. (hapuu) and/or native shrub understory or closed *Acacia koa* (koa)-*Metrosideros polymorpha* wet forest at elevations between 765 and 1,555 meters (2,510 to 5,100 feet) (U.S. Fish and Wildlife Service 1999b, 2002b; Hawaii Natural Heritage Program Database 2001; R. Hobdy et al., personal communication 2001) (USFWS, 2002).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Slightly increasing (USFWS, 2014)

Resiliency:

Very low (inferred from NatureServe, 2015; see current range/distribution)

Number of Populations:

8 populations (USFWS, 2018)

Population Size:

<400 wild individuals, 50 outplanted individuals (USFWS, 2018)

Population Narrative:

There are currently between 458 and 558 individuals in the wild, including both mature and immature individuals (Maui Nui Task Force 2010; USFWS 2012). The number of individuals has slightly increased from an estimated range of 382 to 482 individuals reported in the previous 5-year review (USFWS, 2014).; In the last 5-year review for *Cyanea hamatiflora* subsp. *hamatiflora*

in 2014, there were between 458 and 558 individuals at three general locations (Kīpahulu, Koʻolau Forest Reserve (FR), and lower Hanawī on east Maui. Currently, populations remain on private lands near and inside the Koʻolau Forest Reserve (west of upper Waiokamilo stream, West Wailua Nui stream, West Wailua Iki stream) as well as in Hanawī Natural Area Reserve (NAR), and in Haleakalā National Park (NP). There are an estimated 300 individuals in the Park (Robertson 2016, in litt.). New populations have been discovered in and near the Koʻolau FR at Waikamoi stream (1 individual), Honomanū stream (3 individuals), upper and lower Haipuaʻena stream (4 to 10 individuals), the cliff area of upper Keʻanae (2 individuals); and at three locations in Kīpahulu Valley in Haleakalā NP (39 to 42 individuals) (Oppenheimer 2018, in litt.). In summary, these populations total fewer than 400 individuals on windward east Maui. (USFWS, 2018)

Threats and Stressors

Stressor: Climate change (USFWS, 2014; USFWS, 2018))

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Cyanea hamatiflora* ssp. *hamatiflora* is moderately vulnerable to the impacts of climate change (USFWS, 2014).; Climate change may pose a threat to this subspecies. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaiʻi using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Cyanea hamatiflora* is vulnerable to the impacts of climate change, with a vulnerability score of 0.378 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Additional management actions may be needed to conserve this taxon into the future. (USFWS, 2018)

Stressor: Nonnative species (USFWS, 2002)

Exposure:

Response:

Consequence:

Narrative: This species is threatened by habitat degradation and/or destruction by feral pigs and competition with the alien plants *Miconia calvescens* (velvet tree), *Clidemia hirta* (Koster's curse), and *Ageratina adenophora* (Maui pamakani) (USFWS, 2002).

Stressor: Predation (USFWS, 2002)

Exposure:

Response:

Consequence:

Narrative: Rats and slugs (USFWS, 2002).

Stressor: Invasive species—Established invasive plant species competition (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: When a Hawaiian koa moth (*Scotorythra paludicola*) infested Haleakalā NP lands, it caused vast defoliations of the native tree and major forest component, *Acacia koa*, its host plant. In turn, a nonnative invasive plant, *Clidemia hirta* (Koster's curse), already present in the Park, quickly occupied newly opened areas when the koa canopy was removed. This nonnative plant formed a dense understory where more than half of the known *Cyanea hamatiflora* subsp. *hamatiflora* occur. Because of this invasion, access to monitor these populations is difficult, and it is unknown what effect the rapid increase in *Clidemia* is having on the native flora, including *C. hamatiflora* subsp. *hamatiflora* (Robertson 2016, in litt.). (USFWS, 2018)

Recovery**Reclassification Criteria:**

1. A total of five to seven populations should be documented on islands where it now occurs or occurred historically (USFWS, 2002).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 2002).
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 2002).

Delisting Criteria:

1. A total of 8 to 10 populations should be documented on islands where it now occurs or occurred historically (USFWS, 2002).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 2002).
3. Each population should persist at this level for a minimum of five consecutive years (USFWS, 2002).

Recovery Actions:

- Protect habitat and control threats (USFWS, 2002).
- Expand existing wild populations (USFWS, 2002).
- Conduct essential research (USFWS, 2002).
- Develop and maintain monitoring plans (USFWS, 2002).
- Reestablish wild populations within the historic range (USFWS, 2002).
- Validate and revise recovery criteria (USFWS, 2002).
- Construct exclosures to protect populations against feral ungulates (USFWS, 2002).
- Maintain adequate genetic stock (USFWS, 2002).
- Control competing alien plant species (USFWS, 2002).
- Enhance wild populations and establish new populations (USFWS, 2002).
- Reduce threats from rodent and slug predation (USFWS, 2002).

- Surveys and inventories—Continue to survey for additional populations of *Cyanea hamatiflora* subsp. *hamatiflora* in areas of potentially suitable habitat. (USFWS, 2018)
- Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect individuals from the negative impacts of feral ungulates. (USFWS, 2018)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. Control invasive nonnative species that compete with the species around all populations. (USFWS, 2018)
- Predator and herbivore monitoring and control—Implement effective control methods for rodents at all known populations. Research and implement effective control methods for slugs. Determine which invertebrate(s) are damaging fruits and research effective control methods. (USFWS, 2018)
- Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock and reintroduction. (USFWS, 2018)
- Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this subspecies. (USFWS, 2018)
- Climate change adaptation strategy—Research the suitability of habitat for reintroducing this subspecies in the future due to the impacts of climate change. (USFWS, 2018)
- Alliance and partnership development—Continue to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2018)

Conservation Measures and Best Management Practices:

- Captive propagation for genetic storage and reintroduction – Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species’ vulnerability to climate change. Continue seed collection for ex situ genetic storage and reintroduction (USFWS, 2014).
- Reintroduction / translocation – Augment populations as genetically appropriate individuals become available in nurseries and as habitat is protected (USFWS, 2014).
- Surveys / inventories – Survey the geographical and historical range for a current assessment of the species’ status (USFWS, 2014).
- Ungulate monitoring and control – Fence remaining populations to protect them from the impacts of feral ungulates (USFWS, 2014).
- Invasive plant monitoring and control – Control invasive introduced plant species within the vicinity of *C. hamatiflora* ssp. *hamatiflora* populations (USFWS, 2014).
- Predator / herbivore monitoring and control – Control rodents and slugs within the vicinity of all known *C. hamatiflora* ssp. *hamatiflora* populations (USFWS, 2014).
- Threats – predator / herbivore control research – Determine what invertebrates are damaging *C. hamatiflora* ssp. *hamatiflora* fruits (USFWS, 2014).
- Climate change adaptation strategy – Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change (USFWS, 2014).
- Alliance and partnership development –Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2014).

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SPECIES ACCOUNT: *Cyanea horrida* (haha nui)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (Region 1) (USFWS, 2017)

Physical Description

A palm-like tree, 1-4 m tall. Leaves are deeply lobed. Flowers are blackish purple or greenish white suffused with purple. (NatureServe, 2015)

Taxonomy

A member of the bellflower family (Campanulaceae) (USFWS, 2016).

Historical Range

This species was known historically from the slopes of Haleakala (Lammers 1999, p. 453; HBMP 2010) (USFWS, 2016).

Current Range

This species current range is restricted to East Maui. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea horrida* (Haha nui) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes ten detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Cyanea horrida* includes ten CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Montane Wet—Unit 1 (and) Palmeria dolei—Unit 10—Montane Wet (and) Pseudonestor xanthophrys—Unit 10— Montane Wet This area consists of 1,313 ac (531 ha) of State land and 798 ac (323 ha) of privately owned land, at Haiku Uka on the northern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Cyanea duvalliorum*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *Phyllostegia pilosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 1 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope ovalis*,

Peperomia subpetiolata, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 11—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 11— Montane Wet This area consists of 4,075 ac (1,649 ha) of State land, 9,633 ac (3,898 ha) of privately owned land, and 875 ac (354 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Puukaukanu and upper Waihoi Valley, on the northern and northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Geranium hanaense*, *G. multiflorum*, and *Wikstroemia villosa*, and by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 2 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea glabra*, *C. maritae*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, and *Schiedea jacobii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 3 (and) *Palmeria dolei*—Unit 12—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 12— Montane Wet This area consists of 2,228 ac (902 ha) of federally owned land (Haleakala National Park) in Kipahulu Valley, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. maritae*, and *Melicope ovalis*, and by the forest bird, *kiwikiu* (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 3 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea duvalliorum*, *C. glabra*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest bird, the *akohekohe* (*Palmeria dolei*), we have determined this area to be essential for the

conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 4 (and) *Palmeria dolei*—Unit 13—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 13— Montane Wet This area consists of 180 ac (73 ha) of State land and 1,653 ac (669 ha) of federally owned land (Haleakala National Park), in Kaapahu Valley on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *Cyrtandra ferripilosa*, and *Huperzia mannii*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 4 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea duvalliorum*, *C. glabra*, *C. mceldowneyi*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 5 (and) *Palmeria dolei*—Unit 14—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 14— Montane Wet This area consists of 222 ac (90 ha) of State land, and 165 ac (67 ha) of federally owned land (Haleakala National Park), near Kaumakani on the eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units area occupied by the plant *Bidens campylotheca* ssp. *pentamera*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 5 is not currently occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small

numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 1 (and) *Palmeria dolei*—Unit 18—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 18— Montane Mesic This area consists of 6,593 ac (2,668 ha) of State land, 707 ac (286 ha) of privately owned land, and 3,672 ac (1,486 ha) of federally owned land (Haleakala National Park), from Kealahou to Puualae, nearly circumscribing the summit of Haleakala on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Asplenium dielirectum*, *A. peruvianum* var. *insulare*, *Clermontia lindseyana*, *Cyanea horrida*, *C. obtusa*, *Cyrtandra ferripilosa*, *C. oxybapha*, *Diplazium molokaiense*, *Geranium arboreum*, *G. multiflorum*, *Huperzia mannii*, *Melicope adscendens*, and *Neraudia sericea*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 1 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Cyanea glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. mcelandneyi*, *Phyllostegia bracteata*, *P. mannii*, *Santalum haleakalae* var. *lanaiense*, *Wikstroemia villosa*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 1 (and) *Palmeria dolei*—Unit 30—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 30— Wet Cliff This area consists of 290 ac (117 ha) of privately owned land along the wall of Keanae Valley on the northern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff— Unit 1 is not currently occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *Cyanea horrida*, *Melicope ovalis*, *Phyllostegia bracteata*, *P. haliakalae*, or *Plantago princeps*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 2 (and) *Palmeria dolei*—Unit 31—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 31— Wet Cliff This area consists of 475 ac (192 ha) of State land, 20 ac (8 ha) of privately owned land, and 912 ac (369 ha) of federally owned land (Haleakala National Park), from Kalapawili Ridge along Kipahulu Valley and north to Puuhoolio, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plants *Bidens campylotheca* ssp.

waihoiensis, *Cyanea copelandii* ssp. *haleakalaensis*, *Melicope ovalis*, *Phyllostegia bracteata*, and *Plantago princeps*. These units also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 2 is not known to be occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Cyanea horrida*, or *Phyllostegia haliakalae*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 3 (and) *Palmeria dolei*—Unit 32—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 32—Wet Cliff This area consists of 5 ac (2 ha) of State land and 433 ac (175 ha) federally owned land (Haleakala National Park) along the south rim of Kipahulu Valley on east Maui. These units include the mixed hermland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff—Unit 3 is not currently occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. horrida*, *Melicope ovalis*, *Phyllostegia bracteata*, *P. haliakalae*, or *Plantago princeps*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 4 (and) *Palmeria dolei*—Unit 33—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 33—Wet Cliff This area consists of 184 ac (75 ha) of State land along the north wall of Waihoi Valley, on the northeastern slopes of east Maui. These units include the mixed hermland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plant *Bidens campylotheca* ssp. *pentamera* and *B. campylotheca* ssp. *waihoiensis*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 4 is not known to be occupied by the plants *Cyanea copelandii* ssp. *haleakalaensis*, *C. horrida*, *Melicope ovalis*, *Phyllostegia bracteata*, *P. haliakalae*, or *Plantago princeps*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea horrida* critical habitat consists of three

components. Montane wet (east Maui), Montane mesic (east Maui) and Wet cliff (east Maui) (81 FR 17790-18110):

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: *Acacia*, *Ilex*, *Metrosideros*, *Myrsine*, *Nestegis*, *Nothocestrum*, *Pisonia*, *Pittosporum*, *Psychotria*, *Sophora*, *Zanthoxylum*. Subcanopy: *Alyxia*, *Charpentiera*, *Coprosma*, *Dodoniaea*, *Kadua*, *Labordia*, *Leptecophylla*, *Phyllostegia*, *Vaccinium*. Understory: Ferns, *Carex*, *Peperomia*.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. Understory: Bryophytes, Ferns, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or

protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Montane mesic, montane wet, and wet cliff ecosystems (see population narrative)

Habitat Narrative

Adult: This species is found in wet forests. (NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from NatureServe, 2015)

Redundancy:

Very low (inferred from NatureServe, 2015)

Number of Populations:

12 (USFWS, 2016)

Population Size:

44 (USFWS, 2016)

Population Narrative:

Currently, *C. horrida* is known from 12 occurrences totaling 44 individuals in the montane mesic, montane wet, and wet cliff ecosystems in Waikamoi Preserve, Hanawai Natural Area Reserve, and Haleakala National Park on east Maui (TNC 2007; PEPP 2009, p. 52; HBMP 2010; Oppenheimer 2010c, in litt.; PEPP 2010, pp. 46–47; TNCH 2010a, p. 1). (USFWS, 2016)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs), nonnative plants, drought, flooding, landslides, trampling, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Drought, flooding, and landslides destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. Human trampling and hiking damaged to plants has been observed. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, rats, and slugs) is considered an ongoing threat to *Cyanea horrida* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor: Small populations (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: *Cyanea horrida* faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). The only known wild occurrences are susceptible to threats from habitat degradation or loss by flooding, landslides, or tree falls, or a combination of these, because of their locations in lowland wet, montane wet, and wet cliff ecosystems (USFWS, 2013).

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

References

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USFWS. 2013. Determination of Endangered Status for 38 Species on Molokai, Lanai, and Maui

Final Rule. 78 Federal Register 102, May 28, 2013. Pages 32014 - 32065.

SPECIES ACCOUNT: *Cyanea humboldtiana* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

Cyanea humboldtiana is a member of the Campanulaceae (bellflower family). It is a short-lived perennial shrub with unbranched woody stems 1 to 2 m (3.2 to 6.6 ft) tall and inversely egg-shaped to broadly elliptic leaves, 18 to 45 cm (7.1 to 17.7 in) long and 7 to 16 cm (3 to 6 in) wide. The leaf edges are hardened and have shallow, ascending rounded teeth. The dark magenta or white flowers are 6 to 7.5 cm (2.4 to 3.0 in) long and form axillary racemes. The fruit is an elliptic shaped pale orange-yellow berry 1.0 to 1.4 cm (0.4 to 0.6 in) long. *C. humboldtiana* is distinguished from other members of this endemic Hawaiian genus by its long and downward bending flowering stalk (Wagner et al. 1999).

Historical Range

Cyanea humboldtiana was known historically from 17 occurrences in the central and southern parts of the Koolau Mountains of Oahu.

Current Range

Currently, between 184 and 334 plants are known from seven occurrences at Kaluanui (1), Konahuanui (25), Maakua (6), Puu Keahiakahoe (100 to 200), Wailupe and Pia (50 to 100), Opaeha Midreach (1), and Poamoho trail (1) (HINHP Database 2001; K. Kawelo, U.S. Army, pers. comm. 2003; J. Lau, HINHP, pers. comm. 2003). They are declining in number and populations are small and widely dispersed with restricted distribution (Service 1998a).

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea humboldtiana* (Haha) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Cyanea humboldtiana* (77 FR 57648-57862). The critical habitat designation includes 14 critical habitat units, which encompass approximately 30,056 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Cyanea humboldtiana* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Cyanea humboldtiana* includes 14 critical habitat units, covering two ecosystem types, which encompass approximately 30,056 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; Oahu—Wet Cliff—Units 6, 7, 8

Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Hauula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikēē, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet—Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet—Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu—Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamoa Ridge.

Oahu—Wet Cliff—Unit 6 [151 ac (61 ha)]. This area consists of 151 ac (61 ha) in the wet cliff ecosystem on State land on the windward side of the Koolau Mountains in Kaipapau Gulch, entirely within the Kaipapau Forest Reserve. Oahu—Wet Cliff—Unit 7 [144 ac (58 ha)]. This area consists of 144 ac (58 ha) in the wet cliff ecosystem in State land on the windward side of the Koolau Mountains in Hauula Gulch, entirely within the Hauula Forest Reserve. Oahu—Wet Cliff—Unit 8 [4,649 ac (1,881 ha)]. This area consists of 1,479 ac (598 ha) of State land, 1,281 ac (519 ha) of City and County of Honolulu land, 5 ac (2 ha) of Federal land, and 1,884 ac (762 ha) of privately owned land, in the wet cliff ecosystem along the summit of the Koolau Mountains,

overlapping portions of Sacred Falls State Park, the Waiahole FR (Waiahole and Iolekaa sections), the Kaneohe and Honolulu Watershed FRs, and the Nuuanu Pali State Wayside.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea humboldtiana* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Cyanea humboldtiana* occurs within the Lowland wet and Wet cliff ecosystems in the Koolau Mountain caldera complex:

Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (E) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Oahu—Wet Cliff—Units 6, 7, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: >65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. (E) Understory: Bryophytes, Ferns, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Cyanea humboldtiana* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: *Cyanea humboldtiana* has been observed in flower from September through January. Little else is known about its flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors (Service 1998a).

Habitat Narrative

Adult: Wet shrublands and forests on ridgcrests and sides of ridges. Usually in the cloud zone (NatureServe, 2015). *Cyanea humboldtiana* is usually found in wet *Metrosideros polymorpha*-*Dicranopteris linearis* lowland forest and shrub between 261 and 959 m (856 and 3,146 ft). Associated native plant species include *Acacia koa*, *Bobea elatior*, *Broussaisia arguta*, *Cibotium chamissoi*, *Dubautia laxa*, *Hedyotis terminalis*, *Ilex anomala*, *Machaerina angustifolia*, *Melicope* sp., *Phyllostegia* sp., *Psychotria mariniana*, *Sadleria* sp., *Scaevola mollis*, *Syzygium sandwicensis*, *Wikstroemia* sp., and ferns (HINHP Database 2001).

Dispersal/Migration***Population Information and Trends*****Resiliency:**

Unknown. (NatureServe, 2015)

Representation:

Unknown. (NatureServe, 2015)

Redundancy:

Unknown. (NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Adaptability:

Unknown. (NatureServe, 2015)

Population Narrative:

Unknown. Between 100 and 220 plants are known. Estimate less than 300 plants. 3 current (between 1982 and 1997) and 14 historical occurrences. (NatureServe, 2015)

Threats and Stressors**Stressor:****Exposure:****Response:****Consequence:**

Narrative: The major threats to *Cyanea humboldtiana* are habitat degradation and destruction by feral pigs, predation by rats, competition with the non-native plant species, and a risk of extinction from naturally occurring stochastic events and/or reduced reproductive vigor due to the small number of remaining occurrences. The non-native plants *Axonopus fissifolius*, *Clidemia hirta*, *Erigeron karvinskianus*, *Psidium cattleianum*, and *Pterolepis glomerata* threaten *C. humboldtiana* by altering its habitat and competing with it for nutrients, light, and space. The types of stochastic events most likely to affect *C. koolauensis* are landslides, hurricanes, or flooding. The Konahuanui summit occurrence is also threatened by trampling by hikers (HINHP Database 2001; Service 1998a; 61 FR 53089).

Recovery***Conservation Measures and Best Management Practices:***

- A State-wide management plan should be developed and implemented for the long-term conservation of all known occurrences of *Cyanea humboldtiana*. This plan should also include

broader landscape actions that are needed for the recovery of this plant throughout its range. The recovery plan for this species identifies the following important conservation actions. Exclosures should be constructed around the known occurrences to reduce impacts from feral pigs. Subsequent control or removal of pigs from these areas will alleviate their impact on native ecosystems. Specific efforts should be made to control non-native plants and protect occurrences, with priority given to occurrences that have only a few remaining individuals. Occurrences of this species on Oahu may be seriously threatened by rat predation. A rat control plan should be developed and implemented which will include the use of the currently-approved rodenticide bait blocks and ultimately a more broad-scale method such as aerial dispersal of rodenticide (Service 1998a). Ongoing Conservation Actions: No specific conservation measures have been undertaken for *Cyanea humboldtiana* statewide. There are no representatives of this species ex situ. However, this species may benefit from habitat level management for other KLOA species (U.S. Army 2003a).

References

USFWS 2016. Status of the Species and Critical Habitat: *Cyanea humboldtiana* (Haha). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016.

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

U.S. Fish and Wildlife Service. 2012. Endangered and Threatened Wildlife and Plants

Endangered Status for 23 Species on Oahu and Designation of Critical Habitat for 124 Species. Final Rule. 77 FR 57648-57862 (September 18, 2012)

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.”

SPECIES ACCOUNT: *Cyanea kauaulaensis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2016)

Physical Description

This species is 6.5 to 13 ft. (2 to 4 m) tall, and is distinguished from other *Cyanea* species by its many-branched habit, with branches often rooting when coming in contact with the soil. Leaves are glabrous and narrow (2 to 3 in (5 to 7 cm) wide), clustered near the end of the branches, flowers are white and tubular, and fruit are bright orange (Oppenheimer and Lorence 2012, pp. 15–23) (USFWS, 2015).

Taxonomy

A member of the bellflower family (Campanulaceae) (USFWS, 2015).

Historical Range

Known only from Kaua`ula and Waikapu valleys on leeward western Maui (NatureServe, 2015).

Current Range

It occurs on leeward west Maui. Currently, *C. kauaulaensis* is known from Kauaula Valley (approximately 50 individuals) and Waikapu Valley (12 individuals) (Oppenheimer and Lorence 2012, pp. 15–16, 20) (USFWS, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available

Habitat Type

Adult: Terrestrial, riparian (USFWS, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Lowland wet *Metrosideros* forest (USFWS, 2015; NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 2,400 - 3,000 ft. elevation (USFWS, 2015)

Habitat Narrative

Adult: It occurs on talus or basalt boulder-strewn slopes along perennial streams at 2,400 to 3,000 ft. (730 to 900 m), in the lowland wet ecosystem (TNCH 2007; HBMP 2010; Oppenheimer and Lorence 2010, pp. 17–18) (USFWS, 2015). The plant community represents a *Metrosideros* lowland wet forest" (Oppenheimer and Lorence 2012; NatureServe, 2015).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Very low (inferred from USFWS, 2015; see current range/distribution)

Redundancy:

Very low (inferred from USFWS, 2014)

Number of Populations:

2 (USFWS, 2014; USFWS, 2015)

Population Size:

62 (USFWS, 2014; USFWS, 2015)

Population Narrative:

Currently, *Cyanea kauaulaensis* is limited to 62 individuals distributed between two occurrences (USFWS, 2014).

Threats and Stressors

Stressor: Small population size/poor recruitment (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: The greatest threats to this species currently are the low numbers of occurrences and individuals, its limited range, poor seedling recruitment, and loss of pollinators and dispersal agents (Oppenheimer and Lorence 2012, p. 20) (USFWS, 2015).

Stressor: Predation (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Rats and slugs are noted as a threat to *Cyanea kauaulaensis* by herbivory and seed predation (Oppenheimer and Lorence 2012, p. 20). Rats are omnivorous and eat almost any type of food (Nelson 2012, in litt.) (USFWS, 2015).

Stressor: Nonnative plants (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Nonnative plants modify and destroy native habitat and outcompete native species, negatively affecting *C. kauaulaensis* and its habitat (Oppenheimer and Lorence 2012, p. 20) (USFWS, 2015).

Stressor: Landslides and flooding (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Because of the terrain, landslides and flooding may impact this species (Oppenheimer and Lorence 2012, pp. 20–21). Landslides can modify and destroy riparian and stream habitat by direct physical damage, and create disturbed areas leading to invasion by nonnative plants, as well as damaging or destroying plants directly (USFWS, 2015).

Recovery**Reclassification Criteria:**

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- PEPP has collected seeds from at least 32 of the adult plants, in addition to implementing propagation of nursery stock at the Lyon Arboretum, National Tropical Botanical Gardens, and Olinda Rare Plant Facility (Oppenheimer and Lorence 2012, p. 21). Restoration outplanting into appropriate habitat and ex situ seed storage is also underway (Oppenheimer and Lorence 2012, p. 21). So far, one-hundred plants have been outplanted near the extant individuals in Kauaula Valley (Oppenheimer and Lorence 2012, p. 21) (USFWS, 2014).
- The Maui Invasive Species Committee (MISC) is working to control the nonnative plant *Cortaderia* (Oppenheimer and Lorence 2012, p. 21) (USFWS, 2014).
- Continue to survey for populations of *Cyanea kauaulaensis* in areas of potentially suitable habitat (USFWS, 2014).
- Expand propagation efforts for maintenance of genetic stock (USFWS, 2014).
- Reintroduce individuals into suitable habitat within historical range that is being managed for additional known threats (e.g., nonnative animals and plants) to this species (USFWS, 2014).

References

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USFWS 2015. Endangered and Threatened Wildlife and Plants

Endangered Status for 49 Species From the Hawaiian Islands

Proposed Rule. 80 Federal Register 189. September 30, 2015. Pages 58819 - 58909.

Proposed Rule. 80 Federal Register 189. September 30, 2015. Pages 58819 - 58909

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USFWS 2014. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form. *Cyanea kauaulaensis*. Region 1 (Pacific Region).

USFWS. 2015. Endangered and Threatened Wildlife and Plants

SPECIES ACCOUNT: *Cyanea kolekoleensis* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Cyanea kolekoleensis is a shrub in the bell flower family (Campanulaceae), 1.5 to 1.9 meters (4.9 to 6.2 feet) tall with a glabrous, unbranched stem and narrowly elliptic leaves. The upper leaf surfaces are green and glabrous while the lower surfaces are greenish white and glabrous with a sparsely pubescent midrib. Flowers are white and purple striped (Lammers 1992). (USFWS, 2017)

Taxonomy

Cyanea kolekoleensis was first collected on Kauai in September 1979 and named *Delissea kolekoleensis* by Harold St. John (1987). In 1992, Lammers reexamined the type specimen and named the species *Cyanea kolekoleensis* (Lammers 1992). This combination has been maintained by Wagner et al. (2012), the most recent treatment of Hawaiian flora. (USFWS, 2017)

Historical Range

First collected in 1979 in Wahiawa Drainage (southern Kauai), the last observation of *Cyanea kolekoleensis* was in 1998 (NTBG 1998). (USFWS, 2017)

Current Range

The current range is restricted to the Wahiawa Mountains in southern Kauai. (USFWS, 2017)

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea kolekoleensis* (Haha) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Cyanea kolekoleensis* includes six CHUs in Kauai County, Hawaii. Note: This species may no longer occur naturally in the wild, therefore there is no known occupied critical habitat for this species. The critical habitat units for this species have been determined to be essential to the conservation of the species because the area provides for the reestablishment of populations within the species' historical range (75 FR 18960-19165).

Kauai—Lowland Wet—Section 1: Lowland Wet—Section 1 consists of 1,164 ac (471 ha) in the lowland wet ecosystem (117 ac (47.4 ha) on State land; 1,047 ac (424 ha) on private land), including wet forest extending from Kulanalilia into Limahuli Valley to Honoanapali, in the Halelea Forest Reserve (Figure 2-A). The section includes 1,099 ac (445 ha) of State and privately owned land within previously designated critical habitat and 65 ac (26 ha) of newly designated

critical habitat on private land. The area that falls within designated critical habitat lies within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and newly designated Critical Habitat Unit 20, Map 217c. This section is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Labordia helleri*, and *Phyllostegia renovans*. This section also contains unoccupied habitat that is essential to the conservation of these four species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet–Section 1 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Melicope paniculata*, *M. puberula*, *Platydesma rostrata*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 2: Lowland Wet–Section 2 consists of 172 ac (70 ha) in the lowland wet ecosystem, including wet forest extending from Alealau to Pohakea, within the Hono o Na Pali NAR and the Na Pali Coast State Park (Figure 2-A, above). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plant *Melicope puberula*. This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet–Section 2 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope paniculata*, *Phyllostegia renovans*, *Platydesma rostrata*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 3: Lowland Wet–Section 3 consists of 756 ac (306 ha) in the lowland wet ecosystem, including wet forest in upper Wainiha Valley, on privately owned land in the Halelea Forest Reserve (Figure 2-B). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyrtandra oenobarba*, *Melicope puberula*, *Phyllostegia renovans*, and *Stenogyne kealiae*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet–Section 3 is not known to be occupied by the species *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Dubautia imbricata* ssp. *imbricata*, *Labordia*

helleri, *Melicope paniculata*, *Platydesma rostrata*, *Tetraplasandra bisattenuata*, and *T. flynii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 4: Lowland Wet—Section 4 consists of 591 ac (239 ha) in the lowland wet ecosystem, including wet forest at the head of Lumahai Valley, on State (10 ac, 4.1 ha) and privately owned (581 ac, 235 ha) land in the Halelea Forest Reserve (Figure 2-B, above). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyrtandra oenobarba*, *Melicope paniculata*, *Phyllostegia renovans*, and *Platydesma rostrata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 4 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope puberula*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population numbers of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 5: Lowland Wet—Section 5 consists of 1,541 ac (624 ha) in the lowland wet ecosystem, including wet forest extending from the headwaters of the Wailua River at “Blue Hole” south to Iole, on State (442 ac, 179 ha) and privately owned (1,099 ac, 445 ha) land in the Lihue-Koloa Forest Reserve (Figure 2-C). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36a, and is occupied by the plants *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Melicope paniculata*, *Phyllostegia renovans*, and *Platydesma rostrata*. This section also contains unoccupied habitat that is essential to the conservation of these five5 species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 5 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Labordia helleri*, *Melicope puberula*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 6: Lowland Wet—Section 6 consists of 789 ac (319 ha) in the lowland wet ecosystem, including wet forest extending from Kapalaoa to Kanaele Bog and Lauahihaihai in the Wahiawa Mountains, on State (134 ac, 54 ha) and privately owned (655 ac, 265 ha) land in the Lihue-Koloa Forest Reserve (Figure 2-D). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36a, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Platydesma rostrata*, and *Tetraplasandra bisattenuata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 6 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Labordia helleri*, *Melicope paniculata*, *M. puberula*, *Phyllostegia renovans*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea kolekoleensis* critical habitat consists of one component (Lowland wet) (75 FR 18960-19165):

Ecosystem: Lowland Wet. Elevation: <3,000 ft (<914 m). Annual precipitation: >75 in (>190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include

habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: This species was observed flowering in September, fruiting when visited in October (1992) and immature fruit were collected for Lyon Arboretum (NTBG 1991, 1998; Lyon Arboretum 2007). (USFWS, 2017)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 2,125 and 2,500 feet (USFWS, 2010)

Habitat Narrative

Adult: This species is found in gulches in wet forests. *Cyanea kolekoleensis* (haha), a shrub in the bellflower family (Campanulaceae), occurs in wet *Metrosideros polymorpha* forest in the lowland wet ecosystem at elevations of 2,125 to 2,500 ft (650 to 765 m) (Lammers 1992, p. 130; HBMP 2007; TNCH 2007). (USFWS, 2010; NatureServe, 2015); *Cyanea kolekoleensis* occurs in *Metrosideros polymorpha* (ohia) forest in the lowland wet ecosystem between 650 to 765 meters (2,125 to 2,500 feet) elevation (Lammers 1992; HBMP 2010; TNCH 2007). In the Wahiawa Mountains, associated native plant species include *Antidesma platyphyllum* (hame), *Athyrium microphyllum* (akolea), *Broussaisia arguta* (kanawao), *Cheirodendron* spp. (olapa), *Cibotium glaucum* (hapuu), *Cyrtandra pickeringii* (haiwale), *Deparia* sp. (NCN), *Dicranopteris linearis* (uluhe), *Diplazium sandwichianum* (hoio), *Diplopterygium pinnatum* (uluhe lau nui), *Dubautia imbricata* (naenae), *Dubautia laxa* (naenae pua melemele), *Elaphoglossum* sp. (moe o Maui), *Embelia pacifica* (kilioe), *Freycinetia arborea* (ie ie), *Hesperomannia lydgatei* (NCN), *Ilex anamola* (kawau), *Kadua affinis* (manono), *Kadua tryblum* (NCN), *Labordia degeneri* (kamakahala), *L. lydgatei* (kamakahala), *Machaerina* sp. (uki), *Melicope* sp. (alani), *Myrsine linearifolia* (kolea), *Perrottetia sandwicensis* (olomea), *Pittosporum glabrum* (hoawa), *Platydesma rostrata* (pilo kea lau lili), *Polyscias* sp. (ohe), *Pritchardia* sp. (loulou), *Psychotria hexandra* (kopiko), *Syngium sandwicensis* (ohia ha), and *Viola helenae* (NCN) (NTBG 1991, 1993, 1995, 1996, 1998; HBMP 2010). (USFWS, 2017)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Number of Populations:

0 (USFWS, 2017)

Population Size:

0 (USFWS, 2017)

Population Narrative:

Only a single plant is known, although more may exist in nearby poorly explored areas. First discovered in 1987 in the Wahiawa drainage, the last known *C. kolekoleensis* was observed in 1992. There is currently 1 historical occurrence. (USFWS, 2010; NatureServe, 2015); First collected in 1979 in Wahiawa Drainage, the last observation of *Cyanea kolekoleensis* was in 1998 (NTBG 1998). However, there are many areas within Wahiawa Drainage, from Mount Kahili to Kapalaoa and the Hanapepe Valley rim area that are within the species' habitat type and have not been surveyed specifically for this species. As a result, species experts are confident that additional individuals could be found in the above unexplored areas (Perlman 2007, in litt.). Additional surveys are identified as necessary to determine if this species is still extant (Kishida and Wood 2015). (USFWS, 2017)

Threats and Stressors

Stressor: Ungulate degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Feral pigs (*Sus scrofa*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil. Feral pigs are reported in the area where *Cyanea kolekoleensis* was last observed (NTBG 1996; HBMP 2010). (USFWS, 2017)

Stressor: Landslides and flooding destruction or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Landslides can have a significant effect on small populations or individuals of *Cyanea kolekoleensis*. Landslides and erosion due to natural weathering destabilize substrates, damage and destroy individual plants, and alter hydrological patterns (HBMP 2010). (USFWS, 2017)

Stressor: Stochastic events—Reduced viability due to low numbers (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Small, isolated populations often exhibit reduced levels of genetic variability, which diminishes the species' capacity to adapt and respond to environmental changes, thereby lessening the probability of long-term persistence (Barrett and Kohn 1991; Newman and Pilson 1997; HBMP 2010). The problems associated with small population size and vulnerability to random demographic fluctuations or natural catastrophes are further magnified by synergistic interactions with other threats, such as anthropogenic impacts like habitat loss from human development or predation by nonnative species. Very small plant populations may experience reduced reproductive vigor due to ineffective pollination or inbreeding depression (DLNR 2005). (USFWS, 2017)

Stressor: Hurricanes—Loss and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013). (USFWS, 2017)

Stressor: Climate change loss or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Cyanea kolekoleensis* is highly vulnerable to the impacts of climate change, giving this species a vulnerability score of 0.812 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, the analysis found that *C. kolekoleensis* has no overlap between current and future climate envelopes, and is unlikely to easily tolerate expected changes in climate within its current climate envelope. This limitation means this species must either endure in suitable microrefugia within its current envelope or move to newly available climate-compatible areas to avoid extinction. Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2017)

Stressor: Rodent predation or herbivory (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Herbivory by rats (*Rattus* spp.) has been noted as a threat to plants in the Wahiawa Mountains, including *Cyanea kolekoleensis* (USFWS 1994). Rats eat virtually every part of plants and at every stage: fleshy fruits, seeds, flowers, stems, leaves, shoots, seedlings, and roots (Russell 1980; Cuddihy and Stone 1990). The effects on plants range from reduced vigor and decreased reproduction to mortality of individuals and complete lack of recruitment. (USFWS, 2017)

Stressor: Slug herbivory (USFWS, 2017)

Exposure:

Response:**Consequence:**

Narrative: While not directly observed in this species, slug herbivory is typical for species in this family (USFWS 2010a). (USFWS, 2017)

Stressor: Lack of adequate biosecurity legislation (USFWS, 2017)

Exposure:**Response:****Consequence:**

Narrative: Invasion of the State of Hawaii by invasive nonnative plant species, and destruction of habitat and competition by nonnative plants are threats to *Cyanea kolekoleensis*. The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, is authorized to prevent the introduction or dissemination of animal and plant pests on all ships, aircraft, and their cargo and baggage arriving in the U.S. and its territories; however, pest species continue to enter the State. In addition, Federal import regulations do not address many species that could be pests in Hawaii (CGAPS 2009; Ikuma et al. 2002). (USFWS, 2017)

Stressor: Invasive species—Established invasive plant species competition (USFWS, 2017)

Exposure:**Response:****Consequence:**

Narrative: Nonnative plant species, especially *Psidium cattleianum* (strawberry guava) and *Rubus rosifolius* (thimbleberry), are a high and imminent threat to *Cyanea kolekoleensis* (NTBG 1993, 1996, 1998). Nonnative plants compete for water, light, and nutrients. (USFWS, 2017)

Recovery**Reclassification Criteria:**

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys. (USFWS, 2010)
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units. (USFWS, 2010)
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys. (USFWS, 2010)

- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range. (USFWS, 2010)
- Conduct research on control methods for introduced slugs and avian malaria. (USFWS, 2010)
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction. (USFWS, 2010)
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security. (USFWS, 2010)
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems. (USFWS, 2010)
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations. (USFWS, 2010)

Conservation Measures and Best Management Practices:

- Not available.

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SPECIES ACCOUNT: *Cyanea koolauensis* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

Cyanea koolauensis is a member of the Campanulaceae (bellflower family). It is a short-lived perennial shrub 1 to 1.5 m (3.5 to 5 ft) tall with unbranched woody stems and linear to narrowly elliptic leaves 16 to 37 cm (6.3. to 14.6 in) long and 1.5 to 4.0 cm (0.6 to 1.6 in) wide with a whitish underside. The leaf edges are hardened with shallow, ascending rounded teeth. The magenta flowers are 5 to 9 cm (2.0 to 3.5 in) long and form axillary racemes. The fruit is a yellow, orange or purple globose berry, and the smooth and shiny seeds are brown to black. *C. koolauensis* is distinguished from other species in this endemic Hawaiian genus by the leaf shape and width; the whitish green lower leaf surface; and the lengths of the leaf stalks, calyx lobes, and hypanthium (base of flower) (Wagner et al. 1999).

Historical Range

Cyanea koolauensis was known historically from 27 occurrences scattered throughout the Koolau Mountains on Oahu.

Current Range

Currently, 18 occurrences totaling 101 to 104 individuals are known from the Aiea Ridge trail (2 individuals), Halawa (3), Kalahao (3 to 5), Kalihi-Nuuanu Ridge (1), Lulumahu (6), Manana trail (1), Niu and Wailupe (6), Waialae Nui Ridge (2), Waimalu (2), Kawainui-Kaipapau-Kawailoa (35), upper Helemano (7), lower Helemano- Opaeha (4), Poamoho (4), Kawaiiki-Kawainui (4), Kawailoa trail (10), north Kaukonahua (1), south Kaukonahua (9), and Malaeakahana-Waimea summit (1 to 2) in the Koolau Mountains (HINHP Database 2001). Occurrences of *C. koolauensis* are declining, and the current locations are small and widely dispersed (HINHP Database 2001; Service 1998a; J. Lau, pers. comm. 2003; K. Kawelo, pers. comm. 2003).

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea koolauensis* (Haha) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Cyanea koolauensis* (77 FR 57648-57862). The critical habitat designation includes 11 critical habitat units, which encompass approximately 25,112 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Cyanea koolauensis* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Cyanea koolauensis* includes 11 critical habitat units, covering one ecosystem type, which encompasses approximately 25,112 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16.

Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Haula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikēē, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet—Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet—Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu—Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 ac (246 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamo Ridge.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea koolauensis* critical habitat consists of

the following components according to ecosystem type (77 FR 57648-57862). Note: *Cyanea koolauensis* occurs within the indicated ecosystem in the Koolau Mountain caldera complex:

Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (E) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Ctenitis squamigera* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: *Cyanea koolauensis* has been observed in flower and fruit from May through August. Little else is known about its flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors (Service 1998a).

Habitat Type

Adult: wet forest

Habitat Narrative

Adult: *Cyanea koolauensis* is usually found on slopes, stream banks, and ridge crests in wet *Metrosideros polymorpha*-*Dicranopteris linearis* wet forest at elevations between 163 and 959 m (535 and 3,146 ft). Associated native plant species include *Acacia koa*, *Antidesma platyphyllum*, *Bidens* sp., *Bobea elatior*, *Broussaisia arguta*, *Cibotium* sp., *Diplopterygium pinnatum*, *Dubautia* sp., *Hedyotis* sp., *Machaerina* sp., *Melicope* sp., *Pittosporum* sp., *Pritchardia martii*, *Psychotria mariniana*, *Sadleria* sp., *Scaevola* sp., *Syzygium sandwicensis*, or *Wikstroemia* sp. (HINHP Database 2001; Wagner et al. 1999).

Dispersal/Migration

Population Information and Trends

Threats and Stressors

Stressor:

Exposure:

Response:**Consequence:**

Narrative: The major threats to *Cyanea koolauensis* are habitat degradation and destruction by feral pigs; potential impacts from military activities; trail clearing; potential predation by rats; competition with non-native plant species; trampling from foot traffic; and a risk of extinction from naturally occurring stochastic events and/or reduced reproductive vigor due to the small number of remaining individuals. The non-native plant species *Clidemia hirta*, *Heliocarpus popayanensis*, *Psidium cattleianum*, and *Pterolepis glomerata* threaten *C. koolauensis* by altering its habitat and competing with it for nutrients, light, and space. The types of stochastic events most likely to affect *C. koolauensis* are landslides, hurricanes, or flooding (HINHP Database 2001; Service 1998a; 61 FR 53089).

Recovery**Conservation Measures and Best Management Practices:**

- A State-wide management plan should be developed and implemented for the long-term conservation of all known occurrences of *Cyanea koolauensis*. This plan should also include broader landscape actions that are needed for the recovery of this plant throughout its range. The recovery plan for this species identifies the following important conservation actions. Fences should be constructed around all known occurrences of *C. koolauensis* to reduce impacts from feral pigs and trampling. In areas where fencing is not feasible, control or removal of pigs should be implemented to benefit the native ecosystem that is needed to sustain this plant. Non-native plants should be removed from the vicinity of all known occurrences of *C. koolauensis*. Ex situ propagation should be initiated using seeds from individuals spread across the current range of the species. The threat of rat predation should be assessed and, if it is considered significant, rats should be controlled in the vicinity of all known occurrences of *C. koolauensis* and across the broader landscape using bait boxes and aerial dispersal of rodenticide, when approved (Service 1998a). Priority for these and other conservation actions should be given to occurrences that have only a few remaining individuals. Ongoing Conservation Actions: No specific conservation measures have been undertaken for *Cyanea koolauensis* statewide by other agencies. There are no representatives of this species ex situ (U.S. Army 2003a). The Service is currently not aware of any other conservation efforts for this species.

References

USFWS 2016. Status of the Species and Critical Habitat: *Cyanea koolauensis* (Haha). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016.

U.S. Fish and Wildlife Service. 2012. Endangered and Threatened Wildlife and Plants

Endangered Status for 23 Species on Oahu and Designation of Critical Habitat for 124 Species. Final Rule. 77 FR 57648-57862 (September 18, 2012)

SPECIES ACCOUNT: *Cyanea kuhihewa* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Cyanea kuhihewa is a shrub in the bell flower family (Campanulaceae), 0.4 to 2.3 meters (1.2 to 7.4 feet) tall with unbranched erect stems 0.4 to 0.5 centimeters (cm) (0.2 inches (in)) in diameter. Leaves are glabrous, 31 to 38 cm (12 to 15 in) long, 1.2 to 1.5 cm (0.5 to 0.6 in) wide, and slightly paler below. Inflorescences are ascending (growing obliquely upward), 5- to 8-flowered, with a peduncle (flower stalk) 10 to 16 millimeters (mm) (0.4 to 0.6 in) long and sparsely pubescent (with soft hairs). Calyx lobes are triangular, 1.4 to 1.5 mm (0.06 in) long, and 0.9 to 1.1 mm (0.04 in) wide. The corolla (flower petals) is rose-purple with lobes edged in white, 47 to 53 mm (1.9 to 2.1 in) long, with a curved tube 28 to 33 mm (1.1 to 1.3 in) long and 5.3 mm (0.2 in) at the base. Seeds are ellipsoid, dark brown or black, 0.7 to 0.8 mm (0.03 in) long, and 0.3 to 0.4 mm (0.01 to 0.02 in) wide, smooth, and shiny (Lammers 1996). (USFWS, 2017)

Taxonomy

A member of the bellflower family (Campanulaceae) (USFWS, 2010).; *Cyanea kuhihewa* was first described by Lammers (1996) based on a collection made by Wood et al. in 1991. This species is recognized as a distinct taxon by Wagner and Herbst (2003) and Wagner et al. (2012), the most recently accepted Hawaiian plant taxonomy. (USFWS, 2017)

Historical Range

On May 10, 1991, *Cyanea kuhihewa* was discovered in Limahuli Valley (Wood et al. 2001). At that time there were 12 individuals. (USFWS, 2017)

Current Range

Known only from the type locality in Limahuli Valley on the island of Kauai, state of Hawaii (USFWS, 2017).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea kuhihewa* (Haha) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Cyanea kuhihewa* includes six CHUs in Kauai County, Hawaii. Note: This species may no longer occur naturally in the wild, therefore there is no known occupied critical habitat for this species. The critical habitat units for this species have been determined to be essential to the conservation of the species because the area provides for the reestablishment of populations within the species' historical range (75 FR 18960-19165).

Kauai—Lowland Wet—Section 1: Lowland Wet—Section 1 consists of 1,164 ac (471 ha) in the lowland wet ecosystem (117 ac (47.4 ha) on State land; 1,047 ac (424 ha) on private land), including wet forest extending from Kulanalilia into Limahuli Valley to Honoonapali, in the Halelea Forest Reserve (Figure 2-A). The section includes 1,099 ac (445 ha) of State and privately owned land within previously designated critical habitat and 65 ac (26 ha) of newly designated critical habitat on private land. The area that falls within designated critical habitat lies within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and newly designated Critical Habitat Unit 20, Map 217c. This section is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Labordia helleri*, and *Phyllostegia renovans*. This section also contains unoccupied habitat that is essential to the conservation of these four species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 1 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Melicope paniculata*, *M. puberula*, *Platydesma rostrata*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 2: Lowland Wet—Section 2 consists of 172 ac (70 ha) in the lowland wet ecosystem, including wet forest extending from Alealau to Pohakea, within the Hono o Na Pali NAR and the Na Pali Coast State Park (Figure 2-A, above). The entire section is Stateowned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plant *Melicope puberula*. This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 2 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope paniculata*, *Phyllostegia renovans*, *Platydesma rostrata*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 3: Lowland Wet—Section 3 consists of 756 ac (306 ha) in the lowland wet ecosystem, including wet forest in upper Wainiha Valley, on privately owned land in the Halelea Forest Reserve (Figure 2-B). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyrtandra oenobarba*, *Melicope puberula*, *Phyllostegia renovans*, and *Stenogyne kealiae*. This section also contains unoccupied habitat that

is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet–Section 3 is not known to be occupied by the species *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope paniculata*, *Platydesma rostrata*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 4: Lowland Wet–Section 4 consists of 591 ac (239 ha) in the lowland wet ecosystem, including wet forest at the head of Lumahai Valley, on State (10 ac, 4.1 ha) and privately owned (581 ac, 235 ha) land in the Halelea Forest Reserve (Figure 2-B, above). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyrtandra oenobarba*, *Melicope paniculata*, *Phyllostegia renovans*, and *Platydesma rostrata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet–Section 4 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope puberula*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population numbers of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 5: Lowland Wet–Section 5 consists of 1,541 ac (624 ha) in the lowland wet ecosystem, including wet forest extending from the headwaters of the Wailua River at “Blue Hole” south to Iole, on State (442 ac, 179 ha) and privately owned (1,099 ac, 445 ha) land in the Lihue-Koloa Forest Reserve (Figure 2-C). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36a, and is occupied by the plants *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Melicope paniculata*, *Phyllostegia renovans*, and *Platydesma rostrata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet–Section 5 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Labordia helleri*, *Melicope puberula*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of

these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 6: Lowland Wet—Section 6 consists of 789 ac (319 ha) in the lowland wet ecosystem, including wet forest extending from Kapalaoa to Kanaele Bog and Lauahihaihai in the Wahiawa Mountains, on State (134 ac, 54 ha) and privately owned (655 ac, 265 ha) land in the Lihue-Koloa Forest Reserve (Figure 2-D). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36a, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Platydesma rostrata*, and *Tetraplasandra bisattenuata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 6 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Labordia helleri*, *Melicope paniculata*, *M. puberula*, *Phyllostegia renovans*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea kuhihewa* critical habitat consists of one component (Lowland wet) (75 FR 18960-19165):

Ecosystem: Lowland Wet. Elevation: <3,000 ft (<914 m). Annual precipitation: >75 in (>190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur

(Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: The type specimen collected by Wood et al. in May 1991 had unopened buds; while specimens collected in June were in full anthesis (the period during which a flower is fully open and functional; Lammers 1996). Seeds of this species were collected in August (Lammers 1996). (USFWS, 2017)

Habitat Type

Adult: Terrestrial and palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Riparian, forest- hardwood, forest/woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: The only known occurrence is located on the bank of a stream in wet forest. (NatureServe, 2015); lowland wet ecosystem (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: Found at an elevation of 1,680 feet (USFWS, 2010)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: *Cyanea kuhihewa* (haha) is reported from *Metrosideros polymorpha*-*Dicranopteris linearis* wet forest at an elevation of 1,680 ft (512 m) in the lowland wet ecosystem (Lammers 1996, pp. 238–240; HBMP 2007; TNCH 2007). The only known occurrence is located on the bank of a stream in wet forest. (USFWS, 2010; NatureServe, 2015); *Cyanea kuhihewa* is typically found in *Metrosideros polymorpha* (ohia)–*Dicranopteris linearis* (uluhe) lowland wet forest at 512 meters (1,680 feet) elevation. Associated native plant species include *Antidesma platyphyllum* (hame), *Athyrium microphyllum* (akolea), *Bidens* spp. (kookoolau), *Bohea* spp. (ahakea), *Boehmeria grandis* (akolea), *Cibotium* spp. (hapuu), *Clermontia* spp. (oha wai), *Cyrtandra* spp. (haiwale), *Diploterigium pinnatum* (uluhe lau nui), *Dubautia knudsenii* (naenae), *Eurya sandwicensis* (anini), *Freycinetia arborea* (ie ie), *Kadua acuminata* (au), *K. tryblidium* (no common name), *Ilex anomala* (kawau), *Isodendron longifolium* (aupaka), *Machaerina* spp. (uki), *Melicope* spp. (alani), *Pisonia* spp. (papala kepau), *Perrottetia sandwicensis* (olomea), *Pipturus* spp. (mamaki), *Polyscias* spp. (ohe), *Psychotria* spp. (kopiko), *Sadleria* spp. (amau), and *Wikstroemia* spp. (akia) (NTBG 1991, 1994; Lammers 1996; HBMP 2010). (USFWS, 2017)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Short-term trends indicate a decline of >70% (NatureServe, 2015)

Resiliency:

None (NatureServe, 2015)

Redundancy:

None (NatureServe, 2015)

Population Growth Rate:

Unknown (NatureServe, 2015)

Number of Populations:

0 (There is suitable habitat to be surveyed; however, it occurs in steep, remote areas that are difficult to access) (USFWS, 2017)

Population Size:

0 (USFWS, 2017)

Population Narrative:

Short-term population trends indicate a decline of >70%. As of 1997 six individuals remained. As of 2003, no individuals existed in the wild (Russell 2004). This species is no longer extant in the wild. It was known from its type locality on Kauai, Hawaii, however, as of 2003 the last individual died (Russell 2004). (NatureServe, 2015) In a 1994 survey for *C. kuhihewa*, seven individuals were observed, most of which were damaged by a nonnative insect, the two-spotted leafhopper (*Sophonia rufofascia*) (NTBG Provenance Report 1994). In 2001, only one individual plant remained, which was observed dead in 2003 (Wood et al. 2002, p. 3; S. Perlman, pers. comm. 2003a). Prior to that time, seeds and tissue were collected for genetic storage and propagation; however, this species is no longer in storage or propagation (Wood et al. 2002, p. 3; Bender 2006, p. 1; N. Sugii, Lyon Arboretum, pers. comm. 2006; V. Pence, Cincinnati Zoo and Botanical Garden, pers. comm. 2007; D. Burney, NTBG, pers. comm. 2009). Much of the suitable habitat (Metrosideros lowland wet forest) for this species on Kauai has not been surveyed (USFWS, 2010).; On May 10, 1991, *Cyanea kuhihewa* was discovered in Limahuli Valley (Wood et al. 2001). At that time there were 12 individuals. In a 1994 survey for *C. kuhihewa*, seven individuals were observed, most of which were damaged by a nonnative insect, the two-spotted leafhopper (*Sophonia rufofascia*; Wood 1994). In 2001, only one plant remained, and was observed dead in 2003 (Wood et al. 2002; Perlman 2006, in litt.). Prior to that time, seeds and tissue were collected for genetic storage and propagation; however, attempts were unsuccessful and this species is no longer in storage or propagation (Wood et al. 2002; Lyon Arboretum 2016; Burney 2007, in litt.). There is suitable habitat to be surveyed; however, it occurs in steep, remote areas that are difficult to access (Lorence 2016). (USFWS, 2017)

Threats and Stressors

Stressor: Ungulate degradation of habitat (USFWS, 2017)

Exposure:

Response:**Consequence:**

Narrative: Feral pigs (*Sus scrofa*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil. Feral pigs are reported in the area where *Cyanea kuhihewa* was last observed (HBMP 2010). (USFWS, 2017)

Stressor: Established ecosystem-altering invasive plant species degradation of habitat (USFWS, 2017)

Exposure:**Response:****Consequence:**

Narrative: Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community. Invasive introduced plants impacting *Cyanea kuhihewa* are *Andropogon virginicus* (broomsedge), *Clidemia hirta* (Koster's curse), and *Schizachyrium condensatum* (little bluestem) (NTBG 1997; HBMP 2010). (USFWS, 2017)

Stressor: Stochastic events—Reduced viability due to low numbers (USFWS, 2017)

Exposure:**Response:****Consequence:**

Narrative: Small, isolated populations often exhibit reduced levels of genetic variability, which diminishes the species' capacity to adapt and respond to environmental changes, thereby lessening the probability of long-term persistence (Barrett and Kohn 1991; Newman and Pilson 1997; HBMP 2010). The problems associated with small population size and vulnerability to random demographic fluctuations or natural catastrophes are further magnified by synergistic interactions with other threats, such as anthropogenic impacts like habitat loss from human development or predation by nonnative species. Very small plant populations may experience reduced reproductive vigor due to ineffective pollination or inbreeding depression (DLNR 2005). (USFWS, 2017)

Stressor: Hurricanes—Loss and degradation of habitat (USFWS, 2017)

Exposure:**Response:****Consequence:**

Narrative: In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of

climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013). (USFWS, 2017)

Stressor: Ungulate predation or herbivory (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Herbivory by feral pigs has been noted as a threat to this species (HBMP 2010). (USFWS, 2017)

Stressor: Rodent predation or herbivory (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Herbivory by rats (*Rattus* spp.) has been noted as a threat to *Cyanea kuhihewa* (Wood et al. 2002, Perlman 2006, in litt.; Perlman 2003, in litt.; HBMP 2010). Rats eat virtually every part of plants and at every stage: fleshy fruits, seeds, flowers, stems, leaves, shoots, seedlings, and roots (Russell 1980; Cuddihy and Stone 1990). The effects on plants range from reduced vigor and decreased reproduction to mortality of individuals and complete lack of recruitment. (USFWS, 2017)

Stressor: Invertebrate predation or herbivory (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Damage to *Cyanea kuhihewa* by a nonnative insect, the two-spotted leafhopper (*Sophonia rufofascia*) was observed in 1994 (HBMP 2010). Leafhoppers feed on plant leaves, causing prominent yellowing of the leaves, leading to stunting of the plant or death of the plant (University of Hawaii Crop Knowledge Master 2007). (USFWS, 2017)

Stressor: Slug herbivory (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: While not directly observed in this species, slug herbivory is typical for species in this family (Wood et al. 2002, Perlman 2006, in litt.; HBMP 2010). (USFWS, 2017)

Stressor: Lack of adequate biosecurity legislation (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Invasion of the State of Hawaii by invasive nonnative plant species, and destruction of habitat and competition by nonnative plants are threats to *Cyanea kuhihewa*. The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, is authorized to prevent the introduction or dissemination of animal and plant pests on all ships, aircraft, and their cargo and baggage arriving in the U.S. and its territories; however,

pest species continue to enter the State. In addition, Federal import regulations do not address many species that could be pests in Hawaii (CGAPS 2009; Ikuma et al. 2002). (USFWS, 2017)

Stressor: Invasive species—Established invasive plant species competition (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Nonnative plant species, especially *Andropogon virginicus*, *Clidemia hirta*, and *Schizachyrium condensatum*, are a high and imminent threat to *Cyanea kuhihewa* (NTBG 1997; HBMP 2010). Nonnative plants compete for water, light, and nutrients. (USFWS, 2017)

Recovery

Reclassification Criteria:

To meet the interim stage of recovery of *Cyanea kuhihewa*, 1,200 mature individuals are needed in one population and all major threats must be controlled around the population designated for recovery at this stage. There should also be demonstrated regeneration of seedlings and growth to at least sapling stage for woody species and documented replacement regeneration within the target population. The population must be adequately represented in an ex situ collection as defined in the Center for Plant Conservation's guidelines (Guerrant et al. 2004). Adequate monitoring must be in place and conducted to assess individual plant survival, population trends, trends of major limiting factors, and response of major limiting factors to management. (USFWS, 2017)

In addition to achieving five populations with 1,000 mature individuals and all of the goals of the interim stage, the target population must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats. (USFWS, 2017)

Delisting Criteria:

In addition to achieving five populations with 1,000 mature individuals per population and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis. (USFWS, 2017)

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys. (USFWS, 2010)
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units. (USFWS, 2010)
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys. (USFWS, 2010)
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range. (USFWS, 2010)
- Conduct research on control methods for introduced slugs and avian malaria. (USFWS, 2010)
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction. (USFWS, 2010)
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security. (USFWS, 2010)
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems. (USFWS, 2010)
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations. (USFWS, 2010)
- Surveys and inventories—Survey for populations of *Cyanea kuhihewa* in areas of potentially suitable habitat. (USFWS, 2017)
- Ungulate monitoring and control—Construct small-scale protective fences around all known individuals to prevent imminent extinction. Protect all occurrences against disturbances from feral ungulates. (USFWS, 2017)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around any populations. (USFWS, 2017)
- Predator and herbivore monitoring and control—Implement effective measures to control feral pigs around any populations. (USFWS, 2017)
- Predator and herbivore control research—Develop and implement adequate two-spotted leafhopper and slug control methods. (USFWS, 2017)
- Captive propagation for genetic storage and reintroduction—Collect and propagate genetic material for long-term genetic storage. (USFWS, 2017)
- Stochastic events---Build resilience and redundancy - Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms. (USFWS, 2017)

- Based on the recovery criteria above, consider development of a recovery plan. (USFWS, 2017)

Conservation Measures and Best Management Practices:

- Not available.

References

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SPECIES ACCOUNT: *Cyanea kunthiana* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Shrubs 0.5-1.5 m tall. Stems subherbaceous, woody only at the base, unbranched or sparingly branched. Racemes axillary, with 8-24 flowers. Corollas whitish with pale lilac longitudinal stripes or dark purplish. (NatureServe, 2015)

Current Range

Cyanea kunthiana is endemic to the island of Maui in the state of Hawaii. It occurs on both of Maui's main mountain masses, West Maui and East Maui. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea kunthiana* (Haha) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 16 detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Cyanea kunthiana* includes 16 CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Lowland Wet—Unit 1 (and) *Palmeria dolei*—Unit 2—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 2— Lowland Wet This area consists of 6,616 ac (2,677 ha) of State land, 7,425 ac (3,005 ha) of privately owned land, and 2,038 ac (825 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Kipahulu Valley on the northern and eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia samuelii*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *M. ovalis*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 1 is not known to be occupied by the plants *Clermontia oblongifolia* ssp. *mauiensis*, *C. peleana*, *Mucuna sloanei* var. *persericea*, *Phyllostegia haliakalae*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwiku* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 2 (and) *Palmeria dolei*—Unit 3—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 3— Lowland Wet (and) *Newcombia cumingi*—Unit 1—Lowland Wet This area consists of 65 ac (26 ha) of State land at Moomoku, on the northwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. Although Maui—Lowland Wet—Unit 2 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendrion pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), or by the Newcomb's tree snail (*Newcombia cumingi*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 3 (and) *Palmeria dolei*—Unit 4—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 4— Lowland Wet This area consists of 1,247 ac (505 ha) of State land at Honanana Gulch on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta*, *Cyanea asplenifolia*, and *Pteris lidgatei*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 3 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendrion pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 4 (and) *Palmeria dolei*—Unit 5—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 5— Lowland Wet This area consists of 864 ac (350 ha) of State land at Kahakuloa Valley on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta* and *Cyanea asplenifolia*. These units also

contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 4 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 5 (and) *Palmeria dolei*—Unit 6—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 6— Lowland Wet This area consists of 30 ac (12 ha) of State land at Iao Valley on the eastern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 5 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 6 (and) *Palmeria dolei*—Unit 7—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 7— Lowland Wet This area consists of 136 ac (55 ha) of State land at Honokowai and Wahikuli valleys on the western slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 6 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have

determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 7 (and) *Palmeria dolei*—Unit 8—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 8— Lowland Wet This area consists of 898 ac (364 ha) of State land at Olowalu Valley, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Alectryon macrococcus*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 7 is not currently occupied by the plants *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 8 (and) *Palmeria dolei*—Unit 9—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 9— Lowland Wet This area consists of 230 ac (93 ha) of State land at upper Ukumehame Gulch, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 8 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 1 (and) *Palmeria dolei*—Unit 10—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 10— Montane Wet This area consists of 1,313 ac (531 ha) of State land and 798 ac (323 ha) of privately owned land, at Haiku Uka on the northern slopes of east Maui. These

units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Cyanea duvalliorum*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *Phyllostegia pilosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 1 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 11—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 11— Montane Wet This area consists of 4,075 ac (1,649 ha) of State land, 9,633 ac (3,898 ha) of privately owned land, and 875 ac (354 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Puukaukanu and upper Waihoi Valley, on the northern and northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Geranium hanaense*, *G. multiflorum*, and *Wikstroemia villosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 2 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea glabra*, *C. maritae*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, and *Schiedea jacobii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 3 (and) *Palmeria dolei*—Unit 12—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 12— Montane Wet This area consists of 2,228 ac (902 ha) of federally owned land (Haleakala National Park) in Kipahulu Valley, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane

wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. maritae*, and *Melicope ovalis*, and by the forest bird, *kiwiku* (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 3 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea duvalliorum*, *C. glabra*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest bird, the *akohekohe* (*Palmeria dolei*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 4 (and) *Palmeria dolei*—Unit 13—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 13—Montane Wet This area consists of 180 ac (73 ha) of State land and 1,653 ac (669 ha) of federally owned land (Haleakala National Park), in Kaapahu Valley on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *Cyrtandra ferripilosa*, and *Huperzia mannii*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 4 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea duvalliorum*, *C. glabra*, *C. mceldowneyi*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwiku* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 5 (and) *Palmeria dolei*—Unit 14—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 14—Montane Wet This area consists of 222 ac (90 ha) of State land, and 165 ac (67 ha) of federally owned land (Haleakala National Park), near Kaumakani on the eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plant *Bidens campylotheca* ssp. *pentamera*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of

the existing wild populations. Although Maui—Montane Wet—Unit 5 is not currently occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 6 (and) *Palmeria dolei*—Unit 15—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 15—Montane Wet This area consists of 1,113 ac (451 ha) of State land, and 286 ac (116 ha) of privately owned land, at the summit and surrounding areas on west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta*, *Calamagrostis hillebrandii*, *Cyanea kunthiana*, *Geranium hillebrandii*, *Myrsine vaccinioides*, and *Sanicula purpurea*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 6 is not known to be occupied by the plants *Acaena exigua*, *Cyrtandra oxybapha*, *Huperzia mannii*, *Phyllostegia bracteata*, or *Platanthera holochila*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 7 (and) *Palmeria dolei*—Unit 16—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 16—Montane Wet This area consists of 80 ac (32 ha) of State land near Hanaula and Pohakea Gulch on the southeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). They are occupied by the plants *Cyrtandra oxybapha* and *Platanthera holochila*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 7 is not known to be occupied by the plants *Acaena exigua*, *Bidens conjuncta*, *Calamagrostis hillebrandii*, *Cyanea kunthiana*, *Geranium hillebrandii*, *Huperzia mannii*, *Myrsine vaccinioides*, *Phyllostegia bracteata*, or *Sanicula purpurea*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 1 (and) *Palmeria dolei*—Unit 18—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 18— Montane Mesic This area consists of 6,593 ac (2,668 ha) of State land, 707 ac (286 ha) of privately owned land, and 3,672 ac (1,486 ha) of federally owned land (Haleakala National Park), from Kealahou to Puualae, nearly circumscribing the summit of Haleakala on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Asplenium dielerectum*, *A. peruvianum* var. *insulare*, *Clermontia lindseyana*, *Cyanea horrida*, *C. obtusa*, *Cyrtandra ferripilosa*, *C. oxybapha*, *Diplazium molokaiense*, *Geranium arboreum*, *G. multiflorum*, *Huperzia mannii*, *Melicope adscendens*, and *Neraudia sericea*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 1 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Cyanea glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. mceldowneyi*, *Phyllostegia bracteata*, *P. mannii*, *Santalum haleakalae* var. *lanaiense*, *Wikstroemia villosa*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea kunthiana* critical habitat consists of three components. Lowland wet (east Maui and west Maui), Montane wet (east Maui and west Maui) and Montane mesic (east Maui) (81 FR 17790-18110):

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: *Acacia*, *Ilex*, *Metrosideros*, *Myrsine*, *Nestegis*, *Nothocestrum*, *Pisonia*, *Pittosporum*, *Psychotria*, *Sophora*, *Zanthoxylum*. Subcanopy: *Alyxia*, *Charpentiera*, *Coprosma*, *Dodonaea*, *Kadua*, *Labordia*, *Leptecophylla*, *Phyllostegia*, *Vaccinium*. Understory: Ferns, *Carex*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant

species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: *Cyanea kunthiana* was known to occur in the montane mesic ecosystem in the east Maui mountains in upper Kipahulu Valley, in Haleakala National Park and Kipahulu FR (HBMP 2010). Currently, in the east Maui mountains, *C. kunthiana* occurs in the lowland wet and montane wet

ecosystems in Waikamoi Preserve, Hanawi NAR, East Bog, Kaapahu, and Kipahulu Valley. In the west Maui mountains, *C. kunthiana* occurs in the lowland wet and montane wet ecosystems at Eke Crater, Kahoolawe ridge, and at the junction of the Honokowai, Hahakea, and Honokohau gulches (TNC 2007; HBMP 2008; NTBG 2009e, pp. 1–3; HBMP 2010; Oppenheimer 2010a, in litt.; Perlman 2010, in litt.). (USFWS, 2010)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Short-term trends indicate a decline of 10-70%, whereas long-term trends suggest a decline of 10-90% (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015)

Population Growth Rate:

Moderate decline (NatureServe, 2015)

Number of Populations:

15 occurrences (NatureServe, 2015)

Population Size:

400 individuals (NatureServe, 2015)

Population Narrative:

Short-term population trends indicate a decline of 10-70%, whereas long-term trends suggest a decline of 10-90%. The 15 occurrences total 165 individuals, although botanists speculate that this species may total as many as 400 individuals with further surveys of potential habitat on east and west Maui (TNC 2007; HBMP 2010; Fay 2010, in litt.; Oppenheimer 2010a, in litt.; Osternak 2010, in litt.). (USFWS, 2010; NatureServe, 2015)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs), nonnative plants, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include

competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, rats, and slugs) is considered an ongoing threat to *Cyanea kunthiana* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

References

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USFWS. 2013. Determination of Endangered Status for 38 Species on Molokai, Lanai, and Maui

Final Rule. 78 Federal Register 102, May 28, 2013. Pages 32014 - 32065.

SPECIES ACCOUNT: *Cyanea lanceolata* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/18/2012; Pacific Region (Region 1) (USFWS, 2016)

Historical Range

Historically, this species was wide- ranging along the Koolau Mountains, from the northern Schofield-Waikane area to Wailupe at the southern end of the range. (USFWS, 2012)

Current Range

Cyanea lanceolata is endemic to the Koolau Mountains on Oahu. It has been recorded from the southern and central portions of the mountain range. All of the records for the species are from the leeward (southwestern) side of the range with the exception of a single historic record from the range's windward (northeastern) side. (NatureServe, 2015)

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On September 18, 2012, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea lanceolata* (Haha) under the Endangered Species Act of 1973, as amended (Act) (77 FR 57648-57862). The critical habitat designation includes 15 critical habitat units, which encompass approximately 27,051 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Cyanea lanceolata* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Cyanea lanceolata* includes 15 critical habitat units, covering two ecosystem types, which encompass approximately 27,051 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 4, 5, 6, 7; Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16.

Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Haula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikēē, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet—Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet—Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu—Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamoa Ridge.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea lanceolata* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Cyanea lanceolata* occurs within the Lowland mesic and Lowland wet ecosystems in the Koolau Mountain caldera complex :

Oahu—Lowland Mesic—Units 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (E) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. (E) Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. (E) Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Cyanea lanceolata* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Wet environments (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found in shady locations; occur at elevations between 1,000 and 2,500 feet (NatureServe, 2015; USFWS, 2012)

Spatial Arrangements of the Population

Adult: Scattered (USFWS, 2012)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: This species is found in wet and mesic forests, primarily in valleys and gulch bottoms and on gulch sides, and occasionally on ridge tops. *Cyanea Lanceolata* occurs at elevations between 1,000 and 2,500 feet (305 and 760 m) (Wagner et al. 1999, p. 483; Wagner and Herbst 2003, p. 17; TNC 2007; HBMP 2008). Many communities where present are dominated by *Acacia koa*, including *Koa (Acacia) Lowland Mesic Forest* communities. Found in shady locations - grows upward into the *koa* branches, but does not overtop them. Currently, there are 4 known occurrences sparsely scattered over a much smaller area of the southern Koolau range. (NatureServe, 2015; USFWS, 2012)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Short-term trends suggest a decline of 10-30% (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Population Growth Rate:

Unknown (NatureServe, 2015)

Number of Populations:

4 occurrences (NatureServe, 2015)

Population Size:

~60 individuals (NatureServe, 2015)

Population Narrative:

Short-term population trends suggest a decline of 10-30%. The U.S. Fish and Wildlife Service reports 20 populations of this species from Oahu (USFWS 2004). The Hawaii Biodiversity and Mapping Program indicates that there are four current (1990-2005) occurrences (J. Lau 2005). It is unclear how many occurrences these 20 populations make up. Currently, there are 4 known occurrences, totaling fewer than 60 individuals, sparsely scattered over a much smaller area of the southern Koolau range. (USFWS, 2012; NatureServe, 2015)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative plants, animals (pigs), rockfalls, landslides, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Rockfalls and landslides destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. The projected effects of climate change will likely exacerbate the effects of the other threats to the species (USFWS, 2012).

Stressor: Predation and herbivory (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, goats, rats, and slugs) is considered an ongoing threat to *Cyanea lanceolata* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2012).

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Recovery**Reclassification Criteria:**

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

References

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

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Final Rule. 77 Federal Register 181. Pages 57648-57862.

USFWS. 2012. Endangered Status for 23 Species on Oahu and Designation of Critical Habitat for 124
Species

Final Rule. 77 Federal Register 181, September 18, 2012. Pages 57648 - 57862.

SPECIES ACCOUNT: *Cyanea lobata* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/15/1992; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Cyanea lobata, a member of the bellflower family (Campanulaceae), is a sparingly branched shrub 1.3-2.3 meters (4.3-7.5 feet) tall with smooth to somewhat rough stems and oblong, irregularly lobed leaves 30-50 cm (12-20 in) long, which may be broader at the end than at the base. The tops of the leaves are smooth; the lower surfaces may be rough and/or downy along the veins. The leaf stalks (petioles) are 7-22 cm (3-9 in) long and are somewhat rough. Flower clusters (inflorescences) occur on stalks 30-75 mm (1.2-3.0 in) long bearing 5-12 flowers, each on an individual stalk 18-35 mm (0.7-1.4 in) long. The base of each flower is 8-12 mm (0.3-0.5 in) long and 3-6 mm (0.1-0.2 in) wide. The flowers are partially tubular, curved, greenish-white or purplish, 60-70 mm (2.4-2.8 in) long and 5-11 mm (0.2-0.4 in) wide, downy at least on the spreading lobes, which are approximately as long as the tube. The berries are yellow and spherical. (USFWS, 1997)

Taxonomy

Lanuners (in Wagner et al. 1990) treated *Cyanea baldwinii* as a synonym of *Cyanea lobata*. St. John and Takeuchi (1987) questioned the distinctions between the two closely related Hawaiian endemic genera *Cyanea* and *Delissea*. St. John (1987) merged the two genera under the older generic name *Delissea*, creating the new combinations, *Delissea baldwinii* (Forbes and Munro) St. John and *Delissea lobata* (H. Mann) St. John. A recent treatment of the genus *Cyanea* (Lammers in Wagner et al. 1990) did not accept the generic changes proposed by St. John (1987). This short-lived perennial is endangered and has two recognized subspecies: *Cyanea lobata* subsp. *lobata*, endemic to the island of Maui, and *C. lobata* subsp. *baldwinii*, endemic to the island of Lanai (USFWS 2011). (USFWS, 1997; USFWS, 2014)

Historical Range

Historically, *Cyanea lobata* was known from Lanai and West Maui (Lammers in Wagner et al. 1990). (USFWS, 1997)

Current Range

Cyanea lobata is current known from West Maui. (NatureServe, 2015)

Critical Habitat Designated

Yes; 5/14/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea lobata* (ssp. *baldwinii* and ssp. *lobata*) (Haha) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes ten detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Cyanea lobata* (ssp. *baldwinii* and ssp. *lobata*) includes ten detailed CHUs in Maui County, Hawaii with detailed unit information. There are also an unknown number of units on Lanai that contain this species (number of units is unknown because detailed unit descriptions for Lanai are not available) (81 FR 17790-18110).

Maui—Lowland Wet—Unit 2 (and) *Palmeria dolei*—Unit 3—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 3— Lowland Wet (and) *Newcombia cumingi*—Unit 1—Lowland Wet This area consists of 65 ac (26 ha) of State land at Moomoku, on the northwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. Although Maui—Lowland Wet—Unit 2 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendrion pyriformum*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), or by the Newcomb's tree snail (*Newcombia cumingi*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 3 (and) *Palmeria dolei*—Unit 4—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 4— Lowland Wet This area consists of 1,247 ac (505 ha) of State land at Honanana Gulch on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta*, *Cyanea asplenifolia*, and *Pteris lidgatei*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 3 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendrion pyriformum*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 4 (and) *Palmeria dolei*—Unit 5—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 5— Lowland Wet This area consists of 864 ac (350 ha) of State land at

Kahakuloa Valley on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta* and *Cyanea asplenifolia*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 4 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 5 (and) *Palmeria dolei*—Unit 6—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 6— Lowland Wet This area consists of 30 ac (12 ha) of State land at Iao Valley on the eastern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 5 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 6 (and) *Palmeria dolei*—Unit 7—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 7— Lowland Wet This area consists of 136 ac (55 ha) of State land at Honokowai and Wahikuli valleys on the western slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 6 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C.*

magnicalyx, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 7 (and) *Palmeria dolei*—Unit 8—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 8— Lowland Wet This area consists of 898 ac (364 ha) of State land at Olowalu Valley, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Alectryon macrococcus*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 7 is not currently occupied by the plants *Asplenium dielarectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 8 (and) *Palmeria dolei*—Unit 9—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 9— Lowland Wet This area consists of 230 ac (93 ha) of State land at upper Ukumehame Gulch, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 8 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielarectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 6 (and) *Palmeria dolei*—Unit 35—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 35— Wet Cliff This area consists of 1,858 ac (752 ha) of State land, and 253 ac (102 ha) of privately owned land, at the summit ridges of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plants *Alectryon macrococcus*, *B. conjuncta*, *Ctenitis squamigera*, *Cyrtandra munroi*, *Remya mauiensis*, and *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 6 is not known to be occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Bonamia menziesii*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyriformis*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, or *Tetramolopium capillare*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 7 (and) *Palmeria dolei*—Unit 36—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 36— Wet Cliff This area consists of 556 ac (225 ha) of State land along Honokowai ridge on the northwestern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units are occupied by the plants *Cyrtandra filipes* and *C. munroi*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 7 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyriformis*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 8 consists of 337 ac (137 ha) of State land along Kahakuloa ridge on the north side of west Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff— Unit 8 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*,

Hesperomannia arborescens, *H. arbuscula*, *Isodendrion pyriformis*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lydgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea lobata* (ssp. *baldwinii* and ssp. *lobata*) critical habitat consists of three components. Montane wet for ssp. *baldwinii* in Lanai and Lowland wet and Wet cliff in west Maui (81 FR 17790-18110):

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. Understory: Bryophytes, Ferns, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other

Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C.*

samuelii, Ctenitis squamigera, Cyanea asplenifolia, C. copelandii ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. magnicalyx, C. mannii, C. maritae, C. mceldowneyi, C. profuga, C. solanacea, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Dubautia plantaginea ssp. humilis, Geranium hanaense, G. multiflorum, Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Lifespan**

Adult: Long-lived, >15 years (USFWS, 1997)

Breeding Season

Adult: August to February (USFWS, 1997)

Reproduction Narrative

Adult: Though a low, soft-wooded shrub, this species can be relatively long-lived. The sole individual of this species known from Lanai was discovered as an adult in 1919 and was still living in 1934, some 15 years later (Degener 1936). Cyanea lobata is known to flower from August to February, even in individuals as small as 50 centimeters (19.7 inches) in height (Rock 1919, Degener 1936). (USFWS, 1997)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Moist and wet environments (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 1,805 and 3,000 feet (USFWS, 1997)

Habitat Narrative

Adult: Cyanea lobata is found in moist and wet forests in gulches. Cyanea lobata has been seen and collected on steep streambanks at elevations of 550-915 meters (1,805-3,000 feet). (USFWS, 1997; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2014)

Redundancy:

Very low (inferred from USFWS, 2014)

Number of Populations:

3 (USFWS, 2018)

Population Size:

3 wild individuals (Maui), 2 wild individuals (Lānaʻi), 36 outplanted individuals (USFWS, 2017)

Population Narrative:

In 2013, the single population of *C. lobata* subsp. *baldwinii* on Lanai contained two mature wild individuals (Plant Extinction Prevention Program [PEPP] 2013). There are two populations of *C. lobata* subsp. *lobata* on Maui containing three wild mature individuals (PEPP 2013). The number of individuals has decreased from the three individuals reported for *C. lobata* subsp. *baldwinii* and four individuals reported for *C. lobata* subsp. *lobata* in the previous 5-year review (USFWS 2011). (USFWS, 2014); As reported in the 5-year review in 2014, *Cyanea lobata* subsp. *baldwinii* was known from one population of two individuals at Lānaʻihale on Lānaʻi. Two individuals at another population at Hauola Gulch have not been observed since 2012. Currently, there are still only two individuals at Lānaʻihale (PEPP 2016, 2017a). Also in 2014, we reported two populations of *C. lobata* subsp. *lobata* on west Maui totaling three individuals. Currently, there are two individuals at Hāʻena Nui (Kapunakea Preserve) and one individual at Honokōhau Gulch (Puʻu Kukui Watershed Preserve) on west Maui (Oppenheimer 2018, in litt.; PEPP 2017a). Two individuals at a third population at Honokōwai have not been observed since 2016 and this population is considered to be extirpated (PEPP 2016). • In 2012, the Service proposed revision of critical habitat for *Cyanea lobata* subsp. *baldwinii*, and the proposed rule identified one critical habitat unit on Lānaʻi in the montane wet ecosystem (238 ac, 101 ha) (77 FR 34464, July 11, 2012). In the final rule published in 2016, the Service excluded critical habitat for this subspecies on the island of Lānaʻi because, as demonstrated by the ongoing conservation activities by the private landowner, their commitment to develop the Lānaʻi Natural Resources Plan, and a memorandum of understanding with the Service, exclusion from critical habitat would provide greater long-term benefits to the subspecies than designation of critical habitat (USFWS 2015; 81 FR 17790, March 30, 2016). Also in 2016, 10 critical habitat units were designated in two ecosystems (lowland wet and wet cliff) on west Maui for *C. lobata* subsp. *lobata* (6,474 ac, 2,621 ha) (81 FR 17790, March 30, 2016). (USFWS, 2018)

Threats and Stressors

Stressor: Climate change (USFWS, 2014; USFWS, 2017)

Exposure:

Response:**Consequence:**

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Cyanea lobata* is moderately vulnerable to the impacts of climate change. Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2014); The assessment by Fortini et al. (2013) was conducted at the species level and concluded that *Cyanea lobata* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.644 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). *C. lobata* subsp. *lobata* and subsp. *baldwinii* are the only two subspecies in this taxon. Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2018)

Stressor: Drought (USFWS, 2014; USFWS, 2018)

Exposure:**Response:****Consequence:**

Narrative: Drought mortality and reduced viability – In 2010, drought was reported as a threat to *C. lobata* subsp. *balwinii* (PEPP 2011, 2012). (USFWS, 2014); Drought is observed to be a threat to both subspecies of *Cyanea lobata* on Lānaʻi and Maui (Spork-Koehler and Chau 2016). Over the past 100 years, the Hawaiian Islands have experienced an annual decline in precipitation from just over 9 percent, increasing to as much as 15 percent within the last 20 years (US-NSTC 2008; Chu and Chen 2005; Diaz 2005). Drought affects plants directly by desiccation. The increase in drought frequency and intensity leads to a self-perpetuating cycle of increase in cover of nonnative plants, increase in the number of fires, and an increase of erosion (US-GCRP 2009; Warren 2011). Recent episodes of drought have also driven axis deer farther into urban and forested areas in search of food, increasing their negative impacts to native vegetation from herbivory and trampling (Waring 1996, in litt; Nishibayashi 2001, in litt.). (USFWS, 2018)

Stressor: Invasive plants (USFWS, 2014)

Exposure:**Response:****Consequence:**

Narrative: Incipient invasive plant species – *Erigeron karvinskianus* (daisy fleabane) was discovered at the Lanai population containing *C. lobata* subsp. *balwinii* (PEPP 2013). This invasive species has not been previously reported from the island of Lanai (PEPP 2013). (USFWS, 2014)

Stressor: Feral pigs (USFWS, 1997)

Exposure:**Response:****Consequence:**

Narrative: Habitat degradation by feral pigs is a major threat to any *Cyanea lobata* populations or individuals located in areas accessible to pigs on West Maui. (USFWS, 1997)

Stressor: Collecting (USFWS, 1997)

Exposure:

Response:**Consequence:**

Narrative: Illegal collecting for scientific or horticultural purposes or excessive visits by individuals interested in seeing rare plants could result from increased publicity and would seriously threaten *Cyanea lobata*. Because of the few (if any) remaining individuals in existence, collection of whole plants or reproductive parts and/or site degradation caused by excessive foot traffic, would adversely impact the gene pool and threaten the survival of the taxon. (USFWS, 1997)

Stressor: Small population size (USFWS, 1997)

Exposure:**Response:****Consequence:**

Narrative: The likely very small number of remaining individuals—if there are any— of *Cyanea lobata* and the limited and scattered distribution of the species are threats since a single natural or human caused environmental disturbance could easily be catastrophic to all or part of the populations. In addition, the limited gene pool may depress reproductive vigor. Finally, cross-pollination would be a problem for single, isolated individuals. (USFWS, 1997)

Stressor: Fire destruction or degradation of habitat (USFWS, 2018)

Exposure:**Response:****Consequence:**

Narrative: Fire is reported to be a threat to *Cyanea lobata* subsp. *lobata* on west Maui (Spork-Koehler and Chau 2016). Fire can destroy dormant seeds as well as individual plants. Successive fires burn farther and farther into native habitat and alter microclimate conditions to further alter habitat conditions to favor nonnative plants. Nonnative plants convert native plant communities to nonnative dominated plant communities (D'Antonio and Vitousek 1992; Tunison et al. 2002). Increasing episodes of drought, expansion of invasive grass cover, and temperature increases, have led to an increase in the number of wildfires on Maui (Trauernicht et al. 2015). (USFWS, 2018)

Recovery**Reclassification Criteria:**

1. A total of five to seven populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1997)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)
2. Each population must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)
3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1997)

Recovery Actions:

- Search for any individuals of this species in former habitat. (USFWS, 1997)
- If plants are located, create new populations. (USFWS, 1997)
- Surveys and inventories—Continue to survey for additional populations of both subspecies of *Cyanea lobata* in areas of potentially suitable habitat. (USFWS, 2018)
- Ungulate monitoring and control—Continue to construct and maintain large-scale and small-scale fenced enclosures to protect individuals from the negative impacts of feral ungulates and to prevent imminent extinction in the wild. (USFWS, 2018)
- Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species around all populations. Continue to control invasive nonnative species that compete with the species around all populations. Research and develop potential biological control agents for the nonnative plants *Clidemia hirta* and *Tibouchina herbacea* that modify and destroy habitat of, and outcompete, both subspecies of *Cyanea lobata*. (USFWS, 2018)
- Captive propagation for genetic storage and reintroduction—Evaluate genetic resources currently in storage to determine the need to place additional genetic resource into long-term storage due to these subspecies' vulnerability to climate change. Continue propagation efforts for maintenance of genetic stock. (USFWS, 2018)
- Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to both subspecies. (USFWS, 2018)
- Fire monitoring and control—Develop and implement fire prevention management plans. (USFWS, 2018)
- Predator and herbivore monitoring and control—Implement effective control methods for rodents at wild and reintroduced populations. Develop and implement effective control methods for slugs. (USFWS, 2018)
- Stochastic events—Build resiliency and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from erosion and drought. (USFWS, 2018)
- Climate change adaptation strategy—Research the suitability of habitat for reintroducing these subspecies in the future due to impacts from climate change. (USFWS, 2018)
- Alliance and partnership development—Continue to initiate, plan, and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2018)

Conservation Measures and Best Management Practices:

- Survey geographical and historical range for a current assessment of the species' status. (USFWS, 2014)
- Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change. (USFWS, 2014)
- Fence remaining populations to protect them from the impacts of feral ungulates. (USFWS, 2014)
- Eradicate invasive introduced plant species within ungulate exclosures and maintain the exclosures free of invasive introduced plants. (USFWS, 2014)
- Control slugs and rodents within the vicinity of all known *C. lobata* populations. (USFWS, 2014)
- Continue monitoring wild and outplanted individuals. (USFWS, 2014)
- Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. (USFWS, 2014)
- Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2014)

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SPECIES ACCOUNT: *Cyanea longiflora* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

It is a single-stemmed or sparingly branched shrub 1 to 3 m (3.3 to 9.8 ft) tall. The leaves are 30 to 55 cm (11.7 to 21.5 in) long and clustered at the stem tips. The tubular, dark magenta flowers are 6 to 9 cm (2.3 to 3.5 in) long. The pear-shaped orange berries are 10 to 12 mm (3.9 to 4.7 in) long (Wagner et al 1999; Makua Implementation Team 2003) (USFWS, 2016).

Taxonomy

A member of the Campanulaceae (bellflower family). The genus *Cyanea* is one of the largest Hawaiian plant genera and incorporates a high proportion of rare taxa, including 28 endangered taxa, one threatened taxon, eight candidates for listing, and 17 species of concern (Service 2006a, Hawaii Biodiversity and Mapping Program 2006) (USFWS, 2016).

Historical Range

Cyanea longiflora is a species endemic to Oahu. Survey data indicate *C. longiflora* historically was known from five occurrences in the Waianae Mountains and six occurrences in the Koolau Mountains (USFWS, 2016).

Current Range

Currently, only the Waianae occurrences are extant, however, they have declined in numbers of known individuals since the listing (USFWS, 2016).

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea longiflora* (Haha) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Cyanea longiflora* (77 FR 57648-57862). The critical habitat designation includes 7 critical habitat units, which encompass approximately 7,823 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Cyanea longiflora* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Cyanea longiflora* includes 7 critical habitat units, covering one ecosystem type, which encompasses approximately 7,823 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea longiflora* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Cyanea longiflora* occurs within the indicated ecosystem in the Waianae Mountain caldera complex and was known historically (last observed > 20 yrs ago) from indicated ecosystem in the Koolau Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Cyanea longiflora* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources**Reproductive Strategy**

Adult: Sexual: cross-pollination, self-pollination (USFWS, 2016)

Lifespan

Adult: < 10 years, based on genus (USFWS, 2016)

Key Resources Needed for Breeding

Adult: Presumably birds (USFWS, 2016)

Reproduction Narrative

Adult: The long tubular flowers and orange berries of this taxon suggest pollination and seed dispersal by birds may be common. As with other *Cyanea* species with long tubular flowers, *C. longiflora* likely was pollinated by nectar-feeding birds. However, it is capable of self-pollination, as evidenced by the fact that isolated plants produce viable seeds. *Cyanea longiflora* presumably lives less than 10 years like other *Cyanea* of similar size (Makua Implementation Team 2003) (USFWS, 2016).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Mesic Acacia koa-Metrosideros polymorpha forests (USFWS, 2016)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at 479 - 3,906 ft. elevation (USFWS, 2016)

Habitat Narrative

Adult: Inhabits moist forests on ridgecrests, gulch slopes and gulch bottoms (NatureServe, 2015). *Cyanea longiflora* usually grows below ridge crests and on upper gulch slopes in mesic Acacia koa-Metrosideros polymorpha forests at elevations between 146 and 1,191 m (479 and 3,906 ft) (USFWS, 2016).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Decreasing since 1996

Resiliency:

Very low (inferred from USFWS, 2016; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2016)

Number of Populations:

3 (USFWS, 2016)

Population Size:

171 (USFWS, 2016)

Minimum Viable Population Size:

75 mature, reproducing individuals (USFWS, 2016)

Population Narrative:

At the time of listing in 1996, there were over 200 individuals in five occurrences (61 FR 53089). Currently, there are 171 total individuals in three population units, located on State and city/county lands (Table SB 10) (U.S. Army Garrison 2006d; 68 FR 35950). None of the currently known population units of this subspecies contain 75 mature, reproducing individuals (the minimum number required for stabilized population defined in the Makua Implementation Plan) (USFWS, 2016).

Threats and Stressors

Stressor: Nonnative plants (USFWS, 2009).

Exposure:

Response:

Consequence:

Narrative: Competition from invasive introduced plant species is another major threat, competing for light, space and water resources. The most serious plant species impacting *C. longiflora* include *Psidium cattleianum* (strawberry guava), *Clidemia hirta* (Koster's curse) and *Rubus argutus* (prickly Florida blackberry) (USFWS 1996, 1998, 2003, 2007) (USFWS, 2009).

Stressor: Predation (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Recruitment probably is limited by slugs, which attack plants of all size classes in this genus (USFWS, 2016).

Stressor: Stochastic events (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: This species is threatened by reduced reproductive vigor due to small population size and limited distribution as well as direct destruction of individual plants by rat or slug predation, erosion, landslides, and rockslides (61 FR 53089; 68 FR 35950; Service 1998a). This species tends to fluctuate widely in population size and has a history of local decline; any catastrophic disturbance during a major low point could extirpate one or more population units or result in species extinction in the wild (Makua Implementation Team 2003). The science of conservation biology has documented a general pattern of population collapse for a wide range of plant and

animal species (Dennis et al 1991; Schemske et al 1994; Morris et al 1999; Menges 2000). According to this pattern, *C. longiflora* already is in a phase of “quasi-extinction” with numbers that have declined to the point where demographic stochasticity alone can result in extirpation (USFWS, 2016). Individuals growing on ridges are vulnerable to direct destruction by erosion, landslides, and rockslides (USFWS 2007; 2009).

Stressor: Loss of pollinators (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: The long-billed, nectar-feeding native Hawaiian birds that were the presumed pollinators of *C. longiflora* have been almost totally extirpated from the Waianae Mountains. Although this species is capable of self-pollination, the loss of its natural pollinators has likely resulted in decreased genetic variability (Makua Implementation Team 2003) (USFWS, 2016).

Stressor: Feral pigs (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The major threats to *Cyanea longiflora* include degradation and loss of habitat from feral pigs (*Sus scrofa*) (USFWS, 2009).

Stressor: Human disturbance (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The population from Makaha to Waianae Kai occurs near a trail and vandalism of plants was reported for this population as plant heads were snapped off from two mature tagged plants. There is also potential impact from military activities. The Kapuna to West Makaleha and Pahole populations are located within low and very low fire risk zones for military training-related wildfire, and the Makaha to Waianae Kai population unit is at risk of fire from illegal campfires (USFWS 2007) (USFWS, 2009).

Recovery

Reclassification Criteria:

1. A total of five to seven populations should be documented on Oahu and at least one other island where they now occur or occurred historically (USFWS, 1998).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1998).
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1998).

Delisting Criteria:

1. A total of 8 to 10 populations should be documented on Oahu and at least one other island where they now occur or occurred historically (USFWS, 1998).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1998).
3. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1998).

Recovery Actions:

- Protect habitat and control threats (USFWS, 1998).
- Expand existing wild populations (USFWS, 1998).
- Conduct essential research (USFWS, 1998).
- Develop and maintain monitoring plans (USFWS, 1998).
- Reestablish wild populations within historic range (USFWS, 1998).
- Validate and revise recovery criteria (USFWS, 1998).
- Construct enclosures to protect populations against feral pigs (USFWS, 1998).
- Control competing alien plant species within enclosures (USFWS, 1998).
- Reduce threat of rat predation (USFWS, 1998).
- Provide protection from fire (USFWS, 1998).

Conservation Measures and Best Management Practices:

- Research on slug control in forest settings is needed to find ways to reduce invertebrate threats to *C. longiflora* and associated native plants (USFWS, 2016).
- The Makua Implementation Team (2003) has developed stabilization protocols for *Cyanea longiflora*, which are incorporated in the Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). This species is located in occurrences over four management units where it will benefit from population unit and/or ecosystem-level protection: Pahole, Upper Kapuna, West Makaleha, and Makaha and Waianae Kai (USFWS, 2016).
- In 2005, this species was represented in ex situ collections that included two cuttings in nurseries (Army Environmental Division, Oahu, and Harold L. Lyon Arboretum), 209 ungerminated seeds in a nursery (Harold L. Lyon Arboretum), 79,173 seeds in seed storage (Lyon Arboretum Seed Storage Facility), and 90 seedlings in a nursery (Harold L. Lyon Arboretum) (Service 2005b) (USFWS, 2016).
- Continue collecting mature fruit from wild individuals particularly for the augmentation of existing populations (USFWS, 2009).
- Continue control of introduced invasive plant species around wild and reintroduced plants (USFWS, 2009).
- Control rats around wild and outplanted individuals (USFWS, 2009).
- Complete large-scale fences around all naturally occurring and reintroduced individuals to control feral ungulates (USFWS, 2009).
- Continue outreach to the community groups near the Makaha population to reduce vandalism (USFWS, 2009).
- Continue reintroducing individuals into protected suitable habitat within historical range and augmenting wild populations (USFWS, 2009).
- Continue research for effective slug control methods (USFWS, 2009).
- Survey historical distribution and habitat for additional populations (USFWS, 2009).

- Assess genetic variability within the populations (USFWS, 2009).
- Study *Cyanea longifolia* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2009).

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SPECIES ACCOUNT: *Cyanea magnicalyx* (haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Cyanea magnicalyx, a member of the bellflower family (Campanulaceae), is a shrub with branched stems, from 1.5 to 3 meters (5 to 10 feet) tall. Leaves are glabrous, 36 to 55 centimeters (cm) (14 to 22 inches (in)) long and up to 27 cm (11 in) wide with pinnately cleft margins 0.4 to 4.5 cm (0.2 to 1.8 in) wide between the segments. Racemes are 6- to 15-flowered. Flowers are yellowish-white and striped with purple, 65 to 70 mm (2.6 to 2.8 in) long, glabrous, with corolla tube laterally compressed. Mature fruit and seeds are not described (Lammers 2004). (USFWS, 2018)

Taxonomy

This species was first described as *Cyanea grimesiana* subsp. *grimesiana*. The distribution of this subspecies at that time included the islands of O‘ahu, Moloka‘i, Lāna‘i, and Maui. Subsequently, Lammers (1998) recognized morphological differences in the broadly circumscribed *Cyanea grimesiana* group and published new combinations for the plants reported from Maui (*C. mauiensis*) and Lāna‘i (*C. munroi*). Plants reported from Moloka‘i were identified as either *C. munroi* or *C. grimesiana* subsp. *grimesiana*. In 2004, Lammers recognized further differences in the plants reported from Maui and described a new species, *C. magnicalyx*, known only from west Maui. The range of *C. grimesiana* subsp. *grimesiana* now includes only O‘ahu and Moloka‘i (Lammers 1998; Lammers 2004). We evaluated the effects of the five factors described in section 4(a)(1) of the Endangered Species Act on *C. magnicalyx* and determined that this species warranted endangered status under the Act (78 FR 32014, May 28, 2013). *Cyanea magnicalyx* is recognized as a distinct taxon in Lammers (2004) and in Wagner et al. (2012) the most recently accepted Hawaiian plant taxonomy. (USFWS, 2018)

Historical Range

Historically, two populations of *Cyanea magnicalyx* from west Maui were formerly classified as *C. grimesiana* subsp. *grimesiana*. (USFWS, 2018)

Current Range

Cyanea magnicalyx is found in west Maui. (USFWS, 2018)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea magnicalyx* (Haha) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 14 detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Cyanea magnicalyx* includes 14 CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Lowland Wet—Unit 2 (and) *Palmeria dolei*—Unit 3—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 3— Lowland Wet (and) *Newcombia cumingi*—Unit 1—Lowland Wet This area consists of 65 ac (26 ha) of State land at Moomoku, on the northwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. Although Maui—Lowland Wet—Unit 2 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendrion pyriformium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), or by the Newcomb's tree snail (*Newcombia cumingi*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 3 (and) *Palmeria dolei*—Unit 4—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 4— Lowland Wet This area consists of 1,247 ac (505 ha) of State land at Honanana Gulch on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta*, *Cyanea asplenifolia*, and *Pteris lidgatei*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 3 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendrion pyriformium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 4 (and) *Palmeria dolei*—Unit 5—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 5— Lowland Wet This area consists of 864 ac (350 ha) of State land at Kahakuloa Valley on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native

plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta* and *Cyanea asplenifolia*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 4 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwiku* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 5 (and) *Palmeria dolei*—Unit 6—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 6— Lowland Wet This area consists of 30 ac (12 ha) of State land at Iao Valley on the eastern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 5 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwiku* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 6 (and) *Palmeria dolei*—Unit 7—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 7— Lowland Wet This area consists of 136 ac (55 ha) of State land at Honokowai and Wahikuli valleys on the western slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 6 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*,

Phyllostegia bracteata, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 7 (and) *Palmeria dolei*—Unit 8—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 8— Lowland Wet This area consists of 898 ac (364 ha) of State land at Olowalu Valley, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Alectryon macrococcus*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 7 is not currently occupied by the plants *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriform*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 8 (and) *Palmeria dolei*—Unit 9—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 9— Lowland Wet This area consists of 230 ac (93 ha) of State land at upper Ukumehame Gulch, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 8 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriform*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 2 (and) *Palmeria dolei*—Unit 19—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 19— Montane Mesic This area consists of 124 ac (50 ha) of State land at Helu and the upper reaches of Puehuhunui on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Lysimachia lydgatei*, *Remya mauiensis*, and *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 2 is not known to be occupied by the plants *Geranium hillebrandii*, *Huperzia mannii*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 3 (and) *Palmeria dolei*—Unit 20—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 20— Montane Mesic This area consists of 174 ac (70 ha) of State land at Lihau on the southwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plant *Geranium hillebrandii*, and contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 3 is not known to be occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Huperzia mannii*, *Lysimachia lydgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 4 (and) *Palmeria dolei*—Unit 21—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 21— Montane Mesic This area consists of 72 ac (29 ha) of State land at Halepohaku on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). Although Maui—Montane Mesic—Unit 4 is not known to be occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Geranium hillebrandii*, *Huperzia mannii*, *Lysimachia lydgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their

small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 5 (and) *Palmeria dolei*—Unit 22—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 22— Montane Mesic This area consists of 170 ac (69 ha) of State land at the upper reaches of Manawainui Gulch on the southeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants *Remya mauiensis* and *Santalum haleakalae* var. *lanaiense*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 5 is not known to be occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Geranium hillebrandii*, *Huperzia mannii*, *Lysimachia lydgatei*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 6 (and) *Palmeria dolei*—Unit 35—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 35— Wet Cliff This area consists of 1,858 ac (752 ha) of State land, and 253 ac (102 ha) of privately owned land, at the summit ridges of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plants *Alectryon macrococcus*, *B. conjuncta*, *Ctenitis squamigera*, *Cyrtandra munroi*, *Remya mauiensis*, and *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 6 is not known to be occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Bonamia menziesii*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyriformis*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, or *Tetramolopium capillare*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 7 (and) *Palmeria dolei*—Unit 36—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 36— Wet Cliff This area consists of 556 ac (225 ha) of State land along Honokowai ridge on the northwestern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units are occupied by the plants *Cyrtandra filipes* and *C. munroi*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the

expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 7 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 8 consists of 337 ac (137 ha) of State land along Kahakuloa ridge on the north side of west Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff—Unit 8 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea magnicalyx* critical habitat consists of three components. Lowland wet (west Maui), Montane mesic (west Maui) and Wet cliff (west Maui) (81 FR 17790-18110):

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: *Acacia*, *Ilex*, *Metrosideros*, *Myrsine*, *Nestegis*, *Nothocestrum*, *Pisonia*, *Pittosporum*, *Psychotria*, *Sophora*, *Zanthoxylum*. Subcanopy: *Alyxia*, *Charpentiera*, *Coprosma*, *Dodonaea*, *Kadua*, *Labordia*, *Leptecophylla*, *Phyllostegia*, *Vaccinium*. Understory: Ferns, *Carex*, *Peperomia*.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaisia*,

Cheirodendron, Leptecophylla, Metrosideros. Understory: Bryophytes, Ferns, Coprosma, Dubautia, Kadua, Peperomia.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into

native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Breeding Season

Adult: This species flowers primarily from September to October (Lammers 2004). (USFWS, 2018)

Reproduction Narrative

Adult: This species flowers primarily from September to October (Lammers 2004). (USFWS, 2018)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliff, forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 450 meters (1,476 feet) elevation (USFWS, 2018)

Habitat Narrative

Adult: This species is found in lowland wet, montane mesic, and wet cliff ecosystems on West Maui. (NatureServe, 2015); Typical habitat for this species includes mesic forest and shrubland at 450 meters (1,476 feet) elevation on west Maui (Lammers 2004). *Cyanea magnicalyx* occurs on west Maui in at Kaluanui Stream in a subgulch of Honokōhau Valley and in Olowalu Gulch in *Metrosideros polymorpha*–*Cibotium* spp. (‘ōhi’a–hāpu‘u) mesic forest with the associated native plant species *Antidesma platyphyllum* (hame), *Broussaisia arguta* (kanawao), *Cheirodendron trigynum* (‘ōlapa), *Clermontia kakeana* (‘ōhā wai), *Cyanea angustifolia* (hāhā), *C. lobata* (hāhā), *Cyrtandra grayana* (ha’iwale), *C. grayi* (ha’iwale), *Dicranopteris linearis* (uluhe), *Diplazium sandwichianum* (hō‘i‘o), *Dodonaea viscosa* (‘a‘ali‘i), *Freycinetia arborea* (‘ie‘ie), *Ilex anomala* (kāwa‘u), *Kadua acuminata* (au), *Melicope hawaiiensis* (mokihana kūkae moa), *Myrsine lessertiana* (kōlea lau nui), *Nestegis sandwicensis* (olopua), *Polyscias hawaiiensis* (‘ohe), *Syzygium sandwicensis* (‘ōhi’a hā), and *Xylosma hawaiiense* (a‘e) (Wood 2009, in litt.). In ‘Īao Valley on west Maui, the vegetative community is *Pisonia* (pāpala kēpau) forest with *Metrosideros polymorpha* and associated native species including *Antidesma platyphyllum*, *Asplenium nidus* (‘ēkaha), *Chrysodracon auwahiensis* (hala pepe), *Cyrtandra grayi*, *Charpentiera obovata* (pāpala), *Cheirodendron trigynum*, *Claoxylon sandwicense* (po‘olā), *Freycinetia arborea*, *Kadua acuminata*, *K. affinis* (manono), *Nothocestrum longifolium* (‘aiea), *Perrottetia sandwicensis* (olomea), *Pittosporum glabrum* (hō‘awa), *Planchonella sandwicensis* (‘āla‘a), *Psychotria mauensis* (‘ōpiko), and *Xylosma hawaiiense* (Oppenheimer 2009, in litt.; Wood 2009, in litt.). (USFWS, 2018)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2016)

Redundancy:

Very low (inferred from USFWS, 2016)

Number of Populations:

3 (USFWS, 2016; USFWS, 2018)

Population Size:

3 wild individuals, 97 outplanted individuals (USFWS, 2018)

Population Narrative:

Currently, there are seven individuals in three occurrences on west Maui: Two individuals in Kaluanui, a subgulch of Honokohau Valley, in the lowland wet ecosystem; four individuals in Lao Valley in the wet cliff ecosystem; and one individual in a small drainage south of the Kauaula rim, in the montane mesic ecosystem (Lammers 2004, p. 87; Perlman 2009b in litt.; Wood 2009d, in litt.). (USFWS, 2016)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs), nonnative plants, fire, landslides, treefalls, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Fire can destroy dormant seeds and plants, even in steep and inaccessible areas. Successive fires can remove habitat for native species by altering microclimate conditions favorable to alien plants. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Fire can destroy dormant seeds and plants, even in steep and inaccessible areas. Successive fires can remove habitat for native species by altering microclimate conditions favorable to alien plants. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Landslides and treefalls destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, rats, and slugs) is considered an ongoing threat to *Cyanea magnicalyx* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor: Stochastic events—Reduced viability due to low numbers (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Small, isolated populations often exhibit reduced levels of genetic variability, which diminishes the species' capacity to adapt and respond to environmental changes, thereby

lessening the probability of long-term persistence (Barrett and Kohn 1991; Newman and Pilson 1997). The problems associated with small population size and vulnerability to random demographic fluctuations or natural catastrophes are further magnified by synergistic interactions with other threats, such as anthropogenic impacts like habitat loss from human development or predation by nonnative species. *Cyanea magnicalyx* is currently known from only three wild individuals on west Maui (Oppenheimer 2018, in litt.). Although reintroduction of individuals is ongoing, fewer than 50 percent of those individuals persist beyond five years (PEPP 2010, 2011, 2012, 2013, 2014, 2015, 2017a). (USFWS, 2018)

Stressor: Ungulate degradation of habitat (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Feral ungulates modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil (Loope 1998; van Riper and van Riper 1982). Feral pigs (*Sus scrofa*) and evidence of their activities have been observed at wild and reintroduced occurrences of *Cyanea magnicalyx* at Honolua-Kaluanui-Honokōhau, Īao Valley, Kahana, and Pūehuehu Nui-Launiupoko (Keir et al. 2015; NTBG 2004a, 2004b, 2004c, PEPP 2010, 2012, 2013, 2015). (USFWS, 2018)

Stressor: Established ecosystem-altering invasive plant modification and degradation of habitat (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community (Cuddihy and Stone 1990). Habitat modification and destruction by invasive introduced plants negatively affects *Cyanea magnicalyx* at all locations where it occurs on west Maui. The nonnative plants with the greatest impacts include *Ageratina adenophora* (Maui pāmakani), *Blechnum appendiculatum* (no common name), *Buddleja asiatica* (dog tail), *Casuarina equisetifolia* (ironwood), *Clidemia hirta* (Koster's curse), *Cordyline fruticosa* (ki), *Grevillea robusta* (silk oak), *Psidium cattleianum* (strawberry guava), *P. guajava* (common guava), *Rubus rosifolius* (thimbleberry), *Schinus terebinthifolius* (christmasberry), and *Tibouchina herbacea* (cane tibouchina) (Keir et al. 2015; NTBG 2004a, 2004b, 2006a). (USFWS, 2018)

Stressor: Landslides and flooding destruction or degradation of habitat (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Landslides have been reported as a threat to individuals of *Cyanea magnicalyx* at Īao Valley and Honolua-Honokōhau (Keir et al. 2015; PEPP 2010, 2011, 2012). Landslides and erosion due to natural weathering destabilizes substrates, damages and destroys individual plants, and alters hydrological patterns (Stearns 1985). (USFWS, 2018)

Stressor: Drought degradation of habitat (USFWS, 2018)

Exposure:**Response:****Consequence:**

Narrative: Drought is observed to be a threat to *Cyanea magnicalyx* at Pūehuehu Nui-Launiupoko, Honokōhau, Olowalu, Īao Valley, and Kahana (PEPP 2010, 2012, 2013, 2014, 2015, 2017a). Over the past 100 years, the Hawaiian Islands have experienced an annual decline in precipitation from just over 9 percent, increasing to as much as 15 percent within the last 20 years (US-NSTC 2008; Chu and Chen 2005; Diaz et al. 2005). Drought affects plants directly by desiccation. The increase in drought frequency and intensity leads to a self-perpetuating cycle of increase in cover of nonnative plants, increase in the number of fires, and an increase of erosion (US-GCRP 2009; Warren 2011). Recent episodes of drought have also driven deer farther into urban and forested areas in search of food, increasing their negative impacts to native vegetation from herbivory and trampling (Waring 1996, in litt; Nishibayashi 2001, in litt.). (USFWS, 2018)

Stressor: Climate change loss or degradation of habitat (USFWS, 2018)

Exposure:**Response:****Consequence:**

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai'i using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. At the time of the analysis, individuals of *Cyanea magnicalyx* were believed to be *C. grimesiana* subsp. *grimesiana*, and the assessment concluded that the subspecies is vulnerable to the impacts of climate change with a vulnerability score of 0.497 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Those individuals on west Maui now known as *Cyanea magnicalyx* have a much smaller range than *C. grimesiana* subsp. *grimesiana*, and may be more vulnerable. Therefore, additional management actions are needed to conserve this taxon into the future. We will update this information for *C. magnicalyx* as it becomes available. (USFWS, 2018)

Stressor: Rodent predation or herbivory (USFWS, 2018)

Exposure:**Response:****Consequence:**

Narrative: Herbivory by rats is noted to be a threat to *Cyanea magnicalyx* at Honolulu, Kaluanui-Honokōhau, Īao Valley, Pūehuehu Nui-Launiupoko, Kahana, and Waikapū (NTBG 2004a, 2004b, 2004c; Oppenheimer 2018, in litt.; PEPP 2010, 2011, 2012, 2013, 2014, 2015). Rats eat virtually every part of plants and at every stage: fleshy fruits, seeds, flowers, stems, leaves, shoots, seedlings, and roots (Russell 1980; Cuddihy and Stone 1990). The effects on plants range from reduced vigor and decreased reproduction to mortality of individuals and complete lack of recruitment. (USFWS, 2018)

Stressor: Invertebrate predation or herbivory (USFWS, 2018)

Exposure:**Response:****Consequence:**

Narrative: Herbivory by slugs has been noted as a threat to this species at Honolulu, Kaluanui-Honokōhau, Īao Valley, Pūehuehu Nui-Launiupoko, Kahana, Waikapū, and Olowalu (NTBG 2004a,

2004b, 2004c; PEPP 2010, 2011, 2012, 2013, 2014, 2015, 2017a). The effects on plants range from reduced vigor and decreased reproduction to mortality of individuals. (USFWS, 2018)

Stressor: Lack of adequate hunting regulations (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Current and historic habitat of *Cyanea magnicalyx* at Olowalu and Pūehuehu Nui is within State hunting areas. Public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations are at risk (DLNR 2010). (USFWS, 2018)

Recovery

Reclassification Criteria:

To meet the interim stage of recovery of *Cyanea magnicalyx*, 300 mature individuals are needed in each of three populations and all major threats must be controlled around the populations designated for recovery at this stage. There should also be demonstrated regeneration of seedlings and growth to at least sapling stage for woody species and documented replacement regeneration within each of the target populations. The populations must be adequately represented in an ex situ collection as defined in the Center for Plant Conservation's guidelines (Guerrant et al. 2004). Adequate monitoring must be in place and conducted to assess individual plant survival, population trends, trends of major limiting factors, and response of major limiting factors to management. (USFWS, 2018)

In addition to achieving 5 to 10 populations with 500 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes major limiting factors, breeding system, population structure and density, and proven management methods for major threats. (USFWS, 2018)

Delisting Criteria:

In addition to achieving 5 to 10 populations with 500 mature individuals per population and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is

present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis. (USFWS, 2018)

Recovery Actions:

- Surveys and inventories—Continue to survey for populations of *Cyanea magnicalyx* in areas of potentially suitable habitat. (USFWS, 2018)
- Ungulate monitoring and control—Protect all occurrences against browsing and disturbances from feral ungulates. Construct and maintain fenced enclosures around existing populations and reintroductions to prevent imminent extinction. (USFWS, 2018)
- Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species around all populations. Continue to control invasive nonnative plant species that compete with *Cyanea magnicalyx*. (USFWS, 2018)
- Rodent predation or herbivory control—Continue to implement effective measures to control rodents around all populations. (USFWS, 2018)
- Invertebrate predation or herbivory control—Continue to implement effective measures to control slugs around all populations. (USFWS, 2018)
- Captive propagation for genetic storage and reintroduction—Continue to secure ex situ stocks with complete representation of remaining individuals. (USFWS, 2018)
- Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2018)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered throughout historic range to reduce impacts from landslides and drought. (USFWS, 2018)
- Climate change adaptation strategy—Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. (USFWS, 2018)
- Alliance and partnership development—Continue to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2018)

Conservation Measures and Best Management Practices:

- Not available.

References

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SPECIES ACCOUNT: *Cyanea mannii* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/08/1992; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Cyanea mannii, a member of the bellflower family, is a branched shrub 1.5 to 3 m (5 to 10 ft) tall. The leaves are narrowly elliptic or lance shaped, 12 to 21 cm (4.7 to 8.3 in) long and 2.5 to 5 cm (1 to 2 in) wide, and have petioles 2.2 to 10 cm (0.9 to 3.9 in) long and hardened teeth along the leaf margins. Each flower cluster, arising from the axil of a leaf on a stalk 20 to 35 mm (0.8 to 1.4 in) long, comprises 6 to 12 flowers, each on a stalk 8 to 12 mm (0.3 to 0.5 in) long. Each flower has a smooth, green hypanthium, which measures about 4 to 6 mm (0.2 in) long and 3 to 5 mm (0.1 to 0.2 in) wide and is topped by triangular calyx lobes 3 to 5 mm (0.1 to 0.2 in) long and 2 to 3 mm (0.08 to 0.1 in) wide. The purplish corolla forms a nearly upright tube 30 to 35 mm (1.2 to 1.4 in) long and 3 to 4 mm (0.1 to 0.2 in) wide, which ends in five spreading lobes. Berries have not been observed. (USFWS, 1996)

Historical Range

Historically, *Cyanea mannii* was known only from Kalae on East Molokai (USEWS 1992). (USFWS, 1996)

Current Range

This species is current found in Molokai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/18/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea mannii* (Haha) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Cyanea mannii* includes four CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Molokai—Lowland Mesic—Unit 1 (and) *Palmeria dolei*—Unit 37—Lowland Mesic (and) *Pseudonestor xanthophrys*—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Ctenitis squamigera*, *Cyanea dunbariae*, *C. mannii*, *C. profuga*, *Cyperus fauriei*, *Cyrtandra filipes*, *Gouania hillebrandii*, *Labordia triflora*, *Neraudia sericea*, *Santalum haleakalae* var. *lanaiense*, *Schiedea lydgatei*, *S. sarmentosa*, *Silene alexandri*, *S. lanceolata*, *Spermolepis hawaiiensis*, and *Zanthoxylum hawaiiense*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied

habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Mesic—Unit 1 is not known to be occupied by *Asplenium dielarectum*, *Bonamia menziesii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea procera*, *C. solanacea*, *Diplazium molokaiense*, *Festuca molokaiensis*, *Flueggea neowawraea*, *Isodendrion pyriformis*, *Kadua laxiflora*, *Melicope mucronulata*, *M. munroi*, *M. reflexa*, *Phyllostegia haliakalae*, *P. mannii*, *P. pilosa*, *Sesbania tomentosa*, *Stenogyne bifida*, or *Vigna o-wahuensis*, or the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 41—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 41— Montane Wet This area consists of 871 ac (353 ha) of State land, and 39 ac (16 ha) of privately owned land, from Honukaupu to Olokui (between Pelekunu and Wailau valleys), in north-central Molokai. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). Although Molokai— Montane Wet—Unit 2 is not known to be occupied by *Adenophorus periers*, *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. procera*, *C. profuga*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Melicope reflexa*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Pteris lidgatei*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 3 consists of 77 ac (31 ha) of State land, and 726 ac (294 ha) of privately owned land, above the east rim of Wailau Valley on eastern Molokai. This unit is occupied by the plant *Melicope reflexa*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Montane Wet—Unit 3 is not known to be occupied by *Adenophorus periers*, *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. procera*, *C. profuga*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Pteris lidgatei*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Mesic—Unit 1 (and) *Palmeria dolei*—Unit 42—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 42— Montane Mesic This area consists of 257 ac (104 ha) of State land, and 559 ac (226 ha) of privately owned land from Kamiloloa to Makolelau in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Bidens wiebkei*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Montane Mesic—Unit 1 is not known to be occupied by *Asplenium dielerectum*, *Cyanea dunbariae*, *C. mannii*, *C. procera*, *C. solanacea*, *Cyperus fauriei*, *Kadua laxiflora*, *Melicope mucronulata*, *Neraudia sericea*, *Plantago princeps*, or *Stenogyne bifida*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea mannii* critical habitat consists of two components. Lowland mesic (east Maui) and Lowland wet (east Maui and west Maui) (81 FR 17790-18110):

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*,

Schiedea jacobii, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkii*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*,

Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Cyanea mannii was observed in flower during July 1984 (HHP 1990e). (USFWS, 1996)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 1,000 and 1,220 meters (USFWS, 1996)

Habitat Narrative

Adult: This species is found in moist forests on gulch sides and in gulch bottoms. This species typically grows on the sides of deep gulches in ohia dominated mesic to wet forests at elevations of about 1,000 to 1,220 meters (3,300 to 4,000 feet) (USEWS 1992). Associated plant taxa include akia, olapa, Dicranopteris linearis (uluhe), and Vaccinium (ohelo) (USFWS 1992). (USFWS, 1996; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2011)

Redundancy:

Very low (inferred from USFWS, 2011)

Number of Populations:

6-8 (USFWS, 2018)

Population Size:

64-114 wild individuals (USFWS, 2018)

Population Narrative:

Since the exact numbers of individuals were often not recorded by field botanists, currently there are approximately less than 200 individuals of *Cyanea mannii* on Molokai in an unknown number of populations. There are currently 9 known occurrences. (USFWS, 2011; NatureServe, 2015); In the 2011 5-year review, there were eight populations of *Cyanea mannii* totaling fewer than 200 individuals. Between 2007 and 2008, there were four individuals observed at Kapuna Spring, two individuals observed at Waihānau Stream, and five individuals observed at the headwaters of east Kawela (Oppenheimer 2010, in litt.). The current status of these populations is unknown, no new information was available. One of the eight populations, at Mokokoko, totals between 50 and 100 individuals (Bakutis 2018, in litt.). There may possibly be three other locations with greater than 40 individuals each, but these observations are from the early 1990s. Other locations from old observations had only a few individuals each. (USFWS, 2018)

Threats and Stressors

Stressor: Pigs and deer (USFWS, 1996)

Exposure:

Response:

Consequence:

Narrative: Feral pigs and Axis deer threaten and modify the habitat of *Cyanea mannii*. (USFWS, 1996)

Stressor: Rats (USFWS, 1996)

Exposure:

Response:

Consequence:

Narrative: Rats may feed on the fruit or other parts of the plant, as shown by predation on related species. (USFWS, 1996)

Stressor: Small population size (USFWS, 1996)

Exposure:

Response:

Consequence:

Narrative: Because of the small number of remaining individuals, one random naturally occurring event could extirpate a significant proportion of the populations (USFWS 1992). (USFWS, 1996)

Stressor: Invasive introduced plants (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species are a threat to *Cyanea mannii* and include *Ageratum conyzoides* (goatweed), *Ageratina riparia* (spreading mist flower), *Axonopus fissifolius* (narrow leaved carpetgrass), *Buddleia asiatica* (dog tail), *Christella dentata* (downy wood fern), *Drymaria cordata* (tropical chickweed), *Erigeron karvinskianus* (daisy fleabane), *Hedychium* sp. (ginger), *Hypochoeris radicata* (hairy cat's ear), *Lantana camara* (lantana), *Melinis minutiflora* (molasses

grass), *Pluchea carolinensis* (sourbush), *Psidium guajava* (common guava), *Nephrolepis* sp. (NCN), *Ricinus communis* (castor bean), *Rubus rosifolius* (thimbleberry), *Sacciolepis indica* (Glenwood grass), *Schinus terebinthifolius* (Christmas berry), and *Setaria parvula* (yellow foxtail) (National Tropical Botanical Garden 2009; Perlman 2009; Wood 2009; Wood and Perlman 2002). (USFWS, 1996)

Stressor: Climate change loss or degradation of habitat (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai'i using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Cyanea mannii* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.844 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2018)

Stressor: Fire destruction or degradation of habitat (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Fire is reported to be a threat to *Cyanea mannii* on Moloka'i (Keir et al. 2016). Fire can destroy dormant seeds as well as individual plants. Successive fires burn farther and farther into native habitat and alter microclimate conditions to further alter habitat conditions to favor nonnative plants. Nonnative plants convert native plant communities to nonnative dominated plant communities (D'Antonio and Vitousek 1992; Tunison et al. 2002). Increasing episodes of drought, expansion of invasive grass cover, and temperature increases, have led to an increase in the number of wildfires on Moloka'i (Trauernicht et al. 2015). (USFWS, 2018)

Stressor: Drought degradation of habitat (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Drought is observed to be a threat to *Cyanea mannii* on Moloka'i (Keir et al. 2016). Over the past 100 years, the Hawaiian Islands have experienced an annual decline in precipitation from just over 9 percent, increasing to as much as 15 percent within the last 20 years (US-NSTC 2008; Chu and Chen 2005; Diaz 2005). Drought affects plants directly by desiccation. The increase in drought frequency and intensity leads to a self-perpetuating cycle of increase in cover of nonnative plants, increase in the number of fires, and an increase of erosion (US-GCRP 2009; Warren 2011). Recent episodes of drought have also driven axis deer farther into urban and forested areas in search of food, increasing their negative impacts to native vegetation from herbivory and trampling (Waring 1996, in litt; Nishibayashi 2001, in litt.). (USFWS, 2018)

Stressor: Landslides and flooding destruction or degradation of habitat(USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Landslides are reported to be a threat to *Cyanea mannii* (Keir et al. 2016). Populations of this species occur in steep, rocky areas along streams or at headwaters of streams. Landslides, including tree falls and erosion associated with them, can have a significant effect on small populations by destabilizing substrate, altering hydrological patterns, and by damaging and destroying individual plants (Stearns 1985). (USFWS, 2018)

Stressor: Lack of adequate hunting regulations (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Four populations of *Cyanea mannii* on Moloka'i occur in a State hunting area. Nonnative feral ungulates pose a major ongoing threat to native species through destruction and modification of habitat, and through direct herbivory or predation. Only one population is fenced and habitat destruction and modification, and predation, by pigs, goats, and axis deer have been noted as threats to the species. In addition, public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations are at risk (DLNR 2010). (USFWS, 2018)

Recovery**Reclassification Criteria:**

1. A total of five to seven populations of each taxon should be documented on Molokai and at least one other island where they now occur or occurred historically. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1996)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1996)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Molokai and at least 1 other island where they now occur or occurred historically. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1996)
3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1996)

Recovery Actions:

- Propagation and maintenance of genetic stock ex situ, and protection of remaining wild individuals from threats. (USFWS, 1996)
- The plan proposes the delineation of management units to conserve not only these taxa, but their habitats as well. These units should be managed to preserve as many native species (flora and fauna) as possible, through threat-control and forest-restoration programs. (USFWS, 1996)
- The next step in the recovery of these species is augmentation of small populations and re-establishment of new populations within the historical range of the species. (USFWS, 1996)
- A research program is also recommended to study the growth and reproductive viability of each taxon, determine the parameters of viable populations of each taxon, study the reproductive strategy and pollinators of each taxon, and study possible pests and diseases. (USFWS, 1996)
- Finally, the recovery criteria should be refined and revised as new information becomes available. (USFWS, 1996)
- Surveys and inventories—Continue to survey for additional populations of *Cyanea mannii* in areas of potentially suitable habitat. Regularly monitor known populations. (USFWS, 2018)
- Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect individuals from the negative impacts of feral ungulates and to prevent imminent extinction in the wild. (USFWS, 2018)
- Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species around all populations. Continue to control invasive nonnative species that compete with the species around all populations. (USFWS, 2018)
- Captive propagation for genetic storage and reintroduction—Begin collection and propagation efforts for maintenance of genetic stock. (USFWS, 2018)
- Reintroduction and translocation—Begin reintroduction of individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2018)
- Fire monitoring and control—Develop and implement fire prevention management plans. (USFWS, 2018)
- Predator and herbivore monitoring and control—Implement effective control methods for rodents at wild and reintroduced populations. Develop and implement effective control methods for slugs. (USFWS, 2018)
- Stochastic events—Build resiliency and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from erosion and drought. (USFWS, 2018)
- Climate change adaptation strategy—Research the suitability of habitat for reintroducing this species in the future due to impacts from climate change. (USFWS, 2018)
- Alliance and partnership development—Continue to initiate, plan, and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2018)
- (USFWS, 2018)
- (USFWS, 2018)

Conservation Measures and Best Management Practices:

- Survey to determine the current status of all wild and reintroduced populations. (USFWS, 2011)
- Monitor known populations. (USFWS, 2011)
- Collect seeds from each population for genetic storage and potentially, for reintroduction. (USFWS, 2011)

- Fence all populations to provide protection from the negative impacts of feral ungulates. (USFWS, 2011)
- Control invasive introduced plant species around all populations. (USFWS, 2011)
- Develop and implement methods to control slugs. (USFWS, 2011)
- Control rats in the vicinity of these populations. (USFWS, 2011)
- Propagate to augment existing populations. (USFWS, 2011)
- Establish additional populations within protected suitable habitat. (USFWS, 2011)
- Work with Hawaii Division of Forestry and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2011)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2011)

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

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SPECIES ACCOUNT: *Cyanea maritae* (haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (R1) (USFWS, 2016)

Physical Description

A shrub in the bellflower family (Campanulaceae). (USFWS, 2012)

Historical Range

Historically, specimens were collected from the northwestern slopes of Haleakala in the Waiohiwi watershed and east to Kipahulu in the early 1900s. (USFWS, 2012)

Current Range

Known only from East Maui. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea maritae* (Haha) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Cyanea maritae* includes six CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Lowland Wet—Unit 1 (and) *Palmeria dolei*—Unit 2—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 2— Lowland Wet This area consists of 6,616 ac (2,677 ha) of State land, 7,425 ac (3,005 ha) of privately owned land, and 2,038 ac (825 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Kipahulu Valley on the northern and eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia samuelii*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *M. ovalis*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 1 is not known to be occupied by the plants *Clermontia oblongifolia* ssp. *mauiensis*, *C. peleana*, *Mucuna sloanei* var. *persericea*, *Phyllostegia haliakalae*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes,

suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 1 (and) *Palmeria dolei*—Unit 10—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 10— Montane Wet This area consists of 1,313 ac (531 ha) of State land and 798 ac (323 ha) of privately owned land, at Haiku Uka on the northern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Cyanea duvalliorum*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *Phyllostegia pilosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 1 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 11—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 11— Montane Wet This area consists of 4,075 ac (1,649 ha) of State land, 9,633 ac (3,898 ha) of privately owned land, and 875 ac (354 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Puukaukanu and upper Waihoi Valley, on the northern and northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Geranium hanaense*, *G. multiflorum*, and *Wikstroemia villosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 2 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea glabra*, *C. maritae*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, and *Schiedea jacobii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 3 (and) *Palmeria dolei*—Unit 12—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 12— Montane Wet This area consists of 2,228 ac (902 ha) of federally owned land (Haleakala National Park) in Kipahulu Valley, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. maritae*, and *Melicope ovalis*, and by the forest bird, *kiwiku* (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 3 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea duvalliorum*, *C. glabra*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest bird, the *akohekohe* (*Palmeria dolei*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 4 (and) *Palmeria dolei*—Unit 13—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 13— Montane Wet This area consists of 180 ac (73 ha) of State land and 1,653 ac (669 ha) of federally owned land (Haleakala National Park), in Kaapahu Valley on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *Cyrtandra ferripilosa*, and *Huperzia mannii*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 4 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea duvalliorum*, *C. glabra*, *C. mceldowneyi*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwiku* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 5 (and) *Palmeria dolei*—Unit 14—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 14— Montane Wet This area consists of 222 ac (90 ha) of State land, and 165

ac (67 ha) of federally owned land (Haleakala National Park), near Kaumakani on the eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plant *Bidens campylotheca* ssp. *pentamera*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 5 is not currently occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea maritae* critical habitat consists of two components. Lowland wet (east Maui) Montane wet (east Maui) (81 FR 17790-18110):

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight

plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; MauiWet

Cliff—Units 6 and 7; and MolokaiMontane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylothea* ssp. *pentamera*, *B. campylothea* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Habitat Narrative

Adult: This species is found in lowland wet and montane wet ecosystems of East Maui (USFWS 2012). (NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2016)

Redundancy:

Very low (inferred from USFWS, 2016)

Number of Populations:

4 (USFWS, 2016)

Population Size:

~50 (USFWS, 2016)

Population Narrative:

Currently, there are 4 occurrences, totaling between 23 and 50 individuals in Kipahulu, Kaapahu, west Kahakapao, and in the Koolau FR. (USFWS, 2016)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs), nonnative plants, landslides, treefalls, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Landslides and treefalls destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response: Predation and herbivory by nonnative animal species (pigs, rats, and slugs) is considered an ongoing threat to *Cyanea maritae* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, rats, and slugs) is considered an ongoing threat to *Cyanea maritae* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor: Small populations (USFWS, 2013)

Exposure:

Response: *Cyanea maritae* faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). The only known wild occurrences are susceptible to threats from habitat

degradation or loss by flooding, landslides, or tree falls, or a combination of these, because of their locations in lowland wet, montane wet, and wet cliff ecosystems (USFWS, 2013).

Consequence:

Narrative: *Cyanea maritae* faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). The only known wild occurrences are susceptible to threats from habitat degradation or loss by flooding, landslides, or tree falls, or a combination of these, because of their locations in lowland wet, montane wet, and wet cliff ecosystems (USFWS, 2013).

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

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U.S. Fish and Wildlife Service. 2016. Endangered and Threatened Wildlife and Plants

Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

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Final Rule. 78 Federal Register 102, May 28, 2013. Pages 32014 - 32065.

SPECIES ACCOUNT: *Cyanea marksii* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/29/2013; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Palm-like trees, 2 m tall. Leaves dimorphic. Juvenile plants with leaf blades 13-18 cm long, 5.5-7 cm wide, upper surface aculeate, lower surface pubescent and aculeate. Mature plants with leaf blades oblong to oblanceolate, 25-31 cm long, 8-12 cm wide, upper surface smooth or muricate, lower surface pubescent. Racemes 5-8-flowered, clustered among the leaves. Corollas blackish purple externally, white within, 70-80 mm long. (NatureServe, 2015)

Taxonomy

This species is related c. *Macrostegia* and c. *Tritomantha*. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Cyanea marksii is endemic to the island of Hawaii in the Hawaiian Islands. It is known only from the district of South Kona, which is on the western flank of Mauna Loa, an active volcano. It has been recorded only from a small portion of South Kona inland

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumps (NatureServe, 2015)

Environmental Specificity

Adult: Medium, with some key requirements (NatureServe, 2015)

Habitat Narrative

Adult: *Cyanea marksii* grows in wet forests on old lava flows. The species has been recorded to be growing "in clumps from one rootstock on fallen moss-covered trunks of *Cibotium* [treefern]" (Rock 1957). (NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

Unknown (NatureServe, 2015)

Population Size:

Unknown (NatureServe, 2015)

Population Narrative:

The current status of the species is unknown, since the area is seldom visited by botanists. The last record of the species was in 1970, when a specimen was collected. (NatureServe, 2015)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs, goats, and cattle), nonnative plants, hurricanes, rockfalls, and landslides. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Rockfalls and landslides destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, cattle, mouflon, rats, and slugs) is considered an ongoing threat to *Cyanea marksii* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor: Small populations (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: *Cyanea marksii* faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). The only known occurrences are threatened either by landslides, rockfalls, inundation by high surf, or erosion, or a combination of these, because of their locations in lowland wet, montane wet, coastal, and dry cliff ecosystems. (USFWS, 2013).

Recovery**Reclassification Criteria:**

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

References

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Accessed August 2016

USFWS. 2016. Environmental Conservation Online System (ECOS) – Species Profile. <http://ecos.fws.gov/ecp0/>. Accessed August 2016

USFWS. 2013. Determination of Endangered Species Status for 15 Species on Hawaii Island

Final Rule. 78 Federal Register 209, October 29, 2013. Pages 64638 - 64690.

SPECIES ACCOUNT: *Cyanea mauiensis* (haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 6/27/2013; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Stout branching or single-stemmed shrubs 1-3.3 m tall. Leaf blades 30-45 cm long, 20-30 cm wide, pinnately divided with 9-12 segments on each side, segments lacinate. Racemes 6-10-flowered. Corollas almost white. (NatureServe, 2015)

Taxonomy

Treated as a synonym within *Cyanea grimesiana* ssp. *grimesiana* in the Hawaii Manual (Wagner et al., 1990); recognized as a species in the Manual's Supplement (Wagner and Herbst, 1999) and by Kartesz (1999 Synthesis). (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Cyanea mauiensis is endemic to the island of Maui in the state of Hawaii. The species has not been observed in about 100 years. (NatureServe, 2015)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Habitat Narrative

Adult: *Cyanea mauiensis* is found in moist to moist-wet forests in gulch and valley bottoms, or on gulch slopes. (NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

None

Redundancy:

None

Number of Populations:

None known (USFWS, 2016)

Population Size:

0 (USFWS, 2016)

Population Narrative:

This species was last observed on Maui about 100 years ago (Lammers 2004, pp. 84–85; TNC 2007). Although there are no documented occurrences of this species known today, botanists believe this species may still be extant as all potentially suitable lowland mesic and dry cliff habitat has not been surveyed. (USFWS, 2016)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs), nonnative plants, fire, landslides, treefalls, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Fire can destroy dormant seeds and plants, even in steep and inaccessible areas. Successive fires can remove habitat for native species by altering microclimate conditions favorable to alien plants. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Landslides and treefalls destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs , rats, and slugs) is considered an ongoing threat to *Cyanea mauiensis* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor: Small populations (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: *Cyanea mauiensis* faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). The last confirmed observation in the wild was over 100 years ago. Botanists believe individuals of this species still remain, as potentially suitable habitat has not been searched. However, there are no tissues, propagules, or seeds in storage or propagation (USFWS, 2013).

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

References

NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Accessed August 2016

USFWS. 2016. Environmental Conservation Online System (ECOS) – Species Profile. <http://ecos.fws.gov/ecp0/>. Accessed August 2016

USFWS. 2016. Endangered and Threatened Wildlife and Plants

Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species. Federal Register 81(61): 17790-18110

USFWS. 2013. Determination of Endangered Status for 38 Species on Molokai, Lanai, and Maui

Final Rule. 78 Federal Register 102, May 28, 2013. Pages 32014 - 32065.

SPECIES ACCOUNT: *Cyanea mceldowneyi* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/15/1992; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Cyanea mceldowneyi, a plant of the bellflower family (Campanulaceae) is an unbranched shrub 2-3 meters (6.6-9.8 feet) tall with rough to prickly stems. Leaves of adult plants are oblong to inverted lance shaped, 20-35 cm (7.9-13.8 in) long, and 5-9 cm (2.0-3.5 in) wide. The leaves have smooth to somewhat rough green upper surfaces and pale green, lightly downy undersides and are characterized by thickened, finely toothed edges and a pointed wedge-shaped base on smooth to rough leaf stalks (petioles) 3.5-6 cm (1.4-2.4 in) long. Juveniles exhibit leaves that are oval to egg shaped (large end at tip), 15-22 cm (5.9-8.7 in) long and 5-9 cm (2.0-3.5 in) wide with prickly green upper surfaces; pale-green, downy and prickly undersides; thickened, toothed edges; and a rounded base on prickly leaf stalks (petioles) 2.5-4.5 cm (1.0-1.8 in) long. Flower clusters (inflorescences) occur on stalks (peduncles) 15-30 mm (0.6-1.2 in) long bearing five to seven flowers, each flower on an individual stalk (pedicel) 10-14 mm (0.4-0.6 in) long. The base of each flower is approximately 5 mm (0.2 in) long and 4 mm (0.2 in) wide. The flowers are partially tubular, curved, rough-surfaced and white with purple longitudinal stripes. Flowers are approximately 40 mm (1.6 in) long and 8 mm (0.3 in) wide, with the spreading lobes being about as long as the tube. The appearance and size of the berries are unknown. (USFWS, 1997)

Taxonomy

Rock (1957) considered this taxon most closely related to *Cyanea rollandioides* Rock, now a synonym of *Cyanea platyphylla* (Gray) Hillebr., endemic to Hawaii Island. St. John and Takeuchi (1987) questioned the distinctions between the two closely related Hawaiian endemic genera, *Cyanea* and *Delissea*. St. John (1987) merged the two genera under the older generic name *Delissea*, creating the new combinations, *Delissea baldwinii* (Forbes and Munro) St. John and *Delissea lobata* (H. Mann) St. John. A recent treatment of the genus *Cyanea* (Lammers in Wagner et al. 1990) did not accept the generic changes proposed by St. John (1987). (USFWS, 1997)

Historical Range

Historically, *Cyanea mceldowneyi* is known from rainforest from west of Waikamoi to Honomanu on northwestern Haleakala, Maui. (USFWS, 1997)

Current Range

Endemic to windward East Maui. (NatureServe, 2015)

Critical Habitat Designated

Yes; 5/14/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea mceldowneyi* (Haha) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes seven detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Cyanea mceldowneyi* includes seven CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Lowland Wet—Unit 1 (and) *Palmeria dolei*—Unit 2—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 2— Lowland Wet This area consists of 6,616 ac (2,677 ha) of State land, 7,425 ac (3,005 ha) of privately owned land, and 2,038 ac (825 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Kipahulu Valley on the northern and eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia samuelii*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *M. ovalis*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 1 is not known to be occupied by the plants *Clermontia oblongifolia* ssp. *mauiensis*, *C. peleana*, *Mucuna sloanei* var. *persericea*, *Phyllostegia haliakalae*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 1 (and) *Palmeria dolei*—Unit 10—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 10— Montane Wet This area consists of 1,313 ac (531 ha) of State land and 798 ac (323 ha) of privately owned land, at Haiku Uka on the northern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Cyanea duvalliorum*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *Phyllostegia pilosa*, and by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 1 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 11—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 11— Montane Wet This area consists of 4,075 ac (1,649 ha) of State land, 9,633 ac (3,898 ha) of privately owned land, and 875 ac (354 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Puukaukanu and upper Waihoi Valley, on the northern and northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Geranium hanaense*, *G. multiflorum*, and *Wikstroemia villosa*, and by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwiku* (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 2 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea glabra*, *C. maritae*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, and *Schiedea jacobii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 3 (and) *Palmeria dolei*—Unit 12—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 12— Montane Wet This area consists of 2,228 ac (902 ha) of federally owned land (Haleakala National Park) in Kipahulu Valley, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. maritae*, and *Melicope ovalis*, and by the forest bird, *kiwiku* (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 3 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea duvalliorum*, *C. glabra*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest bird, the *akohekohe* (*Palmeria dolei*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 4 (and) *Palmeria dolei*—Unit 13—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 13— Montane Wet This area consists of 180 ac (73 ha) of State land and

1,653 ac (669 ha) of federally owned land (Haleakala National Park), in Kaapahu Valley on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *Cyrtandra ferripilosa*, and *Huperzia mannii*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 4 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea duvalliorum*, *C. glabra*, *C. mceldowneyi*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 5 (and) *Palmeria dolei*—Unit 14—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 14—Montane Wet This area consists of 222 ac (90 ha) of State land, and 165 ac (67 ha) of federally owned land (Haleakala National Park), near Kaumakani on the eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units area occupied by the plant *Bidens campylotheca* ssp. *pentamera*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 5 is not currently occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 1 (and) *Palmeria dolei*—Unit 18—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 18—Montane Mesic This area consists of 6,593 ac (2,668 ha) of State land, 707 ac (286 ha) of privately owned land, and 3,672 ac (1,486 ha) of federally owned land (Haleakala National Park), from Kealahou to Puualae, nearly circumscribing the summit of Haleakala on east Maui. These units include the mixed herbland and shrubland, the moisture

regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Asplenium dielirectum*, *A. peruvianum* var. *insulare*, *Clermontia lindseyana*, *Cyanea horrida*, *C. obtusa*, *Cyrtandra ferripilosa*, *C. oxybapha*, *Diplazium molokaiense*, *Geranium arboreum*, *G. multiflorum*, *Huperzia mannii*, *Melicope adscendens*, and *Neraudia sericea*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 1 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Cyanea glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. mceldowneyi*, *Phyllostegia bracteata*, *P. mannii*, *Santalum haleakalae* var. *lanaiense*, *Wikstroemia villosa*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea mceldowneyi* critical habitat consists of three components. Lowland wet (east Maui), Montane wet (east Maui) and Montane mesic (east Maui) (81 FR 17790-18110):

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: *Acacia*, *Ilex*, *Metrosideros*, *Myrsine*, *Nestegis*, *Nothocestrum*, *Pisonia*, *Pittosporum*, *Psychotria*, *Sophora*, *Zanthoxylum*. Subcanopy: *Alyxia*, *Charpentiera*, *Coprosma*, *Dodonaea*, *Kadua*, *Labordia*, *Leptecophylla*, *Phyllostegia*, *Vaccinium*. Understory: Ferns, *Carex*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is

needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass),

and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 925 and 1,280 meters (USFWS, 1997)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1997)

Habitat Narrative

Adult: The habitat of *Cyanea mceldowneyi* is montane wet forest with mixed *Metrosideros* and *Acacia koa*. This species is found in moist and wet forests in gulch bottoms and on gulch sides. A detailed description of the habitat, species composition, etc., in the vicinity is given by Kitayama and Mueller-Dombois (1992). *Cyanea mceldowneyi* typically grows at elevations between 925 and 1,280 meters (3,034 and 4,200 feet). Associated native plants include *Melicope clusifolia*, *Hedyotis*, *Metrosideros polymorpha*, *Acacia koa*, *Clermontia arborescens*, *Diplazium sandwichianum*, *Broussaisia arguta*, *Cibotium*, *Cyrtandra*, *Dicranopteris linearis*, and

Cheirodendron trigynum (USFWS 1992a; HPCC 1994). Associated alien plants include Ageratina adenophora, Rubus argutus, Setaria palmifolia, and Tibouchina herbacea. (USFWS, 1997; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Resiliency:

Low (inferred from USFWS, 2014)

Redundancy:

Low (inferred from USFWS, 2014)

Number of Populations:

13 (USFWS, 2018)

Population Size:

>100 wild (USFWS, 2018)

Population Narrative:

Overall, the numbers of individuals have increased from approximately 60 wild individuals reported in the previous 5-year review to more than 100 wild individuals (USFWS 2012). There are currently 3 known occurrences and 1 historical occurrence. (USFWS, 2014; NatureServe, 2015); The previous 5-year review reported three new populations of Cyanea mceldowneyi on private land totaling 22 mature individuals, two immature individuals, and two seedlings. Between 2012 and 2013, four new populations were observed at Honomāʻele Stream (one individual), Kawakoe Gulch (five sites, four in poor health), Kūhiwa Valley, and in the Koʻolau Forest Reserve (scattered individuals) (NTBG 2012, 2013a, b; PEPP 2013). Currently, all known populations on east Maui are estimated to total just over 100 individuals (Oppenheimer 2018, in litt.). (USFWS, 2018)

Threats and Stressors

Stressor: Climate change (USFWS, 2014; USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under

climate change. The assessment by Fortini et al. (2013) concluded that *C. mceldowneyi* is moderately vulnerable to the impacts of climate change. Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2014); The assessment by Fortini et al. (2013) concluded that *Cyanea mceldowneyi* is vulnerable to the impacts of climate change, with a vulnerability score of 0.531 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2018)

Stressor: Herbivory by slugs (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Herbivory by slugs has been reported as a new threat to this species (PEPP 2009). (USFWS, 2014)

Stressor: Herbivory by rats (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Predation or herbivory by rats have been reported as a threat to this species (PEPP 2009). (USFWS, 2014)

Stressor: Non-native invasive plants (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Newly observed invasive introduced plants that are a threat to *C. mceldowneyi* include *Hedychium coronarium* (white ginger), *Spathiphyllum cannifolium* (spathe flower), and *Psidium cattleianum* (strawberry guava) (PEPP 2013). (USFWS, 2014)

Stressor: Flooding (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Flooding is a threat to this species (PEPP 2013). (USFWS, 2014)

Stressor: Feral pigs (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: Habitat degradation and physical destruction by feral pigs is the major threat to *Cyanea mceldowneyi*. This species has undergone a substantial decline since the late 1970s in the vicinity of the Lower Waikamoi Flume, clearly attributable to direct impacts of feral pigs (A.C. Medeiros and R.W. Hobdy, personal communication 1994). (USFWS, 1997)

Stressor: Alien plants (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: Habitat degradation by feral pigs works in concert with invasion of alien plant species. As of 1994, palm grass (*Setaria palmifolia*) is rapidly spreading unchecked into the habitat of *Cyanea mceldowneyi*. Palm grass invades the stream banks where *C. mceldowneyi* grows, forming dense stands and displacing native vegetation. (USFWS, 1997)

Stressor: Lack of adequate hunting regulations (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Six of the 13 locations where *Cyanea mceldowneyi* is found on east Maui are within a State hunting area. Nonnative feral ungulates pose a major ongoing threat to native species through destruction and modification of habitat, and through direct herbivory or predation. Habitat destruction and modification by pigs and goats has been noted as a threat to the species. Only two populations are within fenced habitat in Hanawā Natural Area Reserve (NAR). In addition, public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations are at risk (DLNR 2010). (USFWS, 2018)

Recovery**Reclassification Criteria:**

1. A total of five to seven populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1997)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)
2. Each population must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)
3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1997)

Recovery Actions:

- Protect habitat of known populations of *Cyanea mceldowneyi*, especially the large population. (USFWS, 1997)

- Construct a series of exclosures to protect extant populations in the lower Waikamoi area. (USFWS, 1997)
- Establish new outplanted populations within protected (i.e., fenced) appropriate habitat in the Waikamoi area. Some of the same areas could also be used for outplanting *Clermontia oblongifolia* ssp. *mautensis*. Do weed control if it is needed and can be done without undue ground disturbance. (USFWS, 1997)
- Determine status of Honomanu population and manage appropriately. If this population is extant and pigs are present, consider low-impact construction of woven-wire exclosure to protect from feral pigs. Do weed control if needed and practical without undue ground disturbance. (USFWS, 1997)
- Surveys and inventories—Continue to survey for additional populations of *Cyanea mceldowneyi* in areas of potentially suitable habitat. Regularly monitor known populations. (USFWS, 2018)
- Ungulate monitoring and control—Fence known populations to protect them from the impacts of feral ungulates. (USFWS, 2018)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. Control invasive nonnative species that compete with the species around all populations, especially focusing on *Clidemia hirta* (Koster's curse), *Tibouchina herbacea* (glorybush), and *Hedychium gardnerianum* (kahili ginger). (USFWS, 2018)
- Predator and herbivore monitoring and control—Implement effective control methods for rodents at wild and reintroduced populations. Develop and implement effective control methods for slugs. (USFWS, 2018)
- Captive propagation for genetic storage and reintroduction—Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. Evaluate genetic resources currently in storage to determine the effects of long-term storage due to this species' vulnerability to climate change. (USFWS, 2018)
- Reintroduction and translocation—Begin reintroduction of individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2018)
- Population viability monitoring and analysis—Monitor all wild populations on east Maui. (USFWS, 2018)
- Climate change adaptation strategy—Research the suitability of habitat for reintroducing this species in the future due to impacts from climate change. (USFWS, 2018)
- Alliance and partnership development—Continue to initiate, plan, and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2018)

Conservation Measures and Best Management Practices:

- Continue surveying geographical and historical range for a current assessment of the species' status. (USFWS, 2014)
- Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. (USFWS, 2014)
- Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change. (USFWS, 2014)
- Fence remaining populations to protect them from the impacts of feral ungulates. (USFWS, 2014)

- Control invasive introduced plant species within the vicinity of all known individuals especially focusing on *Clidemia hirta* (Koster's curse), *Tibouchina herbacea* (glorybush), and *Hedychium gardnerianum* (kahili ginger) (PEPP 2013). (USFWS, 2014)
- Control slugs and rodents within the vicinity of all known *C. mceldowneyi* populations. (USFWS, 2014)
- Monitor wild populations on East Maui. (USFWS, 2014)
- Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. (USFWS, 2014)
- Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2014)

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

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SPECIES ACCOUNT: *Cyanea munroi* (haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (Region 1) (USFWS, 2016a)

Physical Description

Cyanea munroi (haha), a short-lived perennial shrub in the bellflower family (Campanulaceae). (USFWS, 2016b)

Taxonomy

Treated as a synonym within *Cyanea grimesiana* ssp. *grimesiana* in the Hawaii Manual (Wagner et al., 1990); recognized as a distinct species in the Manual's Supplement (Wagner and Herbst 1999) and by Kartesz (1999, Synthesis). (NatureServe, 2015)

Historical Range

Endemic to Molokai and Lanai. (NatureServe, 2015)

Current Range

Endemic to Molokai and Lanai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea munroi* (haha) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Cyanea munroi* includes three CHUs in Maui County, Hawaii with detailed unit information. There are also an unknown number of units on Lanai that contain this species (number of units is unknown because detailed unit descriptions for Lanai are not available). Note also that *C. munroi* is used as the abbreviated plant name in some of the detailed unit descriptions and it is unclear if these refer to *Cyanea munroi* or *Cyrtandra munroi* (or both) as both species are found in the Wet cliff ecosystem (81 FR 17790-18110).

Molokai—Wet Cliff—Unit 1 (and) *Palmeria dolei*—Unit 43—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 43—Wet Cliff This area consists of 1,395 ac (565 ha) of State land, and 212 ac (86 ha) of privately owned land, and encircles the plateau between Pelekunu and Wailau valleys, in north-central Molokai. These units are occupied by the plants *Brighamia rockii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea munroi*, and *Hibiscus arnottianus* ssp. *immaculatus*, and include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations Although Molokai—Wet Cliff—Unit 1 is not known to be occupied by

Cyanea grimesiana ssp. *grimesiana*, *Hesperomannia arborescens*, *Phyllostegia hispida*, *Pteris lidgatei*, or *Stenogyne bifida*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Wet Cliff—Unit 2 (and) *Palmeria dolei*—Unit 44—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 44—Wet Cliff This area consists of 462 ac (187 ha) of State land, and 806 ac (326 ha) of privately owned land (partly within The Nature Conservancy's Pelekunu Preserve), along the rim of Pelekunu Valley from Kipapa Ridge to Mapulehu, in central Molokai. These units are occupied by the plants *Clermontia oblongifolia* ssp. *brevipes* and *Phyllostegia hispida*, and include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Wet Cliff—Unit 2 is not known to be occupied by *Brighamia rockii*, *Canavalia molokaiensis*, *Cyanea grimesiana* ssp. *grimesiana*, *C. munroi*, *Hesperomannia arborescens*, *Hibiscus arnottianus* ssp. *immaculatus*, *Pteris lidgatei*, or *Stenogyne bifida*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Wet Cliff—Unit 3 consists of 1,137 ac (460 ha) of State land, and 225 ac (91 ha) of privately owned land, along the rim of Wailau Valley from Mapulehu to Kahiwa Gulch, in eastern Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Molokai—Wet Cliff—Unit 3 is not known to be occupied by *Brighamia rockii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea grimesiana* ssp. *grimesiana*, *C. munroi*, *Hesperomannia arborescens*, *Hibiscus arnottianus* ssp. *immaculatus*, *Phyllostegia hispida*, *Pteris lidgatei*, or *Stenogyne bifida*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea munroi* critical habitat consists of one component. Wet cliff (Lanai and Molokai) (81 FR 17790-18110):

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaisia*,

Cheirodendron, Leptecophylla, Metrosideros. Understory: Bryophytes, Ferns, Coprosma, Dubautia, Kadua, Peperomia.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into

native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 200 and 730 meters (NatureServe, 2015)

Habitat Narrative

Adult: This species is found in mesic to wet forests at elevations between 200-730 meters. (NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Resiliency:**

Very low (inferred from NatureServe, 2015)

Redundancy:

Very low (inferred from NatureServe, 2015)

Number of Populations:

1 (NatureServe, 2015)

Population Size:

2 individuals (NatureServe, 2015)

Population Narrative:

No individuals known on Molokai (last observed in 2001), and only two individuals on Lanai at a single location (TNC 2007; HBMP 2008; Oppenheimer 2010; Perlman 2008.; Wood 2009 cited by USFWS 2012). (NatureServe, 2015)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (goats and axis deer), nonnative plants, treefalls, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Treefalls destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (goats, axis deer, rats, and slugs) is considered an ongoing threat to *Cyanea munroi* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor: Small populations (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: *Cyanea munroi* faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). The only known wild occurrences are susceptible to threats from habitat degradation or loss by flooding, landslides, or tree falls, or a combination of these, because of their locations in lowland wet, montane wet, and wet cliff ecosystems (USFWS, 2013).

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

References

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species. Federal Register 81(16): 17790-18110.

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

Final Rule . 81 FR 17790-18110 (March 30, 2016).

NatureServe. 2015. NatureServe Explorer: an encyclopedia of life [web application]. Accessed August 2016

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Final Rule. 78 Federal Register 102, May 28, 2013. Pages 32014 - 32065.

SPECIES ACCOUNT: *Cyanea obtusa* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

A branched shrub, 2-5 m tall. Racemes axillary, with 6-12 flowers. Corollas purplish. (NatureServe, 2015)

Taxonomy

Genus endemic to Hawaiian islands, species endemic to Maui. (NatureServe, 2015)

Current Range

Endemic to the island of Maui in the state of Hawaii, the species is still extant on both West Maui and East Maui. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea obtusa* (Haha) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Cyanea obtusa* includes three CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Lowland Dry—Unit 5 consists of 3,615 ac (1,463 ha) of State land, and 43 ac (17 ha) of privately owned land, from Panaewa to Manawainui on the western and southern slopes of west Maui. This unit is occupied by the plants *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, *Cenchrus agrimonioides*, *Gouania hillebrandii*, *Kadua coriacea*, *Remya mauensis*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and *Tetramolopium capillare*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 5 is not known to be occupied by *Ctenitis squamigera*, *Cyanea obtusa*, *Hesperomannia arbuscula*, *Hibiscus brackenridgei*, *Lysimachia lydgatei*, *Neraudia sericea*, *Schiedea salicaria*, *Sesbania tomentosa*, or *T. remyi*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 6 consists of 3 ac (1 ha) of State land, and 237 ac (96 ha) of privately owned land, from Paleaahu Gulch to Puu Hona on the southern slopes of west Maui. This unit is occupied by the plants *Hibiscus brackenridgei* and *Schiedea salicaria*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 6 is not known to be occupied by *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, *Cenchrus agrimonoides*, *Ctenitis squamigera*, *Cyanea obtusa*, *Gouania hillebrandii*, *Hesperomannia arbuscula*, *Kadua coriacea*, *Lysimachia lydgatei*, *Neraudia sericea*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Spermolepis hawaiiensis*, *Tetramolopium capillare*, or *T. remyi*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 1 (and) *Palmeria dolei*—Unit 18—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 18—Montane Mesic This area consists of 6,593 ac (2,668 ha) of State land, 707 ac (286 ha) of privately owned land, and 3,672 ac (1,486 ha) of federally owned land (Haleakala National Park), from Kealahou to Puualae, nearly circumscribing the summit of Haleakala on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Asplenium dielerectum*, *A. peruvianum* var. *insulare*, *Clermontia lindseyana*, *Cyanea horrida*, *C. obtusa*, *Cyrtandra ferripilosa*, *C. oxybapha*, *Diplazium molokaiense*, *Geranium arboreum*, *G. multiflorum*, *Huperzia mannii*, *Melicope adscendens*, and *Neraudia sericea*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 1 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Cyanea glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. mceldowneyi*, *Phyllostegia bracteata*, *P. mannii*, *Santalum haleakalae* var. *lanaiense*, *Wikstroemia villosa*, or *Zanthoxylum hawaiiense*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea obtusa* critical habitat consists of two components. Lowland dry (west Maui) Montane mesic (east Maui) (81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*. Subcanopy: *Chamaesyce*, *Dodonaea*, *Leptecophylla*,

Osteomeles, Psydrax, Scaevola, Wikstroemia. Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Sicyos.

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: Acacia, Ilex, Metrosideros, Myrsine, Nestegis, Nothocestrum, Pisonia, Pittosporum, Psychotria, Sophora, Zanthoxylum. Subcanopy: Alyxia, Charpentiera, Coprosma, Dodonaea, Kadua, Labordia, Leptecophylla, Phyllostegia, Vaccinium. Understory: Ferns, Carex, Peperomia.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative

ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 902 and 1,487 meters. (NatureServe, 2015)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: Cyanea obtusa is found along moist gulch slopes in Metrosidero polymorpha mixed mesic forests at an elevation of 951 meters. It has also been observed on steep sections of watercourses in Metrosideros-Acacia-Cheirodendron montane mesic forests at an elevation of 902-1,487 meters (Russell 2004). (NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Resiliency:

Very low (inferred from NatureServe, 2015)

Redundancy:

Very low (inferred from NatureServe, 2015)

Population Growth Rate:

Unknown (NatureServe, 2015)

Number of Populations:

1 (USFWS, 2016)

Population Size:

1-30 (USFWS, 2016; NatureServe, 2015)

Population Narrative:

In 1999, additional plants were found, increasing the known populations to six and the known number of individuals to approximately 30 (Russell 2002, Russell 2004). Currently, this species is known from one occurrence of only a few individuals in the montane mesic ecosystem on east Maui. (NatureServe, 2015; USFWS, 2016)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs, goats, axis deer, and cattle), nonnative plants, fire, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Fire can destroy dormant seeds as well as plants themselves, even in steep or inaccessible areas. Successive fires that burn farther and farther into native habitat destroy native plants and remove habitat for native species by altering microclimate conditions favorable to alien plants. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, goats, axis deer, cattle, rats, and slugs) is considered an ongoing threat to *Cyanea obtusa* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor: Small populations and hybridization (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: *Cyanea obtusa* faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). *Cyanea obtusa* is susceptible to predation by feral pigs, goats, axis deer, and cattle, and to direct destruction and habitat degradation and loss by fire because the only two known individuals of this species are not protected from direct predation by ungulates, or from fire. Hybridization will adversely impact this species because it may lead to extinction of one or both of the original genotypically distinct species. On east Maui, the species *Cyanea obtusa* is known from two individuals, but only hybrids between *C. obtusa* and the more abundant *C. elliptica* are known on west Maui (USFWS, 2013).

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

References

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Final Rule. 78 Federal Register 102, May 28, 2013. Pages 32014 - 32065.

SPECIES ACCOUNT: *Cyanea pinnatifida* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/29/1991; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

A shrub 0.8-3 m tall. Stems are unbranched or sparingly branched. Slightly curved flowers are greenish white with purplish stripes at the base. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Endemic to the Waianae Mountains of Oahu. The last known wild individual died in 2001, although the species remains in cultivation (USFWS, 2012).

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea pinnatifida* (Haha) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Cyanea pinnatifida* (77 FR 57648-57862). The critical habitat designation includes 3 critical habitat units, which encompass approximately 5,884 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Cyanea pinnatifida* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Cyanea pinnatifida* includes 3 critical habitat units, covering one ecosystem type, which encompasses approximately 5,884 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea pinnatifida* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Cyanea pinnatifida* was known historically (last observed > 20 yrs ago) from indicated ecosystem in the Waianae Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Cyanea pinnatifida* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (NatureServe, 2015)

Reproduction Narrative

Adult: This species reproductive strategy is sexual. This species has been observed flowering in August (BISH 24360). (USFWS, 1998; NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 490 and 520 meters (USFWS, 1998)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1998)

Habitat Narrative

Adult: *Cyanea pinnatifida* typically grows on steep, shady ravines, wet, rocky slopes in diverse mesic forest at an elevation of 490 to 520 meters (1,600 to 1,700 feet) in association with mamaki and ferns (USFWS 1995). (USFWS, 1998)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Resiliency:

Very low (inferred from USFWS, 2014)

Redundancy:

Very low (inferred from USFWS, 2014)

Number of Populations:

2 (USFWS, 2014)

Population Size:

~20 (USFWS, 2014)

Population Narrative:

In 2008, there were two populations of *Cyanea pinnatifida* at Ekahanui at Honouliuli and at the reintroduction site at Kaluaa containing approximately 10 individuals at each population totaling 20 individuals (Plant Extinction Prevention Program 2008). In 2010, 10 individuals remained at the reintroduction site at Kaluaa (Plant Extinction Prevention Program 2010); the number of individuals at Ekahanui was not reported. (USFWS, 2012)

Threats and Stressors

Stressor: Feral pigs (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: As early as 1778, European explorers introduced livestock, which became feral, increased in number and range, and caused significant changes to the natural environment of Hawaii. The pig is originally native to Europe, northern Africa, Asia Minor, and Asia. European pigs became feral and invaded forested areas, especially wet and mesic forests and dry areas at high elevations. Feral pigs are currently present on Oahu and inhabit rain forests and grasslands. While rooting in the ground in search of the invertebrates and plant material they eat, feral pigs disturb and destroy vegetative cover, trample plants and seedlings, and threaten forest regeneration by damaging seeds and seedlings. They disturb soil and cause erosion, especially on slopes. Alien plant seeds are dispersed on their hooves and coats as well as through their

digestive tracts, and the disturbed soil is fertilized by their feces, helping these plants to establish. Feral pigs are a primary vector in the spread of many introduced plant species (Smith 1985; Stone 1985; Medeiros et al. 1986; Scott et al. 1986; Tomich 1986; Cuddihy and Stone 1990; Wagner et al. 1999). Currently, the individuals of *C. pinnatifida* outplanted in Honouliuli Preserve are threatened by feral pigs that degrade the habitat. (USFWS, 2007)

Stressor: Alien plants (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: At the time of listing, *Cyanea pinnatifida* was threatened by competition with and habitat degradation by alien plants such as *Clidemia hirta* (Koster's curse) (56 FR 55770). Currently, the nonnative plant species that impact the historical range and the outplanting area in Honouliuli are *Clidemia hirta*, *Passiflora suberosa* (huehue haole), *Melinis minutiflora* (molasses grass), *Psidium cattleianum* (strawberry guava), *Psidium guajava* (common guava), and *Schinus terebinthifolius* (Christmas berry) (TNCH 2006b). The outplanting site mentioned above is maintained by periodic weed control (TNCH 2006b). (USFWS, 2007)

Stressor: Herbivory by rats and slugs (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: In 1998 when the Recovery Plan was published, *Cyanea pinnatifida* was potentially threatened by predation by rats and slugs (Service 1998). Rats occur on all the main Hawaiian Islands around human habitations, in cultivated fields, and in dry to wet forests. Rats are known to eat the fruit and strip the bark of some native plants, particularly fruits of plants in the bellflower (Campanulaceae) family with fleshy stems and fruits (Tomich 1986; Cuddihy and Stone 1990). Rats are being controlled at the outplanting area by the use of bait stations and snap traps as part of the habitat protection program at Honouliuli Preserve (TNCH 2006b). New information in the U.S. Army's 2005 Status Report for the Makua Implementation Plan indicates that slugs can be a threat to all species of *Cyanea* (Makua Implementation Team 2003). Field experiments conducted by Alvin Yoshinaga and Curt Daehler demonstrated that slugs could reduce the survival of *Cyanea* spp. seedlings by as much as 80 percent (Makua Implementation Team 2003). Graduate student Stephanie Joe has been recently hired by the Army as a Natural Resources Research Specialist, and included among her duties is the investigation of control of slug herbivory. Her research on slug impacts on *Cyanea* seedlings has revealed similar levels of mortality, approximately 53 percent (Joe 2006). (USFWS, 2007)

Stressor: Small population size and local catastrophes (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Species like *Cyanea pinnatifida* that are endemic to a small portion of a single island are inherently more vulnerable to extinction than widespread species because of higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes and disease outbreaks. All of the existing plants descend from a cutting that was collected from one known wild plant (Service 2005; Nellie Sugii, Lyon Arboretum, pers. comm. 2006). *Cyanea pinnatifida* was also threatened by collection and

trampling by humans on or near trails (Factor E), but the current outplanting site is fenced (TNCH 2006b). When the Recovery Plan was published in 1998, the last individual of *C. pinnatifida* was located on the side of a gulch wall and was threatened by mortality due to environmental disturbances such as washouts and falling rocks and trees, but this type of disturbance does not affect the current outplanting site (Service 1998; TNCH 2006b). (USFWS, 2007)

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2012)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1998)

Recovery Actions:

- Surveys are needed of appropriate habitat in historical locations to determine if any other extant populations of this plant exist. (USFWS, 1998)
- Monitor the remaining wild plant for changes in status and threats and implement management actions to protect remaining wild plant, if possible. Potential management actions include weeding and control of feral pigs, slugs, and rats if they are determined to be threats. (USFWS, 1998)

- Monitor the remaining wild plant for changes in reproductive status. Collect seeds for ex-situ propagation if fruits are produced. Continue cloning if feasible. (USFWS, 1998)
- Enhance wild populations and establish new populations. Once adequate propagated material is available, and fencing, rat control, and weed control, as appropriate, are underway in the area of the remaining in situ population, these populations should be enhanced by outplanting. Establishment of new populations within the historical range of *Cyanea pinnatifida* should be initiated in areas that are managed to minimize the impacts of feral ungulates, rats and alien plants. (USFWS, 1998)

Conservation Measures and Best Management Practices:

- Formulate a plan to maintain or increase genetic variability of *Cyanea pinnatifida*. (USFWS, 2007)
- Conduct surveys of appropriate habitat in historical locations to determine if any other extant populations of *Cyanea pinnatifida* exist. (USFWS, 2007)
- Reintroduce additional populations of *Cyanea pinnatifida* within its historical range. (USFWS, 2007)
- Continue to collect seeds from tagged individuals, keeping close track of the maternal source for use in ex situ propagation. Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation. (USFWS, 2012)
- Reintroduce the species back into its known historical range. (USFWS, 2012)
- Control invasive introduced plant species around reintroduced populations. (USFWS, 2012)
- Conduct research to develop a plan to maintain or increase genetic variability of *Cyanea pinnatifida*. (USFWS, 2012)
- Conduct thorough surveys of all suitable habitats where *Cyanea pinnatifida* was historically seen. (USFWS, 2012)
- Conduct studies to develop and implement control methods for slugs around all known populations. (USFWS, 2012)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2012)
- Develop and implement effective measures to reduce the impact of drought and landslides and flooding. (USFWS, 2012)
- Work with the Hawaii Division of Forestry and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2012)

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USFWS. 2012. *Cyanea pinnatifida* (Haha) 5-Year Review Short Form Summary. Pacific Islands Fish and Wildlife Office (PIFWO), Honolulu, Hawaii

USFWS. 2007. *Cyanea pinnatifida* (Haha) 5-Year Review Summary and Evaluation. Pacific Islands Fish and Wildlife Office Honolulu, Hawaii

USFWS. 1998. Recovery Plan for Oahu Plants. U.S. Fish and Wildlife Service, Portland, OR

SPECIES ACCOUNT: *Cyanea platyphylla* (Aku aku, haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Cyanea platyphylla, of the bellflower family, is an unbranched palm-like shrub 1 to 3 m (3 to 10 ft) tall with stems that are covered with short, sharp, pale spines on the upper portions, especially as juveniles. This species has different leaves in the juvenile and adult plants. The juvenile leaves are 10.5 to 25 cm (4.1 to 10 in) long and 4 to 7.5 cm (1.6 to 3.0 in) wide, with prickles on leaves and stalks. Adult leaves are 34 to 87 cm (13 to 34 in) long and 7 to 22 cm (2.8 to 8.7 in) wide, and are only sparsely prickled. Six to 25 flowers are clustered on the end of a main stalk 20 to 90 cm (8 to 35 in) long, and each flower has a stalk 1 to 2.5 cm (0.4 to 1 in) long. The hypanthium is topped by five small, triangular calyx lobes. Petals, which are white or yellowish white with magenta stripes, are fused into a curved tube with five spreading lobes. The corolla is 4.2 to 5.4 cm (1.7 to 2.1 in) long and 5 to 10 mm (0.2 to 0.4 in) wide. Berries are pale orange, 8 to 10 mm (0.3 to 0.4 in) long, and 6 to 8 mm (0.2 to 0.3 in) wide. (USFWS, 1996)

Taxonomy

Asa Gray named *Delissea platyphylla* in 1861 from a specimen collected by Horace Mann and W.T. Brigham in the Puna District of the island of Hawaii. Wilhelm Hillebrand (1888) transferred the species to *Cyanea*, creating *Cyanea platyphylla*. Harold St. John (1987a, St. John and Takeuchi 1987), believing there to be no generic distinction between *Cyanea* and *Delissea*, transferred the species back in 1987 to the genus *Delissea*, the older of the two generic names. The current treatment of the family (Lammers 1990), however, maintains the separation of the two genera. The following taxa have been synonymized with *Cyanea platyphylla*: *C. bryanii*, *C. crispohirta*, *C. fernaldii*, *C. nolimetangere*, *C. pulchra*, and *C. rollandioides*. (USFWS, 1996)

Historical Range

Historically, *Cyanea platyphylla* was found in the Kohala Mountains near Hiilawe Falls and also the Hamakua Ditch Trail; in Honaunau; in the Puna District near Glenwood, on Kalapana Road in Pahoia, and in Puu Kauka; in Waiakea Forest Reserve; and in an unknown location called "Kalanilehua" (I-IHP 1991a1—1991a4, 1991a7, 1991a8, 1991a11, 1991a12, 1993b; Rock 1917, 1919, 1957; Skottsberg 1926; Wimmer 1943, 1968). (USFWS, 1996)

Current Range

Current range: Island of Hawaii. (NatureServe, 2015)

Critical Habitat Designated

Yes; 7/2/2003.

Legal Description

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Cyanea platyphylla* on the island of Hawaii (68 FR 39623 - 39722).. This rule designates critical habitat for a total of nine populations of this species, each with 300 mature, reproducing individuals.

Critical Habitat Designation

The critical habitat designation for *Cyanea platyphylla* includes two units totaling 7,234 acres in Hawaii county, Hawaii. The units are Hawaii 3—*Cyanea platyphylla*—a and Hawaii 29—*Cyanea platyphylla*—b. Both units are currently occupied. Each unit is essential to the conservation of *C. platyphylla* because it supports an extant colony of this island-endemic species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. These units are geographically separated to avoid their destruction by one naturally occurring catastrophic event.

Hawaii 3—*Cyanea platyphylla*—a [1,403 ha (3,467 ac)]: This unit contains a portion of Haakoa, Kaiwilahilahi, and Kilau streams and is bordered in the northwest by Laupahoehoe watershed and in the southeast by Maulua watershed. It also contains portions of Haakoa, Kaiwilahilahi, Kilau, Manowaiopae, and Pahale watersheds. The unit lies almost completely within Laupahoehoe NAR with a small portion in the northwest in the Hilo Forest Reserve. This unit provides habitat for three populations of 300 individuals of *C. platyphylla* and is currently occupied by 57 individuals.

Hawaii 29—*Cyanea platyphylla*—b [1,524 ha (3,767 ac)]: This unit contains Waterhole Spring, a portion of the Wailuku River, and a branch of the Kalohehewa Stream. It lies completely within the Wailuku watershed. The unit also lies almost completely within the Hilo Forest Reserve. This unit provides habitat for 6 populations of 300 individuals of *C. platyphylla*; and is currently occupied by 1 individual.

Primary Constituent Elements/Physical or Biological Features

Habitat features that are essential for this species include, but are not limited to, open *Metrosideros polymorpha*-*Acacia koa* lowland and montane wet forests.

Special Management Considerations or Protections

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for this species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources**

Reproduction Narrative

Adult: Specimens annotated at Bishop Museum by the specialist Dr. Thomas Lammers show the flowering cycle to be essentially year-round, with only the months of April and June not being represented by flowering specimens (Bishop Museum 2011). In contrast, fruiting material is rare, known only in February and March (Bishop Museum 2011; National Tropical Botanical Garden 2011). (USFWS, 2012)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 615 and 1,082 meters (USFWS, 2012)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1996)

Habitat Narrative

Adult: *Cyanea platyphylla* is typically found in *Metrosideros polymorpha* (ohia)-*Acacia koa* (koa) Lowland and Montane Wet Forests on gentle slopes and gulch sides. The elevational range of the species as most recently understood is approximately 615 to 1,082 meters (2,017 to 3,551 feet) (USFWS 2003), which corresponds to rainfall averages of 1,200 to 3,800 mm (47 to 150 in) a year (USFWS 1998). The soil groups from which *Cyanea platyphylla* has been recorded includes typic tropofolists, lithic tropofolists, typic hydrandepts, and histic plaqaquepts (Hawaii Biodiversity and Mapping Program 2010). Associated taxa include *Cibotium* sp. (hapuu), *Athyrium sandwichianum* (hoio), *Antidesma* sp. (hame), *Clermontia* spp. (oha wai), *Hedyotis* sp. (pilo), and *Cyrtandra* spp. (haiwale) (HHP 1991a6; HPCC 1991a). (USFWS, 1996; USFWS, 2012)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2012)

Redundancy:

Very low (inferred from USFWS, 2012)

Number of Populations:

2 (USFWS, 2012)

Population Size:

<100

Population Narrative:

In 2010, the Plant Extinction Prevention Program (2010) reported possibly finding a single new individual, for a total of 13 wild individuals in 2 populations. Currently, fewer than 100 plants are known at just a couple of locations. (USFWS, 2012)

Threats and Stressors

Stressor: Feral pigs (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Disturbance by feral pigs (*Sus scrofa*) (Hawaii Biodiversity and Mapping Program 2010; USFWS 1996; Plant Extinction Prevention Program 2009) is a threat to *C. platyphylla*. (USFWS, 2012)

Stressor: Invasive plant species (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Established ecosystem-altering invasive plant species degradation of habitat (Hawaii Biodiversity and Mapping Program 2010; USFWS 1996, 2002; Plant Extinction Prevention Program 2009; National Tropical Botanical Garden 2011) including *Angiopteris evecta* (mule's-foot fern), *Clidemia hirta* (Koster's curse), *Cyathea cooperi* (Australian tree fern), *Psidium cattleianum* (strawberry guava), *Psidium guajava* (guava) o *Rubus rosifolius* (thimbleberry), and *Tibouchina herbacea* (cane ti, cane tibouchina, glorybush). (USFWS, 2012)

Stressor: Volcanic activity (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Degradation of habitat by volcanic activity (USFWS 1996; Plant Extinction Prevention Program 2009) is a threat to *C. platyphylla*. (USFWS, 2012)

Stressor: Rodent herbivory (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Rodent predation or herbivory are potentially a threat to *C. platyphylla*. (USFWS 1996; Plant Extinction Prevention Program 2009). (USFWS, 2012)

Stressor: Small population size (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Low numbers – increased likelihood of stochastic extinction due to changes in demography, the environment, genetics, or other factors (USFWS 1996; Plant Extinction Prevention Program 2009). (USFWS, 2012)

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2012)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on the Big Island and at least one other island where it now occurs or occurred historically, if it is not endemic to the Big Island. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1996)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1996)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on the Big Island and at least 1 other island where they now occur or occurred historically, if it is not endemic to the Big Island. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 individuals per population for short-lived perennials. (USFWS, 1996)
3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1996)

Recovery Actions:

- Remove alien plants inside completed exclosures. The fenced areas should be surveyed for strawberry guava, guava, sweet granadilla, and thimbleberry, and other alien plants. Efforts should be made to remove and prevent reintroduction of alien plants. (USFWS, 1996)
- Outplant new populations in area of reduced threat. Attempts should be made to establish this species in outplanting sites free from impacts of feral ungulates and rats. Prior to

outplanting, the sites should be fenced and ungulates and alien plants should be removed. (USFWS, 1996)

- Reduce threats from rodent predation. Steps should be taken to control rats within and surrounding the exclosures. This should include the use of the currently approved Diphacinone bait blocks and ultimately a more broad-scale method such as aerial dispersal of rodenticide. (USFWS, 1996)

Conservation Measures and Best Management Practices:

- Increase the number of individuals in ex situ propagation. Continue to collect seed and cuttings from all existing individuals in the wild and ex situ, and closely monitor the crossing process during propagation to maximize the genetic variation among offspring. (USFWS, 2012)
- Continue to reintroduce the species back into its historical native range of the species. (USFWS, 2012)
- Identify new sites within the historical range of the species to establish additional reintroductions. (USFWS, 2012)
- Control invasive introduced plant species around all populations. (USFWS, 2012)
- Build exclosure fences around each ex situ population to exclude ungulate species. Monitor exclosure fences after completion for signs of breaching. Continue to maintain fenced exclosures around all populations. (USFWS, 2012)
- Protect all populations against disturbances from feral ungulates. (USFWS, 2012)
- Resurvey the historical range of *Cyanea platyphylla* for populations that may have been overlooked previously. (USFWS, 2012)
- Study existing populations in the field to determine what species of insect or bird pollinate the species. (USFWS, 2012)
- Monitor existing wild populations for evidence of decline due to insects or disease, respond with control as needed. Monitor existing wild and introduced populations for predation or herbivory by rats, if rats are impacting the species implement effective control methods. (USFWS, 2012)
- Work with the Hawaii Division of Forestry and Wildlife and other land managers to continue implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2012)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2012)

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SPECIES ACCOUNT: *Cyanea procera* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/08/1992; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Cyanea procera, a member of the bellflower family, is a palm-like tree 3 to 9 m (10 to 30 ft) tall with stalkless, lance-shaped leaves 60 to 75 cm (24 to 30 in) long and 10 to 17 cm (3.9 to 6.7 in) wide with tiny hardened teeth along the margins. Each flower cluster has a stalk 25 to 40 mm (1.0 to 1.6 in) long and comprises 10 to 20 flowers, each on a stalk 6 to 10 mm (0.2 to 0.4 in) long. Each flower has a hypanthium, 15 to 20 mm (0.6 to 0.8 in) in length and 8 to 13 mm (0.3 to 0.5 in) in width, topped by shallow triangular calyx lobes 3 to 4 mm (0.1 to 0.2 in) long and about 4 to 5 mm (0.2 in) wide. The purplish corolla forms an early upright or slightly curved tube 60 to 80 mm (2.4 to 3.1 in) long and 6 to 11 mm (0.2 to 0.4 in) wide, which ends in five downwardly curving lobes that make the flower appear one-lipped. The ellipse- or egg-shaped berries are 3.0 to 4.5 cm (1.2 to 1.8 in) long and 2.0 to 2.8 cm (0.8 to 1.1 in) wide. This species can be distinguished from other species of the genus and from *C. mannii* by its growth habit, its sessile leaves, and the single-lipped appearance of the corolla (USFWS 1992). (USFWS, 1996)

Taxonomy

St. John (1987, St. John and Takeuchi 1987), believing thereto be no generic distinction between *Cyanea* and *Delissea*, transferred the species to the genus *Delissea*, the older of the two generic names, creating *D. procera*. The current treatment, however, maintains the separation of the two genera (Lammers 1990). (USFWS, 1996)

Historical Range

Historically known from Kamalo. (NatureServe, 2015)

Current Range

Current range in Kawela region, Kamakou Preserve and Puu Alii NAR. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/18/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea procera* (Haha) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes five detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Cyanea procera* includes five CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Molokai—Lowland Mesic—Unit 1 (and) *Palmeria dolei*—Unit 37—Lowland Mesic (and) *Pseudonestor xanthophrys*—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in

central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Ctenitis squamigera*, *Cyanea dunbariae*, *C. mannii*, *C. profuga*, *Cyperus fauriei*, *Cyrtandra filipes*, *Gouania hillebrandii*, *Labordia triflora*, *Neraudia sericea*, *Santalum haleakalae* var. *lanaiense*, *Schiedea lydgatei*, *S. sarmentosa*, *Silene alexandri*, *S. lanceolata*, *Spermolepis hawaiiensis*, and *Zanthoxylum hawaiiense*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Mesic—Unit 1 is not known to be occupied by *Asplenium dielerectum*, *Bonamia menziesii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea procera*, *C. solanacea*, *Diplazium molokaiense*, *Festuca molokaiensis*, *Flueggea neowawraea*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Melicope mucronulata*, *M. munroi*, *M. reflexa*, *Phyllostegia haliakalae*, *P. mannii*, *P. pilosa*, *Sesbania tomentosa*, *Stenogyne bifida*, or *Vigna o-wahuensis*, or the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 1 (and) *Palmeria dolei*—Unit 40—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 40— Montane Wet This area consists of 1,545 ac (625 ha) of State land, and 1,851 ac (749 ha) of privately owned land, from the headwaters of Waialeale Stream and above Pelekunu Valley, eastward along the summit area to Mapulehu, in northcentral Molokai. These units are occupied by the plants *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. profuga*, *Phyllostegia hispida*, and *Pteris lidgatei*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Montane Wet—Unit 1 is not known to be occupied by *Adenophorus periens*, *Cyanea procera*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Melicope reflexa*, *Phyllostegia mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 41—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 41— Montane Wet This area consists of 871 ac (353 ha) of State land, and 39 ac (16 ha) of privately owned land, from Honukaupu to Olokui (between Pelekunu and Wailau valleys), in north-central Molokai. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). Although Molokai— Montane Wet—Unit 2 is not known to be occupied by *Adenophorus periens*, *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. procera*, *C. profuga*, *C.*

solanacea, *Hesperomannia arborescens*, *Lysimachia maxima*, *Melicope reflexa*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Pteris lidgatei*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 3 consists of 77 ac (31 ha) of State land, and 726 ac (294 ha) of privately owned land, above the east rim of Wailau Valley on eastern Molokai. This unit is occupied by the plant *Melicope reflexa*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Montane Wet—Unit 3 is not known to be occupied by *Adenophorus periens*, *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. procera*, *C. profuga*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Pteris lidgatei*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Mesic—Unit 1 (and) *Palmeria dolei*—Unit 42—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 42—Montane Mesic This area consists of 257 ac (104 ha) of State land, and 559 ac (226 ha) of privately owned land from Kamiloloa to Makolelau in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Bidens wiebkei*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Montane Mesic—Unit 1 is not known to be occupied by *Asplenium dielerectum*, *Cyanea dunbariae*, *C. mannii*, *C. procera*, *C. solanacea*, *Cyperus fauriei*, *Kadua laxiflora*, *Melicope mucronulata*, *Neraudia sericea*, *Plantago princeps*, or *Stenogyne bifida*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea procera* critical habitat consists of three

components. Lowland mesic (Molokai), Montane wet (Molokai) and Montane mesic (Molokai) (81 FR 17790-18110):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: *Acacia*, *Ilex*, *Metrosideros*, *Myrsine*, *Nestegis*, *Nothocestrum*, *Pisonia*, *Pittosporum*, *Psychotria*, *Sophora*, *Zanthoxylum*. Subcanopy: *Alyxia*, *Charpentiera*, *Coprosma*, *Dodonaea*, *Kadua*, *Labordia*, *Leptecophylla*, *Phyllostegia*, *Vaccinium*. Understory: Ferns, *Carex*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent

elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkii*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at an elevation of 1,060 meters (USFWS, 1996)

Habitat Narrative

Adult: This species is found in wet forests in gulch bottoms and on gulch slopes. Individuals have been found in a wet ohia-dominated forest at an elevation of 1,060 meters (3,480 feet), on a steep rock wall, with thin soil, on the southwest slope of a narrow gulch. Associated plant species include various species of *Asplenium*, *Coprosma ochracea* (pilo), *Pipturus albidus* (mamaki), and *Touchardia latifolia* (olona) (USFWS 1992). (NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2014)

Redundancy:

Very low (inferred from USFWS, 2014)

Number of Populations:

2 wild populations (USFWS, 2018)

Population Size:

7 wild individuals, >600 (USFWS, 2018)

Population Narrative:

This species is currently known from only 3 locations, with a total of fewer than 10 plants. In 2012, one to two individuals of *Cyanea procera* were reported at Kawela on Molokai (USFWS 2012). Overall, *C. procera* has increased from a single individual reported in the last 5-year review to two individuals (Plant Extinction Prevention Program [PEPP] 2013). (USFWS, 2014); The previous 5-year review reported two individuals of *Cyanea procera* observed at Kawela (in Kamakou Preserve (PR)) in 2012. By 2016, only one wild individual remained (PEPP 2016). This individual is represented in three outplantings at Kawela totaling 635 individuals and in one outplanting of 39 individuals at Hanalilolilo (PEPP 2017). In the same year, two to three wild individuals were observed on an aerial survey of Wailau Valley (PEPP 2016). Currently, there are six founders at Wailau, five of which have collected material in storage and are currently being propagated and outplanted (PEPP 2017). (USFWS, 2018)

Threats and Stressors

Stressor: Climate change (USFWS, 2014; USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Cyanea procera* is moderately vulnerable to the impacts of climate change. Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2014); The assessment by Fortini et al. (2013) w concluded that *Cyanea procera* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.6 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2018)

Stressor: Landslides and erosion (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: The single population is threatened by landslides and erosion (PEPP 2009). Flood is a threat to this species (PEPP 2010). (USFWS, 2014)

Stressor: Herbivory by slugs (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Herbivory by slugs have been reported as a new threat to this species (PEPP 2010). (USFWS, 2014)

Stressor: Herbivory by an unknown invertebrate (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: In 2012, an unknown invertebrate reportedly damaged the fruit and leaves of the remaining wild individuals (PEPP 2013). (USFWS, 2014)

Stressor: Loss of mutualists (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Monitoring of wild individuals indicated a threat of lack of pollinators or fruit set related to absence of viable seeds and aborted fruit set (PEPP 2010). (USFWS, 2014)

Stressor: Habitat degradation by feral pigs (USFWS, 1996)

Exposure:

Response:

Consequence:

Narrative: Habitat degradation by feral pigs is a potential threat (USFWS 1992). (USFWS, 1996)

Stressor: Lack of adequate hunting regulations (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: One wild population of *Cyanea procera* occurs in a State hunting area in the Moloka'i Forest Reserve. Nonnative feral ungulates pose a major ongoing threat to native species through destruction and modification of habitat, and through direct herbivory or predation. Habitat destruction and modification by feral pigs and goats has been noted as a threat to the species. Only one wild population is within fenced habitat in Kamakou PR. In addition, public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations are at risk (DLNR 2010). (USFWS, 2018)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Molokai and at least one other island where they now occur or occurred historically. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1996)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1996)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Molokai and at least 1 other island where they now occur or occurred historically. (USFWS, 1996)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1996)

3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1996)

Recovery Actions:

- In order to prevent this species from going extinct, the propagation and maintenance of ex situ genetic stock should be immediately undertaken, as well as the protection of remaining wild individuals from the effects of goats, pigs and rats. (USFWS, 1996)
- The highest priority for the recovery of the Molokai plant cluster taxa is the implementation of immediate recovery actions needed to keep “on-the-brink” species (those that number fewer than 100 individuals in the wild) from going extinct. These actions include propagation and maintenance of genetic stock ex situ, and protection of remaining wild individuals from threats. (USFWS, 1996)
- Secondly, the plan proposes the delineation of management units to conserve not only these taxa, but their habitats as well. These units should be managed to preserve as many native species (flora and fauna) as possible, through threat-control and forest-restoration programs. Current threats to the species are addressed through fencing and/or hunting to control ungulates; control of alien plants; protection from fire; control of rodents; protection from human disturbance; collection, storage and maintenance of genetic material; a comprehensive monitoring program; and, if deemed necessary, protection from insects and disease. (USFWS, 1996)
- The next step in the recovery of these species is augmentation of small populations and re-establishment of new populations within the historical range of the species. (USFWS, 1996)
- A research program is also recommended to study the growth and reproductive viability of each taxon, determine the parameters of viable populations of each taxon, study the reproductive strategy and pollinators of each taxon, and study possible pests and diseases. (USFWS, 1996)
- Finally, the recovery criteria should be refined and revised as new information becomes available. (USFWS, 1996)
- Population viability and monitoring—Continue to monitor the wild populations on Molokai. (USFWS, 2018)
- Ungulate monitoring and control—Fence populations to protect them from the impacts of feral ungulates. (USFWS, 2018)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. (USFWS, 2018)
- Predator and herbivore monitoring and control—Implement effective control methods for rodents at wild and reintroduced populations. Develop and implement effective control methods for slugs. Identify unknown invertebrate damaging the flowers and fruit of *C. procera* at all known locations. (USFWS, 2018)
- Captive propagation for genetic storage and reintroduction—Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. Evaluate genetic resources currently in storage to determine the

need to place additional material into long-term storage due to this species' vulnerability to climate change. (USFWS, 2018)

- Reintroduction and translocation—Continue reintroduction of individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2018)
- Population biology research—Conduct pollination or reproductive studies to determine cause of low seed viability. (USFWS, 2018)
- Climate change adaptation strategy—Research the suitability of habitat for reintroducing these subspecies in the future due to impacts from climate change. (USFWS, 2018)
- Alliance and partnership development—Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2018)

Conservation Measures and Best Management Practices:

- Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change. (USFWS, 2014)
- Augment current natural populations to increase numbers of individuals. (USFWS, 2014)
- Control invasive introduced plant species within the vicinity of all known individuals. (USFWS, 2014)
- Control slugs and rodents within the vicinity of all known *C. procera* populations. (USFWS, 2014)
- Continue to monitor the wild population on Molokai. (USFWS, 2014)
- Identify unknown invertebrate damaging the fruit and flowers of the remaining wild individuals. (USFWS, 2014)
- Conduct pollination or reproductive studies to determine cause of low seed viability. (USFWS, 2014)
- Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. (USFWS, 2014)
- Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2014)

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

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SPECIES ACCOUNT: *Cyanea profuga* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

An unbranched shrub 1.8-2.4 m tall. Flowers are white, and borne 9-12 per inflorescence. (NatureServe, 2015)

Taxonomy

Genus endemic to Hawaiian Islands, species endemic to Molokai. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Endemic to Molokai (USFWS 2012). (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea profuga* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Cyanea profuga* includes four CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Molokai—Lowland Mesic—Unit 1 (and) Palmeria dolei—Unit 37—Lowland Mesic (and) Pseudonestor xanthophrys—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Ctenitis squamigera*, *Cyanea dunbariae*, *C. mannii*, *C. profuga*, *Cyperus fauriei*, *Cyrtandra filipes*, *Gouania hillebrandii*, *Labordia triflora*, *Neraudia sericea*, *Santalum haleakalae* var. *lanaiense*, *Schiedea lydgatei*, *S. sarmentosa*, *Silene alexandri*, *S. lanceolata*, *Spermolepis hawaiiensis*, and *Zanthoxylum hawaiiense*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Mesic—Unit 1 is not known to be occupied by *Asplenium dielerectum*, *Bonamia menziesii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea procera*, *C. solanacea*, *Diplazium molokaiense*, *Festuca molokaiensis*, *Flueggea neowawraea*, *Isodendron pyriformis*, *Kadua laxiflora*, *Melicope mucronulata*, *M. munroi*, *M. reflexa*, *Phyllostegia haliakalae*, *P. mannii*, *P. pilosa*, *Sesbania*

tomentosa, *Stenogyne bifida*, or *Vigna o-wahuensis*, or the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 1 (and) *Palmeria dolei*—Unit 40—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 40— Montane Wet This area consists of 1,545 ac (625 ha) of State land, and 1,851 ac (749 ha) of privately owned land, from the headwaters of Waialeia Stream and above Pelekunu Valley, eastward along the summit area to Mapulehu, in northcentral Molokai. These units are occupied by the plants *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. profuga*, *Phyllostegia hispida*, and *Pteris lidgatei*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Montane Wet—Unit 1 is not known to be occupied by *Adenophorus periens*, *Cyanea procera*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Melicope reflexa*, *Phyllostegia mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 41—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 41— Montane Wet This area consists of 871 ac (353 ha) of State land, and 39 ac (16 ha) of privately owned land, from Honukaupu to Olokui (between Pelekunu and Wailau valleys), in north-central Molokai. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). Although Molokai— Montane Wet—Unit 2 is not known to be occupied by *Adenophorus periens*, *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. procera*, *C. profuga*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Melicope reflexa*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Pteris lidgatei*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 3 consists of 77 ac (31 ha) of State land, and 726 ac (294 ha) of privately owned land, above the east rim of Wailau Valley on eastern Molokai. This unit is occupied by the plant *Melicope reflexa*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as

physical or biological features in the montane wet ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Montane Wet—Unit 3 is not known to be occupied by *Adenophorus periens*, *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. procera*, *C. profuga*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Pteris lidgatei*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea profuga* critical habitat consists of two components. Lowland mesic (Molokai) Montane wet (Molokai) (81 FR 17790-18110):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other

Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C.*

samuelii, Ctenitis squamigera, Cyanea asplenifolia, C. copelandii ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. magnicalyx, C. mannii, C. maritae, C. mceldowneyi, C. profuga, C. solanacea, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Dubautia plantaginea ssp. humilis, Geranium hanaense, G. multiflorum, Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Habitat Narrative

Adult: This species is found in lowland mesic and montane wet ecosystems on Molokai (USFWS 2012). (NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Low (inferred from USFWS, 2016)

Redundancy:

Low (inferred from USFWS, 2016)

Number of Populations:

4 (USFWS, 2016)

Population Size:

34 individuals (USFWS, 2016)

Population Narrative:

Currently, there are 4 occurrences totaling up to 34 individuals in the lowland mesic and montane wet ecosystems on Molokai (TNC 2007; Bakutis 2010, in litt.; Perlman 2010, in litt.). (USFWS, 2016)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs and goats), nonnative plants, flooding, landslides, rockfalls, treefalls, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Flooding, landslides, rock falls, and treefalls destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, goats, rats, and slugs) is considered an ongoing threat to *Cyanea profuga* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor: Small populations (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: *Cyanea profuga* faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). *Cyanea profuga* is known from fewer than five scattered occurrences in the montane wet ecosystem. This species is susceptible to predation by nonnative pigs and goats, as well as habitat degradation or destruction by these nonnative animals and by landslides, rock and tree falls, or flooding, or a combination of these (USFWS, 2013).

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

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USFWS. 2013. Determination of Endangered Status for 38 Species on Molokai, Lanai, and Maui

Final Rule. 78 Federal Register 102, May 28, 2013. Pages 32014 - 32065.

SPECIES ACCOUNT: *Cyanea purpurellifolia* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/18/2012; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Cyanea purpurellifolia (haha) is an unbranched shrub (USFWS, 2012). Stems fleshy, 0.2-0.5 m long. Leaves are up to 35 cm long, with purple lower surfaces. Flowers are dark magenta. (NatureServe, 2015)

Taxonomy

Species endemic to Oahu. Tom Lammers et al. (1993) have merged all of the species of the endemic Hawaiian genus *Rollandia* under *Cyanea*. (NatureServe, 2015)

Historical Range

Historically known from the area of Kaluanui Valley north to Maakua-Papali Ridge (USFWS 2011) (NatureServe, 2015)

Current Range

Currently known from Maakua-Kaipapau to Punaluu-Kaluanui Ridge (USFWS 2011). (NatureServe, 2015)

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On September 18, 2012, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea purpurellifolia* under the Endangered Species Act of 1973, as amended (Act) (77 FR 57648-57862). The critical habitat designation includes 14 critical habitat units, which encompass approximately 30,056 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Cyanea purpurellifolia* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Cyanea purpurellifolia* includes 14 critical habitat units, covering two ecosystem types, which encompass approximately 30,056 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; Oahu—Wet Cliff—Units 6, 7, 8.

Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Haula Forest Reserves and Sacred Falls State Park,

from Puukainapuaa to Kaluanui (Sacred Falls). Oahu— Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikēkee, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet— Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet— Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu— Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamoa Ridge.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea purpurellifolia* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Cyanea purpurellifolia* occurs within the Lowland wet and Wet cliff ecosystems in the Koolau Mountain caldera complex:

Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (E) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Cyanea purpurellifolia* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History**Food/Nutrient Resources****Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 1,860 and 2,160 feet (USFWS, 2012)

Habitat Narrative

Adult: *Cyanea purpurellifolia* (haha) is an unbranched shrub in the bellflower family (Campanulaceae) that occurs in the Koolau Mountains in the lowland wet and wet cliff ecosystems, at elevations between 1,860 and 2,160 ft (570 and 660 m) (TNC 2007; HBMP 2008). This species occurs in moist and wet forests in gulches. (NatureServe, 2015; USFWS, 2012)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2012)

Redundancy:

Very low (inferred from USFWS, 2012)

Number of Populations:

5 occurrences (USFWS, 2012)

Population Size:

~20 (USFWS, 2012)

Population Narrative:

Currently, *C. purpurellifolia* occurs in the northern Koolau Mountains from Maakua- Kaipapau to Punaluu-Kaluanui Ridge, in 5 occurrences totaling approximately 20 individuals (Plant Extinction Prevention (PEP) Program 2008, pp. 20–21; HBMP 2008). (USFWS, 2012)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative plants and animals (pigs). The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The projected effects of climate change will likely exacerbate the effects of the other threats to the species (USFWS, 2012).

Stressor: Predation and herbivory (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, goats, and slugs) is considered an ongoing threat to *Cyanea purpurellifolia* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2012).

Stressor: Small populations (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: *Cyanea purpurellifolia* faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). *C. purpurellifolia* is susceptible to reduced reproductive vigor due to the low number (20) of individuals remaining. Although facing severe threats from feral pigs, none of the individuals of this species are protected from ungulate predation (USFWS, 2012).

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

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SPECIES ACCOUNT: *Cyanea recta* (Haha)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/10/1996; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

An unbranched shrub up to 1.5 m (3.3 to 4.9 ft) tall. The narrowly elliptic leaves are 12 to 28 cm (4.7 to 11 in) long and 1.2 to 5 cm (0.5 to 2 in) wide, with minutely toothed margins. The upper surface is green and smooth, while the lower surface is whitish green to pale green, and smooth or hairy. Five to seven flowers are arranged on an inflorescence stalk 7 to 10 cm (3 to 4 in) long, each having an individual stalk 5 to 17 mm (0.2 to 0.7 in) in length. The densely hairy flowers are purple or white with purple longitudinal stripes, 30 to 40 mm (1.2 to 1.6 in) long, and 3 to 4 mm (0.1 to 0.2 in) wide, with spreading lobes. The staminal column is smooth or sparsely hairy at the base. The anthers are covered with minute epidermal projections, the lower two with tufts of white hairs at the tip. The fruit is an egg-shaped, purple berry. (USFWS 2010)

Taxonomy

Other published names, which Lammers consider to be synonymous with *Cyanea recta*, include *Cyanea larrisonii*, *Cyanea rockii*, *Cyanea salicina*, *Delissea larrisonii*, and *Delissea rockii* (USFWS 1996). (USFWS, 1998)

Historical Range

Historically, *Cyanea recta* was found in upper Hanalei Valley, Waioli Valley, Hanapepe Valley, Kalalau cliffs, Wainiha Valley, Makaleha Mountains, Limahuli Valley, Powerline Trail, and the Lehua Makanoe-Alakai area on the island of Kauai (USFWS 2003). (USFWS 2010)

Current Range

Endemic to the island of Kauai. In 2003, there was a total of 8 populations, with approximately 198 to 208 individuals, on State and private lands in the following areas: Waioli Valley, the left and right branches of Wainiha Valley, Makaleha Mountains, and Puu Eu, including areas in Halelea Forest Reserve, Kealia Forest Reserve, and the Lihue-Koloa Forest Reserve (USFWS 2003). (USFWS 2010)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service designated critical habitat for *Cyanea recta* pursuant to the Endangered Species Act of 1973, as amended (68 FR 9116 - 9214).

Critical Habitat Designation

Critical habitat is designated in four units in Kauai.

Kauai 4—*Cyanea recta*—a. This unit is critical habitat for *Cyanea recta* and is 252 ha (623 ac) on State (Kealia and Moloaa Forest Reserves) and private land. This unit contains Kahili, Kekoiki, Leleiwai, Namahana, and Puu Eu Summits. This unit provides habitat for two populations of 300 mature, reproducing individuals of the shortlived perennial *Cyanea recta* and is currently

occupied with 43 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, gulches or slopes in lowland wet or mesic *Metrosideros polymorpha* forest or shrubland. This unit is geographically separated from the other three units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 4—*Cyanea recta*—b. This unit is critical habitat for *Cyanea recta* and is 352 ha (868 ac) on State (Kealia Forest Reserve) and private land. This unit contains Makaleha and Leleiwi Summits. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial *Cyanea recta* and is currently occupied with 80 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, gulches or slopes in lowland wet or mesic *Metrosideros polymorpha* forest or shrubland. This unit is geographically separated from the other three units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 11—*Cyanea recta*—c. This unit is critical habitat for *Cyanea recta* and is 553 ha (1,367 ac) on State (Halelea Forest Reserve) and private land. This unit contains Puu Manu and Kaliko Summits, and Mount Namolokama. This unit provides habitat for three populations of 300 mature, reproducing individuals of the short-lived perennial *Cyanea recta* and is currently occupied with between 75 and 85 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, gulches or slopes in lowland wet or mesic *Metrosideros polymorpha* forest or shrubland. This unit is geographically separated from other units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 11—*Cyanea recta*—d. This unit is critical habitat for *Cyanea recta* and is 398 ha (982 ac) on State (Halelea Forest Reserve, Hono o Na Pali NAR, and Na Pali Coast State Park) and private land. This unit contains Pali Elele Summit and Limahuli Falls. This unit provides habitat for three populations of 300 mature, reproducing individuals of the short-lived perennial *Cyanea recta* and is currently unoccupied. This unit provides habitat that is essential to the establishment of additional populations on Kauai in order to reach recovery goals. The habitat features contained in this unit that are essential for this species include, but are not limited to, gulches or slopes in lowland wet or mesic *Metrosideros polymorpha* forest or shrubland. This unit is geographically separated from other units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Primary Constituent Elements/Physical or Biological Features

Not available.

Special Management Considerations or Protections

Activities that, when carried out, funded, or authorized by a Federal agency, may directly or indirectly destroy or adversely modify critical habitat include, but are not limited to: (1) Activities that appreciably degrade or destroy the primary constituent elements including, but not limited to: Overgrazing; maintenance of feral ungulates; clearing or cutting of native live trees and shrubs, whether by burning or mechanical, chemical, or other means (e.g., woodcutting, bulldozing, construction, road building, mining, herbicide application); introducing or enabling the spread of nonnative species; and taking actions that pose a risk of fire; (2) Activities that alter watershed characteristics in ways that would appreciably reduce groundwater recharge or alter natural, dynamic wetland or other vegetative communities. Such activities may include water diversion or impoundment, excess groundwater pumping, manipulation of vegetation such as timber harvesting, residential and commercial development, and grazing of livestock that degrades watershed values; (3) Rural residential construction that includes concrete pads for foundations and the installation of septic systems in wetlands where a permit under section 404 of the Clean Water Act would be required by the Corps; (4) Recreational activities that appreciably degrade vegetation; (5) Mining of sand or other minerals; (6) Introducing or encouraging the spread of nonnative plant species into critical habitat units; and (7) Importation of nonnative species for research, agriculture, and aquaculture, and the release of biological control agents that would have unanticipated effects on the listed species and the primary constituent elements of their habitat.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Wet forests. (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 234 and 1,406 meters (USFWS, 2010)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 2010)

Habitat Narrative

Adult: *Cyanea recta* grows in lowland wet *Metrosideros polymorpha* (ohia) forest, usually in gulches or on slopes, and typically at elevations between 234 and 1,406 meters (768 and 4,613 feet). Associated native plant species include *Antidesma platyphyllum* (hame), *Boehmeria grandis* (akolea), *Broussaisia arguta* (kanawao), *Cheirodendron platyphyllum* (lapalapa), *Cibotium* spp. (hapuu), *Dicranopteris linearis* (uluhe), *Diplazium* spp. (hoio), *Ilex anomala* (kawau), *Kadua affinis* (manono), *Machaerina angustifolia* (uki), *Myrsine lessertiana* (kolea lau nui), *Perrottetia sandwicensis* (olomea), *Pipturus albidus* (mamake), *Psychotria* spp. (kopiko),

Sadleria sp. (amau), and Syzygium sandwicensis (ohia ha) (Perlman 2008; USFWS 2003). (USFWS, 2010)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Resiliency:

Medium (inferred from USFWS, 2010)

Redundancy:

Low (inferred from USFWS, 2010)

Number of Populations:

8 (USFWS, 2010)

Population Size:

>1000 wild individuals (USFWS, 2017)

Population Narrative:

At the time of listing in 1994 there were 6 populations with 150 to 1,500 individuals located in upper Waioli Valley, Wainiha Valley, Makaleha Mountains, Limahuli Valley, the Wahiawa Bog area, Iliiliula drainage, and the back of Hanalei Valley (USFWS 1996). In 1998, the recovery plan stated that there were 1,000 to 1,500 individuals in 7 populations of those same areas (USFWS 1998). In 2003, there was a total of 8 populations, with approximately 198 to 208 individuals, on State and private lands in the following areas: Waioli Valley, the left and right branches of Wainiha Valley, Makaleha Mountains, and Puu Eu, including areas in Halelea Forest Reserve, Kealia Forest Reserve, and the Lihue-Koloa Forest Reserve (USFWS 2003). In September 2008, Ken Wood observed several thousand individuals while exploring the upper side gulches of the upper Wainiha Valley, where several hundred individuals were noted in 2004 (Wood 2008). (USFWS, 2010); Between 2011 and 2012, surveys documented individuals of *Cyanea recta* at previously known (more than 10 years ago) populations including Puu Eu, Makaleha-Kapahi ridge, Wailua River, and Iole ridge and headwaters. PEPP regularly monitors individuals at Wainiha, and estimates over 100 individuals in the area (PEPP 2015). K.R. Wood (2014) from National Tropical Botanical Garden (NTBG) conducted several botanical surveys from January 2012 to December 2013 along the windward slopes of Kawaikini Ridge (central southeastern Kauai) to gather data on the distribution and abundance of rare plant taxa in the region. The botanical survey report documented *Cyanea recta* in several locations including approximately 100 individuals along the Kawaikini Ridge and windward drainages (Wood 2014). (USFWS, 2017)

Threats and Stressors

Stressor: Feral pigs (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The major threats to this species are habitat degradation by feral pigs (*Sus scrofa*). (USFWS, 2010)

Stressor: Invasive introduced plants (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Threats include competition with invasive introduced plant species including *Blechnum appendiculatum* (NCN), *Clidemia hirta* (Koster's curse), *Crassocephalum crepidioides* (NCN), *Deparia petersenii* (NCN), *Erechtites valerianifolia* (fireweed), *Lantana camara*, *Melastoma candidum* (NCN), *Paspalum conjugatum* (Hilo grass), *Rubus rosifolius* (thimbleberry), *Sacciolepis indica* (Glenwood grass), and *Youngia japonica* (Oriental hawksbeard) (USFWS 2003). In Wainiha, threats include introduced invasive plant species including *Andropogon glomeratus* (beardgrass), *Angiopteris evecta* (mule's foot fern), *Buddleia asiatica* (dog tail), *Clidemia hirta*, *Sphaeropteris cooperi* (Australian tree fern), *Erigeron karvinskianus* (daisy fleabane), *Juncus planifolius* (rush), *Mariscus meyenianus* (NCN), *Paspalum conjugatum* (Hilo grass), *Pluchea carolinensis* (sourbush), *Rubus rosifolius*, and *Setaria parviflora* (yellow foxtail) (Wood 2008). In Waioli, *Clidemia hirta* and *Rubus rosifolius* compete with *Cyanea recta* (Wood 2008). (USFWS, 2010)

Stressor: Bark removal by rats and goats (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Bark removal and chewing by rats (*Rattus rattus*) damages these plants, as does browsing by goats (*Capra hirtus*). (USFWS, 2010)

Stressor: Slugs (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Unidentified species of slugs feed on the stems (USFWS 2003; Wood 2008). (USFWS, 2010)

Stressor: Climate change (USFWS, 2010; USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to *Cyanea recta*. However, current climate change models do not allow us to predict specifically what those effects, and their extent, would be for this species. (USFWS, 2010); Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Cyanea*

recta is vulnerable to the impacts of climate change, with a vulnerability score of 0.492 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2017)

Stressor: Hurricanes - Loss and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Hurricanes were omitted in the last five year review. In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event, and 70 percent of all listed plant species on Kauai are only found on Kauai. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013). (USFWS, 2017)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Kauai where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Kauai where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)

3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1998)

Recovery Actions:

- Reduce threats from rodent and slug predation. A management plan to control rats should be developed. This should include the use of the currently approved Diphacinone bait blocks and ultimately a more broad-scale method such as aerial dispersal of rodenticide. Methods to control slug predation on this species need to be determined and carried out. (USFWS, 1998)
- Construct enclosures to protect against feral ungulates. Enclosures on both State and private land should be constructed to reduce impacts from feral ungulates. Because some of the land is privately owned a commitment should be developed for long-term stewardship and conservation of these areas once they have been enclosed. (USFWS, 1998)
- Maintenance of adequate genetic stock. In order to prevent this taxon from going extinct, propagation efforts and the maintenance of adequate genetic stock ex situ should be continued. Additional wild seeds should be collected periodically until the cryopreservation method of long-term storage is perfected. This will insure that viable seed stock is available for outplanting. (USFWS, 1998)
- Surveys and inventories—Survey for additional populations of *Cyanea recta* in areas of potentially suitable habitat. (USFWS, 2017)
- Ungulate monitoring and control—Construct fenced exclosures around all wild populations to exclude feral ungulates. Protect all occurrences against browsing and disturbances from feral ungulates. (USFWS, 2017)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. Control invasive nonnative plant species around all populations that compete with the species. (USFWS, 2017)
- Captive propagation for genetic storage and reintroduction—Continue to collect seeds for adequate genetic storage. (USFWS, 2017)
- Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2017)
- Predator and herbivore monitoring and control—Determine and implement effective control methods for slugs. Implement effective control methods for rodents. (USFWS, 2017)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides. (USFWS, 2017)
- Population biology research—Study *Cyanea recta* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. (USFWS, 2017)

Conservation Measures and Best Management Practices:

- Continue to collect seeds for adequate genetic storage. (USFWS, 2010)
- Exclude feral ungulates from wild populations. (USFWS, 2010)
- Determine and implement efficient and effective control for rats and slugs. (USFWS, 2010)
- Develop propagation methods. (USFWS, 2010)
- Survey to determine the current status of the species. (USFWS, 2010)
- Research distribution and genetic relationships with *Cyanea salicina*. (USFWS, 2010)

- Work with Hawaii Division of Forestry and Wildlife and other landowners to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2010)

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SPECIES ACCOUNT: *Cyanea remyi* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Cyanea remyi, a member of the bellflower family, is a shrub 0.9 to 2 m (3 to 6.6 ft) tall with generally unbranched stems 1 to 2.5 cm (0.4 to 1 in) in diameter. The stems are erect, unarmed, dark purple and hairy toward the apex, and brown and hairless below. The leaves are broadly elliptic, egg-shaped, or broadly oblong, and 16 to 40 cm (6 to 16 in) long and 9.5 to 19.5 cm (3.7 to 7.7 in) wide. The upper leaf surface is green, glossy, and hairless. The lower leaf surface is whitish green and glossy with scattered short white hairs on the midrib and veins. The leaf margins are hardened and slightly toothed. The inflorescence rises upward, contains 6 to 13 flowers, and is covered with short white hairs. The dark maroon sepal lobes are triangular or narrowly triangular, spreading or ascending, and 4 to 6 mm (0.2 in) long and 1 to 2 mm (0.04 to 0.08 in) wide. The tubular flowers, 40 to 53 mm (2 in) long, have two lips, are dark purple (shading to purplish white at the apex of the lobes on their inner surface), and are densely covered with short white hairs. The flower tube is curved, 30 to 31 mm (1 in) long and 5 to 5.5 mm (0.2 in) in diameter. The staminal column is slightly protruding. The maroon or dark purple fruit is a round berry, 10 to 13 mm (0.4 to 0.5 in) in diameter, with orange flesh and small projections on the outer surface. (USFWS, 1998)

Taxonomy

Treated in a note in Wagner et al. (Vol. 1, p. 466). Lammers has resurrected this name (W.L. Wagner, pers. comm., 92-09-03). (NatureServe, 2015)

Historical Range

The three original discoveries of *Cyanea remyi* are within a relatively small area of Kauai's Wahiawa Mountains. (USFWS, 2010)

Current Range

This species is endemic to Kauai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service designated critical habitat for *Cyanea remyi* pursuant to the Endangered Species Act of 1973, as amended (68 FR 9116 - 9214).

Critical Habitat Designation

Kauai 4—*Cyanea remyi*—a, Kauai 10—*Cyanea remyi*—b, Kauai 11— *Cyanea remyi*—c, and Kauai 11— *Cyanea remyi*—d constitute critical habitat for *Cyanea remyi* on Kauai.

Kauai 4—*Cyanea remyi*—a. This unit is critical habitat for *Cyanea remyi* and is 354 ha (874 ac) on State (Kealia Forest Reserve) and private land. This unit contains Leleiwi Summit and portions of the Makaleha Mountains. This unit provides habitat for two populations of 300 mature,

reproducing individuals of the short-lived perennial *Cyanea remyi* and is currently occupied with between 11 and 51 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, narrow drainages and seepy stream banks in lowland wet forest or shrubland. This unit is geographically separated from other units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 10—*Cyanea remyi*—b. This unit is critical habitat for *Cyanea remyi* and is 1,904 ha (4,706 ac) on private land. This unit contains Ioloe, Kalalea, Kamanu, Kapalaoa and Palikea Summits. This unit provides habitat for four populations of 300 mature, reproducing individuals of the short-lived perennial *Cyanea remyi* and is currently occupied with between 70 and 120 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, narrow drainages and seepy stream banks in lowland wet forest or shrubland. This unit is geographically separated from other units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 11—*Cyanea remyi*—c. This unit is critical habitat for *Cyanea remyi* and is 365 ha (902 ac) on State land (Halelea Forest Reserve), containing Puu Manu Summit. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Cyanea remyi* and is currently occupied with 12 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, narrow drainages and seepy stream banks in lowland wet forest or shrubland. This unit is geographically separated from other units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 11—*Cyanea remyi*—c. This unit is critical habitat for *Cyanea remyi* and is 365 ha (902 ac) on State land (Halelea Forest Reserve), containing Puu Manu Summit. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Cyanea remyi* and is currently occupied with 12 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, narrow drainages and seepy stream banks in lowland wet forest or shrubland. This unit is geographically separated from other units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 11—*Cyanea remyi*—d. This unit is critical habitat for *Cyanea remyi* and is 664 ha (1,642 ac) on State (Halelea Forest Reserve, Hono o Na Pali NAR, and Haena and Na Pali Coast State Parks) and private land. This unit contains Pohakea and Maunapuluo Summits, Hanakapiai and Limahuli

Valleys, and Manoa Stream. This unit provides habitat for three populations of 300 mature, reproducing individuals of the short-lived perennial *Cyanea remyi* and is currently occupied with one plant. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, narrow drainages and seepy stream banks in lowland wet forest or shrubland. This unit is geographically separated from other units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Narrow drainages and wet stream banks in lowland wet forest or shrubland and containing one or more of the following native plant species: various grammitid and filmy ferns (Grammitidaceae and Hymenophyllaceae), *Adenophorus* spp., *Antidesma platyphyllum*, *Bidens* spp., *Broussaisia arguta*, *Cheirodendron* spp., *Cyrtandra* spp., *Diplazium sandwichianum*, *Eragrostis grandis*, *Freycinetia arborea*, *Hedyotis terminalis*, *Machaerina angustifolia*, *Metrosideros polymorpha*, *Perrottetia sandwicensis*, *Pipturus* spp., *Psychotria hexandra*, *Syzygium sandwicensis*, *Thelypteris* spp., *Touchardia latifolia*, or *Urera glabra*; and

(ii) Elevations between 219 and 1,089 m (719 and 3,571 ft).

Special Management Considerations or Protections

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species and therefore are not included in the critical habitat designations.

In addition to monitoring the plant populations, management actions include, but are not limited to: (1) Feral ungulate control; (2) nonnative plant control; (3) rodent control; (4) invertebrate pest control; (5) fire management; (6) maintenance of genetic material of the endangered and threatened plant species; (7) propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of these species; (8) ongoing management of the wild, outplanted, and augmented populations; and (9) habitat management and restoration in areas deemed essential for the recovery of the species.

Life History

Food/Nutrient Resources**Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland, shrubland/chaparral (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Wet environments (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations of 360 to 930 meters (USFWS, 2010)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 2010)

Habitat Narrative

Adult: *Cyanea remyi* is usually found in lowland wet forest or shrubland at an elevation of 360 to 930 meters (1,180 to 3,060 feet). This species is often found in seeping or saturated substrates in wet forests and shrublands. The three original discoveries of *Cyanea remyi* are within a relatively small area of Kauai's Wahiawa Mountains. The natural plant community located around Blue Hole, at the base of Mt. Waialeale, on the north fork of the Wailua River is a low, stunted *Metrosideros polymorpha* (ohia) lowland wet forest with an understory of ferns. Associated plant species include hame, kanawao, ohia, *Freycinetia arborea* (ieie), and *Perrottetia sandwicensis* (olomea) (USFWS 1996). (USFWS, 1998; USFWS, 2010; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2010)

Redundancy:

Very low (inferred from USFWS, 2010)

Number of Populations:

10 (USFWS, 2017)

Population Size:

<50 (USFWS, 2010; USFWS, 2017)

Population Narrative:

At the time of listing, several hundred individuals were known from four populations (USFWS 1996). In 2006, Perlman estimated a total of 50 individuals for the species (Perlman 2008) at this locality. Currently, since floods destroyed populations along Wahiawa Stream and on Mt. Kahili, there may be as few as 24 individuals remaining in three populations, at Blue Hole, below Mt. Kahili and at Hulua. (USFWS, 2010) ; Walsh reports 46 (mature and immature) individuals in 10 “subpopulations” (considered by USFWS as populations) at three main locations: Blue Hole, Wahiawa Valley, and Mt. Kahili (Wood 2014; Walsh 2016). A few of these individuals are reported at Waiahi headwaters, Hanakapiai headwaters and Limahuli stream (NTBG 1996, 2012, 2013, 2014; Wood 2014). This species’ status was reviewed by PEPP in 2010 and *Cyanea remyi* was added to the list of regularly monitored species (with fewer than 50 individuals in the wild). Currently, PEPP reports two populations, including eight mature individuals at Blue Hole and one mature individual at Hanakapiai (PEPP 2016). In 2017, there are 15 mature individuals plus some seedlings and immature plants at Blue Hole, immature plants at Wahiawa, one mature individual at Hanakapiai, and two mature individuals at Kawaikini (Kishida 2017, in litt.). (USFWS, 2017)

Threats and Stressors

Stressor: Pigs and invasive plants (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Pigs (*Sus scrofa*) are damaging habitat in areas where *Cyanea remyi* grows. They dig up the ground and open it to invasive introduced plant species, including *Clidemia hirta* (Koster’s curse), *Melastoma septemnerium* (NCN), *Phaius tankarvilleae* (Chinese ground orchid), *Psidium cattleianum* (strawberry guava), *Trema orientalis* (gunpowder tree), and *Rubus rosifolius* (thimbleberry) which crowd out native vegetation. (USFWS, 2010)

Stressor: Floods and landslides (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Additionally, the species grows in areas subject to floods and landslides, and has been damaged in the past by hurricanes (Perlman 2008; Tangalin 2006). (USFWS, 2010)

Stressor: Herbivory by rats and slugs (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Rats (*Rattus rattus*) and introduced species of slugs have been observed eating this species (Perlman 2008). (USFWS, 2010)

Stressor: Climate change (USFWS, 2010; USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to *Cyanea remyi*. However, current climate change models do not allow us to predict specifically what those effects, and their extent, would be for this species. (USFWS, 2010); Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Cyanea remyi* is vulnerable to the impacts of climate change, with a vulnerability score of 0.574 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2017)

Stressor: Small population size and range (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: In addition to all of the other threats, species like *Cyanea remyi* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding and disease outbreaks. The extent of these natural processes on this single island endemic are exacerbated by anthropogenic threats, such as habitat loss for human development or predation by introduced species (USFWS 1998). (USFWS, 2010)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Kauai where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Kauai where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived

perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)

3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1998)

Recovery Actions:

- Reduce threats from rodent and slug predation. A management plan to control rats should be developed. This should include the use of the currently approved Diphacinone bait blocks and ultimately a more broad-scale method such as aerial dispersal of rodenticide. Methods to control slug predation on this species need to be determined and carried out. (USFWS, 1998)
- Construct enclosures to protect against feral ungulates. Enclosures on both State and private land should be constructed to reduce impacts from feral ungulates. Because some of the land is privately owned a commitment should be developed for long-term stewardship and conservation of these areas once they have been enclosed. (USFWS, 1998)
- Surveys and inventories—Survey the geographical and historic range of *Cyanea remyi* for additional populations. (USFWS, 2017)
- Ungulate monitoring and control—Protect all occurrences against browsing and disturbances from feral ungulates to prevent imminent extinction. Continue to construct and maintain fenced exclosures around all populations. (USFWS, 2017)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. Control invasive nonnative plant species around all populations that compete with the species. (USFWS, 2017)
- Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. (USFWS, 2017)
- Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2017)
- Predator and herbivore monitoring and control—Develop and implement effective control methods for slugs. Implement effective control methods for rodents. (USFWS, 2017)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides. (USFWS, 2017)

Conservation Measures and Best Management Practices:

- Fence areas where this species grows to protect against pig damage. (USFWS, 2010)
- Conduct rat and slug control around known plants. (USFWS, 2010)
- Continue to store seeds. (USFWS, 2010)
- Propagate plants for outplanting. (USFWS, 2010)
- Work with Hawaii Division of Forestry and Wildlife, The Nature Conservancy of Hawaii, and Hawaii State Parks to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2010)

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USFWS. 2017. 5-year Review, Short Form Summary, *Cyanea remyi* (Haha). PIFWO, Honolulu, Hawaii.

SPECIES ACCOUNT: *Cyanea shipmanii* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/04/1994; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Cyanea shipmanii Rock is a small unbranched or sparsely branched shrub 8-13 ft tall (Lammers 1990). Young plants often have sharp outgrowths on the stem. Leaves are divided 3/4 to 7/8 of the distance to the midrib into 20 to 30 segments. The blades are 6.7-12 in long and 2.8-5.7 in wide. The leaf stalk (petiole) is 1.2-2.2 in long and is also muricate (spiny). Ten to 15 flowers are in a cluster at the tip of a main flower cluster stalk (peduncle) 0.4-1.2 in long. Each flower is subtended by a stalk (pedicel) 0.4-0.6 in long. The calyx and the petals are fused at the base into a tube (hypanthium) 0.16-0.2 in long and 0.12-0.16 in wide. The calyx has five small oblong lobes 0.12-0.2 in long and 0.02-0.04 in wide. Five lobed green-white petals 1.2-1.4 in long are fused below into a curved tube 0.1-0.2 in wide. The berry is elliptic, 0.5-0.6 in long, and 0.5 in wide. Flowers are pale greenish white. (USFWS, 1996; NatureServe, 2015)

Taxonomy

Formerly spelled '*Cyanea shipmannii*' by the US Fish and Wildlife Service, but spelling was updated to '*Cyanea shipmanii*' between September and December 2008. (NatureServe, 2015)

Historical Range

Cyanea shipmanii is known only from the eastern slopes of Mauna Kea, Hawaii. (USFWS, 1996)

Current Range

In 2007, the species had declined to only two extant wild individuals in Upper Waiakea Forest Reserve and Puu Kipu unit of the Kilauea Forest Reserve (Plant Extinction Prevention Program 2007, 2008; USFWS 2008). (USFWS, 2009)

Critical Habitat Designated

Yes; 7/2/2003.

Legal Description

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Cyanea shipmanii*.

Critical Habitat Designation

Three critical habitat units encompassing 6,088 acres on the island of HI are designated for *Cyanea shipmanii*. Two of the units, "Hawaii 1—*Cyanea shipmanii*—a" and "Hawaii 30—*Cyanea shipmanii*—b," are currently occupied. Each of these two units is essential to the conservation of *C. shipmanii* because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The unoccupied unit, "Hawaii 30—*Cyanea shipmanii*—c," is essential to the conservation of the species because it supports habitat that is necessary for the establishment of additional populations in order to reach recovery goals.

Hawaii 1—*Cyanea shipmanii*—a [1,557 ha (3,898 ac)]: This unit contains Puu Akala and portions of Awehi, Honoliii, and Kapue streams. It is bordered by Kolekole watershed in the north and Wailuku in the south, with Honolii and Kapue watersheds in the central portion. The unit is completely within Hakalau Forest NWR; provides habitat for 3 populations of 300 individuals of *C. shipmanii*; and is currently occupied by 1 individual.

Hawaii 30—*Cyanea shipmanii*—b [62 ha (152 ac)]: This unit contains no named natural features, lies completely within the Wailoa watershed, and is completely within the Mauna Loa Forest Reserve. The unit provides habitat for 1 population of 300 individuals of *C. shipmanii*; and is currently occupied by 1 individual.

Hawaii 30—*Cyanea shipmanii*—c [825 ha (2,038 ac)]: This unit, which contains no named natural features, lies almost completely within the Wailoa watershed with a small segment of the southern portion lying in the Kaahakini watershed. The unit is completely within the Olaakilauea Partnership. This unit provides habitat for 3 populations of 300 individuals of *C. shipmanii*; and is currently unoccupied.

Primary Constituent Elements/Physical or Biological Features

Features that are essential for this species including, but not limited to, mesic forest dominated by *Acacia koa*-*Metrosideros polymorpha*.

Special Management Considerations or Protections

The Service publishes this final rule acknowledging that we have incomplete information regarding many of the primary biological and physical requirements for these species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Environmental Specificity

Adult: High, with several key requirements (USFWS, 1996)

Habitat Narrative

Adult: The habitat of *Cyanea shipmanii* is montane mesic forest dominated by *Metrosideros polymorpha* (ohia) on the windward slopes of the island, at elevations between 5,400 and 6,200 ft (1,650 and 1,900 m) (HFIP 1991h, 59 FR 10305). Associated native plants include *Zanthoxylum*, *Myrsine* (kolea), *Acacia koa* (koa) and *Metrosideros polymorpha* (L. Pratt, pers. comm., 1995). The four individuals in Hakalau Forest National Wildlife Refuge are growing with *Clermontia lindseyana* (J. Jeffrey, pers. comm., 1995). (USFWS, 1996)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2009)

Redundancy:

Very low (inferred from USFWS, 2009)

Number of Populations:

2 (USFWS, 2009; USFWS, 2015)

Population Size:

8 wild (only 1 mature), 763 outplanted (USFWS, 2015)

Population Narrative:

In 2002, the taxon consisted of total of five populations with 12 individuals on State land in north Hilo, Upper Waiakea Forest Reserve; on Federal land in the Hakalau Unit of the Hakalau Forest National Wildlife Refuge (NWR); and on private land at Papaikou, south Hilo (USFWS 2002). However, by 2007 the species had declined to only two extant wild individuals in Upper Waiakea Forest Reserve and Puu Kipu unit of the Kilauea Forest Reserve (Plant Extinction Prevention Program 2007, 2008; USFWS 2008). (USFWS, 2009); In 2010, there were two populations containing two wild individuals of *Cyanea shipmanii* (Plant Extinction Prevention Program [PEPP] 2010). A new wild individual was found in the Ka'u Forest Reserve (PEPP 2010). At Pu'u Kipu, only one wild individual was observed from the four individuals originally found (PEPP 2010). In 2013, the Upper Waiakea Forest Reserve population contained four wild immature individuals of *Cyanea shipmanii* (PEPP 2014). There are 25 reintroduced individuals of

C. shipmanii at Kipimana (PEPP 2014). In addition, two new seedlings were discovered near the original wild plant at Kipimana (PEPP 2014). At Kahuku, there are approximately 447 reintroduced individuals of *C. shipmanii* (PEPP 2014). There are two wild individuals (one mature and one immature) at Hakalau Forest National Wildlife Refuge (J. VanDeMark, PEPP, pers. comm. 2014). Overall, the numbers of individuals have increased from the four individuals reported in the previous 5-year review, to approximately eight wild individuals in 2014. Only one of these individuals is mature. (USFWS, 2015)

Threats and Stressors

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Climate change destruction or degradation of habitat – Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Cyanea shipmanii* is highly vulnerable to the impacts of climate change and identified as a wink-out species. Wink-out species are species projected to lose more than 99 percent of its current climate envelope (areas that contain the full range of climate conditions under which the species is known to occur) by 2100. Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2015)

Stressor: Herbivory by slugs (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Herbivory by slugs has been reported as a new threat to this species (PEPP 2011, 2014). (USFWS, 2015)

Stressor: Non-native plants (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: In Puu Kipu, the outplanted population is threatened by competition from the introduced invasive plant species *Ehrharta stipoides* (meadow ricegrass) (PEPP 2011). At Hakalau Forest National Wildlife Refuge, the reintroduced population is threatened by competition from the introduced invasive plant species *Rubus argutus* (prickly Florida blackberry) and *Ilex aquifolium* (English holly) (PEPP 2011). (USFWS, 2015)

Stressor: Habitat destruction by pigs (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Feral ungulates and introduced invasive plant species remain as the major threats to the species and surrounding habitat (USFWS 2008). In particular, the remaining wild individual in

the Upper Waiakea Forest Reserve is threatened from habitat destruction due to pigs (*Sus scrofa*) (Plant Extinction Prevention Program 2007). (USFWS, 2009)

Stressor: Herbivory by sheep and rats (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The remaining wild individual in the Upper Waiakea Forest Reserve is threatened from predation by sheep (*Ovis montanus*), and the Kilauea populations are at risk from fruit and seed predation by rats (*Rattus* spp.) (Plant Extinction Prevention Program 2007; USFWS 2008). Rat herbivory on foliage, flowers and ripe fruit has been a continuous problem in Hakalau NWR (Jeffrey and Horiuchi 2008). Trapping and rodenticide bait stations provide relief, but the remoteness of the plants does not allow for continuous monitoring and baiting of traps. (USFWS, 2009)

Stressor: Small population size (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: A single human-caused or natural environmental disturbance could destroy a significant percentage of the wild individuals or cause the complete loss of a population. Reduced reproductive vigor due to the small number of individuals remains as a limitation to the survival of the species. (USFWS, 2009)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on the Big Island and at least one other island where it now occurs or occurred historically, if it is not endemic to the Big Island. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1996)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1996)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on the Big Island and at least 1 other island where they now occur or occurred historically, if it is not endemic to the Big Island. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 individuals per population for short-lived perennials. (USFWS, 1996)

3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1996)

Recovery Actions:

- Propagation and maintenance of ex situ stock should be continued, and current populations protected from pigs and augmented. (USFWS, 1996)
- One new population will need to be established and numbers increased in order to meet recovery criteria. (USFWS, 1996)

Conservation Measures and Best Management Practices:

- Survey geographical and historical range for a current assessment of the species' status. (USFWS, 2015)
- Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change. (USFWS, 2015)
- Maintain existing fences and fence remaining populations to protect them from the impacts of feral ungulates. (USFWS, 2015)
- Eradicate invasive introduced plants within ungulate exclosures and maintain exclosures free of invasive plants. (USFWS, 2015)
- Control slugs (unidentified species) and rodents within the vicinity of all known *C. shipmanii* populations. (USFWS, 2015)
- Continue monitoring wild and outplanted individuals. (USFWS, 2015)
- Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. As a species likely to wink out by 2100, ensure that adequate genetic storage is maintained as viable material. (USFWS, 2015)
- Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2015)
- Continue to collect genetic material for augmentation of extant populations and establishment of new populations within appropriate habitat areas protected from feral ungulates and non-native plant species. (USFWS, 2009)
- Protection of extant populations from feral ungulates and non-native rodents. (USFWS, 2009)
- Continue support of the Hakalau National Wildlife Refuge and the Tri-Mountain Alliance for ecosystem-level management of suitable habitat for *Cyanea shipmanii*, as funding is available. (USFWS, 2009)
- Map genetic diversity in surviving ex-situ populations. (USFWS, 2009)
- Research of the life history and biology of the taxon. (USFWS, 2009)
- Survey for populations in appropriate ecological habitats. (USFWS, 2009)

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SPECIES ACCOUNT: *Cyanea solanacea* (Popolo)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Cyanea solanacea (popolo, haha nui), a short-lived perennial shrub in the bellflower family (Campanulaceae). A shrub, 2-5 m tall, with branched stems. Leaves are shallowly to deeply cut. Flowers are white tinged with pale lilac. (USFWS, 2016; NatureServe, 2015)

Taxonomy

Genus endemic to Hawaiian Islands, species endemic to Molokai and possibly West Maui (only sterile specimens, tentatively placed with *C. solanacea* are known). Oppenheimer (2010 cited by USFWS 2012) reports that plants on west Maui were misidentified as *C. solanacea* and are actually *C. macrostegia*. (NatureServe, 2015)

Historical Range

Historically, *Cyanea solanacea* ranged from central Molokai at Kalae, eastward to Pukoo in the lowland mesic, lowland wet, and montane mesic ecosystems (HBMP 2010). (USFWS, 2016)

Current Range

The current range includes Molokai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea solanacea* (Popolo) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes eight detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Cyanea solanacea* includes eight CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Molokai—Lowland Mesic—Unit 1 (and) *Palmeria dolei*—Unit 37—Lowland Mesic (and) *Pseudonestor xanthophrys*—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Ctenitis squamigera*, *Cyanea dunbariae*, *C. mannii*, *C. profuga*, *Cyperus fauriei*, *Cyrtandra filipes*, *Gouania hillebrandii*, *Labordia triflora*, *Neraudia sericea*, *Santalum haleakalae* var. *lanaiense*, *Schiedea lydgatei*, *S. sarmentosa*, *Silene alexandri*, *S. lanceolata*, *Spermolepis hawaiiensis*, and *Zanthoxylum hawaiiense*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for

the expansion of the existing wild populations. Although Molokai— Lowland Mesic—Unit 1 is not known to be occupied by *Asplenium dielirectum*, *Bonamia menziesii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea procera*, *C. solanacea*, *Diplazium molokaiense*, *Festuca molokaiensis*, *Flueggea neowawraea*, *Isodendrion pyrifolium*, *Kadua laxiflora*, *Melicope mucronulata*, *M. munroi*, *M. reflexa*, *Phyllostegia haliakalae*, *P. mannii*, *P. pilosa*, *Sesbania tomentosa*, *Stenogyne bifida*, or *Vigna o-wahuensis*, or the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 1 (and) *Palmeria dolei*—Unit 38—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 38— Lowland Wet This area consists of 2,195 ac (888 ha) of State land, and 754 ac (305 ha) of privately owned land (partly within The Nature Conservancy's Pelekunu Preserve), from Pelekunu Valley to Wailau Valley, in north-central Molokai. These units are occupied by the plant *Cyrtandra filipes*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Wet—Unit 1 is not known to be occupied by *Asplenium dielirectum*, *Bidens wiebkei*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Lysimachia maxima*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 2 (and) *Palmeria dolei*—Unit 39—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 39— Lowland Wet This area consists of 1,356 ac (549 ha) of State land and 594 ac (241 ha) of privately owned land, from Kahanui to Pelekunu Valley, in north-central Molokai. These units are occupied by the plant *Lysimachia maxima*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Wet—Unit 2 is not known to be occupied by *Asplenium dielirectum*, *Bidens wiebkei*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Cyrtandra filipes*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small

numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 3 consists of 94 ac (38 ha) of State land, and 3,125 ac (1,265 ha) of privately owned land, from Waiahookalo gulch to Moaula stream and Puniuohua, on eastern Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Molokai—Lowland Wet—Unit 3 is not known to be occupied by *Asplenium dielirectum*, *Bidens wiebkei*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Cyrtandra filipes*, *Lysimachia maxima*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 1 (and) *Palmeria dolei*—Unit 40—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 40— Montane Wet This area consists of 1,545 ac (625 ha) of State land, and 1,851 ac (749 ha) of privately owned land, from the headwaters of Waialelia Stream and above Pelekunu Valley, eastward along the summit area to Mapulehu, in northcentral Molokai. These units are occupied by the plants *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. profuga*, *Phyllostegia hispida*, and *Pteris lidgatei*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Montane Wet—Unit 1 is not known to be occupied by *Adenophorus periens*, *Cyanea procera*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Melicope reflexa*, *Phyllostegia mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 41—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 41— Montane Wet This area consists of 871 ac (353 ha) of State land, and 39 ac (16 ha) of privately owned land, from Honukaupu to Olokui (between Pelekunu and Wailau valleys), in north-central Molokai. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). Although Molokai— Montane Wet—Unit 2 is not known to be occupied by *Adenophorus periens*, *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. procera*, *C. profuga*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Melicope reflexa*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Pteris lidgatei*, *Schiedea laui*, *Stenogyne bifida*,

or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 3 consists of 77 ac (31 ha) of State land, and 726 ac (294 ha) of privately owned land, above the east rim of Wailau Valley on eastern Molokai. This unit is occupied by the plant *Melicope reflexa*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Montane Wet—Unit 3 is not known to be occupied by *Adenophorus periens*, *Bidens wiebkiei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. procera*, *C. profuga*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Pteris lidgatei*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Mesic—Unit 1 (and) *Palmeria dolei*—Unit 42—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 42—Montane Mesic This area consists of 257 ac (104 ha) of State land, and 559 ac (226 ha) of privately owned land from Kamiloloa to Makolelau in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Bidens wiebkiei*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Montane Mesic—Unit 1 is not known to be occupied by *Asplenium dielirectum*, *Cyanea dunbariae*, *C. mannii*, *C. procera*, *C. solanacea*, *Cyperus fauriei*, *Kadua laxiflora*, *Melicope mucronulata*, *Neraudia sericea*, *Plantago princeps*, or *Stenogyne bifida*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea solanacea* critical habitat consists of four components. Lowland mesic (Molokai), Lowland wet (Molokai), Montane wet (Molokai) and Montane mesic (Molokai) (81 FR 17790-18110):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: Acacia, Charpentiera, Cheirodendron, Metrosideros. Subcanopy: Broussaisia, Cibotium, Eurya, Ilex, Myrsine. Understory: Ferns, Carex, Coprosma, Leptecophylla, Oreobolus, Rhynchospora, Vaccinium.

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: Acacia, Ilex, Metrosideros, Myrsine, Nestegis, Nothocestrum, Pisonia, Pittosporum, Psychotria, Sophora, Zanthoxylum. Subcanopy: Alyxia, Charpentiera, Coprosma, Dodonaea, Kadua, Labordia, Leptecophylla, Phyllostegia, Vaccinium. Understory: Ferns, Carex, Peperomia.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and

Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkii*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*,

Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 2016)

Habitat Narrative

Adult: Cyanea solanacea ranged from central Molokai at Kalae, eastward to Pukoo in the lowland mesic, lowland wet, and montane mesic ecosystems. This species is found in wet forests on gulch slopes. (NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2016)

Redundancy:

Very low (inferred from USFWS, 2016)

Number of Populations:

4 occurrences (USFWS, 2016; NatureServe, 2015)

Population Size:

26 (USFWS, 2016; NatureServe, 2015)

Population Narrative:

Currently, there are four small occurrences at Hanalilolilo, near Pepeopae Bog, Kaunakakai Gulch, and Kawela Gulch, in the montane wet ecosystem. These occurrences total 26 individuals (Bakutis 2010, in litt.; Oppenheimer 2010a, in litt.; TNCH 2011, pp. 21, 57). (USFWS, 2016)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs and goats), nonnative plants, landslides, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Landslides destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, goats, rats, and slugs) is considered an ongoing threat to *Cyanea solanacea* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor: Small populations (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: *Cyanea solanacea* faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). *Cyanea solanacea* is known from fewer than five scattered occurrences in the montane wet ecosystem. This species is susceptible to predation by nonnative pigs and goats, as well as habitat degradation or destruction by these nonnative animals and by landslides, rock and tree falls, or flooding, or a combination of these (USFWS, 2013).

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

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SPECIES ACCOUNT: *Cyanea st.-johnii* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

Cyanea st.-johnii is a member of the Campanulaceae (bellflower family). It is a short-lived perennial shrub with an unbranched woody stem 30 to 60 cm (12 to 24 in) long. Its leaves are lance-shaped to inversely lance-shaped, 6 to 13 cm (2.4 to 5.1 in) long and 1.5 to 2.0 cm (0.6 to 0.8 in) wide. The leaf edges are thickened, smoothly toothed and curl under. The white flowers form groups of five to 20 flowers on stalks 0.5 to 1.5 cm (0.2 to 0.6 in) tall. The fruit is probably a berry, but detailed information on fruiting is unknown. This species is distinguished from others in this endemic Hawaiian genus by the length of the leaves, the distinctly curled leaf margins, and the petal color (Wagner et al. 1999).

Taxonomy

Genus restricted to Oahu, except one species endemic to Kauai, species endemic to Oahu. Tom Lammers et al. (1993) have merged all of the species of the endemic Hawaiian genus *Rollandia* under *Cyanea*. USFWS tracks as *Cyanea st.-johnii*. (NatureServe, 2015)

Historical Range

Cyanea st.-johnii was known historically from 11 occurrences in the central and southern Koolau Mountains of Oahu. .

Current Range

Currently, 58 to 63 plants are known from seven occurrences, including Helemanu (3 individuals), north Halawa summit ridge (15), Poamoho- Punaluu summit ridge (1), Waiawa-Waiahole summit crest (4), Wailupe summit (15), Waimalu- Waihee summit Ridge (10), and Waimano (10 to 15) (HINHP Database 2001). The number of occurrences and the number of individuals of *C. st.-johnii* are declining and those that remain are small and widely dispersed with restricted distribution (U.S. Army 2003a).

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea st.-johnii* (Haha) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Cyanea st.-johnii* (77 FR 57648-57862). The critical habitat designation includes 14 critical habitat units, which encompass approximately 30,056 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Cyanea st.-johnii* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Cyanea st.-johnii* includes 14 critical habitat units, covering two ecosystem types, which encompass approximately 30,056 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, Oahu—Wet Cliff—Units 6, 7, 8.

Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Haula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikeekee, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet—Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet—Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu—Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamo Ridge.

Oahu—Wet Cliff—Unit 6 [151 ac (61 ha)]. This area consists of 151 ac (61 ha) in the wet cliff ecosystem on State land on the windward side of the Koolau Mountains in Kaipapau Gulch,

entirely within the Kaipapau Forest Reserve. Oahu—Wet Cliff—Unit 7 [144 ac (58 ha)]. This area consists of 144 ac (58 ha) in the wet cliff ecosystem in State land on the windward side of the Koolau Mountains in Hauula Gulch, entirely within the Hauula Forest Reserve. Oahu—Wet Cliff—Unit 8 [4,649 ac (1,881 ha)]. This area consists of 1,479 ac (598 ha) of State land, 1,281 ac (519 ha) of City and County of Honolulu land, 5 ac (2 ha) of Federal land, and 1,884 ac (762 ha) of privately owned land, in the wet cliff ecosystem along the summit of the Koolau Mountains, overlapping portions of Sacred Falls State Park, the Waiahole FR (Waiahole and Iolekaa sections), the Kaneohe and Honolulu Watershed FRs, and the Nuuanu Pali State Wayside.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea st.-johnii* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Cyanea st.-johnii* occurs within the Lowland wet and Wet cliff ecosystems in the Koolau Mountain caldera complex:

Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (E) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Oahu—Wet Cliff—Units 6, 7, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: >65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. (E) Understory: Bryophytes, Ferns, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Cyanea st.-johnii* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: *C. st.-johnii* has been observed in flower in July through September. Little else is known about its flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors (Service 1998a).

Habitat Type

Adult: lowland forest/lowland shrubland

Habitat Narrative

Adult: *Cyanea st.-johnii* typically grows on wet, windswept slopes and ridges between 415 and 959 m (1,361 and 3,146 ft) elevation in *Metrosideros polymorpha* mixed lowland forest and shrubland or *Metrosideros polymorpha-Dicranopteris linearis* lowland forest and shrubland. Associated native plant species include *Alyxia oliviformis*, *Antidesma* sp., *Bidens macrocarpa*, *Broussaisia arguta*, *Chamaesyce clusiifolia*, *Cibotium* sp., *Dubautia laxa*, *Freycinetia arborea*, *Hedyotis* sp., *Labordia* sp., *Machaerina angustifolia*, *Melicope* sp., *Psychotria* sp., *Sadleria pallida*, *Scaevola mollis*, or *Syzygium sandwicensis* (HINHP Database 2001).

Dispersal/Migration***Population Information and Trends*****Number of Populations:**

6 - 20 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Fragility unknown. Currently between 40 and 50 plants are known. 6 current (between 1982 and 1997) and 5 historical occurrences. (NatureServe, 2015)

Threats and Stressors**Stressor:****Exposure:****Response:****Consequence:**

Narrative: The major threats to *Cyanea st.-johnii* are habitat degradation and destruction by feral pigs, potential predation by rats, predation by slugs and snails, competition with non-native plant species, and a risk of extinction from naturally occurring events and/or reduced reproductive vigor due to the small number of remaining occurrences and individuals. The non-native plant species *Andropogon virginicus*, *Axonopus fissifolius*, *Clidemia hirta*, and *Sacciolepis indica* threaten *C. st.-johnii* by altering its habitat and competing with it for nutrients, light, and space. The types of stochastic events most likely to affect *C. st.-johnii* are landslides, hurricanes, or flooding. The plants between the summit of Aiea and Halawa trails are also threatened by trampling from foot traffic (HINHP Database 2001; Service 1998a; 61 FR 53089).

Recovery***Conservation Measures and Best Management Practices:***

- Captive propagation for genetic storage and reintroduction: Continue to collect seeds from tagged individuals, keeping close track of the maternal source for use in ex situ propagation. Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation (USFWS, 2012).

- Reintroduction / translocation implementation – Reintroduce the species back into its known historical range (USFWS, 2012).
- Ungulate exclosures: Continue to construct fenced exclosures around existing and reintroduced populations to provide protection from feral ungulates. Monitor fenced exclosures for evidence of breaching by feral ungulates (USFWS, 2012).
- Ungulate control – Continue to protect all populations against disturbances from feral ungulates (USFWS, 2012).
- Ecosystem-altering invasive plant species control – Continue to control invasive introduced plant species around all populations (USFWS, 2012).
- Predator / herbivore control – Implement effective control methods for rats (USFWS, 2012).
- Surveys / inventories: Continue to conduct thorough surveys of all suitable habitats where *Cyanea st-johnii* was historically seen. Conduct surveys north of the Puu Pauao site to get an accurate population record of *Cyanea st-johnii* (USFWS, 2012).
- Threats research: Conduct studies to develop and implement control methods for slugs around all known populations. Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2012).
- Population biology research – Study *Cyanea st.-johnii* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2012).
- Site / area / habitat protection – Develop and implement effective measures to reduce the impact of hiking and trail maintenance (USFWS, 2012).
- Alliance and partnership development – Work with the U.S. Army, Hawaii Division of Forestry and Wildlife, and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2012).
- A State-wide management plan should be developed and implemented for the long-term conservation of all known occurrences of *Cyanea st.-johnii*. This plan should also include broader landscape actions that are needed for the recovery of this plant throughout its range. The recovery plan for this species identifies the following important conservation actions. Fences should be constructed around all known occurrences of *C. st.-johnii* to reduce impacts from feral pigs and trampling. Control or removal of pigs from the broader landscape area should also be undertaken to alleviate impacts on the native ecosystem needed to sustain this species. Ex situ propagation of *C. st.-johnii* should be initiated using material collected from individuals throughout the range of the species. Rats may be a serious threat to this species, as they are for other species of *Cyanea*. Rats should be controlled in the vicinity of all known occurrences of *C. st.-johnii* using approved rodenticides. Work on aerial dispersal of rodenticides should be supported (Service 1998a).
Ongoing Conservation Actions: No specific conservation measures have been undertaken for *Cyanea st. johnii* statewide by other agencies (Army 2003a).

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SPECIES ACCOUNT: *Cyanea stictophylla* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/04/1994; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Cyanea stictophylla Rock is a small tree or shrub 2-20 ft (0.6-6 m) tall (Lammers 1990). The stems are sparsely branched and occasionally equipped with sharp outgrowths. The leaves are long and narrow with toothed or lobed blades, 7.8-15 in (20-38 cm) long and 1.6-3.1 in (4-8 cm) wide. Leaf stalks (petioles) are 0.6-1.4 in (1.5-3.5 cm) long. Five or six flowers form a cluster at the tip of the main flower cluster stalk, which is 0.3-0.9 in (0.7-2.2 cm) long. The calyx and petals are fused at the base into an oval, sparsely hairy tube (hypanthium) about 0.2 in (5-6 mm) long. At the tube tip, five triangular calyx lobes are 0.1-0.2 in (2-4 mm) long and 0.04-0.1 in (1-2 mm) wide. Sparsely hairy, spreading, deeply lobed petals, 1.4-2 in (3.5-5 cm) long, are fused into an arched tube about 0.2 in (5-6 mm) wide. The five petals are yellow-white or purple. Berries are orange and round. (USFWS, 1996)

Taxonomy

Rock first collected *Cyanea stictophylla* on the slopes of Mauna Loa. Rock described the taxon in 1913 based on these specimens. Other authors recognized the following synonyms: *Cyanea palakea* C. Forbes (Forbes 1916), *C. quercifolia* (Hillebr.) F. Wimmer var. *atropurpurea* F. Wimmer (Wimmer 1953), *C. stictophylla* var. *inermis* Rock (Rock 1957), and *C. nelsonii* St. John (St. John 1976). St. John (1987b) and St. John and Takeuchi (1987), disregarding the separation of the genera *Cyanea* and *Delissea*, merged the two into the genus *Delissea*, resulting in the new combinations of *Delissea palakea* (C. Forbes) St. John, *D. quercifolia* (Hillebr.) St. John var. *atropurpurea* (F. Wimmer) St. John, *D. stictophylla* (Rock) St. John, *D. stictophylla* var. *inermis* (Rock) St. John, and *D. nelsonii* (St. John) St. John. However, Lammers (1990) recognized the generic distinction and retained both genera. (USFWS, 1996)

Historical Range

Cyanea stictophylla is known historically from the western, southern, southeastern, and eastern slopes of Mauna Loa on the Big Island (Table 10) (Lammers 1990). (USFWS, 1996)

Current Range

Current range includes Island of Hawaii. (NatureServe, 2015)

Critical Habitat Designated

Yes; 7/2/2003.

Legal Description

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Cyanea stictophylla* on the island of Hawaii.

Critical Habitat Designation

The critical habitat designation for *Cyanea stictophylla* includes four units totaling 95,484 acres in Hawaii County, Hawaii. The units are Hawaii 15—*Cyanea stictophylla*—a, Hawaii 16—*Cyanea*

stictophylla—b, Hawaii 24—Cyanea stictophylla—c, Hawaii 30—Cyanea stictophylla—d. Two of the units, “Hawaii 15—Cyanea stictophylla—a” and “Hawaii 16—Cyanea stictophylla—b” currently are occupied by individuals of this species. These two units are each essential to the conservation of *C. stictophylla* because each supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. Each of the two unoccupied units are essential to the conservation of the species because each supports habitat that is necessary for the establishment of additional populations in order to reach recovery goals. Each unit is geographically separated from others on this island to reduce the likelihood of the destruction of all the units by one naturally occurring catastrophic event. Within the 4 units designated for *C. stictophylla* in this rule, habitat is provided for a total of 10 populations, each with 300 mature, reproducing individuals.

Hawaii 15—Cyanea stictophylla—a [685 ha (1,693 ac)]: This unit contains no named natural features and lies completely within the Kiilae watershed. The unit is almost completely within the South Kona Forest Reserve. This unit provides habitat for 1 population of 300 individuals of *C. stictophylla* and is currently occupied by 1 individual.

Hawaii 16—Cyanea stictophylla—b [327 ha (809 ac)]: This contains no named natural features and lies completely within the Kiilae watershed. The unit also lies completely within Kipahoe NAR. This unit provides habitat for 1 population of 300 individuals of *C. stictophylla* and is currently occupied by 1 individual. This unit provides the southernmost critical habitat within the species’ historical range.

Hawaii 24—Cyanea stictophylla—c [584 ha (1,443 ac)]: This unit is just north of, but does not include, Uwewale Gulch, it lies completely within the Pahala watershed, and also lies completely within Kau Forest Reserve; provides habitat for 2 populations of 300 individuals of *C. stictophylla*; and is currently unoccupied.

Hawaii 30—Cyanea stictophylla—d [632 ha (91,539 ac)]: This unit straddles the Kulani summit but otherwise has no named natural features, and it lies completely within the Kaahakini watershed. The unit also is completely within the Olaa-Kilauea Partnership lands; provides habitat for 6 populations of 300 individuals of *C. stictophylla*; and is currently unoccupied.

Primary Constituent Elements/Physical or Biological Features

Habitat features that are essential for this species include, but are not limited to, *Acacia koa* or wet *Metrosideros polymorpha* forests.

Special Management Considerations or Protections

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for this species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas

essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Flowering appears to occur year round when conditions are favorable (USFWS 2002; Bishop Museum 2011; National Tropical Botanical Garden 2011). Fruit has been observed on herbarium specimens collected in April (Bishop Museum 2011), although given its confirmed flowering year-round as moisture allows, fruit can probably also be found throughout the year. (USFWS, 2012)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Wet environment (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 3,500 and 6,400 feet (USFWS, 1995)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1996)

Habitat Narrative

Adult: The habitats of *Cyanea stictophylla* are lowland to montane, mesic to wet forest dominated by *Acacia koa* and *Metrosideros polymorpha* on old volcanic substrate. Populations grow between 3,500 to 6,400 ft (1,070 to 1,950 m) in elevation (Lammers 1990, HELP 1991i1-i3). Associated native species include *Melicope volcanica* (A. Gray) T. Hartley & B. Stone (alani) and *Urera glabra* (Hook. & Arnott) Wedd. (opuhe) (HHP 1991i1-i3). (USFWS, 1996; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Resiliency:

Very low (inferred from USFWS, 2012)

Redundancy:

Very low (inferred from USFWS, 2012)

Number of Populations:

4 (USFWS, 2012)

Population Size:

45 (USFWS, 2012)

Population Narrative:

Most recently, the Plant Extinction Prevention program (2010) reported 4 populations with a total of 45 individuals. These numbers include two adults and several juvenile individuals at Kahuku pit crater, Hawaii Volcanoes National Park, 17 adults between Kukuiopae Forest Reserve and Kaohe, and 25 individuals at Olelomoana South Kona Forest Reserve, Hawaii Island (Plant Extinction Prevention Program 2009). (USFWS, 2012)

Threats and Stressors

Stressor: Small population size (USFWS, 1996)

Exposure:

Response:

Consequence:

Narrative: In addition, the small number of plants and the scattered distribution of populations may limit the gene pool, resulting in decreased reproductive vigor, and make them vulnerable to extirpation by random events. (USFWS, 1996)

Stressor: Cattle grazing and habitat degradation by pigs (USFWS, 1996)

Exposure:

Response:

Consequence:

Narrative: The primary reasons for decline of this species are destruction of former habitat by cattle grazing and degradation of current habitat by feral pigs. (USFWS, 1996)

Stressor: Invasive plants (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Invasive plant species are a threat by degradation of habitat including *Passiflora tarminiana* (banana poka) and *Ehrharta stipoides* (meadow rice grass) (Plant Extinction Prevention Program 2007b, 2009). (USFWS, 2012)

Stressor: Tree falls (USFWS, 2012)

Exposure:

Response:**Consequence:**

Narrative: Tree falls at the Hakalau Forest National Wildlife Refuge Kona Forest Unit can potentially damage *C. stictophylla* (Jeffrey and Horiuchi 2008). (USFWS, 2012)

Stressor: Climate change (USFWS, 2012)

Exposure:**Response:****Consequence:**

Narrative: Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2012)

Recovery**Reclassification Criteria:**

1. A total of five to seven populations of each taxon should be documented on the Big Island and at least one other island where it now occurs or occurred historically, if it is not endemic to the Big Island. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1996)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1996)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on the Big Island and at least 1 other island where they now occur or occurred historically, if it is not endemic to the Big Island. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 individuals per population for short-lived perennials. (USFWS, 1996)
3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1996)

Recovery Actions:

- Propagation and maintenance of ex situ stock are necessary and efforts to do such should be encouraged. (USFWS, 1996)
- Current populations should be protected from ungulates and augmented, where possible. (USFWS, 1996)

- At least two new populations will need to be established and numbers increased to meet recovery criteria. (USFWS, 1996)

Conservation Measures and Best Management Practices:

- Continue to collect seed from all populations and distribute to at least two centers where it may be stored or propagated. Maximize the number of individuals from which seed is collected to help maintain existing genetic variation within the species. (USFWS, 2012)
- Identify suitable habitat within the historical range of the species for reintroduction. (USFWS, 2012)
- Continue to reintroduce the species into its known historical range. (USFWS, 2012)
- Continue to fence all known populations. Monitor fences biannually for evidence of breaching. (USFWS, 2012)
- Protect all populations against disturbances from feral ungulates. (USFWS, 2012)
- Continue to control all invasive introduced plant species around all populations. (USFWS, 2012)
- Resurvey the known historical range of the species to search for additional populations. (USFWS, 2012)
- Monitor existing populations for evidence of insect damage or plant disease, and control as necessary. (USFWS, 2012)
- Control rodents around existing populations. (USFWS, 2012)
- Develop and implement effective measures to reduce the impact of landslides and erosion associated with tree falls at the Hakalau Forest National Wildlife Refuge Kona Forest Unit. (USFWS, 2012)
- Use microsatellites or other DNA techniques to determine overall levels of genetic diversity, including how such diversity is partitioned among extant populations. (USFWS, 2012)
- Carry out field studies to determine the pollinators and seed dispersal mechanism of the species. (USFWS, 2012)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2012)
- Work with the Hawaii Division of Forestry and Wildlife, and other land managers to continue implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2012)

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SPECIES ACCOUNT: *Cyanea superba* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/11/1991; Pacific Region (R1) (USFWS, 2016)

Physical Description

It is a tree 4 to 6 m (13 to 20 ft) tall with a single major stem, or occasionally two or more major stems arising from the base of the plant. The leaves are 0.5 to 1.0 m (1.6 to 3.3 ft) long and clustered at the stem tips. The curved, tubular, white or cream-colored flowers are 5.5 to 8.8 cm (2.1 to 3.4 in) long. The egg-shaped yellow or orange berries are 16 to 22 mm (0.6 to 0.9 in) long (Wagner et al 1999; Makua Implementation Team 2003) (USFWS, 2016).

Taxonomy

A member of the Campanulaceae (bellflower family). *Cyanea superba* is comprised of two subspecies, *C. superba* ssp. *superba* of the northern Waianae Mountains and *C. superba* ssp. *regina* of the southeastern Koolau Mountains. Both subspecies are contained within the listed taxon, but *Cyanea superba* ssp. *regina* has not been observed since 1960 (Makua Implementation Team 2003). The genus *Cyanea* is one of the largest Hawaiian plant genera and incorporates a high proportion of rare taxa, including 28 endangered taxa, one threatened taxon, eight candidates for listing, and 17 species of concern (Service 2006a, Hawaii Biodiversity and Mapping Program 2006) (USFWS, 2016).

Historical Range

Cyanea superba ssp. *superba* is a subspecies endemic to Oahu. Survey data indicate *C. superba* ssp. *superba* historically was first collected in 1870 from eastern Mt. Kaala and Makaleha Valley in the northern Waianae Mountains (USFWS, 2016).

Current Range

Current range includes Waianae Mountains of Oahu (NatureServe, 2015). The Kahanahaiki and Pahole to Kapuna population units are current (U.S. Army Garrison 2005b). The Central and East Makaleha, and Makaha, population units are designated as future reintroduction sites for this subspecies (USFWS, 2016).

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea superba* (Haha) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Cyanea superba* (77 FR 57648-57862). The critical habitat designation includes 3 critical habitat units, which encompass approximately 5,884 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Cyanea superba* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Cyanea superba* includes 3 critical habitat units, covering one ecosystem type, which encompasses approximately 5,884 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea superba* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Cyanea superba* occurs within the indicated ecosystem in the Waianae Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Cyanea superba* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual: self-pollination, cross-pollination (USFWS, 2016)

Lifespan

Adult: Unknown, possibly up to 20 years (USFWS, 2016); < 10 years (USFWS, 2012)

Breeding Season

Adult: August - October (USFWS, 2016)

Key Resources Needed for Breeding

Adult: Presumably birds, possibly bees (USFWS, 2016)

Reproduction Narrative

Adult: Flowering season varies from year to year depending on rainfall, usually from late August to early October and peaking in early to mid-September. Fruits mature in two to five months (68 FR 35950). The long tubular flowers and yellow-orange berries suggest pollination and seed dispersal by birds may be common. As with other *Cyanea* species with long tubular flowers, *C. superba* ssp. *superba* likely was pollinated by nectar-feeding birds. It is capable of self-pollination, as evidenced by the fact that isolated plants produce viable seeds. Recent research indicates native bees (genus *Hylaeus*) and the non-native Japanese white-eye bird (*Zosterops japonicus*) also may pollinate this subspecies (U.S. Army Garrison 2005b). The longevity of *C. superba* ssp. *superba* is unknown, but may be up to 20 years as indicated by observed growth rates and the size of mature plants (Makua Implementation Team 2003) (USFWS, 2016). *Cyanea superba* is a short-lived perennial (< 10 years) (USFWS, 2012).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Moist and wet forests (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at 761 - 2,860 ft. elevation (USFWS, 2016)

Habitat Narrative

Adult: Inhabits moist and wet forests in gulch bottoms (NatureServe, 2015). *Cyanea superba* ssp. *superba* usually grows in the understory of mesic forest on well-drained rocky substrate on sloping terrain at elevations between 232 and 872 m (761 and 2,860 ft) (USFWS, 2016).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Extinct in the wild in 2002 (USFWS, 2016)

Species Trends:

All occurrences are reintroductions from propagated stock (USFWS, 2016)

Resiliency:

Very low (inferred from NatureServe, 2015; see current range/distribution)

Representation:

Low (USFWS, 2016)

Redundancy:

Low (USFWS, 2016)

Number of Populations:

2 (USFWS, 2012)

Population Size:

169 mature reintroduced (USFWS, 2012)

Minimum Viable Population Size:

50 mature, reproducing individuals (USFWS, 2016)

Population Narrative:

At the time of listing, there were fewer than 20 individuals in two occurrences, Pahole and Kahanahaiki (56 FR 46235). By 2002, all naturally occurring plants had died. All currently existing plants in the wild are reintroductions from greenhouse-propagated stock, which the Army has been outplanting since 1999 and the State since the mid 1990s (U.S. Army Garrison 2005b). Trends in abundance and distribution indicate there are currently 311 total individuals in four population units located on Federal and State lands (Table SB 11) (U.S. Army Garrison 2006d). Both of these population units are exceeding minimum numeric criteria for stabilization (defined as 50 mature, reproducing individuals per population unit). Although studies have demonstrated extremely low genetic variability in this subspecies, inbreeding depression apparently is not significant as plants grow vigorously, flower, and produce viable seed (USFWS, 2016). As of 2010, there are 2 populations containing 169 mature reintroduced individuals of *C. superba* subsp. *superba* (U.S. Army Garrison 2010) (USFWS, 2012).

Threats and Stressors

Stressor: Habitat degradation (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: Threats include alien plants and animals (pigs) (NatureServe, 2015).

Stressor: Herbivory (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: Herbivory by alien slugs (NatureServe, 2015). There is no evidence of recruitment in the wild, due to very high slug predation on small size classes and rat predation of fruits (U.S. Army Garrison 2005b) (USFWS, 2016).

Stressor: Fire (NatureServe, 2015)

Exposure:**Response:****Consequence:**

Narrative: There are threats of fires from Makua firing range (NatureServe, 2015).

Stressor: Stochastic events (USFWS, 2016)

Exposure:**Response:****Consequence:**

Narrative: This subspecies has a history of precipitous decline and extremely low genetic variability; any catastrophic disturbance during a major low point could extirpate one or more population units or result in the extinction of the species in the wild (Makua Implementation Team 2003). The science of conservation biology has documented a general pattern of population collapse for a wide range of plant and animal species (Dennis et al 1991; Schemske et al 1994; Morris et al 1999; Menges 2000). According to this pattern, *C. superba* ssp. *superba* already is in a phase of “quasi-extinction” with numbers that have declined to the point where demographic stochasticity alone can result in extirpation (USFWS, 2016).

Stressor: Loss of pollinators (USFWS, 2016)

Exposure:**Response:****Consequence:**

Narrative: The long-billed, nectar-feeding native Hawaiian birds that were the presumed pollinators of *C. superba* ssp. *superba* have been almost totally extirpated from the Waianae Mountains. Although this subspecies is capable of self-pollination, the loss of its natural pollinators has likely resulted in decreased genetic variability (Makua Implementation Team 2003) (USFWS, 2016).

Stressor: Climate change (USFWS, 2012)

Exposure:**Response:****Consequence:**

Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. We anticipate high spatial resolution climate outputs by 2013 (USFWS, 2012).

Recovery**Reclassification Criteria:**

1. A total of five to seven populations should be documented on Oahu and at least one other island where they now occur or occurred historically (USFWS, 1998).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1998).

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1998).

Delisting Criteria:

1. A total of 8 to 10 populations should be documented on Oahu and at least one other island where they now occur or occurred historically (USFWS, 1998).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1998).

3. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1998).

Recovery Actions:

- Protect habitat and control threats (USFS, 1998).
- Expand existing wild populations (USFWS, 1998).
- Conduct essential research (USFWS, 1998).
- Develop and maintain monitoring plans (USFWS, 1998).
- Reestablish wild populations within historic range (USFWS, 1998).
- Validate and revise recovery criteria (USFWS, 1998).
- Control competing alien plant species within enclosures (USFWS, 1998).
- Provide protection from fire (USFWS, 1998).
- Reduce threat of rat predation (USFWS, 1998).
- Relocate and protect *Cyanea superba* var. *regina* (USFWS, 1998).

Conservation Measures and Best Management Practices:

- Particular conservation needs include research on slug control measures in forest settings and rat control during the fruiting and seed collection season (USFWS, 2016).
- The Makua Implementation Team (2003) has developed stabilization protocols for *Cyanea superba* ssp. *superba*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). This subspecies is located in occurrences over three management units where it will benefit from population unit and/or ecosystem-level protection: Kahanahaiki, Pahole, and Upper Kapuna. In addition, all reintroductions are within fenced ungulate exclosures. Rats are partially controlled in the Kahanahaiki and Honouliuli population units. Weeds are controlled in the Kahanahaiki population unit and partially controlled in the Pahole to Kapuna population unit. Reintroduced plants in all population units are within fenced ungulate exclosures (U.S. Army Garrison 2005b) (USFWS, 2016).
- As of 2005, there were several ex situ collections for *C. superba* ssp. *superba*, including 47 vegetative buds in micropropagation (Harold L. Lyon Arboretum), three cuttings in a nursery (Harold L. Lyon Arboretum), nine plants in botanical garden (Waimea Valley Audubon Center), 2,176 ungerminated seeds in a nursery (Harold L. Lyon Arboretum), 52,000 seeds in seed storage (Lyon Arboretum Seed Storage Facility), and 47 seedlings in a nursery (Harold L. Lyon Arboretum) (Service 2005b) (USFWS, 2016).
- Captive propagation for genetic storage and reintroduction: Continue to collect seeds from tagged individuals, keeping close track of the maternal source for use in ex situ propagation. Continue to

collect seeds from all existing populations and send to at least two or three different venues for propagation (USFWS, 2012).

- Reintroduction / translocation implementation – Continue to reintroduce the species back into its known historical range (USFWS, 2012).
- Ungulate exclosures: Continue to construct fenced exclosures around existing and reintroduced populations to provide protection from feral ungulates. Monitor fenced exclosures for evidence of breaching by feral ungulates (USFWS, 2012).
- Ungulate control – Continue to protect all populations against disturbances from feral ungulates (USFWS, 2012).
- Ecosystem-altering invasive plant species control – Continue to control invasive introduced plant species around all populations (USFWS, 2012).
- Predator / herbivore control – Continue to implement effective control methods for rodents (USFWS, 2012).
- Genetic research – Conduct research to develop a plan to maintain or increase genetic variability of *Cyanea superba* subsp. *superba* (USFWS, 2012).
- Surveys / inventories: Conduct surveys of appropriate habitat in historical locations to determine if any wild populations of *Cyanea superba* subsp. *regina* still exist. Continue to conduct thorough surveys of all suitable habitats where *Cyanea superba* subsp. *superba* was historically seen (USFWS, 2012).
- Threats research: Continue to conduct research on the use of Sluggo® for control of nonnative slugs around all known populations. Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2012).
- Fire protection – Develop and implement a fire management plan for all populations of *Cyanea superba* subsp. *superba* (USFWS, 2012).
- Alliance and partnership development – Work with the U.S. Army and other land managers to continue planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2012).

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U.S. Fish and Wildlife Service. 1998. Recovery Plan for Oahu Plants. U.S. Fish and Wildlife Service, Portland, Oregon. 207 pp., plus appendices.

SPECIES ACCOUNT: *Cyanea tritomantha* (`aku)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/29/2013; Pacific Region (R1) (USFWS, 2016)

Physical Description

Cyanea tritomantha (`aku) is an endangered palm-like shrub, endemic to the island of Hawaii in the Hawaiian Islands, in the bellflower family (Campanulaceae). It has been documented in the Kohala Mountains in the north, further south along the windward (eastern) sides of Mauna Kea, Mauna Loa and Kilauea (volcanoes), and as far south as the district of Kau on the southeastern flank of Mauna Loa. The palm-like trees range in height from 1.8-3 m tall. Its leaf blades range from 38-95 cm long, and 11-20 cm wide. The racemes are axillary, clustered among the leaves, 5-20-flowered and corollas range 60-75 mm long, blackish purple or greenish white externally and pale bluish white or white within. (NatureServe).

Taxonomy

Genus of 52 species endemic to Hawaiian Islands. Species endemic to Island of Hawaii. (NatureServe, 2015)

Historical Range

See Current

Current Range

Cyanea tritomantha is endemic to the island of Hawaii in the Hawaiian Islands. It is documented in the Kohala Mountains in the north, further south along the windward (eastern) sides of Mauna Kea, Mauna Loa and Kilauea (volcanoes), as far south as the the district of Kau on the southeastern flank of Mauna Loa (NatureServe). It is known only from the island of Hawai'i (Lammers 2004, Pratt and Abbott 1997). This species was known historically from the windward slopes of Mauna Kea, Mauna Loa, Kilauea, and the Kohala Mountains, in the lowland wet, montane wet, and wet cliff ecosystems (Pratt and Abbott 1997).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: *Cyanea tritomantha* produces few seeds and their viability tends to be low (Moriyasu 2009, in litt.)

Habitat Type

Adult: Wet forest

Habitat Narrative

Adult: Lowland wet, montane wet, and wet cliff ecosystems; wet forests and on old volcanic substrates (NatureServe).

Dispersal/Migration

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Population Growth Rate:

Unknown (NatureServe, 2015)

Number of Populations:

1 - 20 (NatureServe, 2015)16

Population Size:

< 400

Population Narrative:

Unknown The estimated total of individuals is 400-500. There are a total of 27 EOs and 15 are known extant occurrences (1990-2006) found on the island of Hawaii. (NatureServe, 2015). There are currently 16 occurrences of *Cyanea tritomantha* totaling fewer than 400 individuals in the lowland wet, montane wet, and wet cliff ecosystems (USFWS 2013a). In addition, a few individuals have been outplanted at Puu Makaala NAR and Upper Waiakea FR (Hawai'i Department of Land and Natural Resources (HDLNR) 2006; Agorastos 2010, in litt.; Belfield 2007, in litt., cited in USFWS 2013a).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs and cattle), nonnative plants, hurricanes, and treefalls,. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Treefalls destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Lack of regeneration (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Lack of, or low levels of, regeneration (reproduction and recruitment) in the wild is a threat to *Cyanea tritomantha*, which is reported to produce few seeds with low viability (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, cattle, rats, and slugs) is considered an ongoing threat to *Cyanea tritomantha* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor:

Exposure:

Response:

Consequence:

Narrative: *Cyanea tritomantha* produces few seeds and tends to have low viability (Moriyasu 2009, in litt., cited in USFWS 2013a). Threats to the species include feral pigs and cattle, ranching, farming, homesteading, and various alien plant species. Also, rats and slugs are known to feed on *Cyaneas* in general. Natural threats to the species are volcanic activity and fires ignited by it. There has been an almost continuous eruption along Kilauea Volcano's East Rift Zone from 1983 to the present (August 2000). Lava flows and ashfalls from this eruption have destroyed or damaged some of *C. tritomantha*'s habitat. Also, lava flows originating on Mauna Loa potentially threaten occurrences of *C. tritomantha* on its eastern and southeastern slopes.

Recovery

Recovery Actions:

- Not known

References

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USFWS. 2013. Determination of Endangered Species Status for 15 Species on Hawaii Island

Final Rule. 78 Federal Register 209, October 29, 2013. Pages 64638 - 64690.

SPECIES ACCOUNT: *Cyanea truncata* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/28/1994; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

A shrub 0.3-2 m tall with unbranched stems. Flowers are white and striped or suffused with magenta. (NatureServe, 2015)

Taxonomy

Genus of 52 species endemic to Hawaiian islands, species endemic to Koolau mts. of Oahu. (NatureServe, 2015)

Historical Range

Historically, *Cyanea truncata* was known from Punaluu, Waikane, and Waiahole in the northern Koolau Mountains of Oahu (USFWS 1996a). (USFWS, 1998)

Current Range

Currently found at Kahana Valley in Oahu. (USFWS, 2012)

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyanea truncata* (Haha) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Cyanea truncata* (77 FR 57648-57862). The critical habitat designation includes 18 critical habitat units, which encompass approximately 31,995 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Cyanea truncata* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Cyanea truncata* includes 18 critical habitat units, covering three ecosystem types, which encompass approximately 31,995 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 4, 6, 7; Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; Oahu—Wet Cliff—Units 6, 7, 8.

Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and

within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Hauula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikēē, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet—Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet—Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu—Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamoa Ridge.

Oahu—Wet Cliff—Unit 6 [151 ac (61 ha)]. This area consists of 151 ac (61 ha) in the wet cliff ecosystem on State land on the windward side of the Koolau Mountains in Kaipapau Gulch, entirely within the Kaipapau Forest Reserve. Oahu—Wet Cliff—Unit 7 [144 ac (58 ha)]. This area consists of 144 ac (58 ha) in the wet cliff ecosystem in State land on the windward side of the Koolau Mountains in Hauula Gulch, entirely within the Hauula Forest Reserve. Oahu—Wet Cliff—Unit 8 [4,649 ac (1,881 ha)]. This area consists of 1,479 ac (598 ha) of State land, 1,281 ac (519 ha) of City and County of Honolulu land, 5 ac (2 ha) of Federal land, and 1,884 ac (762 ha) of privately owned land, in the wet cliff ecosystem along the summit of the Koolau Mountains, overlapping portions of Sacred Falls State Park, the Waiahole FR (Waiahole and Iolekaa sections), the Kaneohe and Honolulu Watershed FRs, and the Nuuanu Pali State Wayside.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyanea truncata* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Cyanea truncata* occurs within the Lowland mesic ecosystem in the Koolea Mountain caldera complex and was known historically (last observed > 20 yrs ago) from the Lowland wet and Wet cliff ecosystems in the Koolau Mountain caldera complex:

Oahu—Lowland Mesic—Units 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (F) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Oahu—Wet Cliff—Units 6, 7, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: >65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. (F) Understory: Bryophytes, Ferns, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Cyanea truncata* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources**Reproduction Narrative**

Adult: This species was observed in flower in December 1919 and November 1980, the last time the species was observed before feral pigs extirpated the population (USFWS 1996a). (USFWS, 1998)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Wet forests (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 240 and 400 meters (USFWS, 1998)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1998)

Habitat Narrative

Adult: *Cyanea truncata* typically grows on windward slopes in mesic to wet forests in gulch bottoms at elevations between 240 and 400 meters (800 and 1,300 feet) (Lanimers 1990, USFWS 1996a). Associated plants include *Hibiscus arnottianus* (kokio keokeo), lama, ohia, *Cyrtandra propinqua* (haiwale), *Neraudia melastomifolia* (maaloa), *Pisonia umbellifera* (papala kepau), and *Piper methysticum* (awa) (USFWS 1996a, Wagner et al. 1990). (USFWS, 1998)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2012)

Redundancy:

Very low (inferred from USFWS, 2012)

Number of Populations:

4 (1 wild, 3 reintroduced) (USFWS, 2012)

Population Size:

~35 (2 wild) (USFWS, 2012)

Population Narrative:

In 2010, the only wild population of *Cyanea truncata* consisted of two mature individuals at Kahana Valley (Plant Extinction Prevention Program 2010). As of 2010, there were four reintroduction sites containing 33 individuals (mature and immature) of *C. truncata* in Kahana Valley: One is located within the same gulch as the wild population in Kahana (12 individuals), one at Makaua enclosure A (10 individuals), one at Makaua enclosure B (7 individuals), and one at Hakipuu (4 individuals) (Plant Extinction Prevention Program 2010). (USFWS, 2012)

Threats and Stressors

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2012)

Stressor: Habitat degradation by pigs (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: A major threat to *Cyanea truncata* is habitat degradation by feral pigs (Service 1998; 68 FR 35950). As early as 1778, European explorers introduced livestock, which became feral, increased in number and range, and caused significant changes to the natural environment of Hawaii. The pig is originally native to Europe, northern Africa, Asia Minor, and Asia. European pigs became feral and invaded forested areas, especially wet and mesic forests and dry areas at high elevations. Feral pigs are currently present on Oahu and inhabit rain forests and grasslands. While rooting in the ground in search of the invertebrates and plant material they eat, feral pigs disturb and destroy vegetative cover, trample plants and seedlings, and threaten forest regeneration by damaging seeds and seedlings. They disturb soil and cause erosion, especially on slopes. Alien plant seeds are dispersed on their hooves and coats as well as through their digestive tracts, and the disturbed soil is fertilized by their feces, helping these plants to establish. Pigs are a major vector in the spread of many introduced plant species (Smith 1985; Stone 1985; Medeiros et al. 1986; Scott et al. 1986; Tomich 1986; Cuddihy and Stone 1990; Wagner et al. 1999). Enclosures designed to exclude wild pigs were constructed around the three wild *C. truncata* plants in Kahana Valley in April 2004 (A. Bakutis, pers. comm. 2006). A 20 by 30 meter (m) enclosure was built around one of the mature plants. Another 3 by 3 m enclosure was constructed around the other mature plant. The immature plant was surrounded by a 2 by 2 m enclosure fence (A. Bakutis, pers. comm. 2006). (USFWS, 2007)

Stressor: Non-native invasive plants (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: *Cyanea truncata* is threatened by habitat degradation by and competition with the invasive nonnative plant species *Aleurites moluccana* (kukui), *Christella parasitica*, *Clidemia hirta* (Koster's curse), *Cordyline fruticosa* (ti), *Oplismenus hirtellus* (basketgrass), *Psidium guajava* (common guava), *Schinus terebinthifolius* (Christmas berry), and *Schefflera actinophylla* (octopus tree) (J. Lau, pers. comm. 2006) (Factors A and E). Weed control is ongoing at the fenced populations of *C. truncata* (A. Bakutis, pers. COInm. 2006). (USFWS, 2007)

Stressor: Predation by rats (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Signs of rat predation have been observed on the Kahana population of *Cyanea truncata* plants. Rats had gnawed off the bark of the stems of one of the plants, almost girdling the stems. A rat control program utilizing rodenticides has been implemented at all three exclosures (A. Bakutis, pers. comm. 2006). (USFWS, 2007)

Stressor: Introduced slugs (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Introduced slugs also pose a threat to *Cyanea truncata* (Service 1998; 68 FR35950) (Factor C). Slugs feed on seedlings, stems, and fruit, thereby reducing the vigor of the plants and limiting regeneration (Service 1998). Field experiments conducted by Alvin Yoshinaga and Curt Daehler demonstrated that slugs could reduce the survival of *Cyanea* spp. seedlings by as much as 80 percent. Graduate student Stephanie Joe has been hired by the Army as a Natural Resources Research Specialist, and included among her duties is the investigation of control of slug herbivory. Her research on slug impacts on *Cyanea* seedlings has revealed similar levels of mortality, approximately 53 percent (Joe 2006). (USFWS, 2007)

Stressor: Small population size (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: In addition to the above threats, species like *Cyanea truncata* that are endemic to a small portion of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes and disease outbreaks. The limited gene pool may depress reproductive vigor. (USFWS, 2007)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)

3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1998)

Recovery Actions:

- Surveys of appropriate habitat in historical locations are needed to determine if any other extant populations of this plant exist. (USFWS, 1998)
- To prevent extinction of this species, ex situ propagation should be initiated immediately if extant individuals are located. (USFWS, 1998)
- Once adequate propagated material is available, and fencing, rat control, and weed control, as appropriate, are underway in the areas of any remaining in situ populations, these populations should be enhanced by outplanting. Establishment of new populations within the historical range of *Cyanea truncata* should be initiated in areas that are managed to minimize the impacts of feral ungulates, rats and alien plants. (USFWS, 1998)

Conservation Measures and Best Management Practices:

- Continue to collect seeds from tagged individuals, keeping close track of the maternal source for use in ex situ propagation. (USFWS, 2012)
- Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation. (USFWS, 2012)
- Continue to reintroduce the species back into its known historical range. (USFWS, 2012)
- Continue to construct fenced exclosures around existing and reintroduced populations to provide protection from feral ungulates. (USFWS, 2012)
- Monitor fenced exclosures for evidence of breaching by feral ungulates. (USFWS, 2012)
- Continue to protect all populations against disturbances from feral ungulates. (USFWS, 2012)
- Continue to control invasive introduced plant species around all populations. (USFWS, 2012)
- Continue to implement effective control methods for rodents. (USFWS, 2012)
- Continue to conduct thorough surveys of all suitable habitats where *Cyanea truncata* was historically seen. (USFWS, 2012)
- Conduct studies to develop and implement control methods for slugs around all known populations. (USFWS, 2012)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2012)

- Study *Cyanea truncata* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. (USFWS, 2012)
- Work with the Hawaii Division of Forestry and Wildlife, and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2012)
- There is much potential habitat for *Cyanea truncata* that has not been surveyed for the species. Surveys of this habitat would likely result in the discovery of new populations of a few additional individuals (J. Lau, pers. comm. 2006). (USFWS, 2007)
- Study *Cyanea truncata* with regard to flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats to the species. (USFWS, 2007)
- Formulate a plan to maintain or increase genetic variability of *Cyanea truncata*. (USFWS, 2007)
- Reintroduce individuals of *Cyanea truncata* into its historical range. (USFWS, 2007)

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SPECIES ACCOUNT: *Cyanea undulata* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/20/1991; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Cyanea undulata is an unbranched (or the stem is occasionally forked) shrub or subshrub 0.5 to 3.6 m (1.5 to 15 ft) tall with narrowly elliptic leaves 28 to 43.5 cm long and 2.5 to 5 cm wide, with wavy margins, a smooth upper surface, and fine rust-colored hairs covering the lower surface. The petiole (leaf stem) may be winged. The inflorescence is unbranched, 8 to 45 cm long, and bears two to six flowers that are slightly curved, hairy, yellowish or greenish yellow and purplish at their base. Flowering material was collected from April to July. The fruit is an orange berry about 1.7 cm long (Lammers 1990, Rock 1919, Wimmer 1943, D. Lorence and Timothy Flynn, NTBG, pers. obser. 1991). (USFWS, 1994)

Taxonomy

A member of the bellflower family (Campanulaceae) (USFWS, 2003).

Historical Range

Historically, *Cyanea undulata* was known only from the Wahiawa Bog area on Kauai (USFWS, 2003).

Current Range

The current range is the Wahiawa Drainage of Kauai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Cyanea undulata* (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Cyanea undulata* includes one unit totaling 2,484 acres in Kauai County, Hawaii. The unit is Kauai 10—*Cyanea undulata*—a.

Kauai 10—*Cyanea undulata*—a: This unit is critical habitat for *Cyanea undulata* and is 1,006 ha (2,483 ac) on State (Lihue-Koloa Forest Reserve) and private land. This unit contains Kanaele Swamp, Kahili, Kapalaoa, and Puu a Uuka Summits. This unit provides habitat for five populations of 250 mature, reproducing individuals of the short-lived perennial *Cyanea undulata* and is currently occupied with 28 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, narrow drainages and seepy stream banks in *Metrosideros polymorpha* dry to wet montane forest or shrubland. This unit is of an appropriate size so that each potential recovery population

on Kauai within the unit is geographically separated enough to avoid their destruction by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Within this unit, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Narrow drainages and wet stream banks in *Metrosideros polymorpha* dry to montane wet forest or shrubland and containing one or more of the following associated native species: various grammitid and filmy ferns (Grammitidaceae and Hymenophyllaceae), *Adenophorus* spp., *Antidesma platyphyllum*, *Bidens* spp., *Broussaisia arguta*, *Cheirodendron* spp., *Diplazium sandwichianum*, *Dryopteris glabra*, *Eragrostis grandis*, *Freycinetia arborea*, *Machaerina angustifolia*, *Mariscus* spp., *Melicope feddei*, *Perrottetia sandwicensis*, *Pipturus* spp., *Psychotria hexandra*, *Psychotria mariniana*, *Sadleria pallida*, *Sadleria squarrosa*, *Smilax melastomifolia*, *Sphenomeris chinensis*, *Syzygium sandwicensis*, or *Thelypteris* spp.; and

(ii) Elevations between 375 and 1,046 m (1,231 and 3,430 ft).

Special Management Considerations or Protections

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Breeding Season**

Adult: Summer months (USFWS, 1994)

Key Resources Needed for Breeding

Adult: Nectar-eating birds, based on genus (USFWS, 2003)

Reproduction Narrative

Adult: Flowering occurs during the summer months, but adults seem not to flower every year (D. Lorence and T. Flynn, pers. obser. 1988-1991). (USFWS, 1994) Native members of the Campanulaceae (bellflower) family, including the genus *Cyanea*, are generally believed to be adapted to pollination by native nectar-eating passerine birds, such as the Hawaiian “honeycreepers.” The long, tubular, slightly curved flowers of *C. undulata* fit this model, but field observations are lacking (USFWS, 2003).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Wet environments, habitat is often cloudy and windy (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found in higher elevations (USFWS, 1994)

Environmental Specificity

Adult: High, with several key requirements (USFWS, 1994)

Habitat Narrative

Adult: *Cyanea undulata* is invariably found in the most pristine, undisturbed, and uninvaded sites, often on shady stream banks or steep to vertical slopes (Lorence & Flynn 1991) that are prone to erosion or landslides. *C. undulata* is restricted to the Wahiawa Drainage Basin. Characterized by rugged, mountainous terrain, this bowl-shaped, roughly triangular area is bounded on the north by Mt. Kapalaoa (3,310 ft), on the southeast by Mt. Kahili (3,089 ft), and on the southwest by Pu'u Au'uka (2,270 ft). Geologically the area is a mixture of older lavas of the Napali formation (5.72 to 4.47 million years old) and younger ones of the Koloa volcanic series (1.42 million years old) (Stearns 1966). Lying in the middle of the triangle is an area of poor drainage, the Wahiawa Bog (also known as Kanaele or "the bog" in Hawaiian). With an elevation of only 620 to 640 m (2,033 to 2,100 ft), it is unique in being the only true low elevation bog in Hawai'i. The soils are classified as Hulua Gravely Silty Clay Loam and Ko'olau Silty Clay, both types characteristic of the areas rough mountainous land (Foote et al. 1972). The area is often cloud-filled and windy. An important watershed, this drainage system is the source of the Wahiawa Stream, whose estuary is near Weli Point between Port Allen and Numila on the south shore of Kaua'i. The Wahiawa Mountains comprise a region of high floristic endemism on Kaua'i. Most of the area is covered by Lowland Wet *Metrosideros* Forest and Lowland Wet *Metrosideros* Shrubland (Cagnd & Cuddihy 1990). (USFWS, 1994)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: *Cyanea*, are generally believed to have adapted to pollination by native nectarivorous passerine birds, such as the Hawaiian "honeycreepers" (Lammers and Freeman 1986, Lammers et al. 1987). The long, tubular, slightly curved flowers of *Cyanea undulata* fit this model, but field observations are lacking. The fleshy orange fruits of this species are adapted for bird dispersal like other species of *Cyanea*. (USFWS, 1994)

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2003)

Redundancy:

Very low (inferred from USFWS, 2003)

Number of Populations:

4 (USFWS, 2017)

Population Size:

19 (USFWS, 2017)

Population Narrative:

Currently, one occurrence with a total of 28 individuals is reported on privately owned land along the bank of a tributary of the Wahiawa Stream in the Wahiawa drainage (GDSI 2000; HINHP Database 2000) (USFWS, 2003).; When *Cyanea undulata* was listed in 1991 there was one population consisting of three to four individuals in the Wahiawa drainage on Kauai. The 1994 recovery plan reported seven locations of this taxon totaling 28 individuals. The 2003 critical habitat document reported the same number of individuals within the Wahiawa drainage area. When the 5-year review was published in 2008, the numbers were reduced to one known living individual. However, the most recent review by the International Union for the Conservation of Nature (Walsh 2016) reports four “subpopulations” (considered by USFWS as populations; all within the Wahiawa drainage) totaling 19 individuals (Walsh 2016). The University of Hawaii Lyon Arboretum’s Hawaiian Rare Plant Program uses in vitro culture and seed storage to rescue, recover, and restore Hawaii’s endangered native plants from extinctions. Various methods are used for surveying for plants, collecting seeds, propagating, and planting. Seeds collected in the wild are difficult to clean without damaging or destroying them during the decontamination process. Sugii (2011) was able to establish a method that showed 45 percent germination success rate of mature fruit of *Cyanea undulata*. Use of this method will help prevent the loss of valuable propagules, and will provide genetically diverse, back-up repositories for this and other plant species that are threatened with extinction in the wild before effective on-the-ground conservation measures can be taken. (USFWS, 2017)

Threats and Stressors

Stressor: Alien plants (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Alien plant species pose the most severe threat to the Wahiawa, Waoili and Makaleha ecosystems, as they compete with native species for light, water, space, and nutrients. Aliens such as the strawberry guava, *Psidium cattleianum*, a member of the Myrtaceae family, may exude allelopathic substances toxic to native species (Tunison 1991). The two most serious alien plants in the areas are as follows: (1) *Melastoma candidum* (no common name in Hawai’i), a member of the Melastome family, is a vigorous invader of the low shrubland on flats surrounding the bog, where it forms dense, impenetrable shrubs 2 to 4 m (6.6 to 13.1 ft) across. (2) The red-fruited strawberry guava, *Psidium cattleianum* var. *cattleianum*, is undoubtedly the worst invader, particularly in valley bottoms and along streams, where it chokes out most other species. (USFWS, 1994)

Stressor: Feral animals (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: At present feral animals appear to pose a significant threat to the Makaleha area (K. Wood, pers. comm. 1993) and slight to moderate feral pig damage was noted in four areas in the Wahiawa Drainage, and in the Waioli Stream Valley (D. Lorence and T. Flynn, pers. obser. 1991). Rooting was primarily confined to moist, shady valley bottoms along streams, the habitat of *Hesperomannia*, *Dubautia*, and *Viola*. Pigs could become a severe problem should more animals move into these areas. There were no signs of goats or other ungulates. Rats were observed on several occasions and are harmful as seed predators and herbivores. (USFWS, 1994)

Stressor: Landslides and erosion (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Although most slopes in these areas are not excessively steep and are usually clothed with vegetation, there is evidence of past landslides in the area, especially after Hurricane Iniki (D. Lorence, pers. obser. 1991-1992). Landslides clearly pose a threat to populations of these species growing on relatively steep slopes or in valley bottoms. In addition, *Cyanea undulata*, *Dubautia pauciflora* and *Viola helenae* most frequently occur on steep soil banks or stream banks that are prone to erosion and undercutting. (USFWS, 1994)

Stressor: Disease and insect predation (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: The impact of various diseases and insects on these five species has not been adequately studied. However, no obvious diseases or insect predation was noted, with the exception of *Hesperomannia lvdgatei*, where insect larvae were often found in the fruiting heads. Seed predation by rats were not observed but is a possibility, as rats were observed in the area (D. Lorence and T. Flynn, pers. obser. 1991). In addition, rats feed on the bark of *Clerinontia* shrubs and the stems of certain *Cyanea* species on Kaua'i (D. Lorence and T. Flynn, pers. obser. 1991-1992). Introduced slugs have also been observed feeding on stems and leaves of *Cyanea* plants that had been previously damaged by rats and hurricane winds (D. Lorence, pers. obser. 1992). Herbivory by rats and slugs therefore are potential threats to *Cyanea undulata*. (USFWS, 1994)

Stressor: Lack of dispersal, germination, and pollination agents (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Two of the species, *Cyanea undulata* and *Labordia lvdgatei*, have fruits obviously adapted for bird dispersal. Passage of these seeds through a bird's gut may be necessary to insure their germination, and pollination may be inhibited by a lack of bird or native insect pollinators. It has been suggested that widespread extinctions of passerine birds may be causing declines in Hawaiian lobelioids that have depended on these birds for pollination (Lammers &

Freeman 1986). Approximately half of the historically known nectarivorous passerine birds in Hawai'i are extinct, and serious population declines threaten many of the other species (Lammers et al. 1987). (USFWS, 1994)

Stressor: Land conversion (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Past clearing of lowland wet forest on Kaua'i for agricultural uses may have contributed to the endangerment of these five species. At present this activity is not a threat at any of the sites. (USFWS, 1994)

Stressor: Over-collection (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Overcollection for scientific or horticultural purposes currently poses little threat to the existence of these five species, as most are difficult to find, inconspicuous, and extremely difficult to propagate and grow. Also, they are probably unknown to all but a few botanists and conservationists. Native gathering rights claims and proposed new rules to relax cultivation restrictions may increase this threat. (USFWS, 1994)

Stressor: Hurricanes (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: On September 11, 1992 Hurricane Iniki passed directly over Kaua'i with winds gusting up to 175 miles per hour. Considerable damage was inflicted on the native forests in many parts of the island (S. Perlman & K. Wood, pers. comm. 1992). A small part of the Wahiawa Drainage was surveyed on October 7, 1992, to assess hurricane damage to populations of the five endangered species known to occur there (D. Lorence, pers. obser. 1992). Damage to the vegetation varied from slight to severe depending on exposure to the winds, and several landslides had occurred. In this very limited survey at least one or several individuals of each endangered species had been severely damaged or destroyed by winds that uprooted the plants or snapped the main stem, falling trees or branches, or landslides. In the Waioli Stream Valley, two of three *Hesperomania lvdgatei* individuals were destroyed by the storm. A complete survey of all known populations and individuals is needed to quantify the amount of damage these five species suffered from Hurricane Iniki. Hurricane damage is clearly a serious threat, but one that is difficult or impossible to manage. (USFWS, 1994)

Stressor: Climate change loss or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate

change. The assessment by Fortini et al. (2013) concluded that *Cyanea undulata* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.934 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). The analysis showed that *C. undulata* has less than a 1 percent overlap of its current climate envelope with its projected future climate envelope. Species with no overlap between current and future climate envelopes are unlikely to easily tolerate expected changes in climate within their current climate envelope. This limitation means they must either endure in suitable microrefugia within their current envelope or move to newly available climate-compatible areas to avoid extinction. Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2017)

Recovery

Reclassification Criteria:

1. a total of at least three populations of *Cyanea undulata* should be documented, each with at least 250 reproductive individuals. (USFWS, 1994)
2. Each of these populations must be naturally reproducing, stable, or increasing in number, by removal of threats, with adequate percentages of adults, juveniles, and seedlings necessary for long-term maintenance of population numbers and genetic diversity. (USFWS, 1994)
3. The full genetic diversity of each population is backed up as living and stored material at one or more nurseries or botanical gardens. (USFWS, 1994)

Delisting Criteria:

1. The target includes locating or establishing, if necessary, at least two additional wild populations for a total of at least five reproductively stable populations, each with at least 250 reproductive individuals. (USFWS, 1994)
2. These populations should be stable over an estimated ten year period. If new populations are established, they should have optimum genetic composition and be within the historical range of the species. (USFWS, 1994)
3. All five populations should be unmanipulated and able to sustain themselves indefinitely without human intervention (including fencing and introduced invasive plant species control) (USFWS 1994). (USFWS, 1994)

Recovery Actions:

- Secure and manage existing populations. Preservation of the existing habitat at the Wahiawa Drainage, Waioli Stream Valley and Makaleha Mountains is essential to stabilize known populations and prevent the decline of these species, as all the known genetic diversity for the five species occurs here. (USFWS, 1994)
- Conduct basic research essential to the conservation of the five species. Few details regarding the ecology, demographics, propagation, habitat requirements and basic life history of these five species are known and such knowledge is essential to their conservation. (USFWS, 1994)
- Increase population numbers at existing sites. Population sizes of these five species should be increased to viable numbers in the Wahiawa Drainage, Waioli Stream Valley and

- Makaleha Mountains. Existing populations may be augmented by enhancement of in situ reproduction and by planting viable seeds, cuttings, or air layers in situ, either directly in the ground or in pots containing soil from nearby. (USFWS, 1994)
- Establish new populations. Plans must be developed for establishing new wild populations, including the selection of genetic stock. Ideally, additional populations of each species should be sought on Kaua'i. If these cannot be located or do not exist, and new populations must be established, then a protocol must be formulated for establishing new populations. (USFWS, 1994)
 - Verify the scientific validity of the recovery objectives. It is important to determine and verify the scientific validity of the recovery objective proposed herein. (USFWS, 1994)
 - Surveys and inventories—Continue surveys for populations of *Cyanea undulata* in areas of potentially suitable habitat. (USFWS, 2017)
 - Ungulate monitoring and control—Protect all occurrences against disturbance from feral ungulates. Construct and maintain small-scale fenced exclosures around known individuals, if feasible, to prevent imminent extinction. (USFWS, 2017)
 - Invasive plant monitoring and control—Continue controlling established ecosystem-altering nonnative invasive plant species around all known individuals. Control invasive nonnative plant species that compete with this taxon. (USFWS, 2017)
 - Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts and prepare sites and propagules for outplanting. (USFWS, 2017)
 - Predator and herbivore monitoring and control—Implement effective measures to control rodents at all known populations. Develop and implement effective measures to control slugs at all known populations. (USFWS, 2017)
 - Stochastic events—Build resiliency and redundancy—Increase numbers of populations and individuals throughout historic range to reduce impacts from landslides and hurricanes. (USFWS, 2017)
 - Population biology research—Study *Cyanea undulata* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. (USFWS, 2017)

Conservation Measures and Best Management Practices:

- Attempt planting into greenhouse situation plants that are currently in micropropagation. (USFWS, 2008)
- Protect habitat of existing population from invasive plants, slugs, rats, and ungulates. (USFWS, 2008)
- Reintroduce propagated plants into suitable habitat that has been adequately protected. (USFWS, 2008)

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USFWS. 2008. *Cyanea undulata* (Haha) 5-Year Review Summary and Evaluation. Pacific Islands Fish and Wildlife Office Honolulu, Hawaii

SPECIES ACCOUNT: *Cycladenia humilis* var. *jonesii* (Jones Cycladenia)

Species Taxonomic and Listing Information

Listing Status: Threatened; 05/05/1986; Mountain-Prairie Region (R6) (USFWS, 2015)

Physical Description

A rhizomatous perennial herb 1-3.6 dm tall, with bright green, rounded, somewhat succulent leaves. Pink, woolly-haired flowers appear in May-June (NatureServe, 2015).

Taxonomy

The genus *Cycladenia* consists of one species *Cycladenia humilis* treated as having two varieties in California (var. *humilis*, var. *venusta*) (Hickman 1993) and a third variety, Jones cycladenia (*Cycladenia humilis* var. *jonesii*) found in Utah and Arizona. The closest taxonomic relative to Jones cycladenia is thought to be *Mandevilla*, a neotropical genus (Wolf et al. 1992) (USFWS, 2008).

Historical Range

At the time of listing, Jones cycladenia (*Cycladenia humilis* var. *jonesii*) was found in Emery, Grand, and Garfield Counties in Utah and known historically from a fourth indeterminate site named Pipe Spring, in the vicinity of Mohave County, Arizona, and Kane County, Utah (51 FR 16526, May 5, 1986). This historic site has since been relocated near Pipe Springs National Monument, Arizona (Sipes et al. 1994) (USFWS, 2008).

Current Range

The five Jones cycladenia complexes include: Joe Hutch Creek, San Rafael, Moab, and Greater Circle Cliffs in Utah, and Pipe Springs in Arizona (USFWS, 2008).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Primarily asexual: vegetative; sexual (NatureServe, 2015)

Lifespan

Adult: Long-lived perennial (USFWS, 2008)

Breeding Season

Adult: April - June (USFWS, 2008)

Reproduction Narrative

Adult: Very low potential for sexual reproduction; relies primarily on clonal growth (Boettinger 1997; Sipes and Wolf 1997; Sipes and Tepedino 1996) (NatureServe, 2015). A long-lived

perennial that produces flowers from mid-April to early June. Fruit and seed production is believed extremely limited (Sipes and Tepedino 1996) (USFWS, 2008).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Desert shrub (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 4,390 - 6,000 ft. elevation (USFWS, 2008)

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits desert shrub community with barren gypsiferous clay hills that form the steep sides and lower slopes of mesas in the canyonlands section of the Colorado Plateau (FR 1986). Restricted to soils with a narrow range of morphological and physical properties, but not an obligate gypsophile (Boettinger 1997). The environmental specificity is narrow (specialist or community with key requirements common) (NatureServe, 2015). It occurs between 4,390 to 6,000 feet (1,338 to 1,829 meters) elevation in plant communities of mixed desert scrub, juniper, or wild buckwheat-Mormon tea. It is found on gypsiferous, saline soils of Cutler, Summerville, and Chinle Formations (USFWS, 2008).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Resiliency:

Low to moderate (inferred from USFWS, 2008; see current range/distribution)

Redundancy:

Moderate (inferred from USFWS, 2008)

Number of Populations:

26 (USFWS, 2008)

Population Size:

1,100 (USFWS, 2008)

Population Narrative:

The long term population trend is unknown (NatureServe, 2015). Today, Jones cycladenia is known from 26 sites. It is estimated that the species has 25,000 ramets (or above-ground stems), but that these stems represent approximately 1,100 ganets (or individuals) (USFWS, 2008).

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Mountain biking and OHV use occurs near sites in Moab and San Rafael complexes; cattle grazing occurs at sites in the San Rafael complex; and uranium mining and tar sands extraction are foreseeable threats in the both the San Rafael and Greater Circle Cliffs complex (USFWS, 2008).

Stressor: Low reproduction (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Preliminary research (1988 to 1993) has shown that the plant has, at best, low fruit production and seed set, likely due to a complicated pollination system and inadequate pollinator abundance (i.e., pollinators may have been lost or may be migratory and appear episodically) (Sipes and Tepedino 1996). No seedling germination events have been documented (Sipes et al. 1994; Sipes and Tepedino 1996; D. Clark, pers. comm., 2007; T. Clark, pers. comm., 2007; K. Ivory, pers. comm., 2007; J. Spence, pers. comm., 2007). Genetic research at San Rafael (the Spotted Wolf Canyon site), Moab (two separate sites at Onion Creek and Castle Valley) and Greater Circle Cliffs complexes (one site at Deer Point, one site at Silver Falls Canyon, and one site at Purple Hills) indicates that these sites of Jones cycladenia are genetically distinct and not inbred, but may face other genetic limitations, such as genetic bottlenecking or genetic drift (Sipes et al. 1994). Several researchers have concluded that an ongoing lack of population recruitment may result in a permanent loss of genetically-important individuals or occupied sites (Sipes et al. 1994; Sipes and Tepedino 1996; Spence and Palmquist in draft). The species' fractured distribution could further complicate issues associated with limited natural reproduction, dispersal constraints, and genetic risks (Spence and Palmquist in draft; Sipes et al. 1994) (USFWS, 2008).

Stressor: Climate change (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: As a Tertiary relict, Jones cycladenia may be impacted by global climate change. Various emissions scenarios suggest that by the end of the 21st century, average global temperatures may increase 0.6 to 4.0°C (1.1 to 7.2°F) with the greatest warming expected over land (Intergovernmental Panel on Climate Change (IPCC) 2007). It is very likely that hot extremes, heat waves, and heavy precipitation will increase in frequency (IPCC 2007). Since 1991, overall mean temperatures have increased 1.5°C (2.7°F) in the Greater Circle Cliffs area (Spence and

Palmquist 2007). Increased temperatures could result in the need for the species to colonize cooler, higher elevation sites (USFWS, 2008).

Recovery

Delisting Criteria:

1. Viable Jones cycladenia populations persist on conserved habitat across the species' historical range (USFWS, 2008).
2. All populations on Federal lands should be managed for the variety's protection (USFWS, 2008).
3. Threats to the species, primarily natural constraints, climate change, and human-caused habitat loss, will be sufficiently understood and if needed, sufficiently abated to ensure a high probability of survival at least 100 years into the future (USFWS, 2008).

Recovery Actions:

- Investigate Jones cycladenia's response to climate change (USFWS, 2008).
- Coordinate with genetic and taxonomic experts in Arizona, California, and Utah to resolve outstanding taxonomic issues (USFWS, 2008).
- Evaluate all known habitat components through a geographic information system database and conduct surveys for additional populations in areas containing habitat characteristics, particularly in Utah (USFWS, 2008).
- Continue ongoing monitoring efforts (USFWS, 2008).
- Expand monitoring programs to include a larger and more representative sample of occupied sites (rather than the easiest sites to visit) (USFWS, 2008).
- Identify sites in urgent need of habitat conservation, set protection priorities, and implement protective measures. As research improves our understanding of the species' needs, adjust management accordingly (USFWS, 2008).
- Where not possible to prevent oil and gas and mineral leasing at occupied sites, limit impacts of these activities through early planning and coordination (USFWS, 2008).
- Continue and expand research into Jones cycladenia's life history and ecology. It is essential to determine the role of sexual reproduction in Jones cycladenia populations including whether the species' pollinator has been lost. If the pollinator still exists, research should identify the pollinator's biological requirements so future conservation efforts address pollinator needs (USFWS, 2008).

Conservation Measures and Best Management Practices:

- Not available

References

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USFWS. 2008. RECOVERY OUTLINE for the Jones Cycladenia (*Cycladenia humilis* var. *jonesii*).

SPECIES ACCOUNT: *Cyrtandra crenata* (Ha`iwale)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/28/1994; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

A few-branched shrub 1-2 m tall. Flowers are white. (NatureServe, 2015)

Taxonomy

In the manual of flowering plants of Hawaii, Wagner et al. (1999) considered *Cyrtandra crenata* a potential hybrid between *C. hawaiiensis* and *C. subumbellata*, as the specimens presented characteristics intermediate between the two species. However, since *C. subumbellata* was not known to occur within the vicinity of the known specimens, the hybrid determination seemed untenable. Since that time, however, *C. subumbellata* has been found in the area, while no additional individuals of *C. crenata* have been found, therefore supporting the idea that *C. crenata* may indeed have been a hybrid (J. Lau, Botanical Consultant, pers. comm. 2010; W. Wagner, Smithsonian Institution, pers. comm. 2010). Wagner and Roalson are currently finalizing a monograph on Hawaiian *Cyrtandra* which should clarify this hybridization issue (W. Wagner, pers. comm. 2010). (USFWS, 2011)

Historical Range

Known historically from Waikane-Kahana area of Koolau Mountains of Oahu. (NatureServe, 2015)

Current Range

No current range. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: This species was observed in flower in June 1947 (USFWS 1996a). (USFWS, 1998)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Wet environments (USFWS, 1998)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 380 and 730 meters (1,250 and 2,400 (feet) (USFWS, 1998)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1998)

Habitat Narrative

Adult: Cyrtandra crenata typically grows in ravines or gulches in mesic to wet forests between elevations of 380 and 730 meters (1,250 and 2,400 feet) with associated plants such as ohia, uluhe, and Machaerina angustifolia (uki) (USFWS 1996a, Wagner et al. 1990). (USFWS, 1998)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

None (USFWS, 2011)

Redundancy:

None (USFWS, 2011)

Number of Populations:

0 (USFWS, 2011)

Population Size:

0 (USFWS, 2011)

Adaptability:

Fragility unknown. (NatureServe, 2015)

Population Narrative:

No observations of this species have been made since 1947 (USFWS 1998, 2003). No current and 2 historical occurrences. (USFWS, 2011)

Threats and Stressors

Stressor: Habitat predation by pigs, predation by rats and slugs, competition with invasive plants, and small population size (USFWS, 1998)

Exposure:

Response:

Consequence:

Narrative: The primary threats to this species are habitat degradation and predation by pigs, suspected predation by rats and slugs, competition with invasive alien plants (Koster's curse and

strawbeny guava), and a risk of extinction from naturally-occurring events, and/or reduced reproductive vigor due to the species' restricted range and the small number of individuals, if any, in fact, remain (USFWS 1996a). (USFWS, 1998)

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2011)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1998)

Recovery Actions:

- Surveys of appropriate habitat in historical locations are needed to determine if any other extant populations of this plant exist. (USFWS, 1994)
- Maintain adequate genetic stock. To prevent extinction of this species, ex situ propagation should be initiated immediately if extant individuals are found. (USFWS, 1994)
- Enhance wild populations and establish new populations. Once adequate propagated material is available, and fencing, rat control, and weed control, as appropriate, are underway in the areas of any remaining in situ populations, these populations should be enhanced by outplanting. Establishment of new populations within the historical range of

Cyrtandra crenata should be initiated in areas that are managed to minimize the impacts of feral ungulates, rats and alien plants. (USFWS, 1994)

Conservation Measures and Best Management Practices:

- Once new monograph of the genus is published, consider whether this species should be delisted. (USFWS, 2011)
- Survey historic locations to determine the current status of the species. (USFWS, 2011)

References

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SPECIES ACCOUNT: *Cyrtandra cyaneoides* (Mapele)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Cyrtandra cyaneoides, a member of the African violet family (Gesneriaceae), is an erect or ascending, fleshy, usually unbranched shrub, about 1 to 4 m (3.3 to 13.1 ft) tall (D. Lorence, personal communication 1997). The opposite, symmetrical, egg-shaped leaves are fleshy and leathery, 40 to 55 cm (16 to 22 in) long and 22 to 35 cm (9 to 14 in) wide. The upper surface of the toothed leaves is wrinkled with impressed veins and sparsely covered with long hairs. The lower surface has raised veins and is sparsely covered with hairs. The leaf stalks are 4.5 to 14 cm (1.8 to 5.5 in) long and winged. The white flowers, covered with shaggy brown hairs, arise from the leaf axils in small dense clusters. The corolla tube (fused petals) is narrowly funnel form, curved near the middle, about 25 mm (1 in) long, and hairless. The corolla lobes are elliptic and about 7 mm (0.3 in) long. The bilaterally symmetrical calyx is spindle-shaped in bud and about 26 to 36 mm (1 to 1.4 in) in length when the flower is fully open, but falls off after the flower matures. The fruit is an egg-shaped berry, which is covered with shaggy hairs, at least when young. Although poorly known, *Cyrtandra cyaneoides* is a very distinctive species. It differs from others of the genus that grow on Kauai by being a succulent, erect or ascending shrub and having a bilaterally symmetrical calyx that is spindle-shaped in bud and falls off after flowering; leaves with a wrinkled surface, 40 to 55 cm (16 to 22 in) long and 22 to 35 cm (9 to 14 in) wide; and berries with shaggy hairs (USFWS 1996). (USFWS, 1998)

Historical Range

Previously known from type locality at Kaholuamono, Kauai. (NatureServe, 2015)

Current Range

The current range includes Namalokama, Wainiha Valley, Makaleha Plateau, and Waioli Valley, Kauai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Cyrtandra cyaneoides* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Cyrtandra cyaneoides* includes three units totaling 5,782 acres in Kauai County, Hawaii. The units are Kauai 4—*Cyrtandra cyaneoides*—a, Kauai 11—*Cyrtandra cyaneoides*—b, and Kauai 11—*Cyrtandra cyaneoides*—c.

Kauai 4—*Cyrtandra cyaneoides*—a: This unit is critical habitat for *Cyrtandra cyaneoides* and is 376 ha (929 ac) on State (Kealia and Lihue-Koloa Forest Reserves) and private land. This unit contains Leleiwi, Makaleha, Puu Eu, and Wekiu Summits. This unit provides habitat for two

populations of 300 mature, reproducing individuals of the short-lived perennial *Cyrtandra cyaneoides* and is currently occupied with one plant. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, talus rubble on steep slopes or cliffs with water seeps running below, near streams or waterfalls in lowland or montane wet forest or shrubland dominated by *Metrosideros polymorpha* or a mixture of *Metrosideros polymorpha*, *Cheirodendron* spp., and *Dicranopteris linearis*. This unit is geographically separated from the other two units designated as critical habitat for this island endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 11—*Cyrtandra cyaneoides*—b: This unit is critical habitat for *Cyrtandra cyaneoides* and is 849 ha (2,098 ac) on State (Halelea Forest Reserve) and private land. This unit contains Mount Namolokama and Kaliko and Puu Manu Summits. This unit provides habitat for four populations of 300 mature, reproducing individuals of the short-lived perennial *Cyrtandra cyaneoides* and is currently occupied with between 51 and 101 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, talus rubble on steep slopes or cliffs with water seeps running below, near streams or waterfalls in lowland or montane wet forest or shrubland dominated by *Metrosideros polymorpha* or a mixture of *Metrosideros polymorpha*, *Cheirodendron* spp., and *Dicranopteris linearis*. This unit is geographically separated from the other two units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 11—*Cyrtandra cyaneoides*—c: This unit is critical habitat for *Cyrtandra cyaneoides* and is 1,117 ha (2,761 ac) on State (Halelea Forest Reserve) and private land. This unit contains Hinalele Falls and portions of Mahinakehau Ridge. This unit provides habitat for four populations of 300 mature, reproducing individuals of the short-lived perennial *Cyrtandra cyaneoides* and is currently occupied with over 300 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population. The habitat features contained in this unit that are essential for this species include, but are not limited to, talus rubble on steep slopes or cliffs with water seeps running below, near streams or waterfalls in lowland or montane wet forest or shrubland dominated by *Metrosideros polymorpha* or a mixture of *Metrosideros polymorpha*, *Cheirodendron* spp., and *Dicranopteris linearis*. This unit is geographically separated from the other two units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

- (i) Talus rubble on steep slopes or cliffs with water seeps running below, near streams or waterfalls in lowland or montane wet forest or shrubland dominated by *Metrosideros polymorpha* or a mixture of *Metrosideros polymorpha*, *Cheirodendron* spp., and *Dicranopteris*

linearis and containing one or more of the following native species: *Bidens* spp., *Boehmeria grandis*, *Coprosma* spp., *Cyanea* spp., *Cyrtandra kauaiensis*, *Cyrtandra limahuliensis*, *Cyrtandra longifolia*, *Diplazium sandwichianum*, *Freycinetia arborea*, *Gunnera kauaiensis*, *Hedyotis terminalis*, *Hedyotis tryblium*, *Machaerina* spp., *Melicope clusiifolia*, *Melicope puberula*, *Perrottetia sandwicensis*, *Pipturus* spp., *Psychotria* spp., *Pritchardia* spp., or *Stenogyne purpurea*; and

(ii) Elevations between 157 and 1,407 m (514 and 4,614 ft).

Special Management Considerations or Protections

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliff, forest- hardwood, forest/woodland (NatureServe, 2015)

Habitat Narrative

Adult: This species is found in wet forests on cliffs and in gulches. This species typically grows on steep slopes or cliffs near streams or waterfalls in lowland or montane wet forest or shrubland dominated by ohia or a mixture of ohia and uluhe. In the back of Wainiha Valley, below Hinalale, *Cyrtandra cyaneoides* grows in two areas of *Metrosideros polymorpha* (ohia) wet forest with 40 to 60 percent closed canopy, the other with closed canopy that is rich in terrestrial and epiphytic ferns and bryophytes (mosses, liverworts, and hornworts) understory. The area at Namolokama Mountain is *Metrosideros polymorpha* montane wet mixed community with sedges, grasses, and bryophytes. In the Alakai Swamp, Koaie Canyon, by the Koaie gauging station, and up the second stream to the north, the habitat is *Metrosideros polymorpha* wet forest. Associated species include *Boehmeria grandis* (akolea), *Pipturus* sp. (mamaki), olapa, uki, *Athyrium* sp., and *Hedyotis* sp. (manono) (USFWS 1996). (USFWS, 1998; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Low (inferred from USFWS, 2010)

Redundancy:

Low (inferred from USFWS, 2010)

Number of Populations:

11 (USFWS, 2010; USFWS, 2017)

Population Size:

250-1000 (USFWS, 2017)

Population Narrative:

In 1996, there were five populations of *Cyrtandra cyaneoides* with an estimated number of 550 to 1,220 individuals (USFWS 1998). In 2003, that estimate had decreased to 354 to 454 individuals (USFWS 2003). In 2008, there were eleven known populations with 800 individuals of *Cyrtandra cyaneoides*. (USFWS, 2010); NTBG reports individuals observed at Makaleha (a small colony), at Ililiula (a few patches), at Koaie (one group of 10 to 15 individuals and other “small patches”), at Hanakapiai headwaters (one individual), and at Kawaikoi headwaters (one individual) (NTBG 2011, 2013a-c, 2014a-c). PEPP also reports individuals at Kawaiiki (30 to 47 individuals) and Wainiha (PEPP 2010, 2015). This species’ status was reviewed by PEPP in 2010 and ranked *Cyrtandra cyaneoides* as “apparently secure,” indicating confidence that there are more than 50 mature reproducing wild individuals (PEPP 2010). The 2015 IUCN Red List Assessment for this species indicated that, although there are between 250 and 1,000 individuals in a total of 11 “subpopulations” (considered populations by USFWS), the numbers are still declining as a result of fragmented populations, habitat degradation, herbivory and seed predation, and loss of viability (Edmonds and Lorence 2015). In 2017, PEPP began to review this species status again due to observed declines in historically larger populations, such as Wainiha (Kishida 2017, in litt.). This decline supports that the minimum plant number from the IUCN Red List Assessment may be the more realistic count to follow. (USFWS, 2017)

Threats and Stressors

Stressor: Alien plants (USFWS, 1998)

Exposure:

Response:

Consequence:

Narrative: The major threats to *Cyrtandra cyaneoides* is competition with alien plant species such as Hilo grass, thimbleberry, *Deparia petersenii*, and *Drymaria cordata* (pipili) and predation of seeds by rats. (USFWS, 1998)

Stressor: Small population size (USFWS, 1998)

Exposure:

Response:

Consequence:

Narrative: Because of the small number of populations, this species is especially vulnerable to extinction by reduced reproductive vigor and from naturally occurring events (for example, landslides and hurricanes). (USFWS, 1998)

Stressor: Feral pigs (USFWS, 1998)

Exposure:

Response:

Consequence:

Narrative: Feral pigs are reported to occur in lower Wainiha Valley; however, no evidence exists of their incursion into the upper valley to date (USFWS 1996). (USFWS, 1998)

Stressor: Climate change loss or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Cyrtandra cyaneoides* is vulnerable to the impacts of climate change, with a vulnerability score of 0.454 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2017)

Stressor: Hurricanes—Loss and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Hurricanes were omitted in the last five year review. In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event, and 70% of all listed plant species on Kauai are only found on Kauai. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013). (USFWS, 2017)

Recovery**Reclassification Criteria:**

1. A total of five to seven populations of each taxon should be documented on Kauai where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Kauai where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1998)

Recovery Actions:

- Maintenance of adequate genetic stock. In order to prevent this taxon from going extinct, propagation efforts and the maintenance of adequate genetic stock ex situ should be continued. Additional wild seeds should be collected periodically until the cryopreservation method of long-term storage is perfected. This will insure that viable seed stock is available for outplanting. Additionally, specific efforts should be made to immediately collect from those populations that have only one remaining individual, such as the Makaleha Plateau and Waioli Valley populations. (USFWS, 1998)
- Development of management plans to control alien plant species. A long-range management plan to control alien plant species, such as fireweed, Hilo grass, thimbleberry, *Deparia petersenii*, and pipili needs to be developed. Additionally, specific efforts should be made to immediately weed and protect those populations that have only one remaining individual, such as the Makaleha Plateau and Waioli Valley populations. Because some of the land is privately owned, a commitment should be developed for long-term stewardship and conservation of these areas. Once an active management plan for control of alien plants in these areas is in place, site selection and outplanting should occur to prevent wild stocks from declining further. (USFWS, 1998)
- Reduce threat from rodent predation. A management plan to control rats should be developed. This should include the use of the currently approved Diphacinone bait blocks and ultimately a more broad-scale method such as aerial dispersal of rodenticide. (USFWS, 1998)

- Surveys and inventories—Survey to determine the current status of the species within historic range. (USFWS, 2017)
- Ungulate monitoring and control—Protect all occurrences against browsing and disturbances from feral ungulates to prevent imminent extinction. Continue to construct and maintain fenced exclosures around all populations. (USFWS, 2017)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. Control invasive nonnative plant species around all populations that compete with the species. (USFWS, 2017)
- Predator and herbivore control research—Study *Cyrtandra cyaneoides* populations to determine the level of threat from invertebrate herbivory and the need for additional recovery actions. (USFWS, 2017)
- Predator and herbivore monitoring and control—Implement effective control methods for rodents. (USFWS, 2017)
- Captive propagation for genetic storage and reintroduction—Collect propagules for storage and for maintenance of genetic stock. (USFWS, 2017)
- Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2017)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides. (USFWS, 2017)
- Genetic research—Research distribution and genetic relationships of *Cyrtandra cyaneoides* and possible hybridization with *C. limahuliensis*. (USFWS, 2017)
- Population biology research—Study *Cyrtandra cyaneoides* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2017)

Conservation Measures and Best Management Practices:

- Fence wild populations to exclude the negative impacts from ungulates. (USFWS, 2010)
- Continue to collect seeds for adequate genetic storage. (USFWS, 2010)
- Implement research needed for the propagation of the species. (USFWS, 2010)
- Identify suitable habitat for reintroductions. (USFWS, 2010)
- Survey to determine the current status of the species. (USFWS, 2010)
- Work with Hawaii Division of Forestry and Wildlife and other landowners to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2010)

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SPECIES ACCOUNT: *Cyrtandra dentata* (Ha'iwale)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

It is a short-lived perennial shrub 1.5 to 5 m (5 to 16 ft) tall with sparsely branched stems. The leaves have a papery texture, are oppositely arranged, very broadly elliptical to suborbicular or broadly ovate to ovate, 9 to 33 cm (3.5 to 13.0 in) long, and 6 to 17-cm (2.4 to 6.7 in) wide. The 8 to 23 cm (3 to 9 in) tall inflorescences are open cymes that originate from the leaf axils. The fruit is 1 to 2 cm (0.4 to 0.8 in) long and contains many minute seeds. This species is distinguished from others in the genus by the number and arrangement of the white flowers, the length of the bracts and flower stalks, and the shape of the leaves (Wagner et al 1999) (USFWS, 2016).

Taxonomy

A member of the Gesneriaceae (African violet) family (USFWS, 2016). Genus found throughout Wetstern pacific basin, species endemic to northern Waianaes and Leeward, northern end of Koolaus, Oahu (NatureServe, 2015).

Historical Range

Cyrtandra dentata is a species endemic to Oahu and was historically known from six occurrences in the Waianae Mountains and three occurrences in the Koolau Mountains (USFWS, 2016).

Current Range

Current range includes Waianae Mountains of Oahu (NatureServe, 2015). Currently, this species is found at Kawaiiki Gulch, Opaepala Stream, Kahanahaiki, and Pahole to Kapuna to West Makaleha (USFWS, 2016).

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyrtandra dentata* (Ha'iwale) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Cyrtandra dentata* (77 FR 57648-57862). The critical habitat designation includes 32 critical habitat units, which encompass approximately 35,073 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Cyrtandra dentata* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Cyrtandra dentata* includes 32 critical habitat units, covering three ecosystem types, which encompass approximately 35,073 acres on the Island of Oahu,

Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7; Oahu—Lowland Wet—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; Oahu—Dry Cliff—Units 1, 2, 3, 4, 5, 6, 7a, 7b, 8.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

Oahu—Lowland Wet—Unit 1 [541 ac (219 ha)]. This area consists of 428 ac (173 ha) of State land and 112 ac (46 ha) of City and County of Honolulu land in the lowland wet ecosystem on the windward side of the Waianae Mountains, and partially within the Mokuleia and Waianae Kai Forest Reserves. Oahu—Lowland Wet—Unit 2 [20 ac (8 ha)]. This area consists of 19 ac (8 ha) of State land in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puuhapapa. Oahu—Lowland Wet—Unit 3 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puukanehoa. Oahu—Lowland Wet—Unit 4 [27 ac (11 ha)]. This area consists of 27 ac (11 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains on State land at Puukaua. Oahu—Lowland Wet—Unit 5 [74 ac (30 ha)]. This area consists of 74 ac (30 ha) of State land in the lowland wet ecosystem, on the windward side of the Waianae Mountains at Palikea. Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Hauula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikēēē, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area

consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet— Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet— Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu— Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamo Ridge.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac(105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on

the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyrtandra dentata* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Cyrtandra dentata* occurs within the Lowland mesic, Lowland wet and Dry cliff ecosystems in the Waianae Mountain caldera complex and the Lowland mesic and Lowland wet ecosystems in the Koolau Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (E) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Oahu—Lowland Wet—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (E) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Oahu—Dry Cliff—Units 1, 2, 3, 4, 5, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: *Antidesma*, *Chamaesyce*, *Diospyros*, *Dodonaea*. (E) Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Schiedea*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Cyrtandra dentata* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Lifespan

Adult: Presumably < 10 years (USFWS, 2016)

Breeding Season

Adult: May and November (USFWS, 2016)

Reproduction Narrative

Adult: *Cyrtandra dentata* has been observed in flower and fruit in May and November. Longevity is presumed to be less than 10 years (USFWS, 2016).

Habitat Type

Adult: Terrestrial (NatureServe, 2015); riparian (USFWS, 2016)

Habitat Vegetation or Surface Water Classification

Adult: Mesic to wet forest (USFWS, 2016)

Geographic or Habitat Restraints or Barriers

Adult: 836 - 3,126 ft. elevation (USFWS, 2016)

Habitat Narrative

Adult: Inhabits moist forests in gulch bottoms and on gulch slopes (NatureServe, 2015). *Cyrtandra dentata* typically grows in lower gulch bottoms, wet slopes, stream banks, or ravines in mesic forest in the Waianae Mountains and in wet forest in the Koolau Mountains. It is found between 255 and 953 m (836 and 3,126 ft) in elevation (USFWS, 2016).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: The dispersal agents are unknown, although its white berries suggest dispersal by fruit-eating birds (USFWS, 2016).

Population Information and Trends**Population Trends:**

Decreasing before ungulate control (USFWS, 2016)

Species Trends:

Increasing (USFWS, 2016)

Resiliency:

Very low (inferred from USFWS, 2016)

Redundancy:

Low (inferred from USFWS, 2016)

Number of Populations:

5 (USFWS, 2012)

Population Size:

1,753 (USFWS, 2012)

Minimum Viable Population Size:

50 mature, reproducing individuals (USFWS, 2016)

Population Narrative:

There are a total of 1,521 individuals in the four known population units. Trends in numbers and reproduction of *C. dentata* populations were declining, but have responded well to ungulate control and are currently increasing (Service 2003b; L. Durand, pers. comm. 2004; U.S. Army Garrison 2005c). Currently, *C. dentata* is characterized by two populations exceeding minimum numerical criteria (more than 50 mature, reproducing individuals) and two population units that have not met minimum numerical criteria on Oahu (USFWS, 2016). In 2010, there were a total of 676 wild mature, 800 wild immature, and 277 seedling *Cyrtandra dentata* at the following locations: Kahanahaiki population unit had 65 mature and 142 immature individuals; Kawaiiki population unit had 15 mature, 31 immature, and 39 seedlings; Opaepa had 16 mature and 12 immature; Pahole to Kapuna to West Makaleha had 577 mature, 615 immature, and 238 seedlings; and central Makaleha population unit had 3 mature individuals (U.S. Army Garrison 2010) (USFWS, 2012).

Threats and Stressors

Stressor: Habitat degradation (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: Competition with the alien plants *Clidemia hirta* (Koster's curse) and *Psidium cattleianum* (strawberry guava) and feral pigs are major threats (NatureServe, 2015).

Stressor: Stochastic events (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: Stochastic extinction and/or reduced reproductive vigor is a threat due to the small number of extant populations and individuals (NatureServe, 2015).

Stressor: Predation (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: *C. dentata* is vulnerable to predation by rats and introduced slugs. Rats pose a threat through consumption of the plant. Introduced slugs and snails threaten the taxon by feeding on its leaves, stems, and seedlings. A study has shown that introduced slugs significantly reduce seedling survival in this species (U.S. Army Garrison 2003b; Service 2003b; Joe and Daehler 2005; 68 FR 35950) (USFWS, 2016).

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently

funded climate modeling that will help resolve these spatial limitations. We anticipate high spatial resolution climate outputs by 2013 (USFWS, 2012).

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically (USFWS, 1998).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1998).
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1998).

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically (USFWS, 1998).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1998).
3. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1998).

Recovery Actions:

- Protect habitat and control threats (USFWS, 1998).
- Expand existing wild populations (USFWS, 1998).
- Conduct essential research (USFWS, 1998).
- Develop and maintain monitoring plans (USFWS, 1998).
- Reestablish wild populations within historic range (USFWS, 1998).
- Validate and revise recovery criteria (USFWS, 1998).
- Control competing alien plant species (USFWS, 1998).
- Reduce threat of rat predation (USFWS, 1998).

Conservation Measures and Best Management Practices:

- All known occurrences of *C. dentata* should be fenced and non-native plants should be removed from the vicinity of each occurrence (USFWS, 2016).
- The threat from rats should be evaluated at all known occurrences of *C. dentata*. Research and implementation of control methods for slugs is also needed (Service 2003b) (USFWS, 2016).
- Since listing, the Makua Implementation Team (2003) has developed stabilization protocols for *Cyrtandra dentata* which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). In 1997, the Hawaii Department of Forestry and Wildlife constructed fenced enclosures to protect all *C. dentata* occurrences, and feral pigs and goats were removed. Control of the invasive plants *Clidemia hirta*, *Psidium cattleianum*, and *Schinus terebinthifolius* is

being conducted in these and surrounding areas. *Cyrtandra dentata* is being propagated at the Lyon Arboretum (Koob 1996; Service 2003b; Hawaii and Pacific Plant Recovery Committee 2007). *Cyrtandra dentata* can be successfully propagated from seed, air layers and cuttings. It is represented in several ex situ collections (USFWS, 2016).

- Captive propagation for genetic storage and reintroduction: Continue to collect seeds from tagged individuals, keeping close track of the maternal source for use in ex situ propagation. Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation (USFWS, 2012).
- Reintroduction / translocation implementation – Reintroduce the species back into its known historical range (USFWS, 2012).
- Ungulate exclosures: Continue to construct fenced exclosures around existing and reintroduced populations to provide protection from feral ungulates. Monitor fenced exclosures for evidence of breaching by feral ungulates (USFWS, 2012).
- Ungulate control – Continue to protect all populations against disturbances from feral ungulates (USFWS, 2012).
- Ecosystem-altering invasive plant species control – Continue to control invasive introduced plant species around all populations (USFWS, 2012).
- Predator / herbivore control – Continue to implement effective control methods for rodents (USFWS, 2012).
- Surveys / inventories – Continue to conduct thorough surveys of all suitable habitats where *Cyrtandra dentata* was historically seen (USFWS, 2012).
- Threats research: Continue to conduct studies to develop and implement control methods for slugs around all known populations. Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2012).
- Fire protection – Develop and implement a fire management plan for all populations of *Cyrtandra dentata* (USFWS, 2012).
- Population biology research – Study *Cyrtandra dentata* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2012).
- Alliance and partnership development – Work with the U.S. Army, Hawaii Division of Forestry and Wildlife, and other land managers to continue planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2012).

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U.S. Fish and Wildlife Service. 1998. Recovery Plan for Oahu Plants. U.S. Fish and Wildlife Service, Portland, Oregon. 207 pp., plus appendices.

SPECIES ACCOUNT: *Cyrtandra ferripilosa* (Ha`iwale)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

A short-lived perennial shrub (NatureServe, 2015)

Taxonomy

Wagner and Herbst (1999) split out *Cyrtandra ferripilosa* from *C. grayi*. Kartesz (1999) does not treat *C. ferripilosa* either as an accepted name or as a synonym. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Known only from East Maui (Wager et al. 2012). (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyrtandra ferripilosa* (haiwale) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Cyrtandra ferripilosa* includes six CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Montane Wet—Unit 1 (and) *Palmeria dolei*—Unit 10—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 10— Montane Wet This area consists of 1,313 ac (531 ha) of State land and 798 ac (323 ha) of privately owned land, at Haiku Uka on the northern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Cyanea duvalliorum*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *Phyllostegia pilosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 1 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *Platanthera holochila*,

Schiedea jacobii, or *Wikstroemia villosa*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 11—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 11—Montane Wet This area consists of 4,075 ac (1,649 ha) of State land, 9,633 ac (3,898 ha) of privately owned land, and 875 ac (354 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Puukaukanu and upper Waihoi Valley, on the northern and northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Geranium hanaense*, *G. multiflorum*, and *Wikstroemia villosa*, and by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 2 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea glabra*, *C. maritae*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, and *Schiedea jacobii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 3 (and) *Palmeria dolei*—Unit 12—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 12—Montane Wet This area consists of 2,228 ac (902 ha) of federally owned land (Haleakala National Park) in Kipahulu Valley, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. maritae*, and *Melicope ovalis*, and by the forest bird, *kiwikiu* (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 3 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea duvalliorum*, *C. glabra*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest bird, the *akohekohe* (*Palmeria dolei*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary

for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 4 (and) *Palmeria dolei*—Unit 13—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 13— Montane Wet This area consists of 180 ac (73 ha) of State land and 1,653 ac (669 ha) of federally owned land (Haleakala National Park), in Kaapahu Valley on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *Cyrtandra ferripilosa*, and *Huperzia mannii*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 4 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea duvalliorum*, *C. glabra*, *C. mceldowneyi*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 5 (and) *Palmeria dolei*—Unit 14—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 14— Montane Wet This area consists of 222 ac (90 ha) of State land, and 165 ac (67 ha) of federally owned land (Haleakala National Park), near Kaumakani on the eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units area occupied by the plant *Bidens campylotheca* ssp. *pentamera*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 5 is not currently occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 1 (and) *Palmeria dolei*—Unit 18—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 18— Montane Mesic This area consists of 6,593 ac (2,668 ha) of State land, 707 ac (286 ha) of privately owned land, and 3,672 ac (1,486 ha) of federally owned land (Haleakala National Park), from Kealahou to Puualae, nearly circumscribing the summit of Haleakala on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Asplenium dielirectum*, *A. peruvianum* var. *insulare*, *Clermontia lindseyana*, *Cyanea horrida*, *C. obtusa*, *Cyrtandra ferripilosa*, *C. oxybapha*, *Diplazium molokaiense*, *Geranium arboreum*, *G. multiflorum*, *Huperzia mannii*, *Melicope adscendens*, and *Neraudia sericea*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 1 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Cyanea glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. mceldowneyi*, *Phyllostegia bracteata*, *P. mannii*, *Santalum haleakalae* var. *lanaiense*, *Wikstroemia villosa*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyrtandra ferripilosa* critical habitat consists of two components. Montane wet (east Maui) and Montane mesic (east Maui) (81 FR 17790-18110):

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: *Acacia*, *Ilex*, *Metrosideros*, *Myrsine*, *Nestegis*, *Nothocestrum*, *Pisonia*, *Pittosporum*, *Psychotria*, *Sophora*, *Zanthoxylum*. Subcanopy: *Alyxia*, *Charpentiera*, *Coprosma*, *Dodonaea*, *Kadua*, *Labordia*, *Leptecophylla*, *Phyllostegia*, *Vaccinium*. Understory: Ferns, *Carex*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is

not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species

such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylothea* ssp. *pentamera*, *B. campylothea* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Habitat Narrative

Adult: This species is found in montane mesic and montane wet ecosystems (Oppenheimer 2010f, in litt.; Welton 2010a, in litt.). (USFWS, 2016)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2016)

Redundancy:

Very low (inferred from USFWS, 2016)

Number of Populations:

2 (USFWS, 2016)

Population Size:

<10 (USFWS, 2016)

Population Narrative:

Currently, there are a few individuals each in two occurrences at Kuiki and on the Manawainui plane in the montane mesic and montane wet ecosystems (Oppenheimer 2010f, in litt.; Welton 2010a, in litt.). (USFWS, 2016)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs and goats), nonnative plants, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, and goats) is considered an ongoing threat to *Cyrtandra ferripilosa* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor: Small populations (USFWS, 2013)

Exposure:

Response:**Consequence:**

Narrative: *Cyrtandra ferripilosa* faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). *Cyrtandra ferripilosa* is known from two disparate occurrences totaling only a few individuals that are not protected from direct predation by nonnative pigs and goats (USFWS, 2013).

Recovery**Reclassification Criteria:**

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

Final Rule . 81 FR 17790-18110 (March 30, 2016).

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species. Federal Register 81(61): 17790-18110.

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Final Rule. 78 Federal Register 102, May 28, 2013. Pages 32014 - 32065.

SPECIES ACCOUNT: *Cyrtandra filipes* (Ha`iwale)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

A shrub, about 1 m tall. Leaves in whorls of 3-4. Flowers solitary or (rarely) 2 per inflorescence. Corollas white. (NatureServe, 2015)

Taxonomy

Genus found throughout western Pacific basin, species endemic to west Maui and southeast Molokai. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Endemic to southeastern Molokai and West Maui, state of Hawaii. Still extant on both mountain masses. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyrtandra filipes* (Ha`iwale) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 14 detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Cyrtandra filipes* includes 14 CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Molokai—Lowland Mesic—Unit 1 (and) *Palmeria dolei*—Unit 37—Lowland Mesic (and) *Pseudonestor xanthophrys*—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Ctenitis squamigera*, *Cyanea dunbariae*, *C. mannii*, *C. profuga*, *Cyperus fauriei*, *Cyrtandra filipes*, *Gouania hillebrandii*, *Labordia triflora*, *Neraudia sericea*, *Santalum haleakalae* var. *lanaiense*, *Schiedea lydgatei*, *S. sarmentosa*, *Silene alexandri*, *S. lanceolata*, *Spermolepis hawaiiensis*, and *Zanthoxylum hawaiiense*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Mesic—Unit 1 is not known to be occupied by *Asplenium dielirectum*, *Bonamia menziesii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea procera*, *C. solanacea*, *Diplazium molokaiense*,

Festuca molokaiensis, *Flueggea neowawraea*, *Isodendron pyriformis*, *Kadua laxiflora*, *Melicope mucronulata*, *M. munroi*, *M. reflexa*, *Phyllostegia haliakalae*, *P. mannii*, *P. pilosa*, *Sesbania tomentosa*, *Stenogyne bifida*, or *Vigna o-wahuensis*, or the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 1 (and) *Palmeria dolei*—Unit 38—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 38— Lowland Wet This area consists of 2,195 ac (888 ha) of State land, and 754 ac (305 ha) of privately owned land (partly within The Nature Conservancy's Pelekunu Preserve), from Pelekunu Valley to Wailau Valley, in north-central Molokai. These units are occupied by the plant *Cyrtandra filipes*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Wet—Unit 1 is not known to be occupied by *Asplenium dielarectum*, *Bidens wiebkii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Lysimachia maxima*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 2 (and) *Palmeria dolei*—Unit 39—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 39— Lowland Wet This area consists of 1,356 ac (549 ha) of State land and 594 ac (241 ha) of privately owned land, from Kahanui to Pelekunu Valley, in north-central Molokai. These units are occupied by the plant *Lysimachia maxima*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Wet—Unit 2 is not known to be occupied by *Asplenium dielarectum*, *Bidens wiebkii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Cyrtandra filipes*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 3 consists of 94 ac (38 ha) of State land, and 3,125 ac (1,265 ha) of privately owned land, from Waiahookalo gulch to Moaula stream and Puniuohua, on eastern Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Molokai—Lowland Wet—Unit 3 is not known to be occupied by *Asplenium dielerectum*, *Bidens wiebkei*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Cyrtandra filipes*, *Lysimachia maxima*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 2 (and) *Palmeria dolei*—Unit 3—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 3— Lowland Wet (and) *Newcombia cumingi*—Unit 1—Lowland Wet This area consists of 65 ac (26 ha) of State land at Moomoku, on the northwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. Although Maui—Lowland Wet—Unit 2 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformum*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwiku* (*Pseudonestor xanthophrys*), or by the Newcomb's tree snail (*Newcombia cumingi*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 3 (and) *Palmeria dolei*—Unit 4—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 4— Lowland Wet This area consists of 1,247 ac (505 ha) of State land at Honanana Gulch on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta*, *Cyanea asplenifolia*, and *Pteris lidgatei*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 3 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformum*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*,

Remya mauiensis, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 4 (and) *Palmeria dolei*—Unit 5—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 5— Lowland Wet This area consists of 864 ac (350 ha) of State land at Kahakuloa Valley on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta* and *Cyanea asplenifolia*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 4 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendrion pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 5 (and) *Palmeria dolei*—Unit 6—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 6— Lowland Wet This area consists of 30 ac (12 ha) of State land at Iao Valley on the eastern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 5 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendrion pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 6 (and) *Palmeria dolei*—Unit 7—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 7— Lowland Wet This area consists of 136 ac (55 ha) of State land at Honokowai and Wahikuli valleys on the western slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 6 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 7 (and) *Palmeria dolei*—Unit 8—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 8— Lowland Wet This area consists of 898 ac (364 ha) of State land at Olowalu Valley, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Alectryon macrococcus*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 7 is not currently occupied by the plants *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 8 (and) *Palmeria dolei*—Unit 9—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 9— Lowland Wet This area consists of 230 ac (93 ha) of State land at upper Ukumehame Gulch, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 8 is not currently occupied by the plants *Alectryon macrococcus*,

Asplenium dielerectum, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 6 (and) *Palmeria dolei*—Unit 35—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 35—Wet Cliff This area consists of 1,858 ac (752 ha) of State land, and 253 ac (102 ha) of privately owned land, at the summit ridges of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plants *Alectryon macrococcus*, *B. conjuncta*, *Ctenitis squamigera*, *Cyrtandra munroi*, *Remya mauiensis*, and *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 6 is not known to be occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Bonamia menziesii*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, or *Tetramolopium capillare*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 7 (and) *Palmeria dolei*—Unit 36—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 36—Wet Cliff This area consists of 556 ac (225 ha) of State land along Honokowai ridge on the northwestern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units are occupied by the plants *Cyrtandra filipes* and *C. munroi*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 7 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the

reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 8 consists of 337 ac (137 ha) of State land along Kahakuloa ridge on the north side of west Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff—Unit 8 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyrtandra filipes* critical habitat consists of three components. Lowland mesic (Molokai), Lowland wet (west Maui and Molokai) and Wet cliff (west Maui) (81 FR 17790-18110):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepis*.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. Understory: *Bryophytes*, *Ferns*, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is

not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species

such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Wet environments (NatureServe, 2015)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: This species is found in moist and moist-wet forests in gulch bottoms and on gulch slopes. (NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends

Population Trends:

Short-term trends suggest declines of 10-30% and long-term trends are unknown. (NatureServe, 2015)

Resiliency:

Low (inferred from USFWS, 2016)

Redundancy:

Low (inferred from USFWS, 2016)

Number of Populations:

5 (USFWS, 2016)

Population Size:

~150 (USFWS, 2016)

Population Narrative:

Short-term population trends suggest declines of 10-30% and long-term trends are unknown. Currently, there are between 134 and 155 individuals in 4 occurrences in the lowland wet and wet cliff ecosystems at Kapalaoa, Honokowai, Honolua, and Waihee Valley on west Maui, and approximately 7 individuals at Mapulehu in the lowland mesic ecosystem on Molokai, with an historical occurrence in the lowland wet ecosystem (Oppenheimer 2010c, in litt.). (USFWS, 2016)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs, goats, and axis deer), nonnative plants, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: Predation and herbivory by nonnative animal species (pigs, goats, axis deer, and slugs) is considered an ongoing threat to *Cyrtandra filipes* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor:**Exposure:****Response:****Consequence:****Narrative:*****Recovery*****Reclassification Criteria:**

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

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SPECIES ACCOUNT: *Cyrtandra giffardii* (Ha`iwale)

Species Taxonomic and Listing Information

Listing Status: Endangered; 3/4/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

Cyrtandra giffardii (ha`iwale) is small shrubby, many-branched, tree that ranges 10-20 feet tall (Wagner et al. 1990) and has white flowers (NatureServe). Opposite leaves are positioned on the upper nodes of the stem. Toothed, papery-textured elliptic blades, 2.4-4.7 in (6-12 cm) long and 1.0- 1.8 in (2.5-4.6 cm) wide, generally have a few brown hairs on the veins. Leaf stalks (petioles) are 0.8-1.6 in (2-4 cm) long. Three to five moderately brown, hairy flowers are in clusters at the tip of the main cluster stalk (peduncle), which is 1-1.4 in (2.5-3.5 cm) long. Each flower is subtended by unequal stalks (pedicels) 0.6-1.2 in (1.5-3 cm) long and two linear bracts 0.25 in (6-7 mm) long. The green calyx, 0.1-0.4 in (3-9 mm) long, is split 0.04-0.08 in (1-2 mm) from its base. Five calyx lobes are narrowly deltate (triangular) and are moderately covered with short brown hairs. The white petals are fused into a cylindrical tube about 0.5 in (1.2 cm) long. Five sparsely hairy lobes are about 0.08-0.1 in (2-3 mm) long. Only immature berries are known, and they are almost round, approximately 0.4 in (1 cm) long, and white.

Taxonomy

Genus found throughout Western Pacific basin, species endemic to island of Hawaii. (NatureServe, 2015)

Historical Range

Historically, *Cyrtandra giffardii* is known from the northeastern slope of Mauna Kea south to the eastern slope of Mauna Loa on Hawai'i Island (Wagner et al. 1990).

Current Range

Since 1975, 11 populations have been identified with the total number of individuals estimated to exceed 1,000 (Warren Wagner, Smithsonian Institution, pers. comm., 1995; HELP 1991). These occur near Puu Makaala, Stainback Highway, and Kilau stream in Laupahoehoe Natural Area Reserve on State owned land, and at Hawaii Volcanoes National Park. As of 1994, 55 known individuals occurred in Hawaii Volcanoes National Park on transects in the Koa Unit and 35 additional individuals were identified in another area of the Koa Unit that were not on the transects, 6 occurred on transects in the Puu Unit (2 inside an enclosure and 4 outside), and 27 individuals occurred on transects in the Ag Unit of the Olaa Tract, as well as 2 on transects in the Small Tract.

Critical Habitat Designated

Yes; 7/2/2003.

Legal Description

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Cyrtandra giffardii* on the island of Hawaii (68 FR 39623 - 39722).

Critical Habitat Designation

The critical habitat designation for *Cyrtandra giffardii* includes three units totaling 15,617 acres in Hawaii County, Hawaii. The units are Hawaii 3—*Cyrtandra giffardii*—a, Hawaii 29—*Cyrtandra giffardii*—b, and Hawaii 30—*Cyrtandra giffardii*—c. Two of the units, “Hawaii 3—*Cyrtandra giffardii*—a” and “Hawaii 30—*Cyrtandra giffardii*—c,” currently are occupied by this species. Each unit is geographically separated from other units on this island to avoid their destruction by one naturally occurring catastrophic event. Within the 3 units designated for *Cyrtandra giffardii* in this rule, habitat is provided for a total of 10 populations, each with 300 mature, reproducing individuals.

Hawaii 3—*Cyrtandra giffardii*—a [1,510 ha (3,731 ac)]: This unit contains a portion of Haakoa, Kawilahilahi, and Kilau streams and is bordered in the northwest by Laupahoehoe watershed with a small overlap into Kaawali watershed, in the southeast by Haakoa and Pahala watersheds, and with the Kaiwilahilahi, Kilau, and Manowaiopae watersheds in the central portion. The unit is almost completely within Laupahohoe NAR with a small overlap into the Hilo Forest Reserve. This unit provides habitat for 3 populations of 300 individuals of *C. giffardii* and is currently occupied by more than 245 individuals. This unit is essential to the conservation of this species because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population.

Hawaii 29—*Cyrtandra giffardii*—b [938 ha (2,319 ac)]: This unit contains portions of two forks of the Wailuku River and two forks of Kalohewahewa Stream and lies completely within the Wailuku watershed. The unit also is completely within the Hilo Forest Reserve; provides habitat for 2 populations of 300 individuals of *C. giffardii*; and is currently unoccupied. This unit is essential to the conservation of the species because it supports habitat that is necessary for the establishment of additional populations in order to reach recovery goals.

Hawaii 30—*Cyrtandra giffardii*—c [3,872 ha (9,567 ac)]: This unit contains Puu Makaala and lies completely within the Kaahakini watershed. It also lies completely within the Olaa-Kilauea Partnership lands. This unit provides habitat for 5 populations of 300 individuals of *C. giffardii* and is currently occupied by one individual. This unit is essential to the conservation of *C. giffardii* because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable.

Primary Constituent Elements/Physical or Biological Features

Habitat features that are essential for this species included, but are not limited to, wet montane forest dominated by *Cibotium* sp. or *Metrosideros polymorpha* and *M. polymorpha*-*Acacia koa* lowland wet forests.

Special Management Considerations or Protections

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for this species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened

plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: This species was observed in fruit and flower during June 1979 (HHP 1991 j2) and November 1988 (HHP 1991 j3), and in flower during December 1933 and January 1918 (HHP 1991 j4). No other life history information is currently available.

Habitat Type

Adult: Wet montane forest

Habitat Narrative

Adult: The habitat of *Cyrtandra giffardii* is wet montane forest dominated by *Cibotium* (tree fern) at elevations between 2,400 and 4,900 ft (720 and 1,500 m) (Wagner et al. 1990, 59 FR 10305). Associated taxa include *Hedyotis* spp., *Perrottetia sandwicensis* A. Gray (olomea), and other species of *Cyrtandra* (HHP 1991j1-j3, 59 FR 10305).

Dispersal/Migration***Population Information and Trends*****Number of Populations:**

11

Population Size:

< 112 wild plants

Population Narrative:

Since 1995, 11 populations have been identified with a total number estimated to exceed 1,000 individuals (HHP 1991a, USFWS 1996a). Currently, this species numbers less than 112 wild (in two populations) and 77 out-planted individuals (USFWS 2012a).

Threats and Stressors**Stressor:****Exposure:****Response:****Consequence:**

Narrative: Rooting and trampling by pigs and alien plant invasion have led to the decline of this species (Pratt, USGS-BRD, 1995, pers. comm., cited in USFWS 1996a). Other threats include

human disturbance and low numbers (USFWS 2012a). Rooting and trampling by pigs result in profound degradation of the substrate and native vegetation. Habitat destruction inevitably leads to alien plant invasions, particularly *Andropogon virginicus* which, ultimately, becomes a problem (L. Pratt, pers. comm., 1995). Control of alien taxa is imperative and fencing to exclude feral animals and control of alien weeds will assist in preserving *Cyrtandra giffardii* (L. Pratt, pers. comm., 1995). Small numbers of populations and individuals may depress and limit the reproductive potential, and also increase the vulnerability of this taxon to extinction from the occurrence of a catastrophic event (Stone 1985; W. Wagner, pers. comm., 1992).

Recovery

Reclassification Criteria:

A total of five to seven populations of *Cyrtandra giffardii* should be documented on the island of Hawaii. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered.

Delisting Criteria:

A total of eight to ten populations of *Cyrtandra giffardii* should be documented on the island of Hawaii. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years before delisting is considered.

Recovery Actions:

- • Captive propagation for genetic storage and reintroduction: - Determine experimentally whether the species can be propagated vegetatively from leaves. - Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation. - Propagate the species ex situ in at least two or three separate venues.
- • Reintroduction / translocation implementation – Continue to reintroduce the species back into its known historical range.
- • Ecosystem-altering invasive plant species control – Control invasive introduced plant species within fenced exclosures.
- • Ungulate exclosures – Continue to construct pig-proof fences around each population and monitor the fences for any signs of breaching.
- • Ungulate control – Continue to protect all populations against disturbances from feral ungulates.
- • Surveys / inventories – Resurvey the historical range of the species to determine if previously unknown or newly reestablished populations exist.
- • Population biology research – Carry out field studies to determine what agents pollinate the flowers and disperse the seeds of this species.
- • Genetic research: - Carry out DNA studies using microsatellites or other genetic markers to assess the relative level of genetic diversity remaining within the species. - Carry out a thorough inventory of genetic resources currently on hand and determine which parts of the historical range (if any) are not represented. - For any such populations not yet sampled

for their genetic resources, obtain cuttings or seed material to maintain the genetic diversity of the species.

- Alliance and partnership development – Work with the National Park Service, Hawaii Division of Forestry and Wildlife, and other land managers to continue implementation of ecosystem-level restoration and management to benefit this species.
- Threats research – Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species.

Conservation Measures and Best Management Practices:

- Captive propagation for genetic storage and reintroduction: Attempts have been made at Volcano Rare Plant Facility to germinate seed *Cyrtandra giffardii* without success (P. Moriyasu, pers. comm., 1995). Further attempts will be pursued when more seed is acquired.
- Ungulate exclosures and control: All of the Koa Unit and some of the Puu Unit of the Olaa Tract in Hawaii Volcanoes National Park are fenced and have been declared pig-free (L. Pratt, pers. comm., 1995). All but four of the plants in this and Small Tract are within exclosures. The plants appear healthy and are flowering and fruiting. It is undetermined how many juveniles are present because they are difficult to distinguish from other members of the genus when immature (L. Pratt, pers. comm., 1995).

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Final Designation and Nondesignation of Critical Habitat for 46 Plant Species From the Island of Hawaii, HI. Final rule. 68 FR 39623 - 39722 (July 2, 2003).

SPECIES ACCOUNT: *Cyrtandra gracilis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/18/2012; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

A shrub. Flowers are white, and borne 1-7 per inflorescence. (NatureServe, 2015)

Taxonomy

Genus found throughout Pacific Basin, species endemic to Koolau Mts. of Oahu. (NatureServe, 2015)

Current Range

Koolau Mountains, Oahu. Apparently extirpated from Palolo Valley, Konahuanui Gulch, and Manoa Valley (Wagner et al. 1999, p. 755; HBMP 2008 cited by USFWS 2011). Discovered in Pia Valley in 2001 (NTBG Provenance Report 2002 cited by USFWS 2011). (NatureServe, 2015)

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On September 18, 2012, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyrtandra gracilis* under the Endangered Species Act of 1973, as amended (Act) (77 FR 57648-57862). The critical habitat designation includes 11 critical habitat units, which encompass approximately 25,112 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Cyrtandra gracilis* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Cyrtandra gracilis* includes 11 critical habitat units, covering one ecosystem type, which encompasses approximately 25,112 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16.

Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Haula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikēēē, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac

(6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet— Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet— Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu— Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamo Ridge.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyrtandra gracilis* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Cyrtandra gracilis* occurs within the indicated ecosystem in the Koolau Mountain caldera complex:

Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (E) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Cyrtandra gracilis* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats

will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations around 1,600 ft (488 m) (USFWS, 2012)

Habitat Narrative

Adult: *Cyrtandra gracilis* (haiwale) (Gesneriaceae, African violet family) is a perennial shrub that is found in *Metrosideros polymorpha*-*Dicranopteris linearis* forest in the lowland wet ecosystem at 1,600 ft (488 m) in elevation, on the leeward side of the southern Koolau Mountains (Wagner et al. 1999, p. 755; National Tropical Botanical Garden (NTBG) Provenance Report 2004; TNC 2007; HBMP 2008; PEP Program 2008, p. 16). (USFWS, 2012)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2012)

Redundancy:

Very low (inferred from USFWS, 2012)

Number of Populations:

1 (USFWS, 2012)

Population Size:

~10 (USFWS, 2012)

Population Narrative:

Presumed extinct since the 1800s, 10 individuals of *C. gracilis* were discovered by botanists in Pia Valley in 2001 (NTBG Provenance Report 2002). Between 2001 and 2008, only six to eight plants were observed at this location (NTBG Provenance Report 2002; PEP Program 2008, p. 16; Bakutis 2008, in litt.). It is apparently extirpated from historical locations in Palolo Valley, Konahuanui Gulch, and Manoa Valley (Wagner et al. 1999, p. 755; HBMP 2008). (USFWS, 2012)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative plants and animals (pigs). The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The projected effects of climate change will likely exacerbate the effects of the other threats to the species (USFWS, 2012).

Stressor: Predation and herbivory (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, goats, rats, and slugs) is considered an ongoing threat to *Cyrtandra gracilis* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2012).

Stressor: Small populations (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: *Cyrtandra gracilis* faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). *C. gracilis* is known only from a single occurrence, with six to eight individuals (USFWS, 2012).

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

References

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USFWS. 2012. Endangered Status for 23 Species on Oahu and Designation of Critical Habitat for 124 Species

Final Rule. 77 Federal Register 181, September 18, 2012. Pages 57648 - 57862.

SPECIES ACCOUNT: *Cyrtandra hematos* (Ha`iwale)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2016)

Physical Description

A shrub 0.3 - 2.0 m tall with few-branched stems. Solitary flowers are white (NatureServe, 2015). This species is 1 to 6.5 ft. (0.3 to 2 m) tall, with minimally branched stems. The leaves are in whorls of 3 to 4 per node, often closely spaced and borne on the upper 5 to 8 nodes (USFWS, 2015).

Taxonomy

A member of the African violet family (Gesneriaceae) (USFWS, 2015). The genus is found throughout western pacific basin, this species is endemic to Molokai. Treated as c. *St-Johnii* by Wagner et al. But *St. John's c. Hematos* takes precedence (NatureServe, 2015).

Historical Range

Endemic to Northeast Molokai (NatureServe, 2015). Historically, this species was known from the Olokui Plateau, Kawela, and Kahuoahu Valley on Molokai (Wagner et al. 1999, pp. 760, 762) (USFWS, 2015).

Current Range

Occurs in Kapulei, Molokai (USFWS, 2015). This species occurs on State land within the Olokui Natural Area Reserve and on privately owned land within the Molokai Watershed (USFWS, 2014).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available

Habitat Type

Adult: Terrestrial (USFWS, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Montane wet forest (USFWS, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 3,400 - 3,800 ft. elevation (USFWS, 2015)

Spatial Arrangements of the Population

Adult: Scattered (USFWS, 2014)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2015)

Habitat Narrative

Adult: *Cyrtandra hematos* occurs in wet forest at 3,400 to 3,800 ft. (1,030 to 1,150 m) on eastern Molokai, in the montane wet ecosystem (Wagner et al. 1999, pp. 760, 762; HBMP 2010; TNCH 2007) (USFWS, 2015). The currently known individuals are scattered on eastern Molokai (USFWS, 2014).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Very low (inferred from USFWS, 2015)

Redundancy:

Very low (inferred from USFWS, 2015)

Number of Populations:

1 (USFWS, 2015)

Population Size:

~30 (USFWS, 2015)

Population Narrative:

Currently, approximately 30 individuals are known from Kapulei, but this occurrence has not been monitored since 1999 (USFWS Rare Taxon Database, in litt.) (USFWS, 2015).

Threats and Stressors

Stressor: Feral ungulates (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Feral pigs and goats modify and destroy the habitat of *Cyrtandra hematos* on Molokai, with evidence of the activities of these animals reported in the areas where this species occurs (USFWS Rare Taxon Database, in litt.) (USFWS, 2015).

Stressor: Nonnative plants (USFWS, 2015)

Exposure:

Response:**Consequence:**

Narrative: Nonnative plants modify and destroy native habitat of *C. hematos* and outcompete this and other native species for water, nutrients, light, and space, or a nonnative plant may produce chemicals that inhibit growth of other plants (USFWS Rare Taxon Database, in litt.) (USFWS, 2015).

Stressor: Lack of regeneration (USFWS, 2015)

Exposure:**Response:****Consequence:**

Narrative: This species may experience reduced reproductive vigor due to low numbers and lack of regeneration, leading to diminished capacity to adapt to environmental changes, and thereby lessening the probability of long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilon 1997, p. 361). The reasons for this species' lack of regeneration in the wild are unknown at this time (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)

Exposure:**Response:****Consequence:**

Narrative: Climate change may result in alteration of the environmental conditions and ecosystem that support this species. *Cyrtandra hematos*, which already is affected by multiple stressors, may be unable to tolerate or adapt to projected changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini et al. 2013, p. 72) (USFWS, 2015). The assessment by Fortini et al. (2013, p. 70) concluded that *Cyrtandra hematos* is highly vulnerable to the impacts of climate change (USFWS, 2014).

Stressor: Small population size/stochastic events (USFWS, 2015)

Exposure:**Response:****Consequence:**

Narrative: The low number of remaining individuals may limit this species' ability to adapt to environmental changes. Low numbers and small occurrences of these plants result in greater vulnerability to stochastic events and can result in reduced levels of genetic variability leading to diminished capacity to adapt to environmental changes. Under these circumstances, the probability of long-term persistence is diminished, potentially resulting in extirpation and extinction (USFWS, 2015).

Recovery**Reclassification Criteria:**

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- *Cyrtandra hematos* occurs in the Olokui Natural Area Reserve, which provides some protections. In addition, PEPP continues to survey for new individuals of *Cyrtandra hematos* and monitoring the known individuals in Olokui NAR (PEPP 2008, pp. 1-9; PEPP 2014, in litt.) (USFWS, 2014).
- Continue to survey for populations of *Cyrtandra hematos* in areas of potentially suitable habitat (USFWS, 2014).
- Begin propagation efforts for maintenance of genetic stock (USFWS, 2014).
- Reintroduce individuals into suitable habitat within historical range that is being managed for additional known threats (e.g., nonnative animals and plants) to this species (USFWS, 2014).

References

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Proposed Rule. Vol. 80, No. 189. Pages 58820-58909

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USFWS. 2016. Environmental Conservation Online System (ECOS) – Species Profile. <http://ecos.fws.gov/ecp0/>. Accessed August 2016

USFWS 2015. Endangered and Threatened Wildlife and Plants

Proposed Rule. 80 Federal Register 189. September 30, 2015. Pages 58819 - 58909

USFWS 2014. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form. *Cyrtandra hematos*. Region 1 (Pacific Region).

Proposed Rule. 80 Federal Register 189. September 30, 2015. Pages 58819 - 58909.

SPECIES ACCOUNT: *Cyrtandra kaulantha* (Ha`iwale)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/18/2012; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Shrubs, usually with several erect stems 1-3 m long. Leaves opposite, clustered on the upper 3-6 nodes, 30-60 cm long and 12-24 cm wide. Inflorescences densely congested with 7-30 flowers, borne on the lower third of the stems, often at or near ground level. Flowers white. (NatureServe, 2015)

Historical Range

Cyrtandra kaulantha was historically known from the Waiahole Ditch Trail and Kahanaiki Stream areas. (USFWS, 2012)

Current Range

Endemic to the Koolau Mountains on Oahu Island, Hawaii. (NatureServe, 2015)

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On September 18, 2012, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyrtandra kaulantha* (Ha`iwale) under the Endangered Species Act of 1973, as amended (Act) (77 FR 57648-57862). The critical habitat designation includes 14 critical habitat units, which encompass approximately 30,056 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Cyrtandra kaulantha* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Cyrtandra kaulantha* includes 14 critical habitat units, covering two ecosystem types, which encompass approximately 30,056 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; Oahu—Wet Cliff—Units 6, 7, 8.

Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Haula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu,

Kahana, Waikane, Waikēkē, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet— Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet— Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu— Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamo Ridge.

Oahu—Wet Cliff—Unit 6 [151 ac (61 ha)]. This area consists of 151 ac (61 ha) in the wet cliff ecosystem on State land on the windward side of the Koolau Mountains in Kaipapau Gulch, entirely within the Kaipapau Forest Reserve. Oahu—Wet Cliff—Unit 7 [144 ac (58 ha)]. This area consists of 144 ac (58 ha) in the wet cliff ecosystem in State land on the windward side of the Koolau Mountains in Hauula Gulch, entirely within the Hauula Forest Reserve. Oahu—Wet Cliff—Unit 8 [4,649 ac (1,881 ha)]. This area consists of 1,479 ac (598 ha) of State land, 1,281 ac (519 ha) of City and County of Honolulu land, 5 ac (2 ha) of Federal land, and 1,884 ac (762 ha) of privately owned land, in the wet cliff ecosystem along the summit of the Koolau Mountains, overlapping portions of Sacred Falls State Park, the Waiahole FR (Waiahole and Iolekaa sections), the Kaneohe and Honolulu Watershed FRs, and the Nuuna Pali State Wayside.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyrtandra kaulantha* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Cyrtandra kaulantha* occurs within the Lowland wet and Wet cliff ecosystems in the Koolau Mountain caldera complex:

Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. (E) Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. (E) Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

Oahu—Wet Cliff—Units 6, 7, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: >65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: Broussaia, Cheirodendron, Leptecophylla, Metrosideros. (E) Understory: Bryophytes, Ferns, Coprosma, Dubautia, Kadua, Peperomia.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Cyrtandra kaulantha* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 840 and 1,050 feet (255 and 320 m) (USFWS, 2012)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: *Cyrtandra kaulantha* (haiwale) is a perennial shrub in the African violet family (Gesneriaceae) found in dense shade in moist wooded gulches at elevations between 840 and 1,050 ft (255 and 320 m), in the lowland wet and wet cliff ecosystems in the Koolau Mountains (Wagner et al. 1999, p. 763; TNC 2007; HBMP 2008). (USFWS, 2012)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends**Population Trends:**

Short-term trends indicate declines of 10-30% (USFWS, 2012)

Resiliency:

Very low (inferred from USFWS, 2012)

Redundancy:

Very low (inferred from USFWS, 2012)

Number of Populations:

5 (USFWS, 2012)

Population Size:

28 wild, 12 outplanted (USFWS, 2012)

Population Narrative:

Cyrtandra kaulantha is therefore currently found in 5 occurrences totaling 28 wild and 12 outplanted individuals. (USFWS, 2012)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative plants, animals (pigs), hurricanes, rockfalls, landslides, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Rockfalls and landslides destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. The projected effects of climate change will likely exacerbate the effects of the other threats to the species (USFWS, 2012).

Stressor: Predation and herbivory (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, goats, and slugs) is considered an ongoing threat to *Cyrtandra kaulantha* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2012).

Stressor: Small populations (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: *Cyrtandra kaulantha* faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). The only known wild populations are facing imminent threats from flooding, landslides, and rock falls because of their locations in steep gulches (USFWS, 2012).

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Recovery**Reclassification Criteria:**

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

References

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Final Rule. 77 Federal Register 181, September 18, 2012. Pages 57648 - 57862.

SPECIES ACCOUNT: *Cyrtandra limahuliensis* (Ha`iwale)

Species Taxonomic and Listing Information

Listing Status: Threatened; 02/25/1994; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Cyrtandra limahuliensis, a member of the African violet family (Gesneriaceae), is an unbranched or few-branched shrub up to 1.5 m (5 ft) tall. The opposite, elliptic leaves are usually 15 to 30 cm (6 to 12 in) long and 5 to 12 cm (2 to 4.7 in) wide. The upper surface of the toothed leaves is moderately hairy and the lower surface, with deep veins, is moderately or densely covered with yellowish brown hairs. Single downy flowers are borne in the leaf axils. The slightly curved corolla tube (fused petals) barely extends beyond the calyx. The calyx encloses the approximately 2 cm (0.8 in) long berries at maturity. The following combination of characteristics distinguish this species from others of the genus: The leaves are usually hairy, especially on lower surfaces; the usually symmetrical calyx is tubular or funnel-shaped and encloses the fruit at maturity; and the flowers are borne singly (St. John 1987a, Wagner et al. 1990). (USFWS, 1995)

Taxonomy

The type of *Cyrtandra kealiae* was actually shown to be *C. limahuliensis* (Wagner and Herbst 1999). (NatureServe, 2015)

Historical Range

Historically, *C. limahuliensis* was known from three locations on Kauai: Wainiha and Lumahai Valleys and near Kilauea River (HHP 1994, USFWS 1994a). (USFWS, 1995)

Current Range

Current range includes Kauai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Cyrtandra limahuliensis* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Cyrtandra limahuliensis* includes four units totaling 9,940 acres in Kauai County, Hawaii. The units are Kauai 4—*Cyrtandra limahuliensis*—a, b, Kauai 10—*Cyrtandra limahuliensis*—c, and Kauai 11—*Cyrtandra limahuliensis*—d, e.

Kauai 4—*Cyrtandra limahuliensis*—a: This unit is critical habitat for *Cyrtandra limahuliensis* and is 501 ha (1,238 ac) on State (Kealia and Moloaa Forest Reserves) and private land. This unit contains portions of Mount Namahana, Leileiwi, Keana Kolea, Puuawa, and Anahola Stream. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Cyrtandra limahuliensis* and is currently occupied with between 51 and 101 plants. This

unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, stream banks in lowland wet forests. This unit is geographically separated from the other four units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. The six to seven other plants on Kauai are not included in critical habitat because the habitat they occupy is not considered essential to the conservation of this species. The more intact and appropriate habitat within its historical range on Kauai, is being designated as critical habitat. Kauai 4—*Cyrtandra limahuliensis*—b: This unit is critical habitat for *Cyrtandra limahuliensis* and is 354 ha (874 ac) on State (Kealia Forest Reserve) and private land. This unit contains Leleiwi Summit and portions of the Makaleha Mountains. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Cyrtandra limahuliensis* and is currently occupied with 109 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, stream banks in lowland wet forests. This unit is geographically separated from the other four units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 10—*Cyrtandra limahuliensis*—c: This unit is critical habitat for *Cyrtandra limahuliensis* and is 2,014 ha (4,975 ac) on State (Halelea and LihueKoloa Forest Reserves) and private land. This unit contains Iole, Kalalea, Kamanu, Kapalaoa, and Kawaikini Summits, all within the Waialeale area. This unit provides habitat for four populations of 300 mature, reproducing individuals of the short-lived perennial *Cyrtandra limahuliensis* and is currently occupied with between 530 and 707 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population. The habitat features contained in this unit that are essential for this species include, but are not limited to, stream banks in lowland wet forests. This unit is geographically separated from the other four units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 11—*Cyrtandra limahuliensis*—d: This unit is critical habitat for *Cyrtandra limahuliensis* and is 816 ha (2,018 ac) on State (Halelea Forest Reserve) and private land. This unit contains Kapailu, Mamalahoa, and Puu Manu Summits. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial *Cyrtandra limahuliensis* and is currently occupied with over 2,000 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population. The habitat features contained in this unit that are essential for this species include, but are not limited to, stream banks in lowland wet forests. This unit is geographically separated from the other four units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Cyrtandra limahuliensis*—e: This unit is critical habitat for *Cyrtandra limahuliensis* and is 693 ha (1,715 ac) on State (Halelea Forest Reserve, Hono o Na Pali NAR, and Haena and Na Pali Coast State Parks) and private land. This unit contains Hono o Na Pali, Kulana'ililia, Maunapuluo, Pali Eleele, Pohakea, Summits, Limahuli Falls, and Pohakukane

Cliff. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial *Cyrtandra limahuliensis* and is currently occupied with between 50 and 100 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, stream banks in lowland wet forests. This unit is geographically separated from the other four units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Stream banks in lowland wet forests containing one or more of the following native plant species: *Antidesma platyphyllum*, *Bidens* spp., *Boehmeria grandis*, *Charpentiera* spp., *Cibotium glaucum*, *Cyanea* spp., *Cyrtandra kealiae*, *Dicranopteris linearis*, *Diplazium sandwichianum*, *Dubautia* spp., *Eugenia reinwardtiana*, *Gunnera kauaiensis*, *Hedyotis terminalis*, *Hibiscus waimeae*, *Metrosideros polymorpha*, *Perrottetia sandwicensis*, *Pisonia* spp., *Pipturus* spp., *Pritchardia* spp., *Psychotria* spp., or *Touchardia latifolia*; and

(ii) Elevations between 208 and 1,591 m (681 and 5,217 ft).

Special Management Considerations or Protections

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 240 and 870 meters (800 and 2,850 feet) (USFWS, 1995)

Habitat Narrative

Adult: This species typically grows along streams in lowland wet forests at elevations between 240 and 870 meters (800 and 2,850 feet). Associated taxa include *Antidesma platyphyllum* var. *hillebrandii* (hame), *Athyrium sandwicense* (hoio), *Perrottetia sandwicensis* (olomea), ohia, *Dicranopteris linearis* (uluhe), *Gunnera kauaiensis* (apeape), *Hedyotis* sp. (manono), and *Psychotria* sp. (kopiko) (USFWS 1994a). (USFWS, 1995)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Low (inferred from USFWS, 2010)

Redundancy:

Low (inferred from USFWS, 2010)

Number of Populations:

possibly 13 (USFWS, 2017)

Population Size:

possibly 1000s (USFWS, 2017)

Population Narrative:

In 2003, USFWS reported a total of 13 populations, containing approximately 2,746 to 3,024 individuals on private and State lands. These locations included the Halelea, Kealia, and Lihue-Koloa Forest Reserves, Limahuli Falls, Lumahai Valley, Waipa Valley, Waioli Valley, Kekoiki, Makaleha, the right fork of Wainiha Valley, Kualapa, Blue Hole, Kepalaoa, and Puu Kolo (USFWS 2003). (USFWS, 2010);

Threats and Stressors

Stressor: Alien plants (USFWS, 1995)

Exposure:

Response:

Consequence:

Narrative: The major threat to *Cyrtandra limahuliensis* is competition from alien plant species, especially strawberry guava. Each population has additional threats: competition with *Paspalum conjugatum* (Hilo grass) and *Melastoma candidum* (NCN) at the Mount Kahili population; competition with common guava and habitat degradation by feral pigs at the Anahola Stream

population; and competition with *Hedychium flavescens* (yellow ginger) at the Wainiha Valley population. The Waioli Valley populations are threatened by several alien weeds: *Rubus rosifolius* (thimbleberry), *Youngia japonica* (Oriental hawksbeard), *Erechtites valerianifolia* (fireweed), and *Blechnum occidentale* (NCN). (USFWS, 1995)

Stressor: Landslides (USFWS, 1995)

Exposure:

Response:

Consequence:

Narrative: Individuals of the Wailua Stream population are situated at the base of a steep cliff and are vulnerable to natural landslides. (USFWS, 1995)

Stressor: Hurricanes (USFWS, 1995; USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Hurricanes are also a potential threat, although most of the plants have grown back vigorously since Hurricane Iniki (USFWS 1994a). (USFWS, 1995); Hurricanes were accidentally not highlighted in the last five year review. In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event, and 70 percent of all listed plant species on Kauai are only found on Kauai. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013). (USFWS, 2017)

Stressor: Feral pigs (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The major threats to this species are habitat degradation by feral pigs (*Sus scrofa*). (USFWS, 2010)

Stressor: Climate change (USFWS, 2010; USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to *Cyrtandra kealiae* subsp. *kealiae*. However, current climate change models do not allow us to predict specifically what those effects, and their extent, would be for this species. (USFWS, 2010); Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change

vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Cyrtandra kealiae* ssp. *kealiae* is vulnerable to the impacts of climate change, with a vulnerability score of 0.52 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2017)

Stressor: Rodent predation or herbivory (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Herbivory by rats has been noted as a threat to occurrences at Kawaikini, Kapalaoa, Iliiliula, Iole, upper Limahuli, Waiahi, and Kekoiki (NTBG 2010a-b, 2012b-c, e, 2013a-c, 2015b) (USFWS, 2017)

Stressor: Slug herbivory (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Herbivory by slugs has been noted as a threat to occurrences at Kawaikini, Kapalaoa, Iliiliula, upper Limahuli, and Kekoiki (NTBG 2010b, 2012ab, e, 2013c, 2015b) (USFWS, 2017)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Kauai and at least one other island where they now occur or occurred historically. (USFWS, 1995)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1995)
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1995)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Kauai and at least one other island where they now occur or occurred historically. (USFWS, 1995)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1995)
3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1995)

Recovery Actions:

- Given the degraded nature of the Kauai plant cluster's habitat, their precariously low numbers, and the severity of the threats, the highest priority actions must be aimed at protecting all extant wild individuals and populations, managing habitat to enhance survival and ensuring maintenance of adequate genetic stock ex situ. (USFWS, 1995)
- It is hoped that by eliminating current threats through management, populations of the Kauai cluster taxa will expand naturally. However, in certain special instances, wild populations of the Kauai cluster taxa may need to be augmented. (USFWS, 1995)
- Research into various aspects of the life history, habitat, pollinators, reproductive biology, symbionts, optimum requirements for growth, requirements for population viability, and control of threats to each of the Kauai cluster taxa must be carried out to better understand the requirements necessary for perpetuation of these plants. (USFWS, 1995)
- If necessary to meet recovery objectives, populations should be reestablished in areas where they are known to have occurred historically, particularly if genetically uncontaminated, cultivated materials exist which are known to have originated from the historical site. (USFWS, 1995)
- The scientific validity of the recovery objectives should be reviewed as more information becomes available. (USFWS, 1995)
- A public education program is needed to increase awareness of and support for plant recovery efforts in Hawaii. (USFWS, 1995)
- Surveys and inventories—Surveys to better understand the current status of the species within historic range. (USFWS, 2017)
- Ungulate monitoring and control—Protect all occurrences against browsing and disturbances from feral pigs. Construct and maintain fenced exclosures around all populations. (USFWS, 2017)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. Control invasive nonnative plant species around all populations that compete with the species. (USFWS, 2017)
- Predator and herbivore monitoring and control—Determine and implement effective control methods for slugs. Implement effective control methods for rodents (USFWS, 2017)
- Captive propagation for genetic storage and reintroduction—Continue to collect propagules for storage and for maintenance of genetic stock. While seed collections had been made in the past, these collections had been collected over twenty-four years ago and viability of these collections is uncertain and should be determined. (USFWS, 2017)
- Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2017)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides, flooding, and loss of habitat resulting from climate change. (USFWS, 2017)
- Federal Register updates—Update the listed entity in the table at 50 CFR 17 to acknowledge currently recognized taxonomy. (USFWS, 2017)

Conservation Measures and Best Management Practices:

- Detailed surveys are needed to assess the current status of the species and the level of impacts from threats. (USFWS, 2010)
- Obtain adequate numbers of seeds to test storage viability. (USFWS, 2010)

- Propagate for augmentation and ex situ plantings. (USFWS, 2010)
- Update the listed entity on 50 CFR 17 to match the currently recognized taxonomy. (USFWS, 2010)

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SPECIES ACCOUNT: *Cyrtandra munroi* (Ha`iwale)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/15/1992; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Cyrtandra munroi of the African violet family (Gesneriaceae) is a shrub with opposite, elliptic to almost circular leaves, 9.5 to 21 cm (3.7 to 8.3 in long and 5.5 to 9.5 cm (2.2 to 3.7 in) wide, which are sparsely to moderately hairy on the upper surface and covered with velvety, rust-colored hairs underneath. The flowers are usually arranged in clusters of three on stalks emerging from the leaf axils. The white petals are fused into a tube, 15 to 20 mm (0.6 to 0.8 in) long, which flares into two upper lobes, 3 mm (0.1 in) long, and three lower lobes, about 5 to 6 mm (0.2 to 0.23 in) long. The white berries, covered with fine hair, are somewhat egg-shaped and 1.8 to 2.3 cm (0.7 to 0.9 in) long. This species is distinguished from other species of the genus by the broad opposite leaves, the length of the flower cluster stalks, the size of the flowers, and the amount of hair on various parts of the plant (Forbes 1920, Wagner et al. 1990). (USFWS, 1994)

Taxonomy

Genus found in Southeast Asia and much of the Western Pacific basin, species endemic to Lanai and Maui. (NatureServe, 2015)

Historical Range

Historically, *Cyrtandra munroi* was known from scattered collections from wet forest on Lana`ihale on Lana`i and from Makamaka`ole Gulch on West Maui (Wagner et al. 1990). (USFWS, 1994)

Current Range

The current range includes Lanai and Maui. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyrtandra munroi* (Ha`iwale) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes five detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Cyrtandra munroi* includes five CHUs in Maui County, Hawaii with detailed unit information. There are also an unknown number of units on Lanai that contain this species (number of units is unknown because detailed unit descriptions for Lanai are not available). Note also that *C. munroi* is used as the abbreviated plant name in some of the detailed unit descriptions and it is unclear if these refer to *Cyanea munroi* or *Cyrtandra munroi* (or both) as both species are found in the Wet cliff ecosystem (81 FR 17790-18110).

Maui—Lowland Wet—Unit 3 (and) *Palmeria dolei*—Unit 4—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 4— Lowland Wet This area consists of 1,247 ac (505 ha) of State land at Honanana Gulch on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta*, *Cyanea asplenifolia*, and *Pteris lidgatei*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 3 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwiku* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 6 (and) *Palmeria dolei*—Unit 7—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 7— Lowland Wet This area consists of 136 ac (55 ha) of State land at Honokowai and Wahikuli valleys on the western slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 6 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwiku* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 6 (and) *Palmeria dolei*—Unit 35—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 35— Wet Cliff This area consists of 1,858 ac (752 ha) of State land, and 253 ac (102 ha) of privately owned land, at the summit ridges of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plants *Alectryon macrococcus*, *B. conjuncta*, *Ctenitis squamigera*,

Cyrtandra munroi, *Remya mauiensis*, and *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 6 is not known to be occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Bonamia menziesii*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyriformis*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, or *Tetramolopium capillare*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 7 (and) *Palmeria dolei*—Unit 8—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 8—Lowland Wet This area consists of 898 ac (364 ha) of State land at Olowalu Valley, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Alectryon macrococcus*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 7 is not currently occupied by the plants *Asplenium dielarectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 7 (and) *Palmeria dolei*—Unit 36—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 36—Wet Cliff This area consists of 556 ac (225 ha) of State land along Honokowai ridge on the northwestern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units are occupied by the plants *Cyrtandra filipes* and *C. munroi*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 7 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyriformis*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or

Tetramolopium capillare, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyrtandra munroi* critical habitat consists of three components. Lowland wet (west Maui), Montane wet (Lanai) and Wet cliff (west Maui and Lanai) (81 FR 17790-18110):

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. Understory: Bryophytes, Ferns, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*,

Cyperus trachysanthos, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkii*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C.*

duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. magnicalyx, C. mannii, C. maritae, C. mcelandowneyi, C. profuga, C. solanacea, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Dubautia plantaginea ssp. humilis, Geranium hanaense, G. multiflorum, Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 300 and 920 meters (USFWS, 1994)

Habitat Narrative

Adult: The habitat of *Cyrtandra munroi* is Lowland Wet Forest (diverse, mixed mesic to wet *Metrosideros* forest), typically on rich, moist to wet, moderately steep talus slopes from 300 to 920 meters (980-3020 feet). It occurs on soil and rock substrates on slopes from watercourses in gulch bottoms and up the sides of gulch slopes to near ridgetops. Associated native species include, *Diospyros*, *Metrosideros polymorpha*, *Hedyotis acuminata*, *Clermontia*, *Alyxia*, *Bobea*, *Coprosma*, *Dicranopteris*, *Freycinetia*, *Melicope*, *Myrsine*, *Perrottetia*, *Pipturus*, *Pittosporum*, *Pleomele*, *Pouteria*, *Pneumatopteris*, *Psychotria*, *Sadleria*, *Scaevola*, *Xylosma*, and other *Cyrtandra*. In addition, strawberry guava (*Psidium cattleianum*) was present at most sites on a site visit in 1991 (J. Lau, personal communication 1992). (USFWS, 1994)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Seed dispersal may be via birds that eat the fruits (Roelofs 1978). (USFWS, 1994)

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Low (inferred from USFWS, 2011)

Redundancy:

Low (inferred from USFWS, 2011)

Number of Populations:

10 (USFWS, 2011)

Population Size:

several dozen to a few 100 on Maui, a few on Lana'i (wild), 0 outplanted (USFWS, 2018)

Population Narrative:

The current estimated census for *Cyrtandra munroi* is fewer than 100 individuals in at least 8 populations on Maui and 2 individuals in 2 populations on Lanai. (USFWS, 2011); In 2011, the 5-year review reported eight populations of *Cyrtandra munroi* on west Maui (totaling less than 100 individuals), and two individuals on Lānaʻi. Currently, there are several dozen to possibly a few hundred individuals in six locations on west Maui, and a few individuals at Hauola on Lānaʻi (Oppenheimer 2018, in litt.). (USFWS, 2018)

Threats and Stressors

Stressor: Browsing and habitat disturbance by axis deer and mouflon sheep (USFWS, 1994, USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Deer have not yet fully invaded the current habitat of *Cyrtandra munroi*, though they have directly (through browsing and trampling) and indirectly (through opening up avenues for invasion of alien plants by their trampling) contributed to the taxon's decline. Browsing and habitat disturbance by axis deer and mouflon sheep (*Ovis musimon*) promise to eliminate *Cyrtandra munroi* if drastic management efforts are not undertaken. (USFWS, 1994; USFWS, 2011)

Stressor: Encroaching alien plant species (USFWS, 1994; USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Even small pockets of virtually undisturbed forest in the heads of gulches on the upper slopes of Lanaʻi are being invaded by *Psidium cattleianum*, *Myrica faya*, *Leptospermum scoparium*, *Pluchea symphytifolia*, *Melinis minutiflora*, *Rubus rosifolius*, *Paspalum conjugatum*, *Cinnamomum camphora*, *Morella faya*, *Ageratina riparia*, *Tibouchina herbacea*, and other alien species. On West Maui, invasive introduced plants include *Aleurites moluccana* (kukui), *Blechnum appendiculatum* (NCN), *Buddleia asiatica* (dog tail), *Clidemia hirta* (Koster's curse), *Cordyline fruticosa* (ti), *Ficus* sp. (banyan), *Lantana camara* (lantana), *Melinis minutiflora* (molasses grass), *Oplismenus hirtellus* (basketgrass), *Paspalum conjugatum* (Hilo grass), *Psidium cattleianum*, *P. guajava* (common guava), *Rubus argutus* (blackberry), *R. rosifolius*, *Schinus terebinthifolius* (Christmas berry), and *Tibouchina herbacea* (National Tropical Botanical Garden 2009a; Oppenheimer 2009; Perlman 2009; Wood 2009). These alien species have become pervasive on adjacent ridges since the forest floor is bombarded by alien propagules, and natural

openings, or openings created by habitat disturbance by axis deer, provide ample sites for these aliens to obtain a foothold. Continuing disturbance by axis deer exacerbates the alien plant invasion problem. (USFWS, 1994; USFWS, 2011)

Stressor: Small population size (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: With its extremely small number of populations and individuals, the limited gene pool may depress reproductive vigor. (USFWS, 1994)

Stressor: Loss of pollinators (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: The decline of native insect pollinators is very likely to pose a major, though undocumented, threat. (USFWS, 1994)

Stressor: Herbivory by slugs and rats (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: On Maui, rats (*Rattus* spp.) and slugs (unidentified species) have been reported to consume the leaves and seeds of various *Cyrtandra* species (Perlman 2009). (USFWS, 2011)

Stressor: Climate change (USFWS, 2011; USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2011); Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Cyrtandra munroi* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.606 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2018)

Stressor: Feral pigs (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Not available.

Stressor: Landslides (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Not available.

Recovery

Reclassification Criteria:

1. A total of five to seven populations are documented on Lanai and at least one other island where they now occur or occurred historically. (USFWS, 1994)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1994)

3. Each of these populations must persist at this level for at least 5 consecutive years before downlisting is considered. (USFWS, 1994)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Lanai and at least one other island where they now occur or occurred historically. (USFWS, 1994)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum or 300 mature individuals per population for short-lived perennials. (USFWS, 1994)

3. Each population should persist at this level for at least 5 consecutive years before delisting is considered. (USFWS, 1994)

Recovery Actions:

- Secure and manage current populations and their habitat. (USFWS, 1994)
- Conduct essential research to the conservation of the species. (USFWS, 1994)
- Expand current populations. (USFWS, 1994)
- Establish new populations as needed to reach recovery objectives. (USFWS, 1994)
- Validate and revise recovery objectives. (USFWS, 1994)
- Population viability and monitoring—Continue to monitor the wild populations on west Maui and Lānaʻi. (USFWS, 2018)
- Ungulate monitoring and control—Continue to construct and maintain exclusion fences to protect *Cyrtandra munroi* from the impacts of feral ungulates. (USFWS, 2018)
- Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species around all populations. (USFWS, 2018)

- Predator and herbivore monitoring and control—Implement effective control methods for rodents at wild and reintroduced populations. Develop and implement effective control methods for slugs.(USFWS, 2018)
- Captive propagation for genetic storage and reintroduction—Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. Evaluate genetic resources currently in storage to determine the need to place additional material into long-term storage due to this species' vulnerability to climate change. (USFWS, 2018)
- Reintroduction and translocation—Begin reintroduction of individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2018)
- Climate change adaptation strategy—Research the suitability of habitat for reintroducing this species in the future due to impacts from climate change. (USFWS, 2018)
- Alliance and partnership development—Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2018)

Conservation Measures and Best Management Practices:

- Monitor known populations and collect any available seeds. (USFWS, 2011)
- Maintain or build fences around existing populations to protect from the negative impacts of ungulates. (USFWS, 2011)
- Collect seeds and/or cuttings from each population for genetic storage and reintroduction. (USFWS, 2011)
- Control invasive introduced plant species around known populations. (USFWS, 2011)
- Control rats in the vicinity of these populations. (USFWS, 2011)
- Develop and implement methods to control slugs. (USFWS, 2011)
- Propagate to augment the existing populations. (USFWS, 2011)
- Establish additional populations within protected suitable habitat. (USFWS, 2011)
- Work with Hawaii Division of Forestry and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2011)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2011)

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SPECIES ACCOUNT: *Cyrtandra nanawaleensis* (Ha`iwale)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/29/2013; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Cyrtandra nanawaleensis (haiwale), a shrub or small tree in the African violet family (Gesneriaceae). (USFWS, 2013)

Taxonomy

Cyrtandra nanawaleensis is not treated by Kartesz 1999. Wagner and Herbst's Supplement to the Manual of the Flowering Plants of Hawai'i note that this is a new species closely related to *C. lesiocsepala* but grows in the Puna District at lower elevations. (NatureServe, 2015)

Current Range

The current range is restricted to Hawaii. (USFWS, 2013)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (USFWS, 2013)

Habitat Narrative

Adult: This species is known from a lowland wet ecosystem. (USFWS, 2013)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Resiliency:

Low (inferred from USFWS, 2013)

Redundancy:

Low (inferred from USFWS, 2013)

Number of Populations:

5 (USFWS, 2013)

Population Size:

160 (USFWS, 2013)

Population Narrative:

Currently, *C. nanawaleensis* is known from 5 occurrences with approximately 160 individuals in the lowland wet ecosystem: 2 occurrences in Malama Ki FR totaling 70 individuals (Lau 2011, pers. comm.); 1 occurrence in Keauohana FR (with 56 individuals) (Magnacca 2011a, in litt.); 2 occurrences in the Halepuaa section of Nanawale FR (one with 28 mature and 65 immature plants at 200 feet (ft) (61 meters (m)) elevation, and a second occurrence with 9 mature and 57 immature plants at 270 ft (82 m)) (Johansen 2012, in litt.; Kobsa 2012, in litt.; Perry 2012, in litt.); and 1 occurrence with an unknown number of individuals on private lands in lower Puna (Perry 2012, in litt.). A total of approximately 56 individuals have been outplanted in Halepuaa and Keauohana (Perry 2012, in litt.). (USFWS, 2013)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs), nonnative plants, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Hybridization (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Hybridization is a threat to *Cyrtandra nanawaleensis* because hybridization may lead to extinction of the original genotypically distinct species. *C. nanawaleensis* is known to hybridize with *C. lysiosepala* (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:**Consequence:**

Narrative: Predation and herbivory by nonnative animal species (pigs, rats, and slugs) is considered an ongoing threat to *Cyrtandra nanawaleensis* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor:**Exposure:****Response:****Consequence:****Narrative:****Stressor:****Exposure:****Response:****Consequence:****Narrative:****Stressor:****Exposure:****Response:****Consequence:****Narrative:****Stressor:****Exposure:****Response:****Consequence:****Narrative:*****Recovery*****Reclassification Criteria:**

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

References

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SPECIES ACCOUNT: *Cyrtandra oenobarba* (Ha`iwale)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (R1) (USFWS, 2016)

Physical Description

Cyrtandra oenobarba, a member of the African violet family (Gesneriaceae), is a low, decumbent (low to the ground with tip ascending), fleshy subshrub with stems becoming subterranean (growing below ground). Leaves are opposite, appearing as a tuft on a portion of the above ground stem, and the leaf axils have a tuft of reddish brown hairs. Leaves are broadly elliptic to ovate (narrowly oval to egg-shaped), 10 to 31 centimeters (cm) (4 to 12 inches (in)) long, and 2.0 to 13.5 cm (0.8 to 5.3 in) wide. The upper leaf surface has sparse long-villous reddish brown hairs, while the lower surface has sparse to moderate-villous reddish brown hairs. Terminal flowers bloom first and are arranged in dense clusters arising from the leaf axils, and moderately brown villous throughout. The calyx is zygomorphic (bilaterally symmetrical), fusiform (spindle-shaped) in the bud, tipped by a beak about 4.0 to 10.0 millimeters (mm) (0.16 to 0.4 in) long, with the tube about 10.0 to 12.0 mm (0.4 to 0.5 in) long. The corolla is white. Berries are cylindrical and 1.6 mm (0.6 in) long (Wagner et al. 1999). (USFWS, 2017)

Taxonomy

A member of the African violet family (Gesneriaceae) (USFWS, 2010b). Genus found throughout Southeast Asia and much of western Pacific basin, species endemic to Kauai (NatureServe, 2015).

Historical Range

Cyrtandra oenobarba is endemic to the island of Kauai in the Hawaiian Islands (NatureServe, 2015).

Current Range

Currently occurs on Kauai: populations of *C. oenobarba* in the Halelea Forest Reserve include east Mamalahoa (10 individuals), north Namolokama (15 to 200 individuals), and Hanalei Valley (scattered) on State land, and upper Lumahai Valley (50 individuals) and Wainiha (100 individuals) on private land (HBMP 2007). Populations of *C. oenobarba* in the Lihue-Koloa Forest Reserve include Wailua River (40 to 50 individuals) on State land, and Iliiliula drainage (occasional) and Wahiawa drainage (50 individuals) on private land (HBMP 2007) (USFWS, 2010b).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyrtandra oenobarba* (Ha`iwale, Shaggy-stem cyrtandra) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes nine critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Cyrtandra oenobarba* includes nine CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Lowland Wet—Section 1: Lowland Wet—Section 1 consists of 1,164 ac (471 ha) in the lowland wet ecosystem (117 ac (47.4 ha) on State land; 1,047 ac (424 ha) on private land), including wet forest extending from Kulanalilia into Limahuli Valley to Hoonoanapali, in the Halelea Forest Reserve (Figure 2-A). The section includes 1,099 ac (445 ha) of State and privately owned land within previously designated critical habitat and 65 ac (26 ha) of newly designated critical habitat on private land. The area that falls within designated critical habitat lies within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and newly designated Critical Habitat Unit 20, Map 217c. This section is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Labordia helleri*, and *Phyllostegia renovans*. This section also contains unoccupied habitat that is essential to the conservation of these four species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 1 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Cyanea elealeensis*, *C. kolekoleensis*, *C. kuhihewa*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Melicope paniculata*, *M. puberula*, *Platydesma rostrata*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 2: Lowland Wet—Section 2 consists of 172 ac (70 ha) in the lowland wet ecosystem, including wet forest extending from Alealau to Pohakea, within the Hono o Na Pali NAR and the Na Pali Coast State Park (Figure 2-A, above). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plant *Melicope puberula*. This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 2 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea elealeensis*, *C. kolekoleensis*, *C. kuhihewa*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope paniculata*, *Phyllostegia renovans*, *Platydesma rostrata*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 3: Lowland Wet—Section 3 consists of 756 ac (306 ha) in the lowland wet ecosystem, including wet forest in upper Wainiha Valley, on privately owned land in the Halelea Forest Reserve (Figure 2-B). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by

the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyrtandra oenobarba*, *Melicope puberula*, *Phyllostegia renovans*, and *Stenogyne kealiae*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet–Section 3 is not known to be occupied by the species *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope paniculata*, *Platydesma rostrata*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 4: Lowland Wet–Section 4 consists of 591 ac (239 ha) in the lowland wet ecosystem, including wet forest at the head of Lumahai Valley, on State (10 ac, 4.1 ha) and privately owned (581 ac, 235 ha) land in the Halelea Forest Reserve (Figure 2-B, above). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyrtandra oenobarba*, *Melicope paniculata*, *Phyllostegia renovans*, and *Platydesma rostrata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet–Section 4 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope puberula*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population numbers of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 5: Lowland Wet–Section 5 consists of 1,541 ac (624 ha) in the lowland wet ecosystem, including wet forest extending from the headwaters of the Wailua River at “Blue Hole” south to Iole, on State (442 ac, 179 ha) and privately owned (1,099 ac, 445 ha) land in the Lihue-Koloa Forest Reserve (Figure 2-C). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36a, and is occupied by the plants *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Melicope paniculata*, *Phyllostegia renovans*, and *Platydesma rostrata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet–Section 5 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C.*

kuhihewa, *Labordia helleri*, *Melicope puberula*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 6: Lowland Wet—Section 6 consists of 789 ac (319 ha) in the lowland wet ecosystem, including wet forest extending from Kapalaoa to Kanaele Bog and Lauahihaihai in the Wahiawa Mountains, on State (134 ac, 54 ha) and privately owned (655 ac, 265 ha) land in the Lihue-Koloa Forest Reserve (Figure 2-D). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36a, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Platydesma rostrata*, and *Tetraplasandra bisattenuata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 6 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuuhihewa*, *Labordia helleri*, *Melicope paniculata*, *M. puberula*, *Phyllostegia renovans*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Wet Cliff—Section 1: Wet Cliff—Section 1 consists of 190 ac (77 ha) in the wet cliff ecosystem, including cliffs along the rim of Kalalau Valley from Alealeau to Pihea, on State-owned land in the Na Pali Coast State Park and the Hono o Na Pali NAR (Figure 6-A). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70b, and is occupied by the plant *Chamaesyce remyi* var. *remyi*. This section includes the wet cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the wet cliff ecosystem (Table 3). Although Wet Cliff—Section 1 is not known to be occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyanea dolichopoda*, *Cyrtandra oenobarba*, *C. paliku*, *Dubautia plantaginea* ssp. *magnifolia*, *Lysimachia iniki*, *L. pendens*, *L. venosa*, and *Platydesma rostrata*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Wet Cliff—Section 2: Wet Cliff—Section 2 consists of 784 ac (317 ha) in the wet cliff ecosystem, and includes the cliffs at the headwaters of the Wailua River or “Blue Hole,” on State (778 ac, 315 ha) and privately owned (6 ac, 3 ha) land in the Lihue-Koloa Forest Reserve (Figure 6-B). There are 489 ac (198 ha) within previously designated critical habitat and 296 ac (120 ha) of newly designated critical habitat on State-owned land. The portion of the section that is in

previously designated critical habitat falls within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36b. The newly designated portion of the section comprises Critical Habitat Unit 18 of 50 CFR 17.99(a)(1), Map 217a. This section is occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyrtandra oenobarba*, *Dubautia plantaginea* ssp. *magnifolia*, *Lysimachia iniki*, *L. pendens*, and *Platydesma rostrata*. The section includes the wet cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the wet cliff ecosystem (Table 3). Although Wet Cliff–Section 2 is not known to be occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyanea dolichopoda*, *Cyrtandra paliku*, and *Lysimachia venosa*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Wet Cliff—Section 3: Wet Cliff –Section 3 consists of 61 ac (24 ha) in the wet cliff ecosystem, including cliffs below Kekoiki, on State (8 ac, 3 ha) and privately owned (53 ac, 22 ha) land in the Halelea, Moloaa and Kealia forest reserves (Figure 6-C). There are 23 ac (9 ha) of newly designated critical habitat on privately owned land within this section. That portion of the section that falls within previously designated critical habitat is within Critical Habitat Unit 4 of 50 CFR 17.99(a)(1), Map 5a. The newly designated portion of the section comprises Critical Habitat Unit 19 of 50 CFR 17.99(a)(1), Map 217b. This section is occupied by the plant *Cyrtandra paliku*, and includes the wet cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the wet cliff ecosystem (Table 3). Although Wet Cliff–Section 3 is not known to be occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Cyanea dolichopoda*, *Cyrtandra oenobarba*, *Dubautia plantaginea* ssp. *magnifolia*, *Lysimachia iniki*, *L. pendens*, *L. venosa*, and *Platydesma rostrata*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyrtandra oenobarba* critical habitat consists of two components (Lowland wet and Wet Cliff) (75 FR 18960-19165):

Ecosystem: Lowland Wet. Elevation: <3,000 ft (<914 m). Annual precipitation: >75 in (>190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. Understory: *Bryophytes*, *Ferns*, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry

Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: *Metrosideros polymorpha*-*Dicranopteris linearis* wet cliffs, forest, and shrubland (USFWS, 2010b)

Dependencies on Specific Environmental Elements

Adult: High rainfall (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 1,320 - 2,800 ft. elevation (USFWS, 2010b)

Environmental Specificity

Adult: Very narrow to narrow (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits extremely wet areas with high rainfall in forests and shrublands. The environmental specificity is very narrow to narrow; it is only found on wet slopes, mossy sites, or crevices in rocks near waterfalls. It is limited to valleys in the interior of the island, where rainfall is very high (NatureServe, 2015). Occurs in the lowland wet and wet cliff ecosystems (Wagner et al. 1999, pp. 770–771; TNCH 2007) in *Metrosideros polymorpha*-*Dicranopteris linearis* wet cliffs, forest, and shrubland, at elevations between 1,320 and 2,800 ft. (402 and 853 m) (Wood 1998, p. 3; HBMP 2007) (USFWS, 2010b).; *Cyrtandra oenobarba* is found on wet slopes, mossy areas, or in rock crevices near waterfalls in *Metrosideros polymorpha*—*Dicranopteris linearis* (ohia-uluhe) wet cliffs, forest, and shrubland, between 402 and 853 meters (1,320 and 2,800 feet) in elevation (Wood 1998; HBMP 2010). Associated native plant species include *Antidesma platyphyllum* (hame), *Bobea brevipes* (ahakea lau lili), *Broussaisia arguta* (kanawao), *Cheirodendron* spp. (olapa), *Cyanea* spp. (haha), *Cyrtandra* spp.

(haiwale), *Dubautia* spp. (naenae), *Kadua* spp. (manono), *Melicope* spp. (alani), *Metrosideros* spp. (ohia), *Perrottetia sandwicensis* (olomea), *Pisonia* spp. (papala kepau), *Polyscias* spp. (ohe), *Psychotria* spp. (kopiko), *Syzygium sandwicensis* (ohia ha), and a rich fern and bryophyte understory (NTBG 2007, 2008, 2010, 2012a-b, 2013a-d, 2014; HBMP 2010; Wood 2012). (USFWS, 2017)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Declining (USFWS, 2017)

Species Trends:

Declining (NatureServe, 2015)

Resiliency:

Very low (inferred from USFWS, 2010b; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2010a)

Number of Populations:

10 (USFWS, 2017)

Population Size:

< 500 wild individuals (USFWS, 2017)

Population Narrative:

The species is declining due to numerous threats, exact percentage is unknown (HBMP 2007) (NatureServe, 2015). There are eight populations containing 270 - 450 individuals (USFWS, 2010a).; Historically, wide-ranging collections were made of *Cyrtandra oenobarba* on Kauai, from the eastern side at Kekoiki Ridge, the northern coast at Maunapulo, the south-central area at Olokele and Hanapepe, and from the south at Haupu (HBMP 2010). At the time of listing, populations of *C. oenobarba* were found mostly in the central areas, except for one at Hanakapiai headwaters. The other populations ranged from Lumahai, to Wainiha (in Wainiha Preserve), Iliiliula, Kawaikini, Wailua headwaters, Iole headwaters, Waiahi near the Kamooloa headwaters, and north Kapalaoa. These nine populations totaled approximately 150 individuals (NTBG 2007, 2008, 2010, 2012a-b, 2013a-d, 2014; HBMP 2010; Wood 2012). Currently, this species occurs in two locations on Kauai, in 10 subpopulations (considered as populations by USFWS) totaling fewer than 500 individuals (mature and immature), and is in decline due to impacts of invasive plants and animals (Walsh 2016). The numbers of individuals known has increased due to the increase in surveys for the species since listing. (USFWS, 2017)

Threats and Stressors

Stressor: Ungulate degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Feral pigs (*Sus scrofa*) and goats (*Capra hircus*) (NTBG 2010, 2013a-d, 2014; HBMP 2010; Wood 2012) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil. (USFWS, 2017)

Stressor: Established ecosystem-altering invasive plant modification and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community. Invasive introduced plants impacting *Cyrtandra oenobarba* are *Axonopus fissifolius* (narrow-leaved carpetgrass), *Buddleja asiatica* (dog tail), *Clidemia hirta* (Koster's curse), *Cyperus meyenianus* (no common name), *Erigeron karvinskianus* (daisy fleabane), *Hedychium gardnerianum* (kahili ginger), *Juncus planifolius* (bog rush), *Melastoma septemnerium* (no common name), *Paspalum conjugatum* (Hilo grass), *Psidium cattleianum* (strawberry guava), *P. guajava* (common guava), *Rhodomirtus tomentosa* (downy myrtle), *Rubus rosifolius* (thimbleberry), *Sacciolepis indica* (glenwood grass), and *Sphaeropteris cooperi* (Australian tree fern) (NTBG 2007, 2008, 2010, 2012a-b, 2013a-d, 2014; HBMP 2010; Wood 2012). (USFWS, 2017)

Stressor: Landslides and flooding destruction or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Landslides, including tree falls and erosion associated with them, can have a significant effect on small populations of *Cyrtandra oenobarba* (HBMP 2010). Landslides and erosion due to natural weathering destabilize substrates, damage and destroy individual plants, and alter hydrological patterns (Stearns 1985). (USFWS, 2017)

Stressor: Hurricanes—Loss and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-

present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013). (USFWS, 2017)

Stressor: Climate change loss or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Cyrtandra oenobarba* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.664 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this species has no overlap between current and future climate envelopes, and is unlikely to tolerate expected changes in climate at its current location. This means that this species must persist within suitable microrefugia, or move to newly available climate-compatible areas to avoid extinction. Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2017)

Stressor: Ungulate predation or herbivory (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Herbivory by pigs and goats has been noted as a threat to this species (NTBG 2008, 2010, 2012a, 2013a-d, 2014; HBMP 2010; Wood 2012). (USFWS, 2017)

Stressor: Rodent predation or herbivory (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Herbivory by rats has been noted as a threat to *Cyrtandra oenobarba* (NTBG 2008, 2010, 2012a, 2013b-d, 2014; Wood 2012). Rats eat virtually every part of plants and at every stage: fleshy fruits, seeds, flowers, stems, leaves, shoot, seedlings, and roots (Russell 1980; Cuddihy and Stone 1990). The effects on plants range from reduced vigor and decreased reproduction to mortality of individuals and complete lack of recruitment. (USFWS, 2017)

Stressor: Slug herbivory (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Herbivory by slugs has been noted as a threat to this species (NTBG 2008, 2012a, 2013a-d, 2014; Wood 2012). (USFWS, 2017)

Stressor: Lack of adequate hunting regulations (USFWS, 2017)

Exposure:

Response:**Consequence:**

Narrative: Nonnative feral ungulates pose a major ongoing threat to native species through destruction and modification of habitat and direct herbivory or predation. Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (i.e., sustained yield) in some areas, with one animal allowed per day; to other areas with as few as one animal allowed per year (DLNR 2010). One of the 10 known populations of *Cyrtandra oenobarba* occurs in a State hunting area, and this population is not fenced. Public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations are at risk. Two populations are within Wainiha Preserve in an area which was recently fenced and are provided protection from ungulates as long as the fences are not breached. (USFWS, 2017)

Stressor: Lack of adequate biosecurity legislation (USFWS, 2017)

Exposure:**Response:****Consequence:**

Narrative: Invasion of the State of Hawaii by invasive nonnative plant species, and destruction of habitat and competition by nonnative plants are threats to *Cyrtandra oenobarba*. The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, is authorized to prevent the introduction or dissemination of animal and plant pests on all ships, aircraft, and their cargo and baggage arriving in the U.S. and its territories; however, pest species continue to enter the State. In addition, Federal import regulations do not address many species that could be pests in Hawaii (CGAPS 2009; Ikuma et al. 2002). (USFWS, 2017)

Stressor: Invasive species (USFWS, 2017)

Exposure:**Response:****Consequence:**

Narrative: Established invasive plant species competition—Plant species including *Clidemia hirta*, *Erigeron karvinskianus* (daisy fleabane), *Melastoma septemnerium*, *Rubus rosifolius* (thimbleberry), and *Sphaeropteris cooperi*, compete with *Cyrtandra oenobarba* for water, light, and nutrients (HBMP 2010). (USFWS, 2017)

Recovery**Reclassification Criteria:**

To meet the interim stage of recovery of *Cyrtandra oenobarba*, 300 mature individuals are needed in each of three populations; all major threats must be controlled around each population designated for recovery at this stage. There should also be demonstrated regeneration of seedlings and growth to at least sapling stage for woody species and documented replacement regeneration within each of the target populations. Each population must be adequately represented in an ex situ collection as defined in the Center for Plant Conservation's guidelines (Guerrant et al. 2004). Adequate monitoring must be in place and conducted to assess individual plant survival, population trends, trends of major limiting factors, and response of major limiting factors to management. (USFWS, 2017)

In addition to achieving 5 to 10 populations with 500 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats. (USFWS, 2017)

Delisting Criteria:

In addition to achieving 5 to 10 populations with 500 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis. (USFWS, 2017)

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys (USFWS, 2010a).
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units (USFWS, 2010a).
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys (USFWS, 2010a).
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range (USFWS, 2010a).
- Conduct research on control methods for introduced slugs and avian malaria (USFWS, 2010a).
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction (USFWS, 2010a).
- Identify threats and prioritize which ones to address first for the two birds (USFWS, 2010a).

- Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program (USFWS, 2010a).
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security (USFWS, 2010a).
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems (USFWS, 2010a).
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations (USFWS, 2010a).
- Surveys and inventories—Survey for populations of *Cyrtandra oenobarba* in areas of potentially suitable habitat. (USFWS, 2017)
- Ungulate monitoring and control—Construct and maintain fenced exclosures around all populations. Protect all occurrences against browsing and disturbances from feral ungulates. (USFWS, 2017)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. Control invasive nonnative plant species around all populations that compete with the species. (USFWS, 2017)
- Predator and herbivore control—Implement rat control at current populations. (USFWS, 2017)
- Predator and herbivore control research—Study *C. oenobarba* populations to determine level of threat from invertebrate herbivory and need for additional recovery actions. (USFWS, 2017)
- Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. (USFWS, 2017)
- Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2017)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms. (USFWS, 2017)
- Population biology research—Study *C. oenobarba* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. (USFWS, 2017)
- Based on the recovery criteria above, consider development of a recovery plan. (USFWS, 2017)

Conservation Measures and Best Management Practices:

- Not available

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SPECIES ACCOUNT: *Cyrtandra oxybapha* (Ha`iwale)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

A shrub, 2-3 m tall, with many-branched stems. Inflorescences axillary, with 1-2 flowers. Corollas white. (NatureServe, 2015)

Taxonomy

Genus found throughout the western Pacific, species endemic to west Maui. New species described by Wagner and Herbst (and accepted by Kartesz, 1994 checklist), known only from type locality. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Known only from one location on West Maui and two on East Maui. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyrtandra oxybapha* (Ha`iwale) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Cyrtandra oxybapha* includes three CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Montane Wet—Unit 6 (and) *Palmeria dolei*—Unit 15—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 15— Montane Wet This area consists of 1,113 ac (451 ha) of State land, and 286 ac (116 ha) of privately owned land, at the summit and surrounding areas on west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta*, *Calamagrostis hillebrandii*, *Cyanea kunthiana*, *Geranium hillebrandii*, *Myrsine vaccinioides*, and *Sanicula purpurea*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 6 is not known to be occupied by the plants *Acaena exigua*, *Cyrtandra oxybapha*, *Huperzia mannii*, *Phyllostegia bracteata*, or *Platanthera holochila*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the

reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 7 (and) *Palmeria dolei*—Unit 16—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 16— Montane Wet This area consists of 80 ac (32 ha) of State land near Hanaula and Pohakea Gulch on the southeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). They are occupied by the plants *Cyrtandra oxybapha* and *Platanthera holochila*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 7 is not known to be occupied by the plants *Acaena exigua*, *Bidens conjuncta*, *Calamagrostis hillebrandii*, *Cyanea kunthiana*, *Geranium hillebrandii*, *Huperzia mannii*, *Myrsine vaccinioides*, *Phyllostegia bracteata*, or *Sanicula purpurea*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 1 (and) *Palmeria dolei*—Unit 18—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 18— Montane Mesic This area consists of 6,593 ac (2,668 ha) of State land, 707 ac (286 ha) of privately owned land, and 3,672 ac (1,486 ha) of federally owned land (Haleakala National Park), from Kealahou to Puualae, nearly circumscribing the summit of Haleakala on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Asplenium dielirectum*, *A. peruvianum* var. *insulare*, *Clermontia lindseyana*, *Cyanea horrida*, *C. obtusa*, *Cyrtandra ferripilosa*, *C. oxybapha*, *Diplazium molokaiense*, *Geranium arboreum*, *G. multiflorum*, *Huperzia mannii*, *Melicope adscendens*, and *Neraudia sericea*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 1 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Cyanea glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. mceldowneyi*, *Phyllostegia bracteata*, *P. mannii*, *Santalum haleakalae* var. *lanaiense*, *Wikstroemia villosa*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyrtandra oxybapha* critical habitat consists of

two components. Montane wet (west Maui) and Montane mesic (east Maui) (81 FR 17790-18110):

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: *Acacia*, *Ilex*, *Metrosideros*, *Myrsine*, *Nestegis*, *Nothocestrum*, *Pisonia*, *Pittosporum*, *Psychotria*, *Sophora*, *Zanthoxylum*. Subcanopy: *Alyxia*, *Charpentiera*, *Coprosma*, *Dodonea*, *Kadua*, *Labordia*, *Leptecophylla*, *Phyllostegia*, *Vaccinium*. Understory: Ferns, *Carex*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire,

drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Wet environment (NatureServe, 2015)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: This species is found in wet and moist forests in gulches. (NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Low (inferred from USFWS, 2016)

Redundancy:

Low (inferred from USFWS, 2016)

Number of Populations:

2 (USFWS, 2016)

Population Size:

137 to 250 (USFWS, 2016)

Population Narrative:

Currently, there are 2 known occurrences with a total of 137 to 250 individuals. (USFWS, 2016)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs, goats, and cattle), nonnative plants, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, goats, and cattle) is considered an ongoing threat to *Cyrtandra oxybapha* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

Final Rule . 81 FR 17790-18110 (March 30, 2016).

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species. Federal Register 81(61): 17790-18110

USFWS. 2013. Determination of Endangered Status for 38 Species on Molokai, Lanai, and Maui

Final Rule. 78 Federal Register 102, May 28, 2013. Pages 32014 - 32065.

SPECIES ACCOUNT: *Cyrtandra paliku* (Ha`iwale)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (R1) (USFWS, 2016)

Physical Description

Cyrtandra paliku is a perennial subshrub 3.0 to 7.5 meters (9.8 to 24 feet) tall in the African violet family (Gesneriaceae). The stems are unbranched to sparsely branched, erect, prominently ringed with leaf scars, and covered with conspicuous shaggy dark reddish-brown hairs. Leaves are oppositely arranged, clustered at the upper 3 to 7 nodes of the branch, typically with one of the opposite pair smaller than the other. The leaf blades are strongly asymmetrical, 7 to 18 centimeters (cm) (2.8 to 7 inches (in)) long and 4.5 to 9 cm (1.8 to 3.5 in) wide, upper and lower surfaces are villous, densely so along the veins. Inflorescences are 1- to 9-flowered and also densely shaggy villous. Calyx lobes are weakly bisymmetrical, pale green, ellipsoid, 12 to 17 millimeters (mm) (0.5 to 0.7 in) long. The corolla is white, slightly curved upward, and 14 to 15 mm (0.6 in) long (Wagner et al. 2001). (USFWS, 2017)

Taxonomy

A member of the African violet family (USFWS, 2016). *Cyrtandra paliku* was discovered in 1993 and published as a distinct species in 2001 (Wagner, W. L. 2001. Novon. 146-152.) (NatureServe, 2015).

Historical Range

Known from north-facing wet cliffs of Kekoiki in the Makaleha Mountains on Kaua'i, Island (NatureServe, 2015).

Current Range

The full range of this species is 0.1 km on Kauai, Hawaiian Islands (Wagner et al. 2001) (NatureServe, 2015).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyrtandra paliku* (Haiwale) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Cyrtandra paliku* includes three CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Wet Cliff—Section 1: Wet Cliff—Section 1 consists of 190 ac (77 ha) in the wet cliff ecosystem, including cliffs along the rim of Kalalau Valley from Alealeau to Pihea, on Stateowned land in the Na Pali Coast State Park and the Hono o Na Pali NAR (Figure 6-A). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR

17.99(a)(1), Map 70b, and is occupied by the plant *Chamaesyce remyi* var. *remyi*. This section includes the wet cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the wet cliff ecosystem (Table 3). Although Wet Cliff–Section 1 is not known to be occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyanea dolichopoda*, *Cyrtandra oenobarbara*, *C. paliku*, *Dubautia plantaginea* ssp. *magnifolia*, *Lysimachia iniki*, *L. pendens*, *L. venosa*, and *Platydesma rostrata*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Wet Cliff—Section 2: Wet Cliff–Section 2 consists of 784 ac (317 ha) in the wet cliff ecosystem, and includes the cliffs at the headwaters of the Wailua River or “Blue Hole,” on State (778 ac, 315 ha) and privately owned (6 ac, 3 ha) land in the LihueKoloa Forest Reserve (Figure 6-B). There are 489 ac (198 ha) within previously designated critical habitat and 296 ac (120 ha) of newly designated critical habitat on State-owned land. The portion of the section that is in previously designated critical habitat falls within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36b. The newly designated portion of the section comprises Critical Habitat Unit 18 of 50 CFR 17.99(a)(1), Map 217a. This section is occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyrtandra oenobarba*, *Dubautia plantaginea* ssp. *magnifolia*, *Lysimachia iniki*, *L. pendens*, and *Platydesma rostrata*. The section includes the wet cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the wet cliff ecosystem (Table 3). Although Wet Cliff–Section 2 is not known to be occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyanea dolichopoda*, *Cyrtandra paliku*, and *Lysimachia venosa*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Wet Cliff—Section 3: Wet Cliff –Section 3 consists of 61 ac (24 ha) in the wet cliff ecosystem, including cliffs below Kekoiki, on State (8 ac, 3 ha) and privately owned (53 ac, 22 ha) land in the Halelea, Moloaa and Kealia forest reserves (Figure 6-C). There are 23 ac (9 ha) of newly designated critical habitat on privately owned land within this section. That portion of the section that falls within previously designated critical habitat is within Critical Habitat Unit 4 of 50 CFR 17.99(a)(1), Map 5a. The newly designated portion of the section comprises Critical Habitat Unit 19 of 50 CFR 17.99(a)(1), Map 217b. This section is occupied by the plant *Cyrtandra paliku*, and includes the wet cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the wet cliff ecosystem (Table 3). Although Wet Cliff–Section 3 is not known to be occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Cyanea dolichopoda*, *Cyrtandra oenobarbara*, *Dubautia plantaginea* ssp. *magnifolia*, *Lysimachia iniki*, *L. pendens*, *L. venosa*, and *Platydesma rostrata*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyrtandra paliku* critical habitat consists of one component (Wet cliff) (75 FR 18960-19165):

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. Understory: Bryophytes, Ferns, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., "sustained yield") in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances

that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Studies of another species of Hawaiian *Cyrtandra* (*C. grandiflora*) found that flowering is correlated with a dry period or increased sunlight three months prior to flowering, that fruits are mature about five months after flowering, and that the species is self-compatible (an individual can produce seeds on its own without cross-pollination (Roelofs 1979). Hawaiian *Cyrtandra* form a monophyletic group (share a single ancestor), probably as a result of a single colonization (Cronk et al. 2005), and intraspecific (inter-species) hybridization may have played a role in the evolution of species in this group (Smith et al. 1996). Other than the general information listed above, very little additional information on the life history for *C. paliku* is available at this time. Flowering has been observed during February and May, fruits have been observed during March, October, November, and December (Wagner et al. 2001; NTBG 2010a; PEPP 2011, 2012). Its pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown. (USFWS, 2017)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: *Metrosideros polymorpha*- *Dicranopteris linearis* wet cliff ecosystem (USFWS, 2010b); lowland wet forest (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 2,200 - 2,800 ft. elevation (USFWS, 2010b)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Habitat Narrative

Adult: The environmental specificity is very narrow; it is known only from vertical, shaded, north-facing basalt rock faces, which are windswept and often mist-shrouded. Occurs with *Selaginella arbuscula*. Population surrounded by patches of lowland wet forest dominated by *Metrosideros polymorpha* (Wagner et al., 2001) (NatureServe, 2015). Occurs in areas dominated by *Metrosideros polymorpha* and *Dicranopteris linearis* in the wet cliff ecosystem, at elevations between 2,200 and 2,800 ft. (670 to 850 m) (USFWS, 2010b).; *Cyrtandra paliku* occurs on seeping basalt rock faces of north-facing *Selaginella arbuscula*-(lepelepe a moa) covered cliffs with *Metrosideros polymorpha* (ohia) and *Dicranopteris linearis* (uluhe), between 800 to 850 meters (2,625 to 2,800 feet) elevation. Other associated native plant species include *Anoectochilus sandwicensis* (jewel orchid), *Bidens campylotheca* (kookoolau), *Broussaisia arguta* (kanawao), *Cyanea hirtella* (haha), *C. fissa* (haha), *Cyrtandra heinrichii* (haiwale), *Dubautia knudsenii* (naenae), *D. laxa* (naenae pua melemele), *Gunnera kauaiensis*; (ape ape), *Freycinetia arborea* (ie ie), *Kadua affinis* (manono), *Machaerina angustifolia* (uki), *Perrottetia sandwicensis* (olomea), *Pipturus ruber* (waimea), *Sadleria pallida* (amau), and *S. squarrosa* (apuu) (HBMP 2010; NTBG 1993a-b, 1999, 2010a-c; Wagner et al. 2001). (USFWS, 2017)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Very low (inferred from NatureServe, 2015; see current range/distribution)

Redundancy:

Very low (inferred from USFWS, 2010a)

Number of Populations:

1 (USFWS, 2010a)

Population Size:

10 (USFWS, 2017)

Population Narrative:

Cyrtandra paliku was first discovered in 1993 on the cliffs below Kekoiki, in the Makaleha Mountains of Kauai, where approximately 70 individuals were found (Wagner et al. 2001; HBMP 2010; TNCH 2007). The species maintained a population of approximately 70 individuals from

1993 through 1999; however, there are currently six mature individuals and four immature individuals (NTBG 1993a-b, 1999, 2010a-c, 2011; Perlman 2006; PEPP 2012; Edmonds and Walsh 2015). (USFWS, 2017)

Threats and Stressors

Stressor: Ungulate degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Feral goats (*Capra hircus*) (NTBG 2010c) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil. (USFWS, 2017)

Stressor: Established ecosystem-altering invasive plant modification and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community. Invasive introduced plants impacting *Cyrtandra paliku* are *Ageratum conyzoides* (maile honohono), *Clidemia hirta* (Koster's curse), *Erechtites valerianifolia* (fireweed), *Melastoma septemnerium* (no common name (NCN)), *Paspalum conjugatum* (Hilo grass), and *Rubus rosifolius* (thimbleberry) (NTBG 1993a-b; Wagner et al. 2001). (USFWS, 2017)

Stressor: Landslides and flooding destruction or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Landslides, including tree falls and erosion associated with them, can have a significant effect on the small population of *Cyrtandra paliku* (NTBG 1998, 1999, 2010c; Wagner et al. 2001; HBMP 2010). Landslides and erosion due to natural weathering destabilize substrates, damage and destroy individual plants, and alter hydrological patterns (Stearns 1985). (USFWS, 2017)

Stressor: Hurricanes—Loss and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants

(Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013). (USFWS, 2017)

Stressor: Climate change degradation or loss of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Cyrtandra paliku* is extremely vulnerable to the impacts of climate change, with a vulnerability score of 0.857 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this species has no overlap between current and future climate envelopes, and is unlikely to tolerate expected changes in climate at its current location. This means that this species must persist within suitable microrefugia, or move to newly available climate-compatible areas to avoid extinction. Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2017)

Stressor: Ungulate predation or herbivory (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Herbivory by goats is a threat to *Cyrtandra paliku* (NTBG 2010c). (USFWS, 2017)

Stressor: Rodent predation or herbivory (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Herbivory of stems, fruits, and seeds by black and Polynesian rats (*Rattus rattus* and *R. exulans*) is a threat to *Cyrtandra paliku* (Edmonds and Walsh 2015). Rats eat virtually every part of plants and at every stage: fleshy fruits, seeds, flowers, stems, leaves, shoot, seedlings, and roots (Russell 1980; Cuddihy and Stone 1990). The effects on plants range from reduced vigor and decreased reproduction to mortality of individuals and complete lack of recruitment. (USFWS, 2017)

Stressor: Invertebrate predation or herbivory (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Severe damage to stems, fruit and seeds from *Deroceras* and *Limax* slugs is a threat to this species (Edmonds and Walsh 2015) (USFWS, 2017)

Stressor: Lack of adequate hunting regulations (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Feral goats pose a major ongoing threat to native species through destruction and modification of habitat and by direct herbivory or predation. *Cyrtandra paliku* occurs outside of a public hunting area. This population is not fenced and goats have been noted as a threat to the species. Public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations are at risk (DLNR 2010). (USFWS, 2017)

Stressor: Lack of adequate biosecurity legislation (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Invasion of the State of Hawaii by invasive nonnative plant species, and destruction of habitat and competition by nonnative plants are threats to *Cyrtandra paliku*. Pests have caused the extinction of native species, the destruction of native forests, and the spread of disease. Interstate commerce provides the pathway for invasive species and commodities infested with non-Federal quarantine pests to enter the State of Hawaii. The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, is authorized to prevent the introduction or dissemination of animal and plant pests on all ships, aircraft, and their cargo and baggage arriving in the U.S. and its territories; however, pest species continue to enter the State. In addition, Federal import regulations do not address many species that could be pests in Hawaii (CGAPS 2009; Ikuma et al. 2002). (USFWS, 2017)

Stressor: Invasive species—Established invasive plant species competition (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Nonnative plant species including *Clidemia hirta*, *Erechtites valerianifolia*, *Lantana camara* (lantana), *Melastoma septemnerium* (NCN), *Paspalum conjugatum*, and *Rubus rosifolius* (thimbleberry) compete with *Cyrtandra paliku* for water, light, and nutrients (NTBG 2010c; Wagner et al. 2001). (USFWS, 2017)

Stressor: Stochastic events—Reduced viability due to low numbers (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Small, isolated populations often exhibit reduced levels of genetic variability, which diminishes the species' capacity to adapt and respond to environmental changes, thereby lessening the probability of long-term persistence (Barrett and Kohn 1991; Newman and Pilson 1997). The problems associated with small population size and vulnerability to random demographic fluctuations or natural catastrophes are further magnified by synergistic interactions with other threats, such as anthropogenic impacts like habitat loss from human development or predation by nonnative species. Very small plant populations may experience reduced reproductive vigor due to ineffective pollination or inbreeding depression. Small

numbers is noted as a threat to *Cyrtandra paliku* as there is only one known population with 10 or fewer individuals. (USFWS, 2017)

Recovery

Reclassification Criteria:

To meet the interim stage of recovery of *Cyrtandra paliku*, 300 mature individuals are needed in each of three populations and all major threats must be controlled around each population designated for recovery at this stage. There should also be demonstrated regeneration of seedlings and growth to at least sapling stage for woody species and documented replacement regeneration within each of the target populations. Each population must be adequately represented in an ex situ collection as defined in the Center for Plant Conservation's guidelines (Guerrant et al. 2004). Adequate monitoring must be in place and conducted to assess individual plant survival, population trends, trends of major limiting factors, and response of major limiting factors to management. (USFWS, 2017)

In addition to achieving 5 to 10 populations with 500 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats. (USFWS, 2017)

Delisting Criteria:

In addition to achieving 5 to 10 populations with 500 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis. (USFWS, 2017)

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys (USFWS, 2010a).

- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units (USFWS, 2010a).
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys (USFWS, 2010a).
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range (USFWS, 2010a).
- Conduct research on control methods for introduced slugs and avian malaria (USFWS, 2010a).
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction (USFWS, 2010a).
- Identify threats and prioritize which ones to address first for the two birds (USFWS, 2010a).
- Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program (USFWS, 2010a).
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security (USFWS, 2010a).
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems (USFWS, 2010a).
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations (USFWS, 2010a).
- Surveys and inventories—Survey for populations of *Cyrtandra paliku* in areas of potentially suitable habitat. (USFWS, 2017)
- Ungulate monitoring and control—Protect all occurrences against browsing and disturbances from feral ungulates. (USFWS, 2017)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. Control invasive nonnative plant species around all populations that compete with the species. (USFWS, 2017)
- Predator and herbivore control—Construct fencing to protect population from herbivory by feral goats. (USFWS, 2017)
- Captive propagation protocol development—Research to determine best seed storage methods. (USFWS, 2017)
- Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2017)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms. (USFWS, 2017)
- Based on the recovery criteria above, consider development of a recovery plan. (USFWS, 2017)

Conservation Measures and Best Management Practices:

- Not available

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SPECIES ACCOUNT: *Cyrtandra polyantha* (Ha`iwale)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/28/1994; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

A shrub 1-3 m tall. The flowers are white, and in clusters of 7-12. (NatureServe, 2015)

Taxonomy

Genus found in portions of Southeast Asia and throughout western pacific basin, species endemic to Koolau mts. of Oahu. (NatureServe, 2015)

Historical Range

Historically no additional range. (NatureServe, 2015)

Current Range

The current range is Koolau Mountains of Oahu. (NatureServe, 2015)

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyrtandra polyantha* (Ha`iwale) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Cyrtandra polyantha* (77 FR 57648-57862). The critical habitat designation includes 15 critical habitat units, which encompass approximately 27,051 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Cyrtandra polyantha* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Cyrtandra polyantha* includes 15 critical habitat units, covering one ecosystem type, which encompasses approximately 27,051 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 4, 5, 6, 7; Oahu— Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16.

Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within

Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Haula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikeekee, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet—Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet—Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu—Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 ac (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamo Ridge.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyrtandra polyantha* critical habitat consists of

the following components according to ecosystem type (77 FR 57648-57862). Note: *Cyrtandra polyantha* occurs within the Lowland mesic and Lowland wet ecosystems in the Koolau Mountain caldera complex:

Oahu—Lowland Mesic—Units 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (E) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Oahu— Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (E) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Cyrtandra polyantha* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: *Cyrtandra polyantha* was also observed to flower in October, with fruit maturing between December and January (Plant Extinction Prevention Program 2007). (USFWS, 2009)

Habitat Type

Adult: Terrestrial (USFWS, 1998)

Habitat Vegetation or Surface Water Classification

Adult: Shrublands, forests (NatureServe, 2015)

Habitat Narrative

Adult: *Cyrtandra polyantha* grows on ridges in *Metrosideros polymorpha* (ohia) mesic or wet forests at elevations between 331 and 762 m (1,086 and 2,499 ft). *Cyrtandra polyantha* probably grows in association with uki, uluhe, hapuu, hame, amau, maile, kanawao, *Coprosma foliosa* (pilo), and kopiko, plants commonly found in the ohia-dominated forests of the Koolau Mountains (USFWS 1996a). (USFWS, 1998; USFWS, 2009)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

2 (USFWS, 2009)

Population Size:

46 (USFWS, 2009)

Population Narrative:

In 2007, 46 mature individuals were known to occur in two populations (USFWS 2008). The Kulepeamoa population, on the leeward side of the Koolau Mountains, consisted of a single mature individual, and the Kuliouou Valley summit population on the windward side of the Koolau Mountains consisted of 45 mature individuals. The extant wild population appears to be in good health, although numbers appear to be declining with time. (USFWS, 2009)

Threats and Stressors

Stressor: Feral pigs (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: A major threat to *Cyrtandra polyantha* is habitat degradation by feral pigs (*Sus scrofa*). (USFWS, 2009)

Stressor: Invasive introduced plants (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Competition from invasive introduced plant species is another major threat, competing for light, space and water resources. The most serious plant species impacting *C. polyantha* include *Ageratina adenophora* (pamakani haole), *Clidemia hirta* (Koster's curse), *Erigeron karvinskianus* (daisy fleabane), and *Melinis minutiflora* (molasses grass). (USFWS, 2009)

Stressor: Over-collection (USFWS, 2009)

Exposure:

Response:**Consequence:**

Narrative: The inaccessibility of the extant populations affords the species some protection from human trampling and collection (Plant Extinction Prevention Program 2007; USFWS 2007). However, the over-collection of plant material and genetic resources for scientific purposes could threaten the species due to the small number of remaining individuals, and potentially reduced reproductive vigor. (USFWS, 2009)

Stressor: Herbivory by rats and slugs (USFWS, 2009)

Exposure:**Response:****Consequence:**

Narrative: *Cyrtandra polyantha* produces white fleshy fruits which are potentially eaten by rats (*Rattus* spp.), and rats therefore potentially threaten the survival of the taxon (USFWS 2007). Herbivory by slugs and snails may also impact the survival of the remaining populations (USFWS 1998). (USFWS, 2009)

Stressor: Small population size (USFWS, 2009)

Exposure:**Response:****Consequence:**

Narrative: In addition to all of the other threats, species like *Cyrtandra polyantha* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding and disease outbreaks. (USFWS, 2009)

Stressor: Climate change (USFWS, 2009)

Exposure:**Response:****Consequence:**

Narrative: Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) funded climate modeling that will help resolve these spatial limitations. High spatial resolution climate outputs are expected to be available sometime in 2013. (USFWS, 2013)

Recovery**Reclassification Criteria:**

1. A total of five to seven populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)

3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1998)

Recovery Actions:

- Surveys of appropriate habitat in historical locations are needed to determine if any other extant populations of this plant exist. Hahaione Valley should also be revisited to determine if the population still exists. (USFWS, 1998)
- Enclosures should be constructed around the extant populations to reduce impacts from feral pigs. Subsequent control or removal of pigs from these areas will alleviate their impact on native ecosystems. A commitment should be developed for long-term stewardship and conservation of these areas once they have been enclosed. (USFWS, 1998)
- Specific efforts should be made to immediately weed and protect the extant populations. (USFWS, 1998)
- To prevent extinction of *Cyrtandra polyantha*, ex situ propagation should be initiated. Specific efforts should be made to immediately collect propagation material from both populations, if feasible. (USFWS, 1998)
- *Cyrtandra polyantha* may be seriously threatened by rat predation. A management plan to control rats should be developed and implemented. This should include the use of the currently-approved Diphacinone bait blocks and ultimately a more broad-scale method such as aerial dispersal of rodenticide. (USFWS, 1998)

Conservation Measures and Best Management Practices:

- Collect genetic material from extant mature individuals for establishment of new populations or enhancement of existing populations. (USFWS, 2013)
- Construct fences and remove ungulates from wild populations. (USFWS, 2013)
- Control invasive introduced plant species. (USFWS, 2013)
- Survey the geographical and historical range of *Cyrtandra polyantha* for additional populations. (USFWS, 2013)
- Identify suitable habitat for manageable reintroductions and augmentations of existing populations. (USFWS, 2013)
- Conduct life history studies, including pollination and seed dispersal research. (USFWS, 2013)
- Initiate planning and contribute to implementation of ecosystem-level management and restoration to benefit this species. (USFWS, 2013)
- Collect genetic material from extant mature individuals for establishment of new populations or enhancement of existing populations. (USFWS, 2009)

- Construct fences and remove ungulates from wild populations and control invasive introduced plant species. (USFWS, 2009)
- Survey the geographical and historical range of *Cyrtandra polyantha* for additional populations. (USFWS, 2009)
- Conduct life history studies, including pollination and seed dispersal research. (USFWS, 2009)

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SPECIES ACCOUNT: *Cyrtandra sessilis* (Ha`iwale)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/18/2012; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

A shrub, 0.5-1 m tall, with branched stems. Leaves in whorls of 3 per node. Cymes axillary, with 3-8 flowers. Corollas white. (NatureServe, 2015)

Taxonomy

(NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Known only from the Pia Gulch and Waikane area of the Koolau Mountains, island of Oahu, state of Hawaii (USFWS 2006). (NatureServe, 2015)

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyrtandra sessilis* (Ha`iwale) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Cyrtandra sessilis* (77 FR 57648-57862). The critical habitat designation includes 14 critical habitat units, which encompass approximately 30,056 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Cyrtandra sessilis* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Cyrtandra sessilis* includes 14 critical habitat units, covering two ecosystem types, which encompass approximately 30,056 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; Oahu—Wet Cliff—Units 6, 7, 8.

Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Haula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231

ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikēkee, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet—Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet—Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu—Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamo Ridge.

Oahu—Wet Cliff—Unit 6 [151 ac (61 ha)]. This area consists of 151 ac (61 ha) in the wet cliff ecosystem on State land on the windward side of the Koolau Mountains in Kaipapau Gulch, entirely within the Kaipapau Forest Reserve. Oahu—Wet Cliff—Unit 7 [144 ac (58 ha)]. This area consists of 144 ac (58 ha) in the wet cliff ecosystem in State land on the windward side of the Koolau Mountains in Hauula Gulch, entirely within the Hauula Forest Reserve. Oahu—Wet Cliff—Unit 8 [4,649 ac (1,881 ha)]. This area consists of 1,479 ac (598 ha) of State land, 1,281 ac (519 ha) of City and County of Honolulu land, 5 ac (2 ha) of Federal land, and 1,884 ac (762 ha) of privately owned land, in the wet cliff ecosystem along the summit of the Koolau Mountains, overlapping portions of Sacred Falls State Park, the Waiahole FR (Waiahole and Iolekaa sections), the Kaneohe and Honolulu Watershed FRs, and the Nuuanu Pali State Wayside.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyrtandra sessilis* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Cyrtandra sessilis*

occurs within the Lowland wet and Wet cliff ecosystems in the Koolau Mountain caldera complex:

Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. (E) Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. (E) Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

Oahu—Wet Cliff—Units 6, 7, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: >65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: Broussaisia, Cheirodendron, Leptecophylla, Metrosideros. (E) Understory: Bryophytes, Ferns, Coprosma, Dubautia, Kadua, Peperomia.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Cyrtandra sessilis* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 1,600 and 2,200 feet (USFWS, 2012)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: Typical habitat is wet *Metrosideros* forests at elevations between 1,600 and 2,200 ft (490 and 670 m) in the lowland wet and wet cliff ecosystems (TNC 2007; HBMP 2008; Bakutis 2008, in litt.). (USFWS, 2012)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Short-term trends suggest a relatively stable population and long-term trends are unknown (NatureServe, 2015)

Resiliency:

Low (inferred from USFWS, 2012)

Redundancy:

Low (inferred from USFWS, 2012)

Population Growth Rate:

Unknown (NatureServe, 2015)

Number of Populations:

4 (USFWS, 2012)

Population Size:

83 (USFWS, 2012)

Population Narrative:

Short-term population trends suggest a relatively stable population and long-term trends are unknown. *Cyrtandra sessilis* is currently known from 4 occurrences totaling approximately 83 individuals: 75 individuals along the Waikane- Schofield Trail in Kahana Valley, 1 individual at Lulumahu Gulch, 2 individuals in Wailupe, and 5 individuals at Hawaii Loa Ridge near Pia Valley (Perlman 2003, in litt.; Bakutis 2006c, in litt.; HBMP 2008; Bakutis 2008, in litt.). (NatureServe, 2015; USFWS, 2012)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative plants, animals (pigs), hurricanes, rockfalls, landslides, floods, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely

impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Rockfalls, landslides, and floods destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. The projected effects of climate change will likely exacerbate the effects of the other threats to the species (USFWS, 2012).

Stressor: Predation and herbivory (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, goats, and slugs) is considered an ongoing threat to *Cyrtandra sessilis* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2012).

Stressor: Trampling by humans (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: *Cyrtandra sessilis* faces the threat of trampling. The largest known population of *C. sessilis* is located along a popular hiking trail in the Koolau Mountains, and individuals climbing and hiking off the established trail to visit this occurrence could trample individual plants and contribute to soil compaction and erosion, preventing growth and establishment of seedlings. This type of activity has been observed with other native species (USFWS, 2012).

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor:

Exposure:

Response:

Consequence:

Narrative:***Recovery*****Reclassification Criteria:**

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

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SPECIES ACCOUNT: *Cyrtandra subumbellata* (Ha`iwale)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

Cyrtandra subumbellata is a member of the Gesneriaceae (African violet family). It is a short-lived perennial shrub 2 to 3 m (6.6 to 10 ft) tall. The leaves are papery in texture, oppositely arranged, circular to egg-shaped, 12 to 39 cm (4.7 to 15.4 in) long, and 3 to 19 cm (1.2 to 7.5 in) wide. The white flowers are 18 to 20 mm (0.7 to 0.8 in) long and form dense umbelliform cymes of 5 to 15 flowers. The white berries are 1.0 to 1.5 cm (0.4 to 0.6 in) long and ovoid shaped. It is distinguished from other species in the genus by its leaf shape and texture; the number of flowers per cluster; and the length of bracts, flower stem, calyx lobes, floral tube, and styles (Wagner et al. 1999).

Taxonomy

Genus found throughout Pacific Basin, species endemic to Koolau mts. of Oahu. (NatureServe, 2015)

Historical Range

Historically, *Cyrtandra subumbellata* was known from the Koolau Mountains of Oahu.

Current Range

Currently, *C. subumbellata* is known from three occurrences in the north and central Koolau Mountains (U.S. Army 2003a) with a total of approximately 108 individuals: two individuals from Kahana on Waikane trail, six individuals from the south Kaukonahua drainage, and more than 100 individuals from the Punaluu Rim (U.S. Army 2003a; HINHP Database 2002; K. Kawelo, U.S. Army, pers. comm. 2003; J. Lau, HINHP, pers. comm. 2003).

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyrtandra subumbellata* (Ha`iwale) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Cyrtandra subumbellata* (77 FR 57648-57862). The critical habitat designation includes 14 critical habitat units, which encompass approximately 30,056 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Ctenitis squamigera* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Cyrtandra subumbellata* includes 14 critical habitat units, covering two ecosystem types, which encompass approximately 30,056 acres on the Island of

Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; Oahu—Wet Cliff—Units 6, 7, 8.

Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Hauula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikēkē, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet—Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet—Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu—Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamoa Ridge.

Oahu—Wet Cliff—Unit 6 [151 ac (61 ha)]. This area consists of 151 ac (61 ha) in the wet cliff ecosystem on State land on the windward side of the Koolau Mountains in Kaipapau Gulch, entirely within the Kaipapau Forest Reserve. Oahu—Wet Cliff—Unit 7 [144 ac (58 ha)]. This area consists of 144 ac (58 ha) in the wet cliff ecosystem in State land on the windward side of the Koolau Mountains in Hauula Gulch, entirely within the Hauula Forest Reserve. Oahu—Wet Cliff—

Unit 8 [4,649 ac (1,881 ha)]. This area consists of 1,479 ac (598 ha) of State land, 1,281 ac (519 ha) of City and County of Honolulu land, 5 ac (2 ha) of Federal land, and 1,884 ac (762 ha) of privately owned land, in the wet cliff ecosystem along the summit of the Koolau Mountains, overlapping portions of Sacred Falls State Park, the Waiahole FR (Waiahole and Iolekaa sections), the Kaneohe and Honolulu Watershed FRs, and the Nuuanu Pali State Wayside.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyrtandra subumbellata* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Cyrtandra subumbellata* occurs within the Lowland wet and Wet cliff ecosystems in the Koolau Mountain caldera complex:

Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (E) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Oahu—Wet Cliff—Units 6, 7, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: >65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. (E) Understory: *Bryophytes*, *Ferns*, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Cyrtandra subumbellata* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: *Cyrtandra subumbellata* has been observed in fruit in September. Little else is known about its flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors (Service 1998a).

Habitat Type

Adult: Wet forest and gulch slopes

Habitat Narrative

Adult: *Cyrtandra subumbellata* typically grows on moist, forested slopes or gulch bottoms dominated by *Metrosideros polymorpha* wet forest or mixed *M. polymorpha*-*Dicranopteris linearis*-*Acacia koa* wet forests between 345 and 790 m (1,132 and 2,591 ft) in elevation. Associated native plant species include *Boehmeria grandis*, *Broussaisia arguta*, *Dryopteris* sp., and *Machaerina* sp. (HINHP Database 2001; Service 1998a; Wagner et al. 1999).

Dispersal/Migration

Population Information and Trends

Number of Populations:

three

Population Size:

108

Population Narrative:

Currently, *C. subumbellata* is known from three occurrences in the north and central Koolau Mountains (U.S. Army 2003a) with a total of approximately 108 individuals: two individuals from Kahana on Waikane trail, six individuals from the south Kaukonahua drainage, and more than 100 individuals from the Punaluu Rim (U.S. Army 2003a; HINHP Database 2002; K. Kawelo, U.S. Army, pers. comm. 2003; J. Lau, HINHP, pers. comm. 2003).

Threats and Stressors

Stressor:

Exposure:

Response:

Consequence:

Narrative: The primary threats are competition with the noxious alien plant *Clidemic hirta* (Koster's curse), feral pigs, and stochastic extinction and/or reduced reproductive vigor due to the small number of extant populations and individuals. (NatureServe, 2015)

Recovery

Conservation Measures and Best Management Practices:

- A State-wide management plan should be developed and implemented for the long-term conservation of all known occurrences of *Cyrtandra subumbellata*. This plan should also include broader landscape actions that are needed for the recovery of this plant throughout its range. The recovery plan for this species identifies the following important conservation actions. Non-native plant species should be controlled or removed in the vicinity of all known occurrences of *C. subumbellata*. The threats from fire need to be addressed, especially on State land at Kaukonahua and private land at Puu Ohulehule. The threat from rats should be evaluated at all known occurrences of *C. dentata*. Rats should be controlled in the vicinity of all threatened occurrences using established and approved rodenticides. Rats should also be controlled across a broader landscape by using aerial dispersal of rodenticides, when this method is approved (Service 1998a). Ongoing Conservation Actions: *Cyrtandra subumbellata* is being propagated at the Lyon

Arboretum and seeds are in storage at the National Tropical Botanical Garden (Service 2002; U.S. Army 2003a). The Service is currently not aware of any other conservation efforts for this species.

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SPECIES ACCOUNT: *Cyrtandra tintinnabula* (Ha`iwale)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/04/1994; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Cyrtandra tintinnabula Rock is a small shrub 3.3-6.6 ft (1-2 m) tall (Wagner et al. 1990). Opposite, elliptic or oval leaf blades are 5-10 in (13-26 cm) long and 2-4.9 in (5-12.3 cm) wide. Papery in texture, the toothed leaf blades are moderately covered with yellow-brown hairs, especially on the lower surface. Stalks of the leaves (petioles) are 2.1-4.1 in (5.3-10.5 cm) long. Three to six flowers are in clusters at the tip of a main cluster stalk (peduncle) 0.4-0.7 in (11.8 cm) long. Each flower is subtended by a stalk 0.2-0.6 in (0.5-1.5 cm) long and oval or heart-shaped leaf-like bracts 0.4-0.6 in (0.9-1.5 cm) long. The calyx, 0.4 in (9-10 mm) long, is pale green, bell-shaped and cleft 1/4 to 1/3 of its length. Five reflexed, deltate lobes are densely and softly hairy. Five white petals, 0.1 in (3 mm) long, are fused into a soft-hairy, cylindric tube, about 0.5 in (12 mm) long and 0.2 in (0.5 mm) wide. (USFWS, 1996)

Taxonomy

(NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Endemic to northeastern portion of Island of Hawaii. (NatureServe, 2015)

Critical Habitat Designated

Yes; 7/2/2003.

Legal Description

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Cyrtandra tintinnabula* on the island of Hawaii (68 FR 39623 - 39722).

Critical Habitat Designation

The critical habitat designation for *Cyrtandra tintinnabula* includes two units totaling 6,672 acres in Hawaii County, Hawaii. The units are Hawaii 3—*Cyrtandra tintinnabula*—a and Hawaii 29—*Cyrtandra tintinnabula*—b. One of the units, “Hawaii 3—*Cyrtandra tintinnabula*—a,” currently is occupied by individuals of this species. The units are geographically separated to avoid their destruction by one naturally occurring catastrophic event. Within the two units, habitat is provided for a total of nine populations, each with 300 mature, reproducing individuals of *C. tintinnabula*.

Hawaii 3—*Cyrtandra tintinnabula*—a [2,322 ha (5,738 ac)]: This unit contains a portion of Haakoa, Kilau, and Kawilahilahi streams and is bordered on the northwest by Kaawali and Laupahoehoe watersheds, and on the southeast by Maulua and Pahala watersheds. It also contains portions of the Haakoa, Kaiwilahilahi, Kilau and Manowaiopae watersheds in the central

portion. The unit is almost completely within Laupahohoe NAR with a very small overlap into the Hilo Forest Reserve. This unit provides habitat for 7 populations, each with 300 individuals of *C. tintinnabula*, and the unit is currently occupied by 18 individuals. This unit is essential to the conservation of *C. tintinnabula* because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable.

Hawaii 29—*Cyrtandra tintinnabula*— b [378 ha (934 ac)]: This unit contains portions of two forks of the Wailuku River, it lies completely within the Wailuku watershed, and also lies completely within the Hilo Forest Reserve; provides habitat for 2 populations of 300 individuals of *C. tintinnabula*; and is currently unoccupied. This unit is essential to the conservation of the species because it supports habitat that is necessary for the establishment of additional populations in order to reach recovery goals.

Primary Constituent Elements/Physical or Biological Features

Habitat features that are essential for this species include, but are not limited to, lowland wet forest dominated by dense *Acacia koa*, *Metrosideros polymorpha*, and *Cibotium* spp.

Special Management Considerations or Protections

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for this species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: This species was observed in flower during July 1909 (HHPI991k1) and August 1977 (HHP1991k3), and in fruit during December 1933 (HIHP1991k2). (USFWS, 1996)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 390 and 1,443 meters (USFWS, 2012)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 2012)

Habitat Narrative

Adult: *Cyrtandra tintinnabula* grows in dense lowland wet forests or gulches dominated by *Metrosideros polymorpha* (ohia), *Acacia koa* (koa), and/or members of the fern genus *Cibotium* (hapuu) (USFWS 1994, 1996). The elevation range is between 390 to 1,443 meters (1,280 to 4,690 feet) (USFWS 2002). The only soil group that is recorded for known sites of *C. tintinnabula* is typic hydrandepts (Hawaii Biodiversity Mapping Program 2010). Native plant species found growing in association with *C. tintinnabula* include other species of *Cyrtandra* and of *Kadua*, *Vaccinium calycinum* (ohelo), *Rubus hawaiiensis* (akala), and *Dryopteris wallichiana* (laukahi; Wallich's tall fern) (USFWS 2002). (USFWS, 2012)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Low (inferred from USFWS, 2012)

Redundancy:

Low (inferred from USFWS, 2012)

Number of Populations:

3 (USFWS, 2012)

Population Size:

>150 (USFWS, 2012)

Population Narrative:

In 2009, the Plant Extinction Prevention Program (2009) reported a total of three populations containing more than 150 individuals. Reports from the Plant Extinction Prevention Program present a similar story regarding population declines for much of the decade between 2000 and 2009, except that (see below) the overall population seemed to rebound in 2009. (USFWS, 2012)

Threats and Stressors

Stressor: Feral pigs and goats (USFWS, 1996; USFWS, 2012)

Exposure:**Response:****Consequence:**

Narrative: Rooting and browsing by feral pigs and goats directly damage and disturb the habitat of *Cyrtandra*, and break its weak and delicate stems (Stone 1985). Indirectly, pigs disturb native vegetation and allow the invasion of alien taxa, which in turn rapidly become established. (USFWS, 1996)

Stressor: Non-native invasive plants (USFWS, 1996; USFW, 2012)

Exposure:**Response:****Consequence:**

Narrative: Continued disturbance exacerbates the alien plant problem and eventually precludes the survivability of native taxa. Altering invasive plant species degradation of habitat include *Angiopteris evecta* (mule's-foot fern), *Clidemia hirta* (Koster's curse), *Cyathea cooperi* (Australian tree fern), and *Psidium cattleianum* (strawberry guava) (Plant Extinction Prevention Program 2008, 2009; Bishop Museum 2011; National Tropical Botanical Garden 2011). (USFWS, 1996; USFWS, 2012)

Stressor: Loss of pollinators (USFWS, 1996)

Exposure:**Response:****Consequence:**

Narrative: Because much of the native habitat is lost, appropriate pollinator(s) may be absent as well. The loss of native vectors is a probable cause for the taxon's demise. (USFWS, 1996)

Stressor: Small population size (USFWS, 1996)

Exposure:**Response:****Consequence:**

Narrative: Small numbers of extant individuals with limited distributions restrict the gene pool and depress reproductive vigor. (USFWS, 1996)

Recovery**Reclassification Criteria:**

1. A total of five to seven populations of each taxon should be documented on the Big Island and at least one other island where it now occurs or occurred historically, if it is not endemic to the Big Island. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1996)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1996)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on the Big Island and at least 1 other island where they now occur or occurred historically, if it is not endemic to the Big Island. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 individuals per population for short-lived perennials. (USFWS, 1996)
3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1996)

Recovery Actions:

- In order to prevent possible extinction of this taxon, maintenance of ex situ genetic stock is necessary. (USFWS, 1996)
- The 18 known individuals should be protected from ungulates, particularly pigs, and encroachment of alien plants. (USFWS, 1996)
- Propagation and outplanting of ex situ stock will likely be needed in order to establish a sufficient number of populations and plants for recovery. (USFWS, 1996)
- Research should be conducted into the species' pollination vectors. (USFWS, 1996)

Conservation Measures and Best Management Practices:

- Continue to collect cuttings or seed from the remaining populations for adequate genetic storage. (USFWS, 2012)
- Implement research needed for the propagation of the species, especially at Hakalau Forest National Wildlife Refuges greenhouse. (USFWS, 2012)
- Identify suitable habitat within the historical range of the species for reintroductions. (USFWS, 2012)
- Reintroduce the species back into its known historical range. (USFWS, 2012)
- Control invasive introduced plant species around all populations. (USFWS, 2012)
- Continue to construct ungulate-proof fenced exclosures around each population and monitor the fences for any signs of breaching. (USFWS, 2012)
- Protect all populations against disturbances from feral ungulates. (USFWS, 2012)
- Resurvey the historical range of the species to search for additional populations or individuals. (USFWS, 2012)
- Monitor each population at least twice yearly for evidence of disease or mortality. (USFWS, 2012)
- Carry out field studies to determine the pollinators associated with the species. (USFWS, 2012)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2012)
- Work with the Hawaii Division of Forestry and Wildlife, and other land managers to continue implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2012)

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SPECIES ACCOUNT: *Cyrtandra viridiflora* (Ha`iwale)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

Cyrtandra viridiflora is a member of the Gesneriaceae (African violet family). It is a short-lived perennial shrub 0.5 to 2 m (1.6 to 6.6 ft) tall. The stems are branched and leaves are sparse. Leaves are opposite, heart-shaped, 6 to 15 cm (2.4 to 5.9 in) long and 3.5 to 7.5 cm (1.4 to 3.0 in) wide. One to five green flowers form open cymes that originate from the leaf axils. The fruit is a white berry 1.3 cm (0.5 in) long. Information on the seeds is lacking. This species is distinguished from others in the genus by the leaves, which are thick, fleshy, heart-shaped, and densely hairy on both surfaces (Wagner et al. 1999).

Taxonomy

Genus found from Southeast Asia through Western and Central Pacific Basin, species endemic to Koolau mts. of Oahu. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Historically, *Cyrtandra viridiflora* was known from scattered occurrences in the Koolau Mountains on the island of Oahu. There are approximately nine occurrences of *C. viridiflora* with a total of 69 individuals found at: Kahuku Cabin (5 individuals), Kawainui and Koloa (8), Opaeha and Helemano (45), Helemano (1), Kaukonahua-Waikakaloa (1), Kaalalea (6), Kaluanui-Maakua Ridge (1), Maakua-Kaipapau Ridge (1), and Puu Kaaumakua (1) (HINHP Database 2001). The occurrences are restricted to the northern Koolau Mountains and range from Kawainui and Koloa to Kaalalea (HINHP Database 2001, K. Kawelo, U.S. Army, pers. comm. 2003; J. Lau, HINHP, pers. comm. 2003). *Cyrtandra viridiflora* populations are declining, and those that remain are small and widely dispersed (U.S. Army 2003a).

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyrtandra viridiflora* (Ha`iwale) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Cyrtandra viridiflora* (77 FR 57648-57862). The critical habitat designation includes 14 critical habitat units, which encompass approximately 30,056 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Cyrtandra viridiflora* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Cyrtandra viridiflora* includes 14 critical habitat units, covering two ecosystem types, which encompass approximately 30,056 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; Oahu—Wet Cliff—Units 6, 7, 8.

Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Haula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikeekee, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet—Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet—Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu—Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 ac (246 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamo Ridge.

Oahu—Wet Cliff—Unit 6 [151 ac (61 ha)]. This area consists of 151 ac (61 ha) in the wet cliff ecosystem on State land on the windward side of the Koolau Mountains in Kaipapau Gulch,

entirely within the Kaipapau Forest Reserve. Oahu—Wet Cliff—Unit 7 [144 ac (58 ha)]. This area consists of 144 ac (58 ha) in the wet cliff ecosystem in State land on the windward side of the Koolau Mountains in Hauula Gulch, entirely within the Hauula Forest Reserve. Oahu—Wet Cliff—Unit 8 [4,649 ac (1,881 ha)]. This area consists of 1,479 ac (598 ha) of State land, 1,281 ac (519 ha) of City and County of Honolulu land, 5 ac (2 ha) of Federal land, and 1,884 ac (762 ha) of privately owned land, in the wet cliff ecosystem along the summit of the Koolau Mountains, overlapping portions of Sacred Falls State Park, the Waiahole FR (Waiahole and Iolekaa sections), the Kaneohe and Honolulu Watershed FRs, and the Nuuanu Pali State Wayside.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyrtandra viridiflora* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Cyrtandra viridiflora* occurs within the Lowland wet and Wet cliff ecosystems in the Koolau Mountain caldera complex:

Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (E) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Oahu—Wet Cliff—Units 6, 7, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: >65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. (E) Understory: Bryophytes, Ferns, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Cyrtandra viridiflora* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: *C. viridiflora* has been observed in flower and fruit from May through November. Little else is known about its flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors (Service 1998a).

Habitat Type

Adult: Wet shrublands/wet forest

Habitat Narrative

Adult: *Cyrtandra viridiflora* is usually found on wind-blown ridge tops in cloud-covered wet forest or shrubland at elevations between 443 and 867 m (1,453 and 2,844 ft). Associated native plant species include *Broussaisia arguta*, *Cheirodendron platyphyllum*, *Dicranopteris linearis*, *Diplopterygium pinnatum*, *Dubautia* sp., *Freycinetia arborea*, *Hedyotis* sp., *Ilex anomala*, *Machaerina* sp., *Melicope* sp., *Metrosideros polymorpha*, *Metrosideros rugosa*, *Psychotria* sp., *Syzygium sandwicensis*, or *Trematolobelia macrostachys* (HINHP Database 2001; Wagner et al. 1999).

Dispersal/Migration***Population Information and Trends*****Number of Populations:**

Nine

Population Size:

69

Population Narrative:

There are approximately nine occurrences of *C. viridiflora* with a total of 69 individuals found at: Kahuku Cabin (5 individuals), Kawainui and Koloa (8), Opaepa and Heleman (45), Heleman (1), Kaukonahua-Waikakaloa (1), Kaalalea (6), Kaluanui-Maakua Ridge (1), Maakua-Kaipapau Ridge (1), and Puu Kaaumakua (1) (HINHP Database 2001). The occurrences are restricted to the northern Koolau Mountains and range from Kawainui and Koloa to Kaalalea (HINHP Database 2001, K. Kawelo, U.S. Army, pers. comm. 2003; J. Lau, HINHP, pers. comm. 2003). *Cyrtandra viridiflora* populations are declining, and those that remain are small and widely dispersed (U.S. Army 2003a).

Threats and Stressors**Stressor:****Exposure:****Response:****Consequence:**

Narrative: The major threats to *Cyrtandra viridiflora* are habitat degradation or destruction by feral pigs, impacts from military activities, predation by rats and slugs, competition with the non-native plant species, and risk of extinction from naturally occurring stochastic events and/or reduced reproductive vigor due to the small number of remaining occurrences and individuals. The nonnative plant species that threaten *C. viridiflora* include such species as *Clidemia hirta* and *Psidium cattleianum*, which alter its habitat and competing with it for nutrients, light, and space. The types of stochastic events most likely to affect *C. viridiflora* are landslides, hurricanes, or flooding (HINHP Database 2001; Service 1998a; 61 FR 53089).

Recovery***Conservation Measures and Best Management Practices:***

- A State-wide management plan should be developed and implemented for the long-term conservation of all known occurrences of *Cyrtandra viridiflora*. This plan should also include broader landscape actions that are needed for the recovery of this plant throughout its range. The recovery plan for this species identifies the following important conservation actions. Where feasible, fences should be constructed around the known occurrences of *C. viridiflora* to reduce impacts from feral pigs. In locations where fencing is not feasible due to topography or potential damage to sensitive summit habitats, pigs should be controlled or removed from the broader landscape to alleviate impacts on native ecosystem and promote survival of naturally germinating seedlings of *C. viridiflora*. Non-native plants should be controlled or removed in the vicinity of all known occurrences of *C. viridiflora*. Rats are a serious threat to *C. viridiflora*, and they should be controlled in the vicinity of all known plant occurrences, using currently approved rodenticides, and across the broader landscape using aerial dispersal of approved rodenticides (Service 1998a). Ongoing Conservation Actions: *Cyrtandra viridiflora* is in genetic storage at the Lyon Arboretum (Service 2002). The Service is currently not aware of any other conservation efforts for this species.

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SPECIES ACCOUNT: *Cyrtandra wagneri* (Ha`iwale)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/29/2013; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Cyrtandra wagneri (haiwale), a shrub or small tree in the African violet family (Gesneriaceae), occurs only on the island of Hawaii (Lorence and Perlman 2007, p. 357). (USFWS, 2013)

Historical Range

See current range/distribution.

Current Range

Known only from Hawaii Island, North Hilo District, in the Laupahoehoe Natural Area Reserve along the Kilau stream and Kaiwilahilahi stream (Lorence and Perlman 2007). (NatureServe, 2015)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Found in moderate to dense shade in wet forests (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 823 and 869 meters (NatureServe, 2015)

Environmental Specificity

Adult: Medium, with some key requirements (NatureServe, 2015)

Habitat Narrative

Adult: Steep slopes of stream banks at 823-869 m elevation, rooting in rocky brown clay soil substrate, in moderate to dense shade of wet forest dominated by *Acacia koa* and *Metrosideros polymorpha* (Lorence and Perlman 2007). (NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2013)

Redundancy:

Very low (inferred from USFWS, 2013)

Number of Populations:

2 (USFWS, 2013)

Population Size:

~10 (USFWS, 2013)

Population Narrative:

In 2002, there were 2 known occurrences totaling fewer than 175 individuals in the Laupahoehoe NAR: One occurrence (totaling 150 individuals (50 adults and 100 juveniles)) along the steep banks of the Kilau Stream (Lorence et al. 2002, in litt.; Perlman and Perry 2003, in litt.; Lorence and Perlman 2007, p. 359), and a second occurrence (with approximately 10 sterile individuals) along the slopes of the Kaiwilahilahi stream banks (Lorence and Perlman 2007, p. 359). Currently, there are no individuals remaining at Kaiwilahilahi Stream, and the individuals at Kilau Stream appear to be hybridizing with the endangered *Cyrtandra tintinnabula*. Biologists have identified only eight individuals at Kilau Stream that express the true phenotype of *Cyrtandra wagneri*, and only three of these individuals are reproducing successfully (PEPP 2010, p. 102; Bio 2011, pers. comm.). (USFWS, 2013)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs), nonnative plants, hurricanes, heavy rain, and erosion. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Hurricanes adversely impact

native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Heavy rain and erosion destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, rats, and slugs) is considered an ongoing threat to *Cyrtandra wagneri* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor: Small populations and hybridization (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: *Cyrtandra wagneri* faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). The only known occurrences are threatened either by landslides, rockfalls, inundation by high surf, or erosion, or a combination of these, because of their locations in lowland wet, montane wet, coastal, and dry cliff ecosystems. Hybridization is also a threat because hybridization may lead to extinction of the original genotypically distinct species. *C. wagneri* is reported to hybridize with *C. tintinnabula*. Only eight individuals express the true phenotype of *C. wagneri*, and only three of these individuals are reproducing successfully (USFWS, 2013).

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor:

Exposure:
Response:
Consequence:
Narrative:

Recovery

Reclassification Criteria:
Not available.

Delisting Criteria:
Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

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Final Rule. 78 Federal Register 209, October 29, 2013. Pages 64638 - 64690.

SPECIES ACCOUNT: *Cyrtandra waiolani* (Ha`iwale)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/18/2012; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

A shrub 1-2 m tall. Leaves are covered with shaggy hairs. Flowers are white, and borne 1-2 per inflorescence. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Endemic to Koolau mountains of Oahu. (NatureServe, 2015)

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On September 18, 2012, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cyrtandra waiolani* (Ha`iwale) under the Endangered Species Act of 1973, as amended (Act) (77 FR 57648-57862). The critical habitat designation includes 11 critical habitat units, which encompass approximately 25,112 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Cyrtandra waiolani* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Cyrtandra waiolani* includes 11 critical habitat units, covering one ecosystem type, which encompasses approximately 25,112 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16.

Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Haula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikeekee, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and

7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet— Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet— Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu— Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamoa Ridge.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cyrtandra waiolani* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Cyrtandra waiolani* was known historically (last observed > 20 yrs ago) from the indicated ecosystem in the Koolau Mountain caldera complex (Note: This species may no longer occur in the wild):

Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (E) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Cyrtandra waiolani* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats

will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Wet forests (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Found in partly sunny gulches; shady, moist banks above creeks; and wet gulch bottoms in lowland wet ecosystems (USFWS, 2012)

Geographic or Habitat Restraints or Barriers

Adult: Historically found at elevations between 800 and 3,000 feet (USFWS, 2012)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 2012)

Habitat Narrative

Adult: *Cyrtandra waiolani* (haiwale), a small shrub in the African violet family (Gesneriaceae), is found in rich, partly sunny gulches; shady, moist banks above creeks; and wet gulch bottoms in the lowland wet ecosystem (Wagner et al. 1999, p. 781; HBMP 2008; Lau 2011, in litt.). *Cyrtandra waiolani* was historically known from at least seven locations: five in the southern Koolau Mountains and two in the northern Koolau Mountains, at elevations between 800 and 3,000 ft (240 and 900 m) (HBMP 2008). (USFWS, 2012)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

None (NatureServe, 2015)

Representation:

None (NatureServe, 2015)

Redundancy:

None (NatureServe, 2015)

Number of Populations:

0 (NatureServe, 2015)

Population Size:

0 (NatureServe, 2015)

Population Narrative:

This species was last collected in 1943. There are no current and 7 historical occurrences. Individuals likely representing *Cyrtandra waiolani*, based on vegetative characteristics, were seen in 1994 along the ridge between Kaipapau and Maakua, and in 2005 in Kahana, but these plants are no longer alive" (J. Lau, in litt. 2009 cited by USFWS 2011). It is thought that the species may be rediscovered with more intensive survey (Bakutis 2008; J. Lau, in litt. 2009 cited by USFWS 2011). (NatureServe, 2015)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative plants and animals (pigs). The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The projected effects of climate change will likely exacerbate the effects of the other threats to the species (USFWS, 2012).

Stressor: Predation and herbivory (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, goats, and slugs) is considered an ongoing threat to *Cyrtandra waiolani* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2012).

Stressor: Small populations (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: *Cyrtandra waiolani* faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). The last confirmed observation of *C. waiolani* in the wild was approximately 40 years ago. The identification of a possible wild individual of *C. waiolani* in 2005 was confirmed not to be this species. In addition, there are no tissues, propagules, or seeds in storage or propagation that have positively been identified (USFWS, 2012).

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

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Endangered Status for 23 Species on Oahu and Designation of Critical Habitat for 124 Species. 77 Federal Register 181. September 18, 2012. Pages 57648 - 57862.

USFWS. 2012. Endangered Status for 23 Species on Oahu and Designation of Critical Habitat for 124 Species

Final Rule. 77 Federal Register 181, September 18, 2012. Pages 57648 - 57862.

SPECIES ACCOUNT: *Dalea carthagenensis floridana* (Florida Prairie-clover)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/6/2017; Southeast Region (R4)

Physical Description

Dalea carthagenensis var. *floridana* is a short-lived (less than 8 years) perennial shrub that is 2.6 to 9.8 ft (0.8 to 3.0 m) tall with a light brown woody stem and non-woody, light brown or reddish branches. The leaves are composed of 9 to 15 oval, gland-tipped leaflets, and are gland-dotted on the underside. The flowers are in small loose heads at ends of hairy, glandular stalks, less than 0.4 in long. The flower color is white and maroon; each of the petals is different lengths and shapes. The fruit is a small one-seeded pod, mostly enclosed by the hairy, gland-dotted calyx (bracts at base of each flower). (USFWS, 2017)

Taxonomy

Chapman (1886, p.102) was the first to report this taxon in Florida, calling it the tropical *Dalea domingensis*, based on specimens collected on Key Biscayne. Small (1913, p. 89) accepted this epithet but included the taxon in the genus *Parosela*, making the plant *P. domingensis*. Rydberg (1920, p. 114) renamed the plant, calling it *Parosela floridana*, which was retained by Small (1933, pp. 694-695). Clausen (1946a, p. 85) reviewed the taxonomy of Florida and West Indian *Dalea* and considered them all to be the same species. Clausen (1946a, p. 85) also found that the name *D. domingensis* was a homonym of *D. emphysodes*, and published the name *D. emphysodes* ssp. *domingensis*. Clausen (1946b, p. 572) later discovered that his use of the name *D. emphysodes* was in error, and renamed the plants *D. carthagenensis* ssp. *domingensis*. Long and Lakela (1971, p. 478) accepted this usage. Barneby (1977), in a monograph of the genus, also found that Florida plants were distinct from West Indian plants, citing differences in leaf characters, naming the Florida species *D. carthagenensis* var. *floridana*. Wunderlin (1998) has followed this treatment.(USFWS, 2017)

Historical Range

The historical range of *Dalea carthagenensis* var. *floridana* includes Miami-Dade, Monroe, Collier, and Palm Beach Counties in Florida (USFWS, 2017).

Current Range

In Florida, the current range of *Dalea carthagenensis* var. *floridana* includes Big Cypress National Park (Monroe and Collier Counties), three Miami-Dade County conservation areas, and three additional unprotected lands within the Cutler Bay region of Miami-Dade County. (USFWS ,2017)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, perennial (USFWS, 2017)

Lifespan

Adult: Less than 8 years (USFWS, 2017)

Reproduction Narrative

Adult: *Dalea carthagenensis* var. *floridana* appears to be a short-lived (less than 8 years) perennial with a persistent seed bank (Maschinski et al. 2014, p. 45; Lange et al. 2016, p.15). *D. carthagenensis* var. *floridana* produces flowers from October to March and fruit ripen from November to April. The seed maturation period is January to May, with a peak in February and March. Larger plants can produce over 500 seeds. Seedling recruitment varies widely from year to year, with lower recruitment in drier years. Seedlings and juveniles experience rapid growth in their first 2 years. (USFWS, 2017)

Habitat Type

Adult: Pine rockland, rockland hammock, marl prairie, and coastal berm, and in the ecotones between these habitats (USFWS, 2017)

Habitat Vegetation or Surface Water Classification

Adult: Forest/Woodland, Woodland-Conifer

Dependencies on Specific Environmental Elements

Adult: Periodic fire is extremely important to maintaining habitat for this species. (USFWS, 2017)

Tolerance Ranges/Thresholds

Adult: The plants can stand partial inundation with fresh water for a portion of the year, but do not tolerate salinity. (USFWS, 2017)

Habitat Narrative

Adult: *Dalea carthagenensis* var. *floridana* grows in pine rockland, rockland hammock, marl prairie, and coastal berm, and in the ecotones between these habitats. It occurs in sparsely vegetated, well-lit, open areas that are maintained by disturbance. The dynamic nature of the habitat means that areas not currently open may become open in the future as a result of canopy disruption from hurricanes or invasive plant management, while areas currently open may develop more dense canopy over time, eventually rendering that portion of the hammock unsuitable for *D. carthagenensis* var. *floridana*. The species may also occur along roadsides within these habitats. The climate of south Florida where *Dalea carthagenensis* var. *floridana* occurs is classified as tropical savanna. (USFWS, 2017)

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Declining; habitat loss continues to occur in the species' range. (USFWS, 2017)

Species Trends:

Declining (USFWS, 2017)

Number of Populations:

9 extant occurrences

Population Size:

Approximately 1000 individuals in 9 populations, ranged from a few to approximately 400 plants per population (USFWS, 2017)

Population Narrative:

The extant populations occur in the Big Cypress National Park (Monroe and Collier Counties, Florida), in several conservation areas in Miami-Dade County (R. Hardy Matheson Preserve, Charles Deering Estate, Virginia Key, and Crandon Park) , and on three additional unprotected lands within the Cutler Bay region of Miami-Dade County. (USFWS, 2017)

Threats and Stressors

Stressor: Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Habitat loss, fragmentation and degradation, and associated pressures from increased human population are major threats this species. These threats are expected to increase as remaining pine rocklands and other habitats are lost to development, placing these plants at greater risk. This species may be impacted when pine rocklands are converted to other uses or when lack of fire causes the conversion to hardwood hammocks or other unsuitable habitats. On public lands, including National Park Service lands and Miami-Dade County-owned lands, implementation of prescribed fire has not been sufficient because of legal constraints (permitting requirements) and inadequate funding. Any populations of this species found on private property could be destroyed due to development. Although efforts are being made to conserve natural areas and apply prescribed fire, most pine rocklands remain in poor fire condition, and the long-term effects of large-scale and wide-ranging habitat modification, destruction, and curtailment will last into the future, while ongoing habitat loss due to population growth, development, and agricultural conversion continues to pose a threat to this species outside of conservation lands. (USFWS, 2017)

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: This species is found on Federal, State and County lands. NPS regulations provide protection at Everglades National Park and Big Cypress National Preserve. These two sites continue to support the largest and best managed populations. State regulations provide protection against trade, but allow private landowners or their agents to clear or remove species on the Florida Regulated Plant Index. State Park regulations provide protection for plants within Florida State Parks. The Natural Forest Communities program in Miami is designed to protect rare and important upland (non-wetlands) habitats in south Florida; however, this regulatory

strategy has several limitations that reduce its ability to protect this plant and its habitat. Although many populations of this species are afforded some level of protection because they are on public conservation lands, especially Federal lands, existing regulatory mechanisms vary in strength and scope, and do not provide substantive protection of habitat at this time. They have not led to a sufficient reduction of threats posed to these plants by a wide array of sources. (USFWS, 2017)

Stressor: Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Threats from other natural or manmade factors to this species include nonnative, invasive plants; management practices (such as mowing); recreation (including off-road vehicle use), effects from small population size and isolation; limited geographic range; and stochastic events including hurricanes, storm surges, and wildfires. Additionally, this plant is particularly vulnerable to the effects of climate change, including sea level rise, as changes in the water table, increased soil salinity from partial inundation, and storm surge will likely result in vegetation shifts in the decades prior to the fully anticipated sea level rise. Some of these threats (e.g., nonnative species) may be reduced on public lands due to active programs by Federal, State, and County land managers. Many of the remaining populations of this plant are small and geographically isolated, and genetic variability is likely low, increasing the inherent risk due to overall low resilience of these plants. The threats act together to impact populations of this species. (USFWS, 2017)

Stressor: Disease or predation (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Scale insects (Coccoidea) and *Cassytha filiformis* (love vine, a parasitic plant) infestations have been noted as parasites for *Dalea carthagenensis* var. *floridana* (Maschinski et al. 2015, p. 39) and may also influence populations of other listed pine rockland plant species. However, the best available data do not indicate that disease or predation is a threat to *Sideroxylon reclinatum* ssp. *austrofloridense*, *Digitaria pauciflora*, *Chamaesyce deltoidea* ssp. *pinetorum*, or *Dalea carthagenensis* var. *floridana*. (USFWS, 2017)

Recovery

Reclassification Criteria:

Not defined.

Delisting Criteria:

Not defined.

Recovery Actions:

- Not defined.

Conservation Measures and Best Management Practices:

- Conserve pine rocklands and suitable habitat through purchase or conservation easements.

- Restore understories by removing exotic plants or hardwoods.
- Provide regular prescribed burns to sites to maintain suitable habitat conditions.
- Monitor and manage the remaining small populations in Miami-Dade County.
- Consider and conduct augmentation and reintroduction, at suitable sites (Maschinski et al. 2005, p. 165).
- Conduct additional surveys in the Big Cypress region, including Florida Panther National Wildlife Refuge.
- Monitor known populations.
- Investigate ways to increase population viability.
- Study the introduced insect lobate lac scale to determine the extent of this threat and identify any necessary actions.
- Conduct studies to determine current level of genetic variation remaining in extant occurrences.
- Research presence and longevity of seed banks in different habitats.

References

USFWS. 2017. Endangered Species Status for *Dalea carthagenensis* var. *floridana* (Florida Prairie-clover), and Threatened Species Status for *Sideroxylon reclinatum* ssp. *austrofloridense* (Everglades Bully), *Digitaria pauciflora* (Florida Pineland Crabgrass), and *Chamaesyce deltoidea* ssp. *pinetorum* (Pineland Sandmat). Final Rule. 82 FR 46691-46715 (October 6, 2017).

USFWS. 2017. Endangered Species Status for *Dalea carthagenensis* var. *floridana* (Florida Prairie-clover), and Threatened Species Status for *Sideroxylon reclinatum* ssp. *austrofloridense* (Everglades Bully), *Digitaria pauciflora* (Florida Pineland Crabgrass), and *Chamaesyce deltoidea* ssp. *pinetorum* (Pineland Sandmat). Final Rule. 82 FR 46691-46715 (October 6, 2017).

USFWS 2013. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for *Dalea carthagenensis floridana* (Florida Prairie-clover). U.S. Fish and Wildlife Service, Region 4 (Southeast Region), March 26, 2013

SPECIES ACCOUNT: *Dalea foliosa* (Leafy prairie-clover)

Species Taxonomic and Listing Information

Listing Status: Endangered; 5/1/1991; Southeast Region (R4) (USFWS, 2015)

Physical Description

A stout perennial herb, 2-8 dm tall, with several stems arising from a hardened root crown. Dense spikes of small purple flowers appear most abundantly from late July to early August, but may continue to bloom sporadically into September. (NatureServe, 2015)

Taxonomy

Dalea foliosa, a member of the legume family or Fabaceae, was first described as *Petalostemon foliosus* by Asa Gray in 1868 (Gray 1868). The generic name *Petalostemon* A. Michaux, first published in 1803, has been conserved over the earlier *Kuhnistera* Lamarck of 1789, with the spelling of *Petalostemon* also conserved over the original *Petalostemon* (Greuter et al. 1988, Farr et al. 1979). Because the gender of *Petalostemon* is neuter, the correct name of leafy prairie-clover under this genus is *Petalostemon foliosus* A. Gray (USFWS, 1996).

Historical Range

The distributional center for *Dalea foliosa* is the limestone cedar glades of central Tennessee and northern Alabama, where the species is considered nearly endemic (Baskin and Baskin 1973) (USFWS, 1996).

Current Range

Mesic dolomite river-terrace prairies of northeastern Illinois, Middle Tennessee Limestone Glades, northern Alabama Limestone Glades. In Tennessee, occurs on only 13 USGS 7.5' quads in seven counties of the Central Basin. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, autogamy (USFWS, 2015)

Lifespan

Adult: 8 years (USFWS, 1996)

Dependency on Other Individuals or Species

Adult: *Bombus* spp. based on closely related species (EPA, 2016)

Breeding Season

Adult: July - August (EPA, 2016)

Key Resources Needed for Breeding

Adult: Insect pollinators (EPA, 2016); moist soil (USFWS, 1996)

Reproduction Narrative

Adult: Produces flowers July to August; seeds ripen by early October. Bumblebees, small bees, syrphid flies have been observed visiting flowers. Bombus species are probably required for successful seed set (based on other species in the same genus). Emergence occurs in March for existing plants. Seeds germinate in April and have several leaves by May (EPA, 2016). Molano-Flores (2005) determined that Dalea foliosa is self-compatible and that self-pollination (i.e., autogamy) can occur in this species, despite the fact that it is protandrous (USFWS, 2015). Dalea foliosa is short-lived and has no capacity for vegetative spread (Baskin and Baskin 1973; Schwegman and Glass, unpublished data). Plants may take up to 3 years to flower under field conditions (Baskin and Baskin 1989). Adequate soil moisture is critical for seedling establishment. The oldest living plants monitored to date have reached 8 years (n=2) and 7 years (n=2) of age (Schwegman and Glass, unpublished data). Mature plants may not flower every year (USFWS, 1996).

Habitat Type

Adult: Terrestrial, riverine, palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Spring, herbaceous wetland, riparian, barrens, grassland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Full sun, periodic fire (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 550-700 ft. elevation (EPA, 2016)

Environmental Specificity

Adult: Moderate (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Occurs in Tennessee and Alabama in open, thin-soiled limestone glades and limestone barrens. In Tennessee, the plants occur on wet calcareous barrens and moist prairies or cedar glades, usually near a stream or where some seepage from limestone provides seasonal moisture. Associates in these habitats are rose-pink (Sabatia angularis), and black-eyed Susan (Rudbeckia triloba). The species is disjunct in Illinois, where it is restricted to thin-soiled (< 4.5 dm), wet or moist, open dolomite prairies on river terraces in the northeastern part of the state. The plants require full sun and low competition for optimum growth and reproduction; periodic fire is needed to maintain these conditions. (NatureServe, 2015). Occurs in shallow silt to silty clay loams over flat, often fractured horizontally bedded limestone or dolomite at 550-700 ft. elevation.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seeds are dispersed by wind, gravity, small mammals, and birds. Seeds are dispersed from late fall to early spring

Population Information and Trends**Population Trends:**

> 45% decline (NatureServe, 2015)

Species Trends:

Stable to declining (USFWS, 2015)

Number of Populations:

21 - 80 (NatureServe, 2015)

Population Size:

Unknown (NatureServe, 2015)

Adaptability:

Low (inferred from NatureServe, 2015)

Population Narrative:

This species has declined by over 45% from historical occurrences due to the destruction of habitat, overgrazing, and habitat loss from encroachment by woody plants (Thompson et al. 2006). There are approximately 60 extant occurrences presently recorded, but about 25 occurrences are of poor or very poor quality. There are currently known extant occurrences in 3 states: 50 in Tennessee, 4 in Alabama, and 8 in Illinois. In Tennessee, only 10 occurrences are ranked as good or excellent (EO data in the NatureServe central database as of February 2012). The Tennessee records occur on only 13 USGS 7.5' quads in 7 counties of the Central Basin. Long-term survival is fair to poor unless more sites can be maintained with mowing or ecological burning (NatureServe, 2015). The species status is stable in IL and TN; monitoring data from these states display substantial interannual variability in total numbers of plants as well as for multiple life history stages. The species has declined in Alabama, where only two extant populations are known to exist. Low levels of genetic variation were documented in this species by Edwards et al. (2004) (USFWS 2015).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Nonetheless, several of the threats to *Dalea foliosa* habitat identified in the recovery plan still have the potential to affect this species even in protected sites, namely, degradation due to invasive exotic or native species encroachment, illegal outdoor recreational vehicle (ORV) use, and incompatible management of utility rights-of-way. Despite its protected status a relatively large population was essentially lost to habitat destruction at the Sneed Road Cedar

Glade DSN site in Tennessee, which at the time was a Registered Natural Area owned by The Nature Conservancy. This site was severely impacted in 2001, apparently by activities associated with development of adjacent property that resulted in placement of fill material on areas where *Dalea foliosa* occurred. This population contained an estimated 300 or more plants in 1980, but had declined to 53 plants in 2000, despite removal of the fill material, and only 6 plants were observed there in 2003 (TDEC 2005a). Barbers and Wilhelm (2005) noted that the population at the Dellwood Park West site is periodically inundated by floodwater from the adjacent Illinois and Michigan Canal, which poses a threat to this population and to habitat restoration efforts at this site (USFWS, 2015).

Stressor: Succession (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: The main threat to protected sites comes from the potential for either exotic or native, invasive plant species to displace *Dalea foliosa* from otherwise suitable habitat. Through the process of vegetation succession in the absence of disturbance (e.g., fire), native herbaceous and woody species also can pose a threat. Prescribed fire is used to manage most of the sites where Illinois populations occur on public lands. Efforts to develop a fire management program for lands managed by TDEC have met limited success, owing to insufficient funding, staff turnover, and challenges associated with burning in the urban interface (USFWS, 2015).

Stressor: Herbivory (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: The recovery plan (Service 1996) identified intense livestock grazing and selective browsing by eastern cotton-tail rabbits (*Sylvilagus floridanus*) and white-tailed deer (*Odocoileus virginianus*) as threats to *D. foliosa*. Molano-Flores (2004) observed herbivory at the Midewin NTP in 2002, with little evidence of recovery of affected plants during that growing season. McNicoll and Sivicek (2005) recorded evidence of damage caused by browsing animals in approximately 21 percent of the adult plants they counted at Keepataw Forest Preserve in 2005, and 483 of the 607 plants at Romeoville Prairie Nature Preserve in 2005 were impacted by herbivory (Key 2005). Taft et al. (2010) reported herbivory affecting 31.3 percent of adult plants at Keepataw Forest Preserve in 2010, which had increased from 12.5 percent in 2009. Because of the threat of browsing to seedlings, cages were used to protect at least a portion of the seedlings at each site where plantings occurred in 2008 as part of a project to reintroduce or augment populations (Redmer and Lah 2008) (USFWS, 2015).

Stressor: Small, isolated populations (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Edwards et al. (2004) found populations of *Dalea foliosa* "...were quite genetically depauperate" and that the isolated populations in Alabama and Illinois contained only a subset of the variation found in Tennessee populations. Measures of both polymorphism and expected heterozygosity were lower than reported averages for other endemic plant species (Hamrick and Godt 1989 in Edwards et al. 2004). Population sizes tend to be small throughout the range of *D.*

foliosa, which combined with spatial isolation could result in genetic drift exerting a dominant influence on population genetic structure. Increased incidence of inbreeding also is a risk associated with small populations, which can lead to a loss of fitness (i.e., inbreeding depression). These factors combined place many *D. foliosa* populations at a potentially heightened risk of localized extinction (Barrett and Kohn 1991). The ability of populations to adapt to environmental change is dependent upon genetic variation, a property of populations that derives from its members possessing different forms (i.e., alleles) of the same gene (Primack 1998). Small populations occurring in isolation on the landscape can lose genetic variation due to the potentially strong influence of genetic drift, i.e., the random change in allele frequency from generation to generation (Barrett and Kohn 1991). Smaller populations experience greater changes in allele frequency due to drift than do larger populations (Allendorf and Luikart 2007). Loss of genetic variation due to genetic drift heightens susceptibility of small populations to adverse genetic effects, including inbreeding depression and loss of evolutionary flexibility (Primack 1998) (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Both the final rule listing *Dalea foliosa* as endangered (Service 1991) and the recovery plan (Service 1996) identify drought as a threat to populations of this species. The recovery plan points out that the species possesses some life history traits (e.g., formation of persistent banks, dormancy response to drought) that enhance its resilience to this threat. However, threats associated with small population sizes and diminished genetic variation could combine with increased drought severity to diminish the species' resilience to this threat over time, leading to substantial declines through the cumulative loss of small, isolated populations. In the face of accelerated climate change, it is imperative that effective monitoring programs are instituted throughout the range of the species in order to track trends in the face of potentially more severe (i.e., frequent, intense, or prolonged) drought conditions. In a study using count data of seedlings/juveniles, non-flowering adults, and flowering adults from Midewin NTP, all stages and total annual census were positively correlated with snowfall. Flowering plants negatively correlated with fall days below 0 °C, seedlings negatively correlated with mean February temperature, and non-flowering adults positively correlated with September precipitation (Molano-Flores and Bell 2012). When the authors incorporated predicted effects of climate change, using projections for mean February temperature and September precipitation in September, into regression models, the majority of the climate models predicted that population size would decrease from the mean population size of 188 plants from 1997-2008 (Molano-Flores and Bell 2012). This provides further evidence to suggest that climate change presents an increased risk of extinction for *Dalea foliosa*, especially for smaller populations and those with reduced genetic variation, which could limit potential for adapting to changing conditions (USFWS, 2015).

Recovery

Reclassification Criteria:

1. A minimum of three populations ranked as high viability are protected and managed in Alabama for a minimum of 5 years. (USFWS, 1996)

2. A minimum of three populations ranked as high viability are protected and managed in Illinois for a minimum of 5 years. (USFWS, 1996)

3. A minimum of twelve populations ranked as high viability are protected and managed in Tennessee. (USFWS, 1996)

4. Restored populations persist at high or moderate viability for a minimum of 10 consecutive years. (USFWS, 1996)

Delisting Criteria:

1. A minimum of three populations ranked as high viability are protected and managed in Alabama for 10 years (USFWS, 1996).

2. A minimum of three populations ranked as high viability are protected and managed in Illinois for 10 years (USFWS, 1996).

3. A minimum of twelve populations ranked as high viability are protected and managed in Tennessee. (USFWS, 1996)

4. Restored populations persist at high or moderate viability for a minimum of 10 consecutive years (USFWS, 1996).

Recovery Actions:

- Identify and prioritize protection, management, and restoration needs for all high- and moderate-viability populations (and low-viability populations with recovery potential for each geographic region in order to achieve the recovery criteria. Of the 21 known or presumed extant leafy prairie-clover populations only 2 (10 percent) rank as high viability, 7 (33 percent) rank as moderate viability, and 12 (57 percent) rank as low viability. To meet the recovery criteria established in this plan, recovery activities need to be implemented for at least 18 (86 percent) populations. This includes all nine populations of high and moderate viability, at least five populations of low viability with recovery potential, and an estimated four new populations. One or more recovery actions can increase a population from a low or moderate viability to a high viability. Key management needs or threats are identified for all critical sites by geographic region below and are summarized in Table 10 of the Recovery Plan. More detailed site recommendations are also provided. (USFWS, 1996)
- Initiate and complete preserve design and implement the protection and management required to meet recovery criteria. Develop preserve designs. Implement protection. Develop management plans. (USFWS, 1996)
- Develop and implement population monitoring programs. A monitoring program should be designed to gauge the status of naturally occurring populations over a period of time and to evaluate the status of population recovery and restoration actions. By relating the data to changing environmental or management conditions, the monitoring program will help determine if and what management or recovery actions are needed for population maintenance. Populations can be monitored by tracking the total census count and by using sampling or demographic data and should at least include accurate mapping of locations (patches). Demographic monitoring is most important in the initial stages of population restoration. Tracking of individual survivorship, reproductive status, and recruitment will help determine if and how these variables are related to changes in successional stage,

management actions, or environmental stochasticity (sensu Shaffer 1981); e.g., drought. At a minimum, monitoring data for all populations should include growth stage (seedling, juvenile, mature, or dormant), flowering frequency, rate of herbivory, number of flowering and/or fruiting ramets per plant, and observations of general vigor. Reproductive potential and seed output can also be estimated. (USFWS, 1996)

- Conduct research needed to enhance recovery efforts. (USFWS, 1996)
- Develop materials to inform the public about the status of the species and the recovery plan objectives. Public support for the conservation of leafy prairie-clover could greatly encourage landowner assistance in conservation efforts. However, informational material should not identify the plant's precise locations in order to discourage vandalism to, or collection of, wild populations. (USFWS, 1996)
- Recommendations for Future Actions from 2015 5-Year Review: A. The Service should coordinate with Drs. Brenda Molano-Flores (pers. comm. 2008) and Tim Bell on their efforts to develop a population viability analysis for *D. foliosa* across its entire range. If this effort were successful across the species range, it could be used in conjunction with the existing PVI to provide a better estimation of the extinction risk faced by individual populations and the species as a whole. (USFWS, 2015)
- Recommendations for Future Actions from 2015 5-Year Review: B. Increase frequency of monitoring in Tennessee and Alabama populations, and standardize methods throughout the species' range, as feasible. Feasibility is a constraint in Tennessee, owing to the large number of populations and the fact that TDEC is the only agency currently monitoring this species at most sites in the state. The Service should work with TDEC to increase capacity by participating in monitoring activities. (USFWS, 2015)
- Recommendations for Future Actions from 2015 5-Year Review: C. Increase use of prescribed fire, or other techniques, for maintaining open conditions with limited competing vegetation in areas with sufficient soil depth to support *D. foliosa*. (USFWS, 2015)
- Recommendations for Future Actions from 2015 5-Year Review: D. Determine the number of populations that are represented by element occurrences throughout the range of *D. foliosa*. This is of highest priority in Tennessee, where multiple occurrences within a single protected area are often tracked as distinct entities. This is especially relevant when calculating PVI values for populations, as aggregating multiple occurrences into what are believed to be biological populations could have the effect of increasing the population size, and in turn the calculated PVI for those populations. It appears that the only circumstance in Illinois where such a determination might be warranted is the case of the two "populations" at the Waterfall Glen Preserve in DuPage County (Appendix B), which might be more appropriately treated as a single population for recovery purposes. Most of the Alabama occurrences appear to be separated by sufficient distance to warrant treatment as separate populations. (USFWS, 2015)
- Recommendations for Future Actions from 2015 5-Year Review: E. Continue efforts to reintroduce/augment Illinois populations. (USFWS, 2015)
- Recommendations for Future Actions from 2015 5-Year Review: F. Collect data to calculate a current PVI for each protected population, in order to evaluate the species' status with respect to recovery criteria. (USFWS, 2015)

Conservation Measures and Best Management Practices:

- The Service should coordinate with Drs. Brenda Molano-Flores (pers. comm. 2008) and Tim Bell on their efforts to develop a population viability analysis for *D. foliosa* across its entire range. If this

effort were successful across the species range, it could be used in conjunction with the existing PVI to provide a better estimation of the extinction risk faced by individual populations and the species as a whole (USFWS, 2015).

- Increase frequency of monitoring in Tennessee and Alabama populations, and standardize methods throughout the species' range, as feasible. Feasibility is a constraint in Tennessee, owing to the large number of populations and the fact that TDEC is the only agency currently monitoring this species at most sites in the state. The Service should work with TDEC to increase capacity by participating in monitoring activities (USFWS, 2015).
- Increase use of prescribed fire, or other techniques, for maintaining open conditions with limited competing vegetation in areas with sufficient soil depth to support *D. foliosa* (USFWS, 2015).
- Determine the number of populations that are represented by element occurrences throughout the range of *D. foliosa*. This is of highest priority in Tennessee, where multiple occurrences within a single protected area are often tracked as distinct entities. This is especially relevant when calculating PVI values for populations, as aggregating multiple occurrences into what are believed to be biological populations could have the effect of increasing the population size, and in turn the calculated PVI for those populations. It appears that the only circumstance in Illinois where such a determination might be warranted is the case of the two "populations" at the Waterfall Glen Preserve in DuPage County (Appendix B), which might be more appropriately treated as a single population for recovery purposes. Most of the Alabama occurrences appear to be separated by sufficient distance to warrant treatment as separate populations (USFWS, 2015).
- Continue efforts to reintroduce/augment Illinois populations (USFWS, 2015).
- Collect data to calculate a current PVI for each protected population, in order to evaluate the species' status with respect to recovery criteria (USFWS, 2015).

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SPECIES ACCOUNT: *Daphnopsis hellerana* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 6/23/1988; Southeast Region (R4) (USFWS, 2015)

Physical Description

A dioecious shrub or small tree, which may reach 6 meters in height and 5 centimeters in diameter. The leaves are simple, alternate, elliptic to obovate in shape, and blunt or rounded at the apex. The leaves may reach 3 to 13 centimeters in length and 1.5 to 6 centimeters in width. Side veins are prominent and curved. The upper surface of the leaves is hairless and green but dries to a reddish—brown color. Both leaves and twigs are golden hairy when young. Flower clusters are borne at the ends of young branches. Male flowers are small (.8 centimeter) long, tubular and finely golden hairy outside. They have four spreading lobes, four scale-like petals and eight stalkless stamens attached to the inside of the petals in two rings. The female flowers are smaller and the calyx is bell shaped, less than .5 centimeters long, golden hairy outside and hairless inside. The fruit is an elliptic, one—seeded, white berry that is less than 2 centimeters long (Vivaldi and Woodbury 1981b, Little et al. 1974) (USFWS, 1992).

Taxonomy

The nomenclatural name of *D. hellerana* was published in the final rule. However, the correct name should have been published as *Daphnopsis helleriana*. The Service intends to correct this nomenclature in 50 CFR 17.12 (USFWS, 2013).

Historical Range

Known from only four locations in Puerto Rico, to the west of the San Juan metropolitan area: the hills near Quebradillas/Isabela; the hills of Rio Lajas; the Nevarez hills; and near the National Institute of Health facility near Sabana Seca. A total of approximately 125 individuals are known from these sites. (USFWS, 1992)

Current Range

At present, *D. helleriana* is found in the municipalities of Isabela/Quebradillas, Arecibo, Vega Baja, Dorado, and Toa Baja. Introduced individuals, are located in Guajataca, Río Abajo, and Cambalache Commonwealth Forests (USFWS, 2013).

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (inferred from USFWS, 1992)

Breeding Season

Adult: February - April (USFWS, 1992)

Reproduction Narrative

Adult: It has been observed in flower between February and April and has been collected in fruit as well. Little information is available on the ratio of female to male plants; however, the abundant seedlings which have been observed in two of the four population sites are evidence of successful pollination and production of viable seeds (USFWS, 1992).

Habitat Type

Adult: Terrestrial (USFWS, 1992)

Habitat Vegetation or Surface Water Classification

Adult: Semi-evergreen and evergreen seasonal forests (USFWS, 1992)

Geographic or Habitat Restraints or Barriers

Adult: ~100 to 350 m elevation (USFWS, 1992)

Habitat Narrative

Adult: All populations of *Daphnopsis hellerana* occur in the semi-evergreen and evergreen seasonal forests of the limestone hills of northern Puerto Rico at elevations which range from 100 to 350 meters. *Daphnopsis hellerana* is restricted to the limestone region of the island. Soils in the limestone hill sites are shallow, well-drained, alkaline and interspersed between outcrops of hard limestone (USFWS, 1992).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Stable (USFWS, 2013)

Population Size:

~1,029 (USFWS, 2013)

Population Narrative:

The species status is stable; when *D. helleriana* was listed in 1988, only 14 plants were known from two localities (Toa Baja and Dorado). Additional information compiled in the office suggests that approximately 500 individuals occur at seven locations throughout northern Puerto Rico (i.e., Dorado, Toa Baja, Isabela/Quebradillas, Arecibo/Utuado, and Vega Baja). Only 1,029 individuals (33%) remain undisturbed in their natural localities (USFWS, 2013).

Threats and Stressors

Stressor: Urban development (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: The majority of the natural populations of *D. helleriana* occur in areas under high pressure for urban development and expansion. Residential, tourist and commercial development projects (e.g., landfills, construction of dwellings and roads, and limestone quarrying) threaten this species. In the expansion of Highway PR-10 from Ponce to Arecibo, a project of the Puerto Rico Highway and Transportation Authority (PRHTA), the goal was to minimize adverse effects to *D. helleriana* and to several other species that occur in the area. Even though the extensive efforts were made to conserve and protect *D. helleriana*, the relocation of the individuals was only 38% successful, resulting in the loss of more than seven hundred individuals. The PRHTA is currently planning the expansion of the Highway PR-22 from Hatillo to Aguadilla. The preferred proposed route is located south of one of the existing populations of *D. helleriana* in Isabela, where adverse effects are not anticipated on the species. However, if the PRHTA changes the preferred route, other alternative routes may affect the species restricting its habitat or eliminating the northern population of Isabela (USFWS, 2013).

Stressor: Low reproduction potential (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: *Daphnopsis helleriana* is a dioecious plant (i.e., male and female flowers are born in different plants). This entails that a self-sustainable population needs to have both female and male specimens for them to reproduce. The best available information does not give us a good picture on demographic features of this plant. However, the low numbers in the currently known natural populations give us an indication that the populations are at risk. In addition, the low numbers may result in adverse effects in reproduction and genetic diversity, which may result in single sex individuals. This could be very significant because it may eliminate the population's ability to continue reproducing. In addition, with respect to the relocation of individuals to other suitable locations, this poses a risk that particular genotypes of each population may be lost due to the specific characteristics of that habitat (USFWS, 2013).

Recovery**Reclassification Criteria:**

Not available

Delisting Criteria:

1. Areas of privately owned populations are given protected status (USFWS, 2013).
2. At least three new self-sustaining populations in Commonwealth Forest units such as Vega Alta, Cambalache, or Guajataca Forests have been established (USFWS, 2013).

Recovery Actions:

- Monitor existing populations (USFWS, 1992).
- Protect privately-owned populations at sites (USFWS, 1992).
- Conduct research on the life history of the species and evaluate methods of propagation (USFWS, 1992).

- Propagate and produce seedlings and saplings for enhancement of existing populations and the establishment of new ones (USFWS, 1992).

Conservation Measures and Best Management Practices:

- The recovery plan should be revised to establish measurable delisting criteria as new information is learned on this plant. The Service, in cooperation with the PRDNER and academia, needs to determine how many individuals constitute a self-sustainable population (USFWS, 2013).
- Efforts to protect privately-owned populations should be conducted. Private-lands initiatives (such as Partners for Fish and Wildlife and Coastal Program) are needed to further protect the areas where *D. helleriana* is known to occur naturally (USFWS, 2013).
- Foster a working partnership with regulatory agencies to address and minimize potential adverse effects of development projects on the species and its habitat (USFWS, 2013).
- Surveys are needed to have a better demographic perspective of the population (USFWS, 2013).
- Obtain information regarding pollination, seed dispersal, and population genetics for the *D. Helleriana* (USFWS, 2013).

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SPECIES ACCOUNT: *Deeringothamnus pulchellus* (Beautiful pawpaw)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/27/1986; Southeast Region (R4)

Physical Description

The beautiful pawpaw is a low-growing, diminutive shrub of the Annonaceae family rarely exceeding 0.5 m in height. The stems may be annual or perennial and arise from a stout taproot that averages 32.5 cm long and is about 2.5 cm wide at its widest point. The leaves are alternate, leathery, deciduous, and 4.0-7.0 cm long with slightly revolute (curving under) margins. The leaf shape is oblong to oblong-ovate or spatulate, with a rounded or notched end. The base of the leaf is rounded or tapering to a 2.0-4.0 mm long petiole. Young leaves have sparse, short, red hairs on both sides. Maturing leaves become dark green to glossy green above and paler green below. The flowers of this species occur singly in leaf axils and have between 6 and 10 creamy-white petals that are about 2.0-3.0 cm long. The fruits are fleshy, smooth and yellow-green when ripe and are 4.0-7.0 cm long. The seeds are dark brown and from 1.0-1.5 cm long. (USFWS, 1999)

Taxonomy

The species was first named and described by John K. Small as the only species belonging to the genus *Deeringothamnus* and separated from the genus *Asimina* by its "dimorphous stamens, the flat or depressed receptacle, and the narrow nearly uniform unsculptured petals" (Small 1924). Rehder and Dayton (1944) discussed placing the species in the genus *Asimina*. Because the use of the combination *Asimina pulchella* did not meet nomenclatural rules, they retained the *Deeringothamnus pulchellus* name. A subsequent treatment of taxonomy is consistent with that of Small (Kral 1960). However, Ward (2001) suggested that, due to the presence of forms that appear to be intermediates between *D. pulchellus* and its congener *D. rugelii*, they should be treated as a single species and varieties should be used to distinguish the two forms. According to Ward's (2001) assessment, beautiful pawpaw should be named *D. rugelii* var. *pulchellus*. The scientific community has not fully embraced this taxonomic change, and Ward also now considers them as two separate species (Norman 2003, 2008). The Integrated Taxonomic Information System (2009) does not indicate any formal changes to the name *D. pulchellus*. (USFWS, 2009)

Historical Range

Historically occurred on poorly drained sands of slash and longleaf pine- saw palmetto flatwoods in Lee and Charlotte Counties in southwestern Florida and was also found in Orange County east of Orlando. (USFWS, 2009)

Current Range

In Florida, in Charlotte, Lee, and Orange Counties. (USFWS, 2009)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources**Reproduction Narrative**

Adult: Research on the beautiful pawpaw has been conducted in the areas of phenology, pollination, reproductive structures, breeding system, germination, and hybridization (Norman 2003). Available information suggests that this species has poor fertilization, seed-setting, germination, and recruitment rates. Pollinators for this species are few, but those noted are a tumbling beetle (*Mordella atrata*) and two species of thrips (*Frankliniella bispinosa* and *Thrips hawaiiensis*) (Norman 2003). The reproductive biology of the species is not thoroughly understood, but the plant is thought to reproduce entirely by seed. Gopher tortoises (*Gopherus polyphemus*) may be an important seed disperser. Although not investigated in detail, ingestion of the seeds by gopher tortoises or other herbivores may be important for seed germination. However, seeds have been germinated without this type of treatment. On Pine Island, Lee County, plants begin flowering by mid-March and are at the peak of flowering the last week of April. Likewise, flowering was observed in Orange County in mid-March and lasted for 6 weeks (Norman 2003). Fruit is likely produced and dispersed during the summer. Because the species is thought to be long-lived, reproductive success is not critical every year (Service 1999). Other than follow-up monitoring during the first year after transplant of three transplanted populations, no long-term estimates of survival have been obtained for the species (Service 1998; Preston et al. 2004). No follow-up data have been collected. Additionally, no information has been reported on survival of individuals in natural occurrences, and life history stage and population structure data have not been collected. Limited experiments with seed collected from Orange County reported very low seedling survival, suggesting that the species may rely on a mycorrhizal fungal association to promote seedling survival (Norman 2009).

Habitat Narrative

Adult: The species occurs in two disjunct locations in central and southwest Florida. It grows in xeric, mesic, and hydric pine flatwoods in western Charlotte and Lee counties and eastern Orange County. Soils in these habitats are poorly drained, although slight elevations provide better drainage than surrounding soils that are wetter. In Lee County, the pawpaw exists on Pine Island, where it occurs in pristine and modified flatwoods, on road edges, and on mowed lots. In Charlotte County it is found in an area broadly known as the Charlotte Harbor flatwoods and includes sites along State Road 765 and FWC's Cecil M. Webb Wildlife Management Area.

Dispersal/Migration***Population Information and Trends*****Number of Populations:**

Three

Population Size:

~5,000

Population Narrative:

Surveys have been conducted intermittently in the past, but trend data are difficult to assess because surveys have generally only assessed a few occurrences at any one time and new occurrences have been discovered. Based upon the most comprehensive data available, there

are currently thought to be approximately 5,000 pawpaw plants (FNAI 2008). The number of plants ranges from 1 to 2 plants on some sites to over 1,000 individuals on 3 sites (FNAI 2008). Nearly one-third of the occurrences were comprised of 15 or fewer pawpaws (FNAI 2008).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Continued habitat loss, fragmentation, and changes in land use threaten the existence of beautiful pawpaw. Where plants occur on private sites, development has led to both direct destruction of habitat as a result of land clearing and habitat degradation from lack of management. One of the occurrences in Orange County has been extirpated (FNAI 2008). The property where this occurrence was reported was located adjacent to houses, the site was overgrown with Brazilian pepper (*Schinus terebinthifolius*), and trash was deposited in the area (FNAI 2008). It is likely that the plants were either crushed by debris or the habitat degraded to the point of being unsuitable for the species. (USFWS, 2009)

Stressor: Inadequacy of existing regulatory mechanisms

Exposure:

Response:

Consequence:

Narrative: The ESA provides protection for this species and its habitat through section 7. The beautiful pawpaw is also listed by the Florida Department of Agriculture and Consumer Services (FDACS) as endangered (5B-40.0055 Regulated Plant Index), but this legislation does not provide any direct habitat protection. Existing Federal regulations prohibit the removal or destruction of listed plant species on Federal lands. State regulations require both written permission from the owner or legal representative and a permit issued by FDACS to collect or remove plants listed as endangered on the Florida Regulated Plant Index. However, these regulations afford no protection to listed plants on private lands. Lee County offers some protection for the beautiful pawpaw through a listed species ordinance which requires mitigation for adverse effects to State and federally listed species (Lee County 1998). However, this ordinance does not apply to agricultural lands or those being re-zoned for agriculture, and part of the threat of habitat loss where pawpaws occur is a result of clearing for agricultural purposes. In some situations, existing regulatory mechanisms do not appear to be adequate, as several private properties with pawpaws have been developed. Because this plant occurs in habitat which is desirable real estate for development along the southwestern coast and inland near Orlando, this species remains vulnerable to development pressures where it occurs on private property. (USFWS, 2009)

Stressor: Inadequate fire or land management (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: This species occurs in pine flatwoods habitat, which is typically maintained by fire. This species is adapted to live in pine flatwoods habitat where frequent ground fires are not hot enough to kill mature pine trees but do remove or thin understory vegetation and reduce competition with larger grasses and shrubs. During the first growing season after fire, the

beautiful pawpaw takes advantage of newly-created openings by flowering and setting fruit (Service 1999). Therefore, land management practices such as prescribed fire are very important to maintaining and working towards recovery of the beautiful pawpaw. - Lack of management is a concern on some protected sites. Vegetation restoration and management programs are costly, and the availability of resources is never assured; therefore, habitat degradation and modification from inadequate management even on protected lands remains an imminent, though moderate, threat. - On many privately owned sites, fire has historically been suppressed, and habitat has not received regular maintenance. Where this species occurs on fragmented landscapes interspersed with development, burning may be unlikely due to proximity to neighbors. In areas that cannot be readily burned, mowing is sometimes used as a management strategy. In mowed habitat, the growth habit of this species is more prostrate with woody stems lying on the ground, while in fire-maintained habitat, it grows more erect with arching stems. (USFWS, 2009)

Stressor: Invasive plant species (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: In the absence of site maintenance, a threat to pawpaws is the establishment of invasive plant species such as Brazilian pepper, melaleuca (*Melaleuca quinquenervia*), and earleaf acacia (*Acacia auriculiformis*). However, herbicides used to control overgrowth, if not properly applied, also may pose a threat to the beautiful pawpaw. (USFWS, 2009)

Stressor: Natural events (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The species' limited distribution and its limited reproductive capacity also renders it vulnerable to random natural events, such as hurricanes and drought. However, Hurricane Charley crossed the northwest portion of the species' range in Lee and Charlotte Counties in 2004, and no apparent damage occurred to the beautiful pawpaws (Woodmansee and Barry 2007). During this hurricane, storm surge did not impact the occurrences but could in cases where storm surge is greater. The possibility of future hurricanes and tropical storms striking Florida is likely; this threat is expected to continue. . (USFWS, 2009)

Stressor: All-terrain vehicles and feral hogs (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: A threat identified when the species was listed was damage by all-terrain vehicles in at least a portion of the species' range. It is presumed that this threat continues on occurrence sites where access is not restricted. Feral hogs (*Sus scrofa*) may also pose a threat to beautiful pawpaw plants. (USFWS, 2009)

Recovery

Reclassification Criteria:

1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to ensure 20 to 90 percent probability of persistence for 100 years (USFWS, 1999)
2. When these sites, within the historic range of *D. pulchellus*, are adequately protected from further habitat loss, degradation, and fragmentation (USFWS, 1999)
3. When these sites are managed to maintain pine flatwoods to support *D. pulchellus* (USFWS, 1999)
4. When monitoring programs demonstrate that these sites support the appropriate numbers of self-sustaining populations, and those populations are stable throughout the historic range of the species (USFWS, 1999)

Delisting Criteria:

1. When at least 30 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (Factor A) (USFWS, 2019)
2. When populations (as defined in criterion 1) occur in pine flatwoods habitat distributed across the historical range of the species in order to maintain and enhance the species geographic patterns of genetic diversity. (Factor A) (USFWS, 2019)
3. When populations (as defined in criterion 1) must be protected via a conservation mechanism and managed such that enough suitable habitat is present for the species to remain viable for the foreseeable future. (Factors A, E) (USFWS, 2019)

Recovery Actions:

- 1. Determine current distribution of *D. pulchellus*. - Conduct surveys for *D. pulchellus*. - Maintain distribution of known populations and suitable habitat in GIS database. Use GIS to map existing populations and to assess the species' status and trends over time. The database should contain information on locations, population sizes, and status. This information should also be used for project review, in land acquisition activities, and to coordinate updates with the Florida Natural Areas Inventory database. (USFWS, 1999)
- 2. Protect and enhance existing populations. - Acquire or otherwise protect habitat through acquisition, conservation easements, or agreements with landowners. - Protect populations on public lands. Develop management guidelines that allow for a fire regime that includes a mosaic of successional stages. - Use local or regional planning to protect habitat. Utilize available regional and county planning processes to encourage protection of suitable unoccupied and habitat occupied habitat of *D. pulchellus*. Protecting this species on private property in Lee County is possible due to county ordinances that require conservation of listed plants. - Enforce available protective measures. Use local, State and Federal regulations to protect this species from overcollecting and damage from off-road vehicle use. Regulations should also be used to protect xeric vegetative communities where *D. pulchellus* lives. - Develop an ex situ collection. Ex situ collections are important for preserving genetic diversity, preventing extirpation, and determining ecological characteristics and habitat management needs of species. These collections will be instrumental in the recovery of *D. pulchellus*. Since longterm seed storage seems impossible for this species, cultivated populations are very important. Although *D. pulchellus* is not

easily grown from cuttings, young plants should be kept for study and reintroduction material. - Augment natural populations of *D. pulchellus*. (USFWS, 1999)

- 3. Conduct research on life history characteristics of *D. pulchellus*. - Conduct research to determine demographic information, such as numbers of sites and populations, numbers of individuals in a population, recruitment, dispersal, growth, survival, and mortality. Observations of the relation of flowering to fire, pollination, seed production, and seedling biology will help to guide reintroduction efforts. - Once demographic data are known, conduct population viability and risk assessment analysis to determine the numbers of plants, sites, subpopulations/populations, and spatial distribution needed to ensure persistence of the species. - Conduct research to assess management requirements of *D. pulchellus*. Determine which natural populations can be stabilized or increased by habitat management. Surveys, research, and monitoring information will provide factors contributing to any declines at each site. Monitoring of populations should be in reference to various habitat management practices. Site-specific management guidelines should be provided to land managers and close coordination among land managers is essential to develop adaptive management techniques. - Assess feasibility of relocating *D. pulchellus*. Removing plants threatened with destruction may be the only conservation strategy available in some situations. Information on transplant techniques and plant survival are needed to assess whether transplanting should be pursued. (USFWS, 1999)
- 4. Monitor existing populations of *D. pulchellus*. - Develop monitoring protocol to assess population trends for *D. pulchellus*. - Develop a quantitative description of the population structure of *D. pulchellus*. This description will provide a baseline for monitoring population dynamics in response to natural environmental changes and management treatments. Data recorded should include morphology, survivorship, mortality, and reproduction for individual plants. Data about each plant's microsite (vegetation cover, litter depth, substrate, and closest neighbors) may prove helpful in future management. - Monitor reintroduced plants. Monitoring of reintroduced plants will be essential for assessing the status of new plants and their contribution to the population as a whole. Compare adult survival, seed production, germination rates, seed survival, seedling survival, and growth rates between transplanted plants and natural plants. Where monitoring indicates that the introduction has been unsuccessful, reevaluate protocol and methodology. (USFWS, 1999)
- 5. Provide public information about *D. pulchellus*. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of *D. pulchellus* and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- 6. Establish delisting criteria. Once reclassification is achieved, research and monitoring results may provide data necessary to develop delisting criteria. (USFWS, 1999)
- Habitat-level Recovery Actions: Prevent degradation of existing habitat. Extensive habitat loss, degradation, and fragmentation have already occurred throughout the range of this species. Urbanization, fire suppression, and agricultural land uses have decreased the available habitat. - Restore areas to suitable habitat. Native habitats that have been disturbed or that have experienced a long history of fire suppression may be good candidates for future reserves. - Continue habitat-level research projects. Study the

response of *D. pulchellus* to various land management practices, such as prescribed fire regimes, vegetative thinning, and control of exotic/invasive vegetation. - Monitor habitat/ecological processes. Monitor the effects of land management actions, such as prescribed fire, mechanical disturbance, etc., on the habitats where *D. pulchellus* occurs. - Provide public information about pine flatwood vegetative communities and their unique biota. Educational efforts, especially those conducted by private conservation organizations, have been successful in providing important information about pine flatwood plant communities to the public. The State's system of biological preserves depends for its funding and future success on a broad base of public understanding and support. In addition to past and ongoing educational efforts by The Nature Conservancy, Bok Tower Gardens, and Archbold Biological Station, future efforts by these organizations, the Florida Park Service, the Florida Native Plant Society and local garden clubs will play crucial roles in increasing public appreciation of pine flatwood plant communities and *D. pulchellus*. (USFWS, 1999)

Conservation Measures and Best Management Practices:

- Management: • Continue management actions to include removal of hogs, debris, and exotic plants. Depending upon site, management efforts may include: licensed hunting or trapping of hogs, careful application of herbicides, controlling public access, and reintroduction of prescribed fire into the ecosystem. • Restore habitat in potential areas where plants could occur but are not currently reported, and provide follow-up surveys post-disturbance to determine if natural occurrences are present. • Identify additional reintroduction sites and establish reintroduced populations; augmentations should also be implemented. • Focus conservation efforts on marginal and small occurrences to preserve the genetic diversity of the species. (USFWS, 2009)
- Research: • Conduct research on the response of beautiful pawpaw to fire and fire prescriptions necessary to benefit the species. • Monitor burned and mowed sites to assess which technique is most beneficial to pawpaw reproduction and survival. • Continue research on the biology, ecology, genetics, and management needs of the species. • Conduct demographic studies to determine the age class structure and long-term viability of the species, especially in areas with active recruitment, and determine critical life stages. • Conduct genetic characterizations on occurrences, and apply this knowledge to future introductions and augmentations. • Continue to evaluate insect pollinators associated with the species over the long-term, and evaluate impacts to pollinators from aerial mosquito spraying. • Conduct seed germination studies and make efforts to develop additional outplanting techniques. • Continue propagation efforts and establish techniques for long-term germplasm storage; make sure all occurrences are represented in the Center for Plant Conservation's National Collection of Endangered Plants. • Evaluate the effects of climate change on the species, including those that result from precipitation pattern changes and temperature rise. (USFWS, 2009)
- Surveys: • Continue to survey potential habitat and pursue conservation agreements, implement management recommendations, and/or acquire land and investigate incentives to encourage land managers to manage pine flatwoods for ecosystem health and listed species. • Conduct additional surveys for beautiful pawpaw on all known (particularly Estero Bay Preserve State Park, Pine Island Flatwoods Preserve, and the newly acquired Babcock Ranch) and potentially suitable sites in the three counties of occurrence; provide updated information to FNAI for consistent tracking. • Continue monitoring both reintroduced and natural occurrences. (USFWS, 2009)
- Other: • Promote partnerships to share information, conduct collaborative research on pine flatwoods habitat conservation, and provide land managers and the interested public with

information about the ecosystem, threats, recovery actions, and associated rare biota. (USFWS, 2009)

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SPECIES ACCOUNT: *Deeringothamnus rugelii* (Rugel's pawpaw)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/27/1986; Southeast Region (R4)

Physical Description

A low, sparingly branched, scented shrub that grows from a stout taproot, rarely to 0.5 m tall. Leaves are alternate, erect, 1-7 cm long, oblong to oval in shape. Stems are arching or occasionally erect, seldom branched. Flowers are solitary in leaf axils with 9 yellow petals (NatureServe, 2015).

Taxonomy

Kartesz (1999) treats *Deeringothamnus pulchellus* and *D. rugelii* as distinct taxa. Ward (2001) treats *D. pulchellus* as a variety of *D. rugelii* (Novon 11(3): 360-365) (NatureServe, 2015).

Historical Range

D. rugelii is endemic to a small area of Volusia county (USFWS, 2018).

Current Range

D. rugelii is known to occur at Deep Creek Preserve, Longleaf Pine Preserve, Tiger Bay State Forest, Port Orange City Forest, Wiregrass Prairie Preserve, and Lake Monroe Conservation Area, which are all in Volusia County, FL (USFWS, 2018).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Lifespan

Adult: 1 - 2 years (above ground) (USFWS, 1988)

Breeding Season

Adult: Germinates in spring (USFWS, 2018)

Key Resources Needed for Breeding

Adult: Fire (USFWS, 1988)

Reproduction Narrative

Adult: Blooms in the spring (Small 1933) (NatureServe, 2015). The above-ground stems bear seed and fruit the first year after a fire, and appear to live for only one or two years (Wunderlin et al. 1981) (USFWS, 1988).

Habitat Type

Adult: Flatwoods with an open canopy of slash pine (*P. elliotii* var *densa*) or longleaf pine. This species also occurs in pastures and in road and utility rights-of-way (USFWS, 2018).

Habitat Vegetation or Surface Water Classification

Adult: Groundcover assemblages within the flatwood communities include wiregrass (*Aristida stricta*) and a diverse array of other herbaceous plants (USFWS, 2018).

Dependencies on Specific Environmental Elements

Adult: Periodic fire (NatureServe, 2015)

Environmental Specificity

Adult: High

Habitat Narrative

Adult: Rugel's pawpaw occurs in flatwoods with an open canopy of slash pine (*P. elliottii* var *densa*) or longleaf pine. This species also occurs in pastures and in road and utility rights-of-way. It is found in mesic and wet flatwood environments, though one occurrence is known to occur in disturbed conditions. Soils that support this species are often deep, fine textured, poorly drained sand or sandy peats (USFWS, 2018). Fires limit the growth of larger shrubs that would otherwise compete with this species (USFWS, 1998).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Stable (USFWS, 2018)

Species Trends:

Stable (USFWS, 2018)

Resiliency:

Very low (inferred from USFWS, 2008; see current range/distribution)

Redundancy:

Moderate (inferred from NatureServe, 2015)

Number of Populations:

9 (USFWS, 2018)

Population Size:

2,142-4,538 (USFWS, 2018)

Population Narrative:

Rugel's pawpaw has only occurred in a small area of Volusia County in northeastern peninsular Florida. From the time of its initial discovery through 1998, 25 occurrences of *D. rugelii* had been located within Volusia County. In 1998, the number of plants reported from previous surveys

among the known populations ranged from 2,142 to 4,538 individuals with 9 of the 25 occurrences including more than 100 plants. Many additional surveys were conducted since 1998 and as of 2017, there are 36 occurrences documented in Volusia County with 33 being natural occurrences. Eighteen occur on protected conservation lands and 15 occurrences on unprotected private lands or highway and utility rights-of-way. The introduced populations occur on two protected sites. When a separation distance between occurrences is used, 9 separate potential populations are evident. The species status is stable but range-wide surveys are needed to confirm presence on all sites and proper management of existing sites will provide long-term benefits to this species (USFWS, 2018).

Threats and Stressors

Stressor: Habitat degradation and destruction (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: The primary threat to this species is destruction and modification of habitat on private lands. Degradation of habitat resulting from a lack of adequate management on public and private lands remain a threat. Habitat loss and destruction from development is not a threat, degradation as a result of inadequate management is a concern. Additionally, elongated fire return frequencies and complete absence of periodic fire in some places has also led to habitat degradation (USFWS, 2018).

Recovery

Reclassification Criteria:

Ten (10) viable populations are established at secure sites (USFWS, 1988).

Delisting Criteria:

Twenty (20) viable populations are established at secure sites (USFWS, 1988).

Recovery Actions:

- Conduct a range-wide survey of all existing populations and historic sites where populations formally existed that have not been developed. For all populations occurring on conservation lands; document current abundance, population trends, demographic trends, and habitat suitability. Conduct a Population Viability Analysis (PVA) to help determine a minimum viable population number (USFWS, 2018).
- When surveying plants note any associations with caterpillars and collect insects for proper identification in order to better understand the relationship between the organisms (USFWS, 2018)
- Support further research on the effects of prescribed burning and other management tools on *D. rugelii*, its life history needs, and microhabitat requirements (USFWS, 2018).
- Support further research into population genetics to better understand basic biology of the species, genetic variation within and among populations and across landscape, and whether hybridization is occurring with related and co-occurring species (USFWS, 2018).
- Support further research into microbiome and whether specific microorganisms are associated with this species, which may serve to inform future introduction sites (USFWS, 2018).

- Continue collaboration with conservation land managers to increase habitat management and suitability of occupied habitat (USFWS, 2018).
- Collect habitat management activity information from conservation land managers to increase habitat management and suitability of occupied habitat (USFWS, 2018).
- Actively engage private landowners and public non-conservation land owners (e.g. roadside rights-of-way) to protect and increase management efforts to benefit occupied habitat (USFWS, 2018).
- Continue transplantings from threatened sites (USFWS, 2018).
- Conduct reintroductions and possibly augmentations on publically owned conservation lands with suitable habitat and develop best approaches for conducting introductions to assist in meeting recovery goals (USFWS, 2018).
- Develop a monitoring protocol that indicates frequency and timing for future consistency and long-term trend analysis (USFWS, 2018).
- Support continued work and research into ex situ cryopreservation to preserve cell lines of this species (USFWS, 2018).

Conservation Measures and Best Management Practices:

- Revise the current recovery plan to include more objective and measurable recovery criteria that are related to reducing threats identified in the recovery plan, as well as update information on the species distribution and biology (USFWS, 2008).
- Support further research on: a. The effects of prescribed burning and other management tools on *D. rugelii*. Continue working with public land managers to increase management efforts to benefit *D. rugelii* on their sites. B. Additional life history needs. C. The most appropriate methodology to germinate seeds or tissue cultures, grow seedlings, and successfully out-plant seedlings to native habitat (USFWS, 2008).
- Encourage non-Federal agencies to protect and manage habitat under the Partners for Fish and Wildlife Program (USFWS, 2008).
- Complete a rangewide survey to find all sites known to be occupied by or have the potential to be occupied by *D. rugelii* and determine population size. Current distribution information is needed to determine where plants currently exist and to prioritize recovery actions (USFWS, 2008).
- Consider reintroduction and monitoring of *D. rugelii* on additional publicly owned lands with suitable habitat. Reintroduction of *D. rugelii* could help to increase the number of populations on protected sites and augment populations where needed (USFWS, 2008).

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SPECIES ACCOUNT: *Deinandra (=Hemizonia) conjugens* (Otay tarplant)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/13/1998; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

Deinandra conjugens is an aromatic annual herb and has a branching stem that generally ranges from 5 to 25 centimeters (2 to 10 inches) in height with deep green or gray-green leaves covered with soft, shaggy hairs. Flower heads consist of 8-10 yellow ray flowers and 13-21 yellow disk flowers with black anthers. (USFWS, 2004; NatureServe, 2015)

Taxonomy

Deinandra conjugens was known as *Hemizonia conjugens* when it was originally listed as threatened (U.S. Fish and Wildlife Service 1998). Since then, studies analyzing plant and floral morphology and genetic information prompted Baldwin (1999) to revise the Madiinae (tarplants), a subtribe of the tribe Heliantheae in the Asteraceae (sunflower family), and segregate several taxa into new or different genera. As a result, *Deinandra conjugens* is now the accepted scientific name for *Hemizonia conjugens*. (USFWS, 2004)

Historical Range

Not available

Current Range

Restricted to a limited portion of southwestern San Diego County from Otay, south of San Diego, to the La Presa-Sweetwater Reservoir area ca. 8 mi ESE of San Diego, at 50-500 ft. Also collected 3 km southwest of La Presa, southeast of Tijuana, Baja, Mexico. (NatureServe, 2015)

Critical Habitat Designated

Yes; 12/10/2002.

Legal Description

On December 10, 2002, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Deinandra conjugens* (Otay tarplant) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in California (67 FR 76030-76053).

Critical Habitat Designation

The critical habitat designation for *Deinandra conjugens* includes two CHUs in San Diego County, California. This species critical habitat encompasses approximately 6,330 acres (ac) (2,560 hectares (ha)) (67 FR 76030-76053).

Unit 1: Sweetwater/Proctor Valley Unit: The Sweetwater/Proctor Valley Unit encompasses approximately 1,440 ha (3,560 ac) at the northeastern limit of this species' distribution. This unit is south and east of State Route 54, south and west of State Route 94, and north of Upper Otay Reservoir. It includes portions of the Otay/Sweetwater Unit of SDNWR; lands belonging to the Sweetwater Authority around the Sweetwater Reservoir; lands belonging to the Otay Water District; lands that are proposed as preserve under the draft City of Chula Vista Subarea Plan;

portions of two project areas within the draft City of Chula Vista Subarea Plan, but outside of the proposed preserve lands; and lands that are within major and minor amendment areas within the County of San Diego Subarea Plan. Two areas in this unit have not been designated as critical habitat, including the alignment for State Route 125 South and the San Diego County Park campground realignment and expansion, because these areas have been analyzed and determined not to be essential to the conservation of *Deinandra conjugens*. This unit contains several large populations of *Deinandra conjugens*, including a portion of the Rancho San Miguel population estimated to contain approximately 855,000 standing *Deinandra conjugens* plants during the 1995 and 1998 growing seasons (CNDDDB 2002; Merkel & Associates, in litt. 1999). A portion of the Proctor Valley population not covered under the approved San Diego County MSCP, which had approximately 10,000 standing plants in the 1990 growing season (CNDDDB 2002), is also included. This unit also contains an area on the north side of the Sweetwater Reservoir where reports indicate there are approximately 2,000 standing plants (Roberts 1997), and an area on the north portion of the SDNWR that had approximately 2,000 standing plants in 1993 (CNDDDB 2002). As discussed in the Changes From the Proposed Rule section of this final rule, portions of lands containing the approximately 28,000 plants in the Rolling Hills Ranch population (i.e., the MSCP Neutral areas and proposed Chula Vista Subarea Plan reserve within the Rolling Hills Ranch project), and portions of other project lands (e.g., Bella Lago, Eastlake Woods) have been retained in the final rule while other areas were excluded. This unit contains multiple large *Deinandra conjugens* populations that are capable of producing large numbers of individuals in good years, which is important for this species to survive through a variety of natural and environmental changes, as well as stochastic (random) events. This unit contains populations in the northern and eastern extent of this species' historical distribution, which is essential for its conservation. Peripheral populations may have genetic characteristics essential to overall longterm conservation of the species (i.e., they may be genetically different than more central populations) (Lesica and Allendorf 1995). The populations in this unit can likely maintain genetic connectivity within and among themselves, and they may maintain genetic connectivity with the Otay Valley/Big Murphy's Unit. Therefore, the populations in this unit are essential to the conservation of the species.

Unit 2: Chula Vista Unit The Chula Vista Unit encompasses approximately 210 ha (520 ac) at the western portion of this plant's range. Most of the populations in this unit are found in the remaining habitat patches along canyon edges that were not developed. This unit contains lands that are proposed as preserve under the draft City of Chula Vista Subarea Plan, lands that are in a minor amendment area under the County of San Diego's Subarea Plan, and lands that are in a minor amendment area under the draft City of Chula Vista Subarea Plan. This unit contains the Rice Canyon population, which had more than 50,000 standing plants in 1994 (CNDDDB 2002), and the Poggi Canyon population that had a reported 10,000 standing plants in 1990 (CNDDDB 2002). This unit contains populations in the western extent of this species' distribution, which although currently isolated from each other, may contain significant amounts of genetic diversity and are, therefore, essential to the conservation of the species.

Unit 3: Otay Valley/Big Murphy's Unit The Otay Valley/Big Murphy's Unit encompasses approximately 910 ha (2,250 ac). It is east of Interstate 805, north of the International Boundary between the United States and Mexico on the east side, north of State Route 905 on the west side, west of Otay Mountain, and along the north rim of Otay Valley including Salt Creek and Wolf Canyon. This unit includes lands owned by INS, lands that are proposed as preserve under the draft City of Chula Vista Subarea Plan, and lands that are in major and minor amendment areas in the County of San Diego Subarea Plan. Areas in this unit that are within the alignment for State Route 125 South have not been

designated as critical habitat because these areas have been analyzed and determined not to be essential. This unit contains several large populations of *Deinandra conjugens*, such as the Johnson Canyon population, estimated at approximately 480,000 individuals (Helix Environmental Planning, Inc. 2001), capable of producing large numbers of individuals in good years. These large populations are essential for this plant to survive through a variety of natural and environmental changes as well as stochastic events. The unit also contains the Otay River Valley population, which was reported to have approximately 4,000 standing plants (Roberts 1997), the Wolf Canyon population, which was reported to have approximately 4,000 standing plants (Roberts 1997), the Brown Field population, which had a reported 5,600 individuals in 1998 (U.S. Army Corps of Engineers 2000), and the upper Salt Creek population, which was reported to have over 1,000 standing plants (Roberts 1997). Unit 3 contains populations in the southern and eastern portions of this species' distribution that are essential to the conservation of the species. One population in this unit is located at the southwestern edge of this species' range in the United States. This population may have connectivity with *Deinandra conjugens* populations in northwestern Baja California, Mexico. Because of its connectivity, this population is essential to the conservation of the species. Based on the proposed preserve design for the draft City of Chula Vista Subarea Plan, and the designated preserve designs for the City and County of San Diego HCPs, these populations may all retain connectivity among themselves because the habitat mosaic does not have large gaps. The populations in this unit may also provide and receive pollen or seed from *Deinandra conjugens* populations in the Sweetwater/Proctor Valley Unit. This connectivity will facilitate gene flow within this unit and among other units which, in turn, may allow evolutionary processes that affect *Deinandra conjugens* to continue relatively unimpeded. Maintaining the *Deinandra conjugens* populations and their genetic connectivity (both within and among units) is essential to the conservation of this species. A *Deinandra conjugens* population north of Otay Valley and west of Otay Lakes is located within designated critical habitat. This population may provide important genetic connectivity between the Salt Creek and Otay Valley populations. Because this unit contains a number of large *Deinandra conjugens* populations, these populations will maintain genetic connectivity within and among themselves, they will maintain genetic connectivity with the Sweetwater/Proctor Valley Unit and possibly with plants in Mexico, therefore, the populations in this unit are essential to the conservation of the species.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Deinandra conjugens* critical habitat consists of one component (67 FR 76030-76053):

The primary constituent elements of critical habitat for *Deinandra conjugens* are those habitat components that are essential for the primary biological needs of the species. Based on our current knowledge of this species, the primary constituent elements for *Deinandra conjugens* consist of, but are not limited to, soils with a high clay content (generally greater than 25 percent) (or clay intrusions or lenses) that are associated with grasslands, open coastal sage scrub, or maritime succulent scrub communities between 25 m (80 ft) and 300 m (1,000 ft) elevation. These plant communities contain natural openings that provide habitat for *Deinandra conjugens* lifecycle, and pollen and seed dispersal agents.

Life History

Food/Nutrient Resources**Reproductive Strategy**

Adult: Sexual (NatureServe, 2015)

Lifespan

Adult: 1 year (USFWS, 2004)

Key Resources Needed for Breeding

Adult: Likely pollinators of *Deinandra conjugens* include, but are not limited to: bee flies (Bombyliidae), hover flies (Syrphidae), digger bees (Apidae), carpenter and cuckoo bees (Anthophoridae), leaf mason and leaf cutting bees (Megachilidae), and metallic bees (Halictidae) (Krombein et al. 1979; Bauder et al. 2002; M. Dodero, pers. comm. 2001). (USFWS, 2004)

Reproduction Narrative

Adult: *Deinandra conjugens* is a glandular, aromatic annual plant in the family Asteraceae. *D. conjugens*, like most other tarplants, is sporophytically self-incompatible (Keck 1959; B. Baldwin in litt. 2001). Likely pollinators of *Deinandra conjugens* include, but are not limited to: bee flies (Bombyliidae), hover flies (Syrphidae), digger bees (Apidae), carpenter and cuckoo bees (Anthophoridae), leaf mason and leaf cutting bees (Megachilidae), and metallic bees (Halictidae) (Krombein et al. 1979; Bauder et al. 2002; M. Dodero, pers. comm. 2001). (USFWS, 2004)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Shrubland/chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 25 and 300 m (80 to 1,000 ft) (USFWS, 2004)

Site Fidelity

Adult: Moderate (inferred USFWS, 2004)

Habitat Narrative

Adult: *Deinandra conjugens* is found in vegetation communities classified as, but not limited to grasslands, open coastal sage scrub, and maritime succulent scrub, as well as the margins of some disturbed sites and cultivated fields (U.S. Fish and Wildlife Service 2002 and references therein, including: Keck 1959; Keil 1993; California Native Plant Society 2001; California Natural Diversity Data Base 2002; D. Hogan in litt. 1990; B. Baldwin, pers. comm. 2001; M. Dodero, pers. comm. 2001; S. McMillan, pers. comm. 2001). The presence of *Deinandra conjugens* is strongly correlated with clay soils, subsoils, or lenses (Figure 2) (Beauchamp 1986, S. Morey in litt. 1994, Bauder et al. 2002). The elevational range for *D. conjugens* appears to be between 25 and 300 meters (80 and 1,000 feet) (U.S. Fish and Wildlife Service GIS database 2004). (USFWS, 2004)

Dispersal/Migration**Dispersal**

Adult: High (USFWS, 2004)

Dependency on Other Individuals or Species for Dispersal

Adult: Small to large-sized mammals and birds including mule deer, gray fox, coyote, black-tailed jackrabbit, bobcat, striped skunk, opossum, raccoon, California ground squirrel, and various small land birds. (USFWS, 2004)

Dispersal/Migration Narrative

Adult: *Deinandra conjugens* fruits (achenes) are each one-seeded and have the potential to be dispersed by small to large-sized mammals and birds based on the sticky nature of the remaining flower parts that are attached to the fruits and the discontinuous distribution of other tarplants (U.S. Fish and Wildlife Service 2002, and references therein). Potential seed/fruit dispersal organisms known to occur in the region include, but are not limited to, mule deer (*Odocoileus hemionus*), gray fox (*Urocyon cinereoargenteus*), coyote (*Canis latrans*), black-tailed jackrabbit (*Lepus californicus bennettii*), bobcat (*Felis rufus*), striped skunk (*Mephitis mephitis*), opossum (*Didelphis virginiana*), raccoon (*Procyon lotor*), California ground squirrel (*Spermophilus beecheyi*), and various small land birds. Additionally, in the late summer, dried *D. conjugens* plants may be blown by the wind (A. Davenport in litt. 2004) thereby moving seeds. (USFWS, 2004)

Population Information and Trends**Population Trends:**

Unknown

Resiliency:

Low (inferred from USFWS, 2004)

Representation:

Low (inferred from USFWS, 2004)

Redundancy:

Low (inferred from USFWS, 2004)

Number of Populations:

34 (USFWS, 2009)

Population Size:

~300,000 (USFWS, 2009)

Population Narrative:

There are currently 34 extant occurrences of *Deinandra conjugens*. At listing, it was estimated that as many as 300,000 plants might exist under favorable conditions. Given that *D. conjugens* is self-incompatible, difficulties withstanding changes in habitat or random events would be expected. (USFWS, 2004)

Threats and Stressors

Stressor: Loss and degradation of habitat (USFWS, 2004)

Exposure:

Response:

Consequence:

Narrative: As discussed in the final rule, the primary cause of the decline of *Deinandra conjugens* was the loss and degradation of occupied and suitable habitat, primarily due to urban development and agriculture, resulting in the fragmentation and isolation of remaining populations. Several populations of *Deinandra conjugens* are subject to impacts from off-road vehicle activity, even within conserved open space and within the San Diego National Wildlife Refuge. Although implementation of the MSCP requires that these effects be alleviated, this activity continues to threaten some populations. (USFWS, 2004)

Stressor: Habitat fragmentation/isolation (USFWS, 2004)

Exposure:

Response:

Consequence:

Narrative: Habitat loss and degradation often result in the fragmentation of remaining habitat patches and the isolation of habitat from the surrounding biological community. The result is disruption or impairment of processes within the biological community upon which *Deinandra conjugens* depends. Remnant patches of native vegetation become habitat islands and are subject to changes in their physical environment and microclimate that can disrupt or curtail their ability to function as suitable habitat. The effects of these changes may be modified by the size, shape and location of the remnant habitat in relation to the surrounding landscape. Fragmentation and isolation of native habitat can affect abiotic factors such as temperature, wind, erosion, and soil nutrients and cycling. For example, fragmentation can lead to changes in temperature; smaller remnants and edges of larger patches may experience higher air temperatures resulting from increased radiation. Higher temperatures may change nutrient cycling and soil microorganisms, and lower soil moisture. Such changes may affect germination and reproduction, and alter the plant community composition (Saunders et al. 1991). As remaining populations of *Deinandra conjugens* are further fragmented by surrounding urban development, the remaining patches of habitat will be more susceptible to changes that affect vegetation and animal communities. Changes in the diversity, distribution, and abundance of plants and animals could adversely affect *D. conjugens* directly or indirectly through changes in habitat suitability, disruption of plant/pollinator relationships, changes in seed dispersal, and demographic changes in extant populations. (USFWS, 2004)

Stressor: Non-native plant interactions (USFWS, 2004)

Exposure:

Response:

Consequence:

Narrative: Extant populations of *Deinandra conjugens* often occur in areas dominated by persistent weeds. Anecdotal field observations indicate that *D. conjugens* does not compete well in areas of dense invasive weeds (A. Davenport, pers. comm. 2003; S. McMillan, pers. comm. 2003). Invasive weeds and the associated buildup of thatch can have significant impacts on local populations of *D. conjugens* (M. Dodero, pers. comm. 2004). Greenhouse experiments with *D. conjugens* have documented significant reductions in plant biomass, plant height, extent of branching on individual plants, and flower production in plants grown in high densities of invasive weeds (Bauder et al. 2002). These factors can reduce successful reproduction and seed

set. The adverse effects of invasive weeds on *D. conjugens* may be greatest in years of abundant rainfall, resulting in depressed populations of *D. conjugens* when conditions would otherwise be most favorable for population growth (Bauder et al. 2002). (USFWS, 2004)

Stressor: Population dynamics (USFWS, 2004)

Exposure:

Response:

Consequence:

Narrative: As discussed under Life History and Ecology (section I.C above), *Deinandra conjugens* is an obligate out-crosser (i.e., is self-incompatible); individual plants exhibiting this trait will not set viable seed when pollinated by pollen from the same plant, and pollination between full siblings will result in significantly reduced fecundity and successful reproduction (e.g., DeMauro 1993). Consequently, cross pollination between unrelated individuals and annual seed set are essential for long-term population survival and recovery. Limited seed dispersal or cross pollination can result in populations with localized clusters of related individuals. Such situations in *D. conjugens* may significantly reduce compatible pollinations, resulting in lowered annual reproduction. A significant decline in a local population, coupled with other environmental and demographic factors and the extensive habitat/population fragmentation and isolation, could result in the complete extirpation of *Deinandra conjugens* from a reserve. It is unlikely that a locally extirpated and isolated population can be naturally recolonized from nearby sites through seed dispersal, especially if the sites are separated by urban development. The lack of connectivity between many extant populations of *D. conjugens* renders these populations susceptible to deterministic or stochastic extirpations (Gilpin and Soulé 1986, Lande 1988, Frankham and Ralls 1998), and increases the risk of species extinction. (USFWS, 2004)

Stressor: Genetics (USFWS, 2004)

Exposure:

Response:

Consequence:

Narrative: Genetic variation is positively correlated with population size and/or species range, and is inextricably linked to population viability and long-term species survival. Large populations occupying contiguous habitat, or ones that cover a large range, generally have higher levels of genetic diversity, while smaller populations, or species occurring within restricted ranges or on islands, have lower levels of genetic variation (Frankham et al. 2002). A reduction in population size, or permanent fragmentation of formerly contiguous populations can result in reduced genetic diversity. The current reserve design for *Deinandra conjugens* includes many fragmented populations surrounded by urban development. The level of genetic diversity across the range of the species, including diversity at the S locus, in *D. conjugens* is unknown; however, initial studies of two populations indicate that diversity is high (Bauder and Truesdale 2000). Maintenance of the genetic diversity and gene flow (through cross pollination and/or seed dispersal) between fragmented populations could be critical to long-term survival and recovery. Nevertheless, we anticipate that the remaining populations may lose varying (but currently unknown) levels of genetic diversity without active management. Completely isolated populations may experience adverse effects from increased genetic drift and inbreeding depression (lowered population growth, reduced fitness, and higher susceptibility to environmental catastrophes; Frankham et al. 2002). These effects can be accelerated in populations that experience repeated and dramatic fluctuations in population size (Hard 1995, Lande 1999), which has been observed in *D. conjugens*. (USFWS, 2004)

Stressor: Plant/pollinator interactions and ecology (USFWS, 2004)

Exposure:

Response:

Consequence:

Narrative: Due to the self-incompatible trait inherent in *Deinandra conjugens*, successful cross pollination between unrelated individuals is essential to the long-term survival of populations of the species. The impacts of fluctuating population size and increased population fragmentation and isolation can be further complicated through changes in plant/pollinator interactions. Habitat fragmentation and degradation can be deleterious to both native pollinators and to the plants that depend upon pollination service. Increased fragmentation and/or decreased patch (population) size can lead to a reduction in frequency of pollinator visits and pollinator diversity, and decrease seed set (Jennersten 1988). If the distance between habitat patches is greater than the foraging range of pollinators, or if pollinators ignore small plant populations or small habitat patches, reduction in pollination service may result. Individual plant size, patch (population) size, and/or plant density of the target species can also contribute to pollination limitation; isolated plants or patches may receive fewer pollinator visits and/or reduced deliverance of pollen from conspecifics versus foreign pollen (Kearns et al. 1998 and references therein). Non-native plant densities may also affect plant/pollinator interaction. Bauder et al. (2002) noted much lower visitation to *D. conjugens* by potential pollinators in an area dominated by non-native vegetation, as opposed to a patch growing in proximity to native scrub vegetation. Further, non-native vegetation may reduce the floral display of *D. conjugens*, thereby reducing their attractiveness to potential pollinators, and likely reducing seed set. Some native pollinators may not find suitable nest conditions within the clay soils that sustain populations of *D. conjugens*. Further, insect populations relying on nectar as a food resource generally require a suite of flowers available throughout the year. Consequently, maintenance of the surrounding native vegetation/habitats must be considered in recovery of *D. conjugens*. Additionally, not all insects that visit *D. conjugens* flowers may provide pollen transfer among individual plants. More research is needed regarding the specific pollinators of *D. conjugens* and their biology/ecology. (USFWS, 2004)

Recovery

Reclassification Criteria:

Reclassification criteria are not available.

Delisting Criteria:

1. Known populations (including naturally occurring seed banks) within areas identified for conservation under the MSCP are permanently protected from future development or other significant threats. (USFWS, 2004)
2. Permanent funding and management mechanisms that are required under the MSCP are in place and functioning. (USFWS, 2004)
3. Established reserves (i.e., MSCP preserve lands, land protected under other habitat conservation plans, National Wildlife Refuge lands, and State preserve lands) provide sufficient suitable habitats and space to sustain the full ecological needs of *Deinandra conjugens*. We expect these needs to include: a) connectivity to maintain natural gene flow among conserved

populations, and b) sufficient habitat to maintain wild populations of native *D. conjugens* pollinators. (USFWS, 2004)

4. Populations of *Deinandra conjugens* are stable or increasing within established reserves. As discussed by Rice (1989), seed banks typically are “more developed in annuals than in perennials” and “more extensive in forbs than in grasses.” For *D. conjugens*, an annual forb, population stability will depend on the long-term maintenance of the seed banks within each reserve. The primary factors that may threaten the long-term maintenance of *D. conjugens* and its seed banks include reduced or failed pollination (i.e., pollinators) and fruiting, excessive seed predation, loss of genetic variability and inbreeding, and impaired seed dispersal within and potentially among reserves. (USFWS, 2004)

5. Criteria 3 and 4 have been assessed through monitoring over an adequate length of time to incorporate year-to-year variability associated with known variations in climate (e.g., drought, El Niño/Southern Oscillation, etc.). We anticipate a period that encompasses three drought cycles; however, this time period may change should additional scientific information on the amount of time necessary to adequately determine the population trend of *Deinandra conjugens* indicate otherwise. If the species is delisted, the monitoring period will be extended for an additional 5 years after delisting, as required by the Endangered Species Act for species that are delisted due to recovery. (USFWS, 2004)

6. The current status (including a threats assessment) and distribution of *Deinandra conjugens* have been determined in Mexico.

7. Depending on the results from criterion 6, dialogue should be established with Mexican governmental and nongovernmental organizations to secure protection for *Deinandra conjugens* in Mexico. (USFWS, 2004)

8. Research on several critical aspects of the species’ biology and ecology, as detailed in the Recovery Narrative section, has been completed to adequately assess the above recovery criteria. Results should be published in readily available refereed journals. Results from this research may redirect the recovery strategy. (USFWS, 2004)

Recovery Actions:

- Stabilize and protect habitat supporting known populations within the conserved areas under MSCP control, outside of MSCP control, and in Mexico. (USFWS, 2004)
- Assess the status of all known populations to determine: population size (area and number of individuals), reproduction, distribution, threats to stability or viability, and land management objectives. (USFWS, 2004)
- Conduct surveys to search for new populations and implement actions to protect populations outside of established reserves when necessary to maintain genetic diversity and/or connectivity between larger reserves. (USFWS, 2004)
- Adaptively manage and monitor conserved areas. (USFWS, 2004)
- Identify research needs and conduct studies on the biology and ecology of *Deinandra conjugens*. (USFWS, 2004)
- Develop and implement a community outreach program. (USFWS, 2004)

Conservation Measures and Best Management Practices:

- Implement and fully fund a management plan for the MSCP Preserve that includes adequate provisions for management of invasive, nonnative plants. (USFWS, 2009)
- Encourage permit holders to complete the MSCP Preserve on private lands, to include the targeted *Deinandra conjugens* occurrences, by identifying opportunities through the Service's Partners Program. (USFWS, 2009)
- Develop, implement, and monitor effective invasive species management actions for all conserved occurrences of *Deinandra conjugens*. (USFWS, 2009)
- Reevaluate recovery criteria for this species to incorporate meaningful measures of the degree to which recovery has been achieved. (USFWS, 2009)
- Identify and monitor measures for indicating species status that are separable or insulated from natural annual population expressions. (USFWS, 2009)

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SPECIES ACCOUNT: *Deinandra increscens* ssp. *villosa* (Gaviota Tarplant)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/20/2000; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

Deinandra increscens ssp. *villosa* has pale to deep yellow disk and ray flowers. The foliage is variable gray-green and soft hairy. The plants generally range from 12 to 35 in (30 to 90 cm) tall with stems that generally branch near the base. The lower leaves are 2 to 3.4 in (5 to 8.6 cm) long. The inflorescence is typically rounded to flattopped with the flower heads in tight groups or paired. The peduncles are generally shorter than the involucre with mostly 13 ray flowers per head, but can vary between 8 and 15 ray flowers, and generally have 16 to 32 disk flowers per head (Baldwin 2009). Each flower head of *Deinandra increscens* ssp. *villosa* and other species in the family Asteraceae produce one-seeded fruits called achenes. (USFWS, 2011)

Taxonomy

Baldwin (2009) states “*Deinandra increscens* subsp. *villosa* differs from subsp. *increscens* in having more congested and, on average, shorter (generally < 45 cm tall) capitulescences, with phyllaries shorter than associated peduncles and peduncular bracts strongly overlapping the phyllaries, sometimes forming a distinct calyculus. Compared to *D. increscens* subsp. *increscens*, *D. increscens* subsp. *villosa* often has larger heads, which can reach the largest sizes in *D. increscens*, with up to 14 (–15) rays and up to 32 discs per head, but head size overlaps strongly with that of *D. increscens* subsp. *increscens*. *Deinandra increscens* subsp. *villosa* is known only from Santa Barbara County, mostly from the vicinity of Point Conception to Gaviota and north to the northern slopes of the western Santa Ynez Mountains”, with outlying populations at Point Arguello and a northern outlier at Lion’s Head (near Point Sal) (Baldwin 2009; Baldwin, pers. comm. 2010a, pers. comm. 2010b; Elvin 2010b). (USFWS, 2011)

Historical Range

Historically, *Deinandra increscens* ssp. *villosa* was originally known only from the immediate vicinity of the unincorporated town of Gaviota, with plants occurring up to several kilometers in either direction along the immediate coast. (USFWS, 2011)

Current Range

Currently, it has a highly localized distribution in western Santa Barbara County, California with seven main populations that range from the vicinity of Point Sal in the north to Gaviota in the south. (USFWS, 2011)

Critical Habitat Designated

Yes; 11/7/2002.

Legal Description

On November 7, 2002, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Deinandra increscens* ssp. *villosa* (Gaviota Tarplant) under the Endangered Species Act of 1973,

as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in California (67 FR 67968-68001).

Critical Habitat Designation

The critical habitat designation for *Deinandra increscens* ssp. *villosa* includes three CHUs in Santa Barbara County, California. This species critical habitat encompasses approximately 9,709 acres (67 FR 67968-68001).

Sudden Peak Unit: The Sudden Peak Unit consists of a 5- km (3-mi) stretch of ridgeline in the western portion of the Santa Ynez Mountains west of Sudden Peak, and generally includes grasslands above the 215-meter (700-foot) contour line. This unit is 320 ha (791 ac) and is comprised entirely of privately owned lands. Vandenberg Air Force Base holds an easement on a portion of these private lands. This unit includes two populations of *Deinandra increscens* ssp. *villosa* that comprised over 1,000 individuals in 1998. This unit is known to support populations away from the immediate coast and is at higher elevation than any other known *D. increscens* ssp. *villosa* location (425 m (1400 ft)). As a result, the populations in this unit experience more extreme seasonal temperatures and a lack of summer fog than most other populations which occur directly on the coast.

Santa Ynez Unit: The Santa Ynez Unit consists of a 9.7-km (6-mi) stretch of ridgeline of the Santa Ynez Mountains, ranging from Canada de las Agujas east to Canada del Agua Caliente. This unit of 433 ha (1,070 ac) is comprised entirely of privately owned lands. *Deinandra increscens* ssp. *villosa* occurs at 305 m (1,000 ft) in this unit, on the sandy mountain ridgelines. This unit supports two known populations of *D. increscens* ssp. *villosa* that comprised approximately 400 individuals in 1998. The terrain here differs from most other known locations in that it is characterized primarily by slopes that intergrade with flatter areas, rather than a flat marine terrace.

Conception-Gaviota Unit The Conception-Gaviota Unit consists of a 51.5-km (23-mi) long stretch of habitat along the coast from Point Conception, east to Gaviota, and encompasses 3,176 ha (7,848 ac). At its widest point, this unit extends inland approximately 3.2 km (2 mi). This unit is comprised almost entirely of privately owned lands (98 percent). This unit also consists of State lands at Gaviota State Beach and lands in the process of being transferred to CDFG for the Gaviota Tarplant Reserve (2 percent). This unit is particularly important because it supports most of the known populations of *Deinandra increscens* ssp. *villosa* that occur along the immediate coast. This includes the Gaviota population which was once extensive but is currently in decline, two small patches discovered in 1998 between Gaviota and Point Conception, and an extensive population discovered in 2000 that ranges from Government Point to the area near Jalama Beach County Park. Given these recent observations and the proximity to existing populations, we believe that there may be additional unsurveyed areas within the unit that may support *D. increscens* ssp. *villosa*. The populations here occur on a flat marine terrace along the immediate coast and likely experience summer fog and a mild maritime climate.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Deinandra increscens* ssp. *villosa* critical habitat consists of two components (67 FR 67968-68001):

- (i) Sandy soils associated with coastal terraces adjacent to the coast or uplifted marine sediments at interior sites up to 5.6 km (3.5 mi) inland from the coast, and
- (ii) Plant communities that support associated species, including needlegrass grassland and coastal sage scrub communities, particularly where the following associated species are found: Needlegrass species (*Nassella* spp.), California sagebrush (*Artemisia californica*), coyote bush (*Baccharis pilularis*), sawtooth golden bush (*Hazardia squarrosa*), and California buckwheat (*Eriogonum fasciculatum*).

Special Management Considerations or Protections

Special management considerations or protections may be needed to maintain the primary constituent elements for the two taxa within the units being designated as critical habitat. In some cases, protection of existing habitat and current ecological processes may be sufficient to ensure that populations of the plants are maintained at those sites, and have the ability to reproduce and disperse in surrounding habitat. In other cases, however, active management may be needed to maintain the primary constituent elements for the two taxa. We have outlined below the kinds of special management and protection that these two taxa would most likely require. These recommendations for management and protection are general in nature. Specific management actions should be developed according to local site conditions. Not all of these will apply to each plant taxon equally. (1) Existing soil conditions should be protected by avoiding activities that cause the erosion or compaction of soils. Maintaining an intact soil profile may be necessary to maintain edaphic features such as a horizon of permeable sandy soils on the surface layer. For example, *Deinandra increscens* ssp. *villosa* is thought to be restricted to acidic, fine sandy loams with a subsurface clay layer that may act as a reservoir of soil moisture. (2) Existing hydrologic conditions should be protected by avoiding activities that cause a change in surface or subsurface water flows upon which the plant taxa depend. For example, development of areas adjacent to a population may result in an increase in runoff and surface water flow. This alteration may affect the soil moisture content to which the local population has adapted. (3) In all plant communities where these taxa occur, invasive, non-native species, such as harding grass (*Phalaris aquaticus*), veldt grass (*Ehrharta calycina*), and iceplant (*Carpobrotus edulis*), should be actively managed. Invasive non-natives pose a serious threat to the survival of *Deinandra increscens* ssp. *villosa* and *Eriodictyon capitatum* and remaining habitat of the taxa. For example, accumulated dead leaves and stems (thatch) from nonnative grass species that dominate the habitat effectively prevent the establishment of *D. increscens* ssp. *villosa* at a site. Iceplant is known to invade native maritime chaparral vegetation occupied by *Eriodictyon capitatum*. Once non-native grasses and other invasive plants (e.g., iceplant) have become established, they cannot be removed without great expenditure of time and effort. (4) The composition of the native plant and animal communities associated with the taxa must be maintained. Native plant diversity may limit the ability of aggressive non-native plants to invade a population (Dukes 2002). In addition, a decline in biodiversity may increase the potential impact of invasive plants on a community (e.g., suppression of growth). Recent research suggests that grassland communities with fewer species may be more likely to decline as a consequence of invasion (Dukes 2001). In addition, native plant diversity may increase pollinator activity and therefore enhance the conservation of a plant species. Biologists have suggested that a plant population may persist as long as it occurs within an area of a diversity of plant species that are attractive to pollinators (Kwak 1988). Habitat fragmentation and isolation of species-rich grasslands, with intervening areas of no or low diversity of native plants, has been found to negatively affect plant-pollinator interactions (Stephann-Dewenter and Tschardt 1999). (5) The local distribution

of plant communities should be managed to provide for the physical requirements of the taxa (e.g., space for establishment). For some grassland areas, it may be important to maintain openings within or between coastal scrub communities that might otherwise encroach upon grassland patches that support *Deinandra increscens* ssp. *villosa*. (6) Certain areas where these taxa occur may need fencing to protect them from accidental or intentional trampling by humans and livestock. Portions of three of the five units are currently used by livestock

Life History**Food/Nutrient Resources****Lifespan**

Adult: 1 year (USFWS, 2011)

Breeding Season

Adult: June to September (NatureServe, 2015)

Reproduction Narrative

Adult: *Deinandra increscens* ssp. *villosa* (Gaviota tarplant) is a self-sterile annual plant in the sunflower family (Asteraceae) (Tanowitz 1982; Keil 1993; B. Baldwin, University of California, Berkeley, Jepson Herbarium, in litt. 2001; Baldwin 2010). Each flower head of *Deinandra increscens* ssp. *villosa* and other species in the family Asteraceae produce one-seeded fruits called achenes.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Grasslands intergrading with coastal sage scrub (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Soil pH of 5.0 or lower, prefers marine terraces and uplifted marine sediments ranging from 150 to 1,000 feet (46 to 305 m) (USFWS, 2011; NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist

Dependency on Other Individuals or Species for Habitat

Adult: *Deinandra increscens* ssp. *villosa* is associated with grasslands comprised of native *Nassella* spp. (needlegrass), nonnative species such as *Avena* spp. (wild oats) and *Bromus diandrus* (ripgut brome), and other herbs and grasses. The grasslands throughout the range of the species are interspersed with coastal sage scrub generally dominated by *Artemisia californica* (California sagebrush), *Baccharis pilularis* (coyote brush), *Hazardia squarrosa* (sawtooth golden bush), and *Eriogonum fasciculatum* (California buckwheat) (California Natural Diversity Database (CNDDB) 2010). (USFWS, 2011)

Habitat Narrative

Adult: This species is associated with marine terraces and uplifted marine sediments, ranging from 150 feet (46 meters (m)) in elevation along the lowest terraces to 1,000 feet (305 m) and fractured shales in the Tranquillon Mountain and Sudden Peak area (Hendrickson et al. 1998 Wilken 1998; CNDDDB 2010; U.S. Department of Agriculture, Soil Conservation Service 1972, 1981). This plant occurs mostly on the Conception, Tierra, Maymen, Los Osos, Botella, Gaviota and Milpitas-Positas soil series, which consist of acidic (pH less than 5), sandy loam, clay loam, loamy sand, and loam soils; duneland; and rock outcrop complexes (U.S. Department of Agriculture, Soil Conservation Service 1972, 1981; All American Pipeline Company 1995). A subsurface clay layer 1 to 36 inches (2.5 to 90 cm) deep may serve as a reservoir of soil moisture in an area otherwise characterized by summer drought (Howald 1989). However, *D. increscens* ssp. *villosa* consistently occurs where the depth to clay is only 1 to 2 inches (2.5 to 5 cm) (K. Rindlaub, biologist, in litt. 1998). (USFWS, 2011)

Dispersal/Migration

Dispersal

Adult: High (USFWS, 2011)

Dispersal/Migration Narrative

Adult: Achenes of *Deinandra* spp. are most likely dispersed by adhesion of the sticky bracts clasping the ray achenes to animal fur or feathers (Baldwin, in litt. 2001). (USFWS, 2011)

Population Information and Trends

Population Trends:

Unknown

Resiliency:

Low (inferred from USFWS, 2011)

Representation:

Low (inferred from USFWS, 2011)

Redundancy:

Low (inferred from USFWS, 2011)

Number of Populations:

7 (USFWS, 2011)

Population Narrative:

Currently, *Deinandra increscens* ssp. *villosa* has a total of 26 known occurrences grouped among 7 populations ranging from the coastal terraces on the bluffs at Lion's Head near Point Sal to the mountains of the Western Transverse Ranges, to the coastal terraces on the bluffs at Point Conception and Gaviota (Service 2000, 2002, CNDDDB 2010, CCH 2010; Baldwin 2009, 2010; Elvin 2010a, 2010b). The number of standing *Deinandra increscens* ssp. *villosa* plants has been shown to vary considerably within any given occurrence from year to year. (USFWS, 2011)

Threats and Stressors

Stressor: Degradation and loss of habitat due to agriculture and urban development (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Since the time of listing, threats to *Deinandra increscens* ssp. *villosa* and its habitat by degradation and loss of habitat have increased due to agriculture and urban development (Service 2000, CNDDDB 2010). Populations on Hollister Ranch, along the coast, and in the Santa Ynez Mountains are affected by trampling from cattle and horses, discing for agricultural practices, and residential development (CNDDDB 2010; M. Meyer, California Department of Fish and Game (CDFG), in litt. 2010a). For instance, CDFG issued an incidental take permit (ITP) for a single family house to be located within an area known to be occupied by *D. increscens* ssp. *villosa* (CDFG ITP permit 2018-2004-042-05) in 2004. Cattle and horses continue to graze in *D. increscens* ssp. *villosa* habitat between Gaviota State Park and Jalama Beach County Park (CNDDDB 2010). Cattle grazing in some areas occupied by *D. increscens* ssp. *villosa* appears to have facilitated the displacement of *D. increscens* ssp. *villosa* and favored the dominance of *D. fasciculata*, (fascicled tarplant) a common native tarplant in other parts of southern California (Rindlaub, in litt. 1998). (USFWS, 2011)

Stressor: Invasion of additional nonnative species of eucalyptus (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Nonnative Eucalyptus trees were planted in the Gaviota area on adjacent private lands and along Highway 101 as visual screens, windbreaks, and landscaping during the early 1900s and have continued to spread since then. Several species of Eucalyptus are present on various private and public properties in the area. Some species are expanding and increasingly overtaking coastal grasslands and scrub-lands (e.g., *Eucalyptus conferminata*, *E. globulus*) (Meyer, in litt. 2010a; Ritter, pers. comm. 2010; Ritter, in litt. 2011). (USFWS, 2011)

Stressor: Loss of habitat and indirect effects from wind energy development (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The Lompoc Wind Energy Project is a commercial wind energy facility proposed to be constructed and operated on approximately 2,950 acres (1,194 ha) in the Sudden Peak and Tranquillion Mountain area (CH2M Hill 2007). The project is planned to include the following components: 60 to 80 wind turbine generators, new access roads and road improvements, a communication system, meteorological towers, an operations and maintenance facility, onsite electrical collection and distribution lines, an onsite project substation, a new 7.85-mile (12.6km), 115-kilovolt Pacific Gas and Electric (PG&E) power line to the Lompoc area to interconnect with the PG&E electric grid, and upgrades to existing PG&E facilities in the area. *Deinandra increscens* ssp. *villosa* occurs throughout the central and western portions of the 2,950-acre (1,194-ha) project site and all 791 acres (320 ha) of the Sudden Peak Unit of critical habitat for *D. increscens* ssp. *villosa* occur within the project site (CH2M Hill 2007, Service 2002). This proposed project would likely have direct and indirect effects to occupied *D. increscens* ssp. *villosa* habitat. Effects from this project (direct and indirect) are estimated to include loss or modification of habitat;

changes in hydrology; temporary or permanent loss of individuals; changes in vegetation; and an increase in nonnative or invasive species, night-lighting, dust, noise, and vehicle emissions (CH2M Hill 2007). The effects of competition with nonnative species is most problematic immediately adjacent to habitat that has been isolated or fragmented by development (Alberts et al. 1993). The development of wind energy projects in areas occupied by *D. increscens* ssp. *villosa* may also affect individuals or seed banks for this species and are further discussed in Factor E below. There are additional leases for wind energy development within the range of *D. increscens* ssp. *villosa* (Meyer, in litt. 2011), at the north end of the range near Point Sal and at the south end of the range near Point Conception. (USFWS, 2011)

Stressor: Sea level rise due to climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Sea level rise, as a result of global climate change, has the potential to alter and diminish the habitat of *Deinandra increscens* ssp. *villosa* because of its proximity to the coastline. At the time of listing *D. increscens* ssp. *villosa*, we did not discuss the potential effects of climate change on its long-term persistence (Service 2000). Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, a rise in sea level, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). The specific manner in which climate change could affect *D. increscens* ssp. *villosa* is unknown at this time due to the general nature of these predictions. Because five of the seven populations of *D. increscens* ssp. *villosa* occurrences are on coastal terraces, erosion of these areas and corresponding loss or decreased quality of habitat could adversely affect these populations by causing habitat conversion within and adjacent to occupied habitat areas for this species. Climate change and sea level rise may also affect individuals or seed banks for this species. (USFWS, 2011)

Stressor: Development and alteration of habitat from mission operations at VAFB (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Facility maintenance and development for military and private commercial purposes planned at VAFB may result in loss and alteration of habitat occupied by *Deinandra increscens* ssp. *villosa* (U.S. Air Force 2008). *Deinandra increscens* ssp. *villosa* is known to occur in and around launch sites on VAFB (CNDDDB 2010, Elvin 2010b). The U.S. Air Force conducts vegetation maintenance activities around launch facilities at VAFB to reduce the chance of fires. Additionally, the potential for deposition of exhaust products from launch vehicles could adversely affect *D. increscens* ssp. *villosa* and its habitat. Mission operations (e.g., antiterrorism operations, space launches), infrastructure support activities (e.g., road and utility maintenance), and environmental management programs (e.g., grazing and invasive species removal) may affect *D. increscens* ssp. *villosa* (U.S. Air Force 2008). Missile launch operations, such as adjacent to Space Launch Complex-6, could adversely affect habitats surrounding launch facilities. In 1993, a missile was destroyed shortly after launching at VAFB, and a series of brush fires caused by burning rocket fuel burned more than 400 acres (162 ha). Large fragments of metal blasted downward toward the ground caused physical damage to the habitat on base around the launch site (Wallace 1993). In September 1997, a 500-acre (200-ha) fire and a 1,500-acre (600-ha) fire burned near occupied habitat of *Eriodictyon capitatum* (Los Angeles Times 1997a). Fire

containment lines constructed by bulldozers in the vicinity of the species were observed after the fire (J. Watkins, U.S. Fish and Wildlife Service, pers. comm. 1997). On November 1, 1997, a 1,225-acre (495-ha) fire that was accidentally set by an explosives disposal team at VAFB was partially contained by back-burning (Los Angeles Times 1997b). Mission operations may also have direct effects to individual *D. increscens* ssp. *villosa* plants and the seed bank and are further discussed in Factor E below. While mission operations at VAFB may have some adverse effects to *D. increscens* ssp. *villosa* and its habitat, the U.S. Air Force's mission at VAFB is expected to have long-term benefits to *D. increscens* ssp. *villosa* and its habitat because, in order to accomplish its mission at VAFB, the U.S. Air Force needs to maintain extensive tracts of undeveloped and encroachment-free property. These extensive tracts of undeveloped and encroachment-free property will likely allow *D. increscens* ssp. *villosa* to persist. (USFWS, 2011)

Stressor: Cattle grazing (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The Service also stated that cattle grazing has occurred within the habitat of *D. increscens* ssp. *villosa* and that low levels of grazing may enhance the opportunities for it to propagate successfully, as it may serve to reduce competition from nonnative species. However, some evidence indicates that heavy grazing has affected individuals of *D. increscens* ssp. *villosa* by reducing their stature and the number of seeds that can be produced. Populations on Hollister Ranch, along the coast, and in the Santa Ynez Mountains are affected by cattle and horse grazing (CNDDB 2010; Meyer, in litt. 2010a). VAFB leases grazing allotments that overlap with portions of all three populations on the base, the allotments are managed under a rest and rotation system that minimizes adverse effects and maximizes the reproductive success of populations that are grazed (U.S. Air Force 2008). An analysis of these threats is contained in the final rule and appears to remain currently valid. (USFWS, 2011)

Stressor: Flower beetle (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The Service stated that approximately 50 percent of the disk and ray achenes of *D. increscens* ssp. *villosa* had been observed to be infested by an unidentified flower beetle (Rindlaub, in litt. 1998). (USFWS, 2011)

Stressor: Genetics issues as affected by small population size (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Most species in the genus *Deinandra* (including *D. increscens* ssp. *villosa* specifically) are self-incompatible and cannot produce viable seeds without cross pollinating within their respective taxa (Baldwin, in litt. 2001). Evolutionary processes such as mutation, natural selection, genetic migration, and random genetic drift are known to adversely affect small populations (Barrett and Kohn 1991). Adverse effects from these evolutionary processes on self-incompatible species such as *D. increscens* ssp. *villosa* are magnified by its self-incompatibility (Keck 1959; Tanowitz 1982; Baldwin, in litt. 2001). Maintaining gene flow among the populations is essential to counter the adverse effects from the evolutionary forces mentioned above and to

ensure the long-term survival and conservation of this species. Both theoretical and empirical evidence indicates that smaller populations (those also possessing lower genetic variation) tend to have higher mortality rates and reduced fecundity, which leads to demographic fluctuations (Lande 1988, Les et al. 1991, DeMauro 1993, Heywood 1993, Lacy 1997, Frankham et al. 2002). At the extreme, very small populations suffer from inbreeding depression and the adverse effects of genetic drift (Barrett and Kohn 1991, Les et al. 1991). In plant species exhibiting sporophytic self-incompatibility, such as *D. increscens* ssp. *villosa*, the potential for adverse effects from inbreeding and genetic drift are greater than in species with gametophytic self-incompatibility (Baldwin, in litt. 2001). A reduction in population size, due to demographic or environmental stochasticity or long-term fragmentation of populations, could reduce the pool of S alleles, thereby reducing successful cross-pollination and reproduction (Les et al. 1991, DeMauro 1993). (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: It is clear that an increase in the rate of sea level rise has been predicted for the coast of California (CCC 2001, California Climate Change Center 2006, Heberger et al. 2009). In particular, beaches and coastal bluffs along the coast will be subject to greater and more frequent wave attack, with a general rule of thumb that 50 to 100 feet (15 to 30 m) of beach width will be lost from use for every foot of sea level rise by the year 2100 with an estimated rise in sea level in Santa Barbara County at 5.28 feet (1.61 m) (CCC 2001, Heberger et al. 2009). Because many *D. increscens* subsp. *villosa* occurrences are on the terraces on coastal bluffs, erosion of these areas caused by an estimated rise in sea level could cause a loss of individual plants and seed banks in five of the seven populations of this species. See Factor A for additional discussions regarding climate change in relation to this species. (USFWS, 2011)

Stressor: Emergency response activities (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Many *Deinandra increscens* ssp. *villosa* populations occur on coastal bluffs or open areas in the Santa Ynez Mountains that are associated with grasslands and sparse coastal sage scrub. Many of the known populations of this species grow in and adjacent to large open areas that generally have little vegetation and a flat or level geography that also has easy access from paved roads. These features are attractive to and preferred by emergency response organizations for use as staging areas and command posts during emergency response situations such as wildfires or other law enforcement actions. Establishing staging areas and or command posts quickly and close to a developing situation is important and the agencies may not have the ability to check resource databases (e.g., CNDDDB) before setting up these posts to conduct their essential operations. Establishing a staging area or command post on *D. increscens* subsp. *villosa* plants would result in the crushing of these plants and seeds. (USFWS, 2011)

Recovery

Reclassification Criteria:

Reclassification criteria are not available.

Delisting Criteria:

Delisting criteria are not available.

Recovery Actions:

- Recovery actions are not available.

Conservation Measures and Best Management Practices:

- Develop a recovery outline and recovery plan for *Deinandra increscens* ssp. *villosa*. (USFWS, 2011)
- Work with the U.S. Air Force at VAFB to implement site-specific management activities (e.g., refining grazing regimes, eradicating nonnative species) to maintain suitable habitat on the base for this species. (USFWS, 2011)
- Work with partners to manage threats to this species throughout its range, such as increasing efforts to remove nonnative species and planning the timing of activities that occur within and adjacent to occupied habitat. (USFWS, 2011)
- Develop conservation and land use management plans or habitat conservation plans with the County of Santa Barbara, the agricultural community, developers, local landowners and stakeholders to facilitate this species occurring and migrating throughout its historical range. (USFWS, 2011)
- Conduct updated surveys throughout the range of the species. (USFWS, 2011)

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U.S. Fish and Wildlife Service. 2002. Endangered and Threatened Wildlife and Plants

Designation of Critical Habitat for *Eriodictyon capitatum* (Lompoc yerba santa) and *Deinandra increscens* ssp. *villosa* (Gaviota tarplant)

Final Rule. 67 FR 67968-68001 (November 7, 2002).

USFWS. 2011. *Deinandra increscens* ssp. *villosa* (Gaviota tarplant)

5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Ventura Fish and Wildlife Office Ventura, California

SPECIES ACCOUNT: *Delissea rhytidosperma* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/25/1994; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Delissea rhytidosperma, a member of the bellflower family, is a branched shrub 0.5 to 2.5 m (1.6 to 8.2 ft) tall. The lance-shaped or elliptic leaves are 8 to 19 cm (3.1 to 7.5 in) long and 2 to 5.5 cm (0.8 to 2.2 in) wide and have toothed margins. Clusters of 5 to 12 flowers are borne on stalks 1 to 2 cm (0.4 to 0.8 in) long; each flower has a stalk 8 to 13 mm (0.3 to 0.5 in) long. The greenish white (sometimes pale purple) corolla is 14 to 20 mm (0.6 to 0.8 in) long. The stamens are hairless, except for a small patch of hair at the base of the anthers. The nearly spherical dark purple fruits are 7 to 12 mm (0.3 to 0.5 in) long and contain numerous white seeds. This species differs from other taxa of the genus by the shape, length, and margins of the leaves and by having hairs at the base of the anthers (Hillebrand 1888; Lammers 1990; Rock 1913, 1919; Wimmer 1953). (USFWS, 1995)

Historical Range

Historically no additional range. (NatureServe, 2015)

Current Range

Endemic to the island of Kauai (USFWS, 2017)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Delissea rhytidosperma* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Delissea rhytidosperma* includes three units totaling 1,437 acres in Kauai County, Hawaii. The units are Kauai 7—*Delissea rhytidosperma*—a and Kauai 11—*Delissea rhytidosperma*—b, c.

Kauai 7—*Delissea rhytidosperma*—a: This unit is critical habitat for *Delissea rhytidosperma* and is 221 ha (545 ac) on private land. This unit contains Haupu and Naluakeina Summits and Queen Victoria's Profile. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial *Delissea rhytidosperma* and is currently occupied with four plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, well-drained soils with medium or finetextured subsoil in *Diospyros* diverse lowland mesic or diverse *Metrosideros polymorpha*-*Acacia koa* forests. This unit is geographically separated from the other two units designated as

critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 11—*Delissea rhytidosperma*—b: This unit is critical habitat for *Delissea rhytidosperma* and is 258 ha (638 ac) on State land (Kuia NAR and Puu Ka Pele Forest Reserve). This unit contains portions of Kuia Valley and Milolii Ridge. This unit provides habitat for two populations of 300 mature, reproducing individuals of the shortlived perennial *Delissea rhytidosperma* and is currently occupied with six plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, well-drained soils with medium or fine-textured subsoil in *Diospyros* diverse lowland mesic or diverse *Metrosideros polymorpha*-*Acacia koa* forests. This unit is geographically separated from the other two units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Although we do not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, the units are of an appropriate distance apart to avoid their destruction by one naturally occurring catastrophic event. Kauai 11—*Delissea rhytidosperma*—c: This unit is critical habitat for *Delissea rhytidosperma* and is 103 ha (254 ac) on State land (Haena and Na Pali Coast State Parks) within Hanakapiai Valley. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial *Delissea rhytidosperma* and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is important to the establishment of additional populations on Kauai in order to reach recovery goals. The habitat features contained in this unit that are essential for this species include, but are not limited to, well-drained soils with medium or finetextured subsoil in *Diospyros* diverse lowland mesic or diverse *Metrosideros polymorpha*-*Acacia koa* forests. This unit is geographically separated from the other two units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Well-drained soils with medium or fine-textured subsoil in *Diospyros* diverse lowland mesic forests or diverse *Metrosideros polymorpha*-*Acacia koa* forests and containing one or more of the following native species: *Adenophorus* spp., *Cyanea* spp., *Dianella sandwicensis*, *Diospyros sandwicensis*, *Dodonaea viscosa*, *Doodia kunthiana*, *Euphorbia haeleeleana*, grammitid ferns (*Grammitidaceae*), *Hedyotis* spp., *Leptecophylla tameiameia*, *Microlepia strigosa*, *Nestegis sandwicensis*, *Pisonia* spp., *Psychotria hobbdi*, or *Pteralyxia kauaiensis*; and

(ii) Elevations between 167 and 895 m (547 and 2,935 ft).

Special Management Considerations or Protections

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their

immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 853 and 915 meters (USFWS, 2008)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1995)

Habitat Narrative

Adult: This species generally grows in diverse lowland mesic forests or koa-dominated lowland dry forests that have well drained soils with medium- to fine-textured subsoil. *Delissea rhytidosperra* grows in mesic forest and the elevation ranges from 260 to 915 meters (853 to 3,000 feet). Associated native plant taxa include *Dianehla sandwicensis* (ukiuki), *lama*, *Nestegis sandwicensis* (olopua), and *pukiawe* (USFWS 1994a). (USFWS, 1995; USFWS, 2008)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Resiliency:

Very low (inferred from USFWS, 2008)

Redundancy:

Very low (inferred from USFWS, 2008)

Number of Populations:

1 (USFWS, 2008)

Population Size:

138 (136 outplanted and 2 wild; USFWS, 2017)

Population Narrative:

Delissea rhytidosperma, as currently recognized by Lammers (2005), is now extinct in the wild. Both Hanakapiai and Limahuli populations are now extinct in the wild, although 119 plants of the Hanakapiai type has been outplanted in the National Tropical Botanical Garden's Limahuli Preserve. None of these plants have reproduced yet (Perlman 2006; Bender 2006). (USFWS, 2008)

Threats and Stressors

Stressor: Habitat modification by pigs, goats, and deer (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: The habitats of *Delissea rhytidosperma* and *D. kauaiensis* have been modified by a combination of pigs (*Sus serofa*), goats (*Capra hirtus*) and mule deer (*Odoeioleus hemionus*). (USFWS, 2008)

Stressor: Invasive plants (USFWS, 1995; USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species compete with and modify the habitat of *D. rhytidosperma* including lantana, *Passiflora ligularis* (sweet granadilla), *Cordyline fruticosa* (ti), and *Passiflora mollissima* (banana poka) (Perlman 2006; Wood et al. 2002). (USFWS, 1995; USFWS, 2008)

Stressor: Small population size (USFWS, 1995)

Exposure:

Response:

Consequence:

Narrative: This species is also threatened by stochastic extinction and/or reduced reproductive vigor due to the small number of existing individuals (USFWS 1994a). (USFWS, 1995)

Stressor: Herbivory by goats, deer, slugs, and rats (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Goats, deer, slugs and rats all eat *Delissea* plants (Perlman 2006; USFWS 1995). They also appear to be affected by diseases transmitted by leafhoppers and spider mites (Bender 2006). (USFWS, 2008)

Stressor: Climate change loss or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Delissea rhytidosperma* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.607 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2017)

Stressor: Hurricanes, loss and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Hurricanes were omitted in the last five year review. In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event, and 70% of all listed plant species on Kauai are only found on Kauai. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013). (USFWS, 2017)

Stressor: Rodent predation or herbivory (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Herbivory by rats has been noted as a threat to occurrence at Moloaa FR (NTBG 2016) (USFWS, 2017)

Stressor: Slug Herbivory (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Herbivory by slugs has been noted as a threat to occurrence at Moloaa FR (NTBG 2016) (USFWS, 2017)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Kauai and at least one other island where they now occur or occurred historically. (USFWS, 1995)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1995)
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1995)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Kauai and at least one other island where they now occur or occurred historically. (USFWS, 1995)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1995)
3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1995)

Recovery Actions:

- In order to prevent this taxon from going extinct, propagation efforts and the maintenance of adequate genetic stock ex situ should be undertaken immediately, as well as the protection of remaining wild individuals from mule deer or black tailed deer, feral goats, and feral pigs. (USFWS, 1995)
- A research program is also recommended to study the growth and reproductive viability of each taxon, determine the parameters of viable populations of each taxon, study the reproductive strategy and pollinators of each taxon, study possible pests and diseases, and use the results of such research to improve management practices. (USFWS, 1995)
- A program of augmentation of very small populations and re establishment of new populations within the historical range of the species is also needed. (USFWS, 1995)

- A public education program is also needed to increase public awareness and support for plant recovery efforts. (USFWS, 1995)
- Finally, the recovery objectives should be refined and revised as new information becomes available. (USFWS, 1995)
- Surveys and inventories—Continue surveys of suitable habitat within historic range for additional individuals. (USFWS, 2017)
- Ungulate monitoring and control—Protect all occurrences against browsing and disturbances from feral ungulates. Construct and maintain fenced exclosures around all populations. (USFWS, 2017)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations; Control invasive nonnative plant species around all populations that compete with the species. (USFWS, 2017)
- Predator and herbivore monitoring and control—Determine and implement effective control methods for slugs; Implement effective control methods for rodents. (USFWS, 2017)
- Predator and herbivore control research—Study *Delissea rhytidosperma* populations to determine level of threat from disease transmitted by leafhoppers and spider mites and the need for additional recovery actions. (USFWS, 2017)
- Captive propagation for genetic storage and reintroduction—Continue to collect propagules for storage and for maintenance of genetic stock. Monitor new plants for reproduction and collect from them. (USFWS, 2017)
- Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2017)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and hurricanes. (USFWS, 2017)
- Fire monitoring and control—Develop and implement fire management plans for all wild and reintroduced populations. (USFWS, 2017)
- Population biology research—Study *Delissea rhytidosperma* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. (USFWS, 2017)
- Federal Register updates—Update the listed entity on 50 CFR 17 to match the currently recognized taxonomy, splitting the species into *Delissea rhytidosperma* and *D. kauaiensis*. (USFWS, 2017)

Conservation Measures and Best Management Practices:

- Continue seed collection from cultivated individuals. (USFWS, 2008)
- Survey suitable habitat within historical range for additional individuals. (USFWS, 2008)
- Control invasive introduced plants around outplanted individuals. (USFWS, 2008)
- Rodents and slugs should be managed and controlled around outplanted individuals. (USFWS, 2008)
- Reintroduce additional populations in protected locations within suitable habitat and historical distribution. (USFWS, 2008)
- Delist *Delissea rhytidosperma* and relist as *Delissea rhytidosperma* and *Delissea kauaiensis* in the Federal Register. (USFWS, 2008)

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USFWS. 2008. *Delissea rhytidosperma* (No common name) 5-Year Review Summary and Evaluation. Pacific Islands Fish and Wildlife Office Honolulu, Hawaii

SPECIES ACCOUNT: *Delissea subcordata* (Oha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

It is a shrub 1 to 3 m (3.5 to 10 ft) tall with a single stem or occasionally branched. The leaves have toothed or cut margins, are 12 to 30 cm (4.7 to 11.7 in) long, and are clustered at the stem tips. Inflorescences are borne close to the stem among the leaves, with curved, white to green flowers 45 to 60 mm (1.8 to 2.4 in) long. The purple berries are 12 to 16 mm (0.5 to 0.6 in) long (Wagner et al 1999; Makua Implementation Team 2003) (USFWS, 2016).

Taxonomy

A member of the Campanulaceae (bellflower family) (USFWS, 2016). Endemic genus of 9 species. Species endemic to oahu. Varieties not recognized by lammers in wagner et al. (NatureServe, 2015).

Historical Range

Delissea subcordata is a species endemic to Oahu. Historic survey data indicate *D. subcordata* was known from 21 scattered populations in the Waianae Mountains and eight populations in the Koolau Mountains (USFWS, 2016).

Current Range

Current range includes Waianae Mountains, Oahu (NatureServe, 2015). This species is absent from several locations in the Waianae Mountains where it was found in the 1970s and 1980s, and it is no longer found in the Koolau Mountains (USFWS, 2016).

Critical Habitat Designated

Yes; 6/7/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Delissea subcordata* (Oha) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Delissea subcordata* (77 FR 57648-57862). The critical habitat designation includes 7 critical habitat units, which encompass approximately 7,823 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Delissea subcordata* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Delissea subcordata* includes 7 critical habitat units, covering one ecosystem type, which encompasses approximately 7,823 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Delissea subcordata* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Delissea subcordata* occurs within the indicated ecosystem in the Waianae Mountain caldera complex and was known historically (last observed > 20 yrs ago) from indicated ecosystem in the Koolau Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Ctenitis squamigera* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources**Reproductive Strategy**

Adult: Sexual: self-pollination, cross-pollination (USFWS, 2016)

Lifespan

Adult: < 10 years, based on genus (USFWS, 2016)

Breeding Season

Adult: Year round (USFWS, 2016)

Key Resources Needed for Breeding

Adult: Presumably birds (USFWS, 2016)

Reproduction Narrative

Adult: Flowering and fruiting has been documented at various times of the year, with peak flowering from February through June followed by fruiting from June through August. Similar to other *Delissea* species with long tubular flowers and colorful berries, this species likely was pollinated by nectar-feeding birds and its fruit dispersed by fruit-eating birds. However, *D. subcordata* is capable of self-pollination, as evidenced by the production of viable seeds by isolated plants. The longevity of the plants is unknown; individuals presumably live for less than 10 years like other taxa of this size in the genus *Delissea* and in the closely-related genus *Cyanea* (Makua Implementation Team 2003) (USFWS, 2016).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Mixed mesic forest (USFWS, 2016)

Geographic or Habitat Restraints or Barriers

Adult: 531 - 3,362 ft. elevation (USFWS, 2016)

Habitat Narrative

Adult: Inhabits moist forests on gulch slopes or in gulch bottoms (NatureServe, 2015). *Delissea subcordata* typically grows on north-facing gulch slopes and sometimes in gulch bottoms in mixed mesic forests dominated by *Diospyros sandwicensis*, *Metrosideros polymorpha*, and/or *Acacia koa* at elevations between 162 and 1,025 m (531 and 3,362 ft) (Makua Implementation Team 2003). This species also survives relatively well in weedy forests dominated by the non-native *Schinus terebinthifolius* and *Psidium cattleianum* (USFWS, 2016).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: There is recruitment at wild sites and new plants are occasionally found away from known occurrences, suggesting dispersal by birds or possibly persistence of a soil seedbank (U.S. Army Garrison 2005b) (USFWS, 2016).

Population Information and Trends**Population Trends:**

Increase in individuals since 1996 (USFWS, 2016)

Species Trends:

83% of individuals are from propagate stock (USFWS, 2016); increasing (USFWS, 2013)

Resiliency:

Very low (inferred from NatureServe, 2015; see current range/distribution)

Number of Populations:

7 (USFWS, 2016)

Population Size:

72 wild, 1,404 reintroduced (USFWS, 2013)

Minimum Viable Population Size:

100 mature, reproducing individuals (USFWS, 2016)

Adaptability:

Low (inferred from USFWS, 2016)

Population Narrative:

When *D. subcordata* was listed in 1996, there were about nine occurrences totaling 70 to 80 individuals (61 FR 53089). According to the Army, this species currently is “very rare and continues to decline in numbers” (U.S. Army Garrison 2005b). Recent survey data indicate there are currently 185 total individuals in seven population units located on Federal, State, and private lands (Table SB 13) (U.S. Army Garrison 2006d). None of these population units are exceeding minimum numeric criteria for stabilization (defined as 100 mature, reproducing individuals per population unit). Demographic data for this species indicate that about 83 percent of all remaining *Delissea subcordata* plants are augmented individuals from greenhouse-propagated stock (USFWS, 2016). As of spring 2012, seven populations have 24 mature and 48 juvenile wild individuals and 736 mature and 668 juvenile reintroduced individuals (OANRP 2012a). This represents an increase from the 40 wild individuals reported in the last five-year review (USFWS, 2013).

Threats and Stressors

Stressor: Habitat degradation (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: Threats include fire, habitat degradation/destruction by feral pigs and goats, and competition with the alien plants *Schinus terebinthifolius* (Christmas berry), *Clidemia hirta* (Koster's curse), and *Lantana camara* (lantana) (NatureServe, 2015).

Stressor: Predation (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: This species is particularly vulnerable to predation by rats and slugs. Slugs are a threat to seedlings of this species and slug damage has been observed on plants of all size classes (USFWS, 2016).

Stressor: Stochastic events (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: This species has a history of population fluctuation and local declines, and may be an obligate out-crosser. Therefore, any catastrophic disturbance during a major low point could extirpate one or more population units and may result in the extinction of the species in the wild (Makua Implementation Team 2003). The science of conservation biology has documented a general pattern of population collapse for a wide range of plant and animal species (Dennis et al 1991; Schemske et al 1994; Morris et al 1999; Menges 2000). According to this pattern, *D. subcordata* already is in a phase of “quasi-extinction” with numbers that have declined to the point where demographic stochasticity alone can result in extirpation (USFWS, 2016).

Stressor: Loss of pollinators (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: The long-billed, nectar-feeding native Hawaiian birds that were the presumed pollinators of *D. subcordata* have been almost totally extirpated from the Waianae Mountains. Although this species may be capable of self-pollination, the loss of its natural pollinators has likely resulted in decreased genetic variability (Makua Implementation Team 2003) (USFWS, 2016).

Stressor: Climate change (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) funded climate modeling that will help resolve these spatial limitations. High spatial resolution climate outputs are expected to be available sometime in 2013 (USFWS, 2013).

Recovery

Reclassification Criteria:

1. A total of five to seven populations should be documented on Oahu and at least one other island where they now occur or occurred historically (USFWS, 1998).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum 300 mature individuals per population for (short-lived perennials) (USFWS, 1998).

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1998).

Delisting Criteria:

1. A total of 8 to 10 populations should be documented on Oahu and at least one other island where they now occur or occurred historically (USFWS, 1998).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum 300 mature individuals per population for (short-lived perennials) (USFWS, 1998).

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1998).

Recovery Actions:

- Protect habitat and control threats (USFWS, 1998).
- Expand existing wild populations (USFWS, 1998).
- Conduct essential research (USFWS, 1998).
- Develop and maintain monitoring plans (USFWS, 1998).
- Reestablish wild populations within historic range (USFWS, 1998).
- Validate and revise recovery criteria (USFWS, 1998).
- Construct enclosures to protect populations against feral ungulates (USFWS, 1998).
- Control competing alien plant species within enclosures (USFWS, 1998).
- Reduce threat of rat predation (USFWS, 1998).
- Provide protection from fire (USFWS, 1998).

Conservation Measures and Best Management Practices:

- The Makua Implementation Team (2003) has developed stabilization protocols for *Delissea subcordata*, which are incorporated in the Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). The Kahanahaiki to Keawapilau population unit is partially fenced; the South Mohiakea, Ekahanui, Kaluaa, and Palawai population units are in fenced management units or smaller fenced exclosures. Rats are controlled in the West Makaleha reintroduction, the only site where rat damage has been observed (U.S. Army Garrison 2005b). In addition, this species is located in occurrences over five management units where it will benefit from population unit and/or ecosystem-level protection: Ekahanui, Kahanahaiki, Kaluaa and Waieli, Pahole, Upper Kapuna (USFWS, 2016).
- *Delissea subcordata* can be successfully propagated from seed, and seed can be stored for up to five years with little or no decrease in viability. Lab germination rates are about 90 percent. Survival of all reintroductions has been at least 80 percent and seedlings have been observed at one site in the Kahanahaiki area of the Kahanahaiki to Keawapilau population unit (U.S. Army Garrison 2005b). As of 2005, this species was represented in several ex situ collections, including five cuttings in a nursery (Harold L. Lyon Arboretum), three plants in a botanical garden (Waimea Valley Audubon Center), 694 ungerminated seeds in a nursery (Harold L. Lyon Arboretum), 110,000 seeds in seed

storage (Lyon Arboretum Seed Storage Facility), and 103 seedlings in a nursery (Harold L. Lyon Arboretum) (Service 2005b) (USFWS, 2016).

- Captive propagation for genetic storage and reintroduction - Complete full genetic storage of all populations (USFWS, 2013).
- Ungulate exclosures - Fence remaining populations to protect from ungulates (USFWS, 2013).
- Ecosystem-altering invasive plant species control - Control invasive plant species within and around remaining populations (USFWS, 2013).
- Predator / herbivore control - Control rats around remaining individuals (USFWS, 2013).
- Threat control research - Continue research to develop efficient and effective methods of slug control (USFWS, 2013).
- Surveys / inventories: Survey for surviving plants of the two species that were formerly also considered *Delissea subcordata*: *D. takeuchii* and both subspecies of *D. subcordata*. Survey for new populations of *Delissea waianaeensis* in suitable habitat, and revisit historical sites for regeneration from seed banks (USFWS, 2013).
- Population biology research - Study *Delissea waianaeensis* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. Alliance and partnership development - Initiate planning and contribute to implementation of ecosystem-level management and restoration to benefit this species (USFWS, 2013).
- Alliance and partnership development - Initiate planning and contribute to implementation of ecosystem-level management and restoration to benefit this species (USFWS, 2013).
- Federal Register updates - Update the listed entity on 50 CFR 17 to match the currently recognized taxonomy (USFWS, 2013).

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SPECIES ACCOUNT: *Delissea undulata* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Delissea undulata is an unbranched, palm-like, woody-stemmed tree, 6-32 ft (210 m) tall (Lammers 1990). A dense cluster of leaves occurs at the stem tip. Leaf blades are elliptic to narrowly lance-shaped, 2-8 in (5-21 cm) long and 1-4 in (3.5-10 cm) wide. Leaf edges are wavy or flat and toothed. Leaf stalks are 0.8-5.9 in (2-15 cm) long. Flower clusters are subtended by a main stalk 2-20 in (5-50 cm) long. Each cluster is composed of about 5-20 flowers. The calyx and petals are fused at the base to form an oval tube 1.2-2.7 in (3-7mm) long. Calyx lobes are awl- or triangular-shaped 0.04-0.08 in (0.1-2 mm) long. Petals are green-white and slightly down-curved, 0.6-1 in (1.6-2.5 cm) long. One or two knoblike structures often occur on the back of the flower tube. Fruits are oval or round, purple berries 0.2-0.48 in (6-12 mm) long. (USFWS, 1996)

Taxonomy

In its listing of *Delissea undulata* as endangered (10/10/96) the USFWS recognizes 3 subspecies. The notice acknowledges that only *D. undulata* ssp. *undulata* is known to be extant. In 2002, however, *D. undulata* ssp. *kauaiensis* was discovered by Hawaiian botanist. Three subspecies, all but the last of which are considered extinct, may be separated on the basis of leaf shape and margin characters: *Delissea undulata* var. *kauaiensis* Lammers (leaf blades are oval and flat-margined with sharp teeth), *D. u.* var. *niihauensis* (St. John) Lammers (leaf blades are heart shaped and flat-margined with shallow, rounded teeth) and *D. u.* var. *undulata* (leaf blades are elliptic to lance-shaped and wavy-margined with small, sharply pointed teeth (Lammers 1990). Lammers (1988) at first narrowed the taxonomic concept of *D. undulata* as being a species restricted to the island of Hawaii, and recognized additional subspecies under *D. niihauensis* (summarized in Lammers [1999]). Lammers (2005) later elevated or re-elevated some of the subspecific taxa to the specific level as *D. undulata*, *D. niihauensis*, *D. kauaiensis*, and *D. argutidentata*. Most importantly from a taxonomic and nomenclatural standpoint, Lammers (2005) now considers the taxon that corresponds to the type specimen of *D. undulata*, the name by which the species was first listed by USFWS (1996a), to be restricted to West Maui. Furthermore, he considers the correct name for the taxon listed for the island of Hawaii to be *Delissea argutidentata* (Lammers 2005). An accepted synonym for *D. argutidentata* is *D. konaensis* (Lammers 2005). (USFWS, 1996; USFWS, 2012; NatureServe, 2015)

Historical Range

Delissea undulata subsp. *undulata* was observed in the late nineteenth century on southwestern Maui in four valleys, and in the early twentieth century on western Hawaii in North and South Kona (HEW, no reference number). (USFWS, 1996)

Current Range

Current range is restricted to western Hawaii. (NatureServe, 2015)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Delissea undulata* on the island of Kauai (68 FR 9116 - 9479).

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Delissea undulata* on the island of Hawaii.

Critical Habitat Designation

The critical habitat designation for *Delissea undulata* includes two units totaling 1,949 acres in Kauai county, Hawaii. The units are Kauai 11—*Delissea undulata*—a, b.

Kauai 11—*Delissea undulata*—a [257 ha (635 ac)]: This unit is critical habitat for *Delissea undulata* and is 256 ha (636 ac) on State (Halelea Forest Reserve, Hono o Na Pali NAR, and Na Pali Coast State Park) and private land. This unit contains Pali Elele Summit. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Delissea undulata* and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is important to the establishment of additional populations on Kauai in order to reach recovery goals. It provides habitat for the westernmost range of the species that is unique to Kauai. The habitat features contained in this unit that are essential for this species include, but are not limited to, dry or open *Metrosideros polymorpha*-*Acacia koa* forest or *Alphitonia ponderosa* forest. This unit provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Kauai 11—*Delissea undulata*—b [532 ha (1,314 ac)]: This unit is critical habitat for *Delissea undulata* and is 532 ha (1,314 ac) on State land (Kuia NAR). This unit contains portions of Mahanaloa Valley and Milolii Ridge. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial *Delissea undulata* and is currently occupied with three plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. It provides habitat for the westernmost range of the species that is unique to Kauai. The habitat features contained in this unit that are essential for this species include, but are not limited to, dry or open *Metrosideros polymorpha*-*Acacia koa* forest or *Alphitonia ponderosa* forest. This unit provides for two populations within this multi-island species' historical range on Kauai that are some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

The critical habitat designation for *Delissea undulata* includes two units totaling 1,165 acres in Hawaii County, Hawaii. The units are Hawaii 10—*Delissea undulata*—a, b. The units are geographically separated from other critical habitat for this multi-island species in order to reduce the likelihood of all recovery populations being destroyed by one naturally occurring catastrophic event. The units designated in this rule provide habitat for two populations on Hawaii, each with 300 mature, reproducing individuals of *D. undulata*. In addition, Kamehameha Schools land excluded from designation in this rule provides habitat for another three populations of *D. undulata*.

Hawaii 10—*Delissea undulata*—a [93 ha (227 ac)]: This unit lies on the northwest slopes of Puuwaawaa and is completely within the Kiholo watershed. The unit provides habitat for 1 population of 300 individuals of *D. undulata* and is currently unoccupied. This unit is essential to the conservation of the species because it supports habitat that is necessary for the establishment of additional populations in order to reach recovery goals. Hawaii 10—*Delissea undulata*—b [379 ha (938 ac)]: This unit lies on the northwest slopes of Puuwaawaa between the Poohohoo summit and Potato Hill and is completely within the Kiholo watershed. The southern portion of this unit lies in Puuwaawaa Wildlife Sanctuary. The unit provides habitat for 1 population of 300 individuals of *D. undulata* and is currently occupied by one individual. This unit is essential to the conservation of *D. undulata* because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Dry or open *Acacia koa*/*Metrosideros polymorpha* mesic forests or *Alphitonia ponderosa* montane forest and containing one or more of the following native plant species: *Diospyros sandwicensis*, *Dodonaea viscosa*, *Doodia kunthiana*, *Eragrostis variabilis*, *Euphorbia haeleeleana*, *Kokia kauaiensis*, *Microlepis strigosa*, *Panicum* spp., *Pleomele aurea*, *Psychotria marianiana*, *Psychotria greenwelliae*, or *Santalum freycinetianum*; and

(ii) Elevations between 139 and 1,006 m (456 and 3,299 ft).

Habitat features that are essential for this species include, but are not limited to, dry cinder cones and open *Sophora chrysophylla* and *Metrosideros polymorpha* forest.

Special Management Considerations or Protections

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species and therefore are not included in the critical habitat designations.

Recommended management actions into account, the following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted,

and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for this species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Breeding Season

Adult: February to June (USFWS, 2012)

Reproduction Narrative

Adult: Lammers (2005) indicates the time of flowering and fruiting material as being in June to mid-February, and fruiting from September to February. (USFWS, 2012)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Shrublands, forests, and cliffs (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations from 915 to 1,585 meters (3,002, to 5,200 feet) (USFWS, 2012)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 2012)

Habitat Narrative

Adult: *Delissea undulata* is found in dry to moist shrublands and forests. It is commonly found on exposed cliffs in West Maui and on old volcanic substrates (lava flows and volcanic cones) in Hawaii. *Delissea undulata* occurs in mesic *Acacia koa* (*koa*) forest from 915 to 1,585 meters

(3,002 to 5,200 feet) elevation. The soils recorded for the species include ustollic eutrandrepts, typic dystandrepts, and typic tropofolists (Hawaii Biodiversity and Mapping Program 2010). Native plant species growing in association with *D. undulata* include *Sophora chrysophylla* (mamane), *Metrosideros polymorpha* (ohia), *Diospyros sandwicensis* (lama), *Dodonaea viscosa* (aalii), *Psychotria* spp. (kopiko), *Santalum paniculatum* (iliahi), and *Nothocestrum breviflorum* (aiea) (USFWS 2002). (USFWS, 2012; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

None (USFWS, 2012)

Representation:

None (USFWS, 2012)

Redundancy:

None (USFWS, 2012)

Number of Populations:

0 (USFWS, 2012)

Population Size:

0 (USFWS, 2012)

Population Narrative:

According to USFWS (2002) and Lammers (2005), a single individual of *Delissea undulata* existed in the wild on Puu Waawaa on State land. Giffin (2009) indicated that the last remaining wild specimen of several species, including *D. undulata*, had been extirpated in the wild by 2006 (L. Perry, Hawaii Department of Land and Natural Resources, pers. comm. 2011). (USFWS, 2012)

Threats and Stressors

Stressor: Grazing, browsing, and trampling by cows, sheep, goats, and pigs (USFWS, 1996)

Exposure:

Response:

Consequence:

Narrative: Damage from feral and domestic animals and the degradation from grazing, browsing and trampling by cows, sheep, goats, and pigs are threats. Although palatability of the taxon is not documented, lack of seedling establishment and low numbers of individuals suggest that the taxon may be negatively impacted by these animals. (USFWS, 1996)

Stressor: Alien plants (USFWS, 1996)

Exposure:

Response:

Consequence:

Narrative: Three alien plant taxa pose a threat to *Delissea undulata*. Two vines, *Passiflora mollissima* and *Senecio mikanioides* Otto ex Walp. (German ivy), and a noxious grass, *Pennisetum clandestinum* (kikuyu grass), compete with *D. undulata* for light, nutrients, and space, and therefore limit or preclude reproductive success (Cuddihy and Stone 1990, O'Connor 1990). (USFWS, 1996)

Stressor: Fire (USFWS, 1996)

Exposure:

Response:

Consequence:

Narrative: Fire is potentially a threat, although fuel loads from *P. clandestinum* are minimized by heavy grazing by cattle (J. Giffin, in lit. 1993; pers. comm., 1995). (USFWS, 1996)

Stressor: Predation by rats and birds (USFWS, 1996)

Exposure:

Response:

Consequence:

Narrative: Predation of the fleshy fruits by black rats and introduced game birds is a threat to *D. undulata* (J. Giffin, in lit. 1993; J. Giffin, pers. comm., 1995). (USFWS, 1996)

Stressor: Small population size (USFWS, 1996)

Exposure:

Response:

Consequence:

Narrative: Because only one remaining wild adult plant known, *D. undulata* is threatened by extinction due to random events. For instance, natural changes to the habitat may threaten the preservation of this individual as it grows in a collapsing lava tube. Obviously a limited gene pool exists. (USFWS, 1996)

Stressor: Herbivory by slugs (USFWS, 1996)

Exposure:

Response:

Consequence:

Narrative: Herbivory of foliage and fruits (USFWS 2002, 2003, 2010; Hawaii Department of Land and Natural Resources 2005) by slugs is a threat. (USFWS, 2012)

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate

modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2012)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on the Big Island and at least one other island where it now occurs or occurred historically, if it is not endemic to the Big Island. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1996)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1996)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on the Big Island and at least 1 other island where they now occur or occurred historically, if it is not endemic to the Big Island. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 individuals per population for short-lived perennials. (USFWS, 1996)
3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1996)

Recovery Actions:

- The propagation and maintenance of ex situ genetic stock for this taxon is necessary in order to protect it from the serious threat of extinction by random event. (USFWS, 1996)
- Protection and outplanting efforts should be encouraged and continued. (USFWS, 1996)

Conservation Measures and Best Management Practices:

- Continue to collect seed from all populations and distribute to at least two centers where it may be stored and/or propagated. (USFWS, 2012)
- Maximize the number of individuals from which seed is collected to help maintain existing genetic variation within the species. (USFWS, 2012)
- Increase the number of individuals growing ex situ for later reintroduction. (USFWS, 2012)
- Investigate seeds of *D. argutidentata* for “physiological dormancy” problem (Baskin et al. no date—a) and determine effective ways to germinate seeds for reintroduction. (USFWS, 2012)
- Identify suitable habitat within the historical range of the species for reintroduction. (USFWS, 2012)
- Continue to reintroduce the species back into its known historical range. (USFWS, 2012)

- Continue to construct ungulate-proof fenced exclosures around each population and monitor the fences for any signs of breaching. (USFWS, 2012)
- Protect all populations against disturbances from feral ungulates. (USFWS, 2012)
- Control invasive introduced plant species around all populations. (USFWS, 2012)

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SPECIES ACCOUNT: *Delphinium bakeri* (Baker's larkspur)

Species Taxonomic and Listing Information

Listing Status: Endangered; 2/25/2000; Pacific Southwest Region (R8)

Physical Description

A perennial dry season-dormant herb that grows from a thickened, tuber-like, fleshy cluster of roots, to a height of 26 inches (in) (65 centimeters (cm)). The leaves are five-lobed, occur primarily along the upper third of the stem, and are green at the time of flowering. Another distinctive feature of the leaves is that they have a whitish area in the center. The flowers are irregularly shaped. The five sepals (outermost whorl or set of floral parts) are conspicuous, bright dark blue or purplish, with the rear sepal elongated into a spur. The inconspicuous petals occur in two pairs. The lower pair is blue-purple; the upper pair is white. Seeds are produced in several dry, many-seeded fruits, called follicles, which split open at maturity on one side (USFWS, 2015).

Taxonomy

In the buttercup family (Ranunculaceae) (USFWS, 2015). Ewan (1942) described *Delphinium bakeri* based on type material collected by Milo Baker in 1939 from Coleman Valley, Sonoma County, California. In the most recent treatment, Warnock (1993) retained the taxon as a full species. (USFWS, 2000)

Historical Range

Marin and Sonoma Counties in California (USFWS, 2015).

Current Range

One natural site and three reintroduced sites in Marin County, California (USFWS, 2015).

Critical Habitat Designated

Yes; 4/17/2003.

Legal Description

On March 18, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective April 17, 2003) for *Delphinium bakeri* (Baker's larkspur) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in California (68 FR 12834-12863).

Critical Habitat Designation

The critical habitat designation for *Delphinium bakeri* includes two CHUs in Sonoma and Marin Counties, California. Approximately 1,828 ac (740 ha) of Federal, State, and private land are being designated as critical habitat. Brief descriptions are presented below. Mapping coordinates and maps depicting the CH units are available in the Final Rule. (68 FR 12834-12863; USFWS, 2003)

Unit B1: Sonoma County, California. This unit is located near Coleman Valley Road west of the town of Occidental, approximately 8 km (5 mi) from the coast. The 322 ha (796 ac) unit is bounded on the north side by Coleman Valley Road and represents an area either near or at the

original type locality for *Delphinium bakeri*. The exact location of the type locality for *D. bakeri* is somewhat vague, with the location described only as “Hedrin Ranch in Coleman Valley, West of Occidental.” The location is mapped to within a 1.6 km (1 mi) radius in the CNDDDB. (USFWS, 2003)

Unit B2: Marin County, California. This unit is near the Marshall-Petaluma Road in Marin County approximately 10 km (6 mi) from the coast. This 418 ha (1,032 ac) unit is bounded on the north side by Salmon Creek and contains an extensive north-facing slope that is essential to maintaining the mesic conditions needed for the conservation of *Delphinium bakeri*. Land in this unit is privately owned with a county right-of-way along the road. (USFWS, 2003)

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Delphinium bakeri* critical habitat consists of three components (68 FR 12834-12863):

(i) Soils that are derived from decomposed shale.

(ii) Plant communities that support associated species, including, but not limited to: *Umbellularia californica* (California bay), *Aesculus californica* (California buckeye), *Quercus agrifolia* (coastal live oak), *Baccharis pulularis* ssp. *consanguinea* (coyotebrush), *Symphoricarpos* cf. *rivularis* (snowberry), *Rubus ursinus* (California blackberry), *Pteridium aquilinum* (bracken fern), *Polystichum munitum* (Sword fern), *Pityrogramma triangularis* (goldback fern), *Dryopteris arguta* (coastal woodfern), *Adiantum jordanii* (maidenhair fern), *Polypodium glycyrrhiza* (licorice fern), *Toxicodendron diversilobum* (poison oak), *Ceanothus thyrsiflorus* (blueblossom ceanothus), *Lithophragma affine* (woodland star), and *Holodiscus discolor* (oceanspray).

(iii) Mesic conditions on extensive north-facing slopes.

Special Management Considerations or Protections

Special management considerations or protections may be needed to maintain the physical and biological features and primary constituent elements that are essential for the conservation of *Delphinium bakeri* within the units being designated as critical habitat. In some cases, protection of existing habitat and current ecological processes may be sufficient to ensure that populations of the plants are maintained at those sites and have the ability to reproduce and disperse in surrounding habitat. In other cases, however, active management may be needed to maintain the primary constituent elements for the species. “Special management considerations or protection” is a term that originates in the definition of critical habitat. The designated critical habitat units may require special management considerations or protection because remaining populations of *Delphinium bakeri* are extremely rare, contain few individuals, and are subject to threats which could extirpate the species. In addition to the risk due to random natural events that can result in the extinction of species with very few, small, and highly isolated populations, potential threats to the habitat of *D. bakeri* include overcollection, application of herbicides, and sheep grazing. Currently, no legally operative plans or agreements have been developed that address the maintenance and improvement of the primary constituent elements important to the species, or that provide management for the long-term conservation of *D. bakeri*. Outlined below are the most likely kinds of special management and protection that the habitat features and primary constituent elements essential to the conservation of *Delphinium bakeri* may

require. The following actions apply to both species, unless otherwise noted: (1) In all plant communities where these taxa occur, invasive, nonnative species need to be actively controlled; (2) The quality of water must be maintained to keep it free from levels of herbicides or other chemical or organic contaminants that would be deleterious to the species; (3) Certain areas where these species occur may need to be fenced to protect them from accidental or intentional trampling by humans and livestock; (4) Aerial application of herbicides and insecticides that are likely to be deleterious to the species needs to be curtailed in the critical habitat. Exposure to deleterious herbicides and insecticides from drift needs to be avoided; (5) Existing hydrologic conditions may need to be protected by avoiding activities that cause a change in surface or subsurface water flows. (USFWS, 2003)

Life History**Food/Nutrient Resources****Breeding Season**

Adult: Flowers from April into May (USFWS, 2015)

Key Resources Needed for Breeding

Adult: Bumblebees and hummingbirds for pollination (USFWS, 2015)

Reproduction Narrative

Adult: Baker's larkspur flowers from April into May. Known pollinators that have been observed visiting flowers of the reintroduced plants on several occasions include bumblebees (Family Apidae) and hummingbirds. Baker's larkspur is self-compatible, but requires visitation by pollinators for good quality and abundant seed set. The approximate foraging distance from their nest of most bumblebees is approximately 1 mile (USFWS, 2015).

Habitat Type

Adult: Terrestrial (USFWS, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Mixed woodland (USFWS, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Elevation range of 295 - 672 ft (USFWS, 2015)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Habitat Narrative

Adult: Baker's larkspur occurs on decomposed shale in mixed woodland at an elevation range of 295 to 672 ft, in moderately moist, shaded conditions on a shallow veneer of soil along an extensive north-facing slope. These habitat requirements limit the availability of suitable reintroduction sites with appropriate habitat conditions and compatible land use (USFWS, 2015).

Dispersal/Migration

Population Information and Trends**Population Trends:**

Decline of >90% (NatureServe, 2015)

Species Trends:

Decline of >70% (NatureServe, 2015)

Population Growth Rate:

Low (inferred from NatureServe, 2015)

Number of Populations:

3 extant populations, 1 historical population, and 2 introduced populations (USFWS, 2019)

Population Size:

11 individuals (natural site); 40-80 individuals (reintroduction sites) (USFWS, 2015)

Population Narrative:

As of 2018, there are three extant populations of Baker's larkspur, one historical population and two introduced populations. The single extant historical population of Baker's larkspur (CNDDDB 2018, occurrence #1; along Marshall-Petaluma Road) has had fewer than five flowering plants each year since 2004. In 2018, the site contained only three plants of flowering size. However, there are signs that the habitat condition at this location has been gradually improving since the damage caused by fire and road maintenance activities in 2004 (H. Forbes, in litt. 2018a). Between 2009 and 2012, 203 adult, greenhouse-raised Baker's larkspurs were planted at three introduction sites, Marshall-Petaluma Road Private Ranch, Chileno Valley Road Private Ranch, and Soulajoule Reservoir (CNDDDB 2018; occurrences #5, #6, and #7, respectively). Descriptions of the sites (all within 5 air miles of the historical occurrence) and details of the introductions can be found in the recovery plan for Baker's larkspur (USFWS 2015). As of 2018, none of the three introduced populations has been successful and only two remain extant. Although seedlings were documented at all introduction sites in the year(s) following out-planting, none of the seedlings produced on site have reached seed set (H. Forbes, in litt. 2018a). The Chileno Valley Road Private Ranch introduction site has supported 0 to 5 flowering plants each spring since 2012 but none of the plants has successfully set seed since 2013. In 2018, there were 25 adult Baker's larkspur plants at the Soulajoule Reservoir introduction site but no plants have flowered at this site since 2013. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: After historical habitat loss, the most significant habitat impact activities are from maintenance crews (e.g., roadside vegetation clearing, fire control, culvert maintenance, etc.). Habitat alteration or loss as a result of establishment of nonnative vegetation presents a minor threat at this time. The three reintroduction sites were specifically selected to avoid any

current and anticipated land use conflicts, and require minimal stewardship activities (USFWS, 2015).

Stressor: Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Overutilization is a significant threat to this species. In 1992, all the capsules were collected from the plants at the only known site of *Delphinium bakeri*. Because these capsules contained the plants' seeds, all sexual reproduction for 1992 was lost. Were this collection to occur regularly or in conjunction with unrelated natural events (e.g., fire) the species may be lost (USFWS, 2012).

Stressor: Disease or predation (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: While most *Delphinium* species are toxic to cattle, the toxicity of *Delphinium bakeri* has not been tested; sheep grazing has been mentioned as a threat. Herbivory of Baker's larkspur by slugs, snails, and gophers is a significant threat to remaining individuals at small and vulnerable microsites (USFWS, 2015).

Stressor: Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Baker's larkspur is at risk from extirpation of small populations which may have endured reduced genetic variability and range constriction due to random natural and human-caused events. This species is also likely threatened by the effects of global climate change throughout its range (USFWS, 2015).

Recovery

Reclassification Criteria:

A.1. Habitat protection: Each reintroduced site will be managed for the species and in conservation ownership (owned in fee title), protected by a conservation easement, or protected by a formal Memorandum of Understanding with the landowner. Lands containing each population must be protected with a buffer of compatible land use. Due to the physical constraints of removing the threats presented by a major road, the Marshall-Petaluma Road Historical occurrence is exempted from this buffer requirement. (USFWS, 2015)

A.2. Outreach to reduce habitat disturbance: Outreach and education to the Marin County road maintenance crews and fire crews will ensure that the Marshall-Petaluma Road Historical Occurrence will no longer be affected by road or fire maintenance activities (USFWS, 2015).

C.1. Herbivory: For the 8 years following achievement of population targets, herbivory by slugs, snails and gophers must not occur in 2 consecutive years at levels which cause a population decline at any of the sites that count toward recovery. (USFWS, 2015)

E.1. Number of Sites/Geographic Distribution: For 5 consecutive years, a total of 12 self-sustaining populations of Baker's larkspur must be distributed across its historical range. This total may include the single extant historical occurrence and any newly discovered populations in addition to reintroduced populations. Microsites within the same reintroduction site may not be considered separate populations toward this total. Populations must be distributed between the Russian River to the north, Point Reyes-Petaluma Road to the south, the Pacific coast to the west and Highway 101 to the east. Marin and Sonoma counties must each support at least two populations of the species. For the purpose of the recovery plan, populations shall be considered separate if they are separated by at least 0.25 mi. (USFWS, 2015).

E.2. Number of Individuals: A minimum of 1,000 flowering individuals must be present at each of the 12 populations annually, for 5 consecutive years, and must include at least 2 lower-than-average water years. This reproductive objective for the minimum reproducing adult population may be met by a combination of surviving transplants and naturally recruited plants that mature and produce abundant seed annually. (USFWS, 2015)

E.3. Seedling Production: Each site must produce at least four seedling cohorts within 10 consecutive years that contribute enough surviving individuals to cause a net population increase at the site. Qualifying seed cohorts must not occur more than 3 years apart. The survival of subsequent generations of seedlings to reproductive maturity that produce viable seeds would demonstrate that plants at the site are completing their life-cycle without augmentation from propagation. Failure to detect surviving seedlings that mature into reproductive individuals within 3 years would indicate that the reintroduction is not yet achieving dynamic population objectives (Guerrant 1996). (USFWS, 2015).

Delisting Criteria:

Development of delisting criteria is not possible given the current lack of information about the species' biology and habitat requirements, the magnitude of current threats, and the precarious environment where the single historical population of the species occurs (USFWS, 2015).

Recovery Actions:

- Monitoring of all known populations (including all microsites): Monitoring of the historical and reintroduction sites is necessary to determine population status and trends. Monitoring data will also be useful in helping to make informed decisions about site management and to determine progress toward reaching recovery criteria and objectives. (USFWS, 2015)
- Reintroduction of additional populations: Reintroductions should be conducted in accordance with the Service's Draft Baker's larkspur (*Delphinium bakeri*) Reintroduction Plan, Marin and Sonoma Counties, California, which describes the important components of site selection methodology, transplant procedures, seeding and labeling techniques, and reporting practices and should be updated as new information is gathered. (USFWS, 2015)
- Management of habitat at all populations. Reintroduction sites will be managed for the species and will be in conservation ownership, protected by a conservation easement, or protected by a formal Memorandum of Understanding with the landowner. This requirement (per relevant recovery criteria) will result in involvement with landowners or

- managers who are willing to allow flexibility in stewardship/management and monitoring activities, if the need arises, to ensure the population persists on their land. Reintroduction sites should be established where they are unlikely to be subject to human-related disturbance. However, if the site has a potential for vandalism, visible attractions (e.g. flags or flagging) should be removed and the reintroduced population should be disguised by surrounding the site with natural-looking accumulations of woody debris. (USFWS, 2015)
- Conduct research into Baker's larkspur genetics, population viability, and planting techniques (USFWS, 2015).
 - Outreach: Due to the severe endemism and range restriction of Baker's larkspur, wide public outreach pertaining to its conservation is not a component of this recovery plan. Any outreach to a large audience that included detailed location information could endanger the species further by inadvertently drawing collectors, resulting in trampling impacts from the public, or infringing upon the privacy of participating landowners. However, recovery of the species is dependent upon willing landowners and managers who volunteer to conduct conservation activities on their lands. (USFWS, 2015)
 - Recommended Future Action: Continue monitoring of the Marshall-Petaluma Road naturally occurring population and the three existing reintroduction sites at private ranches on Marshall-Petaluma and Chileno Valley Roads, and Marin Municipal Water District's Soula Joule Reservoir. (USFWS, 2012)
 - Recommended Future Action: Continue seed multiplication and propagation efforts at the Garden. (USFWS, 2012)
 - Recommended Future Action: Identify additional reintroduction sites and reintroduce *Delphinium bakeri* to at least two additional locations within its historic range. (USFWS, 2012)
 - Recommended Future Action: The implementation of an adaptive strategy is recommended, whereby detailed observations of successes and failures are recorded and used to evaluate and adapt methods on a regular basis. (USFWS, 2019)

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SPECIES ACCOUNT: *Delphinium luteum* (Yellow larkspur)

Species Taxonomic and Listing Information

Listing Status: Endangered; 1/26/2000; Pacific Southwest Region (R8) (USFWS, 2015)

Physical Description

A perennial herb that grows from fibrous roots to 56 centimeters (22 inches) tall. The leaves are mostly basal, fleshy, and green at the time of flowering, which occurs from March to May. The flowers are cornucopia shaped with five conspicuous bright yellow sepals, with the posterior sepal elongated into a spur. The inconspicuous petals occur in two pairs: the upper petals are narrow and unlobed and the lower petals are oblong to ovate. The fruit is a follicle (USFWS, 2011).

Taxonomy

In the buttercup family (Ranunculaceae). Although Jepson (1975) reduced *D. luteum* to a variety of *D. nudicaule* (red larkspur), it is currently recognized as a full species (Warnock 1993) (USFWS, 2011).

Historical Range

See current range/distribution.

Current Range

Historically occurred within northwestern Marin and southwestern Sonoma counties, California (USFWS, 2011).

Critical Habitat Designated

Yes; 3/18/2003.

Legal Description

On March 18, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Delphinium luteum* (Yellow larkspur) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in California (68 FR 12834-12863).

Critical Habitat Designation

The critical habitat designation for *Delphinium luteum* includes three CHUs in Sonoma and Marin Counties, California. Approximately 2,525 ac (1,022 ha) of Federal, State, and private land are being designated as critical habitat for *Delphinium luteum*. (68 FR 12834-12863).

Unit L1: Bodega Bay, Sonoma County, California.

Unit L2: Estero Americano, Marin County, California

Unit L3: Estero de San Antonio, Marin County, California

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Delphinium luteum* critical habitat consists of four components (68 FR 12834-12863):

(i) Plant communities, including north coastal scrub or coastal prairie communities, including but not limited to: *Arabis blepharophylla* (rose rockcress), *Calochortus tolmei* (Tolmei startulip), *Mimulus aurantiacus* (orange bush monkeyflower), *Dudleya caespitosa* (sea lettuce), *Polypodium californicum* (California polyploidy), *Eriogonum parviflorum* (sea cliff buckwheat), *Toxicodendron diversilobum* (poison oak), *Romanzoffia californica* (California mistmaiden), *Hesperis matronalis* (evax), *Pentagramma triangularis* (goldenback fern), and *Sedum spathulifolium* (broadleaf stonecrop).

(ii) Relatively steep sloped soils (30 percent or greater) derived from sandstone or shale, with rapid runoff and high erosion potential, such as Kneeland or Yorkville series soils.

(iii) Generally north aspected areas; and

(iv) Habitat upslope and downslope from known populations to maintain disturbance such as occasional rock slides or soil slumping that the species appears to require.

Special Management Considerations or Protections

Special management considerations or protections may be needed to maintain the physical and biological features and primary constituent elements that are essential for the conservation of *Delphinium bakeri* and *D. luteum* within the units being designated as critical habitat. In some cases, protection of existing habitat and current ecological processes may be sufficient to ensure that populations of the plants are maintained at those sites and have the ability to reproduce and disperse in surrounding habitat. In other cases, however, active management may be needed to maintain the primary constituent elements for the two species. As noted in the Critical Habitat section, "special management considerations or protection" is a term that originates in the definition of critical habitat. We believe the designated critical habitat units may require special management considerations or protection because remaining populations of *Delphinium bakeri* and *D. luteum* are extremely rare, contain few individuals, and are subject to threats which could extirpate them. In addition to the risk due to random natural events that can result in the extinction of species with very few, small, and highly isolated populations, potential threats to the habitat of *D. bakeri* include overcollection, application of herbicides, and sheep grazing, and potential threats to the habitat of *D. luteum* include overcollection, road widening, sheep grazing, fire suppression, and hybridization. Currently, no legally operative plans or agreements have been developed that address the maintenance and improvement of the primary constituent elements important to the species, or that provide management for the long-term conservation of *D. bakeri* or *D. luteum*. We have outlined below the most likely kinds of special management and protection that the habitat features and primary constituent elements essential to the conservation of *Delphinium bakeri* and *D. luteum* may require. The following actions apply to both species, unless otherwise noted: (1) In all plant communities where these taxa occur, invasive, nonnative species need to be actively controlled; (2) The quality of water must be maintained to keep it free from levels of herbicides or other chemical or organic contaminants that would be deleterious to the species; (3) Certain areas where these species occur may need to be fenced to protect them from accidental or intentional trampling by humans and livestock; (4) Aerial application of herbicides and insecticides that are likely to be deleterious to the species

needs to be curtailed in the critical habitat. Exposure to deleterious herbicides and insecticides from drift needs to be avoided; (5) The appropriate level of soil disturbance needs to be maintained (this applies only to *Delphinium luteum*); and (6) Existing hydrologic conditions may need to be protected by avoiding activities that cause a change in surface or subsurface water flows.

Life History**Food/Nutrient Resources****Lifespan**

Adult: Probably at least 10 years (USFWS, 2011)

Breeding Season

Adult: Flowers from March to May (USFWS, 2011)

Key Resources Needed for Breeding

Adult: Hummingbirds (and possibly bumblebees) for pollination (USFWS, 2011)

Reproduction Narrative

Adult: Flowering is from March to May. Hummingbirds (and possibly bumblebees) for pollination. Lifespan is unknown, but is at least 10 years. (USFWS, 2011).

Habitat Type

Adult: Terrestrial (USFWS, 2011)

Habitat Vegetation or Surface Water Classification

Adult: Coastal prairie and coastal scrub areas, which typically have no overstory vegetation (USFWS, 2011)

Dependencies on Specific Environmental Elements

Adult: Moderate to steep slopes, generally near areas showing evidence of some level of ground disturbance in the past (USFWS, 2011).

Geographic or Habitat Restraints or Barriers

Adult: Elevations ranging from sea level to 300 ft (USFWS, 2011)

Habitat Narrative

Adult: The species occurs in Coastal prairie and coastal scrub areas, which typically have no overstory vegetation, on moderate to steep slopes, at elevations ranging from sea level to 300 ft, and are generally near areas showing evidence of some level of ground disturbance in the past, including landslides. Typical soil types include the Kneeland series in Sonoma County and the Yorkville series in Marin County. These soils derive from sandstone or shale, and share qualities of rapid runoff and high erosion potential (USFWS, 2011). Primary constituent elements of critical habitat include Relatively steep sloped soils (30 percent or greater) derived from sandstone or shale, with rapid runoff and high erosion potential, such as Kneeland or Yorkville series soils; generally north aspected areas, and habitat upslope and downslope from known populations to maintain disturbance that the species appears to require (USFWS, 2003).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Dispersal information is not described in the 5-year review (USFWS, 2011).

Population Information and Trends**Population Trends:**

Decline of 50-70% (NatureServe, 2015)

Species Trends:

Decline of 30-50% (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

5 (USFWS, 2011)

Population Size:

Approx 200 individuals (USFWS, 2011)

Population Narrative:

Due to its small population size, low population number and apparently low reproductive rate, this plant is vulnerable. Grazing and home development threaten sites in the short term (30-50% decline). If the 7 historical and extirpated sites are truly gone, this represents a 58% decline over the past 100 yrs (long-term decline of 50-70%). *Delphinium luteum* is known from approximately 200 individuals total, in three drainages two in Marin County and one in Sonoma County (NatureServe, 2015)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Habitat destruction is still considered the greatest immediate threat for *Delphinium luteum*, with quarry activities, erosion, and disturbance of roadside locations listed as factors (USFWS, 2011).

Stressor: Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: At the time of Listing Rule in 2000, unrestricted collecting for scientific or horticultural purposes or excessive visits by individuals interested in seeing rare plants was said to be a threat (65 FR 4156). Overcollecting may still be a threat. *Delphinium luteum* is the only known yellow flowered larkspur. Due to this distinctive morphology, it has been and continues to be of horticultural interest, and some of the historical decline to *D. luteum* can be attributed to overcollecting (USFWS, 2011).

Stressor: Disease or predation (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Predation remains a threat for populations located on sheep grazing land. Most *Delphinium* species are toxic to cattle but not sheep. Several populations may be threatened by sheep grazing (USFWS, 2011).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The Federal Endangered Species Act is the primary Federal law that provides protection for *Delphinium luteum* since it was considered endangered with the Listing Rule of 2000. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act. Therefore, other laws and regulations have limited ability to protect the species in absence of the Act (USFWS, 2011).

Stressor: Risk of extirpation due to small population sizes (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The small number of individuals in the single *Delphinium luteum* population increases the threat of extinction of the species as a whole through stochastic demographic and environmental events. *Delphinium* has been reduced to a few unprotected populations with fluctuating numbers of individuals (USFWS, 2011).

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Global climate change is a potential threat to *Delphinium luteum*. Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying. However, predictions of climatic conditions for smaller sub-regions such as California remain

uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects (USFWS, 2011).

Recovery

Reclassification Criteria:

At present there is no approved draft or final Recovery Plan for *Delphinium luteum* and therefore no recovery criteria (USFWS, 2011).

Delisting Criteria:

At present there is no approved draft or final Recovery Plan for *Delphinium luteum* and therefore no recovery criteria (USFWS, 2011).

Recovery Actions:

- Gather information on habitat needs and requirements. Little is known about the habitat needs and requirements for *Delphinium luteum*. All wild populations grow on north-facing rocky slopes in Sonoma or Marin counties, but the plant is grown easily in horticulture. Research to gather information about soil and moisture requirements, pollination and germination requirements and viability of the seed bank is recommended (USFWS, 2011).
- Continue captive propagation efforts for *Delphinium luteum* at the University of California Botanical Garden at Berkeley (USFWS, 2011).

Conservation Measures and Best Management Practices:

- Write a Recovery Plan. The Act requires that all listed species have recovery plans. *Delphinium luteum* has been listed since 2000, development of a recovery plan would provide guidance to conservation efforts already in progress and provide criteria for successful recovery of the species (USFWS, 2011).
- Pursue communication with landowners for access to survey plants. Some of the CNDDDB occurrences are on private property and have not been observed in many years. The Service recommends communicating with landowners to negotiate access to their properties to survey for plants (USFWS, 2011).
- Yearly surveys of plants. Currently there is little knowledge about the numbers of plants and populations of *Delphinium luteum*. The Service recommends yearly surveys of sites listed in the CNDDDB in addition to sites on north-facing rocky slopes that may have unknown populations of *D. luteum*. With yearly surveys the Service can establish basic knowledge of the population numbers and range of the species, in addition to more information about any changes in habitat, a more comprehensive threats analysis and an estimation of the population trends of the species (declining, stable, or increasing) (USFWS, 2011).
- Find appropriate reintroduction sites. Survey for reintroduction sites on protected property and pursue landowner agreements (USFWS, 2011).
- Not available.

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SPECIES ACCOUNT: *Delphinium variegatum* ssp. *kinkiense* (San Clemente Island larkspur)

Species Taxonomic and Listing Information

Listing Status: Endangered; 9/12/1977; Pacific Southwest Region (R8) (USFWS, 2015); Proposed Delisting

Physical Description

Herbaceous perennial that grows 6 to 33 inches in height, but generally is less than 20 in tall. The flowers are light blue to white in color and are bilaterally symmetrical with five petal-like sepals and four smaller petals. The uppermost sepal is a straight or downcurved spur that is characteristic for the genus. Flowers are borne along branched flower stalks typically bearing less than 12 flowers. Leaves are generally found along the lower one third of the stem and have few to many overlapping lobes that radiate from hairy petioles. The fruit is a follicle (dry, pod-like structure with a single suture), with up to three follicles possible per flower. Each follicle bears many winged seeds that are likely wind dispersed when the fruit passively splits open (USFWS, 2008).

Taxonomy

In the buttercup family (Ranunculaceae). *Delphinium kinkiense* Munz was the name used for this taxon when it was listed in 1977 (42 FR 40682). Subsequent to the listing, Warnock (1990a) reduced *D. kinkiense* to the rank of subspecies as *Delphinium variegatum* Torrey & A. Gray subsp. [i.e. ssp.] *kinkiense* (Munz) Warnock in recognition of its alliance with another island endemic taxon, *D. variegatum* ssp. *thornei*. This nomenclatural change was further supported in his taxonomic review of California *Delphinium* (Warnock 1990b) and has been followed in the current floristic treatment (Jepson Manual) for California (Warnock 1993). *Delphinium variegatum* ssp. *kinkiense* will be followed in the upcoming revision of the Jepson Manual (Jason Koontz, pers. comm. 2008) and by the Service. The taxonomic realignment, published since listing, changes the listed entity's rank to subspecies but does not alter the definition, distribution, or range of the taxon from what it was at the time of listing. Thus, based on the most recent systematic (Warnock 1990a, 1990b) and floristic treatments for the genus (Warnock 1993, 1997), the listed taxon is now regarded as one of three subspecies of *Delphinium variegatum* (USFWS, 2008).

Historical Range

Known only from coastal Sonoma County and Marin County, California. Historical populations have been extirpated and the available habitat greatly diminished. (NatureServe, 2015)

Current Range

San Clemente Island, in Los Angeles County, California (USFWS, 2008).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources**Breeding Season**

Adult: Flowers from March to April (USFWS, 2008)

Key Resources Needed for Breeding

Adult: Bees or bumblebees for pollination (USFWS, 2008)

Reproduction Narrative

Adult: The mating system is poorly understood. This species flowers from March to April. Pollinators that have been observed include a large black and white solitary bee and bumblebee. Insect-mediated pollination is consistent with fruit and flower production information (USFWS, 2008).

Habitat Type

Adult: Terrestrial (USFWS, 2008)

Habitat Vegetation or Surface Water Classification

Adult: Mid- to high-elevation grasslands on San Clemente Island (USFWS, 2008)

Geographic or Habitat Restraints or Barriers

Adult: Elevation range of 262 - 837 ft (USFWS, 2008)

Habitat Narrative

Adult: San Clemente Island larkspur is found within mid- to high-elevation (262 - 837 ft) grasslands on the east side of the northern and central portions of San Clemente Island where it occurs in clay, loam, and rocky soils (USFWS, 2008).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Seeds are likely dispersed by wind (USFWS, 2008).

Population Information and Trends**Population Trends:**

Not available.

Species Trends:

Not available.

Resiliency:

Low (inferred from USFWS, 2008)

Representation:

Low (inferred from USFWS, 2008)

Redundancy:

Low (inferred from USFWS, 2008)

Number of Populations:

24 (USFWS, 2008)

Population Size:

~11,000 individuals (USFWS, 2008)

Population Narrative:

The distribution of San Clemente Island larkspur includes a scattering of occurrences that span a distance of about 12 km (7.45 mi) on the east side of the northern and central portions of the island within mid- to high-elevation grasslands, and a single occurrence near the southern tip of the island above Pyramid Head. There is little information for directly inferring population trends. Since removal of feral mammalian herbivores from San Clemente Island, around 9,500 individuals have been documented from 24 locations supporting just San Clemente Island larkspur, and an additional 1,550 plants of mixed and possibly hybridizing genealogy occur in three locations where the two island subspecies are suspected to co-occur (USFWS, 2008).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: While domestic and feral herbivores responsible for habitat damage and erosion have been removed from San Clemente Island, remaining threats to the habitat includes alteration by military activities, increased fire frequencies associated with military training activities, and erosion from past land use and existing roads (USFWS, 2008).

Stressor: Competition from non-native species (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: One of the potential threats to larkspur is the spread and proliferation of invasive non-native plants in its habitat. San Clemente Island larkspur occurs in grassland areas that have become dominated by non-native annual grasses. Nonnative species have potential to compete with larkspur for space or other resources such as light, water, and nutrients. Non-native invasives can also alter habitat structure, ecological processes such as nutrient cycling, and the prevalence of fire (USFWS, 2008).

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Perform additional systematic studies to determine the evolutionary relationships of *Delphinium variegatum* ssp. *kinkiense* to the two taxa with which it co-occurs on San Clemente Island (*D. variegatum* ssp. *thornei* and *D. parryi*) and to mainland *D. variegatum* (USFWS, 2008).
- Develop and implement a species reintroduction program in coordination with San Clemente Island restoration actions to accelerate the recovery of this subspecies. Such a plan should use genetic and geographic information to prevent the loss of genetic integrity, if warranted, between the two island subspecies (USFWS, 2008).
- Control erosion within island grasslands, with priority given to locations where erosion may be threatening specific occurrences of San Clemente Island larkspur (USFWS, 2008).
- Perform additional ecological studies to determine what species may be eating seeds of San Clemente Island larkspur and whether seed predation is a significant threat to the recovery of this subspecies (USFWS, 2008).
- Work with the Navy to develop a program to monitor the status of San Clemente Island larkspur populations to better understand population dynamics and track the recovery of the subspecies. Directed sensitive plant surveys should also continue to be implemented every several years to document new occurrences and further range expansions (USFWS, 2008).
- Study the effect of fire on San Clemente Island larkspur and establish appropriate fire management goals for island grasslands that are sensitive to this subspecies (USFWS, 2008).

Conservation Measures and Best Management Practices:

- Not available.

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USFWS. 2008. *Delphinium ariegatum* ssp. *kinkiense* (San Clemente Island Larkspur)

SPECIES ACCOUNT: *Dicerandra christmanii* (Garrett's mint)

Species Taxonomic and Listing Information

Listing Status: Endangered; 9/21/1989; Southeast Region (R4)

Physical Description

Dicerandra christmanii is a small, fragrant shrub that reaches 50 cm in height (Huck et al. 1989). Both its floriferous and vegetative shoots are stiff and ascend from a ramose (many branched, branching), woody base. Its taproot is branched with extensive, spreading, fibrous roots. The leaves of Garrett's mint are sessile and have rounded apices, cuneate bases, entire margins and glandularpitted upper and lower surfaces (Huck et al. 1989). Leaves found on the determinate, flowering shoots are narrowly ovate to narrowly oblong. Those that subtend the cymes are 2 to 8 mm long and 0.5 to 1.8 mm wide, while those that do not subtend the cymes are approximately 5 to 11 mm long, and 1 to 2.5 mm wide. The leaves of overwintering, vegetative shoots are similarly shaped, but larger. The inflorescence is a verticillaster (Huck et al. 1989), with each cyme containing 1 to 3 flowers. The calyx is 6.5 to 10 mm long, approximately 2 mm wide (at midpoint), and bordered with an indistinct white band. The corolla is funnel shaped and abruptly bent to about 90 degrees. Its tube is 7 to 10 mm long, and its limb (from geniculum to distal edge of upper lobe) is 5 to 10 mm long. The corolla buds yellow, but at maturity, it is a pale cream (eventually fading to white). It has vivid purple-red markings that are often trellise-patterned on the upper lobe, but irregularly spotted on the lower lobe. The upper lobe is a recurving, cleft standard, and the lower lobe is tripartite (three parted) with a recurving middle petal. The flowers have four, paired stamens, which are exerted slightly beyond the lower corolla lip (Huck et al. 1989). The filaments are white, the anther sacs are brilliant yellow, and the connective is widened and may be covered with a few small, reddish and yellow glands at the basal end. The pollen is white and sticky. The pistil is white and has a slender, hirtellous style. The fruit is a schizocarp of four ovoid, brown, smooth nutlets. (USFWS, 1999)

Taxonomy

Specimens of *D. christmanii* were first collected by Garrett in 1948 east of Sebring and originally identified as *D. frutescens* by Ward (1979), Wunderlin (1984), and Huck (1987). *D. christmanii* was named as a distinct species in 1989 (Huck et al. 1989). (USFWS, 1999)

Historical Range

The historic distribution of Garrett's mint was along a 6-km section of an ancient yellow-sand ridge that has only been fragmented within the last 40 to 60 years (Menges et al. 2001). (USFWS, 2009)

Current Range

In Highlands County, Florida, between Lake Jackson and Lake Istokpoga. (USFWS, 1999)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Flowers from July to November, primarily in September and October (USFWS, 1999)

Reproduction Narrative

Adult: *Dicerandra christmanii* flowers from July to November, primarily in September and October (Huck et al. 1989). Like other *Dicerandra* species, it has spurred anthers which must be triggered by insects for the pollen to be released and dispersed (FWS 1987). This pollination process occurs mainly through bee-flies (*Exoprosopa fasciata*), and few other insects visit the plant (Huck et al. 1989). (USFWS, 1999)

Habitat Type

Adult: Pine Scrub/Oak-hickory scrub

Habitat Narrative

Adult: *Dicerandra christmanii* is found within openings in sclerophyllous oak scrub (Huck et al. 1989). As a “gap” species, it prefers open areas and does not grow vigorously when in shaded conditions. The species occurs on well-to excessively drained yellow sands of Astatula and Tavares soil types and is found where the seasonal high water table is at least 1 to 2 m deep. (USFWS, 1999)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: The seeds do not have mechanisms for wind dispersal and generally fall close to the plant (R. Huck, personal communication, 1996). Some *Dicerandra* species have been shown to use water as a dispersal agent, sometimes having their seeds carried by streams (Huck 1987). However, the limited distributions of *D. christmanii*, *D. frutescens*, and *D. immaculata* indicate that this mechanism is not effective in South Florida. Given this limited dispersal, colonization of a newly disturbed area by *D. christmanii* depends on whether or not it is present in the seedbank. The lifespan of seeds in the seedbank is unknown. (USFWS, 1999)

Population Information and Trends**Number of Populations:**

Four

Population Size:

3,891

Population Narrative:

The loss of scrub on the Lake Wales Ridge habitat was the primary reason for listing Garrett’s mint as endangered. Garrett’s mint is known from four sites, all occurring in a 6-km (3.7 mi) (north to south) by 3-km (1.9 mi) (east to west) area of Highlands County, Florida (FNAI 2009). The species is poorly represented on conservation land. Only one of the four occurrences is located within a protected area at the Flamingo Villas unit of the LWRNWR (Service 1999a, FNAI 2009). Three of four occurrences are located on private land. The area in the vicinity of these occurrences has been largely converted to citrus groves and scattered single family residences.

Fire suppression continues to be a threat to Garrett's mint populations because the species thrives in the open conditions (gaps between shrubs) created and maintained by fire (Menges et al. 1999; Evans et al. 2004; Menges et al. 2006; Evans et al. 2008). At Flamingo Villas, estimates of the number of plants in the population began in 1994. From 1994 to 1998, the number of plants ranged from 2,266 to 3,507 (Menges and Weekly 1999). In 2009, a complete census of the population located 3,891 plants (Bok Tower Gardens 2010). Work is still required to complete land acquisition, control unauthorized access, remove trash, and restore the scrub vegetation with prescribed fire. Garrett's mint occurs at 'Carter Creek East', also known as 'Sebring Railroad East Scrub', a parcel targeted for acquisition by the Florida Forever program (FDEP 2008). The site is a 40-acre block of scrub located adjacent to a railroad track in a relatively remote area with no nearby public roads (Schultz et al. 1999). A large and thriving population of Garrett's mint was extant on this site as of October 2010 (C. Peterson, Bok Tower Garden, pers. comm. 2010). The occurrence in the vicinity of Moon Ranch Road is in an area lightly developed with single-family residences. Access for surveys was denied in 2009 (Bok Tower Gardens 2010). Remaining nearby scrub habitat may still support Garrett's mint. The occurrence in the vicinity of Snyder Road is extant along the roadside and on parcels that still contain habitat. Plants on the roadside are subjected to occasional mowing. The population consisted of a mere 88 plants in October 2009. Most of the surrounding area is converted to citrus groves and heavily disturbed (Bok Tower Gardens 2010).

Threats and Stressors

Stressor: Habitat destruction or modification

Exposure:

Response:

Consequence:

Narrative: This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 million persons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

Stressor: Lack of adequate fire management

Exposure:

Response:

Consequence:

Narrative: Fire is necessary to maintain the scrub habitats upon which this species depends. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time (Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species. (USFWS, 2019)

Stressor: Limited geographic range

Exposure:

Response:

Consequence:

Narrative: This species occurs within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

Recovery

Reclassification Criteria:

1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations required to ensure 20 to 90 percent probability of persistence for 100 years (USFWS, 1999)
2. When these populations, within the historic range of *D. christmanii* are adequately protected from further habitat loss, degradation, and fire suppression (USFWS, 1999)
3. When these sites are managed to maintain the seral stage of xeric oak scrub that supports *D. christmanii* (USFWS, 1999)
4. When monitoring programs demonstrate that these sites support sufficient population sizes, are distributed throughout the historic range, and are sexually or vegetatively reproducing at sufficient rates to maintain the population (USFWS, 1999)

Delisting Criteria:

1. At least 20 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)
2. Populations (as defined in criterion 1) in yellow sand scrub habitats are distributed across the known range of the species. (USFWS, 2019)
3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

Recovery Actions:

- Determine current distribution of *D. christmanii*. Conduct surveys for additional populations of *D. christmanii*. Maintain distribution of known populations and suitable habitat in GIS database. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Monitor existing populations of *D. christmanii*. Develop monitoring protocol to assess population trends for *D. christmanii*. Develop a quantitative description of the population structure of *D. christmanii*. Monitor re-introduced plants. (USFWS, 1999)
- Provide public information about *D. christmanii*. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. However, caution should be taken to avoid revealing specific locality information of *D. christmanii*. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of *D. christmanii* and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- Habitat-Level Recovery Actions: Prevent degradation of existing habitat. Secure habitat through acquisition, landowner agreements, and conservation easements. Manage and enhance habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

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SPECIES ACCOUNT: *Dicerandra cornutissima* (Longspurred mint)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/1/1985; Southeast Region (R4) (USFWS, 2015)

Physical Description

A pungently aromatic, low shrub from a woody taproot. Leaves are opposite, needle-like, mostly ascending, with margins that are sometimes slightly wavy. The inflorescence appears as a narrow system of axillary clusters, each with 1-5 flowers. Flower petals are rose-purple, strongly 2-lipped, about 13 mm long. (Based on Kral 1983.) (NatureServe, 2015).

Taxonomy

Distinct species; one of six in Florida (NatureServe, 2015). *Dicerandra* is a genus of seven species in the mint family (Lamiaceae or Labiatae) (USFWS, 1987).

Historical Range

Originally found in Marion and Sumter Counties (USFWS, 2008).

Current Range

Currently known to occur at four sites in Marion County: CFG, along the I-75 right-of-way, Marion Oaks subdivision, and Ocala Waterways Estates subdivision (USFWS, 2008).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 1987)

Dependency on Other Individuals or Species

Adult: Apidae spp. (USFWS, 1987)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 1987)

Reproduction Narrative

Adult: The three perennial species of *Dicerandra* are obligate outcrossers that reproduce entirely by seed (Huck 1984). Each has spurred anthers, which must be triggered by insect pollen vectors (usually the Apidae) for pollen to be released and dispersed (Huck 1984).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Longleaf pine-turkey oak scrub/sandhill, slash pine-palmetto scrub (NatureServe, 2015)

Habitat Narrative

Adult: Scattered in openings (natural or artificial) in longleaf pine-turkey oak scrub/sandhill or on low rises in slash pine-palmetto scrub. (Based on Kral 1983.) (NatureServe, 2015). The habitat occupied by this species needs periodic prescribed fires. *D. cornutissima* grows well in open, sandy patches usually along roadside edges (USFWS, 2008).; *D. cornutissima* is endemic to sand pine scrub habitat that can best be described as scrub composed of overstory of older mature sand pine (*Pinus clausa*), with an open to thick understory of sand live oak (*Quercus geminate*), Chapman's oak (*Q. chapmanii*), myrtle oak (*Q. myrtifolia*), saw palmetto (*Serenoa repens*), scrub palmetto (*Sabal etonia*), Florida rosemary (*Ceratiola ericoides*), and the state listed *Garberia heterophylla* (Herring 2005). The ground cover component of this habitat is composed of patchy occurrences of lichens (*Cladina evansii*, *Cladina subtenuis*, and *Cladonia leporine*), as well as grasses such as wiregrass (*Aristida stricta*), arrowfeather threeawn (*Aristida purpurescens*), and sandy field beaksedge (*Rhynchospora megalocarpa*). *D. cornutissima* grows well in open, sandy patches usually along roadside edges. Although *D. cornutissima* occurs in a fire-adapted habitat, the timing of fires related to the plants survivorship and reproduction is not known (Herring 2005). At CFG, *D. cornutissima* mostly occurs within sand pinedominated scrub that has a mosaic of sandhill throughout the site (Herring 2005). The overstory is open, consisting of mostly sand pine, but longleaf pines are occasionally found. Fire suppression in the sandhill has led to an invasion of sand pine, but prescribed burning of this area needs to be conducted carefully, since response of *D. cornutissima* is unknown (Herring 2005). Menges (1992) found that a similar species, *D. frutescens*, a short-lived perennial is killed by fire and reestablishes vigorously from seed. Weekley (2006) notes its close relative *D. christmanii* is also killed by fire and reestablishes from seed. There has recently been research (K. Holsinger, University of Connecticut, unpublished data, 2008) to show that longer intervals of fire (more than 12 years) may be optimum for these species. Therefore, research on the similar *D. frutescens*, which grows in yellow sand scrub at Archbold Biological Station on the Lake Wales Ridge, should be considered to elucidate the effects of fire on *Dicerandra* species and help refine prescribed burning activities (A. Johnson, FNAI, personal communication, 2008). Further east on the CFG, along the I-75 right-of-way, and Marion Oaks and Ocala Waterway Estates subdivisions, *D. cornutissima* occurs along roadside edges, its preferred habitat (Herring 2005). Care must be taken along these edges to not move dirt, mow, and establish fire lines with heavy equipment (Herring 2005). There are plans at CFG to manage the scrub habitat using mechanical means to open the habitat and reduce the sand pine. Due to the close proximity of I-75 to this site, prescribed burning is extremely difficult. The OGT recently completed a management plan for CFG that has goals and objectives to protect, enhance, and increase *D. cornutissima* found on the site (FDEP 2007). (USFWS, 2016)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Species Trends:

Unknown (USFWS, 2008)

Resiliency:

Very low (inferred from USFWS, 2008)

Redundancy:

Low (inferred from USFWS, 2008)

Number of Populations:

4 (USFWS, 2008)

Population Size:

~14731 individual plants (USFWS, 2018)

Adaptability:

Low (inferred from NatureServe, 2015)

Population Narrative:

the species status is unknown; the last comprehensive population survey was completed in 1991. During the 2005 FNAI survey, a total of 731 plants were documented on the FDOT 1-75 right-of-way. Four sites of *D. cornutissima* are known to occur in Marion county, FL (USFWS, 2008). This species has few individuals and a very restricted range, and is experiencing a reduction in habitat from development pressures (NatureServe, 2015).; *D. cornutissima* was originally found in Marion and Sumter Counties. Currently *D. cornutissima* is only known to occur at four sites in Marion County: CFG, along the I-75 right-of-way, Marion Oaks subdivision, and Ocala Waterways Estates subdivision. A survey of the historic locations of *D. cornutissima* in Sumter County was conducted in 1984 and no plants were found (Wunderlin 1984). Florida Natural Areas Inventory (FNAI) has a record of *D. cornutissima* south of Marion Oaks along a powerline in Sumter County in 1988. The site along the powerline was discovered after the recovery plan was written in 1987. The recovery plan states that there was no suitable habitat left at the sites surveyed in 1984 in Sumter County, although suitable habitat may still exist between Sumter County and southern Marion County. (USFWS 1987, Wunderlin 1984). Other FNAI records include plants on private lands in Marion County near Rainbow Lakes Estates in 1993 and along State Road 200 (Bahia Oaks development) in 1991. No surveys of these sites have occurred since the early 1990s. Adjacent protected lands (Ross Prairie State Forest, Halpata Tastanaki Preserve, and Potts Preserve) have been surveyed the past five years but no *D. cornutissima* have been located in suitable habitat at these locations (A. Johnson, FNAI, personnel communication, 2008). (USFWS, 2018)

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Habitat destruction remains the greatest threat to *D. cornutissima*. Populations along the I-75 right-of-way have been impacted by road construction, exotic plant invasion, and other road-related activities. The other two remaining sites are on private property and are susceptible to destruction due to urban development. Without natural caused or prescribed fires, sand pine creates a dense overstory, making the habitat unsuitable for *D. cornutissima* (USFWS, 2008).

Stressor: Invasive species (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: The introduction of cogon grass along the I-75 right-of-way as well as on a few sites in the CFG in areas occupied by *D. cornutissima* has reduced the amount of suitable habitat for this species (USFWS, 2008).

Stressor: Fire suppression (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: This species occurs mainly along areas that have been naturally maintained with fire. Where fire has been suppressed for long periods, canopy cover increase and understory vegetation increases, reducing open sandy patches. The majority of sites containing *D. cornutissima* are degraded due to fire exclusion or lack of mechanical vegetative management (USFWS, 2008).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: The Florida Administrative Code 5B-40 (Preservation of Native Flora in Florida) provides the Florida Department of Agriculture and Consumer Services with limited authority to protect these plants (primarily from the standpoint of illegal harvest) on state and private lands. Only a few populations of *D. cornutissima* are located on protected land (CFO) where they are being managed. The FDOT is managing the I-75 right-of-way by controlling exotics however the right-of-way would not be considered protected land. CFO was acquired by the State of Florida in 1991, after Congress de-authorized the Cross Florida Barge Canal construction and transferred all the lands to the State. CFO has an approved unit management plan in place to protect *D. cornutissima* (FDEP 2007). FDOT currently manages for *D. cornutissima* along the I-75 right-of-way by working with their contractors that mow this right-of-way to avoid routine mowing outside the highway clear zone (approximately 36 feet from the travel lanes) and to control the cogon grass found on the right-of-way. A monitoring and management program should be established, including experimentation with different regimes of vegetation management outside the clear zone and re-establishment of an extirpated cluster of *D. cornutissima* that occurred within the southbound rest area before the construction. Two of the populations occur on private lands with little to no protection. The Service's Partners for Fish and Wildlife program could work with these landowners to better manage and protect these populations. (USFWS, 2018)

Recovery

Reclassification Criteria:

Ten separate, self-sustaining populations of the species are established at secure sites in peninsular Florida. This numerical goal is subject to revision as information becomes available on the population biology of each species and as suitable sites are found (USFWS, 1987).

Delisting Criteria:

20 separate, self-sustaining populations are established at secure sites in peninsular Florida (USFWS, 2008).

Recovery Actions:

- Protect and manage existing population (USFWS, 1987).
- Conserve germ plasm (USFWS, 1987).
- Establish and manage new populations (USFWS, 1987).
- 1. Revise the current recovery plan to include more objective and measurable recovery criteria that are related to reducing and/or eliminating threats to *D. cornutissima* as well as updated information on the species distribution, biology, and management needs. (USFWS, 2018)
- 2. Support further research on: a) the effects of prescribed burning and other management tools on *D. cornutissima*. Continue working with public land managers to increase management efforts to benefit *D. cornutissima* on their sites. b) Additional life history needs. Additional information is needed on how cogon grass and other invasive plants affect *D. cornutissima* plants and what the effects of the herbicides used to eradicate cogon grass have on this species. c) The most appropriate methodology to germinate seeds, grow seedlings, and successfully out-plant seedlings to native habitat. d) The various pollinators (e.g., Hymenoptera and Lepidoptera), as well as how different ant species assist with seed dispersal. (USFWS, 2018)
- 3. Encourage non-Federal agencies to protect and manage habitat under the Partners for Fish and Wildlife Program. (USFWS, 2018)
- 4. Complete a rangewide survey to find all known and potential sites occupied by *D. cornutissima* and determine population size. Current distribution information is needed to determine where plants currently exist and to prioritize recovery actions. (USFWS, 2018)
- 5. Consider reintroduction and monitoring of *D. cornutissima* on additional publicly owned lands with suitable habitat. Reintroduction of *D. cornutissima* could help to increase the number of populations on protected sites and augment populations \Where needed. (USFWS, 2018)

Conservation Measures and Best Management Practices:

- Revise the current recovery plan to include more objective and measurable recovery criteria that are related to reducing and/or eliminating threats to *D. cornutissima* as well as updated information on the species distribution, biology, and management needs (USFWS, 2008).
- Support further research on A. The effects of prescribed burning and other management tools on *D. cornutissima*. Continue working with public land managers to increase management efforts to benefit *D. cornutissima* on their sites. B. Additional life history needs. Additional information is needed on how cogon grass and other invasive plants affect *D. cornutissima* plants and what the effects of the herbicides used to eradicate cogon grass have on this species. C. The most appropriate methodology to germinate seeds, grow seedlings, and successfully out-plant seedlings to native

habitat. D. The various pollinators (e.g. Hymenoptera and Lepidoptera), as well as how different ant species assist with seed dispersal (USFWS, 2008).

- Encourage non-Federal agencies to protect and manage habitat under the Partners for Fish and Wildlife Program (USFWS, 2008).
- Complete a rangewide survey to find all known and potential sites occupied by *D. cornutissima* and determine population size. Current distribution information is needed to determine where plants currently exist and to prioritize recovery actions (USFWS, 2008).
- Consider reintroduction and monitoring of *D. cornutissima* on additional publicly owned lands with suitable habitat. Reintroduction of *D. cornutissima* could help to increase the number of populations on protected sites and augment populations where needed (USFWS, 2008).

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SPECIES ACCOUNT: *Dicerandra frutescens* (Scrub mint)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/2/1985; Southeast Region (R4)

Physical Description

The scrub mint is a dense or straggly, low-growing shrub (Kral, 1983). It reaches 50 cm in height and grows from a deep, stout, spreading-branching taproot. Its branches are mostly spreading, and sometimes are prostrate. Its shoots have two forms, one which is strictly leafy and overwintering, and another which is flowering and dies back after fruiting. The leaves vary in shape. They can be narrowly oblongelliptic, linear-elliptic, or linear-oblongate (Kral 1983). The upper surface of the leaves is dark green, with the midrib slightly impressed. The lower surface is slightly paler, with the midrib slightly raised. They are 1.5 to 2.5 cm long, 2 to 3 mm wide, subsessile, flattish but somewhat fleshy, narrowly or broadly rounded at the apical end, have entire margins, and are not revolute. Scrub mint has an inflorescence that is elongated and interrupted, and, at least half of the flowering shoot is floriferous (Kral 1983). The calyx, at anthesis, is approximately 9 to 10 mm long, nearly erect, proximally and medially green, and distally tinged with red, with a broad white zone around the orifice. The corolla is 1.9 to 2.0 cm long, with an erect tube that is approximately 7 mm long. The external surface of the throat and limb is white or yellowish white. The upper lip is marked internally with a trellis pattern of lines and dots of deep purple, while the lower lip is maculate with larger, concentric spots from lobe bases to base of the lip. The flower has two pairs of stamens, with one pair slightly longer than the other (Kral 1983). The filaments are white, and the anthers are purple. Styles are almost white and bent forward or curved downward (usually above the anthers). (USFWS, 1999)

Taxonomy

Dicerandra frutescens was named by Lloyd Shinnery (1962); his circumscription of the species was modified by Huck (1981), who reassigned specimens from Sumter and Marion counties to a new species, *Dicerandra cornutissima*. Kral (1982), working independently of Huck, came to the same conclusion. (USFWS, 1999)

Historical Range

Historically distributed more or less contiguously along a high yellow-sand ridge that has only been fragmented within the last 40 to 60 years (Menges et al. 2001). (USFWS, 2009)

Current Range

Dicerandra frutescens is endemic to a very limited portion of the Lake Wales Ridge in Highlands County, Florida, and is found at four localities. The mint occurs at Archbold Biological Station; in the Sun 'n' Lakes Estates subdivision east of US highway 27 and southeast of the town of Lake Placid; at YMCA Camp Florida on the west side of Grassy Lake southeast of the town of Lake Placid; and on a sand ridge along the northwest shore of Lake Placid. All four of these areas are native vegetation which are surrounded by agricultural and residential areas. (NatureServe, 2015.)

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexually, with outcrossing (USFWS, 1999)

Dependency on Other Individuals or Species

Adult: Needs insects for pollination (USFWS, 1999)

Other Reproductive Information

Adult: Scrub mint is insect pollinated and requires insect visits for seed production (Evans et al. 2004). *Exprosopa fasciata* (Diptera: Bombyliidae), a bee-fly is the dominant pollinator, accounting for 95 percent of all visits at Archbold Biological Station (ABS) . (USFWS, 2019).

Reproduction Narrative

Adult: *Dicerandra frutescens* has perfect flowers (Kral 1983) and reproduces sexually, with outcrossing (Huck 1981). It is not capable of spreading clonally (Menges 1992), but has been shown to root easily from cuttings of vegetative growth (FWS 1987). Growth containing flowers or flower buds will also root, but will often flower then die (FWS 1987). Its flowers have spurred anthers, which require triggering by insects to release and disperse pollen (FWS 1987). Though visited by a variety of insects (Huck et al. 1989), the scrub mint is pollinated mainly by bee-flies (Menges 1992). Its flowering occurs from August through winter, and fruit production occurs from September through winter (Wunderlin 1984). (USFWS, 1999)

Habitat Type

Adult: Scrub vegetation

Environmental Specificity

Adult: *Dicerandra frutescens* is a gap-utilizing species; it inhabits open areas in the vegetation. It does not tolerate shading by other plants. (USFWS, 1999)

Habitat Narrative

Adult: *Dicerandra frutescens* is mostly restricted to excessively drained, yellow sandy soils of the Astatula and Paola soil types (Menges 1992). However, it has been found on a moderately well-drained, yellow sand of the Orsino type (Menges 1992). In these soil types, scrub mint occurs adjacent to or within disturbed areas in sand pine scrub, oak scrub and sandhill habitats (FWS 1987, Menges 1992). It occupies sites with shallow litter layers that have an incomplete, or non-existent, tree and shrub canopy (Menges 1992). (USFWS, 1999)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: The scrub mint's seed dissemination mechanisms are unknown, though they possibly include passive dispersal (E. Menges, Archbold Biological Station, personal communication 1997). It is possible that the seeds are not dispersed far from the parent plant, since seed dispersal in the related Lakela's mint (*Dicerandra immaculata*) is known to be very limited. Observations of an introduced population of Lakela's mint at Hobe Sound NWR indicate that the

seedlings occur a maximum distance of 2 m from parent plants (Race 1994). Scrub mint's seeds survive in the seed bank for at least 2 years (E. Menges, Archbold Biological Station, personal communication 1997), and if dispersal in scrub mint is similarly limited, then persistence in the seed bank may be an important strategy that this species uses for colonizing newly disturbed areas. (USFWS, 1999)

Population Information and Trends

Number of Populations:

14

Population Size:

~5,000

Population Narrative:

In the most recent FNAI Element Tracking Summary (FNAI 2015), scrub mint was known from 14 occurrences, 7 of which were on managed areas. The other seven occurrences were located on private land and their status was unknown. Based on 2008 aerial images, it appeared that four occurrences were likely extirpated or heavily disturbed and another five were possibly still extant based on remaining habitat in the area where they were previously recorded. Scrub mint populations are dependent on fire for long-term persistence (Menges et al. 2006). There is an inverse relationship between time-since-fire and multiple demographic and reproductive factors, including mortality of adult plants, growth and maturation rates, plant fecundity, number of pollinator visits, and seedling recruitment. Populations begin to decline six years after a fire (Menges et al. 2006; Evans et al. 2008). A population viability analysis (PVA) indicated that population growth rates decline below the replacement level of 1.0 (on average) in populations that remain unburned more than five years (Menges et al. 2006). Most demographic parameters peak at 3 to 5 years post-fire, after which populations experience a long, slow decline (Menges and Weekley 1999). Stochastic simulations using both regular and stochastic fire regimes predicted that fire return intervals of 6 to 12 and 6 to 21 years, respectively, were optimal for minimizing extinction risk. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat destruction or modification

Exposure:

Response:

Consequence:

Narrative: This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 million persons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land

uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

Stressor: Lack of adequate fire management

Exposure:

Response:

Consequence:

Narrative: Fire is necessary to maintain the scrub habitats upon which this species depends. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time (Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species. (USFWS, 2019)

Stressor: Limited geographic range

Exposure:

Response:

Consequence:

Narrative: This species occurs within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

Stressor: Drought

Exposure:

Response:

Consequence:

Narrative: Drought exacerbates declines due to lack of fire and prevents strong post-fire recovery of scrub mint populations. Regeneration of populations from seed after fire appears to be lower due to reduced seedling survival when a 'dry' year follows a fire. At ABS, a burn in 2006

was followed by a drought period and did not result in a strong population recovery as observed following other fire events. Since 2005, the scrub mint populations at ABS have been declining. Few seedlings were recruited in 2006 and 2007 (E. Menges pers. comm. 2008). Although 188 seedlings recruited early in 2008, less than half (48.4 percent) survived the spring drought (C. Weekley, pers. comm. 2008). (USFWS, 2009)

Recovery

Reclassification Criteria:

1. Enough demographic data are available to determine the appropriate numbers of self-sustaining populations required to ensure 20 to 90 percent probability of persistence for 100 years (USFWS, 1999)
2. When these populations, within the historic range of *D. frutescens*, are adequately protected from further habitat loss, degradation, and fire suppression (USFWS, 1999)
3. When these sites are managed to maintain the seral stage of xeric oak scrub that supports *D. frutescens* (USFWS, 1999)
4. When monitoring programs demonstrate that these sites support populations of sufficient sizes, are distributed throughout the historic range, and are sexually or vegetatively reproducing at sufficient rates to maintain the population (USFWS, 1999)

Delisting Criteria:

1. At least 20 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)
2. Populations (as defined in criterion 1) in yellow sand scrub habitats are distributed across the known range of the species. (USFWS, 2019)
3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

Recovery Actions:

- Determine current distribution of *D. frutescens*. Conduct surveys of *D. frutescens*. Maintain distribution of known populations and suitable habitat in GIS database. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Continue research on life history characteristics of *D. frutescens*. Although recent work on *D. frutescens* can be used to infer answers to some life history questions, much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species more specific biological information is needed. (USFWS, 1999)
- Monitor existing and reintroduced populations of *D. frutescens*. (USFWS, 1999)

- Provide public information about *D. frutescens*. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. However, caution should be taken to avoid revealing specific locality information of *D. frutescens*. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of *D. frutescens* and other rare species require a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- Habitat-Level Actions: Prevent degradation of existing habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

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SPECIES ACCOUNT: *Dicerandra immaculata* (Lakela's mint)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015)

Physical Description

Lakela's mint is a small, fragrant shrub that can be differentiated from other *Dicerandra* by its spotless, lavender-rose colored flower. Lakela's mint reaches 20 inches (in) tall (Kral 1982). Its growth is bushy when in open sun but becomes lax when in shade. It forms small mats or domes of ascending to spreading or sprawling branches. The primary branches arise from a stout, deep, woody-branched taproot, and its numerous innovations arise from spreading or sprawling older growth. The main leaves are spreading (horizontal) or ascending (pointing upward), while those in the inflorescence (flower cluster) are sometimes reflexed (pointing downward) (Kral 1982). All leaves are linear, oblong-linear, linear-elliptic, linear-lanceolate or linear-oblongate in shape. They are 0.75–1.2 in long, 0.08–0.16 in wide, smooth, flattened, subsessile, narrowly rounded at the apical end, often slightly emarginate, and entire, though larger leaves can be minutely serrulate at the apical end. The inflorescence is usually 6–10 in long (Kral 1982). Its flowering cymes overlap and each has one, three, or five flowers. The calyx body is 0.28–0.31 in long and is usually purplish, becoming white or roseate toward the orifice. The corolla is about 0.75 in long, immaculate (not spotted), and is a bright lavender-rose. The upper corolla lip is broadly ovate to obovate, about 0.28 in long, apically upswept, and broadly rounded-emarginate. The lower lip is broadly obovate, trilobate, 0.35–0.40 in long, and downswept. The lateral lobes are spreading, oblong, broadly rounded, or oblique-truncate, and the medial lobe is emarginate. The anthers are exserted, and the style is projecting. (USFWS, 2016)

Taxonomy

The color of the corolla, lavender-rose to purplish, and its lack of spots separate Lakela's mint from other species of the *Dicerandra* genus (Service 1985). A new variety, *D. immaculata* Lakela var. *savannarum*, was described from southern St. Lucie County and is separated from *D. immaculata* var. *immaculata* by its wider leaves and lax habit (Huck 2001). With the original description of *Dicerandra immaculata* (Lakela 1963), Lakela briefly described and named a white-flowered form she found in the populations. She named this form *D. immaculata* forma *nivea* Lakela. In accordance with 50 CFR Subpart B, section 17.12(g), when we listed Lakela's mint as an endangered species, all lower taxonomic units were considered included as the listed entity. Thus the taxon *D. immaculata* forma *nivea* was treated as endangered at the time of listing. Although described as a different, but still lower taxonomic rank than species, the same endangered status applies to the more recently described *D. immaculata* var. *savannarum*. (USFWS, 2016)

Historical Range

The historic range of Lakela's mint is extremely small, encompassing an area only one-half mile wide by three miles long in southern Indian River and northern St. Lucie Counties (USFWS, 1999).

Current Range

The current range of Lakela's mint is limited to St. Lucie and southern Indian River Counties in Florida, with an additional introduced site in Martin County. (USFWS, 2008)

Critical Habitat Designated

Yes;

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Seedling recruitment occurs primarily from December through March but can occur at any time of the year (Peterson et al. 2009). Leafing occurs from February to August. Anthesis occurs primarily from September to November and sporadically throughout the year. Fruiting occurs primarily from October to December and sporadically throughout the year (Austin et al. 1980). Mortality rates increase during September through December (Peterson et al. 2009). Plants appear to become reproductive at 1 to 2 years of age (Peterson et al. 2009). However, Lakela's mint has very low germination rates and germination is inconsistent (Peterson et al. 2009). Experimental germination trials seem to indicate that fire may increase germination success (Peterson et al. 2007); however, Huck (in litt. 2008) cautioned that fire does not trigger germination and should be used with care. Lakela's mint only reproduces through seeding and needs insects for pollination. Its flowers have spurred anthers, which require triggering by insect vectors to release and disperse pollen (Service 1987). Not all of the insect species responsible for the pollination of this mint are known, but it is thought that bees may pollinate the plants (Huck 1987). Seed dispersal of Lakela's mint is limited. Introduced colonies at the Hobe Sound National Wildlife Refuge (NWR) have dispersed no more than 6.5 feet from parent plants (Race 1994). In addition, Austin et al. (1980) indicated that areas of disturbed sandy soils within the vicinity of Lakela's mint colonies provided no evidence of recolonization. Oliveira et al. (2007) indicated that closely related taxa occur in close physical proximity to one another, which supports seed dispersal hypotheses; there is a lack of long-distance seed dispersal except by intermittent rainfall events that transported fruits along waterways, by high winds from hurricanes, or by the rise and fall of sea level during the Pleistocene as new habitat formed (Huck and Chambers 1997, Oliveira et al. 2007). It is interesting to note that all of the perennial taxa, including Lakela's mint, have very narrow geographic distributions, whereas the annuals are more widely distributed and none are listed or considered rare.

Habitat Type

Adult: Scrub

Habitat Narrative

Adult: Lakela's mint is found in light shade or clearings in scrub in a limited area along the Atlantic coastal ridge in south Florida (Service 1987). Lakela's mint is a "gap" species. It abounds in open sunlight, but becomes straggly and weak as woody plants and saw palmetto invade open areas (Kral 1982). It occupies sites with varying degrees of litter, from partly covered to bare sand. These bare sands are probably created through a combination of wind action and fires. The mint has been observed growing on both white and yellow sands of the following soil series: Astatula sands, Paola sands, and St. Lucie sands (Service 1985). These soils are deep, nearly level to sloping, occur on high, dune-like ridges, and are acidic. Intensive site maintenance, including removal of vines, invasive species, grass competitors, and small trees and limbs that over-shade the plants, improves habitat conditions and provides additional

capacity to support more individuals (Peterson et al. 2007). However, if not managed as such, overgrowth of the habitat reduces the amount of sunlight available and increases competition from other plants for nutrients and light, rendering long-term proliferation of the species unlikely without fire or other disturbance. Habitat conditions in and around the existing populations of *D. immaculata* var. *savannarum* also continue to deteriorate, resulting in population decline (Barry et al. 2007).

Dispersal/Migration

Population Information and Trends

Population Trends:

Declining (USFWS, 2008)

Number of Populations:

11

Population Size:

6,100 - 9,660

Adaptability:

Very sensitive to disturbance and successional canopy closure. (NatureServe, 2015)

Population Narrative:

Like other *Dicerandra* species, Lakela's mint is protected from insect herbivory by its essential oils (McCormick et al. 1993). Likewise, the variety *savannarum* also has essential oils, although it contains three compounds that are not present in Lakela's mint (Peterson et al. 2009). The cut leaves of one of its relatives, scrub mint (*Dicerandra frutescens*), have been shown to repel ants, and only Pyralid moths are known to feed on it (Eisner et al. 1990). Whether Lakela's mint is protected to this degree has not been verified. Though resistant to insect feeding, Lakela's mint populations have been adversely affected by mildew. Mildew grows on the nectary glands and can cause destruction of the fruits, destroying the viability of seeds before dispersal (Austin et al. 1980, Robinson 1981). Because of urban development, the overall distribution of Lakela's mint is significantly reduced. Trends in spatial distribution show increasing fragmentation of Lakela's mint as the coastal ridge has become developed and fire has been suppressed. Spatial distribution of Lakela's mint may be affected by disturbance factors. All *Dicerandra* mints, including Lakela's mint, in the southeastern United States tend to grow on disturbed sites, such as eroded dunes, sides of scraped dirt roads, fire lanes, unsodded banks, drainage ditches with loose sand, steep river banks, and gopher tortoise holes (Huck 1987, Huck in litt. 2008). On the Hallstrom Farmstead, plants are generally clustered in two areas on the property at tree-line edges next to sand paths or sandy openings (Peterson 2007a). The Service has observed that the distribution of the other remaining large natural population is similar. During fall 2006, 29 private properties in coastal scrub within the vicinity of the Hallstrom Farmstead and south to Indrio Road were surveyed (Peterson 2007b, Peterson et al. 2007). Only one new mint site was identified from this effort, and it contained approximately 10 plants (Peterson et al. 2007). It is presumed that this colony is part of one of the originally identified Florida Natural Areas Inventory sites (Peterson 2007b, Peterson et al. 2007). Additionally, two other sites containing the mint were brought to our attention (Peterson 2007b, Peterson et al. 2007). These small

colonies were estimated to each contain 15-50 individual plants (Peterson 2006). All of these new sites are at risk of being developed and rescue efforts to obtain and preserve genetic material have taken place. At least one of the sites has already been cleared for development (Peterson et al. 2007). The population where it is believed that Dr. O. Lakela first collected the original type specimen for the species 45 years ago has disappeared (Huck in litt. 2008). Additionally, 53 private parcels encompassing over 100 acres along the Atlantic coastal ridge from Midway Road south to County Line Road in St. Lucie County and additional areas in Martin County south to Sewall's Point were surveyed to determine if the variety occurs in other locations, but no new populations were observed (Barry et al. 2007). At least seven sites where Lakela's mint occurred have been extirpated, including one that contained the new variety. In total, there are seven extant sites where populations naturally occur and four introduced populations. However, two of the sites where they occur naturally are slated to be developed. Four of the natural sites are privately-owned and three are on public lands. The four introduced populations (two populations of Lakela's mint and two of the new variety) are all on public lands. Trend data indicate declines in populations of both Lakela's mint and the variety savannarum. The total population of Lakela's mint is estimated to be between 6,100 and 9,660 plants (Peterson et al. 2009). When first discovered in 1995, approximately 200 individuals of the new variety were counted (Huck 2001). Due to drought and over-shading from competing plants, the natural population steadily declined to 89 individuals in 2005 and to nearly zero plants in 2012 (Peterson and Richardson in press). Lakela's mint occupies open areas in scrub, so prescribed burning or equivalent management is necessary to maintain the quality of its habitat. The way this species responds to disturbance and the frequency of disturbance needed are not known.

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Continued habitat loss, fragmentation, and changes in land use threaten the existence of Lakela's mint. Although a few populations are on sites that are publicly owned, populations on private sites are threatened with destruction or habitat modification due to improper or lack of management. - Just since July 2006, HBS has rescued plants from two sites slated for development that were identified as a result of the survey effort from the Hallstrom Farmstead south to Indrio Road, one containing 2 plants and the other containing 56 (Peterson et al. 2007). The germplasm was added in the National Collection, but the sites where these plants naturally occurred have now been lost. One of these sites was near the Hallstrom Farmstead, but because recent surveys in the surrounding area have yielded no positive results it is presumed that all adjacent colonies have been lost to development (Peterson et al. 2007). - Two additional plant rescues have been initiated since July 2006, and HBS is in the process of tagging and removing seeds and cuttings from all individuals on the sites with the hope of removing as many adult plants as possible (Peterson et al. 2007). One site containing 50-100 plants will be cleared to become a retention pond as part of a road project, and a bridge and development will be built through the other property that contained over 500 healthy plants and seedlings (Peterson et al. 2007). The only two locations where the variety is known to occur naturally are on private lands and both are threatened with destruction as a result of lack of management, dumping, or development (Peterson et al. 2007). Because of these threats, some of the plants were rescued, propagated,

and introduced onto protected land in 2005, and germplasm was placed in the National Collection for preservation of genetic material (Peterson et al. 2007). However, it is probable that both of these natural populations will be extirpated. - Between 2005 and 2060 Florida's population is projected to double from approximately 18 to 36 million people (Zwick and Can 2006). Assuming a similar pattern of development at current gross urban densities for each county, this translates into the need to convert an additional 7 million acres of undeveloped land into urban land uses (Zwick and Carr 2006). It is projected that the coastal counties of Florida will be almost entirely built out by 2060 (Zwick and Carr 2006). Within the range of Lakela's mint, the model predicts that the human population will grow from just below 130,000 to nearly 285,000 in Indian River County and from 232,000 to over 563,000 in St. Lucie County between 2005 and 2060 (Zwick and Can 2006). Therefore, habitat loss, degradation, and fragmentation continue to threaten the species. (USFWS, 2008)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Generally, managing agencies have limited regulatory tools. The Act provides protection for this species and its habitat through section 7 (interagency cooperation). Lakela's mint is also listed by FDACS as endangered (5B-40.0055 Regulated Plant Index), but this legislation does not provide any direct habitat protection. Existing federal regulations prohibit the removal or destruction of listed plant species on Federal lands. State regulations require both written permission from the owner or legal representative and a permit issued by FDACS to collect or remove plants listed as endangered on the Florida Regulated Plant Index. However, these regulations afford no protection to listed plants on private lands. In some situations, existing regulatory mechanisms do not appear to be adequate, as several private properties with mints have been developed, and the only option for the plants was to rescue them prior to clearing. Because this plant occurs in habitat along the Atlantic coastal ridge, which is desirable real estate for development due to its elevation, this species remains vulnerable where it occurs on private property. (USFWS, 2008)

Stressor: Land management practices (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Land management practices such as canopy reduction are vitally important to maintaining and working towards recovery of Lakela's mint. Even though some sites are protected from development, habitat degradation may still be a concern at these sites. This species occurs in scrub habitat along the Atlantic coastal ridge, which is typically maintained by fire (Peterson 2007b). On many privately owned scrub sites, fire has historically been suppressed, and habitat has not received regular maintenance. If sites are not regularly maintained, vines tend to overtake the mints, competition for light, water, and nutrients from grasses and invasive species becomes too great, and limbs and small trees limit the amount of available sunlight necessary for survival (Peterson 2007b). Invasive plant species that impact the mints include, but are not limited to, Brazilian pepper (*Schinus terebinthifolius*), rosary pea (*Abrus precatorius*), natal grass (*Rhynchelytrum repens*), and guinea grass (*Panicum maximum*). (USFWS, 2008)

Stressor: Other natural or manmade factors (USFWS, 2008)

Exposure:**Response:****Consequence:**

Narrative: Vegetation restoration and management programs are costly, and the availability of funding is never assured; therefore, habitat modification from inadequate management on protected lands remains an imminent, though moderate, threat. Degradation to habitat can also occur from damage by feral hogs (*Sus scrofa*), as cited in recent reports that assessed three Florida state parks (Engeman et al. 2003, 2004). Also, the species' limited distribution renders it vulnerable to random natural events, such as hurricanes and drought. (USFWS, 2008)

Recovery**Reclassification Criteria:**

Not defined. (USFWS, 1999; USFWS, 2019)

Delisting Criteria:

1. When at least 20 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (Factor A) (USFWS, 2019)
2. When populations (as defined in criterion 1) in coastal sand pine scrub habitat are distributed across the historical range of the species in order to maintain and enhance the species geographic patterns of genetic diversity. (Factor A) (USFWS, 2019)
3. When populations (as defined in criterion 1) must be protected via a conservation mechanism and managed such that enough suitable habitat is present for the species to remain viable for the foreseeable future. (Factors A, D, E). (USFWS, 2019)

Recovery Actions:

- 1. Determine current distribution of *D. immaculata*. A comprehensive survey of *D. Immaculata*'s range was completed in fall 1996. Taxonomic questions still exist with a newly located population at the Martin County border that make a definitive distribution difficult. (USFS, 1999)
- 2. Protect and enhance existing populations. Much of the native xeric uplands on the Atlantic coastal ridge has been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- 3. Conduct research on life history characteristics of *D. immaculata*. To effectively recover this species, more specific biological information is needed. (USFWS, 1999)
- 4. Monitor existing populations of *D. immaculata*. Develop monitoring protocol to assess population trends for *D. immaculata*. Develop a quantitative description of the population structure of *D. immaculata*. Monitor re-introduced plants. (USFWS, 1999)
- 5. Provide public information about *D. immaculata*. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. However, caution should be taken to avoid revealing specific locality information of *D. immaculata*. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of

threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of *D. immaculata* and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)

- **Habitat-level Recovery Actions:** Prevent degradation of existing habitat. Extensive habitat loss, degradation, and fragmentation have already occurred throughout the range of this species. Both urbanization and fire suppression have decreased the available habitat. To date, there are no protected sites for this species in its historic range. - Restore areas to suitable habitat. Native habitats that have been disturbed or that have experienced a long history of fire suppression may be good candidates for future reserves. - Conduct habitat-level research projects. Study the response of *D. immaculata* to various land management practices, such as prescribed fire regimes, vegetative thinning, and control of exotic/invasive vegetation. - Monitor habitat/ecological processes. Monitor the effects of land management actions, such as prescribed fire, mechanical disturbance, etc., on the habitats where *D. immaculata* occurs. - Provide public information about xeric vegetative communities and its unique biota. (USFWS, 1999)

Conservation Measures and Best Management Practices:

- Continue to survey potential habitat and pursue conservation agreements/implement management recommendations and/or acquire land. This is a high priority action, particularly for *D. immaculata* var. *savannarum*. • Include *D. immaculata* var. *savannarum* in conservation programs to conserve the genetic diversity found in the entire genus (Oliveira et al. 2007) • Write a management plan after acquisition of the portion of property containing the Lakela's mint at the HBOI property. (USFWS, 2008)
- Identify additional reintroduction sites and establish reintroduced populations; population augmentations should also be implemented. • Continue monitoring for both reintroduced and natural populations. • Propagation efforts should continue and clones of the original "parent" should be placed throughout the Halstrom site to augment the population. • Where private sites are being developed, efforts should be continued to rescue individual plants and use them for propagation or to augment populations on protected sites. (USFWS, 2008)
- Federal, state, and local agencies, botanical gardens, and conservation organizations should convene to evaluate the current status of protection and the level of implementation of management practices at each site and to discuss current levels of support, threats to habitat and individual plants, and any obstacles to management and recovery. (USFWS, 2008)
- Evaluate the effects of climate change on the species, including those that result from precipitation pattern changes and temperature rise. (USFWS, 2008)
- To re-create open soils, managers should consider implementing mechanical disturbance, such as scratching or raking around plants, removing competitive plants in the vicinity of mints, or lightly disking larger areas, after mints flower but before the fruits drop (approximately two months after blooming) (Huck in litt. 2008). • Work with staff at Savannas Preserve State Park to understand habitat requirements of this species. • Conduct research on the response of Lakela's mint to fire and fire prescriptions necessary to benefit the species. • Continue seed germination studies and make efforts to develop additional outplanting techniques, especially those that may alleviate dessication of plants during dry conditions. • Demographic studies such as long-term survival and potential correlations with rainfall cycles and other variables should be examined. (USFWS, 2008)
- Opportunities should be sought where possible to include the media in the first Hallstrom Farmstead augmentation to provide information about this species to the public. • Conduct

additional research on the biology, ecology, genetics, and management needs of the species. (USFWS, 2008)

- Partnerships should be promoted to share information, conduct collaborative research on coastal scrub habitat conservation, and provide land managers and the interested public with information about the ecosystem, threats, recovery actions, and associated rare biota. • Continue management actions to include removal of debris and exotics, canopy and vine reduction, controlling public access, re-creation of open areas and loose sands, and the careful reintroduction of prescribed fire into the ecosystem. (USFWS, 2008)

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SPECIES ACCOUNT: *Diplacus vandenbergensis* (= *Mimulus fremontii* var. v.) (Vandenberg monkeyflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 9/25/2014; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

Vandenberg monkeyflower is a small, annual herbaceous plant that grows from 0.5 to 10 inches (in) (1.2 to 25.4 centimeters (cm)) tall. The stems are glandular and usually green with purplish tinting. Leaves are obovate (narrowly elliptic) and reach 1.2 in (3 cm) in length. Plants produce a single flower or plants are branched producing multiple flowers. The tubular yellow flowers are bilaterally symmetrical, with the distal ends of the petals forming a unique structure that is likened to a face; hence the common name monkeyflower. Seed capsules are ovoid and reach 0.5 in (1.3 cm) in length. The capsule splits open longitudinally from the tip to release approximately 20 to 100 seeds. (USFWS, 2013)

Taxonomy

Vandenberg monkeyflower was first described as *Mimulus fremontii* (Benth.) A. Gray var. *vandenbergensis* D.M. Thompson (Thompson 2005, p. 134) as a member of the Scrophulariaceae (figwort family). This is the name and family placement we have previously followed. Molecular systematics studies examining members of the Scrophulariaceae, including *Mimulus*, determined that this genus and a few others constituted a separate monophyletic group warranting recognition at the family rank as Phrymaceae (Beardsley and Olmstead 2002, pp. 1193-1101; Olmstead 2002, p. 18). Placement of *Mimulus* in the family Phrymaceae is recognized by species experts, is used in the recent flora of California (Thompson 2012, pp. 988-998), and will be treated as such in the upcoming volume of the Flora of North America. In 2012, Barker et al. (2012) recognized a redefined genus *Diplacus* that includes 46 taxa previously segregated as *Mimulus*, including Vandenberg monkeyflower as *Diplacus vandenbergensis* (D.M. Thompson) Nesom (Barker et al. 2012, p. 29). The citation in Barker et al. (2012, p. 29) attributes the nomenclatural combination at the species rank to Nesom in *Phytoneuron* 2012-47: 2, which was published electronically on the same day as Barker et al. (2012). The Start Printed Page 64842 current citation for Vandenberg monkeyflower is at the species rank as *Diplacus vandenbergensis* (D.M. Thompson) G.L. Nesom. This combination is accepted by species and genus experts and will be used in the upcoming treatment in the Flora of North America. Accordingly, we will use the correct name (*Diplacus vandenbergensis*) and family attribution (Phrymaceae) throughout this and subsequent documents. (USFWS, 2013)

Historical Range

Historical locations for Vandenberg monkeyflower are known from Santa Rita Valley, Lower Pine Canyon, Lower Santa Lucia Canyon in Santa Barbara County, California. (USFWS, 2013)

Current Range

Endemic to the eastern portion of Burton Mesa (Wilken 2010 in Elvin 2010) in Santa Barbara County, California. *Mimulus fremontii* var. *vandenbergensis* is bounded by Purisima Hills to the north and east, Santa Ynez River to the south, and the mesa edge on the west side of Santa Lucia Canyon, including the tributary canyons to the west (e.g., Lakes, Oak, and Pine Canyons).

The habitat and soils that it grows on are only found in a crescent-shaped area approximately 10.7 km long by 3.0 km wide that comprises less than 6,070 ha or 60.7 square km (Elvin 2010). (NatureServe, 2015)

Critical Habitat Designated

Yes; 9/10/2015.

Legal Description

On August 11, 2015, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective September 10, 2015) for *Diplacus vandenbergensis* (Vandenberg monkeyflower) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four critical habitat units (CHUs), in California (80 FR 48142-48170).

Critical Habitat Designation

The critical habitat designation for *Diplacus vandenbergensis* includes four CHUs in Santa Barbara County, California. This species critical habitat encompasses approximately 5,755 acres (ac) (2,329 hectares (ha)). Brief descriptions are presented below. Maps depicting the CH units are available in the Final Rule. (80 FR 48142-48170).

Unit 1: Vandenberg: Unit 1 is within the geographical area occupied by Vandenberg monkeyflower at the time of listing and consists of 223 ac (90 ha). Unit 1 is located adjacent to and between two extant occurrences (Oak Canyon and Pine Canyon, which are located on Vandenberg AFB) and is known to support suitable habitat for Vandenberg monkeyflower.

Unit 2: Santa Lucia: Unit 2 is within the geographical area occupied by Vandenberg monkeyflower at the time of listing, is currently occupied by the species, and consists of 1,484 ac (601 ha). This unit includes State lands (96 percent) within the Reserve, relatively small portions of local agency lands (for example, school districts, water districts, community services districts) (less than 1 percent) and private lands (3 percent). Unit 2 contains the appropriate vegetation structure of contiguous chaparral habitat with canopy gaps (PCE 1) and loose, sandy soils (PCE 2) that support Vandenberg monkeyflower. The eastern boundary of Vandenberg AFB delineates the western boundary of this unit. Unit 2 includes most of the Vandenberg and Santa Lucia Management Units of the Reserve. Unit 2 extends from Purisima Hills at the northern extent through the width of Burton Mesa to the agricultural lands south of the Reserve, and to the eastern boundary of the Vandenberg and Santa Lucia Management Units where these units abut Vandenberg Village.

Unit 3: Encina: Unit 3 is within the geographical area occupied by Vandenberg monkeyflower at the time of listing and consists of 2,024 ac (819 ha). This unit contains State-owned lands (72 percent), including most of the Encina Management Unit of the Reserve, local agency lands (1.2 percent), and privately owned lands such as areas adjacent to the Clubhouse Estates residential development (27 percent) (see Table 1 above). Unit 3 contains the appropriate vegetation structure of contiguous chaparral habitat with canopy gaps (PCE 1) and loose, sandy soils (PCE 2) that support Vandenberg monkeyflower. Unit 3 extends from approximately the Purisima Hills to the north, through the Reserve and to the agricultural lands just south of the Reserve boundary, and is between Vandenberg Village and State Route 1 to the east and the residential communities of Mesa Oaks and Mission Hills to the west.

Unit 4: La Purisima: Unit 4 is within the geographical area occupied by Vandenberg monkeyflower at the time of listing and consists of 2,024 ac (819 ha). Unit 4 contains mostly State-owned lands (89 percent) consisting of most of La Purisima Mission SHP and a small portion of the La Purisima Management Unit of the Reserve that is north of La Purisima Mission SHP. This unit also contains private land to the east of La Purisima Mission SHP (11 percent), and a small portion of local agency lands (less than 1 percent) (see Table 1 above). Unit 4 contains the appropriate vegetation structure of contiguous chaparral habitat with canopy gaps (PCE 1) and loose, sandy soils (PCE 2) that support Vandenberg monkeyflower. This unit extends approximately from the Purisima Hills in the north to the southern boundary of La Purisima Mission SHP, and between the residential communities of Mesa Oaks and Mission Hills to the west and to just east of, and outside, the State Park's eastern boundary.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Diplacus vandenbergensis* critical habitat consists of two components (80 FR 48142-48170):

(i) Native maritime chaparral communities of Burton Mesa comprising maritime chaparral and maritime chaparral mixed with coastal scrub, oak woodland, and small patches of native grasslands. The mosaic structure of the native plant communities (arranged in a mosaic of dominant vegetation and sandy openings (canopy gaps)) may change spatially as a result of succession, and physical processes such as windblown sand and wildfire.

(ii) Loose sandy soils on Burton Mesa. As mapped by the Natural Resources Conservation Service (NRCS), these could include the following soil series: Arnold Sand, Marina Sand, Narlon Sand, Tangair Sand, Botella Loam, Terrace Escarpments, and Gullied Land.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographic area occupied by the species at the time of listing contain physical and biological features that are essential to the conservation of the species and that may require special management considerations or protection. All areas proposed as critical habitat will require some level of management to address the current and future threats to the physical and biological features essential to the conservation of Vandenberg monkeyflower. In all areas, special management is needed to ensure that the habitat is able to provide for the growth and reproduction of the species. The habitat where Vandenberg monkeyflower occurs faces threats from urban development, maintenance of existing utility pipelines, anthropogenic fire, unauthorized recreational activities, and most substantially the expansion of invasive, nonnative plants (see Factors A and E in the proposed listing rule). Management activities that may reduce these threats include, but are not limited to: (1) Protecting from development lands that provide suitable habitat; (2) minimizing habitat fragmentation; (3) minimizing the spread of invasive, nonnative plants; (4) limiting authorized casual recreational use to existing paths and trails (as opposed to off-trail use that can spread invasive species to unaffected areas); (5) controlled burning; and (6) encouraging habitat restoration. These management activities would limit the impact to the physical or biological features for Vandenberg monkeyflower by decreasing the direct loss of habitat, maintaining the appropriate vegetation structure that provides the sandy openings that are necessary components of Vandenberg monkeyflower habitat, and minimizing invasive, nonnative plants spreading to areas where they currently do not exist. Preserving large

areas of contiguous suitable habitat throughout the range of the species should maintain the mosaic structure of the Burton Mesa chaparral that may be present at any given time, and maintain the genetic and demographic diversity of Vandenberg monkeyflower. (USFWS, 2013)

Life History**Food/Nutrient Resources****Competition**

Adult: Veldt grass, eucalyptus, and pine groves (USFWS, 2015)

Food/Nutrient Narrative

Adult: The Vandenberg monkeyflower competes with non-native species such as veldt grass, eucalyptus, and pine groves (USFWS, 2015)

Reproductive Strategy

Adult: Mixed mating (USFWS, 2015); seed-banking annual (NatureServe, 2015)

Lifespan

Adult: One year (inferred from USFWS, 2015)

Dependency on Other Individuals or Species

Adult: Pollinators to achieve seed production; namely smaller solitary bees to medium and larger social bees (USFWS, 2015)

Reproduction Narrative

Adult: The Vandenberg monkeyflower is a seed-banking annual plant (NatureServe, 2015). It reproduces with a "mixed mating" strategy and, as an annual plant, lives no more than one year. It is dependent on pollinators to achieve seed production, particularly small to large-sized bees (USFWS, 2015).

Habitat Type

Adult: Coastal scrub, chaparral, and woodlands (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Elevation 30-122 m; restricted to the Burton Mesa region (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Moderately sparse (inferred from USFWS, 2014). Restricted to the Burton Mesa region is and openings of coastal scrub, chaparral, and woodlands (NatureServe, 2015)

Habitat Narrative

Adult: The Vandenberg Monkeyflower inhabits coastal scrub, chaparral, and woodland areas. The species is restricted to the Burton Mesa region in sandy openings of coastal scrub, chaparral, and woodlands from 30-122 m in elevation (Elvin 2010). (NatureServe, 2015). Its spatial arrangement is relatively sparse, and habitat connectivity is named as a key resource needed for habitat (USFWS, 2015).

Dispersal/Migration**Dispersal**

Adult: High (inferred from USFWS, 2014)

Dependency on Other Individuals or Species for Dispersal

Adult: Small mammals (USFWS, 2015)

Dispersal/Migration Narrative

Adult: Seeds are primarily dispersed by gravity, along with wind and water over relatively short distances. Long-distance dispersal of seeds occurs in numerous ways, including vertebrate dispersal (e.g. small mammals, by adhesion or ingestion), wind dispersal of seeds (in updrafts and storms, or by secondary dispersal over the substrate), wind dispersal of plants (tumble-plant dispersal), and water dispersal. High dispersal is inferred based on discussion and implied relevancy of the surprisingly long flight distances of its pollinators (USFWS, 2014; USFWS, 2015).

Additional Life History Information

Adult: Gravity is also named as a means of dispersal (USFWS, 2015)

Population Information and Trends**Population Trends:**

Declining (NatureServe, 2015)

Species Trends:

Not available

Number of Populations:

7 (NatureServe, 2015)

Population Size:

2,000 total individuals observed in 2006; size may vary considerably year to year (NatureServe, 2015)

Additional Population-level Information:

The variety was named in 2005 so it is difficult to assess long term trends (NatureServe, 2015)

Population Narrative:

There are 7 known populations of this species. While species level trends are not available, a decline has been observed at the population level. Total population size was 2,000 individuals in 2006 and estimated to be similar in 2009, but acknowledged to likely vary considerably from year to year due to the species' status as a seed-banking annual. One population was destroyed in 2007 while the remaining populations are vulnerable to multiple stressors, notably invasion of non-native species. Long-term trends have been difficult to assess, in part because the variety was named in 2005 (NatureServe, 2015).

Threats and Stressors

Stressor: Habitat destruction and alteration (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: The majority of remaining Burton Mesa chaparral where Vandenberg monkeyflower occurs is within Federal or State-owned lands and is protected from development. Therefore, large-scale future development of remaining Burton Mesa chaparral is not likely to occur and thus is not a significant threat to Vandenberg monkeyflower. However, smaller-scale private property development; access to easements; maintenance of utility, oil, and gas pipelines; fire and fire suppression; and authorized and unauthorized recreational activities may continue to take place throughout Burton Mesa. Some of these activities may occur within Burton Mesa chaparral or adjacent to occurrences of Vandenberg monkeyflower, resulting in the destruction and possible removal of Vandenberg monkeyflower habitat and creating open areas for nonnative plants to invade. Therefore, the direct destruction and alteration of chaparral habitat is likely to continue on a relatively small scale and is thus considered a threat to Vandenberg monkeyflower both currently and in the future. (USFWS, 2014)

Stressor: Utility and pipeline maintenance (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Utility and pipeline structures occur within the Burton Mesa Ecological Reserve (Reserve), and access routes through the Reserve service the Plains Exploration and Production Company oil processing plant, which surrounds the La Purisima Management Unit of the Reserve. Additionally, local land use agencies and public works agencies retain other utilities and pipelines, and easements for access. For example, the Vandenberg Village Community Services District has several structures (including water tanks, a water processing plant, wells, and water lines and sewer lines) located within the Reserve (Gevirtz et al. 2007, p. 63). These existing facilities or structures at times require routine maintenance to ensure proper operation. As a result, vehicles and foot traffic could occur at or adjacent to these structures and potentially result in trampling of habitat and other soil surface disturbance, which in turn could result in ground disturbance that removes Burton Mesa chaparral and creates open areas in the vegetation that act as pathways for nonnative plants to expand or invade. There is no indication that ongoing maintenance activities of existing pipelines and utilities have directly impacted Vandenberg monkeyflower habitat. However, utility maintenance actions could result in ground disturbance that removes Burton Mesa chaparral, creating open areas in the vegetation that act as pathways for nonnative plants to invade. (USFWS, 2014)

Stressor: Invasive, non-native species (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Invasive, nonnative plants occur and are expanding throughout the Burton Mesa. More specifically, at least one of the four most problematic invasive plants occurs within or adjacent to suitable habitat at each of the nine extant occurrences of Vandenberg monkeyflower and at one potentially extirpated location. Invasive plants have demonstrated the ability to reduce the diversity of native vegetation and convert the native shrublands into nonnative-dominated vegetation. (USFWS, 2014)

Stressor: Anthropogenic fire (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Because of the human presence and infrastructure on Burton Mesa, the frequency of human-caused wildfires is likely greater than the frequency of historical fires on the mesa. An increased fire frequency in Burton Mesa chaparral would tend to favor the establishment of nonnative vegetation in open areas at the expense of native vegetation. However, the primary threat to Vandenberg monkeyflower and its habitat from fire is the post-fire expansion of invasive, nonnative plants, regardless of the fire frequency. Because an abundance of nonnative plants already occurs on the mesa, and invasive plants rapidly invade open areas, any fire that occurs within or adjacent to Vandenberg monkeyflower habitat is likely to result in an increase of invasive, nonnative vegetation. Likewise, fire suppression activities that include clearing vegetation in fuel breaks or spreading retardant would increase the likelihood of nonnative species invading suitable Vandenberg monkeyflower habitat, as well as enhance the habitat conditions for invasive species expansion. Additionally, because the presence of invasive, nonnative plants creates a positive feedback mechanism, the greater the percent cover of nonnative vegetation, the more likely fires will occur on Burton Mesa. Based on the information presented in this section, the current threat from anthropogenic fire and associated fire suppression activities to Vandenberg monkeyflower habitat described above is expected to continue into the future. (USFWS, 2014)

Stressor: Recreation (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Recreation is enumerated among the threats and stressors to this species. Recreational activities that occur throughout Burton Mesa include authorized uses such as hunting, hiking, biking, wildlife observation, and leashed-dog walking. Additionally, off-road vehicle (ORV) use is authorized on Vandenberg AFB (Air Force 2011a, p. 6), but it is not permitted on the Reserve (Gevirtz et al. 2007, p. 70) or La Purisima Mission SHP (California State Parks 1991, p. 109). ORV use and other casual recreational activities may contribute to soil disturbance and increase the potential for invasive, nonnative plants to be introduced and further spread across Burton Mesa, including into locations where Vandenberg monkeyflower and its suitable habitat occurs (USFWS, 2014).

Stressor: Climate change (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Climate change is enumerated among the threats and stressors to this species. Climate change may have potential impacts on Vandenberg monkeyflower and its habitat, such as increased temperatures and decreased precipitation that would likely reduce suitable habitat. Scientific measurements spanning several decades demonstrate that changes in climate are occurring, and that the rate of change has increased since the 1950s (FR, 2014).

Recovery

Reclassification Criteria:

Not yet developed

Conservation Measures and Best Management Practices:

- The Air Force has an approved Integrated Natural Resources Management Plan (INRMP) on Vandenberg Air Force Base in 2011. Included are the following components: (1) Development. The Air Force is not likely to construct new launch facilities within suitable habitat near human-populated areas, and the future siting of community facilities is expected to occur in a manner that capitalizes on existing infrastructure and circulation systems (Air Force 2009a, p. 32). Thus, no specific conservation measures have been proposed to minimize the threat of development to Vandenberg monkeyflower or its habitat on Base. (2) Utility Maintenance and Miscellaneous Activities. Construction of new facilities is not likely to occur within Vandenberg monkeyflower habitat; however, existing utilities will require periodic maintenance. No specific conservation measures were proposed in the addendum to the INRMP (Air Force 2012). The main objective is to avoid any impacts to habitat, when possible, by either confining the work to existing disturbed areas or rerouting the work to avoid suitable habitat completely, and minimize the impact as much as possible (Air Force 2012, p. 2). For Vandenberg monkeyflower, the Air Force would avoid impacting Burton Mesa chaparral as much as possible if utility maintenance is required in suitable habitat. (3) Invasive, Nonnative Plants. The INRMP (Air Force 2011a) includes an Invasive Plant Species Management Plan that identifies the threat of invasive, nonnative plants on Base, and proposes removal methods to limit further spread and assist in restoration of habitat degraded by invasive species. In most cases, the Air Force would utilize chemical application to manage for invasive plants (Air Force 2011a, p. 43). Although the INRMP identified invasive, nonnative plants as a threat and calls for their removal, it did not identify which nonnative species, and which areas on Base, were a priority for treatment. In the 2012 addendum to their INRMP, the Air Force identifies veldt grass as the most problematic invasive, nonnative plant on Base for Vandenberg monkeyflower. As part of this addendum, the Air Force also identified their 10-year funding program, which included more than \$500,000 to treat veldt grass, starting in 2009 and continuing through 2019 (Air Force 2012). While the Air Force does not specify precisely where, when, or how much veldt grass will be treated or removed in specific years, they state that a substantial portion of this effort will focus on areas within the range of Vandenberg monkeyflower (Air Force 2012, p. 1). Through 2012, the Air Force has chemically treated approximately 141 acres (57 ha) of invasive, nonnative plants, mostly treating pampas grass within Burton Mesa chaparral but not near extant Vandenberg monkeyflower occurrences (treatment was to benefit *Eriodictyon capitatum* (Lompoc yerba santa)). Other invasive, nonnative plants treated included veldt grass, iceplant, *Eucalyptus* spp. (*Eucalyptus*), and *Pinus* spp. (Pine)). Only a small proportion of this chemical removal occurred within Burton Mesa chaparral at two locations where Vandenberg monkeyflower occurs (Lake and Pine Canyons) (Lum in litt. 2013). (4) Fire. For fires that would affect Vandenberg monkeyflower and its habitat, the Air Force developed a GIS layer incorporating all potential suitable habitat areas, which has been made available to fire response crews for use during actual fire events. Multiple conservation measures that address the potential threat of fire are included in the addendum (Air Force 2012, p. 2), including the following: (a) Established roads, both paved and unpaved, would be used to the greatest extent possible as fire lines unless an emergency dictates otherwise. (b) Burned areas would be assessed after a fire for rehabilitation options within 10 days of the area being declared safe for entry. (c) Vandenberg monkeyflower habitat affected by wildfire and rehabilitation projects will be monitored, which would include recommendations for nonnative species control. (d) Following any significant wildfire event within the range of Vandenberg monkeyflower on Base, a

Burn Area Emergency Response (BAER) project will be initiated. This generally includes implementation of erosion control, native vegetation restoration, firebreak rehabilitation, and invasive species management. Additionally, the addendum proposes to incorporate portions of Vandenberg monkeyflower habitat in a controlled burn program (Air Force 2012, p. 2). (5) Recreation. No conservation measures have been proposed to address the threat of recreation to Vandenberg monkeyflower. (USFWS, 2013)

- **Burton Mesa Ecological Reserve (Reserve):** The State Lands Commission signed a 49-year lease of the Burton Mesa Ecological Reserve on January 20, 2000. The purpose of the lease is to manage, operate, and maintain these sovereign lands for the sensitive species and habitats they support. The CDFW developed a management plan for the Reserve that guides management of habitats, species, and programs to achieve the mission of CDFW to protect and enhance wildlife values. Conservation measures are proposed in the management plan, contingent upon available funding and staffing. (1) Development. Because new development would not occur on the Reserve, there are no conservation measures to implement that would minimize this threat to Vandenberg monkeyflower. (2) Utility Maintenance and Miscellaneous Activities. Several public utilities and local governmental agencies provide services to the local community and use the Reserve to accomplish their roles. Within the Reserve, agencies responsible for conducting maintenance activities submit maintenance plans for all scheduled activities to CDFW, who in turn may request conservation measures (such as modifying the size and frequency of actions) to minimize impacts on natural resources. (3) Invasive, Nonnative Species. The Reserve's management plan encourages minimizing the impact and presence of invasive, nonnative plants, including monitoring and removing nonnative plants; preventing new introductions by working with public utilities, local governmental agencies, and recreationists that use the Reserve; and restoring disturbed and degraded areas with native species. (4) Fire. The CDFW management plan for the Reserve calls for coordination among the Santa Barbara County Fire Department, enforcement agencies, local governmental agencies, and adjacent small and large landowners to ensure that fire risk is reduced, that new development projects adjacent to the Reserve are reviewed by CDFW staff and address fuel reduction needs and requirements, and that appropriate and efficient post-fire remediation takes place, where needed. Reducing the risk of fire would limit the potential for wildfire to occur within Vandenberg monkeyflower habitat, and thus reduce the impact of fire suppression activities and the impact of invasive, nonnative plants invading the habitat post-fire. No controlled burns within Vandenberg monkeyflower habitat have occurred to date. (5) Recreation. CDFW developed a trails plan that shows existing trails within the Reserve as well as proposed new trail construction; seasonal trail closures or restrictions may occur to protect sensitive resources such as wildlife breeding locations or rare plant assemblages that vary from year to year (Gevirtz et al. 2007, p. 70). This system of trails would reduce the risk of authorized recreational uses directly impacting suitable Vandenberg monkeyflower habitat. The management plan calls for maintaining public access to the Reserve through pedestrian hiking trails by providing a network of trails, including loop trails, linking interesting areas while protecting resources, and preventing unauthorized uses (Gevirtz et al. 2007, p. 231).
- **La Purisima Mission State Historic Park:** A general management plan for La Purisima Mission SHP was completed in 1991, and an ecosystem characterization of La Purisima Mission SHP was completed in 2005. Directives specific to La Purisima Mission SHP that concern the habitat where Vandenberg monkeyflower occurs include preserving Burton Mesa chaparral, protecting and managing rare and endangered plants in perpetuity, controlling nonnative plants that have become established, and developing a prescribed-burn plan. Conservation measures are proposed in the general management plan, as outlined below, with implementation contingent upon available funding and staffing. (a) Development. There are multiple existing structures within the park, and

any new structures must provide for visitors' needs without competing for attention with historical buildings or the natural setting. All new development must be sensitive to that purpose of providing appropriate visitor facilities without detracting from the historical and natural setting of La Purisima Mission. Burton Mesa chaparral habitat areas are designated as low-intensity use areas. Therefore, any new development is unlikely to impact Vandenberg monkeyflower or its habitat in the park. (b) Invasive, Nonnative Species. California State Parks' resource management programs try to remove or control invasive, nonnative species and reestablish indigenous native species. (c) Fire. In 2007, California State Parks initiated development of a wildfire management plan that would include management strategies to protect the existing infrastructure (buildings) and protect cultural resources and biological resources of the park (which would include Vandenberg monkeyflower habitat), as well as informing fire suppression agencies of the areas with high-value resources and the limits of fire suppression activities in those areas. No prescribed burns currently occur within the park. (d) Recreation. Consideration will be given to designating trails for specific types of uses and constructing new trail segments to avoid conflicts (California State Parks 1991, p. 65). The trail system requires continual brush and erosion control, in which California State Parks often relies on numerous volunteers such as scouts and environmental groups to assist the park each year in various projects, from litter pickup to trail construction. A designated trail system would reduce the risk of authorized recreational uses directly impacting Vandenberg monkeyflower habitat. However, the best available information indicates that recreational activities are currently having minimal to no effect on Vandenberg monkeyflower habitat at La Purisima Mission SHP

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SPECIES ACCOUNT: *Dodecahema leptoceras* (Slender-horned spineflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 9/28/1987; Pacific Southwest Region (R8) (USFWS, 2015)

Physical Description

An annual plant that has a distinctive basal rosette of leaves ranging from 3 to 8 centimeters (cm) (1.2 to 3.1 inch (in)) in diameter. The leaves frequently become reddish at maturity. The flower stalks are branched and erect 3 to 10 cm (1.2 to 4 in) tall. Flowers are arranged in clusters along the flower stalks and each cluster is surrounded by an involucre (a ring of modified leaves beneath a flower cluster). Characteristic of this species, each of the 6 involucre segments has an awn at its base as well as at its apex. This feature distinguished this genus from the closely related genera *Chorizanthe* and *Centrostegia* (Reveal and Hardham 1989, p. 86). The flowers are white to pink, 1.2 to 2 millimeters (mm) (0.5 to 0.8 in) long, each producing a single achene (a dry single-seeded fruit), 1.7 to 2 mm (0.06 to 0.08 in) long (USFWS, 2010).

Taxonomy

In the buckwheat family (Polygonaceae). At the time of listing, the species was classified as *Centrostegia leptoceras* A. Gray. A reassessment of the distinct morphology of the involucre and relationships to other closely related taxa resulted in a taxonomic revision. The current recognized name for slender horned spineflower is *Dodecahema leptoceras* (A. Gray) Reveal and Hardham (Reveal and Hardham 1989, p. 85) (USFWS, 2010).

Historical Range

See current range/distribution.

Current Range

Southwestern California, in the foothills of the San Gabriel Mountains in Los Angeles County, the San Bernardino Mountains in San Bernardino County, and the San Jacinto Mountains in western Riverside County (USFWS, 2010).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: The level of gene similarity (or homozygosity) detected in this species indicates that *Dodecahema leptoceras* has a mixed mating system (e.g., seed is produced both through pollination between flowers on a single plant and between flowers on different plants), but the latter condition, outcrossing, is more prevalent. The level of gene similarity (or homozygosity) detected in this species indicates that *Dodecahema leptoceras* has a mixed mating system (e.g., seed is produced both through pollination between flowers on a single plant and between

flowers on different plants), but the latter condition, outcrossing, is more prevalent (USFWS, 2010).

Habitat Type

Adult: Terrestrial (USFWS, 2010)

Habitat Vegetation or Surface Water Classification

Adult: Alluvial scrub on sandy and gravelly soils in sandy wash systems (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: Elevation range of 656 to 2,296 feet (USFWS, 2010)

Habitat Narrative

Adult: Species habitat is alluvial scrub on sandy and gravelly soils in sandy wash systems, at elevations ranging from 656 to 2,296 feet, in areas where intermittent, scouring flood events occur (USFWS, 2010). Soils are riverbed alluvium high in silt and low in organic matter (NatureServe, 2015).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Dispersal may be by small animals or sheet flows during heavy rains (USFWS, 2010).

Population Information and Trends**Population Trends:**

Decline of 70-90% (NatureServe, 2015)

Species Trends:

Decline of >50% (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

35 (NatureServe, 2015)

Population Size:

2500 - 10,000 individuals (NatureServe, 2015)

Population Narrative:

The alluvial terrace habitat where this species lives has been severely altered, degraded and destroyed over the past 100 years. The long-term trend is a decline of 70-90%; the short-term trend is a decline of >50%. Thousands of individuals at the San Jacinto River and Temescal Canyon sites. A total of 35 occurrences are known, however, only 19 are non-historic. While several populations are known to be extirpated or historic, between 1/3-2/3 of the story of loss and decline is known. In other words, it is suspected that more decline is occurring than researchers know about (NatureServe, 2015).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The current threats to habitat are urban and agricultural development, mining, altered hydrology, off-highway vehicle activity, trash dumping, fire, invasive nonnative plants, and other habitat degrading activities (USFWS, 2010).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The Endangered Species Act is the primary Federal law that has provided protection for this species since its listing as endangered in 1987 (USFWS 1987, pp. 36265-36270). Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act (USFWS, 2010).

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- There is no final approved recovery plan for this species (USFWS, 2010).

Conservation Measures and Best Management Practices:

- Monitor known and historical occurrences as well as suitable habitat to determine presence and condition of *Dodecahema leptoceras*.
- Identify opportunities to work with private landowners to encourage conservation actions for *Dodecahema leptoceras* on sites that are not conserved. This could be done through the Partners for Fish and Wildlife Program as well other cooperative programs.
- Determine by experimental means and field studies the extent to which the presence of invasive nonnative plants impacts growth and persistence of *Dodecahema leptoceras*.

- Identify pollen and seed (fruit) vectors and their habitat requirements. Incorporate these requirements into habitat management considerations for *Dodecahema leptoceras*.
- Identify the structure and dynamics of the seed bank of *Dodecahema leptoceras*

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SPECIES ACCOUNT: *Dubautia herbstobatae* (Na`ena`e)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/29/1991; Pacific Region (R1) (USFWS, 2016)

Physical Description

Dubautia herbstobatae is a shrub that can be either upright or sprawling, and has stems reaching to 0.5 m (1.6 ft) in length. Its leaves are opposite, or rarely ternate (three per node), and measure 2 to 5.5 cm (0.8 to 2.1 in) long. The inflorescences are borne on the stem tips and contain 5 to 15 yellowish-orange flower heads. The flower heads contain 4 to 20 disk florets and lack ray florets. The achenes (a type of dry, seed-like fruit) are 4 to 6 mm (0.157 to 0.236 in) long and are tipped by feather-like bristles (Wagner et al 1999) (USFWS, 2016).

Taxonomy

A member of the Asteraceae (sunflower) family (USFWS, 2016). The genus is endemic to hawaiian islands, this species is endemic to waianae mts. of Oahu (NatureServe, 2015).

Historical Range

See current range/distribution

Current Range

Dubautia herbstobatae is endemic to the Hawaiian Islands and is known to occur on the leeward side of the northern Waianae Mountains on only two ridge systems. These ridge systems span a distance of approximately 6 km (4 mi). One system includes Ohikilolo Ridge and the ridges in and around Keaau Valley. The second ridge system includes Kamaileunu, encompassing the Kamaileunu and Waianae Kai population units (USFWS, 2016).

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Dubautia herbstobatae* (Pauoa) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Dubautia herbstobatae* (77 FR 57648-57862). The critical habitat designation includes 11 critical habitat units, which encompass approximately 7,332 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Dubautia herbstobatae* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Dubautia herbstobatae* includes 11 critical habitat units, covering two ecosystem types, which encompass approximately 7,332 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3; Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac (105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Dubautia herbstobatae* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Dubautia herbstobatae* occurs within the Lowland mesic and Dry cliff ecosystems in the Waianae Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freyinetia*, *Leptocophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy:

Antidesma, Chamaesyce, Diospyros, Dodonaea. (E) Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Dubautia herbstobatae* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (inferred from USFWS, 2016)

Lifespan

Adult: < 10 years (USFWS, 2013)

Breeding Season

Adult: May - June (USFWS, 2016)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 2016)

Reproduction Narrative

Adult: Flowering usually occurs in May and June. The species is almost certainly pollinated by insects, as are most other yellow-flowered members of the sunflower family, along with those *Dubautia* species whose mode of pollination has been studied (USFWS, 2016). *Dubautia herbstobatae* is a short-lived perennial (< 10 years) (USFWS, 2013).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Moist shrublands and forests (NatureServe, 2015); dry to mesic shrubland and forest (USFWS, 2016)

Habitat Narrative

Adult: Moist shrublands and forests on ridgetops, sides of ridges, steep slopes and cliffs (NatureServe, 2015). *Dubautia herbstobatae* occurs in dry-mesic to mesic areas and is often found on open rocky slopes and cliff faces. These slopes and cliffs are usually more or less north-facing. The vegetation of these habitats is rather sparse shrublands and scrubby forests (USFWS, 2016).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Stable (USFWS, 2013)

Resiliency:

Very low (inferred from USFWS, 2016; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2016)

Number of Populations:

7 (USFWS, 2016)

Population Size:

1,242 (USFWS, 2013)

Minimum Viable Population Size:

50 mature, reproducing individuals (USFWS, 2016)

Population Narrative:

This species appears to be increasing. Currently, there are approximately 1,188 individuals in the Keaau (70 mature plants), Makaha/Ohikilolo (350 mature plants), Ohikilolo/Makai (358 mature plants), Ohikilolo/Mauka (382 mature and six immature plants), Makaha (36 mature and one immature plant), and Waianae Kai (10 mature and four immature plants) population units (U.S. Army Garrison 2005c). *D. herbstobatae* is characterized by three populations each with more than 50 mature, reproducing individuals (the recommended number for stabilization populations for this species; Service 1995a, 1998a) in the action area and four populations outside of the action area each with fewer than 50 mature reproducing individuals (USFWS, 2016). The 1,242 mature and immature individuals reported in 2012 represent little change from the 1,237 reported in the last five-year review (USFWS, 2013).

Threats and Stressors

Stressor: Nonnative plants (USFWS, 1998)

Exposure:

Response:

Consequence:

Narrative: Alien plants compete with natives for space, light, water, and nutrients (Cuddihy and Stone 1990). The most significant aliens appear to be *Schinus terebinthifolius* (Christmas berry), *Psidium cattleianum* (strawberry guava), *Melinis minutiflora* (molasses grass), *Clidemia hirta* (Koster's curse), *Lantana camara* (lantana), *Leucaena leucocephala* (koa haole), *Rubus argutus* (prickly Florida blackberry), *Grevillea robusta* (silk oak), *Erigeron karvinskianus* (daisy fleabane), *Myrica faya* (firetree), *Paspalum conjugatum* (Hilo grass), *Casuarina equisetifolia* (common ironwood), *Passiflora suberosa* (huehue haole), *Ageratina adenophora* (Maui pamakani), *Ageratina riparia* (Hamakua pamakani), *Kalanchoe pinnata* (air plant), *Tibouchina herbacea* (a relative of Koster's curse), and *Ardisia elliptica* (shoebutton ardisia). (USFWS 1995, 1996a, 1996b) (USFWS, 1998).

Stressor: Stochastic events (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: *Dubautia herbastobatae* are vulnerable to extirpation from naturally occurring events such as landslides, hurricanes, flooding, and/or reduced reproductive vigor due to small population size and limited distribution (61 FR 53108; Service 1995a, 1998a) (USFWS, 2016).

Stressor: Feral ungulates (USFWS, 1998)

Exposure:

Response:

Consequence:

Narrative: Animals such as pigs, goats, and cattle were introduced by the early Hawaiians (pigs) or more recently by European settlers (goats and cattle) for food and/or commercial ranching activities. Over the 200 years following their introduction, their numbers increased and the adverse effects of feral ungulates on native vegetation have become increasingly apparent. Beyond the direct effect of trampling and grazing native plants, feral ungulates have contributed significantly to dispersal of introduced plant species and to the heavy erosion still taking place on most of the main Hawaiian Islands (Cuddihy and Stone 1990) (USFWS, 1998).

Stressor: Fire (USFWS, 1998)

Exposure:

Response:

Consequence:

Narrative: Because Hawaii's native plants have evolved with only infrequent, naturally occurring episodes of fire (lava flows, infrequent lightning strikes), most are not adapted to fire and are unable to recover well after recurring, human-set fires. Some alien plants are more fire-adapted than the natives and will quickly exploit suitable habitat after a fire (Cuddihy and Stone 1990). Species that grow in dry and mesic vegetation may be susceptible to fires set accidentally or maliciously, especially near areas of habitation from which fires could easily spread. Fire threatens plants upslope from Makua Military Reservation and Schofield Barracks, where current military firing exercises could unintentionally ignite fires (USFWS, 1998).

Stressor: Human disturbance (USFWS, 1998)

Exposure:

Response:

Consequence:

Narrative: On Oahu, habitat disturbance caused by human activities may threaten rare plant populations that grow where military training exercises and ground maneuvers are occasionally conducted. However, because most of the taxa grow on moderate to steep slopes, ridges, and gulches, habitat disturbance is probably restricted to foot and helicopter traffic. Trampling by ground troops associated with training activities and construction, maintenance, and use of helicopter landing zones could affect many recovery plan plant taxa (USFWS 1995, 1996a, 1996b) (USFWS, 1998).

Stressor: Climate change (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) funded climate modeling that will help resolve these spatial limitations. High spatial resolution climate outputs are expected to be available sometime in 2013 (USFWS, 2013).

Recovery

Reclassification Criteria:

1. A total of five to seven populations should be documented on Oahu and at least one other island where they now occur or occurred historically (USFWS, 1998).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1998).
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1998).

Delisting Criteria:

1. A total of 8 to 10 populations should be documented on Oahu and at least one other island where they now occur or occurred historically (USFWS, 1998).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1998).
3. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1998).

Recovery Actions:

- Protect habitat and control threats (USFWS, 1998).
- Expand existing wild populations (USFWS, 1998).
- Conduct essential research (USFWS, 1998).
- Develop and maintain monitoring plans (USFWS, 1998).
- Reestablish wild populations within historic range (USFWS, 1998).

- Validate and revise recovery criteria (USFWS, 1998).
- Construct strategic fencing to protect populations from feral ungulates (USFWS, 1998).
- Control competing alien plant species in enclosures (USFWS, 1998).
- Maintain adequate genetic stock (USFWS, 1998).
- Provide protection from fire (USFWS, 1998).

Conservation Measures and Best Management Practices:

- The types of management actions needed will depend on local site characteristics but should include fencing, ungulate control, protection from fire, weed control, maintenance of adequate genetic stock, and outplanting of local genetic material (Service 1998a) (USFWS, 2016).
- The Makua Implementation Team (2003) has developed stabilization protocols for *Dubautia herbstobatae* which are incorporated in the Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). *Dubautia herbstobatae* can be successfully propagated from seed, air layers and cuttings. It is represented in several ex situ collections including: 23 cuttings in nurseries (Army Environmental Division, Oahu and Harold L. Lyon Arboretum), 3,000 seeds in seed storage (Lyon Arboretum Seed Storage Facility), and six seedlings in a nursery (Harold L. Lyon Arboretum) (Service 2005b). Feral ungulate control is being implemented by the Army and State in Makua (U.S. Army Garrison 2005b) (USFWS, 2016).
- Captive propagation for genetic storage and reintroduction - Continue seed collection for genetic storage (USFWS, 2013).
- Fire protection – Develop and implement fire management plans (USFWS, 2013).
- Predator / herbivore control – Control rats and slugs (USFWS, 2013).
- Ungulate exclosures - Complete fencing of last unfenced population (USFWS, 2013).
- Surveys / inventories - Survey for populations in known historical sites and suitable habitat (USFWS, 2013).
- Population biology research: Develop pollination studies. Study populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors and threats (USFWS, 2013).
- Reintroduction / translocation - Reintroduce individuals into suitable habitat within historical range (USFWS, 2013).
- Alliance and partnership development - Initiate planning and contribute to implementation of ecosystem-level management and restoration to benefit this species (USFWS, 2013).

References

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USFWS 2013. *Dubautia herbstobatae* (na'ena'e) 5-Year Review Short Form Summary. Region 1/Pacific Islands Fish and Wildlife Office (PIFWO), Honolulu, Hawaii.

SPECIES ACCOUNT: *Dubautia imbricata imbricata* (Na`ena`e)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (R1) (USFWS, 2016)

Physical Description

Dubautia imbricata ssp. *imbricata*, a member of the sunflower family (Asteraceae), is a shrub up to 2.5 meters (m) (8 feet (ft)) tall, forming dense clumps up to 2 m (6.6 ft) across, with glabrous (hairless) stems. Leaves are opposite, oblong-lanceolate (longer than wide; either with parallel sides or with widest point below the middle), 6 to 15 centimeters (cm) (2.4 to 6 inches (in)) long, and 0.8 to 2.5 cm (0.3 to 1 in) wide. Flower heads are usually 4 to 10 cm (2 to 4 in) long, cymosely clustered, paniculate (branched, with flowers maturing from the bottom up), nearly glabrous inflorescences, 2 to 9 cm (0.8 to 3.5 in) wide, with false bracts (leaflike structures at the base of the flower) 3.5 to 9 millimeters (mm) (0.1 to 0.4 in) long. Corollas are yellow and finely glandular on the tube. Achenes (dry fruiting capsules) are 2 to 3.5 mm (0.08 to 0.1 in) long with coarse hairs. This subspecies is distinguished by its glabrous inflorescences and false bracts (Carr 1999). (USFWS, 2017)

Taxonomy

A member of the sunflower family (Asteraceae) (USFWS, 2010b). Genus endemic to Hawaiian Islands, species endemic to Kauai, subspecies endemic to Wahiawa Mts. of Kauai (NatureServe, 2015).

Historical Range

Historically and currently, *Dubautia imbricata* ssp. *imbricata* is known only from the Wahiawa Mountains of Kauai (Carr 1999; HBMP 2010). (USFWS, 2017)

Current Range

Historically and currently, *D. imbricata* ssp. *imbricata* is known only from the Wahiawa Mountains of Kauai (St. John and Carr 1981, pp. 198, 201; Carr 1999, p. 298; HBMP 2007) (USFWS, 2010b).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Dubautia imbricata imbricata* (Na`ena`e) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Dubautia imbricata imbricata* includes six CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Lowland Wet—Section 1: Lowland Wet—Section 1 consists of 1,164 ac (471 ha) in the lowland wet ecosystem (117 ac (47.4 ha) on State land; 1,047 ac (424 ha) on private land),

including wet forest extending from Kulanalilia into Limahuli Valley to Honoonapali, in the Halelea Forest Reserve (Figure 2-A). The section includes 1,099 ac (445 ha) of State and privately owned land within previously designated critical habitat and 65 ac (26 ha) of newly designated critical habitat on private land. The area that falls within designated critical habitat lies within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and newly designated Critical Habitat Unit 20, Map 217c. This section is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Labordia helleri*, and *Phyllostegia renovans*. This section also contains unoccupied habitat that is essential to the conservation of these four species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 1 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Melicope paniculata*, *M. puberula*, *Platydesma rostrata*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 2: Lowland Wet—Section 2 consists of 172 ac (70 ha) in the lowland wet ecosystem, including wet forest extending from Alealau to Pohakea, within the Hono o Na Pali NAR and the Na Pali Coast State Park (Figure 2-A, above). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plant *Melicope puberula*. This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 2 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope paniculata*, *Phyllostegia renovans*, *Platydesma rostrata*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 3: Lowland Wet—Section 3 consists of 756 ac (306 ha) in the lowland wet ecosystem, including wet forest in upper Wainiha Valley, on privately owned land in the Halelea Forest Reserve (Figure 2-B). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyrtandra oenobarba*, *Melicope puberula*, *Phyllostegia renovans*, and *Stenogyne kealiae*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species

identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 3 is not known to be occupied by the species *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope paniculata*, *Platydesma rostrata*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 4: Lowland Wet—Section 4 consists of 591 ac (239 ha) in the lowland wet ecosystem, including wet forest at the head of Lumahai Valley, on State (10 ac, 4.1 ha) and privately owned (581 ac, 235 ha) land in the Halelea Forest Reserve (Figure 2-B, above). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyrtandra oenobarba*, *Melicope paniculata*, *Phyllostegia renovans*, and *Platydesma rostrata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 4 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope puberula*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population numbers of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 5: Lowland Wet—Section 5 consists of 1,541 ac (624 ha) in the lowland wet ecosystem, including wet forest extending from the headwaters of the Wailua River at “Blue Hole” south to Iole, on State (442 ac, 179 ha) and privately owned (1,099 ac, 445 ha) land in the Lihue-Koloa Forest Reserve (Figure 2-C). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36a, and is occupied by the plants *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Melicope paniculata*, *Phyllostegia renovans*, and *Platydesma rostrata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 5 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Labordia helleri*, *Melicope puberula*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of

individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 6: Lowland Wet—Section 6 consists of 789 ac (319 ha) in the lowland wet ecosystem, including wet forest extending from Kapalaoa to Kanaele Bog and Lauahihaihai in the Wahiawa Mountains, on State (134 ac, 54 ha) and privately owned (655 ac, 265 ha) land in the Lihue-Koloa Forest Reserve (Figure 2-D). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36a, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Platydesma rostrata*, and *Tetraplasandra bisattenuata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 6 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Labordia helleri*, *Melicope paniculata*, *M. puberula*, *Phyllostegia renovans*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Dubautia imbricata imbricata* critical habitat consists of one component (Lowland wet) (75 FR 18960-19165):

Ecosystem: Lowland Wet. Elevation: <3,000 ft (<914 m). Annual precipitation: >75 in (>190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary

throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History

Food/Nutrient Resources**Reproduction Narrative**

Adult: This species has been observed flowering in July through November (Carr 1999; HBMP 2010; NTBG 1991a-b, 1993, 2008a-b, 2009a). (USFWS, 2017)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Lowland wet ecosystem: Metrosideros polymorpha forest, Metrosideros, Oreobolus (sedge), Rhynchospora (kuolohia) bogs (USFWS, 2010b).

Geographic or Habitat Restraints or Barriers

Adult: 2,165 - 3,640 ft. elevation (USFWS, 2010b)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits wet shrublands and forests. The environmental specificity is unknown (NatureServe, 2015). It currently occurs in the lowland wet ecosystem. Occurrence records show that *D. imbricata* ssp. *imbricata* has typically been found in wet Metrosideros polymorpha forest and Metrosideros, Oreobolus (sedge), Rhynchospora (kuolohia) bogs at elevations between approximately 2,165 and 3,640 ft. (660 and 1,110 m) (HBMP 2007) (USFWS, 2010b; USFWS, 2017).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Resiliency:

Very low (inferred from USFWS, 2010b; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2010b)

Number of Populations:

5 (USFWS, 2017)

Population Size:

5000 wild individuals, 3 outplanted individuals (USFWS, 2017)

Population Narrative:

Historically and currently, *Dubautia imbricata* ssp. *imbricata* is known only from the Wahiawa Mountains of Kauai (Carr 1999; HBMP 2010). At the time of listing, there were approximately 200 individuals at Wahiawa Drainage (NTBG 2000), approximately 1,000 individuals on both sides of the ridge between Hanapepe and Iole, and an estimate of several 100 individuals at Iliiliula (HBMP 2010). These three populations totaled approximately 1,400 individuals. Surveys conducted since listing have delineated more occurrences. Currently, there is estimated to be about 3,000 individuals in the Waialeale summit area (NTBG 2008a). Another 2,000 individuals are estimated ranging from Kamooloa to Kapalaoa, and extending south past Hulua to Puuauuka (NTBG 2009b, 2011, 2012). (USFWS, 2017)

Threats and Stressors

Stressor: Ungulate degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Feral pigs (*Sus scrofa*) and goats (*Capra hircus*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil (Loope 1998; van Riper and van Riper 1982). Feral pigs and goats and evidence of their activities have been observed at the Waialeale summit, Kamooloa headwaters, and the entire Wahiawa drainage (HBMP 2010; NTBG 1998, 2000, 2008a, 2009a-b, 2011). (USFWS, 2017)

Stressor: Established ecosystem-altering invasive plant modification and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community (Cuddihy and Stone 1990). Invasive introduced plants with the greatest impacts on *Dubautia imbricata* ssp. *imbricata* are: *Andropogon virginicus* (broomsedge), *Axonopus fissifolius* (narrow-leaved carpetgrass), *Buddleja asiatica* (dog tail), *Clidemia hirta* (Koster's curse), *Cyperus meyenianus* (NCN), *Juncus planifolius* (bog rush), *Melastoma septemnerium* (NCN), *Oplismenus hirtellus* (basketgrass), *Psidium cattleianum* (strawberry guava), *Rhodomyrtus tomentosa* (downy myrtle), *Rubus rosifolius* (thimbleberry), *Setaria parviflora* (yellow foxtail), and *Sphaeropteris cooperi* (Australian tree fern) (HBMP 2010; NTBG 1998, 2008a-b, 2009a, 2011). (USFWS, 2017)

Stressor: Hurricanes—Loss and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013). (USFWS, 2017)

Stressor: Climate change loss or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Dubautia imbricata* ssp. *imbricata* is vulnerable to the impacts of climate change with a vulnerability score of 0.541 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2017)

Stressor: Lack of adequate hunting regulations (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Although only one each of the historic and currently known populations (Waialeale summit area) of *Dubautia imbricata* ssp. *imbricata* occur or occurred in state hunting areas, public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations are at risk (DLNR 2010). (USFWS, 2017)

Stressor: Lack of adequate biosecurity legislation (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Invasion of the State of Hawaii by invasive nonnative plant species, and destruction of habitat and 12 competition by nonnative plants are threats to *Dubautia imbricata* ssp. *imbricata*. Pest species have caused the extinction of native species, the destruction of native forests, and the spread of disease. The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, is authorized to prevent the introduction or dissemination of animal and plant pests on all ships, aircraft, and their cargo and baggage arriving in the U.S. and its territories; however, pest species continue to enter the State. In addition,

Federal import regulations do not address many species that could be pests in Hawaii (CGAPS 2009; Ikuma et al. 2002). (USFWS, 2017)

Recovery

Reclassification Criteria:

To meet the interim stage of recovery of *Dubautia imbricata* ssp. *imbricata*, 300 mature individuals are needed in each of three populations and all major threats must be controlled around the populations designated for recovery at this stage. There should also be demonstrated regeneration of seedlings and growth to at least sapling stage for woody species and documented replacement regeneration within each of the target populations. The populations must be adequately represented in an ex situ collection as defined in the Center for Plant Conservation's guidelines (Guerrant et al. 2004). Adequate monitoring must be in place and conducted to assess individual plant survival, population trends, trends of major limiting factors, and response of major limiting factors to management. (USFWS, 2017)

In addition to achieving 5 to 10 populations with 500 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats. (USFWS, 2017)

Delisting Criteria:

Delisting Criteria In addition to achieving 5 to 10 populations with 500 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis. (USFWS, 2017)

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys (USFWS, 2010a).

- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units (USFWS, 2010a).
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys (USFWS, 2010a).
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range (USFWS, 2010a).
- Conduct research on control methods for introduced slugs and avian malaria (USFWS, 2010a).
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction (USFWS, 2010a).
- Identify threats and prioritize which ones to address first for the two birds (USFWS, 2010a).
- Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program (USFWS, 2010a).
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security (USFWS, 2010a).
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems (USFWS, 2010a).
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations (USFWS, 2010a).
- Surveys and inventories—Survey for populations of *Dubautia imbricata* ssp. *imbricata* in areas of potentially suitable habitat. (USFWS, 2017)
- Ungulate monitoring and control—Continue to construct and maintain fenced exclosures around all populations. Continue to protect all occurrences against disturbances from feral ungulates. (USFWS, 2017)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. (USFWS, 2017)
- Captive propagation for genetic storage and reintroduction—Continue to collect seeds and cuttings from all known populations. (USFWS, 2017)
- Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2017)
- Population biology research—Study *Dubautia imbricata* ssp. *imbricata* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. (USFWS, 2017)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from hurricanes. (USFWS, 2017)
- Based on the recovery criteria above, consider development of a recovery plan. (USFWS, 2017)

Conservation Measures and Best Management Practices:

- This species is currently in controlled propagation for genetic storage and/or reintroduction efforts (USFWS, 2010a).

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Final Rule . 75 FR 18960-19165 (April 13, 2010).

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SPECIES ACCOUNT: *Dubautia kalalauensis* (Naenae)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (R1) (USFWS, 2016)

Physical Description

Dubautia kalalauensis, a member of the sunflower family (Asteraceae), is a shrub or tree, 1.8 to 3.5 meters (6 to 11.4 feet) tall, with opposite leaves 8 to 14 by 1.6 to 3.2 centimeters (cm) (3.2 to 5.5 by 0.6 to 1.3 inches in) and leaves of immature individuals up to 20 by 5.6 cm (7.9 by 2.2 in). Inflorescences contain 6 to 55 heads, in dense flat-topped or rounded arrays, 4 to 10 cm long (1.6 to 3.9 in) and 4 to 10 cm (1.6 to 3.9 in) wide. *Dubautia kalalauensis* differs from *D. laxa* by having a more branching habit, softer leaf surfaces, greenish cream corollas and less glandular corolla tubes. Unlike other species of *Dubautia*, *D. kalalauensis* combines opposite leaves, peduncles without glands, receptacular bracts throughout the heads, greenish scales and pappi (a calyx composed of scales) of bristle-like scales that are about 4 millimeters (0.2 in) long (Baldwin and Carr 2005). (USFWS, 2017)

Taxonomy

A member of the sunflower family (Asteraceae) (USFWS, 2010b). *Dubautia kalalauensis* was described in 2005; before its description as a distinct species, this taxon had been treated within the circumscription of *Dubautia laxa* ssp. *hirsuta*. According to Baldwin and Carr (2005), this species differs from all previously described taxa of *Dubautia* in combining opposite leaves, eglandular peduncles, receptacular bracts throughout the heads (one per floret), greenish cream corollas, and pappi of setiform scales ca. 4 mm long. These authors also report molecular phylogenetic findings showing that *D. kalalauensis* is less closely related to the widespread *D. laxa* than to other Kaua'i endemics, including *D. imbricata*, *D. kenwoodii*, *D. laevigata*, *D. syndetica*, and *D. waialealae* (NatureServe, 2015).

Historical Range

Endemic to northwestern Kauai, in the vicinity of the rim of Kalalau Valley (Baldwin and Carr 2005) (NatureServe, 2015).; Historically, *Dubautia kalalauensis*, as a part of the species *Dubautia laxa*, was known from several locations below the rim of Kalalau Valley in Kokee State Park, in the northwestern region of Kauai (USFWS, 2017)

Current Range

It is currently found in only one location along the rim of Kalalau Valley near Puu o Kila Lookout (USFWS, 2010b).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Dubautia kalalauensis* (Naenae) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Dubautia kalalauensis* includes three CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Montane Wet—Section 1: Montane Wet—Section 1 consists of 13,055 ac (5,257 ha) in the montane wet ecosystem, extending across the Alakai Plateau from Hanakoa to Mount Waialeale, on State (12,628 ac, 5,110 ha) and privately owned (427 ac, 173 ha) land in the Na Pali Coast State Park, the Alakai Wilderness Preserve, the Na PaliKona and Halelea forest reserves, and Hono o Na Pali NAR (Figure 4). It is occupied by the plants *Astelia waialealae*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *K. helenae*, *Labordia helleri*, *L. pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, and *Platydesma rostrata*; by the akekee and akikiki; and by the picture-wing fly. This section also contains unoccupied habitat that is essential to the conservation of these 18 species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the montane wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and the species-specific PCEs including (1) bogs (identified as PCEs for *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*) (2) bog hummocks (identified as PCEs for *Astelia waialealae* and *Lysimachia daphnoides*); (3) arthropod prey (identified as PCEs for the akekee and the akikiki); and (4) larval-stage host plants, *Cheirodendron* and *Tetraplasandra* sp., (identified as a PCE for the picture-wing fly). Although Montane Wet—Section 1 is not known to be occupied by the plants *Dubautia kalalauensis*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, those portions of the section that overlie previously designated critical habitat fall within two existing Critical Habitat Units of 50 CFR 17.99(a)(1): Unit 10, Map 35a; and Unit 11, Map 64a. The previously undesignated land comprises Unit 23, Map 217f; and Unit 24, Map 217g. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 4—Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 4—Montane Wet).

Kauai—Montane Wet—Section 2: Montane Wet—Section 2 consists of 790 ac (320 ha) in the montane wet ecosystem, extending from Kahuamaa Flat south to the edge of Waimea Canyon, on State-owned land in Kokee State Park (Figure 4, above). The entire section is within previously designated critical habitat, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Dubautia kalalauensis*, *Labordia helleri*, *Melicope puberula*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*, and by the akekee. This section includes montane wet forest, potentially some small-scale boggy areas, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and arthropod prey (identified as a species-specific PCE for the akekee). Although Montane Wet—Section 2 is not known to be occupied by the plants *Astelia waialeale*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialeale*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *Myrsine mezii*, and *Phyllostegia renovans*; by the akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides

the physical and biological features necessary for the reestablishment of wild populations within their historical range. This area also supports the arthropod prey identified as a PCE for the akikiki, and the larval-stage host plants (*Cheirodendron* and *Tetraplasandra* spp.) identified as a PCE for the picturewing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within previously designated Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 5—Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 5— Montane Wet).

Kauai—Montane Wet—Section 3: Montane Wet—Section 3 consists of 413 ac (167 ha) in the montane wet ecosystem, encompasses the summit of Namolokama, on State (156 ac, 63 ha) and privately owned (257 ac, 104 ha) land in the Halelea Forest Reserve (Figure 4, above). It is entirely within previously designated critical habitat, and is occupied by the plants *Keysseria erici* and *Labordia pumila*. This section includes the montane wet forest, the moisture regime, and the canopy, subcanopy, and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and bogs (identified as a species-specific PCE for *K. erici*). Although Montane Wet—Section 3 is not known to be occupied by the plants *Astelia waialeale*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia kalalauensis*, *D. waialeale*, *Geranium kauaiense*, *Keysseria helenae*, *Labordia helleri*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*; by the akekee and akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. It also supports the arthropod prey identified as a PCE for the akekee and akikiki, and the larval-stage host plants (*Cheirodendron* and *Tetraplasandra* spp.) identified as a PCE for the picture-wing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 6—Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 6—Montane Wet).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Dubautia kalalauensis* critical habitat consists of one component (Montane wet). Species-specific PCEs include: Bogs (75 FR 18960-19165):

Ecosystem: Montane Wet. Elevation: 3,000–5,243 ft (914-1,598 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat

may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their

entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: This species has been observed flowering in August through November (Baldwin and Carr 2005; NTBG 1985a-b, 1986, 2004). (USFWS, 2017)

Habitat Type

Adult: Terrestrial (USFWS, 2010b)

Habitat Vegetation or Surface Water Classification

Adult: *Metrosideros polymorpha* montane wet forest (USFWS, 2010b)

Geographic or Habitat Restraints or Barriers

Adult: 4,000 - 4,050 ft. elevation (USFWS, 2010b)

Habitat Narrative

Adult: It is found in the montane wet ecosystem in *Metrosideros polymorpha* wet forest at elevations between 4,000 and 4,050 ft (1,205 and 1,235 m) (Baldwin and Carr 2005, p. 261; TNCH 2007) (USFWS, 2010b).; *Dubautia kalalauensis* is found on Kauai in the montane wet ecosystem in *Metrosideros polymorpha* (ohia) wet forest at elevations between 1,205 and 1,235 meters (3,950 and 4,050 feet) (Baldwin and Carr 2005; TNCH 2007). Associated native species include *Broussaisia arguta* (kanawao), *Cibotium* spp. (hapuu), *Cheirodendron* spp. (olapa), *Dubautia* spp. (naenae), *Elaphoglossum*, *Kadua* spp., *Pittosporum* spp. (hoawa), *Sadleria* spp. (amau), and *Scaevola procera* (naupaka kuahiwi) (Baldwin and Carr 2005). (USFWS, 2017)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

30 - 70% decline (NatureServe, 2015)

Resiliency:

Very low (inferred from USFWS, 2010b; see current range/distribution)

Redundancy:

Very low (inferred from USFWS, 2010a)

Number of Populations:

1 (3 occurrences in the same area; USFWS, 2017)

Population Size:

25 wild individuals, 34 outplanted (USFWS, 2017)

Population Narrative:

There is one population totaling 26 individuals (USFWS, 2010a). This species has experienced a long term decline of 30 - 70% (NatureServe, 2015).; At the time of listing, *D. kalalauensis* was found in only one location along the rim of Kalalau Valley, between Kalalau Lookout and Puu o Kila, totaling 26 individuals (Baldwin and Carr 2005). Currently, *D. kalalauensis* is known from three occurrences in the same area totaling about eight mature individuals and fewer than 20 immature individuals (Flynn 2016, PEPP 2017). (USFWS, 2017)

Threats and Stressors

Stressor: Ungulate degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Feral pigs (*Sus scrofa*) and goats (*Capra hircus*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil (Loope 1998; van Riper and van Riper 1982). Feral pigs and goats and evidence of their activities have been observed at occurrences of *Dubautia kalalauensis* (PEPP 2010, 2011, 2014, 2015). (USFWS, 2017)

Stressor: Established ecosystem-altering invasive plant modification and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community (Cuddihy and Stone 1990). Invasive introduced plants with the greatest impacts on *Dubautia kalalauensis* include *Hedychium gardnerianum* (kahili ginger), *Passiflora tarminiana* (banana poka), and *Rubus argutus* (prickly Florida blackberry) (Baldwin and Carr 2005; PEPP 2010). (USFWS, 2017)

Stressor: Landslides and flooding destruction or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: The only known individuals of *Dubautia kalalauensis* occur on cliffs and at the headwaters of a stream. Erosion associated with this habitat, and resulting from the activities of

feral ungulates, can have a significant effect on small populations (PEPP 2011, 2014). Landslides and erosion due to natural weathering destabilize substrates, damage and destroy individual plants, and alter hydrological patterns (Stearns 1985). (USFWS, 2017)

Stressor: Hurricanes—Loss and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013). (USFWS, 2017)

Stressor: Climate change loss or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment was not conducted specifically for *Dubautia kalalauensis*. However, it was concluded that the Hawaiian Asteraceae (with a vulnerability score of 0.455; on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change) is the ninth most vulnerable family in Hawaii. Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2017)

Stressor: Invertebrate predation or herbivory (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Damage to apical meristems (shoot tips) by caterpillars has been observed at all occurrences of *Dubautia kalalauensis* (PEPP 2011, 2012, 2013, 2014). Severe infestations can weaken and possibly kill plants. (USFWS, 2017)

Stressor: Rodent predation or herbivory (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Damage to shoot tips, leaves, and seeds by rats is noted to be a threat to *Dubautia kalalauensis* (PEPP 2015). Rats eat virtually every part of plants and at every stage: fleshy fruits, seeds, flowers, stems, leaves, shoot, seedlings, and roots (Russell 1980; Cuddihy and Stone 1990). The effects on plants range from reduced vigor and decreased reproduction to mortality of individuals and complete lack of recruitment. (USFWS, 2017)

Stressor: Lack of adequate hunting regulations (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Some individuals of *Dubautia kalalauensis* outside of any hunting safety zones in Kokee State Park or Na Pali Coast State Wilderness Preserve may occur within a State hunting area. Public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations are at risk (DLNR 2010). (USFWS, 2017)

Stressor: Lack of adequate biosecurity legislation (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Invasion of the State of Hawaii by invasive nonnative plant species, and destruction of habitat and competition by nonnative plants are threats to *Dubautia kalalauensis*. Pest species have caused the extinction of native species, the destruction of native forests, and the spread of disease. The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, is authorized to prevent the introduction or dissemination of animal and plant pests on all ships, aircraft, and their cargo and baggage arriving in the U.S. and its territories; however, pest species continue to enter the State. In addition, Federal import regulations do not address many species that could be pests in Hawaii (CGAPS 2009; Ikuma et al. 2002). (USFWS, 2017)

Stressor: Stochastic events (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Reduced viability due to low numbers—Small, isolated populations often exhibit reduced levels of genetic variability, which diminishes the species' capacity to adapt and respond to environmental changes, thereby lessening the probability of long-term persistence (Barrett and Kohn 1991; Newman and Pilon 1997). The problems associated with small population size and vulnerability to random demographic fluctuations or natural catastrophes are further magnified by synergistic interactions with other threats, such as anthropogenic impacts like habitat loss from human development or predation by nonnative species. Very small plant populations may experience reduced reproductive vigor due to ineffective pollination or inbreeding depression. Individuals of *Dubautia kalalauensis* have been observed to be in poor health (PEPP 2011). (USFWS, 2017)

Recovery

Reclassification Criteria:

To meet the interim stage of recovery of *Dubautia kalalauensis*, 300 mature individuals are needed in each of three populations, all major threats must be controlled around each population designated for recovery at this stage. There should also be demonstrated regeneration of seedlings and growth to at least sapling stage for woody species and documented replacement regeneration within each of the target populations. The populations must be adequately represented in an ex situ collection as defined in the Center for Plant Conservation's guidelines (Guerrant et al. 2004). Adequate monitoring must be in place and conducted to assess individual plant survival, population trends, trends of major limiting factors, and response of major limiting factors to management. (USFWS, 2017)

In addition to achieving 5 to 10 populations with 500 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats. (USFWS, 2017)

Delisting Criteria:

In addition to achieving 5 to 10 populations with 500 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVA for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis. (USFWS, 2017)

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys (USFWS, 2010a).
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units (USFWS, 2010a).
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys (USFWS, 2010a).

- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range (USFWS, 2010a).
- Conduct research on control methods for introduced slugs and avian malaria (USFWS, 2010a).
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction (USFWS, 2010a).
- Identify threats and prioritize which ones to address first for the two birds (USFWS, 2010a).
- Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program (USFWS, 2010a).
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security (USFWS, 2010a).
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems (USFWS, 2010a).
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations (USFWS, 2010a).
- Surveys and inventories—Survey for populations of *Dubautia kalalauensis* in areas of potentially suitable habitat. (USFWS, 2017)
- Ungulate monitoring and control—Construct and maintain fenced exclosures around all populations. Protect all occurrences against disturbances (browsing, trampling) from feral ungulates. Construct small-scale fences around remaining populations to prevent imminent extinction. (USFWS, 2017)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. (USFWS, 2017)
- Captive propagation for genetic storage and reintroduction—Continue to collect seeds and cuttings from all known populations. (USFWS, 2017)
- Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2017)
- Predator and herbivore monitoring and control—Implement effective control methods for invertebrates and rodents. (USFWS, 2017)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and erosions and storms. (USFWS, 2017)
- Based on the recovery criteria above, consider development of a recovery plan. (USFWS, 2017)

Conservation Measures and Best Management Practices:

- Not available

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SPECIES ACCOUNT: *Dubautia kenwoodii* (Naenae)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (R1) (USFWS, 2016)

Physical Description

Dubautia kenwoodii, a member of the sunflower family (Asteraceae), is a shrub 5 meters (16.4 feet) tall with opposite leaves 4 to 12 centimeters (cm) (1.6 to 4.7 inches (in)) long and 0.8 to 2 cm (0.3 to 0.8 in) wide, narrowly elliptic to sometimes narrowly lanceolate. Inflorescences are about 14 cm (5.5 in) long and 10 cm (3.9 in) wide, with numerous heads and typically 12 to 18 florets. The corollas become rusty yellow with age. *Dubautia kenwoodii* differs from other members of the genus by a combination of uniseriate (arranged in one row), peripheral, very firmly coalescent (fused together) receptacular bracts (modified or specialized leaf, especially one associated with a reproductive structure such as a flower), cymose (determinate simple inflorescences)-glomerate (tightly clustered) capitula (flat cluster of small flowers or florets) and leathery, shiny leaves with somewhat cartilaginous-toothed margins and abruptly narrowed, broadly clasping bases (Carr 1998). (USFWS, 2017)

Taxonomy

A member of the sunflower family (Asteraceae) (USFWS, 2010b). Described in Novon 8:8-11, 1998 (see Wagner and Herbst 1999, Supplement to Manual of Flowering Plants of Hawaii). Not accepted or rejected in Kartesz's 1999 Synthesis (NatureServe, 2015).

Historical Range

Dubautia kenwoodii is known from a single individual found in 1991 below the western rim of Kalalau Valley, in the northwestern region of Kauai (Carr 1998; NTBG 1991). (USFWS, 2017)

Current Range

Dubautia kenwoodii is known from a single individual found in 1991 below the western rim of Kalalau Valley, in the northwestern region of Kauai (Carr 1998; NTBG 1991). This individual was not observed after Hurricane Iniki, and may possibly be extirpated; however, there are many cliff faces in Kalalau Valley and other nearby valleys that may support additional plants and more individuals may be found with additional surveys (Carr 1998, Walsh 2016). (USFWS, 2017)

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Dubautia kenwoodii* (Naenae) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes five critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Dubautia kenwoodii* includes five CHUs in Kauai County, Hawaii. Note: This species may no longer occur naturally in the wild, therefore there is no known occupied critical habitat for this species. The critical habitat units for this species have been

determined to be essential to the conservation of the species because the area provides for the reestablishment of populations within the species' historical range (75 FR 18960-19165).

Kauai—Lowland Mesic—Section 1: Lowland Mesic—Section 1 consists of 2,006 ac (812 ha) in the lowland mesic ecosystem, including mesic forest extending from Awaawapuhi Trail south to Makaha Ridge, in the Na Pali Kona Forest Reserve and the Kuia NAR (Figure 1-A). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plants *Doryopteris angelica*, *Labordia helleri*, *Platydesma rostrata* and *Psychotria hobbdi*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these four species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic—Section 1 is not known to be occupied by the species *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Dubautia kenwoodii*, *Pittosporum napaliense*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 2: Lowland Mesic—Section 2 consists of 379 ac (154 ha) in the lowland mesic ecosystem, including mesic forest extending from Keanapuka to Kahuamaa Flat along the rim and cliffs of the Kalalau Valley, in the Na Pali Coast State Park (Figure 1-A, above). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plants *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Pittosporum napaliense*, and *Psychotria hobbdi*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these six species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic—Section 2 is not known to be occupied by the species *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Platydesma rostrata*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 3: Lowland Mesic—Section 3 consists of 124 ac (50 ha) in the lowland mesic ecosystem, including mesic forest extending from Manono Ridge, Pohakuao Valley, to Kanakuu, within the Na Pali Coast State Park (Figure 1- A, above). The entire section is Stateowned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plants *Canavalia napaliensis*, *Chamaesyce eleanoriae*, and *Charpentiera densiflora*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the

lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these three species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic—Section 3 is not known to be occupied by the species *Chamaesyce remyi* var. *remyi*, *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Pittosporum napaliense*, *Platydesma rostrata*, *Psychotria hobdyi*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 4: Lowland Mesic—Section 4 consists of 81 ac (33 ha) in the lowland mesic ecosystem, including mesic forest at the head of the Hanakapiai Valley, in the Na Pali Coast State Park (Figure 1-A, above). The entire section is Stateowned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plant *Charpentiera densiflora* and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. Although Lowland Mesic—Section 4 is not known to be occupied by the species *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *Chamaesyce remyi* var. *remyi*, *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Pittosporum napaliense*, *Platydesma rostrata*, *Psychotria hobdyi*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 5: Lowland Mesic—Section 5 consists of 37 ac (15 ha) in the lowland mesic ecosystem, including mesic forest on the slopes of Mt. Haupū, on privately owned land (Figure 1-B). The entire section is within previously designated critical habitat, and falls within Critical Habitat Unit 7 of 50 CFR 17.99(a)(1), Map 23a. This section is occupied by the plants *Chamaesyce remyi* var. *remyi* and *Tetraplasandra bisattenuata*, and includes mesic forest and shrubland, the moisture regime, and subcanopy and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these two species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic—Section 5 is not known to be occupied by the species *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *Charpentiera densiflora*, *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Pittosporum napaliense*, *Platydesma rostrata*, and *Psychotria hobdyi*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Dubautia kenwoodii* critical habitat consists of one components (Lowland mesic and dry cliff) (75 FR 18960-19165):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<914 m). Annual precipitation: 50–75 in (127–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular

attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Based on extremely limited observations of seasonal changes, flowering appears to occur in June (Carr 1998; NTBG 1991). (USFWS, 2017)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Lowland mesic forest (USFWS, 2010b)

Geographic or Habitat Restraints or Barriers

Adult: 2,625 ft. elevation (USFWS, 2010b)

Habitat Narrative

Adult: The only plant of *D. kenwoodii* ever seen was on a cliff face vegetated with moist shrubland and moist forest species (NatureServe, 2015). It occurs in diverse lowland mesic forest in the lowland mesic ecosystem at an elevation of 2,625 ft (800 m) (HBMP 2007; TNCH 2007; Wood 2007b) (USFWS, 2010b); *Dubautia kenwoodii* is found in diverse lowland mesic forest in the lowland mesic ecosystem at an elevation of 800 meters (2,625 feet) (HBMP 2010; TNCH 2007; Wood 2007). Associated native species include *Euphorbia eleanoriae* (akoko), *Hibiscadelphus woodii* (hau kuahiwi), *Kadua flynnii* (pilo), *Lobelia niihauensis* (no common name

(NCN)), *Lysimachia* spp. (NCN), *Melicope pallida* (alani), *Nototrichium divaricatum* (kului), *Poa manni* (NCN), and *Stenogyne campanulata* (NCN) (Carr 1998; Wood 2007). (USFWS, 2017)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Resiliency:

Very low (inferred from NatureServe, 2015; see historic range/distribution)

Redundancy:

Very low (inferred from USFWS, 2010a)

Number of Populations:

1 (USFWS, 2010a; USFWS, 2017)

Population Size:

0 (USFWS, 2017)

Population Narrative:

Dubautia kenwoodii is known from a single individual found in 1991 below the western rim of Kalalau Valley, in the northwestern region of Kauai (Carr 1998; NTBG 1991). This individual was not observed after Hurricane Iniki, and may possibly be extirpated; however, there are many cliff faces in Kalalau Valley and other nearby valleys that may support additional plants and more individuals may be found with additional surveys (Carr 1998, Walsh 2016). (USFWS, 2017)

Threats and Stressors

Stressor: Stochastic events—Reduced viability due to low numbers (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: *Dubautia kenwoodii* has not been confirmed to persist in the wild. This species is not in storage or propagation, but individuals familiar with this species believe it may possibly remain extant and that much of its suitable habitat (lowland mesic, lowland wet, and wet cliff) on Kauai remains to be surveyed (USFWS, 2010).; Small, isolated populations often exhibit reduced levels of genetic variability, which diminishes the species' capacity to adapt and respond to environmental changes, thereby lessening the probability of long-term persistence (Barrett and Kohn 1991; Newman and Pilson 1997). The problems associated with small population size and vulnerability to random demographic fluctuations or natural catastrophes are further magnified by synergistic interactions with other threats, such as anthropogenic impacts like habitat loss

from human development or predation by nonnative species. *Dubautia kenwoodii* is only known from one individual (Carr 1998; NTBG 1991; Wood 2007). (USFWS, 2017)

Stressor: Ungulate degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Feral pigs (*Sus scrofa*) and goats (*Capra hircus*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil (Loope 1998; van Riper and van Riper 1982). Feral pigs and goats and evidence of their activities have been observed at the only known occurrence of *Dubautia kenwoodii* (NTBG 1991; Carr 1998; Wood 2007). (USFWS, 2017)

Stressor: Established ecosystem-altering invasive plant modification and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community (Cuddihy and Stone 1990). Habitat modification and destruction by invasive introduced plants negatively affects *Dubautia kenwoodii* at its last known location (Carr 1998). Invasive introduced plants with the greatest impacts on *Dubautia kenwoodii* include *Erigeron karvinskianum*, *Kalanchoe pinnata*, and *Lantana camara* (Walsh 2016). (USFWS, 2017)

Stressor: Landslides and flooding destruction or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: The only known individual of *Dubautia kenwoodii* occurred on a cliff. Erosion associated with this habitat, and resulting from the activities of feral ungulates, can have a significant effect on small populations (Carr 1998; Wood 2007). (USFWS, 2017)

Stressor: Hurricanes—Loss and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not

predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013). (USFWS, 2017)

Stressor: Climate change loss or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment was not conducted specifically for *Dubautia kenwoodii* as there are no known extant plants. However, it was concluded that the Hawaiian Asteraceae (with a vulnerability score of 0.455; on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change) is the ninth most vulnerable family in Hawaii. Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2017)

Stressor: Ungulate predation or herbivory (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Damage or destruction to any remaining individuals could occur, as evidence of the activities of feral pigs and goats is reported at the last known occurrence of *Dubautia kenwoodii* (Carr 1998; Wood 2007). (USFWS, 2017)

Stressor: Lack of adequate hunting regulations (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Habitat of *Dubautia kenwoodii* is within State hunting areas. Public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations are at risk (DLNR 2010). (USFWS, 2017)

Stressor: Lack of adequate biosecurity legislation (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Invasion of the State of Hawaii by invasive nonnative plant species, and destruction of habitat and competition by nonnative plants are threats to *Dubautia kenwoodii*. Pest species have caused the extinction of native species, the destruction of native forests, and the spread of disease. The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, is authorized to prevent the introduction or dissemination of animal and plant pests on all ships, aircraft, and their cargo and baggage arriving in the U.S. and its territories; however, pest species continue to enter the State. In addition, Federal import

regulations do not address many species that could be pests in Hawaii (CGAPS 2009; Ikuma et al. 2002). (USFWS, 2017)

Recovery

Reclassification Criteria:

To meet the interim stage of recovery of *Dubautia kenwoodii*, 300 mature individuals are needed in each of three populations and all major threats must be controlled around the populations designated for recovery at this stage. There should also be demonstrated regeneration of seedlings and growth to at least sapling stage for woody species and documented replacement regeneration within each of the target populations. The populations must be adequately represented in an ex situ collection as defined in the Center for Plant Conservation's guidelines (Guerrant et al. 2004). Adequate monitoring must be in place and conducted to assess individual plant survival, population trends, trends of major limiting factors, and response of major limiting factors to management. (USFWS, 2017)

In addition to achieving 5 to 10 populations with 500 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats. (USFWS, 2017)

Delisting Criteria:

In addition to achieving 5 to 10 populations with 500 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis. (USFWS, 2017)

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys (USFWS, 2010a).

- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units (USFWS, 2010a).
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys (USFWS, 2010a).
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range (USFWS, 2010a).
- Conduct research on control methods for introduced slugs and avian malaria (USFWS, 2010a).
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction (USFWS, 2010a).
- Identify threats and prioritize which ones to address first for the two birds (USFWS, 2010a).
- Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program (USFWS, 2010a).
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security (USFWS, 2010a).
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems (USFWS, 2010a).
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations (USFWS, 2010a).
- Surveys and inventories—Survey potential suitable habitat for surviving populations. (USFWS, 2017)
- Ungulate monitoring and control—Construct fenced enclosure to exclude feral ungulates from where the individual plant was last observed. (USFWS, 2017)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all the area of the last known individual. (USFWS, 2017)
- Captive propagation for genetic storage and reintroduction—Collect seeds for genetic storage if any individuals are found. (USFWS, 2017)
- Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species if any individuals are found. (USFWS, 2017)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through suitable habitat to reduce impacts from landslides and hurricanes. (USFWS, 2017)
- Based on the recovery criteria above, consider development of a recovery plan. (USFWS, 2017)

Conservation Measures and Best Management Practices:

- Not available

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SPECIES ACCOUNT: *Dubautia latifolia* (Koholapehu, Na`ena`e)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/1992; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Dubautia latifolia is a diffusely branched, woody vine in the aster family (Asteraceae) with stems up to 8 m (26 ft) long and occasionally up to 7 cm (3 in) in diameter near the base. The paired, egg- to oval-shaped leaves are 8 to 17 cm (3 to 7 in) long and 2.5 to 7 cm (1 to 3 in) wide. The leaves are conspicuously net-veined, with the smaller veins outlining nearly square areas. The distinct petioles are usually about 5 mm (0.2 in) long. The inflorescences comprise a large aggregation of very small, yellow flowered heads. The fruits are dry seeds, usually about 5 mm (0.2 in) long. A vining habit, distinct petioles, and broad leaves with conspicuous net veins outlining squarish areas separate *Dubautia latifolia* from closely related species (Carr 1982, 1985, 1990). (USFWS, 1995)

Historical Range

All collections and confirmed sightings of this species are from six areas on the island of Kauai: Makaha, Awaawapuhi, Waialae, Kawaiula and Kauhau Valleys in Na Pali-Kona Forest Reserve; Nualolo Trail and Valley in Kuia NAR; Halemanu in Kokee State Park; along Mohihi Road in both Kokee State Park and Na Pali-Kona Forest Reserve; along the Mohihi-Waialae Trail on Mohihi and Kohua ridges in both Na Pali-Kona Forest Reserve and Alakai Wilderness Preserve; and at Kaholuamanu on privately owned land (Carr 1982b; HHP 1994; USFWS 1992a; S. Perlman, personal communication 1994). (USFWS, 1995)

Current Range

Current range is northwestern Kauai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designate critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Dubautia latifolia* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Dubautia latifolia* includes three units totaling 5,836 acres in Kauai County, Hawaii. The units are Kauai 11—*Dubautia latifolia*—a, b, c.

Kauai 11—*Dubautia latifolia*—a: This unit is critical habitat for *Dubautia latifolia* and is 31 ha (76 ac) on State land (Kokee State Park). This unit provides habitat for three populations of 300 mature, reproducing individuals of the short-lived perennial *Dubautia latifolia* and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is essential to the establishment of additional populations on Kauai in order to reach recovery goals. The habitat features contained in this unit that are essential for this species include, but are not limited to, gentle or steep slopes on well drained soil in semi-open or closed,

diverse montane mesic forest dominated by *Acacia koa* and/or *Metrosideros polymorpha*. This unit is geographically separated from the other two units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Dubautia latifolia*—b: This unit is critical habitat for *Dubautia latifolia* and is 1,522 ha (3,764 ac) on State land (Kuia Natural Area Reserve and Kokee State Park). This unit contains portions of Kawaiiki Ridge and Kipalau Valley. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Dubautia latifolia* and is currently occupied with between 50 and 69 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, gentle or steep slopes on well drained soil in semi-open or closed, diverse montane mesic forest dominated by *Acacia koa* and/or *Metrosideros polymorpha*. This unit is geographically separated from the other two units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Dubautia latifolia*—c: This unit is critical habitat for *Dubautia latifolia* and is 809 ha (1,999 ac) on State land (Alakai Wilderness Preserve). This unit contains Iole and Kahili Summits. This unit provides habitat for three populations of 300 mature, reproducing individuals of the short-lived perennial *Dubautia latifolia* and is currently occupied with three plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, gentle or steep slopes on well drained soil in semi-open or closed, diverse montane mesic forest dominated by *Acacia koa* and/or *Metrosideros polymorpha*. This unit is geographically separated from the other two units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Gentle or steep slopes on well drained soil in semi-open or closed, diverse montane mesic forest dominated by *Acacia koa* and/or *Metrosideros polymorpha* and containing one or more of the following native plant species: *Alphitonia ponderosa*, *Antidesma platyphyllum*, *Bobea* spp., *Claoxylon sandwicense*, *Coprosma waimeae*, *Cyrtandra* spp., *Dicranopteris linearis*, *Diplazium sandwichianum*, *Dodonaea viscosa*, *Elaeocarpus bifidus*, *Hedyotis terminalis*, *Ilex anomala*, *Melicope anisata*, *Nestegis sandwicensis*, *Pleomele aurea*, *Pouteria sandwicensis*, *Psychotria mariniana*, *Scaevola* spp., or *Xylosma* spp.; and

(ii) Elevations between 545 and 1,277 m (1,786 and 4,189 ft).

Special Management Considerations or Protections

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations;

maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Breeding Season**

Adult: September to November (USFWS, 2010)

Reproduction Narrative

Adult: Dubautia latifolia flowers from September to November (National Tropical Botanical Garden 2008a). (USFWS, 2010)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 850 and 1,200 meters (USFWS, 1995)

Spatial Arrangements of the Population

Adult: Scattered (USFWS, 2010)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1995)

Habitat Narrative

Adult: Dubautia latifolia typically grows on gentle to steep slopes on well drained soil in semi-open, diverse montane mesic forest dominated by koa and ohia, at an elevation of 975 to 1,200 meters (3,200 to 3,900 feet). Less often, this species is found in either closed forest, conifer plantations or ohia-dominated forest, and as low as 850 meters (2,800 feet) in elevation. The most common associated native species are kauila, Athyrium sandwicensis, Bobea (ahakea), Coprosma waimeae (olena), uluhe, Hedyotis terminalis (manono), Ilex anomala (aiea), Melicope anisata (mokihana), Psychotria mariniana (kopiko), and Scaevola (naupaka kuahiwi). Associated alien species include prickly Florida blackberry, strawberry guava, Acacia mearnsii (black wattle), Acacia melanoxylon (Australian blackwood), Erigeron karvinskianus (daisy fleabane), ginger, Lonicera japonica (Japanese honeysuckle), Myrica faya (firetree), and banana poka (USFWS 1992a). (USFWS, 1995)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Low (inferred from USFWS, 2010)

Redundancy:

Low (inferred from USFWS, 2010)

Number of Populations:

17 (USFWS, 2017)

Population Size:

225 wild individuals (USFWS, 2017)

Population Narrative:

Dubautia latifolia still occurs in many scattered locations, with an estimated population of 100 to 200 individuals (Perlman 2008). There are 18 current (between 1982 and 1997) and 4 historical occurrences. (USFWS, 2010; NatureServe, 2015); Walsh (2016) reports 17 “subpopulations” (considered populations by USFWS) with an estimated total of as many as 225 individuals. • Observations of this species since the previous 5-year review confirm occurrences at Kumuwela (at least 20 individuals), Makaha (about 10 individuals), Mahanaloa (about 10 individuals), Kuia (one individual), Nualolo area (at least 25 individuals), Awaawapuhi area (at least 10 individuals), Honopu (occasional), above the Kokee museum (one individual), Mohihi (at least 20 individuals), Waiakoali-Kawaikoi (at least five individuals), Kohua area (25 individuals), and Kawaiiki area (15 individuals (NTBG 2010, 2011a-c, 2012a-p, 2013a-f, 2014a-c, 2015a-f, 2016a-d). (USFWS, 2017)

Threats and Stressors

Stressor: Invasive plants (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species that compete with and modify the habitat of *Dubautia latifolia* include *Erechtites valerianifolia* (fireweed), *Erigeron karvinskianus* (daisy fleabane), *Hedychium* sp. (ginger), *Lantana camara* (lantana), *Psidium* spp. (guava), *Kalanchoe pinnata* (airplant), *Passiflora tarminiana* (banana poka), *Morella faya* (firetree), *Grevillea robusta* (silk oak), *Rubus argutus* (blackberry), and *Solanum americanum* (glossy nightshade) (Factor E) (National Tropical Botanical Garden 2008a, b; Perlman 2008; Tangalin 2008). (USFWS, 2010)

Stressor: Pigs, goats, and deer (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Major threats are pigs (*Sus scrofa*), feral goats (*Capra hircus*), and mule deer (*Odocoileus hemionus*). (USFWS, 2010)

Stressor: Rats, goats, and deer (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Rats (*Rattus* spp.), goats, and deer eat *Dubautia latifolia* plants (Perlman 2008). (USFWS, 2010)

Stressor: Climate change (USFWS, 2010; USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Dubautia latifolia* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.807 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2017)

Stressor: Vehicle traffic and maintenance (USFWS, 1995)

Exposure:

Response:

Consequence:

Narrative: Vehicle traffic and road maintenance constitute a potential threat to several individuals that overhang a State park road. (USFWS, 1995)

Stressor: Small population size (USFWS, 1995)

Exposure:

Response:

Consequence:

Narrative: *Dubautia latifolia* is threatened by the small number of extant individuals and restricted distribution (USFWS 1992a). (USFWS, 1995)

Stressor: Seasonal dieback (USFWS, 1995)

Exposure:

Response:

Consequence:

Narrative: This species suffers from seasonal dieback that could be a potential threat. (USFWS, 1995)

Stressor: Hurricanes—Loss and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013). (USFWS, 2017)

Stressor: Fire destruction or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Fire can destroy dormant seeds as well as individual plants. Successive fires burn farther and farther into native habitat and alter microclimate conditions to further alter habitat conditions to favor nonnative plants. Nonnative plants convert native plant communities to nonnative dominated plant communities (D'Antonio and Vitousek 1992; Tunison et al. 2002). Habitat destruction or direct destruction of individual plants by fire is reported to be a threat at the Nualolo, Makaha, Kuia, Kumuwela, Honopu, and Kawaiiki occurrences (NTBG 2011c, 2012c, d, g-k, o, 2013b-d, 2014a, 2105b, d, 2016b-c). (USFWS, 2017)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Kauai and at least one other island where they now occur or occurred historically. (USFWS, 1995)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1995)
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1995)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Kauai and at least one other island where they now occur or occurred historically. (USFWS, 1995)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1995)

3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1995)

Recovery Actions:

- The plan begins with the protection and management of current habitats of the Kauai cluster taxa. Current threats are addressed through fencing and/or hunting to control ungulates; control of alien plants; protection from fire; control of rodents and slugs; control of insects, pests and disease; protection from human disturbance; collection, storage and maintenance of genetic material; and, a comprehensive monitoring program. (USFWS, 1995)
- A research program is also recommended to study the growth and reproductive viability of each taxon, determine the parameters of viable populations of each taxon, study the reproductive strategy and pollinators of each taxon, study possible pests and diseases, and use the results of such research to improve management practices. (USFWS, 1995)
- A program of augmentation of very small populations and re establishment of new populations within the historical range of the species is also needed. (USFWS, 1995)
- A public education program is also needed to increase public awareness and support for plant recovery efforts. (USFWS, 1995)
- Finally, the recovery objectives should be refined and revised as new information becomes available. (USFWS, 1995)
- Ungulate monitoring and control—Protect all occurrences against browsing and disturbances from feral ungulates. Construct and maintain fenced exclosures around all populations. (USFWS, 2017)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. Control invasive nonnative plant species around all populations that compete with the species. (USFWS, 2017)
- Captive propagation for genetic storage and reintroduction—Continue to collect propagules for storage and for maintenance of genetic stock. Conduct reproductive biology studies that explore self-incompatibility in this species. (USFWS, 2017)
- Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2017)
- Fire monitoring and control—Develop and implement fire management plans for all wild and reintroduced populations. (USFWS, 2017)

Conservation Measures and Best Management Practices:

- Continue to collect seeds for genetic storage and propagation. (USFWS, 2010)
- Fence areas where this species grows to protect against negative impacts from ungulates and control invasive introduced plant species. (USFWS, 2010)
- Identify appropriate sites for reintroduction. (USFWS, 2010)
- Propagate for augmentation and reintroduction into suitable protected habitat. (USFWS, 2010)
- Work with Hawaii Division of Forestry and Wildlife and Hawaii State Parks to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2010)

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Final Designation or Nondesignation of Critical Habitat for 95 Plant Species From the Islands of Kauai and Niihau, HI. Final rule. 68 FR 9116 - 9479 (February 27, 2003).

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SPECIES ACCOUNT: *Dubautia pauciflorula* (Na`ena`e)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/20/1991; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Dubautia pauciflorula is a somewhat sprawling shrub or erect small tree up to 3 m (10 ft) tall, with narrowly lance-shaped or elliptic leaves, broadest above middle, 8 to 21 cm (3 to 8 in) long and 1.2 to 3.2 cm (0.5 to 1.3 in) wide, and clustered toward the ends of the stems. There are 50 to 500 flower heads in a purplish, open, pyramidal inflorescence 8 to 30 cm (3 to 12 in) long and 6 to 30 cm (2 to 12 in) wide. Each head comprises 2 to 4 yellow florets 2.5 to 3.5 mm (0.1 to 0.15 in) long. The fruits are small, dry seeds (achenes) about 3 mm (0.1 in) long, with a crown of slender bristles (pappus) 2.5 to 3.5 mm (0.1 to 0.15 in) long. Flowering material was collected in August, September, and November and fruiting material in November (Carr 1985, St. John and Carr 1981, D. Lorence and T. Flynn, pers. obser. 1991). The tiny, 2 to 4 flowered heads distinguish this species from its relatives (Carr 1985). (USFWS, 1994)

Historical Range

Historically, no additional range. (NatureServe, 2015)

Current Range

Current range in Wahiawa Mountains, Kauai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Dubautia pauciflorula* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Dubautia pauciflorula* includes one unit totaling 2,012 acres in Kauai County, Hawaii. The unit is Kauai 10—*Dubautia pauciflorula*—a.

Kauai 10—*Dubautia pauciflorula*—a: This unit is critical habitat for *Dubautia pauciflorula* and is 814 ha (2,012 ac) on State (Lihue-Koloa Forest Reserve) and private land. This unit contains portions of Iole and Kahili Summits. This unit provides habitat for four populations of 250 mature, reproducing individuals of the shortlived perennial *Dubautia pauciflorula* and is currently occupied with 42 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, stream drainages containing *Metrosideros polymorpha*, *Dicranopteris linearis* lowland wet forest. Although we do not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is an appropriate size so that each potential

recovery population on Kauai within the unit is geographically separated enough to avoid their destruction by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Within this unit, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) *Metrosideros polymorpha*/*Dicranopteris linearis* lowland wet forest within stream drainages containing one or more of the following associated native plant species: *Antidesma platyphyllum*, *Broussaisia arguta*, *Cheirodendron* spp., *Dubautia laxa*, *Embelia pacifica*, *Hesperomannia lydgatei*, *Labordia waialealae*, *Melicope* spp., *Nothoperanema rubiginosa*, *Pritchardia* spp., *Psychotria* spp., *Sadleria* spp., *Scaevola mollis*, *Syzygium sandwicensis*, or *Tetraplasandra* spp.; and

(ii) Elevations between 564 and 1,094 m (1,849 and 3,587 ft).

Special Management Considerations or Protections

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Key Resources Needed for Breeding**

Adult: Possibly pollinated by small insects (USFWS, 1994)

Reproduction Narrative

Adult: Few details are known about the life history of any *Dubautia* species under natural conditions (Carr 1985). Certain species produce viable seed when self-pollinated (are self-fertile), although others fail to do so (are self-infertile) (Carr 1985, Gerald Carr, University of Hawai'i - Manoa, pers. comm. 1992). Because of their structure and small size, flowers of *D. pauciflora* are presumably pollinated by small generalist insects, although field observations are lacking. (USFWS, 1994)

Habitat Type

Adult: Terrestrial and palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Riparian, forest- hardwood, forest/woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Wet environment (NatureServe, 2015)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1994)

Habitat Narrative

Adult: This species is found in wet forests along streams. The area this species occurs is characterized by rugged, mountainous terrain, this bowl-shaped, roughly triangular area is bounded on the north by Mt. Kapalaoa (3,310 ft), on the southeast by Mt. Kahili (3,089 ft), and on the southwest by Pu'u Au'uka (2,270 ft). Geologically the area is a mixture of older lavas of the Napali formation (5.72 to 4.47 million years old) and younger ones of the Koloa volcanic series (1.42 million years old) (Stearns 1966). Lying in the middle of the triangle is an area of poor drainage, the Wahiawa Bog (also known as Kanaele or "the bog" in Hawaiian). With an elevation of only 620 to 640 m (2,033 to 2,100 ft), it is unique in being the only true low elevation bog in Hawai'i. The soils are classified as Hulua Gravely Silty Clay Loam and Ko'olau Silty Clay, both types characteristic of the areas rough mountainous land (Foote et al. 1972). The area is often cloud-filled and windy. An important watershed, this drainage system is the source of the Wahiawa Stream, whose estuary is near Weli Point between Port Allen and Numila on the south shore of Kaua'i. The Wahiawa Mountains comprise a region of high floristic endemism on Kaua'i. Most of the area is covered by Lowland Wet *Metrosideros* Forest and Lowland Wet *Metrosideros* Shrubland (Cagnd & Cuddihy 1990). (USFWS, 1994)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: The bristle-like pappus crowning the fruit probably represents an adaptation for wind dispersal. (USFWS, 1994)

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Low (inferred from USFWS, 2009)

Redundancy:

Low (inferred from USFWS, 2009)

Number of Populations:

3 (USFWS, 2017)

Population Size:

57 wild individuals, 2 out planted individuals (USFWS, 2017)

Population Narrative:

In the most recent estimate (USFWS 2008), four populations totaling 47 individuals are reported as of February 2004. The following recent collections may increase population numbers and

extend the geographic range of *Dubautia pauciflora*. A collection from Iliiliula Valley, on the northern slope below the dividing ridge and flats of Iole Valley documented a population of approximately 50 individuals (National Tropical Botanical Garden 2008a). Another population of three immature individuals and two seedlings was found in a gulch south of Kapalaoa Peak which appears to be north of the documented populations (Hawaii Biodiversity and Mapping Program 2007). (USFWS, 2009); Walsh (2016) reports three “subpopulations” (considered populations by USFWS) with an estimated total of 57 individuals. • Observations of this species since the previous 5-year review confirm occurrences at Kapalaoa and Wahiawa drainage, Iliiliula, and Makaleha (NTBG 2009a, b, 2012a-c; PEPP 2010, 2012, 2013, 2014). (USFWS, 2017)

Threats and Stressors

Stressor: Invasive plants (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The major threats to this species remain direct competition with invasive introduced plant species, especially *Melastoma septemnerium* (no common name) and *Psidium cattleianum* (strawberry guava). (USFWS, 2009)

Stressor: Feral animals (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: At present feral animals appear to pose a significant threat to the Makaleha area (K. Wood, pers. comm. 1993) and slight to moderate feral pig damage was noted in four areas in the Wahiawa Drainage, and in the Waioli Stream Valley (D. Lorence and T. Flynn, pers. obser. 1991). Rooting was primarily confined to moist, shady valley bottoms along streams, the habitat of *Hesperomannia*, *Dubautia*, and *Viola*. Pigs could become a severe problem should more animals move into these areas. There were no signs of goats or other ungulates. Rats were observed on several occasions and are harmful as seed predators and herbivores. (USFWS, 1994)

Stressor: Landslides (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Although most slopes in these areas are not excessively steep and are usually clothed with vegetation, there is evidence of past landslides in the area, especially after Hurricane Iniki (D. Lorence, pers. obser. 1991-1992). Landslides clearly pose a threat to populations of these species growing on relatively steep slopes or in valley bottoms. In addition, *Cyanea undulata*, *Dubautia pauciflora* and *Viola helenae* most frequently occur on steep soil banks or stream banks that are prone to erosion and undercutting. (USFWS, 1994)

Stressor: Land conversion (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Past clearing of lowland wet forest on Kaua'i for agricultural uses may have contributed to the endangerment of these five species. At present this activity is not a threat at any of the sites. (USFWS, 1994)

Stressor: Hurricanes (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: In September 11, 1992 Hurricane Iniki passed directly over Kaua'i with winds gusting up to 175 miles per hour. Considerable damage was inflicted on the native forests in many parts of the island (S. Perlman & K. Wood, pers. comm. 1992). A small part of the Wahiawa Drainage was surveyed on October 7, 1992, to assess hurricane damage to populations of the five endangered species known to occur there (D. Lorence, pers. obser. 1992). Damage to the vegetation varied from slight to severe depending on exposure to the winds, and several landslides had occurred. In this very limited survey at least one or several individuals of each endangered species had been severely damaged or destroyed by winds that uprooted the plants or snapped the main stem, falling trees or branches, or landslides. (USFWS, 1994)

Stressor: Climate change loss or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Dubautia pauciflora* is highly vulnerable to the impacts of climate change with a vulnerability score of 0.823 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this species has no overlap between current and future climate envelopes, and is unlikely to tolerate expected changes in climate at its current location. This means that this species must persist within suitable microrefugia, or move to newly available climate-compatible areas to avoid extinction. Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2017)

Recovery

Reclassification Criteria:

1. a total of at least three populations of *Cyanea undulata* should be documented, each with at least 250 reproductive individuals. (USFWS, 1994)
2. Each of these populations must be naturally reproducing, stable, or increasing in number, by removal of threats, with adequate percentages of adults, juveniles, and seedlings necessary for long-term maintenance of population numbers and genetic diversity. (USFWS, 1994)
3. The full genetic diversity of each population is backed up as living and stored material at one or more nurseries or botanical gardens. (USFWS, 1994)

Delisting Criteria:

1. The target includes locating or establishing, if necessary, at least two additional wild populations for a total of at least five reproductively stable populations, each with at least 250 reproductive individuals. (USFWS, 1994)
2. These populations should be stable over an estimated ten year period. If new populations are established, they should have optimum genetic composition and be within the historical range of the species. (USFWS, 1994)
3. All five populations should be unmanipulated and able to sustain themselves indefinitely without human intervention (including fencing and introduced invasive plant species control) (USFWS 1994). (USFWS, 1994)

Recovery Actions:

- Preservation of the existing habitat at the Wahiawa Drainage, Waioli Stream Valley and Makaleha Mountains is essential to stabilize known populations and prevent the decline of these species, as all the known genetic diversity for the five species occurs here. This task involves managing the Wahiawa Drainage and Waioli Stream Valley habitats to protect the remaining wild plants of these five species until their populations can either expand naturally or be artificially increased by outplanting. (USFWS, 1994)
- Conduct basic research essential to the conservation of the five species. Few details regarding the ecology, demographics, propagation, habitat requirements and basic life history of these five species are known and such knowledge is essential to their conservation. (USFWS, 1994)
- Population sizes of these five species should be increased to viable numbers in the Wahiawa Drainage, Waioli Stream Valley and Makaleha Mountains. Existing populations may be augmented by enhancement of in situ reproduction and by planting viable seeds, cuttings, or air layers in situ, either directly in the ground or in pots containing soil from nearby. (USFWS, 1994)
- Plans must be developed for establishing new wild populations, including the selection of genetic stock. Ideally, additional populations of each species should be sought on Kaua'i. If these cannot be located or do not exist, and new populations must be established, then a protocol must be formulated for establishing new populations. (USFWS, 1994)
- It is important to determine and verify the scientific validity of the recovery objective proposed herein. (USFWS, 1994)
- Ungulate monitoring and control—Construct and maintain large-scale fenced enclosures around all populations to control feral ungulates. (USFWS, 2017)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. Control invasive nonnative plant species around all populations that compete with the species. (USFWS, 2017)
- Captive propagation for genetic storage and reintroduction—Continue to collect propagules for storage and for maintenance of genetic stock. Assess genetic variability within extant populations. (USFWS, 2017)
- Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2017)

Conservation Measures and Best Management Practices:

- Collect fruit from all wild and any reintroduced individuals that set seed to add to the genetic diversity of the ex situ material. (USFWS, 2009)
- Control introduced invasive plant species around wild and outplanted plants. (USFWS, 2009)
- Construct large-scale fences around all naturally occurring and reintroduced individuals to control feral ungulates. (USFWS, 2009)
- Continue reintroducing individuals into protected suitable habitat within historical range. (USFWS, 2009)
- Assess genetic variability within extant population. (USFWS, 2009)
- Study *Dubautia pauciflora* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. (USFWS, 2009)

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USFWS. 2017. 5-year Review, Short Form Summary, *Dubautia pauciflora* (Na'ena'e). PIFWO, Honolulu, Hawaii.

SPECIES ACCOUNT: *Dubautia plantaginea magnifolia* (Na`ena`e)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (R1) (USFWS, 2016)

Physical Description

Dubautia plantaginea ssp. *magnifolia*, a member of the sunflower family (Asteraceae), is a shrub or small tree up to 7 meters (23 feet) tall; stems glabrous (smooth), occasionally sparsely strigose (with stiff flat hairs). Leaves are opposite, oblong-lanceolate (longer than wide; either with parallel sides or with widest point below the middle), 8 to 26 centimeters (cm) (3.2 to 10 inches (in)) long, 0.7 to 4.5 cm (0.3 to 1.8 in) wide, glabrous, with toothed margins. Flower heads are up to 500 or more in panicle inflorescences (branched, with flowers maturing from the bottom up), 6 to 30 cm (2.4 to 12 in) long, 6 to 30 cm (2.4 to 12 in) wide, and yellowish to purple with age. Achenes (dry fruiting capsules) are 2.5 to 4 millimeters (mm) (0.1 to 0.2 in) long. This subspecies differs in that it has firmly connate bracts (fused leaf-like structures at the base of the flower) of a false involucre (whorl of bracts) in a single series that are 5.5 to 6.5 mm (0.2 to 0.3 in) long (Carr 1999). (USFWS, 2017)

Taxonomy

A member of the sunflower family (Asteraceae) (USFWS, 2010b).

Historical Range

Historically, *Dubautia plantaginea* ssp. *magnifolia* was known from two populations less than 3.2 kilometers (2 miles) apart in bog habitat in the Alakai Wilderness Preserve and the Na Pali-Kona FR on Kauai (HBMP 2010). It is suspected that *D. plantaginea* ssp. *magnifolia* evolved relatively recently and never had a wide historic distribution on Kauai (Carr 1985). (USFWS, 2017)

Current Range

Recorded from two areas on the island of Kauai, state of Hawaii (NatureServe, 2015).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Dubautia plantaginea magnifolia* (Na`ena`e) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Dubautia plantaginea magnifolia* includes three CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Wet Cliff—Section 1: Wet Cliff—Section 1 consists of 190 ac (77 ha) in the wet cliff ecosystem, including cliffs along the rim of Kalalau Valley from Alealeau to Pihea, on State-owned land in the Na Pali Coast State Park and the Hono o Na Pali NAR (Figure 6-A). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR

17.99(a)(1), Map 70b, and is occupied by the plant *Chamaesyce remyi* var. *remyi*. This section includes the wet cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the wet cliff ecosystem (Table 3). Although Wet Cliff–Section 1 is not known to be occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyanea dolichopoda*, *Cyrtandra oenobarbara*, *C. paliku*, *Dubautia plantaginea* ssp. *magnifolia*, *Lysimachia iniki*, *L. pendens*, *L. venosa*, and *Platydesma rostrata*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Wet Cliff—Section 2: Wet Cliff–Section 2 consists of 784 ac (317 ha) in the wet cliff ecosystem, and includes the cliffs at the headwaters of the Wailua River or “Blue Hole,” on State (778 ac, 315 ha) and privately owned (6 ac, 3 ha) land in the LihueKoloa Forest Reserve (Figure 6-B). There are 489 ac (198 ha) within previously designated critical habitat and 296 ac (120 ha) of newly designated critical habitat on State-owned land. The portion of the section that is in previously designated critical habitat falls within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36b. The newly designated portion of the section comprises Critical Habitat Unit 18 of 50 CFR 17.99(a)(1), Map 217a. This section is occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyrtandra oenobarba*, *Dubautia plantaginea* ssp. *magnifolia*, *Lysimachia iniki*, *L. pendens*, and *Platydesma rostrata*. The section includes the wet cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the wet cliff ecosystem (Table 3). Although Wet Cliff–Section 2 is not known to be occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyanea dolichopoda*, *Cyrtandra paliku*, and *Lysimachia venosa*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Wet Cliff—Section 3: Wet Cliff –Section 3 consists of 61 ac (24 ha) in the wet cliff ecosystem, including cliffs below Kekoiki, on State (8 ac, 3 ha) and privately owned (53 ac, 22 ha) land in the Halelea, Moloaa and Kealia forest reserves (Figure 6-C). There are 23 ac (9 ha) of newly designated critical habitat on privately owned land within this section. That portion of the section that falls within previously designated critical habitat is within Critical Habitat Unit 4 of 50 CFR 17.99(a)(1), Map 5a. The newly designated portion of the section comprises Critical Habitat Unit 19 of 50 CFR 17.99(a)(1), Map 217b. This section is occupied by the plant *Cyrtandra paliku*, and includes the wet cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the wet cliff ecosystem (Table 3). Although Wet Cliff–Section 3 is not known to be occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Cyanea dolichopoda*, *Cyrtandra oenobarbara*, *Dubautia plantaginea* ssp. *magnifolia*, *Lysimachia iniki*, *L. pendens*, *L. venosa*, and *Platydesma rostrata*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Dubautia plantaginea magnifolia* critical habitat consists of one component (Wet cliff) (75 FR 18960-19165):

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. Understory: Bryophytes, Ferns, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., "sustained yield") in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances

that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: This subspecies flowers primarily from August through December (Carr 1999; NTBG 2008a, 2011, 2012, 2014a-b). *Dubautia plantaginea* ssp. *magnifolia* occasionally hybridizes in the wild with *D. microcephala* (Carr 1985). (USFWS, 2017)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Wet cliff, wet forest, shrubland (USFWS, 2010b)

Geographic or Habitat Restraints or Barriers

Adult: 1,542 - 2,395 ft. elevation (USFWS, 2010b)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits moist to wet shrublands or forests, on steep slopes and cliffs. The environmental specificity is unknown (NatureServe, 2015). Typical habitat for this species includes wet cliff and wet forest and shrubland at elevations between 1,542 and 2,395 ft. (470 and 730 m) (HBMP 2007) (USFWS, 2010b).; Typical habitat for this species includes wet cliff and wet forest and

shrubland between 617 and 914 meters (2,024 and 3,000 feet) elevation (NTBG 2008, 2012, 2014a-c, 2015a; TNCH 2007). At Wainiha (Blue Hole), *Dubautia plantaginea* ssp. *magnifolia* is typically found in montane bog and lowland wet forest with associated native plant species including *Bidens* spp. (kookoolau), *Bobea* spp. (ahakea), *Cyanea asarifolia* (haha), *Cyrtandra* spp. (haiwale), *Gunnera kauaiensis* (ape ape), *Kadua elatior* (awiwi), *Machaerina* spp. (uki), *Metrosideros* spp. (ohia), *Perrottetia sandwicensis* (olomea), *Plantago* spp. (laukahi kuahiwi), and various ferns (HBMP 2010). At the Waikoko occurrence, the associated native plant species include *Cheirodendron* spp. (olapa), *Dubautia* spp. (naenae), *Cyrtandra* spp., *Isachne* spp. (ohe), *Kadua centranthoides* (no common name), *K. elatior* (awiwi), *K. foggiana* (NCN), *Melicope* spp. (alani), *Machaerina* spp. (uki), *Pipturus* spp. (mamaki), *Psychotria* spp. (kopiko), with the ferns *Asplenium* spp., *Cyclosorus* spp., *Deparia* spp., and *Microlepia* spp. (NTBG 2008). (USFWS, 2017)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Resiliency:

Very low (inferred from NatureServe, 2015; see current range/distribution)

Redundancy:

Very low (inferred from USFWS, 2010a)

Number of Populations:

4 (USFWS, 2017)

Population Size:

160 wild individuals (USFWS, 2017)

Population Narrative:

The long term population trend is unknown; it is suspected that this subspecies evolved relatively recently and never had a wide historic distribution on Kauai, but the magnitude of the threats facing the species has increased dramatically (Russell 2002) (NatureServe, 2015). There is one population containing 100 individuals (USFWS, 2010a).; Historically, *Dubautia plantaginea* ssp. *magnifolia* was known from two populations less than 3.2 kilometers (2 miles) apart in bog habitat in the Alakai Wilderness Preserve and the Na Pali-Kona FR on Kauai (HBMP 2010). It is suspected that *D. plantaginea* ssp. *magnifolia* evolved relatively recently and never had a wide historic distribution on Kauai (Carr 1985). In 1992, the year that Hurricane Iniki struck Kauai, the only known population of a few hundred individuals at Blue Hole, at the headwaters of the Wailua River, was greatly reduced. In 1996, however, the population was estimated to again be a few hundred individuals (HBMP 2010). A collection made in 1987 from the cliffs at the headwaters of the north fork of the Wailua River appears to be a dwarf form of *Dubautia plantaginea* ssp. *magnifolia*, which is otherwise known only from two collections, probably both

from Waialae Stream near Kaholuamanu (Carr 1999). However, as more collections of the Kauai taxon from Wailua River were made, a broader range of plant sizes were noted (Carr 1999). Another dwarf form of *D. plantaginea* ssp. *magnifolia* with smaller leaves and simpler inflorescences was collected at Blue Hole, one of the original sites for the species (Carr 1999). All of these forms are considered to be *D. plantaginea* ssp. *magnifolia*, totaling four locations for this taxon. Currently, there are approximately 100 individuals in the Blue Hole population (NTBG 2014a, 2015a), though estimates were higher for this population (200 individuals) in Flynn (2016), with approximately 60 additional individuals in the three other locations (Flynn 2016). (USFWS, 2017)

Threats and Stressors

Stressor: Ungulate degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Feral pigs (*Sus scrofa*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil (Loope 1998; van Riper and van Riper 1982). Feral pigs and evidence of their activities have been observed at both occurrences of *Dubautia plantaginea* ssp. *magnifolia* (NTBG 2008, 2014a-b, 2015a). (USFWS, 2017)

Stressor: Established ecosystem-altering invasive plant modification and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community (Cuddihy and Stone 1990). Habitat modification and destruction by invasive introduced plants negatively affects *Dubautia plantaginea* ssp. *magnifolia* at both locations. The nonnative plants with the greatest impacts include *Ageratina adenophora* (Maui pamakani), *Buddleja asiatica* (dog tail), *Clidemia hirta* (Koster's curse), *Cyathea cooperi*, *Cyperus meyenianus* (NCN), *Erigeron karvinskianus* (daisy fleabane), *Hedychium gardnerianum* (kahili ginger), *Juncus planifolius* (bog rush), *Passiflora edulis* (passion fruit), *Psidium cattleianum* (strawberry guava), *Psidium guajava* (common guava), *Rubus rosifolius* (thimbleberry), *Sphaeropteris cooperi* (Australian tree fern), and *Tibouchina herbacea* (glorybush) (HBMP 2010; NTBG 2008, 2014a-c, 2015a). (USFWS, 2017)

Stressor: Landslides and flooding destruction or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: The only known individuals of *Dubautia plantaginea* ssp. *magnifolia* occur on or near cliffs. Erosion associated with this habitat, and resulting from the activities of feral ungulates, can have a significant effect on small populations (HBMP 2010; NTBG 2008, 2014c). (USFWS, 2017)

Stressor: Hurricanes—Loss and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013). (USFWS, 2017)

Stressor: Climate change loss or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment was not conducted specifically for *Dubautia plantaginea* ssp. *magnifolia* (it was conducted only on the species level; *Dubautia plantaginea*, 0.17). However, it was concluded that the Hawaiian Asteraceae (with a vulnerability score of 0.455; on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change) is the ninth most vulnerable family in Hawaii. Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2017)

Stressor: Rodent predation or herbivory (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Herbivory by rats is noted to be a threat to *Dubautia plantaginea* ssp. *magnifolia* at the Wainiha population (HBMP 2010; NTB 2014a-b, 2015a). Rats eat virtually every part of plants and at every stage: fleshy fruits, seeds, flowers, stems, leaves, shoot, seedlings, and roots (Russell 1980; Cuddihy and Stone 1990). The effects on plants range from reduced vigor and decreased reproduction to mortality of individuals and complete lack of recruitment. (USFWS, 2017)

Stressor: Lack of adequate hunting regulations (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Current and historic habitat of *Dubautia plantaginea* ssp. *magnifolia* is within State hunting areas. Public hunting areas are not fenced and game mammals have unrestricted access

to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations are at risk (DLNR 2010). (USFWS, 2017)

Stressor: Lack of adequate biosecurity legislation (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Invasion of the State of Hawaii by invasive nonnative plant species, and destruction of habitat and competition by nonnative plants are threats to *Dubautia plantaginea* ssp. *magnifolia*. Pest species have caused the extinction of native species, the destruction of native forests, and the spread of disease. The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, is authorized to prevent the introduction or dissemination of animal and plant pests on all ships, aircraft, and their cargo and baggage arriving in the U.S. and its territories; however, pest species continue to enter the State. In addition, Federal import regulations do not address many species that could be pests in Hawaii (CGAPS 2009; Ikuma et al. 2002). (USFWS, 2017)

Stressor: Stochastic events—Reduced viability due to low numbers (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Small, isolated populations often exhibit reduced levels of genetic variability, which diminishes the species' capacity to adapt and respond to environmental changes, thereby lessening the probability of long-term persistence (Barrett and Kohn 1991; Newman and Pilson 1997). The problems associated with small population size and vulnerability to random demographic fluctuations or natural catastrophes are further magnified by synergistic interactions with other threats, such as anthropogenic impacts like habitat loss from human development or predation by nonnative species. *Dubautia plantaginea* ssp. *magnifolia* is only known from only two occurrences (HBMP 2010; NTB 2008, 2015a). (USFWS, 2017)

Stressor: Hybridization impacts (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: *Dubautia plantaginea* ssp. *magnifolia* occasionally hybridizes in the wild with *D. microcephala* (Carr 1999). (USFWS, 2017)

Recovery

Reclassification Criteria:

To meet the interim stage of recovery of *Dubautia plantaginea* ssp. *magnifolia*, 300 mature individuals are needed in each of three populations and all major threats must be controlled around the populations designated for recovery at this stage. There should also be demonstrated regeneration of seedlings and growth to at least sapling stage for woody species and documented replacement regeneration within each of the target populations. The populations must be adequately represented in an ex situ collection as defined in the Center for Plant Conservation's guidelines (Guerrant et al. 2004). Adequate monitoring must be in place

and conducted to assess individual plant survival, population trends, trends of major limiting factors, and response of major limiting factors to management. (USFWS, 2017)

In addition to achieving 5 to 10 populations with 500 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats. (USFWS, 2017)

Delisting Criteria:

In addition to achieving 5 to 10 populations with 500 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis. (USFWS, 2017)

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys (USFWS, 2010a).
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units (USFWS, 2010a).
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys (USFWS, 2010a).
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range (USFWS, 2010a).
- Conduct research on control methods for introduced slugs and avian malaria (USFWS, 2010a).

- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction (USFWS, 2010a).
- Identify threats and prioritize which ones to address first for the two birds (USFWS, 2010a).
- Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program (USFWS, 2010a).
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security (USFWS, 2010a).
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems (USFWS, 2010a).
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations (USFWS, 2010a).
- Surveys and inventories—Survey for populations of *Dubautia plantaginea* subsp. *magnifolia* in areas of suitable habitat. (USFWS, 2017)
- Ungulate monitoring and control—Construct and maintain small-scale fenced exclosures around all populations to prevent imminent extinction. Protect all occurrences against disturbances from feral ungulates. (USFWS, 2017)
- Invasive plant monitoring and control—Control invasive nonnative plant species around all populations. (USFWS, 2017)
- Rodent predation or herbivory—Implement effective control methods for rats. (USFWS, 2017)
- Captive propagation for genetic storage and reintroduction—Collect seeds from all individuals for genetic storage and conduct propagation for reintroduction. (USFWS, 2017)
- Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2017)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms. (USFWS, 2017)
- Population biology research—Study *Dubautia plantaginea* ssp. *magnifolia* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. (USFWS, 2017)
- Based on the recovery criteria above, consider development of a recovery plan. (USFWS, 2017)

Conservation Measures and Best Management Practices:

- This species is currently in controlled propagation for genetic storage and/or reintroduction efforts (USFWS, 2010a).

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SPECIES ACCOUNT: *Dubautia plantaginea* ssp. *humilis* (Na`ena`e)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/03/1999; Pacific Region (R1) (USFWS, 2016)

Physical Description

A shrub or small tree up to 7 m tall. Flowers are yellow or purple with age (NatureServe, 2015)

Taxonomy

A member of the aster family (Asteraceae) (USFWS, 2002).

Historical Range

Dubautia plantaginea ssp. *humilis* has only been reported from Iao Valley, on West Maui (USFWS, 2002).

Current Range

It currently occurs at Iao Valley on West Maui (USFWS, 2018).

Critical Habitat Designated

Yes; 5/14/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Dubautia plantaginea* ssp. *humilis* (Na`ena`e) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Dubautia plantaginea* ssp. *humilis* includes three CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Wet Cliff—Unit 6 (and) *Palmeria dolei*—Unit 35—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 35—Wet Cliff This area consists of 1,858 ac (752 ha) of State land, and 253 ac (102 ha) of privately owned land, at the summit ridges of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plants *Alectryon macrococcus*, *B. conjuncta*, *Ctenitis squamigera*, *Cyrtandra munroi*, *Remya mauiensis*, and *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 6 is not known to be occupied by the plants *Bidens campylothea* ssp. *pentamera*, *Bonamia menziesii*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendrion pyrifolium*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, or *Tetramolopium capillare*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the

reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 7 (and) *Palmeria dolei*—Unit 36—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 36—Wet Cliff This area consists of 556 ac (225 ha) of State land along Honokowai ridge on the northwestern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units are occupied by the plants *Cyrtandra filipes* and *C. munroi*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 7 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 8 consists of 337 ac (137 ha) of State land along Kahakuloa ridge on the north side of west Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff—Unit 8 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Dubautia plantaginea* ssp. *humilis* critical habitat consists of one component. Wet cliff (west Maui) (81 FR 17790-18110):

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. Understory: *Bryophytes*, *Ferns*, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of

invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkii*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Lifespan

Adult: < 10 years (USFWS, 2014)

Breeding Season

Adult: Unknown (USFWS, 2002)

Key Resources Needed for Breeding

Adult: Unknown (USFWS, 2002)

Reproduction Narrative

Adult: It is a short-lived perennial (fewer than 10 years) (USFWS, 2014). Flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown (U.S. Fish and Wildlife Service 1999b, 2002b) (USFWS, 2002).

Habitat Type

Adult: Terrestrial (USFWS, 2002)

Habitat Vegetation or Surface Water Classification

Adult: Rocky cliff (USFWS, 2002)

Geographic or Habitat Restraints or Barriers

Adult: 870 - 5,230 ft. elevation (USFWS, 2002)

Habitat Narrative

Adult: Inhabits steep cliff faces with grasses and shrubs (NatureServe, 2015). The typical habitat of the species is wet, barren, steep, rocky, wind-blown cliffs between 265 and 1,595 meters (870 and 5,230 feet) elevation (USFWS, 2002).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Decreasing (USFWS, 2014)

Resiliency:

Very low (inferred from NatureServe, 2015; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2014)

Number of Populations:

1 (USFWS, 2018)

Population Size:

22 wild individuals (USFWS, 2018)

Population Narrative:

Overall, the number of individuals has decreased from the 50 individuals reported for *D. plantaginea* ssp. *humilis* in the previous 5-year review to approximately 30 individuals (PEPP 2012). There are 3 populations (USFWS, 2014).; In 2014, the only known population totaled approximately 50 individuals. Currently, there are only 22 individuals at this location (PEPP 2017a, b). (USFWS, 2018)

Threats and Stressors

Stressor: Herbivory (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Herbivory by slugs (unidentified species) is a severe threat to remote populations of *D. plantaginea* ssp. *humilis* (PEPP 2009, 2011, 2012). Rats (*Rattus* spp.) are a severe threat to remote populations of *D. plantaginea* ssp. *humilis* (PEPP 2011) (USFWS, 2014).

Stressor: Nonnative species (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Established invasive plant species – Additional invasive introduced plants have been identified as a threat to this species including *Psidium cattleianum* (strawberry guava) and *Schinus terebinthifolius* (Christmasberry) (PEPP 2011) (USFWS, 2014).

Stressor: Climate change (USFWS, 2014; USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Dubautia plantaginea* ssp. *humilis* has low vulnerability to the impacts of climate change (USFWS, 2014).; The assessment by Fortini et al. (2013) was conducted at the species level and concluded that *Dubautia plantaginea* is vulnerable to the impacts of climate change, with a vulnerability score of 0.17 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). However, we assume that with the very limited range this subspecies occupies, that its vulnerability may be higher for this subspecies compared to the entire species. Additional management actions may be needed to conserve this taxon into the future. (USFWS, 2018)

Stressor: Stochastic events (USFWS, 2002)

Exposure:

Response:

Consequence:

Narrative: Random environmental events (e.g. landslides) are also a threat because of the limited number of individuals and populations and their narrow distribution (USFWS, 2002).

Stressor: Collection (USFWS, 2002)

Exposure:

Response:

Consequence:

Narrative: Potential threats include unrestricted collecting or excessive visits by individuals interested in seeing rare plants (U.S. Fish and Wildlife Service 1999b, 2002b) (USFWS, 2002).

Recovery

Reclassification Criteria:

1. A total of five to seven populations should be documented on islands where it now occurs or occurred historically (USFWS, 2002).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 2002).
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 2002).

Delisting Criteria:

1. A total of 8 to 10 populations should be documented on islands where it now occurs or occurred historically (USFWS, 2002).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 2002).
3. Each population should persist at this level for a minimum of five consecutive years (USFWS, 2002).

Recovery Actions:

- Protect habitat and control threats (USFWS, 2002).
- Expand existing wild populations (USFWS, 2002).
- Conduct essential research (USFWS, 2002).
- Develop and maintain monitoring plans (USFWS, 2002).
- Reestablish wild populations within the historic range (USFWS, 2002).
- Validate and revise recovery criteria (USFWS, 2002).
- Maintain adequate genetic stock (USFWS, 2002).
- Control competing alien plant species (USFWS, 2002).
- Enhance wild populations and establish new populations (USFWS, 2002).
- Population viability and monitoring—Continue to monitor the wild and outplanted populations on west Maui. (USFWS, 2018)
- Surveys and inventories—Survey geographical and historical range of *Dubautia plantaginea* subsp. *humilis* for a current assessment of the species' status. (USFWS, 2018)
- Ungulate monitoring and control—Construct and maintain strategic exclusion fences to protect *D. plantaginea* subsp. *humilis* from the impacts of feral ungulates. (USFWS, 2018)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. (USFWS, 2018)
- Predator and herbivore monitoring and control—Implement effective control methods for rodents at wild and reintroduced populations. Develop and implement effective control methods for slugs.(USFWS, 2018)
- Captive propagation for genetic storage and reintroduction—Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. (USFWS, 2018)

- Reintroduction and translocation—Continue reintroduction of individuals into suitable habitat within historic range that is being managed for known threats to this subspecies. (USFWS, 2018)
- Climate change adaptation strategy—Research the suitability of habitat for reintroducing this subspecies in the future due to impacts from climate change. (USFWS, 2018)
- Alliance and partnership development—Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2018)

Conservation Measures and Best Management Practices:

- Captive propagation for genetic storage and reintroduction – Continue seed collection for ex situ genetic storage and reintroduction (USFWS, 2014).
- Reintroduction / translocation – Continue augmenting populations as genetically appropriate individuals become available in nurseries and as habitat is protected (USFWS, 2014).
- Surveys / inventories – Survey geographical and historical range of *D. plantaginea* ssp. *humilis* for a current assessment of the species' status (USFWS, 2014).
- Invasive plant species control – Control invasive introduced plants within the vicinity of *D. plantaginea* ssp. *humilis* populations (USFWS, 2014).
- Predator / herbivore monitoring and control – Control slugs and rodents within the vicinity of all known populations (USFWS, 2014).
- Population viability monitoring and analysis – Continue monitoring wild and outplanted populations (USFWS, 2014).
- Climate change adaptation strategy – Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change (USFWS, 2014).
- Alliance and partnership development –Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2014).

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SPECIES ACCOUNT: *Dubautia waialealae* (Na`ena`e)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (R1) (USFWS, 2016)

Physical Description

Dubautia waialealae, a member of the sunflower family (Asteraceae), is a dome or tussock-shaped shrub 10 to 40 centimeters (cm) (0.3 to 1.3 feet (ft)) tall. Leaves are alternate, spreading, linear-elliptic to lanceolate, and 2.5 to 10 cm (1 to 4 in) long, 5 to 17 millimeters (mm) (0.2 to 0.7 in) wide, with both surfaces hispidulous (covered with stiff, short hairs). Fifteen to 200 flowers are borne in compact clusters 2 to 15 cm (0.8 to 6 in) long and 1.5 to 12 cm (0.6 to 4.7 in) wide. Corollas are yellowish orange, 2 to 3 mm (0.08 to 0.12 in) long, with 2 to 3 mm (0.08 to 0.12 in) long ascending bristles. Achenes (dry fruiting capsules) are 3 to 4 mm (0.12 to 0.16 in) long, pilosulous (with small soft hairs) above, and glabrate (smooth) below (Carr 1999). (USFWS, 2017)

Taxonomy

A member of the sunflower family (Asteraceae) (USFWS, 2010b).

Historical Range

The type collection was made on the summit of Waialeale in 1909 (Rock 1910, p. 304), but little is known of other historical locations of *D. waialealae* on Kauai (USFWS, 2010b).

Current Range

It currently occurs on the summit of Waialeale (USFWS, 2010b).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Dubautia waialealae* (Na`ena`e) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Dubautia waialealae* includes three CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Montane Wet—Section 1: Montane Wet—Section 1 consists of 13,055 ac (5,257 ha) in the montane wet ecosystem, extending across the Alakai Plateau from Hanakoa to Mount Waialeale, on State (12,628 ac, 5,110 ha) and privately owned (427 ac, 173 ha) land in the Na Pali Coast State Park, the Alakai Wilderness Preserve, the Na PaliKona and Halelea forest reserves, and Hono o Na Pali NAR (Figure 4). It is occupied by the plants *Astelia waialealae*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *K. helenae*, *Labordia helleri*, *L. pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, and *Platydesma rostrata*; by the

akekee and akikiki; and by the picture-wing fly. This section also contains unoccupied habitat that is essential to the conservation of these 18 species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the montane wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and the species-specific PCEs including (1) bogs (identified as PCEs for *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*) (2) bog hummocks (identified as PCEs for *Astelia waialealae* and *Lysimachia daphnoides*); (3) arthropod prey (identified as PCEs for the akekee and the akikiki); and (4) larval-stage host plants, *Cheirodendron* and *Tetraplasandra* sp., (identified as a PCE for the picture-wing fly). Although Montane Wet–Section 1 is not known to be occupied by the plants *Dubautia kalalauensis*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, those portions of the section that overlie previously designated critical habitat fall within two existing Critical Habitat Units of 50 CFR 17.99(a)(1): Unit 10, Map 35a; and Unit 11, Map 64a. The previously undesignated land comprises Unit 23, Map 217f; and Unit 24, Map 217g. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 4–Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 4–Montane Wet).

Kauai—Montane Wet—Section 2: Montane Wet–Section 2 consists of 790 ac (320 ha) in the montane wet ecosystem, extending from Kahuamaa Flat south to the edge of Waimea Canyon, on State-owned land in Kokee State Park (Figure 4, above). The entire section is within previously designated critical habitat, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Dubautia kalalauensis*, *Labordia helleri*, *Melicope puberula*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*, and by the akekee. This section includes montane wet forest, potentially some small-scale boggy areas, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and arthropod prey (identified as a species-specific PCE for the akekee). Although Montane Wet–Section 2 is not known to be occupied by the plants *Astelia waialeale*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialeale*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *Myrsine mezii*, and *Phyllostegia renovans*; by the akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. This area also supports the arthropod prey identified as a PCE for the akikiki, and the larval-stage host plants (*Cheirodendron* and *Tetraplasandra* spp.) identified as a PCE for the picturewing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within previously designated Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 5–Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 5–Montane Wet).

Kauai—Montane Wet—Section 3: Montane Wet–Section 3 consists of 413 ac (167 ha) in the montane wet ecosystem, encompasses the summit of Namolokama, on State (156 ac, 63 ha) and

privately owned (257 ac, 104 ha) land in the Halelea Forest Reserve (Figure 4, above). It is entirely within previously designated critical habitat, and is occupied by the plants *Keysseria erici* and *Labordia pumila*. This section includes the montane wet forest, the moisture regime, and the canopy, subcanopy, and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and bogs (identified as a species-specific PCE for *K. erici*). Although Montane Wet–Section 3 is not known to be occupied by the plants *Astelia waialeale*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia kalalauensis*, *D. waialeale*, *Geranium kauaiense*, *Keysseria helenae*, *Labordia helleri*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*; by the akekee and akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. It also supports the arthropod prey identified as a PCE for the akekee and akikiki, and the larval-stage host plants (*Cheirodendron* and *Tetraplasandra* spp.) identified as a PCE for the picture-wing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 6–Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 6–Montane Wet).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Dubautia waialealae* critical habitat consists of one component (Montane wet). Species-specific PCEs include: bogs (75 FR 18960-19165):

Ecosystem: Montane Wet. Elevation: 3,000–5,243 ft (914-1,598 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: *Ferns*, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include

habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: This species has been observed flowering from August through February (Carr 1999; NTBG 2011, 2015a-b). (USFWS, 2017)

Habitat Type

Adult: Wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Montane wet ecosystem (USFWS, 2010b); montane bog (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 3,980 - 5,249 ft. elevation (USFWS, 2010b)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits montane bogs in upper elevation wet forest regions. The environmental specificity is unknown (NatureServe, 2015). It occurs in bogs in the montane wet ecosystem at elevations between 3,980 and 5,249 ft. (1,213 and 1,600 m) (Carr 1999, p. 308; HBMP 2007; TNCH 2007) (USFWS, 2010b).; *Dubautia waialealae* occurs in the montane wet ecosystem between 1,219 and 1,600 meters (4,000 and 5,249 feet) elevation (Carr 1999; HBMP 2010; NTBG 2008, 2011, 2015a-d; TNCH 2007). Typical habitat is montane bogs with mixed sedges and grasses, and montane bogs dissected with riparian vegetation of *Metrosideros polymorpha* (ohia)–*Cheirodendron* spp. (olapa) forest with associated native plant species including *Astelia waialealae* (painiu), *Deschampsia nubigena* (hairgrass), *Dichanthelium* spp. (NCN), *Dubautia imbricata* ssp. *acronaea* (naenae), *D. laxa* ssp. *hirsuta* (naenae), *Leptechophylla tameiameia* (pukiawe), *Machaerina* spp. (uki), *Plantago pachyphylla* (laukahi kuahiwi), *Rhynchospora* spp. (kuolohia), and *Viola* spp. (violet) (Carr 1999; Wood 2006; NTBG 2015a). (USFWS, 2017)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Species Trends:

< 30% decline (NatureServe, 2015)

Resiliency:

Very low (inferred from USFWS, 2010b; see current range/distribution)

Redundancy:

Very low (inferred from USFWS, 2010b)

Number of Populations:

2 (USFWS, 2017)

Population Size:

4000-5000 wild individuals (USFWS, 2017)

Population Narrative:

The long term population trend is unknown. The short term trend is a < 30% decline; pig damage was observed on at least ten percent of the entire remaining population (Russell 2002). At current rates of damage, the remaining population will decline dramatically in the foreseeable future (Russell 2004, Russell 2002). Further, about half of the larger subpopulation has been fenced to prevent pigs from getting to the site. However, pigs do still break in where the fencing is weak in between fence maintenance work and eat this species (Russell 2004) (NatureServe, 2015). Currently, there is one large population centered on the rain-gauge summit of Waialeale, with many subpopulations radiating about 0.6 mi (1 km) to the north and south. These subpopulations were observed in groups of 7 to 400 individuals (Wood 2006, pp. 25–29), with a total population of 3,000 individuals (Wood 2006, p. 9) (USFWS, 2010b).; In 1994, a single individual of *D. waialealae* was reported at North Bog, 14 kilometers (km; 8.5 miles (mi)) away from the population at Waialeale; however, in 2006, it was reported that this individual had died (Perlman and Wood 1995; Bruegmann 2006; HBMP 2010). It is possible that individuals may still exist there (HBMP 2010; Bruegmann 2006). Currently, there are two populations. There is one large population centered on the rain-gauge summit of Waialeale, with many subpopulations radiating about 1 km (0.6 mi) to the north and south. These subpopulations were observed in groups of 7 to 400 individuals each, with a total population of approximately 3,000 individuals (HBMP 2010; Wood 2006). A survey of the Kawaikini summit (about 1.5 km (0.9 mi) south of Waialeale summit) revealed the second population of *D. waialealae* ranging from Kawaikini towards Waialeale, estimated to total from 1,000 to 2,000 individuals (NTBG 2015b; PEPP 2015). (USFWS, 2017)

Threats and Stressors

Stressor: Ungulate degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Feral pigs (*Sus scrofa*) and goats (*Capra hircus*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil (Loope 1998; van Riper and van Riper 1982). Feral pigs and goats and evidence of their activities have been observed at both occurrences of *Dubautia waialealae* (Bruegmann 2002; HBMP 2010; NTBG 2011, 2015a-d; Wood 2006). (USFWS, 2017)

Stressor: Established ecosystem-altering invasive plant modification and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community (Cuddihy and Stone 1990). Habitat modification and destruction by invasive introduced plants negatively affects *Dubautia waialealae* at both locations. The nonnative plants with the greatest impacts include *Andropogon virginicus* (broomsedge), *Axonopus fissifolius* (narrow-leaved carpetgrass), *Blechnum appendiculatum* (NCN), *Buddleja asiatica* (dog tail), *Clidemia hirta* (Koster's curse), *Cyperus meyenianus* (NCN), *Erigeron karvinskianus* (daisy fleabane), *Juncus planifolius* (bog rush), *Paspalum conjugatum* (Hilo grass), *Psidium cattleianum* (strawberry guava), *Rubus rosifolius* (thimbleberry), and *Sacciolepis indica* (glenwood grass) (Bruegmann et al. 2011; HBMP 2010; NTBG 2015a-d; Perlman and Wood 1995; Wood 2006). (USFWS, 2017)

Stressor: Hurricanes—Loss and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013). (USFWS, 2017)

Stressor: Climate change loss or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Dubautia waialealae* is highly vulnerable to the impacts of climate change with a vulnerability score of 0.811 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2017)

Stressor: Rodent predation or herbivory (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Herbivory by rats is noted to be a threat to *Dubautia waialealae* (HBMP 2010; NTBG 2015a-d). Rats eat virtually every part of plants and at every stage: fleshy fruits, seeds, flowers, stems, leaves, shoot, seedlings, and roots (Russell 1980; Cuddihy and Stone 1990). The effects on plants range from reduced vigor and decreased reproduction to mortality of individuals and complete lack of recruitment. (USFWS, 2017)

Stressor: Lack of adequate hunting regulations (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: The Waialeale summit bog individuals are provided some protection by a fenced enclosure; however, individuals at Kawaikini are not fenced. Hunting areas surround the two occurrences. Public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations are at risk (DLNR 2010). (USFWS, 2017)

Stressor: Lack of adequate biosecurity legislation (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Invasion of the State of Hawaii by invasive nonnative plant species, and destruction of habitat and competition by nonnative plants are threats to *Dubautia waialealae*. Pest species have caused the extinction of native species, the destruction of native forests, and the spread of disease. The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, is authorized to prevent the introduction or dissemination of animal and plant pests on all ships, aircraft, and their cargo and baggage arriving in the U.S. and its territories; however, pest species continue to enter the State. In addition, Federal import regulations do not address many species that could be pests in Hawaii (CGAPS 2009; Ikuma et al. 2002). (USFWS, 2017)

Stressor: Invasive species—Established invasive plant species competition (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: The nonnative plants noted to compete with *Dubautia waialealae* for water, light, and nutrients include *Axonopus fissifolius*, *Erechtites valerianifolia* (fireweed), *Juncus planifolius*, and *Sacciolepis indica* (Bruegmann et al. 2011; Perlman and Wood 1995; Wood 2006). (USFWS, 2017)

Recovery

Reclassification Criteria:

In addition to achieving 5 to 10 populations with 500 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist.

Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats. (USFWS, 2017)

To meet the interim stage of recovery of *Dubautia waialealae*, 300 mature individuals are needed in each of three populations and all major threats must be controlled around the populations designated for recovery at this stage. There should also be demonstrated regeneration of seedlings and growth to at least sapling stage for woody species and documented replacement regeneration within each of the target populations. The populations must be adequately represented in an ex situ collection as defined in the Center for Plant Conservation's guidelines (Guerrant et al. 2004). Adequate monitoring must be in place and conducted to assess individual plant survival, population trends, trends of major limiting factors, and response of major limiting factors to management. (USFWS, 2017)

Delisting Criteria:

In addition to achieving 5 to 10 populations with 500 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis. (USFWS, 2017)

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys (USFWS, 2010a).
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units (USFWS, 2010a).
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys (USFWS, 2010a).
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range (USFWS, 2010a).
- Conduct research on control methods for introduced slugs and avian malaria (USFWS, 2010a).

- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction (USFWS, 2010a).
- Identify threats and prioritize which ones to address first for the two birds (USFWS, 2010a).
- Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program (USFWS, 2010a).
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security (USFWS, 2010a).
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems (USFWS, 2010a).
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations (USFWS, 2010a).
- Surveys and inventories—Continue to survey for other populations of *Dubautia waialealae* in areas of potentially suitable habitat. (USFWS, 2017)
- Ungulate monitoring and control—Continue to maintain fenced exclosures for breaches by feral pigs and goats. Protect all occurrences against browsing and disturbances from feral ungulates. Construct and maintain a large-scale fenced exclosure at the Kawaikini population. (USFWS, 2017)
- Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species around all populations. Continue to control invasive nonnative plant species around all populations that compete with the species. (USFWS, 2017)
- Captive propagation for genetic storage and reintroduction—Continue collection of propagules and seeds for maintenance of genetic stock. (USFWS, 2017)
- Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2017)
- Population viability monitoring and analysis—Continue to monitor the vegetative cover, vigor, and phenology of *Dubautia waialealae* regularly within Waialeale, North Bog, and also at Kawaikini. (USFWS, 2017)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms. (USFWS, 2017)
- Based on the recovery criteria above, consider development of a recovery plan. (USFWS, 2017)

Conservation Measures and Best Management Practices:

- USFWS and the Hawaii Division of Forestry and Wildlife have fenced 9 montane bogs in the Alakai Plateau, totaling approximately 40 hectares (100 acres). These fenced bogs contain roughly half of the *D. waialealae* individuals (USFWS, 2010a).
- This species is currently in controlled propagation for genetic storage and/or reintroduction efforts (USFWS, 2010a).

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SPECIES ACCOUNT: *Dudleya abramsii* ssp. *parva* (Conejo dudleya)

Species Taxonomic and Listing Information

Listing Status: Threatened; 2/28/1997; Pacific Southwest Region (R8)

Physical Description

A succulent dicot, rosette-forming perennial herb with vernal leaves (summer deciduous), an inflorescence stem 5 to 18 centimeters long, and pale yellow-green flowers that often exhibit flecks of red on the keel. The roots are constricted at irregular intervals . (USWS, 2015)

Taxonomy

In the stonecrop family (Crassulaceae). *Dudleya parva* was recognized as a distinct species by Munz and Keck in 1959 and 1968, Nakai in 1983, and Moran in 1980 (McCabe in litt. 2008a). In 1991, Bartel published a revision treating *D. parva* as a subspecies of *D. abramsii* (Bartel 1991) based on similarities between the flowers of *D. abramsii* and *D. parva* noted by Reid Moran (1948). However, *D. parva* and *D. abramsii* have differing micromorphological leaf surface characters, caudex diameters, and wound responses that appear to clearly separate the two (McCabe in litt. 2008a). The name of this species has been returned to *Dudleya parva* (from *Dudleya abramsii* ssp. *parva*) as of November 2006. (USFWS, 2015)

Historical Range

See current range/distribution.

Current Range

Known locations are in a narrow band of recorded occurrences along a 10-mile stretch of land from the western portion of the Simi Hills, through Mountclef Ridge, to the Conejo Grade in Ventura County, California (USFWS, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: Unknown; up to 24 years in cultivation (USFWS, 2015)

Breeding Season

Adult: Blooms in late spring (May-June) (USFWS, 2015)

Key Resources Needed for Breeding

Adult: Bees and flies for pollination (USFWS, 2015)

Reproduction Narrative

Adult: Blooms in late spring (May - June), and is pollinated by bees and flies. *D. parva* tends to exhibit a higher degree of auto-fertility and is prone to pollinator unreliability, short and

unpredictable reproductive seasons, small population size, and high population turnover. *D. parva* will hybridize with some of the other *Dudleya* species (e.g., *D. pulverulenta*), which is typical of the *Dudleya* genus. Seeds sprout in the winter when there is ample precipitation and continue to grow throughout the rainy season. The plants may spread slowly underground by roots or stems, and any stem within 2 to 3 cm (0.8 to 1.2 in) of a centrally established individual may be a clone of that individual (USFWS, 2015).

Habitat Type

Adult: Terrestrial (USFWS, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Scattered rock outcrops in grassland and cactus dominated coastal sage scrub habitat (USFWS, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Elevations ranging from 60 to 450 meters (USFWS, 2015)

Habitat Narrative

Adult: On a broad scale, suitable habitat for *Dudleya parva* is comprised of coastal sage scrub and valley and foothill grassland with clay or volcanic soils, at elevations ranging from 60 to 450 meters (180 to 1350 ft), and on slopes ranging from 0 to 90 degrees, but most commonly on north-facing slopes of approximately 10 degrees. This species is highly localized in its distribution, occurring exclusively in thin-soiled substrate over rocky outcrops derived from the Miocene Conejo volcanics (USFWS, 2015).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Dispersal information is not available (inferred from USFWS, 2015).

Population Information and Trends**Population Trends:**

Stable (inferred from USFWS, 2015)

Species Trends:

Stable (inferred from USFWS, 2015)

Number of Populations:

14 (USFWS, 2015)

Population Size:

~150,000 individuals (USFWS, 2015)

Population Narrative:

The population boundaries and numbers for *Dudleya parva* exhibit some annual fluctuations; however, the species has generally remained in the same suitable habitat areas noted at the time of listing in 1997. Since the time of listing, the number of documented individuals within

the noted occurrences of the species has increased in some cases, while decreasing somewhat in others; however, the information gathered from the more recent population surveys seems to show that overall the species has remained at relatively constant levels since the time of listing. While many of the sites occur on private lands and could not be adequately surveyed, the numbers of plants that were seen on public lands have substantially increased in a few areas. Observed increases from different population surveys does not represent an actual increase in the number of plants, but rather is likely a result of the more thorough surveys (USFWS, 2015).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Habitat encroachment from new or existing development, fire suppression activities, human recreational activities (such as hiking, rock climbing, biking, and horseback riding) continue to be a threat (USFWS, 2015).

Stressor: Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Due to the accessibility of some of the habitat sites to the public and the appeal of *Dudleya* species to horticulturalists, collection still constitutes a threat to the species. However, due to the vernal nature of this species (leaves wither and fall off in the summer), it may be slightly less attractive to collectors than non-vernal species (USFWS, 2015).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: The Endangered Species Act is the primary Federal law that has provided some level of protection for *Dudleya parva* since its listing as threatened in 1997. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act (USFWS, 2015).

Stressor: Other natural or manmade factors affecting its continued existence (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: The low numbers of individuals and limited range of *Dudleya parva* make it particularly vulnerable to extinction from random human-caused or natural events. *Dudleya parva* is potentially threatened by: (1) pre-fire fuel-reduction activities, such as removal of native vegetation and disturbance of soils that can reduce habitat quality; (2) the wildfire itself, in which the intense heat can kill or set back the growth of individuals; and (3) fire suppression activities,

including the disturbance of native vegetation and soils during the grubbing of fire lines and the dropping of fire retardants, the latter of which increases soil nitrogen and stimulates the growth of non-native grasses that could compete with *D. parva* (USFWS, 2015).

Recovery

Reclassification Criteria:

Not applicable.

Delisting Criteria:

1. All current sites (including seedbanks) are fully protected and managed with the primary intention of preserving the populations in perpetuity (USFWS, 1999).
2. All current sites (including seedbanks) are shown to be self-sustaining over a minimum of 10 years (USFWS, 1999).

Recovery Actions:

- Protect and secure populations and habitat on unprotected lands. Habitat for the listed plants must be protected and secured in perpetuity, from identified threats of loss. Methods for securing lands include permanent conservation easements established through land use decisions, in-fee purchase, gifts of easement, or fee interest by property owner (USFWS, 1999).
- Manage and monitor protected areas. The process of evaluating past and current management and making adjustments as needed is termed “adaptive management.” Public and private conservation lands should be adaptively managed to maximize their potential to support listed species and their habitats. (USFWS, 1999)
- Survey historic locations and other potential habitat where species may occur, Surveys of the potential albeit limited, habitat within the species range should be done. Several California Natural Diversity Database occurrence records for the listed species are represented only by observations. Information on population status, threats, and abundance is also needed for these sites. Information gathered from the additional details will be used to provide lead agencies to determine protective land use designation for the listed plant species. Data gathered will assist in determining the range of site characteristics, population vigor, and species viability to help establish minimum population standards for rare plant reserves, and consequently, for recovery. (USFWS, 1999)
- Conduct biological and ecological research to define life history strategies and population dynamics to guide recovery/conservation efforts. A better understanding of the population dynamics and identification of ecological factors that may be affecting those dynamics are needed to develop appropriate management plans to recover the plant species. (USFWS, 1999).
- Develop outreach plans to conserve the species. Outreach is an important component of implementing this recovery plan. This plan should be developed to enhance the public’s understanding of issues related to conservation and recovery of the listed species. Participation from both public and private entities should be encouraged for the establishment of conservation plans for the listed species. (USFWS, 1999)
- Recommendation for Future Action from 2015 5-Year Review: Conduct new, up-to-date, extensive population surveys of known occurrences and areas of suitable habitat. - Develop

and implement monitoring and adaptive management plans for known existing occurrences. Monitoring should occur at intervals of 3 years and include population abundance surveys, habitat condition assessment, and documentation of existing and potential threats. - Update and expand knowledge of the species' life history and specific habitat requirements (USFWS, 2015).

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SPECIES ACCOUNT: *Dudleya cymosa ssp. marcescens* (Marcescent dudleya)

Species Taxonomic and Listing Information

Listing Status: Threatened; 01/29/1997; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

A perennial herb that forms a rosette of succulent leaves in the spring, withering in summer. The rosette leaves are 1.5 to 4 centimeters (0.6 to 1.6 inches) long, 5 to 12 millimeters (2.0 to 4.7 inches) wide; the caudex (stem) is 2 to 7 centimeters (0.8 to 2.8 inches) thick, flowering stems are 4 to 10 centimeters (1.6 to 4 inches) tall and the corolla is bright yellow, to yellow with red markings, to bright red (Munz 1974; Hickman 1993). (USFWS, 1999)

Taxonomy

Dudleya cymosa was described by Charles Antoine Lemaire in 1858 as *Echeveria cymosa* based on a collection sent to him by horticulturist Louis de Smet of Ledeburg, Belgium; unfortunately, the type locality is unknown and the type specimen has been lost (Moran 1951). Britton and Rose (1903) included this species in their newly described genus *Dudleya*, as *D. cymosa* (Moran 1951). Other subspecies of *D. cymosa* range throughout the Sierra Nevada, the coast ranges, the transverse ranges, and the northern portion of the peninsular ranges. *Dudleya cymosa ssp. marcescens* differs from other subspecies of *D. cymosa* in that its rosette leaves wither in the summer, but do not fall off (i.e., they are marcescent). (USFWS, 1999)

Historical Range

See current range/distribution.

Current Range

Dudleya cymosa ssp. marcescens is endemic to the Santa Monica Mountains in California and is known from a 24-km (15-mi) stretch between Hidden Valley and Malibu Creek State Park (Raven et al. 1986). The total area that encompasses all of the known *D. cymosa ssp. marcescens* occurrences is approximately 230 square km (88 square mi) (USFWS, 2009).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Dependency on Other Individuals or Species

Adult: *Dudleya cymosa ssp. marcescens* is pollinated by hummingbirds and bees, and produces an abundant amount of small seed. (USFWS, 2009)

Breeding Season

Adult: May to June (USFWS, 2009)

Reproduction Narrative

Adult: Flowering generally occurs between May and June and produces fruits with five follicles that split open to release abundant small seeds in late summer or early fall (Skinner and Pavlik 1994, Dorsey 2007). *Dudleya cymosa* ssp. *marcescens* is pollinated by hummingbirds and bees, and produces an abundant amount of small seed. Pollination services to *D. cymosa* ssp. *marcescens* may be less than for other *Dudleya* taxa because they grow on rock faces with no other flowering plants to attract pollinators. The seeds of *D. cymosa* ssp. *marcescens* range from 0.2 to 1.2 millimeters (0.008 to 0.047 inch) in diameter (Wall 2008). Compared with other rare *Dudleya* taxa found in the Santa Monica Mountains, *D. cymosa* ssp. *marcescens* had a relatively low reproductive output and low seed germination that may put it in greater danger of extinction than other rare *Dudleya* taxa (Dorsey 2007). (USFWS, 2009)

Habitat Type

Adult: Terrestrial (USFWS, 2009)

Habitat Vegetation or Surface Water Classification

Adult: Sheer volcanic cliffs and canyon walls in canyons with perennial streams (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Grows with mosses and lichens in places too steep for soil to form (NatureServe, 2015)

Dependency on Other Individuals or Species for Habitat

Adult: Riefner and Bowler (1995) hypothesize that the fog-capturing lichen found in the coastal bluffs and cliffs of California may trap *Dudleya* seeds, provide nutrients and water, and may protect young plants from snail and slug herbivory. (USFWS, 2009)

Habitat Narrative

Adult: suitable habitat for *Dudleya cymosa* ssp. *marcescens* is generally located on the lower reaches of volcanic rock outcrops adjacent to streams, chaparral, and coast live oak (*Quercus agrifolia*) woodland (CNDDDB 2008, NPS 2003). In most locations, the topographic relief has prevented deep soil formation; therefore, this species may be the only flowering plant occurring in a microhabitat that is otherwise dominated by mosses, lichens, and ferns (CNDDDB 2008). The mosses and lichens may play a crucial role in trapping *D. cymosa* ssp. *marcescens* seeds and allowing them to germinate and establish on the volcanic outcrops (Riefner and Bowler 1995, Riefner and Wishner 2000). (USFWS, 2009)

Dispersal/Migration**Dependency on Other Individuals or Species for Dispersal**

Adult: Animals (USFWS, 2009)

Dispersal/Migration Narrative

Adult: The grouping of the plants along the watershed corridor may indicate a dispersal mechanism that is driven by water or short-distance wind dispersal. The seeds of *D. cymosa* ssp. *marcescens* are very small in size and may be easily transported by water, wind, or animals within and outside of the watershed (Wall 2008). (USFWS, 2009)

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Low (inferred from USFWS, 2009)

Representation:

Moderate (inferred from USFWS, 2009)

Redundancy:

Low (inferred from USFWS, 2009)

Number of Populations:

13 (USFWS, 2009)

Population Size:

12,000 (USFWS, 2009)

Population Narrative:

According to EO records available through the CNDDDB, field surveys from the National Park Service (NPS), and seed collection studies, 13 sites currently or historically supported *Dudleya cymosa* ssp. *marcescens*. The most recent surveys, completed in 2003 by NPS and in 2005 by Dorsey, indicate that the total number of individuals of *D. cymosa* ssp. *marcescens* throughout its range is approximately 12,000. (USFWS, 2009)

Threats and Stressors

Stressor: Recreation (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: *Dudleya cymosa* ssp. *marcescens* habitat is often used for rock climbing and rappelling (Service 1997). These activities have the potential to destroy the moss substrate that the species depends on and can tear out individual plants. Rock climbing and rappelling may occur on both public and private land where *D. cymosa* ssp. *marcescens* occurs. Popular rock climbing areas located in the vicinity of known *D. cymosa* ssp. *marcescens* occurrences include Planet of the Apes Wall, Ghetto Wall, Echo Cliffs, and Century Lake Canyon (The Mountain Project 2008, Rockclimbing.com 2008).

Stressor: Vandalism (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: On April 27, 2009 the Service was notified by NPS staff that large swaths of moss that support *Dudleya cymosa* ssp. *marcescens* had been damaged at the Seminole Hot Springs occurrence (Sagar 2009). The moss appeared to be scraped away from the rock face to form

pictures and initials (Figure 3). An unknown number of individual plants have been damaged or destroyed by the disturbance (Figure 4). The site appears to be used as a local social gathering place, and will likely suffer recurring damage if some type of protective action is not taken (e.g. closing the site to public access, posting signage, etc.).

Stressor: Development (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: In the rule listing the species, we also discussed that occurrences are located on both public and private lands, and that individuals of *Dudleya cymosa* ssp. *marcescens* on private lands may be threatened by development. One occurrence on private land, Seminole Hot Springs, is owned by the Mountains Restoration Trust, a non-profit land trust dedicated to preserving natural land in the Santa Monica Mountains. This site is protected from development, but is threatened by recreational activities as demonstrated by the damage to the moss substrate observed in 2009. For the other six occurrences on private lands, local zoning designations can provide some information about the potential for development at each site. Private lands that support *D. cymosa* ssp. *marcescens* individuals are primarily zoned for open space or agriculture, with certain parcels in Ventura County falling under the Santa Monica Mountains Overlay Zone, which provides protections for sensitive species including *D. cymosa* ssp. *marcescens*. (USFWS, 2009)

Stressor: Overutilization (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: At the time of listing in 1997, we discussed that species of *Dudleya* are collected by professional horticulturalists as well as amateur collectors and gardeners (Service 1997). We believe that collection still may constitute a threat to the species. Although we do not have specific reports of vandalism for *D. cymosa* ssp. *marcescens*, we believe that, due to the accessibility of certain populations to the public, collection still constitutes a threat to the species. (USFWS, 2009)

Stressor: Fire (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: At the time of listing *Dudleya cymosa* ssp. *marcescens* in 1997, we discussed that fire can be a natural or human caused factor affecting *D. cymosa* ssp. *marcescens* (Service 1997). The ecosystems of the Santa Monica Mountains have evolved with periodic lightning-caused fires that were generally small in size and intensity, but occurred at frequent intervals (NPS 2007b). With the expansion of human settlement, it has been suggested that large fires are the result of effective suppression of small fires (NPS 2007b). Fire has been observed to reduce moss substrate that *D. cymosa* ssp. *marcescens* requires (Dedero 1992). Furthermore, it may be assumed that large fires pose a greater threat to *D. cymosa* ssp. *marcescens* because large fires may have a greater flame height and burn temperature that may impact the rocky outcrops that might otherwise be unaffected by small fires with lower flame heights and burn temperatures.

Large fires may also burn through the entire range of the species whereas small fires would cover less area. (USFWS, 2009)

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Hayhoe et al. 2004, Cayan et al. 2005, IPCC 2007). Based on modeling, they predicted that species' distributions will shift in response to climate change, and that species will "move" or disperse to higher elevations and northward, depending on the ability of each species to do so. While we lack adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors such as small population size, will affect *Dudleya cymosa* ssp. *marcescens*, small-ranged species, such as *D. cymosa* ssp. *marcescens*, are generally more vulnerable to extinction due to these changing conditions (Pimm and Raven 2000, Loarie et al. 2008). Some *Dudleya* taxa have evolved characteristics such as facultative leaf withering (McCabe et al. in prep. 2008) and switching between CAM and C3 photosynthesis pathways (Thorngton et al. 1977), which allow them to live in water-limited environments and adapt to climate fluctuations. These characteristics may benefit the species in the face of a changing climate. (USFWS, 2009)

Recovery

Reclassification Criteria:

Reclassification criteria are not available.

Delisting Criteria:

1. All the current sites (including seedbanks) are fully protected and managed with the primary intention of preserving the populations in perpetuity. (USFWS, 2009)
2. All the current sites (including seedbanks) are shown to be self-sustaining over a minimum of 10 years. (USFWS, 2009)

Recovery Actions:

- Protect and secure all current sites of these plant species (including seedbanks). (USFWS, 1999)
- Manage and monitor protected areas where plants occur. (USFWS, 1999)
- Manage and monitor protected areas where plants occur. (USFWS, 1999)
- Conduct biological and ecological research to define life history strategies, population dynamics, and to guide recovery/conservation efforts. (USFWS, 1999)
- Develop public outreach plans to enhance the public's understanding of conservation needs of these endangered and threatened plant species. (USFWS, 1999)

Conservation Measures and Best Management Practices:

- Establish a monitoring strategy to understand the population and demographic dynamics of *Dudleya cymosa* ssp. *marcescens*. The minimal survey data that is available indicates that many of the

populations may be stable or increasing. However, without population data at all sites, abundance trends cannot be determined; without demographic data, population stability cannot be presumed. At a minimum, all known occurrences should be surveyed for abundance and demographics. If survey results indicate that populations are stable or increasing, and all occurrences have multiple age classes, indicating regular recruitment, the species may be considered to be self-sustaining. If survey results indicate that populations are declining or demographics show a single age class, further monitoring will be required to determine population trends. (USFWS, 2009)

- Work with the National Park Service and California Department of Parks and Recreation to identify *Dudleya cymosa* ssp. *marcescens* occurrences on public lands that may be degraded by recreational activities such as climbing, and conduct a study to clearly identify impacts to the species caused by recreational activities. If impacts are identified, install fencing, signage, or other mechanisms to eliminate threats to the plants and their habitat. (USFWS, 2009)
- Work with rock climbing leaders, organizations, and websites to make them aware of the sensitive species that may occur in the vicinity of their climbing areas. Explore the possibility of establishing “best climbing practices,” such as avoiding vegetation on rock faces, and not establishing new climbing sites on rock faces that are vegetated. (USFWS, 2009)
- Work with the Mountains Restoration Trust and other partners to reduce impacts to the individuals and habitat at Seminole Hot Springs by installing signage, installing fencing, closing the area to visitors, or using other means to eliminate recreational threats. (USFWS, 2009)
- Work with private landowners at locations where zoning may permit development to raise awareness of the species. Cooperation with landowners is crucial to monitoring and protecting *Dudleya cymosa* ssp. *marcescens* occurrences on private lands. (USFWS, 2009)
- Work with Ventura County and Los Angeles County to educate them about *Dudleya cymosa* ssp. *marcescens*, so that when issuing development permits the counties are able to identify developments that may impact the species and encourage measures that would protect the species. (USFWS, 2009)
- Survey previously uninvestigated areas with potentially suitable habitat within and adjacent to the known range of *Dudleya cymosa* ssp. *marcescens* to determine if habitat and individuals are present. (USFWS, 2009)

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Office Carlsbad, California

SPECIES ACCOUNT: *Dudleya cymosa ssp. ovatifolia* (Santa Monica Mountains dudleyea)

Species Taxonomic and Listing Information

Listing Status: Threatened; 01/29/1997; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

A perennial herb that forms a rosettes of evergreen, succulent leaves. Leaves are 2 to 5 cm (0.8 to 2.0 in long, 1.5 to 2.5 cm (0.6 to 1.0 in wide; floral stems are 4 to 15 cm (1.6 to 6.0 in tall; corollas are pale yellow (Munz 1974). The ovateleaves have a maroon underside. (USFWS, 1999; NatureServe, 2015)

Taxonomy

Dudleya cymosa ssp. *ovatifolia* was originally described as *Dudleya ovatifolia* by Britton (1903) based on a collection made by H.M. Hall in 1902. The type locality is listed as “Sierra Santa Monica,” thought to be Topanga Canyon, Los Angeles County (Moran 1951). The species was subsequently recognized as *Cotyledon ovatifolia* and *Echeveria ovatifolia* (Fedde 1904 and Berger 1930 respectively, cited in Moran 1951) when different generic concepts were used in the family Crassulaceae. Moran (1957) published the currently accepted combination of *Dudleya cymosa* ssp. *ovatifolia*. Nakai (1983) considered plants from near Agoura, Los Angeles County to be distinct from *Dudleya cymosa* ssp. *ovatifolia*. Subsequently, (Nakai 1987) published the new name *D. cymosa* ssp. *agouensis*. Nakai distinguished the new subspecies from the other on the basis of number and shape of rosette leaves, pedicel length, and degree of spreading in petal apices. Nakai (1987) considered *D. cymosa* ssp. *agouensis* to differ from *D. cymosa* ssp. *ovatifolia* in having a simple- to several-branched caudex and glaucous elliptical basal leaves. Nakai (1987) noted that *D. cymosa* ssp. *ovatifolia* has an unbranched caudex and green, ovate basal leaves. Bartel (1993) apparently considered these differences consistent, and included *D. cymosa* ssp. *agouensis* in *D. cymosa* ssp. *ovatifolia* in his treatment of the genus *Dudleya*, for the Jepson Manual. (USFWS, 1999)

Current Range

Currently, there are four populations of what the Service considered to be *Dudleya cymosa* subsp. *ovatifolia* at the time of listing in Los Angeles and Orange Counties. This includes two in the Santa Monica Mountains, one in the Santa Ana Mountains, and one in Agoura Hills. (USFWS, 2009)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Dependency on Other Individuals or Species

Adult: The Dudleya species which have small yellow to orange flowers (including *D. cymosa* subsp. *ovatifolia*) are pollinated by bees and flies, while species with larger red flowers are pollinated mostly by hummingbirds. (USFWS, 2009)

Breeding Season

Adult: May to June (USFWS, 2009)

Reproduction Narrative

Adult: The flowering season is from May through June for *D. cymosa* subsp. *agourensis* and from March through May for *D. cymosa* subsp. *ovatifolia* (Dorsey 2007). The Dudleya species which have small yellow to orange flowers (including *D. cymosa* subsp. *ovatifolia*) are pollinated by bees and flies, while species with larger red flowers are pollinated mostly by hummingbirds. A study performed on *Dudleya cymosa* subsp. *ovatifolia* ex situ found that the average number of fruits produced per individual was 19 and the maximum number of seeds per fruit was 114. (USFWS, 2009)

Habitat Type

Adult: Terrestrial (USFWS, 2009)

Habitat Vegetation or Surface Water Classification

Adult: North-facing slopes and cliffs in chaparral communities and deep canyon bottoms (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Typically found on sedimentary conglomerate rock; persists in exposed dry habitat (NatureServe, 2015)

Habitat Narrative

Adult: On a broad scale, suitable habitat for *Dudleya cymosa* subsp. *ovatifolia* is generally located on sedimentary and conglomerate rock on canyon bottoms and shaded slopes in drainages along the south-facing slope of the Santa Monica Mountains (Dorsey 2007). In the Santa Ana Mountains, it occurs on shaded sandstone cliffs (Roberts 2008). Adjacent plant communities include coastal scrub and chaparral (CNDDB 2008b). In most locations, the topographic relief has prevented deep soil formation; therefore, this species may be the only flowering plant occurring in a microhabitat that otherwise supports mosses, lichens, and clubmoss (*Selaginella* spp.) (Dorsey 2007, CNDDB 2008b). (USFWS, 2009)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Low (inferred from USFWS, 2009)

Representation:

Low (inferred from USFWS, 2009)

Redundancy:

Low (inferred from USFWS, 2009)

Number of Populations:

4 (USFWS, 2009)

Population Narrative:

Currently, there are four populations of what the Service considers to be *Dudleya cymosa* subsp. *Ovatifolia*. (USFWS, 2009)

Threats and Stressors

Stressor: Development (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The threat of habitat encroachment from new or existing development surrounding several of the known *Dudleya cymosa* subsp. *ovatifolia* (and *D. cymosa* subsp. *agourensis*) population sites continues to be a threat. Due to an increase in residential and commercial development in the surrounding and adjacent areas (City of Agoura Hills 2009), such fire suppression activities may be an increasing threat to both *D. cymosa* subsp. *ovatifolia* and *D. cymosa* subsp. *agourensis* (see Appendix 1 and 2) (Halsey 2006, Service 2007, Halsey in litt. 2008). However, because most occurrences are on rocky outcrops with little vegetative cover, we believe the threat is low at this time. (USFWS, 2009)

Stressor: Roadside scraping (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Roadside scraping for weed abatement has modified habitat for *D. cymosa* subsp. *ovatifolia*. Since most individuals occur on rocky substrates, the Service believe this threat would be confined to the margins of the populations that are along existing road edges. (USFWS, 2009)

Stressor: Recreation (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Recreational activities such as rock climbing and hiking were not discussed at the time of listing as a threat to the species. The Service considers this to be a new threat at certain locations. In Orange County, the Modjeska Peak occurrences (EOs #9 and 12) are located near a dirt road that is used by the public to access the peak, and Soza and Boyd (1999) noted the vulnerability of these occurrences and the presence of trash and footprints at EO #12; however, these occurrences are now thought to be a different *Dudleya* taxon (Roberts 2008). The

Modjeska Canyon occurrence (EO #1) is inaccessible, and no visible signs of disturbance were seen in 1999 (Soza and Boyd 1999). Disturbance from recreational activities is also noted in CNDDDB (2009) as a potential threat for the two populations in the Santa Monica Mountains, Los Angeles County. A site visit in 2009 confirmed that the Malibu Canyon population (EO #10) is being impacted by rock climbing activity (Marek in litt. 2009); the extent of recreational impacts on the Topanga Canyon population is unknown at this time. (USFWS, 2009)

Stressor: Collectors (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Dudleya species were included in the Smithsonian's list of Commercially Exploited Endangered and Threatened Species in the Continental United States, citing private collectors as a threat; although no specific reference to *D. cymosa* subsp. *ovatifolia* was made, *D. cymosa* subsp. *marcescens* was considered endangered by the authors and thus included (Ayensu and DeFillips 1978). Collection for horticultural purposes by professional horticulturists and amateur collectors and gardeners was identified as a threat to all of the *Dudleya* taxa including *D. cymosa* subsp. *ovatifolia* (inclusive of plants now identified as *D. cymosa* subsp. *agourensis*) in the 1997 final listing rule (Service 1997). (USFWS, 2009)

Stressor: Fire suppression and fuel modification (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Despite efforts to suppress fires in coastal southern California, the present fire frequency of every 15 years or less is substantially higher than it was historically, which, for coastal scrub, is thought to be every 50 to 100 years (Keeley 2006). Over a period of 60 years, most of the area in the Santa Monica Mountains has burned an average of three to five times, with an average interval of every 12.4 to 20.7 years (Radtke et al. 1982). An increase in fire frequency can result in type-conversion of chaparral and coastal sage scrub communities to annual invasive grasses which aggressively compete with native species for resources. However, because the specific sites where *Dudleya cymosa* subsp. *ovatifolia* grow are on rocky outcrops and would not support dense stands of chaparral or coastal sage scrub (Christy Brigham, Santa Monica Mountains National Recreation Area, pers. comm. 2009; CNDDDB 2008a, b; Marek in litt. 2009), the Service believes that impacts from wildfires on the *Dudleya* taxa would likely be less severe than on the surrounding native plant communities. The practice of discing for fire prevention and suppression is unlikely to directly affect *D. cymosa* subsp. *ovatifolia* because it inhabits rocky outcrops. The spraying of fire retardant has been demonstrated to affect native species in grassland habitats outside California because they facilitate the growth of annual grasses (Larson and Newton 1996, Bell 2003). The impacts from their use on sites where *D. cymosa* subsp. *ovatifolia* occurs are unknown at this point in time. (USFWS, 2009)

Stressor: Competition with non-native species (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: In recent site visits, competition with non-native grasses has not been noted as a concern at any of the sites (Marek in litt. 2009, Roberts in litt. 2009, Soza and Boyd 1999). Jade

plant (*Crassula argentea*), a non-native species from South Africa, was observed growing in Topanga Canyon within EO #2 by McCabe (Sagar in litt. 2008); its impacts on the *Dudleya cymosa* subsp. *ovatifolia* population are unknown. (USFWS, 2009)

Stressor: Stochastic extinction (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The Service now considers *Dudleya cymosa* ssp. *ovatifolia* to be threatened by stochastic events due to the small size and isolation of the populations. Conservation biology literature commonly notes the vulnerability of taxa known from small populations (Shaffer 1981, 1987; Meffe and Carroll 1997; Primack 1998). It is generally accepted that small populations have higher probabilities of extinction than larger populations because their low numbers make them susceptible to inbreeding, loss of genetic variation, high variability in age and sex ratios, demographic stochasticity, and random naturally occurring events such as wildfires, floods, droughts, or disease epidemics (Menges 1991, Ellstrand and Elam 1993, Shaffer 1981, 1987; Soulé 1987; Meffe and Carroll 1997; Primack 1998). Isolation often acts in concert with small population size to increase the probability of extinction. Isolated populations are more susceptible to long-term/permanent extirpation by accidental or natural catastrophes because the likelihood of recolonization following such events is negatively correlated with the extent of isolation (Wilcox and Murphy 1985, Meffe and Carroll 1997). Human development exacerbates the risk of stochastic extinction because it further isolates and fragments remaining populations as time goes on. (USFWS, 2009)

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Hayhoe et al. 2004, Cayan et al. 2005, IPCC 2007). Due to the elevation and coastal location of the Santa Monica Mountains, this area is expected to become one of these potential future refugia and greatly increase in diversity (Loarie et al. 2008). We recognize that climate change is an important issue with potential effects to listed species and their habitats. While we lack adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors such as small population size, will affect small-ranged species that are restricted to soils of limited distribution, such as *Dudleya cymosa* subsp. *ovatifolia* and *D. cymosa* subsp. *agourensis*, we acknowledge that they are more vulnerable to extinction due to these changing conditions (Pimm and Raven 2000, Loarie et al. 2008). (USFWS, 2009)

Recovery

Delisting Criteria:

1. All current sites are fully protected and managed with the primary intention of preserving the populations in perpetuity. (USFWS, 2009)
2. All current sites are shown to be self-sustaining over a minimum of 10 years. (USFWS, 2009)

Recovery Actions:

- Protect and secure all current sites of these plant species (including seedbanks). (USFWS, 1999)
- Manage and monitor protected areas where plants occur. (USFWS, 1999)
- Manage and monitor protected areas where plants occur. (USFWS, 1999)
- Conduct biological and ecological research to define life history strategies, population dynamics, and to guide recovery/conservation efforts. (USFWS, 1999)
- Develop public outreach plans to enhance the public's understanding of conservation needs of these endangered and threatened plant species. (USFWS, 1999)

Conservation Measures and Best Management Practices:

- Develop and implement monitoring and adaptive management plans for known existing occurrences of *Dudleya cymosa* subsp. *ovatifolia* and *D. cymosa* subsp. *agourensis* populations. Monitoring should occur at intervals of 3 years and include population abundance surveys, habitat condition assessment, and documentation of existing and potential threats. (USFWS, 2009)
- Work with private landowners and local agencies to protect and manage *Dudleya cymosa* subsp. *ovatifolia* and *D. cymosa* subsp. *agourensis* on private property. If development is proposed or planned near *D. cymosa* subsp. *ovatifolia* and *D. cymosa* subsp. *agourensis*, recommend measures to protect the species such as creating large buffer zones between development and plants and invasive plant prevention and control. (USFWS, 2009)
- Work with local fire departments to: a) develop or modify fire management plans for when fires occur in or near the habitat of each species and b) prevent or limit discing of soil in fire management zones near *Dudleya cymosa* subsp. *ovatifolia* and *D. cymosa* subsp. *agourensis* habitat to prevent the spread of invasive, nonnative plants. (USFWS, 2009)
- Once additional information concerning the status of populations and current threats is obtained, consider whether: a) a change in status for *Dudleya cymosa* subsp. *ovatifolia* may be warranted and, b) candidate status may be warranted for *D. cymosa* subsp. *agourensis*. (USFWS, 2009)

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5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Ventura Fish and Wildlife Office Ventura, California

SPECIES ACCOUNT: *Dudleya nesiotica* (Santa Cruz Island dudleya)

Species Taxonomic and Listing Information

Listing Status: Threatened; 07/31/1997; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

Santa Cruz Island dudleya is a succulent perennial in the stonecrop family (Crassulaceae). The plant has a stem that resembles a short, thick, underground stem (corm-like) with 8 to 16 narrow leaves in a basal rosette from which several flowering stems 3 to 10 centimeters (1.2 to 4.0 inches) tall arise. The white five-petaled flowers and resulting fruits are erect to ascending. Recent research by Wilken (1996) indicates that the number of flowers per plant ranges from 6 to 12. (USFWS, 2000)

Taxonomy

Santa Cruz Island dudleya was described by Moran (1950) as *Hasseanthus nesioticus* based on a specimen collected from a "flat area near the edge of sea bluff, Fraser Point," on the west end of Santa Cruz Island in 1950. Three years later, Moran (1953) transferred the species to the genus *Dudleya*, as *Dudleya nesiotica*. In California there are 39 different species and subspecies within the *Dudleya* genus, which fall under three subgenera (*Dudleya*, *Hasseanthus*, and *Stylophyllum*), with *D. nesiotica* belonging to the subgenus of *Hasseanthus* (Moran 1953, McCabe in litt. 2009b). *Dudleya nesiotica* will hybridize with some of the other *Dudleya* species (e.g., *D. greenei* and *D. candelabrum*), which is typical of the *Dudleya* genus (McEachern et al. 2009). In the most recent survey conducted in 2006, there were three reported occurrences of hybrids of *D. nesiotica* and *D. greenii* located just to the northwest of the pure *D. nesiotica* population (McEachern et al. 2009). (USFWS, 2000; USFWS, 2009)

Historical Range

See current range/distribution.

Current Range

There is only one known occurrence of *D. nesiotica*, which constitutes a single population that is scattered in varying densities over approximately 13 hectares (32 acres) of land at Fraser Point in the western portion of Santa Cruz Island, California. (USFWS, 2009)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual (self-fertilization) and Sexual (hybridization) (USFWS, 2009)

Lifespan

Adult: >10 years (USFWS, 2009)

Dependency on Other Individuals or Species

Adult: The *Dudleya* species that have small yellow to white flowers (including *D. nesiotica*) are well adapted to being pollinated by bees and flies, while species with larger red flowers are adapted to pollination by hummingbirds (Aigner 2004).

Breeding Season

Adult: April to June (USFWS, 2009)

Reproduction Narrative

Adult: *Dudleya nesiotica* blooms in late spring (April through June), forming one to five flowering stems that are 3 to 10 cm (1 to 4 in) long with pale white flowers consisting of five petals and fruits that are erect to ascending (Bartel 1993, Service 2000, Center for Plant Conservation (CPC) 2007). Each plant forms between 7 and 15 flowers on each flowering stem (CPC 2007). The results indicated that *Dudleya nesiotica* is self-compatible (capable of self-fertilization), but in the absence of human-assisted pollination, the species must be pollinated by insects. *Dudleya nesiotica* plants do not flower during the first year of propagation from seed and individuals do not always produce a flowering stem from each caudex every year. Flowering occurs over a 6- to 8-week period and fruit maturation takes an average of 8 to 10 weeks. Furthermore, each flower generally produces an average of 22 to 27 seeds. The *Dudleya* species that have small yellow to white flowers (including *D. nesiotica*) are well adapted to being pollinated by bees and flies, while species with larger red flowers are adapted to pollination by hummingbirds (Aigner 2004). One plant in cultivation is reported to be more than 10 years old (McCabe in litt. 2009a) and likewise, individuals growing in situ have been reported to live 10 years or more (Wilken 1996). (USFWS, 2009)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Grassland and coastal bluffs (USFWS, 2009)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations ranging from 10 to 50 m (33 to 164 ft) (USFWS, 2009)

Environmental Specificity

Adult: Narrow/specialist

Site Fidelity

Adult: High (USFW, 2009)

Dependency on Other Individuals or Species for Habitat

Adult: There is evidence that mosses and lichens aid in seed germination and recruitment by providing nutrients, moisture, substrate, and protection against herbivory by snails and slugs (Riefner and Bowler 1995). (USFWS, 2000)

Habitat Narrative

Adult: On a broad scale, suitable habitat for *Dudleya nesiotica* is comprised of grassland and coastal bluff scrub with rocky clay soils derived from Quaternary alluvium, at elevations ranging

from 10 to 50 m (33 to 164 ft) above sea level (Service 1997, CNPS 2009, CPC 2007) on marine terraces with little to no slope (Dorsey 2007, Klinger et al., in prep.). Specifically, there are two main soil types which occur at Fraser Point; sandy marine sediments and shallow basaltic rock (Klinger et al., in prep.). This species is extremely localized in its distribution, exhibiting a high degree of habitat specificity, as do most of the other federally listed taxa on Santa Cruz Island. There is evidence that mosses and lichens aid in seed germination and recruitment by providing nutrients, moisture, substrate, and protection against herbivory by snails and slugs (Riefner and Bowler 1995). (USFWS, 2000; USFWS, 2009)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Species Trends:

Slightly decreasing (USFWS, 2009)

Resiliency:

Low (inferred from USFWS, 2009)

Representation:

Low (inferred from USFWS, 2009)

Redundancy:

Low (inferred from USFWS, 2009)

Number of Populations:

1 (USFWS, 2009)

Population Size:

3,500 to 260,000 (USFWS, 2009)

Population Narrative:

Since the time of listing, the number of documented individuals within the population has fluctuated, overall showing a slightly decreasing trend (Wilken 1996, CNDDDB 2009, McEachern et al. 2009). *Dudleya nesiotica* continues to exist as a single population at the type locality (CNDDDB 2009) and the number of individuals within this population has ranged from approximately 260,000 to 3,500 between 1994 and 2006 (CNDDDB 2009, Consortium 2009, McEachern et al. 2009), showing an overall decrease in numbers within the last few years. (USFWS, 2009)

Threats and Stressors

Stressor: Collectors (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: In the listing rule for the species, we discussed that species of *Dudleya* are collected by professional horticulturalists as well as amateur collectors and gardeners (Service 1997). In a recent San Francisco Chronicle newspaper article (Eaton and Sullivan 2009), the popularity of collecting plants from the wild, specifically species of *Dudleya*, and the respective potential consequences for collecting these plants from the wild were discussed. We do not have specific reports of unauthorized collection of *D. nesiotica* and we believe that the relative inaccessibility of the *D. nesiotica* population to the general public helps to decrease the threat of collection and/or removal; therefore, Factor B is not considered a significant threat to this species at this time. (USFWS, 2009)

Stressor: Nonnative invasive species (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Non-native plant species, including grasses and herbs, have been present on Santa Cruz Island for greater than 150 years (Service 1997; Klinger et al., in prep; McEachern et al. 2009). Some of the non-native plant species that compete directly with *Dudleya nesiotica* include iceplant, ryegrass, ripgut brome, and wild oats, among others. The fennel (*Foeniculum vulgare*) infestation that has taken over a substantial portion of the native habitat on Santa Cruz Island currently does not occur within the *D. nesiotica* habitat areas; however, it does occur in the vicinity, suggesting that it could pose a threat to *D. nesiotica* in the near future if not eradicated (H. Abbey, Service Biologist, pers. obs. 2009). The recent increase in overall cover of nonnative herbaceous species was likely an indirect result of the eradication of sheep from the island in the 1980's (Klinger et al., in prep.). A study of *Dudleya nesiotica* conducted from 1991 to 1998 on Santa Cruz Island (Klinger et al., in prep.) found that the overall decline of *D. nesiotica* within the survey plots over the study period was correlated with an increase in non-native plants and subsequent increase in leaf litter cover on the ground. This study also found an overall decrease in native herb cover and native species richness in the high-density *D. nesiotica* strata survey areas during this time period. Overall species richness (number of species in an area) increased, because the number of nonnative species increased at a greater rate than native species decreased. However, the dominance of non-native grass in some of the high density plots resulted in an overall decrease in species diversity and evenness. The exact mechanism underlying the relationship between the increase in non-native plant species cover and the subsequent decrease in *D. nesiotica* density is not known; however, it is likely attributed to the fact that as the abundance and cover of the non-native plant species increases, so does the competition for light and water (Klinger et al., in prep.; D'Antonio and Vitousek 1992). During the study period from 1991 to 1998, there was little evidence of pig rooting or damage within the *Dudleya nesiotica* survey plots at Fraser Point; however, some pig rooting did occur in several of the plots for at least two of the years within the study period (Klinger et al., in prep.). Now that pigs have been fully eradicated from Santa Cruz Island, there may be some expansion of the boundaries of the existing *Dudleya nesiotica* population (McEachern et al. 2009). The eradication of non-native mammals from Santa Cruz Island has generally been considered a success in terms of achieving many of the overall long-term conservation goals for the island (Klinger et al. 1994). However, the study concluded that the changes in community structure and species composition

at Fraser Point and the subsequent decrease in the abundance of *Dudleya nesiotica* was directly correlated with the end of the drought and the eradication of feral sheep, which led to an increased abundance of non-native plant species and organic litter (Klinger et al., in prep.). When the sheep and cattle were present on the island, there was likely a strong enough grazing pressure to keep some of the non-native grasses and fennel at lower levels of density and abundance; however, when the 5-year drought period ended in 1991 and there were no longer sheep and cattle present to graze on the island, the relative cover and abundance of many of these non-native species increased rapidly (Klinger et al. 1994). Ultimately, this explosion of non-natives has led to a decrease in diversity of native plant species throughout the grassland ecosystems over much of Santa Cruz Island (Klinger et al. 1994). (USFWS, 2009)

Stressor: Hybridization (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: *Dudleya nesiotica* hybridizes with several other *Dudleya* species, including *D. greenii* and *D. candelabrum*, which occur on Santa Cruz Island. There are three documented occurrences of *D. greenii* and *D. nesiotica* hybrids to the east of the main population of *D. nesiotica* at Fraser Point (McEachern et al. 2009). Because the current distribution of the *D. nesiotica* population at Fraser Point (EO 1) seems to have remained similar to what it was at the time of listing (CNDDDB 2009, McEachern et al. 2009), it appears as though *D. nesiotica* is moving into and hybridizing within the areas where *D. greenii* occurs, rather than vice versa. There are not any documented occurrences of *D. nesiotica* and *D. candelabrum* hybrids within the population of *D. nesiotica* at Fraser Point (EO 1); however, a *D. candelabrum* plant on the bluff amongst the *D. nesiotica* population at Fraser Point was observed during a site visit to the island on May 25, 2009 (H. Abbey, Service Biologist, pers. obs. 2009). Further analysis is needed to determine if any hybridization between *D. nesiotica* and *D. candelabrum* has already occurred within the *D. nesiotica* population at Fraser Point. (USFWS, 2009)

Stressor: Stochastic extinction (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: At the time of listing, we noted that due to the limited number of individuals and geographic range of *Dudleya nesiotica*, this species was at risk of extinction from naturally occurring events, such as fire, drought, disease, or landslides (Service 1997). We believe that the existence of only one relatively isolated population of *D. nesiotica* places this species at risk of extinction from stochastic events. Likewise, the population has shown some instability in numbers of individuals over the last 15 years, adding to the potential risk of stochastic extinction. Although the plants are apparently self-compatible, the small size of the population makes it difficult for this species to persist while sustaining the impacts of soil damage (compaction and erosion) and habitat alteration that favors non-native species. Overall, there are three main factors that may cause *Dudleya nesiotica* to be at risk for stochastic extinction: fire, effects from climate change (such as those associated with sea level rise), and lack of genetic viability due to the existence of the species as a single isolated population. Although the plants have the ability to survive as underground rootstock during the dormant period and probably would not be significantly affected during a small, low-intensity fire, there is a high probability that even the dormant rootstock of the plants may not survive a larger, high intensity fire (Sagar in litt. 2008).

Because the population of *D. nesiotica* occurs on a cliff in close proximity to the ocean it is subject to a wide range of climatic conditions, such as occasional salt spray (Wilken 1996), which may directly affect the soils and plants at Fraser Point. Sea level rise and the continued erosion of the ocean-front cliffs at Fraser Point from high surf and storm events, in addition to climate variability, both from year to year and due to largescale climate change, pose a threat to the relatively small and exposed *D. nesiotica* population. As a result of the limited range and the species' existence as a single population, the genetic viability and resilience of *D. nesiotica* to human caused or natural disasters may be greatly reduced (Menges 1991, Ellstrand and Elam 1993). (USFWS, 2009)

Stressor: Rainfall and drought (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The average annual rainfall on Santa Cruz Island is approximately 20 in (51 cm) (Erskine-Ogden and Rejma'nek 2005, NPS 2006b). Perennial plants such as *Dudleya nesiotica* may be better able to persist through short-term weather anomalies, because they may be able to simply "wait" for more favorable conditions. The apparent decline of *D. nesiotica* is likely not a direct result of highly variable rainfall conditions over the last 10 to 20 years alone; rather, it is most likely the result of the cumulative effects from the increase in non-native species abundance combined with climate variability (Klinger et al., in prep.). (USFWS, 2009)

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). In addition, an increase in the rate of sea level rise has been predicted for the coast of California (California Coastal Commission (CCC) 2001, California Climate Change Center 2006). In particular, ocean bluffs along the coast will likely be subject to greater and more frequent wave attack, resulting in erosion and shoreline retreat (CCC 2001). Jeff Severinghaus, a professor of geosciences at the Scripps Institute of Oceanography in San Diego, recently estimated that for every foot (.3 m) that the sea level rises in California, approximately 100 ft (30.5 m) of shoreline might be lost (Scolari 2009). The IPCC (IPCC 2007) estimates that the sea level will rise anywhere from approximately 7 to 22 in (0.2 to 0.6 m) by the end of this century. In the case of smaller island ecosystems, such as Santa Cruz Island, the opportunities to move to higher elevations or further north are limited. We lack adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors such as limited geographical distribution, will affect federally listed species; however, small-ranged species such as *D. nesiotica* are more vulnerable to extinction due to these changing conditions (Loarie et al. 2008). (USFWS, 2009)

Recovery

Reclassification Criteria:

Reclassification criteria are not available.

Delisting Criteria:

1. Maintain the existing population as stable with evidence of natural recruitment for a period of 20 years that includes the normal precipitation cycle. (USFWS, 2000)
2. Seed stored in CPC cooperating facilities. (USFWS, 2000)
3. Seed germination and propagation techniques are understood. (USFWS, 2000)
4. Weed competition understood and managed. (USFWS, 2000)
5. Pig damage is controlled. (USFWS, 2000)
6. Life history research is conducted. (USFWS, 2000)

Recovery Actions:

- Recovery actions are not available.

Conservation Measures and Best Management Practices:

- Develop and implement monitoring and adaptive management plans for the existing population. Monitoring should occur at intervals of 1 to 2 years and include population abundance surveys, habitat condition assessment, and documentation of existing and potential threats. (USFWS, 2009)
- Develop and implement an integrated non-native plant control program for Santa Cruz Island. (USFWS, 2009)
- Continue to research the species' life history requirements, especially with regard to the habitat conditions favorable to *Dudleya nesiotica*. (USFWS, 2009)

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5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Ventura Fish and Wildlife
Office Ventura, California

SPECIES ACCOUNT: *Dudleya setchellii* (Santa Clara Valley dudleya)

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/03/1995; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

Dudleya setchellii is a low-growing perennial of the stonecrop family (Crassulaceae) with fleshy, glabrous (hairless) leaves. The oblong to triangular, slightly glaucous (covered with a whitish or bluish waxy or powdery film) leaves are 3 to 8 cm (1 to 3 in long and 7 to 15 mm (0.3 to 0.6 in) wide. Two or three flowering stems ascend to heights of 5 to 20 cm (2 to 8 in) in mid to late spring. The pale yellow petals are 8 to 13 mm (0.3 to 0.5 in) long (Hickman 1993). (USFWS, 2013)

Taxonomy

Dudleya setchellii was variously treated as *Cotyledon setchellii* (Fedde 1904), *Echeveria setchellii* (Nelson and Macbride 1913), and *Echeveria laxa* var. *setchellii* (Jepson 1936). Reid Moran (1959) combined the material referred to as *Dudleya setchellii* and *Dudleya paniculata* in *Dudleya cymosa* ssp. *setchellii*. Kei Nakai (1987) separated the two entities into *Dudleya cymosa* ssp. *paniculata* and *Dudleya cymosa* ssp. *setchellii* on the basis of leaf shape, inflorescence branching patterns, and pedicel (stalk of individual flower or fruit) length. Bartel's treatment of *Dudleya* retains Nakai's *Dudleya cymosa* ssp. *paniculata* and resurrects Britton and Rose's *Dudleya setchellii* for the Santa Clara Valley dudleya (Hickman 1993). (USFWS, 1998)

Historical Range

There are four historic reports of *Streptanthus albidus* ssp. *albidus*. One occurrence from 1895 may actually be a different species of *Streptanthus*. The second historic occurrence documented in 1937 has likely been extirpated because it is located in an area now covered by Anderson Lake. A third occurrence first documented in 1980 at Tulare Hill was extirpated when the plants were covered by fill during construction of a housing development. A fourth occurrence was documented in Gilroy along Llagas Avenue in 1957 and has not been reported since. There is some taxonomic uncertainty about this occurrence (CDFG 1997, Whittall 2011). (USFWS, 2013)

Current Range

Two occurrences are located approximately 5 miles southwest of the previously known southernmost extent of the historic range. One of which is located within the Mount Madonna Santa Clara County Park. (USFWS, 2013)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual (vegetative) (USFWS, 2013)

Lifespan

Adult: ~10 years (USFWS, 1998)

Breeding Season

Adult: May to June (USFWS, 2013)

Reproduction Narrative

Adult: Dudleya setchellii flowers from May to June (Munz and Keck 1959) and producing wind dispersed seeds (McCarten 1993). The species can also reproduce vegetatively by forming rosettes that can separate from the parent plant or remain attached. Individual plants may live for approximately 10 years. (USFWS, 1998; USFWS, 2013)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Barrens, Grassland/herbaceous (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 120 and 300 m (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Habitat Narrative

Adult: Dudleya setchelli are found on rocky outcrops within serpentine grasslands at elevations between 120 and 300 m (NatureServe, 2015). McCarten (in litt., 1998) suggests (1) the narrow distribution of Dudleya setchelli may be associated with the limited number of appropriate rock crevices available and (2) potential habitat for Dudleya setchelli cannot be determined by counting the number of rock outcrops because only some have crevices deep enough to provide habitat. (USFWS, 1998; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Dudleya setchellii flowers from May to June (Munz and Keck 1959) and producing wind dispersed seeds (McCarten 1993). (USFWS, 2013)

Population Information and Trends**Population Trends:**

Long-term decline of 50-70%; short-term decline of 30-50% (NatureServe, 2015)

Number of Populations:

207 (USFWS, 2013)

Population Size:

10,000 - 100,000 individuals (NatureServe, 2015)

Population Narrative:

Long-term populations trend indicate a decline of 50-70%, while short-term trends suggest a 30-50% decline (NatureServe, 2015). There are currently 207 known occurrences in the entire range (ICF 2012; CNDDDB 2009). (USFWS, 2013; NatureServe, 2013)

Threats and Stressors

Stressor: Development (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: At the time of listing, 11 of the 14 populations were on private land and were subject to various levels of threat due to development. Three in the northernmost portion of its range were threatened by development. One population was threatened by the proposed Cerro Plata Project, consisting of 550 dwelling units and a 164 acre golf course on a 575 acre site. This population contained approximately 20,000 plants, 61 percent of all known plants, of which approximately 2,380 would be directly eliminated by planned construction activities (City of San Jose 1993). All remaining plants would be exposed to human activities during and after construction that could result in significant impacts to the population. These impacts included potentially harmful runoff from and upslope golf course, introduction of weed species during construction, and uncontrolled foot traffic. The second of the northern sites was threatened by the proposed construction of the Valley Christian School and South Valley Christian Church. The construction was thought to eliminate 74 percent of the approximately 1,900 plants found on the site (City of San Jose 1992). In the central part of its range, 2 of the 3 central populations were also threatened with residential development and road construction. The 3rd central population was threatened by off-road motorcycle traffic and unauthorized dumping due to its proximity to an off-road motorcycle park. In the southernmost portion of its range, around Morgan Hill, 3 populations were in an area developing rapidly and had been proposed for development. (USFWS, 2013)

Stressor: Predation (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: After construction of the Ranch on Silver Creek housing development and golf course project, reduction of coyotes occurred on the property. As a result, the ground squirrel population increased to the extent that the squirrels began devouring *Dudleya setchellii*. This new threat is an indirect effect of the housing and golf course development. At the same site, an expansion of native sagebrush led to an increased rabbit population that in turn reduced *Dudleya setchellii* (WRA 2010). (USFWS, 2013)

Stressor: Nitrogen deposition (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: A relatively recently identified threat is nitrogen deposition into grasslands from air pollution sources and the resultant increase in productivity of the soils has facilitated increased

invasion of nonnative species (ICF 2012). The main effect for Santa Clara Valley dudleya and Metcalf Canyon jewelflower is their vulnerability to annual grass overgrowth. Nonnative annuals are much less dominant in serpentine areas, although increasing nitrogen deposition from air pollution has increased the productivity of serpentine soils and allowed a greater number of nonnatives to invade (Evens and San 2004; Harrison et al. 2003; Weiss 1999). Santa Clara Valley dudleya (*Dudleya setchellii*) lives on rock outcrops and is relatively immune from grass invasions except when extremely tall grasses smother small rock outcrops. The species persists on medium to large rock outcrops in ungrazed areas. Metcalf Canyon jewelflower can be a poor competitor against dense annual grasses, and some degree of grazing appears necessary to maintain populations (ICF 2012). Livestock grazing is an important management tool to combat increased invasive nonnative plants in serpentine grasslands due to atmospheric nitrogen deposition (Weiss 1999). (USFWS, 2013)

Stressor: Climate change (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: ICF (2012) summarized the potential effects of climate change to serpentine plant species and its relationship to the proposed permitted activities during the Santa Clara Valley Habitat Plan's proposed 50 year permit span. Serpentine plant distribution is restricted to highly specialized and localized habitat requirements that include species-specific microclimate conditions coincident with serpentine soil occurrence. Restriction to serpentine soils limits species range and distribution to this soil type. Climate change could change microclimate conditions so that species can no longer persist within their current range. Increase in favorable microclimate conditions could lead to an expansion of distribution and increase in abundance, both in terms of number of populations and number of plants within each population. Change in timing or intensity of seasonal events could have an effect on pollinator reproductive and plant flowering periods leading to phenological mismatches. (USFWS, 2013)

Recovery

Reclassification Criteria:

1. If 20 populations of *Dudleya setchellii* within and representing its entire range are (1) fully protected and managed with the primary intention of preserving the populations in perpetuity and (2) shown to be stable or increasing over a minimum of 20 years that include the normal precipitation cycle, the species should be evaluated for downlisting. (USFWS, 2013)
2. Management plans emphasizing *Dudleya setchellii* and other special status species for all populations and any occupied or unoccupied habitat identified as essential to survival must be developed and implemented. (USFWS, 2013)
3. Population monitoring in specified recovery areas must show stable or increasing for a period of 20 years that include the normal precipitation cycle. (USFWS, 2013)

Delisting Criteria:

1. *Dudleya setchellii* should not be considered for delisting unless 30 populations distributed throughout its entire range. (USFWS, 2013)

2. Management plans emphasizing *Dudleya setchellii* and other special status species for all populations and any occupied or unoccupied habitat identified as essential to survival must be developed and implemented. (USFWS, 2013)

3. Once downlisted, there must not be a decline after downlisting to consider delisting for this criteria; if declining, determine cause and reverse trend prior to considering delisting. (USFWS, 2013)

Recovery Actions:

- Populations on private land should be protected by land acquisition, conservation easements, or other means. Protection should, at least, involve securing the populations themselves as well as a 150-meter (500-foot) buffer around each population, where possible, to reduce external influences and allow expansion of populations. (USFWS, 1998)
- Management plans emphasizing *Dudleya setchellii* and other special status species in these locations must be developed and implemented. The plans should include provisions for standardized monitoring of *Dudleya setchellii* populations every 3 years to determine demographic trends. (USFWS, 1998)
- Also of value in recovery efforts for *Dudleya setchellii* is collection and banking of seed in Center for Plant Conservation certified botanic gardens. (USFWS, 1998)
- In addition to protection of known populations and seed collection of *Dudleya setchellii*, other suitable serpentine habitat should be surveyed to determine whether undiscovered populations exist. (USFWS, 1998)
- Certain types of research are also high priority recovery activities for *Dudleya setchellii*. In particular, because *Dudleya setchellii* co-occurs in a number of locations with bay checkerspot butterfly and because bay checkerspot butterfly habitat benefits from vegetation management, the effect of various vegetation management techniques on *Dudleya setchellii* needs to be evaluated. (USFWS, 1998)

Conservation Measures and Best Management Practices:

- Preserve, protect, manage, and monitor *Dudleya setchellii* CNDDDB occurrence number 43. Occurrence number 43 was found in the year 2005, subsequent to listing of the species and the Recovery Plan. The occurrence represents the most southwesterly extent of its current known range.
- Confirm if the historic and current westernmost and southernmost occurrences for *Streptanthus albidus* ssp. *albidus* are valid. Perform additional surveys in suitable habitat around CNDDDB number 6 and 21 to confirm if the range of the species is smaller than previously understood.
- Conservation measures should include focus on preserving, monitoring, and managing pollinator fauna as it appears to be essential for any significant fruit set in *Streptanthus albidus* ssp. *albidus*.
- *Streptanthus albidus* ssp. *albidus* plant numbers can fluctuate drastically from year to year (Whittall 2011). Reliable methods should be developed to evaluate when a population should be considered as stable and viable. The methods should include ways to measure and evaluate natural and human influenced variables.

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SPECIES ACCOUNT: *Dudleya stolonifera* (Laguna Beach liveforever)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/13/1998; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

A succulent perennial herb with basal rosettes of flattened, bright green, purple-tinged leaves. Reddish flowering stems, mostly 8-20 cm tall, are topped with yellow-green flowers during May, June, and July. This species branches by stolons, forming lateral vegetative branches that arise from the basal rosette. (NatureServe, 2015)

Taxonomy

Two hybrids of *Dudleya stolonifera* occur in Aliso Canyon (Thomson 1993, pp. 208, 210). This canyon is the only location where *D. stolonifera* and *D. edulis* co-occur, resulting in reported hybrids and apparent backcrosses that appear morphologically similar to one of the parent types. Results from genetic analysis reveal no irregularity of meiosis in *D. stolonifera* x *D. edulis* hybrids (Moran 1949, p. 112). Aliso Canyon also supports *D. lanceolata* x *D. stolonifera* hybrids, which represent the former presumed parent in the leaf rosette shape and the latter in shorter, thicker leaves with maroon undersides (Thomson 1993, p. 210). (USFWS, 2010)

Historical Range

See current range/distribution.

Current Range

Dudleya stolonifera was historically found only in Orange County, California. At listing, the species was found in six occurrences near Laguna Beach (USFWS 1998, p. 54939). Historical occurrences were restricted between Laguna Canyon to the north and Aliso Canyon to the south, an area of approximately 10 sq. km (3.9 sq. mi). Since listing, no new occurrences have been reported. All six of the historical occurrences are considered extant. (USFWS, 2010)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual (self-fertilization (USFWS, 2010)

Dependency on Other Individuals or Species

Adult: Bees in the genera *Bombus* and *Anthophora* have been identified as important pollinators of other *Dudleya* (Moldenke 1976). *Niebla ceruchoides* is a saxicolous (lives among rocks) lichen also found in abundance in fog zones near the Pacific coast in Orange County (Riefner and Bowler 1995, p. 82). This fruticose (shrubby) lichen may benefit *D. stolonifera* by capturing seeds. The body of the lichen also provides the seed adequate moisture and a nutrient-rich soil bed. (USFWS, 2010)

Breeding Season

Adult: May to July (USFWS, 2010)

Reproduction Narrative

Adult: During late spring and early summer (May to July), a flowering stalk grows up to 20 cm (8 in) tall. The tubular yellow flowers found in *D. stolonifera* are similar to the flowers of other *Dudleya* species that are known to be self-fertilizing. This similarity suggests some degree of self-pollination may occur in *D. stolonifera*. Bees in the genera *Bombus* and *Anthophora* have been identified as important pollinators of other *Dudleya* (Moldenke 1976). *Niebla ceruchoides* is a saxicolous (lives among rocks) lichen also found in abundance in fog zones near the Pacific coast in Orange County (Riefner and Bowler 1995, p. 82). This fruticose (shrubby) lichen may benefit *D. stolonifera* by capturing seeds. The body of the lichen also provides the seed adequate moisture and a nutrient-rich soil bed. (USFWS, 2010)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliff, shrubland/chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations up to 300 m (1000 ft) (USFWS, 2013)

Environmental Specificity

Adult: Narrow/specialist

Dependency on Other Individuals or Species for Habitat

Adult: *Dudleya stolonifera* almost always co-occurs with mosses and lichens in a very thin layer of soil, often less than 1 cm (0.4 in) deep (Moran 1977, p. 1). *Dudleya stolonifera* may have a positive association with a co-occurring lichen species, *Niebla ceruchoides* (angel-hair sea fog lichen) (Riefner and Bowler 1995, p. 81). (USFWS, 2013)

Habitat Narrative

Adult: Distribution of *Dudleya stolonifera* is restricted to shaded north-facing Miocene sandstone and San Onofre breccia rock outcrops, slopes, and canyon walls primarily in coastal sage scrub ecotypes (Moran, 1977, p. 1; Roberts 1997, p. 1). The taxon is also found in chaparral, cismontane woodlands, and valley and foothill grasslands at elevations up to 300 meters (1000 feet) (CDFG 1987, p. 1). *Dudleya stolonifera* almost always co-occurs with mosses and lichens in a very thin layer of soil, often less than 1 cm (0.4 in) deep (Moran 1977, p. 1). *Dudleya stolonifera* may have a positive association with a co-occurring lichen species, *Niebla ceruchoides* (angel-hair sea fog lichen) (Riefner and Bowler 1995, p. 81). *Niebla ceruchoides* is a saxicolous (lives among rocks) lichen also found in abundance in fog zones near the Pacific coast in Orange County (Riefner and Bowler 1995, p. 82). This fruticose (shrubby) lichen may benefit *D. stolonifera* by capturing seeds. The body of the lichen also provides the seed adequate moisture and a nutrient-rich soil bed. (USFWS, 2013)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Low (inferred from USFWS, 2010)

Representation:

Low (inferred from USFWS, 2010)

Number of Populations:

6 (USFWS, 2010)

Population Size:

~30,000 (USFWS, 2010)

Population Narrative:

At listing, six known occurrences of *Dudleya stolonifera* were reported to support up to approximately 8,000 to 10,000 individual standing plants (USFWS 1998, p. 54946). Since listing, we discovered that the Mathis Canyon (EO 7) count made in 1992 by Karlin Marsh reported 20,000 individuals (CNDDDB 2010a, p. 7). This count was unknown to the Service at listing and increases the known abundance of *Dudleya stolonifera* to approximately 30,000 standing plants. (USFWS, 2010)

Threats and Stressors

Stressor: Urbanization (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Since listing, none of the known occurrences has been directly impacted by development related activities. The steep and rugged nature of *Dudleya stolonifera* habitat makes the remaining occurrences on private property undesirable for development. Nevertheless, adverse development effects are a potential threat to the two occurrences on private lands, Aliso Canyon and Canyon Acres (EO 2, 5), as pressure to develop private lands is not curbed by regulatory measures in the densely urbanized coastal portion of Orange County. (USFWS, 2010)

Stressor: Proposed development (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Aliso Canyon (EO 2) is the occurrence most adversely affected by past development activities. The portion of this occurrence that was lost prior to listing is commercially developed. The remaining portion of this occurrence is threatened by expanded development as a result of the Aliso Canyon Redevelopment Plan (S. Drapkin, Senior Planner, City of Laguna Beach, pers. comm. 2010). This plan could result in the rebuilding of the Aliso Canyon Inn, but is delayed indefinitely as of 2008 (Drapkin, pers. comm. 2010). (USFWS, 2010)

Stressor: Small population size (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The listing rule discussed the vulnerabilities associated with few occurrences of small population sizes for *Dudleya stolonifera*. These vulnerabilities included susceptibility to stochastic events such as flood, fire, or drought and inbreeding depression (USFWS 1998, p. 54950). Stochastic, or unexpected, events represent a significant threat to small occurrences. In the case of *Dudleya stolonifera*, two of the six occurrences (Canyon Acres (EO 5) and Lateral Canyon B (EO 6)) can be considered small, each represented by less than 100 standing plants. Stochastic events that could destroy these smaller occurrences include flood, fire, or drought. Given the impact these events could have on a third of the known populations of *D. stolonifera*, they represent a potential threat to the species as a whole. There is also a potential for small populations to suffer from inbreeding depression. Inbreeding depression is the reduced fitness resulting from breeding of related individuals, most often in small populations, by highlighting deleterious genetic traits. In order to avoid inbreeding depression, it is important to maintain genetic diversity, especially for rare alleles (different forms of a gene). The likelihood of maintaining this diversity decreases in smaller populations (Barrett and Kohn 1991, pp. 9, 10, and 13). (USFWS, 2010)

Stressor: Nonnative plant competition (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: At listing, nonnative plant competition was considered a threat to *Dudleya stolonifera*, though severity and specific occurrence information were not provided (USFWS 1998, p. 54950). Since listing, direct competition to *D. stolonifera* by nonnative plant species has remained a threat at two occurrences, Aliso Canyon (EO 2) and Mathis Canyon (EO 7). This threat is most prevalent in Aliso Canyon (EO 2) where *Tropaeolum majus* (nasturtium), *Aeonium haworthii* (pinwheel) (Roberts, pers. comm. 2009b), *Myoporum laetum* (myoporum) (Roberts 1995, p. 2), *Echium* spp., and *Echeveria* spp. (Marsh 1992, p. 65) have been found within habitat occupied by *D. stolonifera*. These nonnative species thrive among rocks and compete directly with *D. stolonifera* for limited resources (e.g., soil moisture, space, light). In particular, *A. haworthii* is accelerating its competition with *D. stolonifera* and is displacing the taxon from the western end of the Aliso Canyon occurrence (EO 2) (Roberts, pers. comm. 2009b). (USFWS, 2010)

Stressor: Fuels modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Threats associated with fuels modification (thinning vegetation, fire breaks, disking, and mowing) for fire prevention and damage reduction were mentioned but not discussed at listing. Fires burned four of the six *Dudleya stolonifera* occurrences in the last 30 years (CDFFP 2003). Though no direct effects to *D. stolonifera* due to fuels modification practices have been documented since listing, the potential hazard of wildfire has prompted the clearing of edge vegetation surrounding the Top of the World subdivision near the Mathis Canyon occurrence (EO 7) (Roberts, pers. comm. 2009b). Proactive measures should be taken to avoid adverse effects while fighting active fires and to ensure that fuels modification activities avoid the taxon to the maximum extent practicable. The Orange County Central-Coastal NCCP/HCP prescribes criteria for fuels modification to limit the encroachment of invasive species and precludes them within reserve boundaries (Orange County 2006, p. II338). However, the plan allows fuels modification to occur in proximity to some of the known occurrences of *D. stolonifera*. Fuels modification related activities remain a potential threat to the Mathis Canyon (EO 7) and Big Bend (EO 1) occurrences of *D. stolonifera*, which are near the Top of the World subdivision. (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Since listing, it has become apparent that potential threats exist to biota of the United States from ongoing, accelerated climate change (IPCC 2007). Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying are predicted for the foreseeable future (Field et al. 1999; Cayan et al. 2005; IPCC 2007). Significant temperature increases create a stressor for endemic species. This stressor enhances pressures from competitors, nonnative species, habitat change, low water supply, and disease. Species must somehow adapt to these pressures in situ (in place) or shift their geographic range (Cayan et al 2009, p. 45). Such a shift in range for narrow endemic species such as *Dudleya stolonifera* could exceed the tolerance of the species. Additionally, there is very little available habitat in coastal Orange County to assist this species with a range shift. Though we know little of the adaptive ability of *D. stolonifera*, climate change could potentially pose a significant range-wide threat to the species. (USFWS, 2010)

Recovery

Reclassification Criteria:

Reclassification criteria are not available.

Delisting Criteria:

Delisting criteria are not available.

Recovery Actions:

- Recovery actions are not available.

Conservation Measures and Best Management Practices:

- Work with partners to help conserve *Dudleya stolonifera* occurrences on private property at Big Bend (EO 1), Aliso Canyon (EO 2), and Canyon Acres (EO 5). Identify opportunities through the

Service's Partners Program to conduct potential research, conduct surveys, and develop monitoring protocols. (USFWS, 2010)

- Identify opportunities for conservation or preservation for *Dudleya stolonifera* occurrences on private lands. Property easements or purchases of these parcels could be made through the Act's section 6 funding and other programs. (USFWS, 2010)
- Develop plan to monitor and document the number of standing plants and threats at all occurrences in coordination with subsequent 5-year reviews. Mathis Canyon (EO 7) is currently the only occurrence with an established monitoring program. (USFWS, 2010)
- Research *Dudleya stolonifera* reproductive strategies and pollinator requirements. (USFWS, 2010)
- Determine if genetic distinctness exists across occurrences in the two watersheds that comprise the existing range. (USFWS, 2010)

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SPECIES ACCOUNT: *Dudleya traskiae* (Santa Barbara Island liveforever)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/27/1978; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

Dudleya traskiae is a small, perennial herb with five-parted flowers; five petals and carpels, and ten stamens (Service 1985). The flowering stems rise from the axils of basal rosettes. Clusters of 20 to 100 rosettes per plant are typically found, with 25 to 35 leaves per rosette (Service 1985). Rosette leaves range up to 15 cm (5.9 in) long and up to 4 cm (1.6 in) wide. The foliage of *D. traskiae* is glaucous gray or non-glaucous green while the flowers are usually bright yellow with red veins (Moran 1951). The plant blooms mid spring, usually from April to May (Moran 1978), but sometimes extends to July (Service 1985, CNPS 2001). The flowers are acute at the tip, with floral stems standing 20-30cm tall. Reduced triangular-ovate cauline leaves attached to the floral stems decrease in size as they progress from the rosettes to the flowers (Service 1985). (USFWS, 2012)

Taxonomy

Dudleya traskiae was described by Rose in Britton and Rose in 1903. Although Moran (1942) placed the species within *Dudleya* and the subgenus *Stylophyllum*, he stated that the flowers of the Santa Barbara Island liveforever are intermediate between the subgenera *Dudleya* and *Stylophyllum*. Moran (1951 and 1978) speculated that because *Dudleya traskiae* is a tetraploid, it may have originated as an amphidiploid between species of the subgenera *Dudleya* and *Stylophyllum*. Accordingly, Munz (1959 and 1974) in his later floras concurred that *D. traskiae* was a distinct species and Philbrick (1972) felt that it was the most distinctive endemic of Santa Barbara Island. (USFWS, 1985)

Historical Range

See current range/distribution.

Current Range

This species has always been restricted to Santa Barbara Island (USFWS, 2012)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: May to July (USFWS, 2012)

Reproduction Narrative

Adult: The plant blooms mid spring, usually from April to May (Moran 1978), but sometimes extends to July (Service 1985, CNPS 2001). (USFWS, 2012)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliff, Shrubland/chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 15 to 110 m (USFWS, 2012)

Spatial Arrangements of the Population

Adult: Colonies (USFWS, 2012)

Environmental Specificity

Adult: Narrow/specialist

Site Fidelity

Adult: High (inferred from USFWS, 2012)

Habitat Narrative

Adult: *Dudleya traskiae* are found among the cliffs and exposed rocky slopes on Santa Barbara Island. *Dudleya traskiae* is generally found in soil pockets on the rocky cliffs and marine terraces that measure 15-110 m (49-360 ft) in height that surround Santa Barbara Island. The largest colony of these plants resides in close proximity to Signal Peak, the highest point of the island with an elevation of 193 m (635 ft). The island supports roughly 11 colonies of *D. traskiae*, with an estimated 1000 individuals in existence. (USFWS, 2012)

Dispersal/Migration**Dispersal**

Adult: Low (USFWS, 2012)

Dispersal/Migration Narrative

Adult: Seed dispersal may be naturally limited in this species of *Dudleya* as it is for others in the genus (Moran in Clark 1989), and may be a factor in maintaining the small, localized colonies that give rise to the high degree of endemism displayed by the genus. Seed caching by deer mice may result in herbivory of some seed, but aid in dispersal of the unconsumed portion of seed (Sieg 1987). The Graveyard Canyon colony of *D. traskiae* (NPS#5) is particularly limited by seed dispersal because the colony resides on the edge of a cliff where seeds, which are most likely dispersed by water splash, fall into the ocean below (Chaney et al. pers. obs. 2011). (USFWS, 2012)

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Low (inferred from USFWS, 2012)

Representation:

Low (inferred from USFWS, 2012)

Redundancy:

Low (inferred from USFWS, 2012)

Number of Populations:

11 (USFWS, 2012)

Population Size:

1,000 (USFWS, 2012)

Adaptability:

Low (inferred from USFWS, 2012)

Population Narrative:

The island supports roughly 11 colonies of *D. traskiae*, with an estimated 1000 individuals in existence. (USFWS, 2012)

Threats and Stressors

Stressor: Habitat alteration (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Though habitat alteration on a landscape scale has ceased with the establishment of the Park (originally designated a National Monument in 1938), residual impacts remain. Specifically, nonnative plant taxa whose spread was favored by the previous disturbances are still present. In areas with steep slopes, another residual impact is soil erosion caused by previous disturbances and high clay composition (Halvorson et al 1988) restoring slope stability may take decades, if not longer (McEachern 2004). (USFWS, 2012)

Stressor: Pelican habitat expansion (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: In 2004, during surveys, Park staff observed that the federally endangered (at the time) brown pelicans had expanded their roosting habitat onto Santa Barbara Island. By early 2006, pelican roosting activity had expanded greatly, and the Park closed access to the eastern portion of the island (National Park Service 2006). According to Laurie Harvey (NPS Seabird Biologist), the pelican colony on Santa Barbara Island reached a historic maximum in 2006 with an estimated 4,000 nests (Gress and Harvey in prep) (See Figure 3). Since 2006, pelican populations have been much smaller on the island. As a result, short-term effects from pelicans on *Dudleya traskiae* and the surrounding habitat may vary depending on the abundance and

locations of pelican nests. Long term effects on the habitat, however, may linger despite the fluctuations in yearly pelican population sizes. Droppings from pelicans tend to be high in nitrates, which can burn *D. traskiae* and act as fertilizer for nonnative plants thereby increasing numbers of nonnative grasses which may outcompete *D. traskiae* (Rodriguez in litt. 2011). In addition, destabilization of slopes result from nesting and roosting pelicans due to the birds' size and weight. A continuous impact from pelican presence can often lead to erosion of soils from canyon slopes and cliff sides, which is where *D. traskiae* are usually found. (USFWS, 2012)

Stressor: Predation (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: At least by 1979, biologists from the Santa Barbara Museum of Natural History observed that the native deer mice (*Peromyscus maniculatus* subsp. *exilis*) were feeding on *Dudleya traskiae* (Collins et al. 1979). Park staff also observed deer mice feeding on *D. traskiae*, and noted that 30 to 40 percent of their fruiting stalks were gnawed through and broken (Drost 1983 in Service 1985). Moreover, caches of *D. traskiae* fruits and fruit debris were observed at the openings of deer mouse burrows (Clark 1989). Herbivory thus could reduce the vigor of individuals through reduction in leaf tissue, and also reduce the amount of seed available to contribute to the seed bank. However, seed caching associated with herbivory may also serve to disperse seed to potentially suitable habitat. It has been documented that mice populations have a positive correlation with the abundance of nonnative grasses. When nonnative grasses increase, mice populations, which rely on grasses and seeds as other major food sources, also increase in number. Thus, overall effects on *D. traskiae* from mice vary over time. Owl moth larva predation has not been observed recently, and so is not considered a major threat for this 5-year review (Blazek pers. obs. 2011). (USFWS, 2012)

Stressor: Low reproduction (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Recruitment rates may not keep pace with rates of mortality. Although good recruitment rates under greenhouse conditions have been achieved, recruitment rates observed in the wild appear to be extremely low and episodic. Small colonies may be even more vulnerable to reduced viability because the seed they produce have lower germination rates than those produced by larger colonies (Clark 1989, Chaney 2007). (USFWS, 2012)

Stressor: Trampling (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: In Factor A, we discussed impacts to *Dudleya traskiae* habitat from pelican nesting and roosting activity. Here in Factor E, we discuss impacts to individual plants. Pelican nesting and roosting results in trampling of rosettes, breakage of floral stems, destabilization of slopes which cause plants to become dislodged, and loss of substrate which precludes new seedlings from becoming established. In 2006, an assessment of pelican impacts on *D. traskiae* colonies was conducted. Seven of the 11 colonies of *D. traskiae* were characterized as having sustained impacts or were immediately vulnerable to impacts from pelican activities (Chaney 2007). Of

these, five colonies were characterized as being at extreme or high risk of extirpation from these impacts (Chaney 2007). (USFWS, 2012)

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). In addition, an increase in the rate of sea level rise has been predicted for the coast of California (California Coastal Commission (CCC) 2001, California Climate Change Center 2006). In particular, ocean bluffs along the coast will likely be subject to greater and more frequent wave attack, resulting in erosion and shoreline retreat (CCC 2001). We lack adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors such as limited geographical distribution, will affect federally listed species; however, small-ranged species such as *Dudleya traskiae* are more vulnerable to extinction due to these changing conditions (Loarie et al. 2008). Wilken (1996) noted that because most colonies of *D. traskiae* occur on cliff sides in close proximity to the ocean, the species is subject to a wide range of climatic conditions, such as occasional salt spray, which may directly affect the soils and plants at Signal Peak. (USFWS, 2012)

Stressor: Cliff failure (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: The largest colony at Signal Peak, which is located on the face of a sea cliff, is vulnerable to cliff failure. The combination of threats associated with erosion, shoreline retreat, limited habitat range, and existence of only a few small colonies of *Dudleya traskiae* may make this species particularly vulnerable to the effects of climate change. (USFWS, 2012)

Stressor: Stochastic extinction (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Stochastic extirpation of colonies and extinction of the species also pose a potential threat to the species and are exacerbated by low recruitment rates. Those colonies with low numbers of individuals are particularly vulnerable to extirpation from stochastic events because, due to their tendency to be clumped into colonies, the stochastic event is likely to affect the entire population (Meffe and Carroll 1997). At the time of listing, we noted that, due to the limited number of individuals and geographic range of *Dudleya traskiae*, this species was at risk of extinction from naturally occurring events, such as fire, drought, disease, or landslides (Service 1985). We believe that, since the majority of *D. traskiae* reside in one location (near Signal Peak) and on a cliff side, this places the species at risk of extinction from stochastic events. In addition, as a result of its limited range, the resilience of *D. traskiae* to human caused or natural disasters may be greatly reduced (Menges 1991). (USFWS, 2012)

Recovery

Reclassification Criteria:

1. Secure all 11 colonies of the species in a vigorous, self-sustaining condition. (USFWS, 2012)
2. Expand the distribution of the plant to include 50 percent of the suitable potential habitat. (USFWS, 2012)

Delisting Criteria:

1. Expand the distribution of the plant to include 95 percent of the suitable potential habitat. (USFWS, 2012)

Recovery Actions:

- Protect the Santa Barbara Island liveforever and its habitat from physical disturbance. (USFWS, 1985)
- Enhance the liveforever and its habitat. (USFWS, 1985)
- Protect the liveforever from collection. (USFWS, 1985)
- Develop and implement an educational/information program to facilitate recovery of the liveforever. (USFWS, 1985)

Conservation Measures and Best Management Practices:

- Continue assessing the threat to *Dudleya traskiae* colonies from pelican nesting, roosting, and flight activity. Undertake actions to protect those colonies found to be at-risk, as appropriate. For example, cages and netting could be placed over individual plants during pelican nesting season. (USFWS, 2012)
- Continue efforts to expand existing colonies and establish new colonies of *Dudleya traskiae*. These efforts should include sufficient logistical support to maximize the success of the efforts (e.g., sufficient staff, funding, and logistical support to carry out and monitor the program). In 2011, Chaney suggested salvaging the surviving *D. traskiae* colony at Arch Canyon (NPS #10), which has been in decline as documented by past surveys, and relocate the colony closer to the Park visitor center where it can be better managed and observed (Chaney et al. pers. obs. 2011). (USFWS, 2012)
- Bank seed from any colonies that are not yet represented in seedbank collections. In addition to maintaining collections at the Park, a portion of the seed banks should be maintained by a facility within the Center for Plant Conservation network (likely Santa Barbara Botanic Garden or Rancho Santa Ana Botanic Garden). (USFWS, 2012)
- Due to the lack of recent surveys and monitoring, particularly on the largest *Dudleya traskiae* colony at Signal Peak, it is recommended that new assessments be made to evaluate the status of *D. traskiae*. New information may clarify the extent of various threats and more effective recovery initiatives. (USFWS, 2012)

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SPECIES ACCOUNT: *Dudleya verityi* (Verity's dudleya)

Species Taxonomic and Listing Information

Listing Status: Threatened; 01/29/1997; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

A perennial herb that forms a rosette of succulent leaves. Flowering stems are 5-15 cm tall, bearing lemon-yellow flowers. This plant forms colonies of up to 100 rosettes. (NatureServe, 2015)

Taxonomy

Dudleya verityi (Verity's dudleya) was described by Kei Nakai (1983) based on a collection he made in 1978 in Long Grade Canyon, Santa Monica Mountains, Ventura County. Raven and Thompson (1966) had assumed these plants to represent a southern extension of *D. farinosa*. During preparation of the 1977 revision of the flora, Dave Verity recognized these plants as representing a distinct species, and he subsequently encouraged Kei Nakai to review the taxonomy of the species. (USFWS, 1999)

Historical Range

See current range/distribution.

Current Range

All known occurrences are within eastern Ventura County, California, along north-facing volcanic rock outcrops on the lower slopes of the west end of the Santa Monica Mountains in coastal sage scrub. The entire distribution of the species is scattered over a 6.4-km (4-mi) stretch of land along the northern slope of Conejo Mountain and on north-facing volcanic outcrops in the vicinity of the California State University Channel Islands campus. (USFWS, 2009)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Dependency on Other Individuals or Species

Adult: The cushion lichen, *Niebla ceruchoides*, appears to provide a nursery habitat for seed capture and germination for *D. verityi* (Riefner 1992) (see cover photo). The *Dudleya* species which have small yellow to orange flowers (including *D. verityi*) are pollinated by bees and flies, while species with larger red flowers are pollinated mostly by hummingbirds (Levin and Mulroy 1985, Aigner 2004). (USFWS, 2009)

Breeding Season

Adult: May to June (USFWS, 2009)

Reproduction Narrative

Adult: *Dudleya verityi* blooms in late spring (May-June) (California Native Plant Society (CNPS) 2008) and has floral stalks 5 to 15 cm (2.0 to 5.9 in) tall with lemon-yellow corollas and petal tips recurved to 90 degrees (Service 1999). The cushion lichen, *Niebla ceruchoides*, appears to provide a nursery habitat for seed capture and germination for *D. verityi* (Riefner 1992). The *Dudleya* species which have small yellow to orange flowers (including *D. verityi*) are pollinated by bees and flies, while species with larger red flowers are pollinated mostly by hummingbirds (Levin and Mulroy 1985, Aigner 2004). (USFWS, 2009)

Habitat Type

Adult: Terrestrial (USFWS, 2009)

Habitat Vegetation or Surface Water Classification

Adult: Forest/Woodland, Shrubland/chaparral, Woodland - Hardwood

Geographic or Habitat Restraints or Barriers

Adult: Based on CNDDDB (2008) records and recently mapped coordinates onto Google Earth (2008), known occurrences of *Dudleya verityi* prefer elevations ranging from 60 to 350 m (200 to 1150 ft) *Dudleya verityi* prefers slopes ranging from 20 to 90 degrees, and most commonly with north-facing exposures (CNDDDB 2008, Sagar 2008). (USFWS, 2009)

Spatial Arrangements of the Population

Adult: Scattered (USFWS, 2009)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Site Fidelity

Adult: High (inferred from USFWS, 2009)

Dependency on Other Individuals or Species for Habitat

Adult: There is evidence that mosses and lichens aid in seed recruitment and germination by providing nutrients, moisture, substrate, and protection against snails and slugs (Riefner and Bowler 1995, Riefner et al. 2003). (USFWS, 2009)

Habitat Narrative

Adult: In general, *Dudleya* taxa typically inhabit ocean bluffs, sheer cliffs, and rock outcrops including open habitat soils that have nutrient poor substrates and little vegetation (Riefner et al. 2003). This species is highly localized in its distribution, occurring exclusively in thin-soiled substrate over rocky outcrops derived from the Miocene Conejo volcanics (Service 1999). Based on CNDDDB (2008) records and recently mapped coordinates onto Google Earth (2008), known occurrences of *Dudleya verityi* prefer elevations ranging from 60 to 350 meters (200 to 1150 feet). *Dudleya verityi* prefers slopes ranging from 20 to 90 degrees, and most commonly with north-facing exposures (CNDDDB 2008, Sagar 2008). The entire distribution of the species is scattered over a 6.4-km (4-mi) stretch of land along the northern slope of Conejo Mountain and on north-facing volcanic outcrops in the vicinity of the California State University Channel Islands campus. (USFWS, 2009)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends**Population Trends:**

Long term trends indicate a decline of <50% to relatively stable, while short-term trends suggest declines of 10-30% (NatureServe, 2015)

Resiliency:

Low (inferred from USFWS, 2009)

Representation:

Low (inferred from USFWS, 2009)

Redundancy:

Low (inferred from USFWS, 2009)

Number of Populations:

9 (USFWS, 2009)

Adaptability:

Low (inferred from USFWS, 2009)

Population Narrative:

As a result of 2003 surveys (Sagar 2008) which reported an additional six occurrences, the number of occurrences is now currently at nine (CNDDDB 2008, Sagar 2008). Due to its location in a highly developable area and a very narrow distribution short-term trends indicate a decline of 10-30% and long term trends of relatively stable to declines less than 50% (NatureServe, 2015). (USFWS, 2009; NatureServe, 2015)

Threats and Stressors

Stressor: Rock quarry (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Historically, the lower slopes of Conejo Mountain near occurrence number 2 have been the site for quarrying of construction-grade rock. This land is zoned by the County of Ventura for mineral extraction and there are abandoned, active, and proposed quarry operations within the distribution of *Dudleya verityi* (Service 1997, 1999). However, the quarrying near occurrence number 2 remains as the only current quarry operation within the distribution of *D. verityi*, and even though we are not aware of any individuals of *D. verityi* that have been affected by these actions, the current quarry operation has violated some of their county permit requirements and has mined beyond the permit boundaries (C. Danko, Ventura County Planning Division, pers. comm. 2009). In addition, the quarry operation, once back in compliance with county requirements, may request to expand its operation. Therefore, the activities and the

effects of this quarry to *D. verityi* or its habitat remain unclear and therefore continue to be a threat. (USFWS, 2009)

Stressor: Development (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: At the current time, habitat encroachment from new or existing development activities surrounding several of the known *Dudleya verityi* occurrences continues to be a threat to the species and its habitat. For the most part, *D. verityi* and associated habitat is located in areas where impacts from development itself may not directly affect the species or its habitat. However, the associated human impacts to the land (e.g., hiking, mountain biking) in these areas adjacent to new or existing developments could result in *D. verityi* and associated lichen communities to be trampled and/or dislodged. Additionally, erosion from such activities may cause changes in the substrate which may change the microhabitat necessary for the lichen communities to persist. (USFWS, 2009)

Stressor: Collection (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: An incident of vandalism of chalk dudleya (*Dudleya pulverulenta*) occurred near a public access location in Topanga Canyon, California in 1999, illustrating that collection of *Dudleya* species continues to be a threat to members of this genus (Farris 1999). Even though we are unaware of any collection of *Dudleya verityi*, occurrence number 1, 5, and 7 are especially prone to collection given the ease of accessibility and proximity to existing development and roads. (USFWS, 2009)

Stressor: Caterpillar predation (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Damage from caterpillars eating the inside of the stems of plants within the *Dudleya* genus has been reported in many locations. These hollow roots and stems were first noticed in some *Dudleya* individuals as early as 1990 and have been reported as far south as the considerably isolated Isla Zapato in Mexico, leading to speculation that it is a native caterpillar that is responsible for the damage (McCabe 2008b). (USFWS, 2009)

Stressor: Air quality (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Air pollution impacts to coastal sage scrub have been documented in the Santa Monica Mountains as a threat to the viability and functioning of the habitat (O'Leary 1990). The diverse lichen flora associated with *D. verityi* contains species that are considered rare and disappearing from southern California (Riefner 1992). The cushion lichen (*Niebla ceruchoides*) appears to provide a nursery habitat for seed capture and germination for *D. verityi* (Riefner 1992). The population of *Niebla* on Conejo Mountain is the largest on the mainland (it is also

known from the California Channel Islands). Lichens are sensitive to air pollutants and have been eliminated from many areas during the past century (Hale 1983). Studies in California have shown a strong correlation between the increases in smog and the loss of the regional lichen flora (Sigal and Nash 1982). With Ventura County's improvements in air quality, air pollution is not the threat it was at the time of listing. However, until studies have been performed to determine the levels of smog that would impair the ability for the cushion lichen, *Niebla ceruchoides*, to persist, air quality may continue to be a threat to *D. verityi*. (USFWS, 2009)

Stressor: Fire suppression, fuel modification, wildfire survivability, and invasive species (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: At the time of listing in 1997, we discussed general threats to several species within the *Dudleya* genus, including the effects of fire (Service 1997). Natural fire regimes of these areas have been affected, consequently having drastic effects on the grassland, coastal sage scrub, chaparral, and oak woodland ecosystems and the species that reside there (Keeley et al. 1999). In some cases, *D. verityi* is threatened by direct removal during fuel modification and fire-break efforts that occur in the vicinity of the habitat for this species due to the large number of residences and buildings that exist in close proximity to the existing distribution of this species (Service 1997, 1999; Sagar 2008). Additionally, fire that reduces or eliminates the lichen community could dramatically reduce the extent and number of populations of *D. verityi*. Lichens grow very slowly and persist for long periods of time (Hale 1983). The population structure of *D. verityi* depends on mature lichen individuals (Service 1999). Therefore, an extremely hot fire could remove the necessary substrate for the species to germinate and would modify *D. verityi* habitat for an uncertain period of time. Although the plants probably have the ability to survive small, low-intensity fire, there is a high probability that the plants may not survive a larger, high intensity fire. Increased fire suppression over the last century in a large portion of southern California increases the chance of having these larger, more intense fires (Keeley et al. 1999) and thus high intensity fires may pose a threat to the species. (USFWS, 2009)

Stressor: Stochastic extinction (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: At the time of listing, we noted that due to the limited number of individuals and the restricted range of *Dudleya verityi*, this species is under threat of extinction from naturally occurring events, such as fire, drought, disease, or rock slides (Service 1997). As a result of the number of individuals and range of *D. verityi*, the genetic viability and thus resilience of the species to human-caused or natural disasters may be greatly reduced (Menges 1991, Ellstrand and Elam 1993). (USFWS, 2009)

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer

continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). The Santa Monica Mountains and Simi Hills are expected to increase in diversity becoming potential future refugia for some species (Loarie et al. 2008). Increases in species diversity in these higher elevations and northern locations due to climate change have the potential to result "...in new species mixes, with consequent novel patterns of competition and other biotic interactions..." with unknown consequences to the species which currently exist there (Loarie et al. 2008). While we lack adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors, such as low numbers of individuals, will affect *Dudleya verityi*, small ranged species such as *D. verityi* are more vulnerable to extinction due to these changing conditions (Loarie et al. 2008). (USFWS, 2009)

Recovery

Reclassification Criteria:

Reclassification criteria are not available.

Delisting Criteria:

1. All the current sites (including seedbanks) are fully protected and managed with the primary intention of preserving the populations in perpetuity. (USFWS, 2009)
2. All the current sites (including seedbanks) are shown to be self-sustaining over a minimum of 10 years. (USFWS, 2009)

Recovery Actions:

- Protect and secure all current sites of these plant species (including seedbanks). (USFWS, 1999)
- Manage and monitor protected areas where plants occur. (USFWS, 1999)
- Survey historic locations and other potential habitat where the six plant species may occur. (USFWS, 1999)
- Conduct biological and ecological research to define life history strategies, population dynamics, and to guide recovery/conservation efforts. (USFWS, 1999)
- Develop public outreach plans to enhance the public's understanding of conservation needs of these endangered and threatened plant species. (USFWS, 1999)

Conservation Measures and Best Management Practices:

- Conduct new, up-to-date extensive population survey of existing and potential habitat sites. Potential partners include the National Park Service (Santa Monica Mountains Recreation Area), California State Parks, and California State University, Channel Islands. (USFWS, 2009)
- Develop and implement monitoring and adaptive management plans for known existing occurrences. Monitoring should follow Sahatjian's (2008) monitoring methodology. Update and expand knowledge of species life history and specific habitat requirements. (USFWS, 2009)
- Work on public outreach and education with private land owners in the area; develop incentives aimed at conservation of the species. Seek input from public and other stakeholders on the management and preservation of the species. Cooperative agreements and coordinated planning and management efforts could assist in conservation efforts. (USFWS, 2009)

- Work closely with agencies to implement a species monitoring and public outreach program, in addition to implementing new conservation measures for the species (e.g., fencing off certain areas, etc.) and preserving additional potential habitat for the species. (USFWS, 2009)
- Work with county planning departments to develop a species conservation plan; if development does occur, onsite protection should be required. (USFWS, 2009)
- Investigate air quality impacts on cushion lichen, *Niebla ceruchoides*. (USFWS, 2009)
- Investigate *Dudleya verityi* (and suspected hybrids) growing and reproducing on the clay tile roofs at California State University Channel Islands campus near occurrence number 5 to determine whether these plants are in fact *D. verityi*, and not hybrids. (USFWS, 2009)

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SPECIES ACCOUNT: *Echinacea laevigata* (Smooth coneflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/8/1992; Southeast Region (R4) (USFWS, 2015); Proposed Reclassification to Threatened

Physical Description

A rhizomatous perennial herb, which grows to a height of about 1.5 m, with smooth stems, few leaves and pink to purplish flowers. This species flowers from May to mid-July and fruits from late June to September (Gaddy 1991) (NatureServe, 2015).

Taxonomy

It belongs to the aster family (Asteraceae) was first described in 1903, under the name *Brauneria*, by Boynton and Beadle from material collected in South Carolina in 1888; it was transferred to the genus *Echinacea* in 1929 (Small 1933, McGregor 1968) (USFWS, 1995).

Historical Range

The reported historical range of smooth coneflower included Pennsylvania, Maryland, Virginia, North Carolina, South Carolina, Georgia, Alabama, and Arkansas (USFWS, 1995).

Current Range

Current range: Georgia, South Carolina, North Carolina, Virginia. Reports from Alabama and Arkansas are believed to have been misidentifications (Gaddy 1991); also an apparent false report from Maryland (NatureServe, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, vegetative (USFWS, 1995)

Breeding Season

Adult: May through July (NatureServe, 2015)

Key Resources Needed for Breeding

Adult: Insect pollinators; bare soil that is rich in magnesium and/or calcium; disturbance (USFWS, 1995)

Reproduction Narrative

Adult: Flowering occurs May through July; fruiting occurs June to October. Seldom produces viable seeds. Rhizomatous/Cormophyte (NatureServe, 2015). Gaddy (1991) stated that reproduction was apparently only by sexual means and that no vegetative reproduction had been observed. However, vegetative reproduction has been reported from the Chattahoochee

National Forest in Georgia (Robert Joslin, U.S. Forest Service, personal communication, 1994) and from the Sumter National Forest in South Carolina (Lonnelle Edwards, U.S. Forest Service, personal communication, 1995). Pollinators for this species are unknown; however, Edwards and Madsen (1993) have documented preliminary list of insect visitors to South Carolina populations of smooth coneflower (see Appendix A). Smooth coneflower appears to need bare soil that is rich in magnesium and/or calcium for seedling germination and growth. Some form of disturbance (such as fire) is also essential (USFWS, 1995)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Prairie, oak-savannas, cedar barrens, limestone bluffs (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Full or partial sun (NatureServe, 2015); periodic fire (USFWS, 1995)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Formerly, a plant of prairie-like habitats or oak-savannas maintained by natural or Native American-set fires. Now, primarily occurs in openings in woods, such as cedar barrens and clear cuts, along roadsides and utility line rights-of-way, and on dry limestone bluffs. Usually found in areas with magnesium and calcium-rich soils. Requires full or partial sun. Associated species include: *Juniperus virginiana* and *Eryngium yuccifolium*. This species is disturbance dependent (NatureServe, 2015). Smooth coneflower occurs in community types described by Schafale and Weakley (1990) as xeric hardpan forests and diabase glades or in Virginia dolomite woodlands or glades as described by Rawinski (1994). Optimal sites for smooth coneflower are characterized by abundant sunlight and little competition in the herbaceous layer (Gaddy 1991). Natural fires, as well as large herbivores, are part of the history of the vegetation in this species' range (USFWS, 1995).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Seeds are probably dispersed by seed-eating birds or small mammals (USFWS, 1995).

Population Information and Trends**Population Trends:**

Decline of 30-70% (NatureServe, 2015)

Species Trends:

Stable (USFWS, 2011)

Resiliency:

Moderate to high (inferred from NatureServe, 2015)

Representation:

High (inferred from USFWS, 2011)

Redundancy:

High (inferred from USFWS, 2011)

Number of Populations:

68 (USFWS, 2011)

Population Size:

2500 - 100,000 individuals (NatureServe, 2015)

Population Narrative:

Remaining populations appear to be small in numbers which may result in low genetic diversity. Since the species' discovery, more than 2/3rds of the historical populations have been lost. Known from 61 populations in 8 states. However, when it was listed, it was known from fewer than 25 sites in 4 states. This species has experienced a long-term decline of 30-70%. A site in North Carolina is probably the largest, with an estimated 2000 individuals. Total estimated population size is 2,500 - 100,000 individuals. Species is limited to 4 states, 10 counties and about 20 populations in a narrow band from Georgia through the Carolinas to Virginia. There are a few restored populations in Georgia and South Carolina. (NatureServe, 2015). Based on survey information gathered at individual populations throughout the range of the species, it appears that the *Echinacea laevigata* is stable. Peters et al. (2009) found that the species displays a relatively high level of diversity based on analyses across the range of populations. A total of 68 populations are considered extant while 32 populations are believed to be extirpated or historical (USFWS, 2011).

Threats and Stressors

Stressor: Habitat destruction and degradation (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: *Echinacea laevigata* is threatened range-wide by the suppression of fire and the ecological succession (competition and/or shading by woody species) that occurs in areas that are not burned on a regular basis. *Echinacea laevigata* also is threatened by timber operations. Sites located within utility rights of-way are threatened by herbicide use and/or mowing during critical growth periods. The destruction of habitat, resulting from development or land conversion also threatens this species, but to a lesser degree than the factors listed above. The invasive plant, *Pueraria lobata* (kudzu), occurs at one *Echinacea laevigata* population in SC. *Lespedeza cuneata* (*Sericea lespedeza*) is problematic at some roadside locations in NC (USFWS, 2011).

Stressor: Longhorn beetle (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The non-native longhorn beetle (*Hemierana marginata*) has been identified at some *Echinacea laevigata* populations in NC. This beetle chews into the flowering stems causing flowers to die before they produce viable seeds. The insect also may burrow into the base of the plant killing the plant (Laura Gadd, NC Plant Conservation Program, Raleigh, NC, pers. comm.) (USFWS, 2011).

Recovery

Reclassification Criteria:

1. 12 geographically distinct, self-sustaining populations are protected across the species' range, including some populations in at least two counties in VA, two counties in NC and two counties in SC and one county in GA (USFWS, 2011).
2. Managers have been designated for each population (USFWS, 2011).
3. Management plans have been developed and implemented (USFWS, 2011).
4. Populations have been maintained at stable or increasing levels for five years (USFWS, 2011).

Delisting Criteria:

1. At least 15 geographically distinct, self-sustaining populations are protected in at least two counties in VA, two counties in NC, two counties in SC and one county in Georgia (GA) (USFWS, 2011).
2. Management plans have been developed and implemented for each site (USFWS, 2011).
3. Populations (as measured by number of adult plants) have been stable or increasing for 10 years (USFWS, 2011).
4. Permanent conservation ownership and management of at least 10 populations are assured by legally binding instruments (USFWS, 2011).

Recovery Actions:

- Maintain cultivated sources for the species and provide for long-term maintenance of selected populations in cultivation (USFWS, 1995).
- Implement protective management for extant populations (USFWS, 1995).
- Survey suitable habitat for additional populations and potential reintroduction sites; reestablish populations within the species' historic range (USFWS, 1995).
- Protect viable populations through a range of protection tools (management agreements, acquisition, registry, cooperative agreements, etc.) (USFWS, 1995).
- Monitor existing populations (USFWS, 1995).
- Conduct research on the biology of the species and on suitable management tools for maintaining the natural ecosystem in which it occurs (USFWS, 1995).

Conservation Measures and Best Management Practices:

- Revisit known populations that have not been visited in the past three years in order to monitor the population size, habitat conditions and to document any potential threats to the viability of each

site; discuss conservation options with landowners and managers where appropriate; report findings to the appropriate NHP (USFWS, 2011).

- Search for additional populations in appropriate habitat (USFWS, 2011).
- Identify those populations/subpopulations that will contribute toward long term recovery and determine their status (increasing, stable or decreasing) (USFWS, 2011).
- Prioritize protection of unprotected sites that are critical for recovery and protect them (USFWS, 2011).
- Develop conservation agreements with applicable landowners to ensure recovery objectives are met (USFWS, 2011).
- Determine which sites have management plans and how they are being implemented and develop and implement management plans for the remaining sites that are deemed to be critical to the recovery of the species (USFWS, 2011).
- Develop monitoring protocols and initiate long-term population monitoring that will demonstrate if a site is stable or not (USFWS, 2011).
- Determine the management techniques for sustaining populations, such as fire frequency and seasonality (USFWS, 2011).
- Conduct further genetic analysis of populations not included in the research by Peters, et al (2009) (USFWS, 2011).
- Organize a meeting of land managers, researchers and other interested parties to discuss the recovery of this species (USFWS, 2011).
- Collect seeds and develop propagation protocols according to Center for Plant Conservation guidelines (USFWS, 2011).
- Conduct research on general biology of the species including life history and reproductive biology (breeding systems, seed production and seedling survivorship) (USFWS, 2011).
- Secure funding to accomplish the actions listed above (USFWS, 2011).

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SPECIES ACCOUNT: *Echinocactus horizonthalonius* var. *nicholii* **(Nichol's Turk's head cactus)**

Species Taxonomic and Listing Information

Commonly-used Acronym: NTHC

Listing Status: Endangered; 11/28/1979; Southwest Region (R2)

Physical Description

The NTHC is a small, blue-green to gray-green, barrel cactus that is globose, becoming more columnar as it grows. Large individuals range in height from 41 to 51 cm (16 to 20 inches) tall and range in diameter from 13 to 20 cm (5 to 8 inches) wide. Individuals are single-stemmed with 8 ribs that spiral around the base to the apex. Each areole has three central spines, one black that curves downwards and two red or basally gray that curve upwards, and 5 radial spines that tend to be black or partially gray. Flowers are 4 to 7 cm (1.5 to 2.7 inches) in diameter when fully opened (Chamberland 1995; Turner et al. 1995). One to five bright pink fruits are produced in May and June (Benson 1982) and are covered with wooly, white hairs at the apex of the stem, becoming dry with maturity. (USFWS, 2009)

Taxonomy

Baker (2007, 2009) is conducting a multivariate analysis to compare the degree of morphological variation of stem characters within populations of variety *nicholii* to populations within *E. horizonthalonius* throughout its known range to determine if these characters are significantly different to the full suite of characters. Baker's results suggest that there are three distinct varieties within the species *E. horizonthalonius*: variety *nicholii* in the Sonoran Desert population, variety *horizonthalonius* in the Chihuahuan Desert, and an unnamed variety in San Luis Potosí, Mexico. However, more populations need to be measured in order for the results to be conclusive (M. Baker, pers. comm. 2009) (USFWS, 2009).

Historical Range

It is endemic to the Sonoran Desert (Pima and Pinal Counties, , Arizona, and Sonora, Mexico). (USFWS, 2009)

Current Range

Populations occur in the Waterman Mountains and Koht Kohl Hills in Pima County, Arizona; the Vekol Mountains including those near the vicinity of the Vekol Mine in Pinal County, Arizona; and a population in the Sierra del Viejo Mountains in Sonora, Mexico (USFWS, 2009).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Food/Nutrient Narrative

Adult: Extremely slow-growing; takes 10 years to reach a height of 2 inches (NatureServe, 2015).

Reproductive Strategy

Adult: Sexual: cross-pollination (USFWS, 2009)

Lifespan

Adult: 35 - 95 years (USFWS, 2009).

Breeding Season

Adult: April - July (USFWS, 2009)

Key Resources Needed for Breeding

Adult: Soil seed bank (USFWS, 2009)

Reproduction Narrative

Adult: Flowering occurs during mid-April to July, with 90 percent of blooms occurring in June (USFWS 1986). One to five bright pink fruits are produced in May and June (Benson 1982). The NTHC is self-incompatible, requiring pollen from another plant for pollination. Individual lifespan is estimated between 35 and 95 years (USFWS 1986; Schmalzel and Francisco 2000). Each fruit generally contain less than 100 seeds (K. Rice, pers. comm. 2008). The Schmalzel and Francisco (2000) study found that individuals reach maturity (i.e. bloom for the first time) at 2 cm (0.78 inches) tall and 8 cm (3.2 inches) wide. Preliminary studies examining population age-structure suggest that an immature cactus takes 11 to 13 years to reach a diameter of 2 cm (0.78 inches). Seeds are incorporated into a soil seed bank until favorable conditions for germination are present (Ecker 1991; Rojas-Aréchiga and Vázquez-Yanes 2000; Godinez-Alvarez et al. 2003; notes from S. Brack, Mesa Garden, courtesy of Desert Botanical Garden files) (USFWS, 2009).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Sonoran desert scrub (USFWS, 2009; NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 730 - 1,250 m elevation (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 2009; see dispersal/migration narrative)

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Habitat Narrative

Adult: Occurs in Sonoran desert scrub on dissected alluvial fans at the foot of limestone mountains, and on inclined terraces and saddles on limestone mountain sides at 730 -1,250 m. It has been found to grow almost exclusively on Pennsylvania-aged Horquilla limestone (USFWS 2009; NatureServe, 2015). The environmental specificity is narrow (specialist or community with key requirements common) (NatureServe, 2015). It occurs on 0 - 30 percent slopes with a north,

west, and south-facing exposure. Grows in open areas and partially to shaded areas underneath the canopy of shrubs and trees, or shouldered next to rocks on steep slopes and within limestone outcrops. Occurs in *Parkinsonia microphylla* scrub with *Ambrosia deltoidea*, *Carnegiea gigantea*, *Cylindropuntia acanthocarpa*, *Encelia farinosa*, *Fouquieria splendens*, *Krameria grayi*, and *Opuntia phaeacantha* (Baker 2007). Other dominant associated plant species include *Larrea tridentata*, *Ambrosia deltoidea*, *Krameria grayi*, and *Opuntia* sp. (USFWS 1986; NatureServe, 2015).

Dispersal/Migration

Dispersal

Adult: Low (inferred from USFWS, 2009)

Dispersal/Migration Narrative

Adult: Seedlings often establish around the base of the “mother” plant and can give the appearance of small clumps (USFWS, 2009).

Population Information and Trends

Population Trends:

Unknown (USFWS, 2019)

Number of Populations:

6 (USFWS, 2019)

Population Size:

Unknown (USFWS, 2019)

Population Narrative:

The long term population trend is unknown. The recovery plan (USFWS 1986), estimated 10,000 individuals within the known range but there are no data to support this estimate (USFWS 2009). Three populations are located in Arizona on land administered by the Bureau of Land Management (BLM), Arizona State Trust, the Tohono O'odham Nation (Nation), and private lands, and one population in Sonora, Mexico on private lands. (NatureServe, 2015). The NTHC occurs in four disjunct populations (USFWS, 2009). In 2012, Van Devender and Reina-Guerrero (2012) found 83 *E. horizontalis* individuals near Mazatán and Nácori Grande in central Sonora, Mexico, which are approximately 380 km (236 miles) south-southeast from the Waterman Mountains in Arizona. The plants are believed to be *var. nicholii* and may possibly comprise a fifth population depending on a taxonomic analyses. In 2018, biologists with the Service, BLM, and Department of Defense (DOD) documented 62 individual *var. nicholii* on approximately 16.2 ha (40 acres) of DOD land adjacent to IFNM. Their occurrence is believed to have been known and recorded by DOD just recently. The plants appear to be a continuation of those growing on a northeast bajada of the main Waterman range, but are separated by a utility right-of-way and unpaved road. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2019)

Exposure:**Response:****Consequence:**

Narrative: Habitat destruction to the Waterman Mountains population is no longer adversely affecting var. *nicholii*. As of 2018, the BLM has completed most of the recovery actions from the Recovery Plan. The establishment of IFNM with the signing of the Presidential Proclamation, permanently protects natural resources within the 906.5 ha (2,240 ac) encompassing var. *nicholii*'s habitat. In accordance with the proclamation, IFNM is withdrawn from all forms of mineral extraction and recreational off-road vehicles (Service 2009, BLM 2011, 2013). In implementing recovery actions, BLM has acquired 148.9 ha (368 ac) out of 222.5 ha (550 ac) of patented land held by a private owner within occupied habitat and continues to pursue acquisition of remaining private acreages (BLM 2011; D. Tersey BLM, pers. comm. 2018). (USFWS, 2019)

Stressor: Herbivory (USFWS, 2019)

Exposure:**Response:****Consequence:**

Narrative: The Recovery Plan stated that moderate levels of grazing did not appear to affect the var. *nicholii* because cows seem to avoid stepping on the plants (Service 1986). Moderate grazing continues throughout var. *nicholii*'s habitat (Service 2012). During the summer months, cattle may congregate under large trees for shade in dense patches of var. *nicholii* and disturb its habitat (K. Robertson, FWS, pers. obs., 2018). We have little evidence (observed or documented) of cows stepping on the cactus or damaging its tissue. BLM manages the Agua Dulce Grazing Allotment to promote var. *nicholii* conservation. Livestock waters are currently located next to existing roads, but BLM will move or replace those that cause habitat impacts. BLM will place any future water developments in locations to move cattle outside of occupied areas with the intent to reduce or minimize any impacts (BLM 2013; Service 2012). However, any potential effects from livestock grazing, as well as bighorn sheep and other small mammals have not been fully evaluated and should be considered in a thorough threats assessment. (USFWS, 2019)

Stressor: Climate change (USFWS, 2019)

Exposure:**Response:****Consequence:**

Narrative: Climate change is considered a threat to var. *nicholii* due to effects from hotter temperatures and increased aridity (Service 2009). Climate change has resulted in some species shifting their range to higher elevation or higher latitude (Hannah et al., 2005; Chen et al., 2011). For southwestern plants, scientists are finding migration may occur in all directions depending on the species' ability to adapt, and having available, connected habitat (Stills et al., 2015; Krause and Pennington 2012; Notaro et al., 2012). Variety *nicholii* grows on mountain slopes that could presumably support more plants in the future if they remain cooler and soils retain more moisture than those on the valley floor. Alternatively, as temperatures and aridity increase, these exposed areas may become hotter, drier and ultimately unsuitable in the future. With the limiting presence of Horquilla limestone on a few mountain ranges, changes in the suitability and amount of available habitat for the taxon could cause dramatic reductions in its range. Gaining a better understanding of its adaptive capacity and conserving the distinct geographic areas where it occurs will allow opportunities for the taxon to endure into the future. (USFWS, 2019)

Stressor: Invasive plant species (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: In the 5-year Status Review, we identified the spread of invasive grass, *Cenchrus ciliaris* as a significant threat to var. *nicholii* habitat. *Cenchrus ciliaris* had expanded into a 7.2 ha (18 ac) area on the north side of Waterman Mountains, including a location near hundreds of var. *nicholii* increasing the fire risk (Service 2009). There have been recurrent efforts to control *Cenchrus ciliaris* by manual removal through various volunteer organizations (2005-2009) and BLM contracted annual herbicide sprayings (2008-2009). In 2010, the BLM organized a mechanical reshaping and contouring of the area that was followed by restoration efforts through 2012 (J. Scheuring, Friends of Ironwood Forest, pers. comm., 2013). *Cenchrus ciliaris* has been effectively brought under control through continued removal and spot treatment which eliminated its threat to nearby var. *nicholii*. In 2016, several var. *nicholii* seedlings were found growing in the restoration area. (USFWS, 2019)

Recovery

Reclassification Criteria:

The criterion for downlisting to threatened status is permanent protection of 75 percent of the known habitat according to the steps outlined in the Recovery Plan. (USFWS, 1986)

Delisting Criteria:

1. Conserve and protect all existing var. *nicholii* individuals and habitat for their pollinators (approximately a 600 meter (0.37 mi) radius around each plant) in three or more extant populations through land protection, land management actions, and restoration techniques (i.e., actions that enhance habitat quality, support increased germination, and establishment). Each var. *nicholii* population must have available habitat of sufficient quality and size for natural population dynamics and long-term expansion, to support a viable seed bank, as well as, habitat for pollinators, allowing pollen exchange within populations. Variety *nicholii* habitat is defined as areas that contain the appropriate geology, elevation, soil type, Sonoran Desert native plants and trees, native pollinators, with minimal ground disturbance and limited non-native invasive grass species. (USFWS, 2019)

2. Each var. *nicholii* population must be self-sustaining, with annual recruitment exceeding mortality over any 20 years of a 30-year period. Long-term monitoring every 3–5 years demonstrates that the annual total estimated population size among three or more extant populations is maintained at or greater than 3,700 individuals for a minimum of 20 years over a 30-year survey period. Threats must be managed so that populations can be maintained at target levels (a minimum of 3,700 total individuals) for a minimum of 20 years over the 30-year period. Expected yearly fluctuations in plant abundance due to changes in precipitation, fire, or other causes, may result in two monitoring events during the time period that does not meet these targets. (USFWS, 2019)

3. Develop a long-term ex-situ (off-site) var. *nicholii* conservation program that includes maintenance of seeds for conservation and recovery at seed storage facilities, captive propagation, germination trials, guidelines for supplementing natural populations, and

postintroduction monitoring that demonstrates the introduced var. *nicholii* are fully functioning in their environment, including flowering, seed production, and survival. (USFWS, 2019)

Recovery Actions:

- Maintain, protect, and enhance natural populations. It is important and crucial to the preservation of the Nichol Turk's head cactus to protect populations in the wild. To do this, a continuing program of law enforcement, monitoring, and management must be implemented and coordinated among Federal agencies, the State of Arizona, and private individuals or organizations. (USFWS, 1986)
- Study populations in their natural habitat at existing sites. An in-depth knowledge of the plant's ecology and biology is needed to understand its habitat requirements. With this information, sound management decisions can be made and implemented to sustain healthy, natural populations. The use of a well documented and accessible living collection could provide a source of material for these types of studies. (USFWS, 1986)
- Develop a comprehensive trade management plan (CTMP) for all cacti. Prior to development of trade management strategies, studies are necessary to determine what species are in the trade, the overall trend of trade in listed cacti, the feasibility of reducing the collecting pressure on the wild populations by promoting a commercial artificial propagation program, and to determine strategies for effective implementation of law enforcement responsibilities of ESA, CITES, Lacey Act, and State laws. These studies should be national in scope and address all cacti. Completion of subtasks 31 through 34 will result in development of an FWS policy on the cactus trade problem and will allow the drafting of a CTMP. (USFWS, 1986)
- Develop public awareness, appreciation, and support for the preservation of the Nichol Turk's head cactus. Education of the public is a vital part of the recovery process. The cooperation of the public is essential for the ultimate success of the foregoing recovery measures. Public interest groups, especially local ones such as botanical gardens native plant societies, cactus societies, and The Nature Conservancy chapters need to be involved. The visibility of their support can be instrumental in shaping public opinion. Specific strategies would include lectures, pamphlets, letters, etc., concerning conservation of threatened and endangered plant species. (USFWS, 1986)
- Recommended Action from 2009 5-Year Review: The 1986 NTHC Recovery Plan should be revised to incorporate new information that has been gathered since it was finalized. The recovery criteria should be revised to address newly identified threats to the subspecies. Criteria for delisting should be established. Threats should be discussed relative to the five-factor analysis regarding their impact to the subspecies and its habitat (USFWS, 2009).
- Recommended Action from 2009 5-Year Review: Establish a systematic monitoring protocol to more effectively evaluate the status of the subspecies across its known range. Expand the area being monitored to include a larger sample size that is more representative of the Waterman Mountains population. Monitoring should be designed to establish long-term population trends and investigate effects of climate change (USFWS, 2009).
- Recommended Action from 2009 5-Year Review: Studies should be conducted to obtain the quantified data in order to support the recovery criteria using the best scientific and commercial data available. Studies should focus on: ecological factors that influence distribution, density-dependence issues, resource requirements for survival, seedling establishment and dispersal, pollination, demographic trends, population biology, and the amount and condition of suitable habitat (USFWS, 2009).

- Recommended Action from 2009 5-Year Review: Evaluate the genetics of this subspecies to better understand its evolutionary history and relationship to *E. horizonthalonius*, and to assess genetic variation within and between the populations. This information would provide a better understanding of its historical range and taxonomic classification (USFWS, 2009).
- Recommended Action from 2009 5-Year Review: Establish a cooperative partnership with OVIS and develop a conservation agreement to survey and (if found) study the cactus in the Sierra del Viejo Mountains in Sonora, Mexico (USFWS, 2009).
- Recommended Action from 2009 5-Year Review: The USFWS should coordinate cooperative agreements with the Tohono O’odham Nation and ensure that partnerships continue to help protect and conserve the cactus on Tribal land (USFWS, 2009).
- Recommended Action from 2009 5-Year Review: The USFWS should coordinate and establish cooperative partnerships with private landowners to implement conservation of the cactus on their land (USFWS, 2009).

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SPECIES ACCOUNT: *Echinocereus chisoensis* var. *chisoensis* (Chisos Mountain hedgehog Cactus)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/31/1988; Southwest Region (R2)

Physical Description

Echinocereus chisoensis var. *chisoensis* is a relatively low—growing (to 10-12 in., 25—30 cm), cylindrical cactus, reddish—maroon, becoming greener in summer. The stems are most often singular, though they also form clumps composed of multiple stems with age or injury. The stems have 11-16 vertical or slightly spiraled ribs, which have distinctly separate tubercles separated by broad valleys. The areoles are less than 0.13 in. (3.2 mm) long and about 0.25 in. (6.4 mm) apart, circular and distinctly wooly when young, but becoming elliptic and bare with age. The spines are relatively sparse and do not completely obscure the stem. The outer (radial) spines number 10-16, and are notably whitish, or ashy to pinkish gray, with brown to maroon tips. The radial spines are slender and irregular in length, the uppermost 0.06—0.13 in. (1.6-3.2 mm) long and bristle-like, the laterals to 0.37 in. (9.5 mm) long and the lowermost to 0.75 in. (19.1 mm) long. The central spines, numbering 1—6, are more slender than the radials, and dark brown to black with whitish bases. The largest central spine, 0.63 in. (15.9 mm) long, is the lowermost and is held nearly perpendicular to the stem. The other central spines are 0.25—0.50 in. (6.4—12.7 mm) and spreading. The flowers are quite distinctive and appear from March to July. They are funnelform, 2.52-3.75 in. (6.4-9.5 cm) long, 0.50 in. (1.3 cm) in diameter, and do not open very widely. The greenish floral tube has a striking woolliness with clusters of bristly or hairy brown-tipped spines. Even more notable are the petals, 2 in. (5.1 cm) long and 0.50 in. (1.3 cm) wide with pointed tips, upright, and having distinctive internal coloration. Internally, the tips of the petals are pinkish to magenta, the throat is white, and the base of the petal is dark crimson. Stamen filaments are white to pink with yellow anthers. The pistil extends about 0.13-0.17 in. (3.2-4.3 mm) above the stamens and has a dark green 10—parted stigma. The fruits are club-shaped, 1.0—1.4 in. (2.5—3.5 cm) long, and 0.5 in. (1.3 cm) wide. They are greenish—red to red, with white semi—dry flesh, and wooly areoles with bristly or hairlike spines. The fruits split open with age. The seeds are oval, less than 0.06 in. (1.6 mm) in diameter, black, and warty (adapted from Benson 1982, Weniger 1984, Taylor 1985, Evans 1986, and Poole and Riskind 1987). The stems are very inconspicuous and the species frequently occurs in the shade and protection of another plant. The best field recognition characters are the distinctive, showy flowers. When encountered without flowers the best recognition characters are the reddish—maroon to dark green stem color, ribs with distinct, separate tubercles, contrasting whiteness of the spine mass, brown or maroon tipped outer spines, and cottony wool around the young areoles (Benson 1982, Heil and Anderson 1982a). (USFWS, 1993)

Taxonomy

It was described as a new species, *Echinocereus chisoensis* by W.T. Marshall (1940). Lyman Benson (1969) reduced the taxon to a variety of *Echinocereus reichenbachii*. The plant was generally known as *Echinocereus reichenbachii* var. *chisoensis* until the publication of Nigel Taylor's monograph of the genus in 1985. He considered it sufficiently distinct that he returned it to species status and named two varieties, *Echinocereus chisoensis* var. *chisoensis* endemic to

Big Bend National Park, and *Echinocereus chisoensis* var. *fobeanus* of Coahuila and northeastern Durango, Mexico (also very rare) (USFWS, 1993).

Historical Range

It was first collected in 1939, reportedly in the Chisos Mountains of Texas (USFWS, 1993).

Current Range

This variety's range is limited to a very small area on the southeastern side of Big Bend National Park in Brewster County, Texas. (USFWS, 2018)

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual: cross-pollination (USFWS, 1993)

Breeding Season

Adult: March - June (USFWS, 1993)

Key Resources Needed for Breeding

Adult: Pollinators - unknown (USFWS, 1993)

Reproduction Narrative

Adult: The status report by Heil and Anderson (1982a) noted that plants may have multiple stems from the same root system, flower from March to June, and fruit from May to August. Plants are known to outcross readily, but the effective pollinator has not been established (Heil and Anderson 1982a) (USFWS, 1993).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Chihuahuan Desert grasslands or xeromorphic shrublands (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 1,950 - 2,250 ft. elevation (USFWS, 1993)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015 and USFWS, 1993)

Habitat Narrative

Adult: Inhabits Chihuahuan Desert grasslands or open, xeromorphic shrublands on unconsolidated gravelly fan and terrace deposits at moderate elevations (NatureServe, 2015). This variety is found on alluvial flats. These flats are unconsolidated Quaternary fan and terrace

deposits at elevations of 1,950—2,250 ft. (650—750 m) (Heil, Brack, and Porter 1985). The soils are Aridisols eroded to rocky desert pavement (Heil and Anderson 1982a and 1982b) (USFWS, 1993).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seed dispersal mechanisms are unknown (USFWS, 1993).

Population Information and Trends

Population Trends:

Declining (USFWS, 1993)

Number of Populations:

12 (USFWS, 2018)

Population Size:

approximately 1,500 individuals (USFWS, 2018)

Population Narrative:

In March, 2016, personnel of BIBE and USFWS collected data from Chisos hedgehog cactus in 3 monitoring plots. The populations within these plots had declined substantially since 2011 (2011 and 2012 were years of exceptional drought at this site), and had not recovered. However, these plots were not representative samples of the entire population. The population decline on the plots is alarming, but it is not possible to extrapolate the plot data to determine an overall demographic trend. Schmidt (2017) reported a total of 1,500 individual Chisos hedgehog cactuses, including 1,490 individuals detected in a 2010 census, and 10 new individuals she found during her field work. Thus, it might appear that the total population had increased more than 50 percent since the time of Heil and Anderson's status report (1982a). However, the earlier figure was only an approximate figure rather than an actual count. the most recent information confirms that Chisos hedgehog cactus is extant in the same areas where it was known when it was listed as threatened. Populations may have declined during recent exceptional droughts, but we have insufficient information to detect any general demographic trends during this 30-year span. (USFWS, 2018)

Threats and Stressors

Stressor: Present or threatened destruction, modification or curtailment of its habitat or range (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Overgrazing in the early 20th Century depleted the native grass cover and the seedling establishment substrate (Heil and Anderson 1982a), and may have increased soil erosion and shrub encroachment (U.S. Fish and Wildlife Service 1993). Three quarters of a century after the park was established and livestock were removed, there appears to be little regeneration of native grass cover within the known populations of Chisos hedgehog cactus. This modification of

habitat, including soil erosion, continues to threaten the species. We have no information on the current trend of shrub encroachment. Schmidt (2017) documented the encroachment of the introduced invasive buffelgrass (*Pennisetum ciliare*) near an area of occupied habitat. Buffelgrass threatens to outcompete Chisos hedgehog and its host plants, and also increases the risk of wildfire. Buffelgrass disperses rapidly in the disturbed soils along roads and trails before spreading into adjacent intact habitats; 39.0 km (24.2 mi) of roads and trails pass through the occupied habitats of Chisos hedgehog cactus (U.S. Fish and Wildlife Service 2015, p. 8). (USFWS, 2018)

Stressor: Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Heil and Anderson (1982a) stated that Chisos hedgehog cactus is sold commercially and is probably collected illegally from BIBE. An incidence of poaching occurred in 1990 (U.S. Fish and Wildlife Service 1993, p. 11). Personnel at BIBE do not know the current extent of illegal collection (Schmidt 2017, p. 16); listing as a threatened subspecies has stimulated greater public awareness of the conservation need, and federal protection has probably reduced the incidence of poaching. Nevertheless, poaching will continue to be a potential threat as long as there are avid cactus collectors who seek specimens dug from wild populations. Portions of the population that are nearest roads and trails are at greater risk of poaching. (USFWS, 2018)

Stressor: Disease or predation (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: The recovery plan (U.S. Fish and Wildlife Service 1993, p. 11) reported that jackrabbits (*Lepus* sp.) or rodents damage Chisos hedgehog cactus plants during periods of dry weather. Personnel of BIBE and USFWS also observed mortality of Chisos hedgehog cactus individuals from herbivory at monitoring sites in March, 2016, following several years of exceptional drought. Thus, herbivory is not only brought on by drought, but exacerbates mortality from other causes during drought. If droughts become more frequent as a result of climate changes, the impact of herbivory may also increase. (USFWS, 2018)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: The ESA does provide some legal protection for federally listed plants on land under federal jurisdiction, including the entire known range of Chisos hedgehog cactus at BIBE. Beginning in 2007, USFWS and the U.S. Department of Homeland Security (DHS) interacted extensively regarding the proposed construction of a border wall along the Rio Grande in south and west Texas. A provision of the REAL ID Act of 2005 gives the Secretary of Homeland Security authority to waive other federal laws, including the ESA, in order to expedite construction of border barriers. Hence, the border wall project was exempt from consultation with USFWS under section 7 of the ESA. Nevertheless, DHS and USFWS have coordinated to establish best management practices for the federally listed plants and animals in the project impact area (U.S.

Department of Homeland Security 2008). Additional border wall construction has been proposed by the current Administration. If implemented, the border wall and related infrastructure may affect populations and habitats of Chisos hedgehog cactus that occur along the Rio Grande/Bravo. Chapter 88 of the Texas Parks and Wildlife Code lists plant species as state-threatened or endangered once they are federally listed with these statuses. Chisos hedgehog cactus was listed as endangered by the State of Texas on December 30, 1988. The State prohibits taking and/or possession for commercial sale of all or any part of an endangered, threatened, or protected plant from public land. TPWD requires permits for the commercial use of listed plants collected from private land. Scientific permits are required for collection of endangered plants or plant parts from public lands for scientific or educational purposes. In addition to State endangered species regulations, other State laws may apply. State law prohibits the destruction or removal of any plant species from State lands without a TPWD permit. (USFWS, 2018)

Stressor: Population genetics (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: The federal listing states, “Any further reduction in plant numbers could reduce the reproductive capabilities and genetic potential of this cactus.” (53 FR 38455). Small, isolated plant populations are vulnerable to genetic drift, loss of genetic diversity, and inbreeding depression. However, the population genetics of Chisos hedgehog cactus have not been investigated; we have no evidence of the extent of the actual impacts of these potential threats. (USFWS, 2018)

Stressor: Climate change (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: The federal listing also states, “Long or short term climatic changes may be creating drier conditions in the area, possibly contributing to a population decline.” We do not know whether the climate changes that have already occurred have affected the populations or distribution of Chisos hedgehog cactus, nor can we predict how the species might be affected by the type and degree of climate changes forecast by the range of models. While many species have adapted to previous climate changes by migrating in latitude or elevation, it is unlikely that this species could migrate, without facilitation, fast enough to match the projected rate of climate change. Changes in temperature and rainfall amounts and patterns could have multiple effects that alter the species’ fitness in opposing ways. For example, hotter summers could increase mortality from drought, but warmer winters could reduce mortality from freezing. Regardless of how these changes may affect its autecology, the altered synecology may be more significant. For example, Chisos hedgehog cactus might benefit from more frequent or more severe droughts if it tolerates extended drought better than other plants that compete with it. Conversely, extended drought followed by extreme rainfall could damage habitats through erosion. At present, we cannot predict how the infinitely complex aggregation of climate changes will affect the synecology of Chisos hedgehog cactus populations and habitat. Therefore, we will adapt our recovery and management strategies when necessary to address the changing conditions; however, our ability to make sound decisions will depend on periodic, verifiable monitoring of the species’ status.

Recovery**Reclassification Criteria:**

Not applicable. (USFWS, 1993)

Delisting Criteria:

Preliminary delisting criteria are as follows: (USFWS, 1993)

1. When 50 distinct populations are established, each consisting of a minimum of 100 reproductive individuals dispersed over a minimum area of 10 -20 acres. (USFWS, 1993)
2. It should be demonstrated that the populations are demographically stable and reproductively successful, as demonstrated by monitoring the species over at least 10 years. (USFWS, 1993)

Recovery Actions:

- 1. Protect known and newly discovered *Echinocereus chisoensis* var. *chisoensis* populations from existing and future threats and develop management plans. Prospects for the protection of *Echinocereus chisoensis* var. *chisoensis* are excellent. Its occurrence on National Park Service (NPS) land gives the variety the protection of the NPS mandate to protect and preserve its natural features. It also gets the added protection associated with special requirements of Federal agencies under section 7(a)(1) and 7(a)(2) of the Endangered Species Act. Well—planned management actions are needed to ensure the protection of these populations. Because population numbers and sizes are so small, inappropriate land management practices could result in significant loss or damage. Illegal collection is a continuing problem and any collection represents a significant threat to the variety. (USFWS, 1993)
- 2. Establish a reserve germ bank/cultivated population with responsible agencies/institutions. Preservation of *Echinocereus chisoensis* var. *chisoensis* in its natural environment is absolutely of first priority. However, natural populations appear to be at critically low levels and occur over a restricted geographical area (Heil and Anderson 1982a, 1982b, Poole 1987). To prevent total loss of the variety through some catastrophic event, a seed bank and cultivated population is advised. If initial investigations indicate that seed can be successfully stored, a seed bank would be the most cost—effective way to maintain the genomic reserve. A cultivated collection operating in cooperation with the seed bank program can provide needed support for periodic testing and replenishment operations. Cultivated plants should also serve as a non—destructive source of material for research, restoration, education, and possible horticultural development. It is essential that this cultivation program proceed responsibly and in a manner that does not threaten the reproductive capacity of existing populations. While promising cultivation work has been initiated with Sul Ross State University and the Chihuahuan Desert Research Institute, this work should be expanded. (USFWS, 1993)
- 3. Conduct studies necessary to provide a basis for designing and evaluating protective management and restoration plans. A basic lack of scientific information about the critical parameters of habitat, growth, and reproduction for *Echinocereus chisoensis* var. *chisoensis* is limiting the ability of conservation agencies to evaluate the limiting factors and to prescribe management activities. Most information available to date is based on qualitative

observation; more quantitative research is needed on these and other specific aspects of the life history. (USFWS, 1993)

- 4. Search areas with potential habitat for additional populations and potential reintroduction sites. As more information about the habitat and biology of *Echinocereus chisoensis* var. *chisoensis* becomes available, predictive abilities for determining areas capable of supporting the variety should improve. Additional surveys should be done for new populations in the U.S. and in Mexico. Potential 33 reintroduction sites in the U.S. should be noted. Knowledgeable NPS employees working in the area may be helpful in recognizing new populations of the variety. (USFWS, 1993)
- 5. Assess restoration feasibility. An evaluation of the need and potential for reintroduction of the variety can be made when more information is available about the possibility of overlooked populations, genetic vitality, population stability, habitat availability, long-term management requirements of the community, and success of cultivation. In the event that this additional information indicates that reintroduction is feasible and advisable, the following recovery actions (tasks 51-53) should be implemented. (USFWS, 1993)
- 6. Develop and implement a reintroduction plan, if feasible. If reintroduction is determined to be feasible based on the 34 assessment of the pilot program, a reintroduction plan should be developed and implemented. The reintroduction plan should provide for all phases including plant multiplication, site selection, site preparation, introduction, establishment (to independent living), monitoring, and short- and long-term management strategies. (USFWS, 1993)
- 7. Develop public concern and support for the preservation and study of *Echinocereus chisoensis* var. *chisoensis*. A broad-based awareness of the variety and support for efforts to recover it need to be developed. However, cacti have natural appeal to collectors, and greater awareness is expected to increase demand and therefore increase collection pressures. Public education efforts should proceed only after a provision to meet horticultural demand is in place. (USFWS, 1993)
- 8. Develop a post-recovery monitoring plan. If recovery is determined to be feasible, a monitoring plan should be developed that will track the condition of natural and introduced populations for at least 5 years after delisting, as required by the 1988 amendments to the Endangered Species Act. Responsibilities for implementation and reporting should be clear. This plan should specify types and levels of decline that should trigger intervention. (USFWS, 1993)
- Recommended Actions from the 2018 5-Year Review: The most important recovery actions during the next five years include, but are not limited to, the following: - Revise the recovery plan and recovery criteria to incorporate updated guidance and specific, measurable recovery criteria that clarify the delineation of populations; the use of a minimum viable population level as a recovery criterion may be more practically applied to metapopulation. The ten-year monitoring period is not long enough to detect demographic trends. - The best-justified taxonomic classification is *Echinocereus chisoensis* subspecies *chisoensis*. - The best-justified common name is Chisos hedgehog cactus. - Continue to improve the potential habitat model as we learn more about the ecological requirements. Conduct expanded surveys based on this model, using representative sampling and appropriate statistical methods to determine reliable estimates of the total population size. Design an efficient sampling protocol that can be repeated at intervals to determine demographic trends. - Establish a controlled propagation and reintroduction plan; collect seeds, following Center for Plant Conservation Guidelines, representing the range of the subspecies'

ecological and genetic diversity; develop propagation methods; and reintroduce the propagated Chisos hedgehog cactus plants into other portions of the potential habitat range to create redundant populations. - Investigate the population genetics to determine the genetic structure, genetic diversity and extent of inbreeding, evidence of gene flow, and other parameters that will be useful in the conservation and recovery of Chisos hedgehog cactus. (USFWS, 2018)

Conservation Measures and Best Management Practices:

- Protection and conservation at Big Bend National Park (BIBE): The entire known global population of Chisos hedgehog cactus lies within BIBE. The National Park Service manages all species on their lands in accordance with the National Park Service Organic Act of 1916. Since the park is federally owned land, it is a violation of the Endangered Species Act (ESA) to remove and reduce to possession its threatened and endangered plant species. Federally funded or regulated actions that may affect Chisos hedgehog cactus, including the National Park Services' operations and management of the park, are subject to consultation with USFWS under section 7 of the ESA. BIBE monitors populations of Chisos hedgehog cactus, and its law enforcement officers discourage illegal collection. (USFWS, 2018)
- Section 7 consultations: BIBE consulted with USFWS under section 7 of the ESA in the development of its Exotic Plant Management Plan (2012). We concurred that the actions described in the plan are not likely to jeopardize the continued existence of Chisos hedgehog cactus (U.S. Fish and Wildlife Service 2015). To the contrary, these actions will benefit Chisos hedgehog cactus and other listed threatened cactus species by reducing competition from buffelgrass and King Ranch bluestem (*Bothriochloa ischaemum*) and by preventing the trampling of cactus by feral livestock. (USFWS, 2018)
- Section 6-funded grants: "The Cooperative Endangered Species Conservation Fund (section 6 of the ESA) provides grants to States and Territories to participate in a wide array of voluntary conservation projects for candidate, proposed, and listed species. The program provides funding to States and Territories for species and habitat conservation actions on non-Federal lands" (USFWS 2009). (USFWS, 2018)

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SPECIES ACCOUNT: *Echinocereus fendleri* var. *kuenzleri* (Kuenzler hedgehog cactus)

Species Taxonomic and Listing Information

Commonly-used Acronym: EFK

Listing Status: Reclassified to Threatened effective 6/11/2018; originally classified as Endangered effective 11/28/1979; Southwest Region (R2)(USFWS, 2018)

Physical Description

EFK grows as solitary stems or 1 to 4 in a cluster, rarely as many as 8 stems; mature stems are conical to short cylindroid, 10–15 centimeters (cm) (4–6 inches [in]) tall, rarely to 30.5 cm (12 in) tall, and 5.1–10.2 cm (2–4 in) in diameter; ribs 9 to 12, usually 10; tubercles conspicuous; spines sharply pointed, angular in cross section, bulbous and fused together at base, central spine usually absent, sometimes one, light to dark brown or dull black 2.2–2.9 cm (0.87–1.14 in) long; radial spines 2–6, mostly 4–5 stout, mostly curved, 0.6–2.2 cm (0.25–0.87 in) long, typically contorted, white and chalky textured; flowers apical 5.7–10 cm (2.25–4.0 in) in length and diameter, tepals are magenta, usually with bands of green and darker color near center, usually pointed (Castetter et al. 1976: 77–78; Ferguson and McDonald 2006: 2). Baker (2007: 25) did not find fusion of the radial spines in the specimens he studied. The few contorted, white, chalky-textured spines and large, magenta flowers separate the EFK from other cacti within the range. Other hedgehog cacti (*Echinocereus* spp.) either have red flowers or multiple central spines present that are gray to black (Benson 1981: 120–121; Weniger 1984: 10–15). *Echinocereus triglochidiatus* var. *triglochidiatus*, a common cactus in the area, can be differentiated by its red flower and lack of stripes on the larger spines, and large fuzzier, white areoles (Zimmerman 1995: 1). (USFWS, 2017a)

Taxonomy

In 1976, EFK, in its New Mexico and Mexico locations, was proposed as endangered under the name *Echinocereus hempelei* (Service 1976: 24,536). Later in 1976, *Echinocereus kuenzleri* was described as a new species specifically for the New Mexico population of what had previously been called *E. hempelei* (Castetter et al. 1976: 77). *Echinocereus hempelei*, presently referred to as *E. fendleri* var. *hempelei* (also taxonomically uncertain at this time), is known only from a few locations in Chihuahua, Mexico (Felix et al. 2014: 65). EFK was originally listed in 1979 as *Echinocereus kuenzleri* (Service 1979: 61,524). Benson (1982: 631) subsequently reduced it to infraspecific rank as *E. fendleri* var. *kuenzleri*. Based on this nomenclatural change we accepted the variety *E. fendleri* var. *kuenzleri* and officially changed the name on the list of Endangered and Threatened Wildlife and Plants in 1984 (Service 1984: 21). Anderson (2001: 236) was uncertain whether this variety should be recognized taxonomically. Felix et al. (2014: 105) elevated EFK to subspecies rank. The taxonomic standing of a named variety depends upon a consensus of opinion and the informed judgment of those taxonomists who publish their opinions. Zimmerman (1995: 1) believed the variety *kuenzleri* was very closely related to typical *E. fendleri*, such that it's just barely a valid taxon and postulated that variety *kuenzleri* is simply a neotenous form of *E. fendleri* that retains juvenile stem and spination characteristics into adulthood. Zimmerman and Parfitt (2003: 157) reduced variety *kuenzleri* to a synonym of the common and widespread *E. fendleri* var. *fendleri* because of its neotenous features. Baker

(2007: entire) examined the morphological variation in the varieties of *Echinocereus fendleri*, and assigned *kuenzleri* as a separate variety based on stem rib morphology and spine length and shape. Felix et al. (2014: entire) published a morphological study of *Echinocereus fendleri* where they found that the structure, texture, and conformation of the spines were unique in *kuenzleri*, warranting subspecies status. *Echinocereus fendleri* var. *kuenzleri* could be classified as 1) an infraspecific taxon representing a discrete geographic lineage worthy of nomenclatural recognition; 2) the same variety as *E. fendleri* var. *fendleri*; or 3) a trivial variant that should not have taxonomic status within the broader suite of unnamed varieties and falls under the species *E. fendleri* (Service 1979: 61,924; Zimmerman and Parfitt 2003: 164). *Echinocereus fendleri* var. *fendleri* exhibits variation throughout its range and occurs in scattered populations that are widespread but not abundant. It is known throughout the western portion of New Mexico, into Arizona, Colorado, and Texas, and in northern Mexico (Chihuahua, Sonora) (Zimmermann and Parfitt 2003: 164; Felix et al. 2014: 65). There does not appear to be any overlap between *E. fendleri* var. *fendleri* and *E. fendleri* var. *kuenzleri* though intermediate forms have been found in the Vera Cruz area (Northern Sacramento Mountains population) (Marron and Associates, Inc. 2000: 4.14–4.15) and along US 54 north of Carrizozo (west side of Sacramento Mountains (Blue Earth Ecological Consultants, Inc. [BEEC] 2002: 28–32). Based on this information, the Service maintains *E. fendleri* var. *kuenzleri* as a variety until further work can be done on the genetics of the taxon. (USFWS, 2017a)

Historical Range

See Current Range.

Current Range

Endemic to the northeast side of the Sacramento, and Capitan Mountains in Lincoln County, New Mexico, to middle of the Guadalupe Mountains in Eddy County, New Mexico.; range includes areas of Chaves County and Otero County. (USFWS, 2017a)

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (USFWS, 2017a)

Lifespan

Adult: Potentially decades; annual mortality of 10 percent (USFWS, 2017a)

Dependency on Other Individuals or Species

Adult: Pollinators (USFWS, 2017a)

Breeding Season

Adult: Budding occurs in April and flowering normally occurs during the first half of May into early June. Fruit forms in August. (USFWS, 2017a)

Other Reproductive Information

Adult: Plants reach a diameter of 0.3, 0.9, and 1.8 cm (0.1, 0.4, and 0.7 in) at 1, 2, and 3 years of age, respectively (NMEMNRD 1989: 97). Growth averaged over all age classes was estimated at 1.4 cm (0.55 in) per year (NMEMNRD 1989: 100). By year 4 plants can exceed 4.0 cm (1.6 in) in diameter (NMEMNRD 1989: 97). Maximum diameter is about 10 cm (3.9 in) (NMEMNRD 1989: 97). The size class distribution indicates the population is dominated by 4+ year old plants with limited recruitment. (USFWS, 2017a)

Reproduction Narrative

Adult: Budding occurs in April and flowering normally occurs during the first half of May into early June. Warm years can initiate earlier flowering and cool springs may delay flowering until early June (BEEC 2002: 27). Flowers are large for the size of the plant. Fruits form in August and average 3-6 per plant (NMEMNRD 1989: 106). Fruits are bright red when mature, ovoid to cylindrical, may be over 5 cm (2 in) long, and are spiny with miniature versions of the stem spines. Each fruit can have as many as 1,050 seeds (NMEMNRD 1989: 106). Seeds are black and pitted. Greenhouse studies at Mesa Gardens in Belen, New Mexico, indicate EFK requires 21 degree Celsius (°C)(70 degree Fahrenheit [°F]) soil temperature and sufficient moisture for germination (NMEMNRD 1989: 106). Seeds have over 90 percent viability and can survive in the soil for at least 5 years (NMEMNRD 1989: 106). There is no known dormancy requirement. (USFWS, 2017a)

Habitat Type

Adult: Terrestrial (USFWS, 2017a)

Habitat Vegetation or Surface Water Classification

Adult: Pinyon-juniper savannah (USFWS, 2017a)

Dependencies on Specific Environmental Elements

Adult: about 1,560 to 2,130 m (5,100 to 6,990 ft) elevation (USFWS, 2017a)

Spatial Arrangements of the Population

Adult: Small, scattered populations (USFWS, 2017a)

Habitat Narrative

Adult: Typical EFK habitat is the lower fringes of the pinyon-juniper woodland from about 1,560 to 2,130 m (5,100 to 6,990 ft) elevation. Occupied habitat consists of flat to gentle slopes (mean slope range 0 to 50 degrees) or benches with gravelly to rocky soils and southern, eastern, and western exposures. Soils may be derived from limestone or intrusive rocks of the Sacramento or Capitan uplifts. EFK also occurs on unconsolidated, gravel hills in the Fort Stanton area (BEEC 2002: 27). EFK distribution does not appear to be random, but restricted to discontinuous microsites. Distribution within the occupied microsites is clumped. It has been suggested that biotic factors such as the proximity of a microsite to another microsite may increase the probability of pollination and thus effective reproduction or seed dispersal vectors. (USFWS, 2017a)

Dispersal/Migration**Dispersal**

Adult: Rodents, wind, water (USFWS, 2017a)

Dispersal/Migration Narrative

Adult: Seed dispersal occurs during September and October by rodents, wind, and water (BEEC 2002: 27). Seed dispersal may be dependent on summer rainfall, average to above-average summer rainfall results in abundant fruit production, which prolongs good seed dispersal. Dry summers result in low fruit abundance, which are intensively consumed by rodents as soon as fruits mature. Only seeds that are not consumed are likely to survive to germinate (BEEC 2002: 27). The size class distribution of the population suggests that successful germination and growth into juvenile plants is rare (USFWS, 2017a)

Population Information and Trends**Population Trends:**

Half the populations are stable to increasing (USFWS, 2017a)

Species Trends:

Stable to increasing (USFWS, 2017a)

Resiliency:

Likely has multiple, resilient populations (USFWS, 2017a)

Representation:

Three populations have a sufficient number of individuals, distributed across their ranges, with adequate connectivity to, provide for the representation needed to decrease the risk of extinction. (USFWS, 2017a)

Redundancy:

All EFK populations are fairly isolated from one another, and it is unknown if any gene flow occurs among the three populations, unless it were augmented for conservation with human assistance. (USFWS, 2017a)

Number of Populations:

11 (USFWS, 2017a)

Population Size:

Global estimate of about 20,000 individuals (USFWS, 2017a)

Additional Population-level Information:

For a population in high (good) overall condition, we estimate that the probability of persistence over the next 50 years would be 90 percent or higher (in other words a 10 percent or less probability of extirpation). For a population in moderate condition, we estimate that the probability of persistence over approximately the next 50 years would be 66 to 90 percent (10 to 33 percent probability of extirpation), and for one in low (poor) condition, a probability of persistence of 0 to 66 percent over 50 years (33 to 100 percent chance of extirpation). (USFWS, 2017a)

Population Narrative:

It was considered to be near extinction in the early 1980s, with population estimates below 500 plants (Fletcher, 1985), but later Chauvin (2001) estimated the population size to be over 2500 plants, and USFWS (2005) counted 3300 plants estimating total population size of 6600 to 13200 individuals. Currently, over half of the suitable habitat has been surveyed and the variety is more extensive than previously thought. This species has experienced a long term population trend of < 50% decline to relatively stable. The population is currently relatively stable. Approximately 3,300 plants have been counted. It may be reasonable to estimate total population size of 6,600 to 13,200 individuals. May et al. (2008) found 2,449 cacti on 21 hillsides at the Fort Stanton Special Area of Environmental Concern in Lincoln Co. (none in Eddy Co.), New Mexico (outnumbering a previous survey of the same locations 10 to 1) also noting several additional sites between the surveyed area and Eddy Co. in subsequent years with the species present; indicating numbers are likely much larger and habitat much broader than previously thought. Eleven population centers are known; two in the Guadalupe Mountains, eight in the Sacramento Range, and one in low hills between the Guadalupe Mountains and the Sacramento Range. May et al. (2008) found 2449 cacti on 21 hillsides at the Fort Stanton Special Area of Environmental Concern in Lincoln Co. (none in Eddy Co.), New Mexico; also noting several additional sites between the surveyed area and Eddy Co. in subsequent years with the species present (USFWS, 2005; NatureServe, 2015). The species status is stable; there have been no recent reports of extirpations or serious population declines (USFWS, 2005).

Threats and Stressors

Stressor: Land Management (USFWS, 2017a)

Exposure:

Response:

Consequence:

Narrative: Habitat destruction by road construction and home building has affected a very small part of the areas occupied by EFK cactus. At the present time, there are no significant mining or oil and gas production activities within the habitat of this cactus. Most of the known occupied habitats occur in relatively remote areas, which are unlikely to be converted to land uses other than open range for livestock grazing (Service 2005: 12). A significant portion of EFK modeled suitable habitat is managed by Forest Service and BLM for multiple uses (i.e., recreation and livestock grazing). Long-term conservation of EFK is achieved through protections and management on Federal lands. However, the ESA does not prohibit or control the take of EFK on private, tribal, or State lands unless the taking is a consequence of an activity that spends Federal funds, requires a Federal permit, or is in violation of State law, or is for commercial, interstate sale. The New Mexico threatened and endangered plant regulations also do not protect EFK or its habitats on private lands, with the exception of plant collection not authorized by the landowner. Government agencies and conservation organizations collaborate and contribute resources to conserve EFK and its habitat. Development and management projects are evaluated and modified, if necessary, to avoid detriment to EFK and its habitat. Threat due to changing land management is considered low. (USFWS, 2017a)

Stressor: Fire (USFWS, 2017a)

Exposure:

Response:

Consequence:

Narrative: EFK probably does not require fire for germination, or establishment. However, periodic fire is likely to be necessary for population persistence to reduce juniper encroachment into suitable habitat and reduce fuel loads. Wilkinson (1997: 83), and Brown et al. (2001: 121), reported that the Sacramento Mountains, pinyon-juniper stands had a historical fire interval of 25–30 years. This fire interval maintained savanna-like conditions in moderate to high productivity pinyon-juniper woodlands by thinning young non-fire resistant trees, before the introduction of grazing and fire suppression. The diverse shrub and forb vegetation that sustains healthy pollinator pollinations is maintained by periodic wildfire; without fire, dense juniper groves frequently displace these shrubs and forbs. Hence, if the native plant diversity of entire landscapes surrounding EFK populations succumbs to juniper encroachment, pollinator populations will likely decline, and reproduction and gene flow between its colonies may be reduced. Sivinski (2007: 93) found that wildfire can cause high mortality in EFK, and that EFK was slow to recover. This led to studying the effect of prescribed burns as a means of reducing wildfire risk. Wester and Britton (2007: 11) found no evidence that the species was negatively affected by prescribed fire. However, impacts are relative to adjacent high fuel loads and the resulting heat intensity during fire events did increase mortality. Fuel reduction projects and vegetation treatments have been proven as a means of mitigating wildfire hazards, to lessen catastrophic fire. This suggests that prescribed burns or mechanical fuel reduction in EFK habitat could be designed to remove fuel loads without causing direct mortality associated with wildfire (May 2006: 44). Livestock grazing has had a significant effect on the frequency of natural fire within EFK habitats. Removal of fine fuels by grazing animals reduces the ability of a fire to start and carry through the landscape. Land managers have in the past followed an aggressive wildfire suppression program. The result is a disruption of the natural fire regime and an increase of woody vegetation in grassland and savanna habitats. Land managers presently see the need to reintroduce fire into these habitats for the purpose of restoring grasslands and increasing forage for livestock production (Service 2017: 1,682). We believe that uncontrolled wildfire to be a significant threat to EFK. Wildfire is capable of devastating or potentially eliminating small populations of EFK. However, prescribed fire or mechanical fuel reduction used to manage fuel loads would be important to reduce the risk of catastrophic wildfire. Therefore, wildfire is considered a moderate threat to EFK. (USFWS, 2017a)

Stressor: Livestock grazing (USFWS, 2017a)

Exposure:

Response:

Consequence:

Narrative: The Recovery Plan lists grazing as a significant threat (Service 1985: 8). A 2-year study (1984- 1985) by The Nature Conservancy found that during a year of cattle grazing with 65 percent forage utilization, 21 out of 172 individual cacti were found dead outside the fenced exclosure while there was zero mortality inside the exclosure where no grazing had occurred (Bates 1985: 2). One cause of mortality to individuals is trampling by livestock. Concentrating livestock by placing feed, salt, or watering points near cactus clusters can increase the likelihood of cactus Kuenzler's Hedgehog Cactus Species Status Assessment – Final 18 being trampled. Livestock grazing also removes grass cover, which can reduce the suitability of sites for seed germination and seedling establishment and can expose adult plants (Service 1985: 10; Service 2005: 12). The direct or indirect impacts due to grazing, such as trampling, and removal of vegetative cover are minor due to effective grazing management by land management agencies that allows the plant to persist in active allotments. We believe conservative livestock grazing managed responsibly can be used as a management tool to help reduce fuel loads and reduce

the risk of wildfire. Therefore, the threats associated with livestock grazing are considered low. (USFWS, 2017a)

Stressor: Illicit collection (USFWS, 2017a)

Exposure:

Response:

Consequence:

Narrative: Many rare cactus populations have been depleted by collectors. The Recovery Plan lists illegal collection as a threat to the species (Service 1985: 9). Evidence of illegal collection has been observed recently (Baggao 2017: 1). Although illicit collection has not significantly impacted the species, the wild populations openly accessed by the public remain vulnerable. In small populations, removal of individuals could have detrimental impacts to the small populations, and even more so on individual colonies due to reduced genetic diversity, and limited mature individuals for reproduction. Illicit collection is considered a moderate threat to EFK. (USFWS, 2017a)

Stressor: Parasitic Insects (USFWS, 2017a)

Exposure:

Response:

Consequence:

Narrative: Observations have noted apparent direct impacts on individual EFK cacti resulting from the coreid bug (*Chelinidea vittiger*) (Alexander 2017a: 1). These insects increase the probability of the introduction of pathogenic bacteria and fungi. Damage associated with these insects are known to induce floral abortions in cactus (Miller et al. 2008: 145). Alexander (2017a: 1) also suggested that coreid bug damage may be interfering with flower development, noting that 26 EFK showed signs of failed flower development. Periodic outbreaks of insect parasitism seems to occur when cactus populations become very dense (DeBruin 1996: 8). In large, dense populations of EFK the threat of parasitic insects is high. In the less dense, smaller populations the risk is lower. Parasitic insect infestation in any EFK population has the ability to significantly reduce reproduction, and reduce population numbers. Therefore, the threat parasitic insect's pose to EFK is considered moderate. (USFWS, 2017a)

Stressor: Herbivory (USFWS, 2017a)

Exposure:

Response:

Consequence:

Narrative: Rodents can act as both predators and dispersers of seeds. Rodent herbivory damage has been observed and is known to increase mortality in EFK (Forest Service 1989a: 4; Forest Service 1989b: 20; Marron and Associates 2004: 3–4). However, seed dispersal can be facilitated by rodents (BEEC 2002: 27). The threat of herbivory is considered low. (USFWS, 2017a)

Stressor: Small population size and density (USFWS, 2017a)

Exposure:

Response:

Consequence:

Narrative: Small populations are less able to recover from losses caused by random environmental changes (Shaffer and Stein 2000: 308–310), such as fluctuations in recruitment (demographic stochasticity), variations in rainfall (environmental stochasticity), or changes in the

frequency of wildfires. EFK has an out-crossing breeding system. The probability of successful fertilization between unrelated individuals is reduced in small, isolated populations. The remaining plants would produce fewer viable seeds, further reducing population recruitment and engendering a downward spiral toward extirpation. The demographic consequences of small population size are compounded by genetic consequences, since reduced out-crossing corresponds to increased inbreeding. In addition to population size, it is likely that population density also influences population viability; density must be high enough for gene flow within meta-populations, but low enough to minimize parasite infestations. Small, reproductively isolated populations are susceptible to the loss of genetic diversity, to genetic drift, and to inbreeding. The loss of genetic diversity may reduce the ability of a species or population to resist pathogens and parasites, to adapt to changing environmental conditions, or to colonize new habitat. Conversely, populations that pass through a "genetic bottleneck" may subsequently benefit through the elimination of harmful alleles. Nevertheless, the net result of loss of the genetic diversity is likely to be a loss of fitness and lower chance of survival of populations and of the taxon. Genetic drift is a change in the frequencies of alleles in a population over time. Genetic drift can arise from random differences in founder populations and the random loss of rare alleles in small isolated populations. Genetic drift may have a neutral effect on fitness, but is also a cause of the loss of genetic diversity in small populations. Genetic drift may also result in the adaptation of an isolated population to the climates and soils of specific sites, leading to the development of distinct ecotypes and to speciation. Because small populations are more susceptible to stochastic events, and loss of genetic diversity reduces EFK's ability to adapt to environmental changes, the threats associated with small population size is moderate. (USFWS, 2017a)

Stressor: Climate change (USFWS, 2017a)

Exposure:

Response:

Consequence:

Narrative: Climate predictions for the cactus area include a 5 to 6 percent increase in maximum temperature (up to 4 °C [7.2 °F]), 11 percent decrease in precipitation, and a 25 percent increase in evaporative deficit over the next 25 years (National Climate Change Viewer, Four County Data, accessed May 15, 2017). EFK has experienced rebounds from periods of drought in the past. However, should substantial climate change materialize with increased severity and frequency of drought, it would likely reduce the long-term survivorship of this species. However, without sufficient monitoring in place to assess trends, the severity of this threat can only be surmised based on other cacti and drought research. Therefore, the threat of climate change may result in impacts on EFK and habitat. We believe the threat of climate change is moderate. (USFWS, 2017a)

Recovery

Reclassification Criteria:

Not applicable; reclassified with "Threatened" status in 2018. (USFWS, 2018)

Delisting Criteria:

1. Demonstrate a stable or increasing trend in abundance for the Fort Stanton, Elk, and Texas Hills subpopulations over a 20-year period. (USFWS, 2019)

2. Maintain a minimum of three geographically separated core sites over a 20-year period. (USFWS, 2019)

3a. Maintain genetic diversity within all core sites as measured by the fixation indices inbreeding coefficient (FIS) at or within one standard deviation of the FIS of a closely related species with similar reproductive strategies and demonstrated acceptable viability. (USFWS, 2019)

3b. Maintain presence in 80 percent of all existing subpopulations (Element Occurrences) outside of the core sites over a 20-year period, with any subpopulation extirpations compensated by a newly identified or colonized subpopulation. (USFWS, 2019)

Recovery Actions:

- Remove existing and potential threats to *E. fendleri* var. *kuenzleri* by enforcement of existing regulations and management for protection. If the long-term goal of delisting is to be achieved, all existing populations must be protected by enforcing existing regulations and managed for protection of both plants and suitable habitat, (USFWS, 1985)
- Obtain data to facilitate management decisions to sustain and reestablish healthy populations in their natural habitat. Actions below are necessary for effective management decisions to protect the Kuenzler hedgehog cactus and its habitat. (USFWS, 1985)
- Develop a comprehensive trade management plan (CTMP) for all cacti. Prior to development of trade management strategies, studies are necessary to determine what species are in the trade, the overall trend of trade in listed cacti, the feasibility of reducing the collecting pressure on the wild populations by promoting a commercial, artificial propagation program and to determine strategies for 30 effective implementation of law enforcement responsibilities of ESA, CITES, Lacey Act, and State laws. These studies should be national in scope and address all cacti. Completion of subtasks 31 through 34 will result in development of FWS policy on the cactus trade problem and will allow the drafting of a CTMP. (USFWS, 1985)
- Investigate propagation techniques and reintroduction methods for *E. fendleri* var. *kuenzleri*. The pressure of collecting on natural populations may be reduced by providing adequate supplies of propagated specimens into the trade and/or by reintroducing into depleted historic habitat. (USFWS, 1985)
- Develop public awareness, appreciation, and support for recovery of *E. fendleri* var. *kuenzleri*. Education of the public and government personnel is a vital part of the recovery process. Cooperation at all levels is essential for the ultimate success of the recovery of this species. Local public interest groups need to be involved because the visibility of their support can be instrumental in shaping public concern. (USFWS, 1985)
- Recommendation for Future Actions from 2017 5-Year Review: A standardized sampling strategy needs to be developed and implemented to give a clearer idea of the current abundance and overall range of *E. f. kuenzleri*. Further greenhouse experiments to verify breeding patterns of the variety may prove useful in determining the taxonomy and resolving the controversy. Molecular research on genetic variations within the species *Echinocereus fendleri* also may help clarify the taxonomic standing of *E. f. kuenzleri*. (USFWS, 2017b)
- Recommendation for Future Actions from 2017 5-Year Review: The success of transplanting is still in question. Further research is need before establishing it as a standard conservation measure. (USFWS, 2017b)

- Recommendation for Future Actions from 2017 5-Year Review: If the Kuenzler hedgehog cactus is reclassified as threatened, the next future action should be to revise the recovery plan with objective and measurable delisting criteria. The revised plan should focus upon the impacts of livestock grazing including trampling and the land management activities, such as prescribed fire, associated with this land use. Recovery criteria should be updated to reflect the current status and threats, and establish population targets for delisting. (USFWS, 2017b)

Conservation Measures and Best Management Practices:

- One formal consultation has been completed under section 7 of the Endangered Species Act (ESA) that have led to actions that address managing existing habitat on public lands listed in the recovery plan; Prescribed burns and their effects on the EFK (22420-2003-F-0078). Seven informal consultations have been completed involving EFK, including grazing permit renewal (02ENNM00-2013-I-0064), power line repair (02ENNM00-2014-I-0265), prescribed fire (02ENNM00-2017-I-0290), prescribed fire (22420-2003-I-0145), grazing permit renewal (22420-2007-I-0098), chemical treatment of invasive woody plants (22420-2009-I-0006), and mechanical treatment of invasive woody plants (22420-2010-I-0011). (USFWS, 2017b)

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SPECIES ACCOUNT: *Echinocereus reichenbachii* var. *albertii* (Black lace cactus)

Species Taxonomic and Listing Information

Commonly-used Acronym: BLC

Listing Status: Endangered; 11/28/1979; Southwest Region (Region 2)

Physical Description

A spin succulent with solitary stems (or sometimes 5-12), the larger green, cylindroid, 7.5 - 15 cm long, 2.5 - 5 cm diam.; ribs about 12 to 18; areoles narrowly elliptic, 1.5 mm long vertically, typically 2 - 4.5 mm apart; central spines none or 1, 2 - 3 mm long, very dark purple, much smaller than the radials, but otherwise similar to them, straight (plants from Kleberg County were found that have well developed central spines, while they are weakly developed or absent in specimens from Jim Wells and Refugio Counties); radial spines white with dark purple tips, 14 - 16 per areole, closely pectinate, 3 - 4 (6) mm long, 0.2 - 0.35 mm diam., circular in cross section; flower 5 - 7.5 cm diam., 2 - 6 cm long; areoles of floral tube with conspicuous fine wool and weak spines; sepals with green midribs and pink margins; petals pink to light purple, largest oblong, 2.5 - 3.5 cm long, + 9 mm broad, short acuminate, entire; filaments pale yellow or pink, + 9 mm long; anthers yellow, 1.5 mm long, oblong; style pink, 20 - 30 mm long, 1 - 2 mm greatest diam.; stigmas 16 - 20, green + 6 mm long, broad; ovary in anthesis + 9 mm long; fruit green (with pink tinge?) with short spines and soft conspicuous, deciduous, long wool in areoles, + 15 mm long, 9 mm diam.; seeds strongly tuberculate, asymmetrical, 1.5 mm long, 1 mm broad, 0.7 mm thick (Benson, 1982) (USFWS, 1986)

Taxonomy

The scientific name for BLC is *Echinocereus reichenbachii* (Terscheck) F. Haage var. *albertii* L.D. Benson. This variety was described from a specimen collected in 1965 in Jim Wells County (USFWS 1987). Some disagreement exists about the taxonomy of the group of *Echinocereus* with large pink flowers, and there are several synonyms for BLC, including *E. melanocentrus* (Lowry) and *E. fitchii* (Britton and Rose) subspecies *albertii* (L. D. Benson) W. Blum and Mich. Lange (Poole et al. 2007) (Table 2). Some cacti specialists lumped the BLC variety *albertii* with a very similar counterpart, *E. reichenbachii* var. *fitchii*. Blum et al (1998) recognized the taxon *albertii* but placed it within the species *fitchii* as a subspecies (*E. fitchii* ssp *albertii*). Others have called it a separate subspecies (Poole et al. 2007). There are distinct morphological differences between *E. reichenbachii* var. *albertii* and *E. reichenbachii* var. *fitchii*. *Echinocereus reichenbachii* var. *fitchii* has 4-7 central spines of a brownish-red color while the variety *albertii* (BLC) has 0-1 central spines (except the Refugio County population that lacks a central spine) and appears more blackish in coloration (Poole et al. 2007). These two varieties are also geographically disjunct, with *E. reichenbachii* var. *fitchii* occurring in thorn shrublands atop limestone soils, calcareous sandy loams, or saline clays in Jim Hogg, Starr, Zapata, and Webb Counties, and in Mexico, while *E. reichenbachii* var. *albertii* grows on sandy soils in Refugio, Jim Wells, and Kleberg Counties (Poole et al. 2007). Even with these distinctions, Zimmerman and Parfitt (2003) did not recognize any varieties of *E. reichenbachii*, in part due to the interfertile nature of the taxa, and also due to pure populations not existing sympatrically (Poole et al. 2007). Poole et al. (2007) pointed out that many geographically isolated taxa have not

developed genetic barriers and therefore, when placed in contact with cacti of the same origin, can cross freely. (USFWS, 2009)

Historical Range

The historic range extends from east-central Jim Wells County on the most southwestern edge of the range to northeastern Kleberg County near Ricardo at the most southeastern point, and up to southern Refugio County at the most northern extent. This range encompasses parts of Jim Wells, Kleberg, Nueces, San Patricio, and Refugio Counties in south Texas (USFWS, 2009).

Current Range

Current range is Atascosa, Jim Wells, Kleberg, McMullen, and Refugio Counties in south Texas (USFWS, 2009).

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Insect (EPA, 2016)

Breeding Season

Adult: Flowers from March through June, with peak in mid-April to early May (USFWS, 2009).

Key Resources Needed for Breeding

Adult: Insects for pollination (USFWS, 1986); Bees and wasps have been observed visiting flowers (USFWS, 2009).

Reproduction Narrative

Adult: Bees and wasps help the black lace cactus reproduce by spreading pollen from plant to plant (EPA, 2016). Species is self-incompatible (USFWS, 1986).

Habitat Type

Adult: Terrestrial (USFWS, 1986)

Habitat Vegetation or Surface Water Classification

Adult: Openings in mesquite brush occurring along streams of the coastal plain (USFWS, 1986).

Dependencies on Specific Environmental Elements

Adult: Sandy loam or silt soil (USFWS, 1986)

Geographic or Habitat Restraints or Barriers

Adult: Elevation of 50 meters or less (USFWS, 1986)

Habitat Narrative

Adult: Terrestrial species; habitat is described as openings in mesquite brush occurring along streams of the coastal plain at 50 meters or less in elevation, in sandy loam or silt soil and in both level and poorly drained or sloped and well drained (USFWS, 1986).

Dispersal/Migration

Motility/Mobility

Adult: Insect, bird, mammal (EPA, 2016)

Dispersal/Migration Narrative

Adult: Seeds fall to the ground or are washed down by rainfall as the seed decomposes. Seed dispersal mechanisms are thought to be unspecialized, but native ants have been observed mining BLC seeds, carrying them back to their mounds, and discarding the seeds outside of the colony. Other seed-dispersal mechanisms may include fur-bearing mammals inadvertently picking up seeds in disperse seeds through their rooting activities (USFWS, 2009).

Population Information and Trends

Population Trends:

Declining (USFWS, 2019)

Species Trends:

Declining (USFWS, 2019)

Number of Populations:

6 natural, 1 introduced (USFWS, 2019)

Population Size:

Uncertain (USFWS, 2019)

Population Narrative:

The 5-year review (USFWS 2009) indicates that six populations of black lace cactus have been found from east-central Jim Wells County to north-east Kleberg County to Refugio County (pp. 11–13). By 2009, only two extant populations were known, in Kleberg and Refugio counties. The status of the Jim Wells population, last observed in 1989, was unknown (p. 5). All extant and historic populations occurred on privately owned land (p. 4). At the Kleberg site, 43,441 individuals were reported in 1983 and 19,250 in 1985. A large portion of the site was cleared in 1986. Since then, 13,250 individuals were reported in 1987, 1,160 in 2001, and 824 in 2002. Similarly, 82,500 individuals were reported from the Refugio site in 1987 and 1,527 in 2004. The Jim Wells population had about 16,000 individuals in one sub-population in 1985; a second subpopulation was cleared, but about 48 individuals survived. Although these population censuses did not use consistent methods, and the relative numbers of juveniles and reproductive adults was not reported, all populations have apparently declined. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat destruction (USFWS, 1986)

Exposure:

Response:**Consequence:**

Narrative: It is common practice in the region to clear brush tracts for cultivation for improved pasture with the planting of coastal Bermuda grass. Brush clearing has partly or completely destroyed three known populations and has recently occurred near several others. Land owners of presently known populations are apparently unaware of the cactus, so land improvements could destroy present populations without the land owners even knowing it (USFWS, 1986).

Stressor: Grazing by cattle (USFWS, 1986)

Exposure:**Response:****Consequence:**

Narrative: Grazing of natural brush tracts has a negative impact on populations. For the grazed population in Jim Wells County, it was observed that cattle trample plants in open ground with few plants surviving to maturity. The only cacti present were those protected by other vegetation (USFWS, 1986).

Stressor: Collection (USFWS, 1986)

Exposure:**Response:****Consequence:**

Narrative: Collecting is always a serious threat to any small desirable species of cactus, particularly when combined with large showy flowers as found in this species (USFWS, 1986).

Stressor: Predation or trampling (USFWS, 2009)

Exposure:**Response:****Consequence:**

Narrative: Individual BLC plants have been uprooted by feral hogs and kicked over by cattle. However, no other severe disturbances caused by these mammals or other animals have been noted with the exception of the presence of red imported fire ants (RIFA). Some BLC individuals at the Refugio County site have been noted to be partially or entirely covered by mounds of RIFA. There is potential that these non-native ants could pose threats to the base or quite possibly the root system of the cacti. Also, RIFA may out-compete native ant species and potentially interfere with the role these natives play in seed dispersal. The level of threat to the continued existence of BLC due to feral hog rooting and cattle trampling is unknown, although observations at the Refugio County population site indicate that this type of impact occurs in a scattered manner (USFWS, 2009).

Stressor: Pesticide use to control insects (USFWS, 2009)

Exposure:**Response:****Consequence:**

Narrative: Chemical eradication techniques used for the RIFA might also negatively affect natural pollinators of the species and/or native ants and could potentially contribute to an overall decrease in any treated BLC population (USFWS, 2009).

Recovery

Reclassification Criteria:

1. Black lace cactus is documented in 10 or more protected, viable populations, with at least three viable populations in each of three recovery units. Populations and metapopulations are delineated by unpopulated gaps of at least 1 km (0.6 mi). However, as described in Section III.a., viable populations that expand and merge with other populations may be counted as separate populations for the purpose of meeting this criterion. (USFWS, 2019)
2. Viable populations have 1,100 or more mature individuals. Mature individuals have flowered at least once or are judged capable of flowering. Population censuses should be conducted during the peak of flowering and fruiting, from mid-April through May. (USFWS, 2019)
3. Protected populations occur on lands that are legally protected and managed to conserve the region's native flora and fauna, including black lace cactus and its habitats. Examples include, but are not limited to, conservation easements on private lands, lands owned and managed for conservation by non-profit organizations, publicly owned land managed for conservation purposes, and legally binding long-term management agreements with private landowners. (USFWS, 2019)

Delisting Criteria:

Periodic monitoring indicates that the downlisting criteria have been met and that demographic trends have subsequently remained stable or have increased over a period of 25 years. (USFWS, 2019)

Recovery Actions:

- Remove threats to *Echinocereus reichenbachii* var. *albertii* populations by enforcement of existing regulations and management of the habitat for protection of the variety. Because of the rarity of this variety, it should be protected from collecting by enforcement of existing regulations and its habitat should be managed to ensure the continued existence of self-sustaining populations. (USFWS, 1986)
- Initiate studies on the ecology and population biology of the black lace cactus. In-depth knowledge of the population biology and ecology of the black lace cactus is needed. Some of this information may be critical to future management of the variety. (USFWS, 1986)
- Determine the genetic relationships among the three populations and between *Echinocereus reichenbachii* var. *albertii* and other closely related taxa. Knowing the level of classification of *E. reichenbachii* var. *albertii* is not so important as understanding its relationship to its closest relatives. Reliable characteristics that can be used to identify flowering or sterile specimens are essential for enforcement of trade regulations. Determination of the distinctness of the taxon is also imperative since considerable expenditures may be necessary to protect and maintain it in perpetuity. Genetic studies using isozymes and/or flavanoids combined with a thorough morphological analysis can provide evidence on the distinctness or indistinctness of the gene pool within or among the populations under study, and with populations of closely related taxa. (USFWS, 1986)
- Develop a comprehensive trade management plan for all cacti. Studies are needed to determine what species are in trade, the overall trend of trade in listed cacti, and the feasibility of reducing collecting pressure on wild populations by promoting a commercial, artificial propagation program. These studies should be national in scope and address all cacti. The results will be used to develop policy and a comprehensive trade management

plan for all cacti. Strategies for effective implementation of law enforcement responsibilities under ESA, CITES, Lacey Act, and State laws need to be developed. (USFWS, 1986)

- Develop cultivated stocks for commercial distribution. Cultivated stocks can be developed by authorized, responsible and/or licensed agencies, e.g., botanical gardens, universities, etc., for sale to licensed commercial distributors if information from the trade study indicates this is a practical method of reducing collecting pressure. Such trade will be subject to applicable Federal or State permits and reporting requirements. (USFWS, 1986)
- Determine delisting criteria. Before the variety can be downlisted to threatened, at least two of the three known populations should be established as safe sites. Criteria for delisting will be established only after the success of management at permanently protected populations can be evaluated and a search for additional populations has been conducted. (USFWS, 1986)
- Develop public awareness, appreciation, and support for preservation of the black lace cactus. The full recovery of the black lace cactus, and of other endangered species, depends on the attitude and support of the public. Educational materials and presentations should be used to gain public appreciation of the endangered species, and support for the program to save it. (USFWS, 1986)
- Recommended Action from 2009 5-Year Review: Thorough, systematic searches for new BLC populations are needed throughout the species' range. Potential habitat should be identified and surveyed, once landowner permission has been granted. Although saline soils underlie all three BLC sites, more in-depth soils investigation at the known populations may help to further characterize specific soils and geologic properties that would aid in identifying areas in which to concentrate future population searches. In light of taxonomic controversy regarding the *E. reichenbachii*-*fitchii* complex, a thorough systematic review, including genetic studies of the species complex, should be conducted. (USFWS, 2009)
- Recommended Action from 2009 5-Year Review: Collaborative studies should be done to investigate life history requirements, including reproductive biology, and propagation techniques. Experimental studies need to address current and potential threats including impacts of insecticide on cacti pollinators and native seed dispersers such as ants and direct threats to BLC from non-native red imported fire ants, as well as from native insects. Feral hog activity levels within BLC populations should be monitored to ascertain the level of damage that occurs from uprooting of, and potentially from foraging on, BLC caused by these animals. In addition, the role of fire in the management of the species should be examined. (USFWS, 2009)
- Recommended Action from 2009 5-Year Review: All known populations of BLC exist on private lands. The Service and TPWD should pursue development of conservation plans with current landowners, along with investigating potential for permanent conservation easements. The assessment of appropriate conservation/management measures should be collaborative between landowners, resource agencies, and researchers. Evaluation of the species' status, degree of threats, and level of protection at known population sites is needed on a more frequent and regular basis. Landowners should be informed of new management strategies. (USFWS, 2009)
- Recommended Action from 2009 5-Year Review: Public education should be implemented to educate others about this endangered species and to protect the species from becoming a target of illegal take and distribution. Information about the regulations governing take and propagation of wild and nursery species for trade should be distributed to appropriate partners. Refugia specimens should be grown and maintained to further aid in propagation

studies and to enhance the ability of nurseries, botanical gardens, and the general public to identify the species, if encountered. (USFWS, 2009)

- Recommended Action from 2009 5-Year Review: The recovery plan for the species needs to be revised to incorporate all new information on biology, ecology, and management recommendations. Objective and measurable recovery criteria for down- and delisting of the species should be developed which also address all listing factors relevant to the species. (USFWS, 2009)

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SPECIES ACCOUNT: *Echinocereus triglochidiatus* var. *arizonicus* **(Arizona hedgehog cactus)**

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/26/1979; Southwest Region (R2) (USFWS, 2016)

Physical Description

A spiny succulent with a few cylindrical stems, 2.25-4 dm tall. Flowers and fruit are deep red in color (NatureServe, 2015). Stems are few in number but as many as 60 in one clump have been reported. Average stem length is 21.6 cm and average stem diameter ranges from 14.4 to 24 cm. Stem ribs number about 10 and are tuberculate. Spines are dark gray, up to 3.6 cm long, straight to slightly curved, not angled. There are 1 to 3 central spines, the largest deflexed, up to 1.8 mm in diameter at the base. Radial spines number 5 to 11. They are often slightly curved, are pinkish-tan and shorter than the centrals. The flowers are bright red, about 4.8 cm in diameter and 6 cm long (USFWS, 1984).

Taxonomy

The plant was first named as *Echinocereus arizonicus* by J. N. Rose in 1926. In his first edition of *The Cacti of Arizona* in 1940, Lyman Benson placed *E. arizonicus* in synonymy with *Echinocereus polycanthus* which he treated as a variety of *E. triglochidiatus* in the book's 1950 second edition. In his third edition of *The Cacti of Arizona* published in 1969, Benson resurrected the taxon as *E. triglochidiatus* var. *arizonicus* (Phillips et. al., 1979). The taxonomic status of this entity has not been completely resolved (USFWS, 1984). Synonyms include *E. coccineus* var. *arizonicus* and *E. arizonicus* ssp. *Arizonicus* (NatureServe, 2015).

Historical Range

Echinocereus triglochidiatus var. *arizonicus* was first collected by Charles Russell Orcutt in the vicinity of the highway between the Arizona towns of Miami and Superior in July, 1922 (USFWS, 1984).

Current Range

So far as is known the present and historic range are the same (USFWS, 1984). It occurs in the mountainous area near the border of Gila and Pima counties in Arizona (NatureServe, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: May - June (USFWS, 1984)

Reproduction Narrative

Adult: Echinocereus triqlochidiatus var. arizonicus flowers annually from late April to mid-May. Fruit is set in May and June (USFWS, 1984).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Interior Chaparral and Madrean Evergreen woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 1,150 - 1,600 m elevation (USFWS, 1984)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Habitat Narrative

Adult: It is found in oak woodlands and chaparral at 1050-1410 m (possibly 1150-1600 m), annual precipitation 48 cm, in a mixture of Interior Chaparral and Madrean Evergreen woodland. It usually grows in clumps among granite boulders with a dense shrub overstory on open slopes or the understory of a more open canopy. The terrain throughout its range is rugged with steep-walled canyons, and boulder-pile ridges and slopes. Cacti are found scattered about on open slopes, in narrow cracks between boulders, and in the understory of shrubs (USFWS 1984). It is normally found on Orthoclase-rich granite of late Cretaceous age; other parent materials in the area include volcanic tuff, mid-Tertiary age dacite and perhaps rhyolite (pH about 6) (NatureServe, 2015). Elevation of the preferred habitat ranges from near 1,150 to about 1,600 m (USFWS, 1984).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: While there is a paucity of species-specific information on seed dispersal, it is known within the genus of Echinocereus that mammals do eat and disperse their seeds. Ringtails, and gray foxes are known to eat the fruits of cacti species in Echinocereus (Willson 1993) (NatureServe, 2015).

Population Information and Trends**Population Trends:**

Not available

Population Size:

1,500 - 14,000+ (USFWS, 1984)

Population Narrative:

Spotty distribution and varying population sizes makes estimating the total number of plants difficult. According to surveys conducted by Fletcher the number of individuals would be as low as 1,500 or over 14,000 (USFWS, 1984).

Threats and Stressors

Stressor: Collection (USFWS, 1984)

Exposure:

Response:

Consequence:

Narrative: Comparison of isolated and roadside populations shows evidence of diminished population levels in readily accessible portions of the range of this cactus and tends to support reported collection pressures. The effect of collection on long-term survival is not presently known and individuals in accessible populations need to be tracked to record effects of collection (USFWS, 1984).

Stressor: Habitat modification (USFWS, 1984)

Exposure:

Response:

Consequence:

Narrative: Construction of Highway 60 and its later realignment destroyed some suitable habitat and undoubtedly a few plants. Likewise, construction of the transmission line that crosses Highway 60 probably displaced some plants and habitat. Six plants were removed and transplanted to Boyce Thompson Arboretum in 1978 to permit construction of the Silver King substation for the Salt River project. Most of the remaining ground disturbance activities relate to mining. The Globe-Miami Superior area is one of concentrated mining activity. Numerous mines occur within and at the periphery of the range of this cactus. It is not known how many plants have been destroyed by mining, but in general the cactus does not prefer the habitats of mineralized areas. A greater threat is mining exploration. Most roads have been constructed to provide exploration access. A few of these have been routed through occupied habitat (USFWS, 1984).

Stressor: Predation / Herbivory (USFWS, 1984)

Exposure:

Response:

Consequence:

Narrative: The effect of livestock on seedling survival is not known. Exclosure studies are needed in order to address potential trampling and cover removal conflicts. Javelina feed extensively on cacti in some areas. The possibility of javelina taking the Arizona hedgehog has not been investigated, but the javelina population should be monitored closely. Insect damage has been noted but no studies have been conducted on its extent or effect on seed production or plant survival (USFWS, 1984).

Stressor: Freeze Loss (USFWS, 1984)

Exposure:

Response:

Consequence:

Narrative: Freeze damage occasionally reduces populations in more exposed sites. In April 1981 four plants in a population of 15 had apparently died from freezing. No studies have been conducted on the extent of loss or damage by freezing. Freeze loss has the capacity to affect management and recovery. If there is a relationship between ground cover and freeze loss, allowable use of grasses by livestock may have to be reduced (USFWS, 1984).

Recovery**Reclassification Criteria:**

Three primary goals set as requirements before downlisting can be considered: (1) providing 5,000 plants into the commercial pipeline each year for 5 years; (2) attaining a wild population level of 10,000 plants; and (3) establishing a safe area of suitable habitat withdrawn from mineral entry. The size of the withdrawal is to be determined by future survey but should contain sufficient habitat to house the majority of the 10,000 wild plants (USFWS, 1984).

Delisting Criteria:

A long-term goal of delisting is dependent upon removal of collection pressures and other threats and a requirement of continued favorable management consideration by land managers after delisting (USFWS, 1984).

Recovery Actions:

- Remove existing and potential threats to *E. triglochidiatus* var. *arizonicus* by enforcement of existing regulations and management for protection (USFWS, 1984).
- Provide data enabling management decisions to attain and maintain healthy populations in their natural habitat (USFWS, 1984).
- Use results of No. 2 above to protect populations on all lands (USFWS, 1984).
- Propagate *E. triglochidiatus* var. *arizonicus* greenhouse stock (USFWS, 1984).
- Develop public awareness, appreciation, and support for recovery of *E. triglochidiatus* var. *arizonicus* (USFWS, 1984).

Conservation Measures and Best Management Practices:

- Not available

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SPECIES ACCOUNT: *Echinocereus viridiflorus* var. *davisii* (Davis' green pitaya)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/07/1979; Southwest Region (R2) (USFWS, 2016)

Physical Description

E. v. davisii has rounded, usually solitary stems from 1.0 to 3.5 centimeters (cm) (0.4 to 1.4 inch [in]) tall, 6 to 10 ribs, from 8 to 15 radial spines per areole and infrequently a single central spine. The faintly lemon-scented flowers have a yellowish-green perianth from 1.5 to 2.7 cm (0.6 to 1.1 in) in diameter. The reddish-green to purplish-brown oval fruits are 5.5 to 11 mm (0.2 to 0.4 in) long by 4 to 8 mm (0.2 to 0.3 in) wide, bearing black, warty seeds up to 1.1 mm (0.04 in) long. (USFWS, 2012)

Taxonomy

First reported by Houghton (1931). There is debate over the systematics of the cactus family. Recognized scientific names for this species include: *Echinocereus davisii* A.D. Houghton (Houghton 1931; Poole et al. 2007; Zimmerman and Parfitt 2011a; Tropicos 2011a; University of Texas 2011); *Echinocereus subinermis* var. *aculeatus* (Houghton) (G. Unger Unger 1941, as cited in Tropicos 2011a); *Echinocereus viridiflorus* subsp. *davisii* (A.D. Houghton) N.P. Taylor (Taylor 1997; Anderson 2001); and *Echinocereus viridiflorus* Engelm. var. *davisii* (A.D. Houghton) W.T. Marsh (Marshall and Bock 1941; Benson 1982; Integrated Taxonomic Information System 2011a; Natural Resources Conservation Service 2011a; U.S. Fish and Wildlife Service 2011a.) Common names used for *Echinocereus viridiflorus* var. *davisii* include: Davis' dwarf hedgehog cactus (Poole et al. 2007); Davis' green pitaya (Poole et al. 2007; Center for Plant Conservation 2011a; U.S. Fish and Wildlife Service 2011a); Davis's green pitaya (Anderson 2001); Davis' hedge cactus (Poole et al. 2007); Davis' hedgehog cactus (Poole et al. 2007; Natural Resources Conservation Service 2011a); Davis's hedgehog cactus (Zimmerman and Parfitt 2011a); and dwarf hedgehog cactus (Poole et al. 2007). The Service will continue to classify Davis's green pitaya as *E. viridiflorus* var. *davisii*. Further systematic revisions are expected in the *E. viridiflorus* complex, particularly as genetic studies provide new tools to reveal the phylogeny of the cactus family. (USFWS, 2012)

Historical Range

Near Marathon, in Brewster County, Texas (USFWS, 2012).

Current Range

Near Marathon, in Brewster County, Texas (USFWS, 2012).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination - based on closely related species (USFWS, 2012)

Breeding Season

Adult: May - August (USFWS, 2012)

Key Resources Needed for Breeding

Adult: Insect pollinators; halictid bees - based on closely related species (USFWS, 2012)

Reproduction Narrative

Adult: Weniger (1979a, 1979b) observed *E. v. davisii* flowering from May to August and fruits ripening in the summer and fall. He found that it is insect pollinated and reproduces entirely by sexually-produced seeds. It begins flowering at three to four years of age. *E. v. davisii* plants produce from 85 to 340 seeds per year. Leuck and Miller (1982) found that all taxa within the *Echinocereus viridiflorus* complex are xenogamous and self-incompatible. Solitary halictid bees pollinate the flowers within the first two hours after anthesis (USFWS, 2012).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Chihuahuan Desert scrub or grassland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 1,200 to 1,350 m elevation (NatureServe, 2015)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015 and USFWS, 2012)

Habitat Narrative

Adult: Inhabits rock crevices on novaculite outcrops (a hard, fine-grained, silica-rich rock), in full sun, among sparse Chihuahuan Desert scrub or grassland. Usually immersed in mats of spikemoss at approximately 1,200 to 1,350 m. (Loflin and Loflin, 2009). It grows underneath the moss in the crevices of limestone ledges on a select few limestone summits (Weniger, 1970) (NatureServe, 2015). It is endemic to outcrops of Caballos novaculite (USFWS, 2012).

Dispersal/Migration**Dispersal**

Adult: Low (inferred from USFWS, 2012)

Dispersal/Migration Narrative

Adult: Seeds apparently fall near the parent plants as fruits decompose and are dispersed by the surface flow of rain water (USFWS, 2012).

Population Information and Trends**Population Trends:**

Not available

Number of Populations:

2 (NatureServe, 2015)

Population Size:

~ 20,000 (USFWS, 2012)

Minimum Viable Population Size:

1,300 or more mature individuals (USFWS, 2019)

Population Narrative:

It is nearly confined to 1 protected ranch area. There are 2 known sites (NatureServe, 2015). The recovery plan estimates a total population of approximately 20,000 individuals. The reported populations occupied an area of 89 ha (220 ac) (USFWS, 2012).

Threats and Stressors

Stressor: Collection (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: The evidence of the threat of illicit and unscrupulous collection to both *E. v. davisii* is clear; the species has been extirpated from their type locations on a publicly-accessible highway ROW – a site well-known to cactus collectors for decades. This cactus species is offered for sale over the internet (B & T World Seeds 2011a, 2011b; High Country Gardens 2011a, 2011b), presumably cultivated legally and ethically from propagated seed or tissue culture rather than seeds or plants collected from the wild. There is no information on the current extent of illicit collection from the remaining wild populations (USFWS, 2012).

Stressor: Herbivory (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Weniger (1979a, 1979b) found no evidence of disease or predation in the wild populations of *E. v. davisii*, however herbivory by insects, rodents, and perhaps other animals constitutes a potential threat to *E. v. davisii* (USFWS, 2012).

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: While many species have adapted to previous climate changes by migrating in latitude or elevation, this cactus species is endemic to a unique geologic formation where there is very little variation in the range of latitude or elevation. Changes in temperature and rainfall amounts and patterns could alter the species competitive advantages in the unique micro-habitats it occupies. Regardless of how these changes may affect its autecology, the altered synecology may be far more significant. For example, this species might benefit from higher winter temperatures

that extend its growing season. Conversely, it might face new threats from a migration of tropical cactus parasites and pathogens into their habitat (USFWS, 2012).

Recovery

Reclassification Criteria:

We will consider reclassifying Davis's green pitaya to threatened status when: (USFWS, 2019)

1. Ten or more viable metapopulations are legally protected and managed for the purpose of conserving Davis's green pitaya and its habitats. Examples include, but are not limited to, conservation easements on private lands, lands owned and managed for conservation by non-profit organizations, and legally-binding long-term management agreements with private landowners. (USFWS, 2019)
2. The 10 or more protected metapopulations described in the previous criterion must have a minimum viable population size of 1,300 or more mature individuals. (USFWS, 2019)

Delisting Criteria:

1. Periodic monitoring indicates that the minimum viable population levels of 1,300 mature individuals within each of 10 protected metapopulations (the criteria for downlisting to threatened) have remained stable or have increased over a period of 25 years. Monitoring (censuses) of each protected metapopulation must be conducted at least once every five years. (USFWS, 2019)

Recovery Actions:

- Remove threats to *Echinocereus viridiflorus* var. *davisii* by enforcement of existing regulations for protection. Because of the rarity of Davis' green pitaya cactus, the population should be protected by the enforcement of existing international, Federal, and State regulations including management of the threats to the species. (USFWS, 1984)
- Obtain management rights for existing populations of *E. viridiflorus* var. *davisii*. Develop cooperative agreements with private landowners for the protection and management of the Davis' green pitaya cactus populations and habitat. Develop and implement habitat management plans for all existing Davis' green pitaya cactus habitat. Protect occupied suitable habitat presently in private ownership. (USFWS, 1984)
- Initiate and support studies on the population biology and ecology of Davis' green pitaya cactus. Due to the rarity of the Davis' green pitaya cactus, the only known population must be sustained in a healthy and vigorous state. An indepth knowledge of the plant's population biology and ecology is needed to understand its habitat requirements. Growth requirements and limiting factors need to be studied in detail. The knowledge gained can be used to help sustain and manage the natural population. (USFWS, 1984)
- Develop a comprehensive trade management plan for all cacti. Prior to development of trade strategies, studies are necessary to determine what species are in the trade, the overall trend of trade in listed cacti, the feasibility of reducing the collecting pressure on the wild populatons by promoting a commercial artificial propagation program, and to determine strategies for effective, implementation of law enforcement responsibility of ESA, CITES, Lacey Act, and State laws. These studies should be national in scope and address all the cacti. (USFWS, 1984)

- Develop public awareness, appreciation, and support for the preservation of Davis' green pitaya cactus. Education of the public is a vital part of this recovery process. The cooperation of the public is essential for the ultimate success of the foregoing recovery measures. An appreciation of Davis' green pitaya cactus and its role in the environment needs to be developed. This can be initiated with educational programs such as pamphlets, talk programs, and slide shows. (USFWS, 1984)
- Recommended Action from 2012 5-Year Review: Revise the recovery plans and recovery criteria for both species to incorporate the most recent recovery planning guidance (National Marine Fisheries Service 2007). Treat both species in a single recovery plan, and include recovery criteria that are specific, measurable, attainable, realistic, and time-referenced (USFWS, 2012).
- Recommended Action from 2012 5-Year Review: Explore means to monitor the species and their habitats that are acceptable to landowners in the Marathon Basin as well as scientifically verifiable. Specific objectives should include a more complete determination of the species' ranges, distributions, population sizes, demographic trends, and threats (USFWS, 2012).
- Recommended Action from 2012 5-Year Review: Support conservation of wild populations on private lands with willing landowners through the USFWS Partners for Fish and Wildlife Program, section 6-funded grants, cooperative efforts with Natural Resources Conservation Service, or non-governmental partners. Establish a private landowner support group for conservation of the Caballos novaculite rare plants, similar to the group now actively working to conserve Texas snowbells (*Styrax platanifolius* ssp. *texanus*) (USFWS, 2012).
- Recommended Action from 2012 5-Year Review: Support continued research on the population dynamics, reproductive biology, and genetic structure of the wild populations (USFWS, 2012).

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SPECIES ACCOUNT: *Echinomastus erectocentrus* var. *acunensis* (Acuña Cactus)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southwest Region (R2); 10-31-2013

Physical Description

The acuña cactus is a small, spherical cactus, usually single-stemmed, that can be up to 40 centimeters (cm) (16 inches (in)) tall and 9 cm (3.5 in) wide. The acuña cactus has 11 to 15 radial spines up to 2.5 cm (1.0 in) long and 3 to 4 mauve-colored, up-turned central spines up to 3.5 cm (1.4 in) long. Rose, pink, or lavender flowers 3.6 to 6 by 4 to 9 cm (1.4 to 2.3 by 1.6 to 3.5 in) are produced in March. The fruits, which are held in place by a tight mesh of spines, are pale green, are 1.25 cm (0.5 in) long, and contain small, nearly black seeds. The fruits ripen in April and as they dry, they split longitudinally, exposing the seeds. (USFWS, 2013)

Taxonomy

This species was originally described in 1953 by W.T. Marshall as *Echinomastus acunensis*. It is known by many synonyms, including *Sclerocactus erectocentrus* var. *acunensis* (Coulter) Taylor and *Neolloydia erectocentra* (W.T. Marshall) var. *acunensis* L. Benson. The Cactaceae treatment in the Flora of North America recognizes the entity as *E. erectocentrus* var. *acunensis*. The other variety, *E. erectocentrus* var. *erectocentrus* (needle-spine cactus), is also recognized as a valid taxon in the Flora of North America. The two varieties are generally considered to be morphologically distinct and geographically isolated, but there have been questions regarding the morphology of some individuals. To address those concerns, the Service funded a project to analyze the morphological distinctness of the two varieties, which was completed in January 2007. The results of this study suggest that there are four distinct taxonomic groups, including the separation of variety *acunensis* and variety *erectocentrus*. Baker recommended nomenclatural changes, based on the International Rules of Botanical nomenclature, but formal name changes were not proposed in his study. Since that time, Baker collected additional morphology data from other *Echinomastus* populations and concluded in his 2012 Intermountain Flora *Echinomastus* treatment, that all varieties of *Echinomastus* be combined into a single species *E. johnsonii*. In this treatment, however, Baker notes that further study is needed in order to determine if separating the species into varieties may be warranted. To date, there are no peer-reviewed publications stating that *E. erectocentrus* var. *acunensis* should not be considered as a valid taxon. Therefore, the Services accept Baker's 2007 work and the Flora of North America, which separate the acuña cactus from the needle-spine cactus as valid and distinct taxa separated morphologically and geographically. (USFWS, 2013)

Historical Range

Available information indicates that the historical range of this species does not differ from the current range, with the exception that the current Ajo populations likely had been part of a larger population that occurred before mining activity began there. However, there are no survey records for this species in the area prior to mining activity. (USFWS, 2013)

Current Range

The acuña cactus populations are known from Maricopa, Pima, and Pinal Counties in Arizona and from Sonora, Mexico. In western Pima County, plants are known from the Puerto Blanco Mountains and adjacent Aguajita Wash on National Park Service (NPS) lands within OPCNM; from the Saucedo Mountains on Bureau of Land Management (BLM) and Tohono O'odham Nation lands; from Department of Defense military lands on the Barry M. Goldwater Gunnery Range (BMGR); and from private lands near Ajo. In Maricopa County, the acuña cactus is known from the Sand Tank Mountains on BLM lands within the Sonoran Desert National Monument. In Pinal County, plants are known from Mineral Mountain on BLM, State, and private lands. In Sonora, Mexico, the acuña cactus occurs on Reserva de la Biosfera El Pinacate y Gran Desierto de Altar (Pinacate Biosphere Reserve), communal ejido lands, and private ranches. (USFWS, 2013)

Critical Habitat Designated

Yes; 9/19/2016.

Legal Description

On August 18, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective September 19, 2016) for *Echinomastus erectocentrus* var. *acunensis* (Acuña cactus) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six critical habitat units (CHUs), in Arizona (81 FR 55266 - 55313).

Critical Habitat Designation

The critical habitat designation for *Echinomastus erectocentrus* var. *acunensis* (Acuña cactus) includes six CHUs in Maricopa, Pima, and Pinal Counties, Arizona. This species' critical habitat encompasses approximately 18,535 acres (ac) (7,501 hectares (ha)). Brief descriptions are presented below. Maps depicting the CH units are available in the Final Rule. (81 FR 55266 - 55313).

Unit 1: Organ Pipe Cactus National Monument: The unit consists of 2,416 ha (5,971 ac) within OPCNM in southwestern Pima County, Arizona. The unit is on federally owned land administered by the National Park Service.

Unit 2: Ajo: Unit 2 is located in and near the town of Ajo in southwestern Pima County, Arizona. The unit consists of two subunits totaling 666 ha (1,645 ac). This unit contains 195 ha (483 ac) of federally owned land and 470 ha (1,162 ac) of private land. The Federal land is administered by the BLM.

Unit 3: Saucedo Mountains: Unit 3 is located in the Saucedo Mountains of northwestern Pima and southwestern Maricopa Counties, Arizona. We are excluding approximately 156 ha (385 ac) of Tohono O'odham land and exempting 378 ha (935 ac) of BMGR land from this unit, leaving 1,102 ha (2,724 ac) of federally owned land administered by the BLM (refer to the Exclusions and Exemptions sections of the preamble to this rule).

Unit 4: Sand Tank Mountains: Unit 4 consists of 549 ha (1,355 ac) within the Sonoran Desert National Monument of southwestern Maricopa County, Arizona. The unit is on federally owned land administered by the BLM.

Unit 5: Mineral Mountain: Unit 5 consists of 787 ha (1,945 ac) on Mineral Mountain of north-central Pinal County, Arizona. This unit contains 570 ha (1,408 ac) of federally owned land and 217 ha (537 ac) of State-owned land. The Federal land is administered by the BLM (569 ha (1,406 ac)) and the Bureau of Reclamation (1 ha (2 ac)).

Unit 6: Box O Wash: Unit 6 is located near Box O Wash of north-central Pinal County, Arizona. This unit consists of two subunits totaling 1,981 ha (4,895 ac). This unit contains 4 ha (9 ac) of federally owned land, 1,506 ha (3,722 ac) of State-owned land, and 471 ha (1,164 ac) of privately owned land. The Federal land is administered by the BLM.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Echinomastus erectocentrus* var. *acunensis* critical habitat consists of the following components (81 FR 55266--55313):

(i) Native vegetation within the Paloverde-Cacti-Mixed-Scrub Series of the Arizona Upland Subdivision of the Sonoran Desert-scrub at elevations between 365 to 1,150 m (1,198 to 3,773 ft). This vegetation must contain predominantly native plant species that: (A) Provide protection to the acuña cactus (Examples of such plants are creosote bush, ironwood, and palo verde.); (B) Provide for pollinator habitat with a radius of 900 m (2,953 ft) around each individual reproducing acuña cactus; (C) Allow for seed dispersal through the presence of bare soils immediately adjacent to and within 10 m (33 ft) of individual acuña cactus.

(ii) Soils overlying rhyolite, andesite, tuff, granite, granodiorite, diorite, or Cornelia quartz monzonite bedrock that are in valley bottoms, on small knolls, or on ridgetops, and are generally on slopes of less than 30 percent.

Special Management Considerations or Protections

When designating critical habitat, the Service assesses whether the specific areas within the geographical area occupied by the species at the time of listing contain features which are essential to the conservation of the species and which may require special management considerations or protection. All areas designated as critical habitat may require some level of management to address the current and future threats to the physical or biological features essential to the conservation of the acuña cactus. In all of the described units, special management may be required to ensure that the primary constituent elements for the cactus are conserved and the habitat provides for the biological needs of the cactus. Some of the management activities that could ameliorate these threats include, but are not limited to, those discussed below. -- (1) Practice livestock grazing in a manner that maintains, improves, and expands the quantity and quality of Sonoran desertscrub habitat. Special management considerations or protection may include the following: manage livestock grazing sustainably with the natural landscape by determining appropriate areas, seasons, and use consistent within the carrying capacity of rangeland in response to current and future drought and warming trends; improve monitoring and documentation of grazing practices; manage cattle and feral hoofed mammals (ungulates) (e.g., burros) to reduce the risk of plants trampled and soil compaction; and manage for other small mammal species to restore desired processes to increase habitat quality and quantity. -- (2) Minimize construction of new border control facilities, roads, towers, or fences. Special management considerations or protections may include the following: protect lands that support suitable habitat such that destruction of

individual plants and their habitat is minimized and habitat is preserved. -- (3) Manage or protect native Sonoran desertscrub vegetation communities from recreational impacts. Special management considerations or protection may include the following: manage trails, campsites, and off-road vehicles (ORVs); reduce the likelihood of wildfires affecting the acuña cactus populations and nearby plant communities. -- (4) Protect suitable habitat from mineral development and associated infrastructure (new access roads). These activities could result in direct plant and habitat loss, or alteration by removing or degrading soils to such an extent that the soils would no longer support the growth of the acuña cactus. Special management considerations or protection may include the following: protect lands that support suitable habitat such that destruction is minimized and habitat is preserved. -- (5) Manage for nonnative, invasive species, such as buffelgrass, by minimizing conditions that may promote or encourage encroachment or establishment of nonnative, invasive species and restore or reestablish conditions that allow native plants to thrive. Within the range of the acuña cactus, the establishment and success of nonnative, invasive species has been a result of historic land use and management practices such as grazing, wildfire suppression actions, mining, and ORV use. Actions have been taken by some land management agencies to reduce the spread of invasive species and reduce the risk of wildfire they pose from creating fine fuel loads. Nonnative, invasive species occur near acuña cactus populations and may pose a threat through competition for resources or increase the risk of fire. Special management considerations or protection may include the following: Prevent or restrict establishment of nonnative, invasive species; minimize ground-disturbing activities that may facilitate their spread; conduct post-disturbance restoration activities such as native plant propagation; practice active removal of nonnative, invasive plant species and targeted herbicide application (provided herbicides can be shown not to negatively impact the acuña cactus or the native pollinators); and improve monitoring and documentation on a site-by-site basis where nonnative, invasive species are present in occupied habitat to assess any effect (beneficial or negative) they pose of the cactus. -- These management activities will protect the physical or biological features essential to the conservation of the acuña cactus by reducing the direct and indirect effects of habitat loss, alteration, or fragmentation; preserving the geology and soils that form the basis of its habitat; and maintaining the native vegetation communities and pollinators. -- In summary, the primary constituent elements of the acuña cactus habitat may be impacted by livestock grazing; U.S.-Mexico border activities; recreational impacts; mineral development and associated transportation infrastructure; and nonnative, invasive species. Currently some of these threats are not identified to occur at a level that threatens populations with extirpation; however, without management of these threats, they could rise to this level. The units designated as critical habitat within the geographical area occupied by the species at the time of listing contain the physical or biological features essential to the conservation of the acuña cactus. Special management considerations or protection may be required to eliminate, or reduce to a negligible level, the threats affecting each unit or subunit and to preserve and maintain the essential features that the critical habitat units and subunits provide to the cactus.

Life History

Food/Nutrient Resources

Competition

Adult: Non-native plant species

Food/Nutrient Narrative

Adult: Non-native plant species reduce native biodiversity through direct competition and alteration of nutrient and disturbance regimes.

Reproductive Strategy

Adult: Seeds and dispersal through pollinators

Lifespan

Adult: At least 35 years

Dependency on Other Individuals or Species

Adult: The leafcutter bee (*Megachile palmensis*) and cactus bee (*Diadasia rinconis*) are thought to be the primary pollinators.

Breeding Season

Adult: Flowers in March; fruits ripen in April.

Key Resources Needed for Breeding

Adult: Non-drought years.

Other Reproductive Information

Adult: Recruitment and adult survivorship are impacted by drought, with recruitment not keeping up with mortality.

Reproduction Narrative

Adult: The acuña cactus relies solely on the production of seeds for reproduction and genetic diversity, with pollination highly linked to survival, as the species cannot fertilize itself. Acuña cacti are pollinated by a suite of bees from the Andrenidae, Anthophoridae, Anthophorinae, Halictidae, and Megachilidae families; however, the leafcutter bee (*Megachile palmensis*) and cactus bee (*Diadasia rinconis*) are thought to be the primary pollinators. Flowers are pink or purple and up to 5 cm and appear in late March and April. Fruits ripen in April and are pale green when young, tan when dry. Seeds are black and rugose (wrinkled or creased). Recruitment and adult survivorship are impacted by drought, with recruitment not keeping up with mortality. Although we do not know the lifespan of acuña cacti, there are individual plants that have been tracked at Organ Pipe Cactus National Monument (OPCNM) since 1977, and are still alive in 2012 (Holm 2012a, pers. comm.). The lifespan of seeds in the seedbank is unknown; however, in independent greenhouse tests of 6 and 4 year-old seed collected from two discrete populations, less than 19 percent and zero percent germination resulted, respectfully (Rutman 2007, p. 7). In tests of 1 and 2 year-old seed, germination ranged from 64 to 100 percent, and tests of seed collected 19 days previously resulted in 82 percent germination (Rutman 2007, p. 7). It is unknown if seed in its natural environment has the same short lifespan as has been demonstrated in these germination trials. Dispersal is likely through fruit predation by rabbits and rodents.

Habitat Type

Adult: Palo-Verde-Saguaro Association of the Arizona Upland subdivision of the Sonoran desertscrub

Habitat Vegetation or Surface Water Classification

Adult: Sonoran desertscrub

Dependencies on Specific Environmental Elements

Adult: Non-drought

Tolerance Ranges/Thresholds

Adult: 365 to 1,150 m (1,198 to 3,773 ft) elevation

Dependency on Other Individuals or Species for Habitat

Adult: Associated plant species include *Larrea tridentata* var. *tridentata* (creosote bush), *Olneya tesota* (ironwood), *Cercidium microphyllum* (palo verde), *Ambrosia deltoidea* (triangle-leaf bursage), and *Acacia greggii* (catclaw). The acuña cactus is often noted growing under the protective canopy of these or other associated species (Phillips et al. 1982, p. 6; Butterwick 1982–1992, entire; Felger 2000, p. 208; Service 2011a, p. 1; Service 2011b, p. 3), which may act as nurse plants, thereby sheltering seedlings from extreme temperatures and providing some protection from mechanical disturbance (Nobel 1984, p. 316; Suzan et al. 1996, p. 635).

Habitat Narrative

Adult: The acuña cactus occurs in valleys and on small knolls and gravel ridges of up to 30 percent slope in the Palo- Verde-Saguaro Association of the Arizona Upland subdivision of the Sonoran Desert scrub at 365 to 1,150 m (1,198 to 3,773 ft) in elevation (Phillips et al. 1982, p. 4; Arizona Rare Plant Guide Committee 2001, unpaginated; AGFD 2011, entire). This species grows on soil overlying various bedrock types including extrusive felsic volcanic rocks of rhyolite, andesite, and tuff, and intrusive igneous rocks composed of granite, granodiorite, diorite, and Cornelia quartz monzonite; Locomotive fanglomerate (sedimentary rock present (Rutman 2007, pp. 1–2; Anderson 2012a, pers. comm.). Mineralogy of these rocks is varied, with felsic or mafic phenocrysts present, depending on bedrock type (Rutman 2007, pp. 1–2; Anderson 2012a, pers. comm.). Soil texture in these locations varies between bedrock and both coarse and fine-textured substrates (Rutman 2007, pp. 1–2). Associated plant species include *Larrea tridentata* var. *tridentata* (creosote bush), *Olneya tesota* (ironwood), *Cercidium microphyllum* (palo verde), *Ambrosia deltoidea* (triangle-leaf bursage), and *Acacia greggii* (catclaw). The acuña cactus is often noted growing under the protective canopy of these or other associated species (Phillips et al. 1982, p. 6; Butterwick 1982–1992, entire; Felger 2000, p. 208; Service 2011a, p. 1; Service 2011b, p. 3), which may act as nurse plants, thereby sheltering seedlings from extreme temperatures and providing some protection from mechanical disturbance (Nobel 1984, p. 316; Suzan et al. 1996, p. 635).

Dispersal/Migration**Motility/Mobility**

Adult: None

Dispersal

Adult: Fruits dispersed by rodents and rabbits

Dependency on Other Individuals or Species for Dispersal

Adult: Rabbits and rodents for dispersal

Dispersal/Migration Narrative

Adult: Dispersal is likely through predation of fruit by rabbits and rodents.

Population Information and Trends**Population Trends:**

Unknown, but likely declining

Species Trends:

Unknown, but likely declining

Population Growth Rate:

Low

Number of Populations:

Five population areas have been identified in the U.S.: Organ Pipe Cactus National Monument (OPCNM) land; Bureau of Land Management land (BLM); Private land; State land, Military land; and 1 population area in Sonora, Mexico.

Population Size:

Surveyed in 2011. OPCNM: ~2,000 individuals (58.9 percent of known individuals); BLM: 655 individuals (19.3 percent); Private land: 48 individuals (1.4 percent); State land: 32 individuals (0.9 percent); Military: 1 individual (0.1 percent). Mexico (Sonora): 659 individuals (19.4 percent).

Minimum Viable Population Size:

Unknown

Resistance to Disease:

Unknown

Adaptability:

Unknown, but likely low.

Population Narrative:

Five population areas in the U.S.: Organ Pipe Cactus National Monument (OPCNM) land; Bureau of Land Management land (BLM); Private land; State land, Military land; One population in Sonora, Mexico. Surveyed in 2011, counts of individuals for each of the five population areas are: OPCNM: ~2,000 individuals (58.9 percent of known individuals); BLM: 655 individuals (19.3 percent); Private land: 48 individuals (1.4 percent); State land: 32 individuals (0.9 percent); Military: 1 individual (0.1 percent). Mexico (Sonora): 659 individuals (19.4 percent). Notable trends are the large amount of mortality within the populations that have been visited more than once and the low numbers of juvenile plants in the populations.

Threats and Stressors

Stressor: Drought and insect predation

Exposure: See narrative.

Response: See narrative.

Consequence: See narrative.

Narrative: Uprooting and depredation of acuña cacti have been ongoing for at least several decades at OPCNM, at Coffeepot Mountain, and in all other populations. The pronounced decline in the acuña cactus numbers over the last three decades documented throughout the species' range on BLM, State, private, and lands in Sonora, Mexico, is of serious concern. It appears that the combination of drought stress and insect attack have reduced adult plant numbers and that warmer winters may be increasing insect numbers attacking acuña cacti. Most, if not all, of the populations are significantly impacted by predation; predation, in the form of insect attacks, occurs throughout the range of the acuña cactus. We also believe that the extent to which this threat affects the acuña cactus populations is interactive with the occurrence of drought and other climatic variables such as warmer winters. The ability of the acuña cactus populations to recover from insect attacks depends on the successful germination and survival of seedlings. However, these populations are also experiencing decreased reproduction, which may render the populations unable to recover as they continue to lose mature individuals, with low levels of seedling recruitment and survival.

Stressor: Cross-border activities

Exposure: See narrative.

Response: See narrative.

Consequence: See narrative.

Narrative: Cross-border violators and associated CBP and LE off-road activities may be affecting individual acuña cactus plants and their habitat. If there is an increase in off-road activities in or near acuña cactus populations or habitat, the likelihood of loss of individuals or loss or modification of habitat also increases.

Stressor: Inadequacy of existing regulatory mechanisms to control cross-border activities

Exposure: See narrative.

Response: See narrative.

Consequence: See narrative.

Narrative: Regulations designed to protect the species and its habitat will be generally of little impact to alleviate the threats caused by activities of cross-border violators. The interdiction efforts of the U.S. Border Patrol (USBP), including patrols, electronic surveillance and fence construction have contributed to a significant reduction in cross-border violator off-road traffic that has benefited the cactus and other species. However, we do not find regulatory mechanisms to be adequate to directly address this threat due to the difficulty and ever-changing status of border issues, compliance with agreements has been difficult. The cross-border violator activities are, by their very nature, in violation of the law and regulations.

Stressor: Climate change

Exposure: See narrative.

Response: See narrative.

Consequence: See narrative.

Narrative: In the acuña cactus, water and heat stress reduce flower and seed production, and seedling survival is dependent on summer precipitation and soil moisture. Warmer and drier winters combined with increased insect attack, negatively impacts the survivorship of reproductive adults. Of the remaining living individuals across the species' range, a large portion

were found in various stages of deteriorating health, primarily blackening from the base upward, when visited by a botanist in 2011. Across populations, minimal or no recruitment has been seen in recent years. Throughout the species' range, rainfall has been declining, and drought conditions have been dominant for several decades; climate change is anticipated to increase drought periods and warming winters. This combination is expected to continue the documented trend of mortality exceeding recruitment across all populations. When mortality exceeds recruitment in a population, the result is often a declining population.

Recovery

Reclassification Criteria:

None developed.

Delisting Criteria:

None developed.

Recovery Actions:

- None developed.

Conservation Measures and Best Management Practices:

- None developed.

References

USFWS. 2013. Endangered Species Status for *Echinomastus erectocentrus* var. *acunensis* (Acuña Cactus) and *Pediocactus peeblesianus* var. *fickeiseniae* (Fickeisen Plains Cactus) Throughout Their Ranges. Final Rule. 78 FR 60608-60652 (October 1, 2013).

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SPECIES ACCOUNT: *Echinomastus mariposensis* (Lloyd's Mariposa cactus)

Species Taxonomic and Listing Information

Listing Status: Threatened; 12/06/1979; Southwest Region (R2)

Physical Description

A small succulent. The stems of *Neolloydia mariposensis* are ovoid—cylindroid, up to 10 cm (3.9 inches) tall, and 4 to 6 cm (1.6 to 2.4 inches) in diameter. The 4 to 7 central spines per areole are white, gray, or pale yellow toward the base with light brown or bluish-gray tips. The upper 3 to 6 central spines spread upward and are often somewhat appressed against the upper radial spines. The upper central spines are 1.3 to 2.0 cm (0.5 to 0.8 inch) long; the lower central spine is porrect (directed outward and forward) or curves downward and is 0.5 to 1.3 cm (0.2 to 0.5 inch) long. The 25 to 36 radial spines per areole are white to gray, sometimes tipped with light brown, and 0.5 to 1.1 cm (0.2 to 0.4 inch) long. The flowers are white, or pinkish fading to white with age, up to 3 cm (1.2 inches) long and of about equal diameter. Fruits are yellowish—green, globose or oblong, and up to 1 cm (0.24 inch) long. Seeds are black, ovate, and slightly over 1.5 mm (0.6 inch) long (Weniger 1970). (USFWS, 1989)

Taxonomy

The Lloyd's Mariposa cactus was first collected by Mr. J. Pinckney Hester at the Mariposa Mine in southwestern Texas and was described by him as *Eschinomastus mariposensis* (Hester 1945). In 1969, Dr. Lyman Benson placed the Lloyd's Mariposa cactus into the genus *Neolloydia* (Benson 1969) (USFWS, 1989). An unpublished phylogenetic analysis indicates that the Coahuilan, Mexico, populations should not be included in *S. mariposensis*. (USFWS, 2018)

Historical Range

This species is known from the Big Bend Region of southwestern Texas (Brewster and Presidio Counties) and from adjacent Coahuila, Mexico (USFWS, 1989).

Current Range

Known from Presidio and Brewster Counties in Texas. (USFWS, 2018)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (USFWS, 2018)

Breeding Season

Adult: February - March (USFWS, 1989)

Key Resources Needed for Breeding

Adult: Rocks (USFWS, 1989)

Reproduction Narrative

Adult: Lloyd's mariposa cactuses reproduce sexually, but the pollinators, breeding system (mating system), and seed dispersal were unknown. Flowering occurs mainly from March to April. Flowers open in the afternoon and remain open for 3 to 4 days. The fruits mature about 1 month later; from 5 to 10 fruits per individual produce 20 to 30 seeds each. The abundance of juvenile individuals in the known populations is evidence of recruitment. Individuals reach sexual maturity in 4 to 5 years. (USFWS, 2018)

Habitat Type

Adult: Terrestrial

Habitat Vegetation or Surface Water Classification

Adult: Sotol-lechuguilla shrublands (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Full sunlight (USFWS, 2018)

Geographic or Habitat Restraints or Barriers

Adult: 750-1050 m (2,460-3,445 ft) elevation (USFWS, 2018)

Spatial Arrangements of the Population

Adult: Scattered individuals, sometime dense colonies (USFWS, 2018)

Habitat Narrative

Adult: Populations of Lloyd's mariposa cactus consist of scattered individuals growing in cracks and fragments of highly fractured, crumbling limestone in Chihuahuan Desert scrubland; elevations range from 750-1050 m (2,460-3,445 ft), and mean annual precipitation ranges from 25-35 cm (10-14 in). Geological substrates include some Quaternary deposits, the Tertiary Chisos Formation, and Cretaceous limestones of the Santa Elena, Sue Peaks, Del Carmen, Telephone Canyon, Boquillas, Glen Rose, Del Rio Clay, Aguja, and Pen formations. Soils are alkaline, very rocky, crumbling limestone gravels of the Chambarino, Lajitas, Lozier, Mariscal, Pantera, Solis, Tornillo, and Upton-Nickel series. The habitats are very open, and most individuals are exposed to full sunlight and reflected light from the white limestone. We provisionally estimate that about 220,000 ha (543,000 ac) of potential habitat occur in Brewster and Presidio counties; potential habitats and populations very likely also extend into Terrell County, but we do not have verifiable records of occurrences there. (USFWS, 2018)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Unknown (USFWS, 2018)

Population Information and Trends**Population Trends:**

Not available

Number of Populations:

U.S.: 12 (USFWS, 2018)

Minimum Viable Population Size:

Estimated to be in the intermediate range (roughly 1,500 to 2,000 individuals (USFWS, 2018))

Population Narrative:

Demographic studies on two plots observed the following: The populations fluctuated widely, but returned to initial levels after 15 years; estimates of first reproductive age ranged from 5 to 33 years; as much as 95 percent of the youngest class of plants do not reach reproductive maturity; mature plants produced fairly typical numbers of seeds (for a small cactus), but the largest plants also had higher mortality rates; favorable years for recruitment may occur about once every 5 years; and the appearance and growth of juvenile plants indicates that populations are resilient. Anecdotal observations of several experts indicate that the species is much more abundant and widespread than previously known; large populations occur on two protected sites, BIBE and BGWMA; and the most significant threat, the large-scale commercial collection of this species from the wild, appears to have subsided significantly, but will probably continue indefinitely. Several experts suggest that the species could be delisted. However, censuses at BIBE and BGWMA documented only 1,094 and 208 individuals, respectively, and the data from 4 small plots cannot be extrapolated to represent the size and trends of entire populations. (USFWS, 2018)

Threats and Stressors

Stressor: Present or threatened destruction, modification or curtailment of its habitat or range (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: McKinney (1998, p. 7) stated that habitats that were destroyed in the Terlingua-Lajitas area by past as well as current uses, such as development and off-road vehicles (ORVs), may never recover. Other protected habitats, such as BBNP, BGWMA, and large ranches that do not allow trespass, are secure. Some ranches do graze livestock, but due to the harsh terrain the threat of trampling is negligible. Porter and Prince (2011, p. 179) include commercial and residential development in the Lajitas-Terlingua area as potential threats, but the impacts of development on Lloyd's mariposa cactus have not been assessed. A possible consequence of development is increased use of ORVs, which can cause significant damage to habitats and populations in a single pass. This threat is likely to be limited to habitats closer to developed areas, and is of a limited extent. Livestock grazing may be a moderate threat in the northeast portion of the range, both from trampling and habitat degradation resulting from overgrazing (p. 180). Pesticides could affect individuals along highway ROWs as well as the species' pollinators. However, most Lloyd's mariposa cactus populations are far from areas of pesticide use, which is at most a moderate threat. (USFWS, 2018)

Stressor: Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2018)

Exposure:**Response:****Consequence:**

Narrative: McKinney (1998, pp. 6-7) has observed thousands of small Lloyd's mariposa cactus that were dug by poachers and left to die in the sun. However, the threat of collection has now diminished, and the plants are actively protected at BBNP and BGWMA. Populations on large ranches that do not allow trespass are also relatively secure. Porter and Prince (2011, p. 179) noted recent incidents involving the take of Lloyd's mariposa cactus from a protected area along a highway ROW. They conclude that the species will remain vulnerable to a persistent, low-grade threat of illegal collection. (USFWS, 2018)

Stressor: Disease or predation (USFWS, 2018)

Exposure:**Response:****Consequence:**

Narrative: Porter and Prince (2011, pp. 180-181) noted that black-tailed jackrabbits (*Lepus californicus*) and desert cottontails (*Sylvilagus auduboni*) may browse the tops of Lloyd's mariposa cactuses, exposing the soft inner tissues to opportunistic attack by snails or insects. Some herbarium specimens were infested with moth larvae or other parasites. Although parasitism of Lloyd's mariposa cactus by the cactus longhorn beetle (*Moneilema armata*) has not been documented, it is possible, but the degree of this threat cannot currently be assessed. Personnel of Big Bend National Park and USFWS observed increased mortality of Chisos hedgehog cactus (*Echinocereus chisoensis* ssp. *chisoensis*) individuals from herbivory at monitoring sites in March, 2016, following several years of exceptional drought (USFWS 2018, p.15). Both species occur at Big Bend National Park and are affected by the same climate and herbivore populations; therefore, we assume that herbivory of Lloyd's mariposa cactus also increases during drought. If droughts become more frequent as a result of climate changes, the impact of herbivory may also increase. (USFWS, 2018)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2018)

Exposure:**Response:****Consequence:**

Narrative: The ESA does provide some legal protection for federally-listed plants on land under federal jurisdiction, including the populations of Lloyd's mariposa cactus at Big Bend National Park. Beginning in 2007, USFWS and the U.S. Department of Homeland Security (DHS) interacted extensively regarding the proposed construction of a border wall along the Rio Grande in south and west Texas. A provision of the REAL ID Act of 2005 gives the Secretary of Homeland Security authority to waive other federal laws, including the ESA, in order to expedite construction of border barriers. Hence, the border wall project was exempt from consultation with USFWS under section 7 of the ESA. Nevertheless, DHS and USFWS have coordinated to establish best management practices for the federally listed plants and animals in the project impact area (U.S. Department of Homeland Security 2008). Additional border wall construction has been proposed by the current Administration. If implemented, the border wall and related infrastructure may affect populations and habitats of Lloyd's mariposa cactus that occur along the Rio Grande. - Chapter 88 of the Texas Parks and Wildlife Code lists plant species as state-threatened or endangered once they are federally-listed with these statuses. Lloyd's mariposa cactus was listed as threatened by the State of Texas on April 29, 1983. The State prohibits taking and/or

possession for commercial sale of all or any part of an endangered, threatened, or protected plant from public land. TPWD requires permits for the commercial use of listed plants collected from private land. Scientific permits are required for collection of endangered plants or plant parts from public lands for scientific or educational purposes. In addition to State endangered species regulations, other State laws may apply. State law prohibits the destruction or removal of any plant species from State lands, including BGWMA, without a TPWD permit. (USFWS, 2018)

Stressor: Demographic and genetic consequences of small population sizes (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: The federal listing states, “Low total population levels intensify the adverse effects of threats to the two plants [Lloyd’s mariposa cactus and bunched cory cactus] and their habitats.” (44 FR 64249). To assess this threat, Porter and Prince (2011, pp. 182-183) considered the scattered distribution, the range of population sizes, and the limited geographic range of Lloyd’s mariposa cactus. They note that smaller populations are vulnerable to extirpation from natural and human disturbance and random events, while large, remote populations are less vulnerable. Nevertheless, climate changes could affect the species throughout its range. Since individuals reach sexual maturity slowly, the species could not recovery quickly following losses. They concluded, “At the present time it is questionable whether population size represents a vulnerability for this species,” (pp. 182-183). Small, isolated plant populations are also vulnerable to genetic drift, loss of genetic diversity, and inbreeding depression. However, the population genetics of Lloyd’s mariposa cactus has not been investigated; we have no evidence of the extent of the actual impacts of these potential threats. (USFWS, 2018)

Stressor: Climate change (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: We do not know whether the climate changes that have already occurred have affected the populations or distribution of Lloyd’s mariposa cactus, nor can we predict how the species might be affected by the type and degree of climate changes forecast by the range of models. While many species have adapted to previous climate changes by migrating in latitude or elevation, it is unlikely that this species could migrate, without facilitation, fast enough to match the projected rate of climate change. Changes in temperature and rainfall amounts and patterns could have multiple effects that alter the species’ fitness in opposing ways. For example, hotter summers could increase mortality from drought, but warmer winters could reduce mortality from freezing. Regardless of how these changes may affect its autecology, the altered synecology may be more significant. For example, Lloyd’s mariposa cactus might benefit from more frequent or more severe droughts if it tolerates extended drought better than other plants that compete with it. Conversely, extended drought could reduce pollinator populations, resulting in pollen limitation and reduced reproductive output. At present, we cannot predict how the infinitely complex aggregation of climate changes will affect the synecology of Lloyd’s mariposa cactus populations and habitat. Therefore, we will continue to monitor the species’ status and will adapt our recovery and management strategies when necessary to address the changing conditions. (USFWS, 2018)

Recovery

Reclassification Criteria:

Not applicable. (USFWS, 1989)

Delisting Criteria:

1. Identify at least three sites where the species can be protected and then carry out protective management measures. One site should be on private land in northeastern Brewster County, one site should be in Big Bend National Park, and one site should be in Mexico. Each site should initially contain at least 1,000 plants, and should have enough available habitat to permit population expansion and growth. (USFWS, 1989)

2. Conduct management measures that are determined to be necessary for continued protection of the three sites and for the general protection of the species and its habitat. (USFWS, 1989)

3. Demonstrate long-term stability or increase in population levels and habitat through monitoring and habitat surveys. A total of 20,000 plants at protected and managed sites must be sustained. This figure is higher than might otherwise be needed because of the degree of collecting threat to this species. (USFWS, 1989)

Recovery Actions:

- 1. Remove threats to *Neolloydia mariposensis* by enforcement of existing regulations and management for protection. Because of the rarity of the Lloyd's Mariposa cactus, the populations must be protected by the enforcement of existing Federal and State regulations and by management to remove threats to the species. (USFWS, 1989)
- 2. Gather information for use in management. A thorough understanding of the population biology and ecology of Lloyd's Mariposa cactus is needed to help manage healthy natural populations. (USFWS, 1989)
- 3. Develop a comprehensive trade management plan for all cacti. Studies are needed to determine which species are in trade, the overall trend of trade in listed cacti, and the feasibility of reducing collecting pressure on wild populations by promoting a commercial program for artificial propagation. (USFWS, 1989).
- 4. Refine propagation techniques to provide nursery stocks and seeds, thereby reducing collecting pressure. The collecting pressure on natural populations could possibly be reduced by making plants commercially available through commercial propagation techniques. This task will be undertaken only if findings from the trade management plan indicate that increased commercial propagation is an advisable means of reducing collecting pressure on natural populations. (USFWS, 1989)
- 5. Establish populations at the botanical gardens of research institutions Even though plants in botanical gardens cannot substitute for healthy populations in natural habitats, a living collection could still contribute significantly to the overall recovery effort. Much information on ecological requirements and reproductive potential could be obtained most easily from a living collection. In addition, a permanent, well documented, and accessible living collection, together with appropriate seed banking, could provide an important source of material for non-destructive research, maintenance of wild populations, and public awareness. An adequate living collection would remove the necessity of repeatedly returning to wild populations to collect plants for various recovery projects. (USFWS, 1989)

- 6. Develop public awareness, appreciation, and support for preservation of the Lloyd's Mariposa cactus. Public education is a vital part of the recovery process. The cooperation of the public is essential for the ultimate success of many recovery measures. (USFWS, 1989).
- Recommendations for Future Actions from 2018 5-Year Review: To ascertain the degree to which the recovery criteria of Lloyd's mariposa cactus have been met, we recommend the following: - Develop efficient, quantitative, verifiable methods to estimate population sizes and trends using representative samples of potential habitats and valid statistical analyses. - Resolve the phylogenetic identity of the Coahuilan populations that were previously included in *Sclerocactus mariposensis*. (USFWS, 2018)
- Recommendations for Future Actions from 2018 5-Year Review: The most important recovery actions during the next five years include, but are not limited to, the following: - Revise the recovery plan and recovery criteria to incorporate updated guidance and specific, measurable recovery criteria, including the length of the monitoring period needed to detect demographic trends. Revise the population size criterion to the provisional minimum viable population level of 1,500 to 2,000 mature, reproductive individuals per metapopulation. - Continue to improve the potential habitat model as we learn more about the ecological requirements. - Explore the potential to conserve populations of Lloyd's mariposa cactus on private lands in Presidio, Brewster, and Terrell counties, Texas through private landowner agreements or other appropriate measures. - If at least some populations in Coahuila, Mexico are determined to be *S. mariposensis* (or *Echinomastus mariposensis*), communicate with Mexican agencies, non-profit conservation organizations, and academic institutions to promote their conservation and management. - Investigate the population genetics to determine the genetic structure, genetic diversity and extent of inbreeding, evidence of gene flow, and other parameters that will be useful in the conservation and recovery of Lloyd's mariposa cactus. (USFWS, 2018)

Conservation Measures and Best Management Practices:

- *Neolloydia mariposensis* is on the Texas State protected plant list. Under Texas law, a scientific collecting permit is required for plant collection on State lands; permits are issued only for scientific or educational activities that benefit the species. Collection from private lands for commercial purposes requires written permission from the landowner and a State commercial collecting permit. Each field collected plant must be tagged and the tag must stay attached until the plant reaches its ultimate destination (USFWS, 1989).

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SPECIES ACCOUNT: *Enceliopsis nudicaulis* var. *corrugata* (Ash Meadows sunray)

Species Taxonomic and Listing Information

Listing Status: Threatened; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

Enceliopsis nudicaulis var. *corrugata* is a perennial plant in Asteraceae (sunflower family) that forms clumps 3.9 to 15.7 inches (in) (10 to 40 centimeters (cm)) high that rise from a stout, woody root-stock (Mozingo and Williams 1980, p. 21). The varietal name *corrugata* refers to leaf margins that are strongly ruffled-corrugate, especially towards the margins (Cronquist 1972, p. 246; Mozingo and Williams 1980, p. 21). The ray flowers are yellow and number 11 to 23. (USFWS, 2011)

Historical Range

See current range/distribution.

Current Range

Enceliopsis nudicaulis var. *corrugata* is endemic to the Ash Meadows area of Nye County, Nevada. The range of *E. nudicaulis* var. *corrugata* encompasses the Ash Meadows National Wildlife Refuge (Refuge) and adjacent Bureau of Land Management's (BLM) Ash Meadows Area of Critical Environmental Concern (ACEC) and private lands. (USFWS, 2011)

Critical Habitat Designated

Yes; 5/20/1985.

Legal Description

On May 20, 1985, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Enceliopsis nudicaulis* var. *corrugata* (Ash Meadows sunray) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat units (CHU), in Nevada (50 FR 20777-20794).

Critical Habitat Designation

The critical habitat designation for *Enceliopsis nudicaulis* var. *corrugata* includes one CHU in Nye County, Nevada (50 FR 20777-20794).

Nevada, Nye County, Ash Meadows.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Enceliopsis nudicaulis* var. *corrugata* critical habitat consists of one component (50 FR 20777-20794):

Known primary constituent elements include dry washes or whitish saline soil associated with outcrops of pale whitish limestone.

Life History**Food/Nutrient Resources****Dependency on Other Individuals or Species**

Adult: Enceliopsis nudicaulis var. corrugata flowers attract at least 21 floral visitors, 19 which are bee taxa (BIO-WEST 2009, pp. 2-5). (USFWS, 2011)

Breeding Season

Adult: March to May (USFWS, 2011)

Reproduction Narrative

Adult: Inflorescence buds begin developing in February and flowers open from late March to late May (Mozingo and Williams 1980, p.21; Pavlik and Moore 2010, p. 51). Enceliopsis nudicaulis var. corrugata flowers attract at least 21 floral visitors, 19 which are bee taxa (BIO-WEST 2009, pp. 2-5). In 2008, the average E. nudicaulis var. corrugata plant output was 12.7 inflorescences and 11.5 infructescences; while in 2009, plant output averaged 18.5 inflorescences and 15.5 infructescences (Pavlik and Moore 2010, p. 52). Inflorescences that developed earlier in the season produced significantly more seeds than those developing later (Pavlik and Moore 2010, p. 52). Plants approximately produced 17.4 mature seeds per bud (Pavlik and Moore 2010, p. 88, Table 16). (USFWS, 2011)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Alkali shrub-scrub, salt desert scrub, desert pavement, pale limestone outcrops, dry washes, spring and seep areas (USFWS, 2011)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 617 to 719 m (2,200 to 2,360 ft) (USFWS, 2011)

Environmental Specificity

Adult: Narrow/specialist

Habitat Narrative

Adult: Enceliopsis nudicaulis var. corrugata occurs between 2,200 and 2,360 feet (ft) (671 and 719 meters (m)) above mean sea level and occurs across a broad range of Refuge habitats including occasionally moist alkaline soils, spring and seep areas, and dry desert washes (Morefield 2001, p. 1; BIO-WEST 2011, p. 113). Enceliopsis nudicaulis var. corrugata most often occupies intermittently flooded to upland mesic Alkali Shrub-Scrub habitat in alkali-clay soil and is occasionally a component of Salt Desert Scrub and Desert Pavement (embedded, tightly packed gravel) habitats (BIO-WEST 2011, p. 113). (USFWS, 2011)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Low (inferred from USFWS, 2011)

Representation:

Low (inferred from USFWS, 2011)

Redundancy:

Low (inferred from USFWS, 2011)

Number of Populations:

30 (USFWS, 2011)

Population Size:

79,508 (USFWS, 2011)

Adaptability:

Low (inferred from USFWS, 2011)

Population Narrative:

Results from the 2008-2010 Refuge wide survey (BIO-WEST 2011, p. 114) estimate that 79,508 individuals are present on the Refuge in 30 minimum scale occurrences (0.1 mi (0.16 km) distance) or 1 maximum scale occurrence (0.6 mi (1 km) distance). (USFWS, 2011)

Threats and Stressors

Stressor: Groundwater withdrawal (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The Refuge encompasses over 23,000 ac (9,172 ha) of spring-fed wetlands and alkaline, desert uplands. More than 50 seeps and springs occur on the Refuge. At the time of listing, groundwater withdrawal was a major threat to the entire Ash Meadows ecosystem. Local groundwater pumping at Ash Meadows (prior to the establishment of the Refuge) was responsible for the destruction of many populations of plants and animals and their wetland habitats. *Enceliopsis nudicaulis* var. *corrugata* depends on near-surface water for its survival; therefore, it is reasonable to conclude that additional declines in groundwater levels in the Ash Meadows area (e.g., due to groundwater pumping) would negatively affect populations of this species. A number of measures have been implemented since the 1970's that, in part, have reduced the risk of groundwater level declines at the Refuge. The significance of the remaining threat posed by groundwater pumping will be evaluated below with respect to each of these measures. (USFWS, 2011)

Stressor: Road construction (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: At the time of listing, *Enceliopsis nudicaulis* var. *corrugata* population numbers had been reduced by the loss of habitat from road construction. Since listing, the Service has ceased road construction and maintains only defined Refuge roads that allow for administrative, visitor, and private landowner access. Truckers often use Refuge roads to avoid the need to obtain permits required to transport loads through California (Service and DOT 2011, p. 27). A transportation study is being completed by the Refuge to identify transportation improvements and management strategies, improve safety, reduce operations and maintenance costs, ensure accessibility, and address traffic circulation needs (Service and Department of Transportation (DOT) 2011, pp. 1-98). Due to ceased road construction and initiation of a transportation study, road construction is no longer a threat to *Enceliopsis nudicaulis* var. *corrugata*. (USFWS, 2011)

Stressor: Off-highway vehicle (OHV) activity (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Prior to listing, OHV activity was a threat to *Enceliopsis nudicaulis* var. *corrugata*. OHV races were permitted on BLM land in the Ash Meadows area. Since listing, OHV activity is prohibited on the Refuge and has been limited by the construction of fencing around the perimeter of the Refuge in 1995 (Service 2006, pp. 9, 103). Periodically, illegal OHV activity, likely due to downed sections of fencing and fence cutting, occurs on the Refuge (Baldino, pers. comm. 2010). Within the BLM ACEC, OHV activity is confined to existing roads, trails, and dry washes (BLM 1998a, Chapter 2 p. 2-32; Map 2-10). Signs and fences are not present to designate the BLM ACEC from the other bordering BLM land, making it unclear to the public that the BLM land surrounding the Refuge has a special ACEC designation (Baldino, pers. comm. 2010). Due to the periodic illegal OHV activity on the Refuge and undefined ACEC designation, OHV activity is still a threat to *Enceliopsis nudicaulis* var. *corrugata*. (USFWS, 2011)

Stressor: Trampling by resident wild and free-roaming horses (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The final listing rule described trampling by wild and free-roaming horses as a threat to *Enceliopsis nudicaulis* var. *corrugata*. Since then, in 1995, a fence was constructed around the perimeter of the Refuge (Service 2006, pp. 9, 103). As a result, wild horse activity on the Refuge was stopped. In 1998, the BLM established the Ash Meadows ACEC that surrounds the Refuge and established the appropriate management level (AML) for wild horses as zero (BLM 1998b, p. 7 Table 2-5). Fences are not present to keep horses out of the designated ACEC and they have been seen infrequently near the area (Baldino, pers. comm., 2011). Thus, inspection and maintenance of the exclusionary fence on the Refuge is necessary to prevent re-invasion (Service 2006, p. 99). Due to these positive management practices, trampling by wild and freeroaming horses is no longer a threat to *E. nudicaulis* var. *corrugata* on the Refuge, but occasionally may be a threat to *E. nudicaulis* var. *corrugata* within the BLM ACEC. (USFWS, 2011)

Stressor: Non-native plant species (USFWS, 2011)

Exposure:**Response:****Consequence:**

Narrative: Since listing, non-native plants species have been identified as a threat to *Enceliopsis nudicaulis* var. *corrugata*. An estimated 42 percent of all species listed under the Act are considered to be at risk primarily due to non-native species (Pimental et al. 2005, p.1). Non-native plants directly compete with native plants for water, nutrients, and sunlight and indirectly by altering ecosystem processes such as hydrology, productivity, nutrient cycling, and fire regime (D'Antonio and Vitousek 1992, pp.63-87; Levine et al. 2003, pp. 775-781; Brooks et al. 2004, pp.677-688). Approximately 100 non-native species occur on the Refuge; 66 of them non-native plant species (Service, 2006, p. 7, pp. 52-53). Of these *Tamarix ramosissima* Ledeb. (saltcedar), *Acroptilon repens* (L.) DC. (Russian knapweed), *Bassia hyssopifolia* (Pall.) Kuntz (fivehorn smotherweed), *Centaurea melitensis* L. (Malta starthistle), and *Bromus rubens* L. (red brome) could potentially threaten *E. nudicaulis* var. *corrugata*. (USFWS, 2011)

Stressor: Wildfire (USFWS, 2011)

Exposure:**Response:****Consequence:**

Narrative: Since listing, nine wildfires have burned on the Refuge (Sunderman and Weisburg 2011, p. 3). The three largest wildfires (Fairbank fire in 2000 which was 744 ac (301 ha); Longstreet fire in 2004 which was 1,401 ac (567 ha); and Meadows fire in 2005 which was 267 ac (108 ha) were all partially in *Enceliopsis nudicaulis* var. *corrugata* habitat and burned prior to initiation of weed treatments in non-native plant species patches of *Tamarix ramosissima*. Non-native plant species alter ecosystem dynamics such as fire regimes. For example, on the Refuge, *Bromus rubens* is an annual, nonnative grass, that could increase its dominance on the landscape under climate change predictions. In turn, this would increase the density of fine fuels and create an environment more susceptible to fire (Chambers and Pellant 2008, p. 31). With the exhaustion of SNPLMA funding for non-native plant species treatments and opportunity for them to re-invade, wildfire frequency may increase through alteration of the fire regime. In addition, non-native plant species such as *Bromus rubens* could invade sparsely vegetated *Enceliopsis nudicaulis* var. *corrugata* habitat, thus providing a vector to carry fire into a habitat that may have less tendency to burn. The threat of wildfire is not easily accessed and is dependent on many other factors, thus we conclude that it is a potential threat to *E. nudicaulis* var. *corrugata*. (USFWS, 2011)

Stressor: Surface mining (USFWS, 2011)

Exposure:**Response:****Consequence:**

Narrative: The Refuge is located in the Ash Meadows mining district (Tingley 1998, p. 20), which has the largest clay production of any district in Nevada (BLM 1998a, p. 3-75). At the time of listing, surface mining was identified as a threat to two other listed plant species, *Grindelia fraxinoprattensis* and *Astragalus phoenix*. Surface mining also poses a threat to *Enceliopsis nudicaulis* var. *corrugata* which co-occurs in many places with *A. phoenix*. Currently, only mining for clay minerals occurs in the Ash Meadows area. The playa sediments covering much of the Refuge contain clays and other minerals that could be classified as locatable minerals under the Mining Law of 1872, as amended (BLM and Service 2000, p. 3-1). Under the Mining Act of 1872,

surface disturbance and impacts to rare species that do not have Federal protection are permissible as long as operations comply with all pertinent Federal and State laws. New mineral claims and mining could cause direct loss of *E. nudicaulis* var. *corrugata* habitat as well as indirect impacts due to diverting or draining water from occupied habitat. (USFWS, 2011)

Stressor: Solar development (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Since listing, solar development has been identified as a threat to *Enceliopsis nudicaulis* var. *corrugata*, specifically due to impacts from groundwater withdrawal. The Amargosa Valley has been selected as a Solar Energy Zone (SEZ) to be evaluated for its environmental and resource sustainability for larger-scale solar energy production (Department of Interior (DOI), 2009, p. 1). The Refuge is located about 20 mi (32 km) southeast of the SEZ (DOE/EIS 2010, pp. 11.1-21). The SEZ is a proposed area of 31,625 acres (12,798 ha) and maximum solar development of this area is assumed to be 80 percent over a period of 20 years on 25,300 ac (10,239 ha) (DOE/EIS 2010, pp. 11.1-1 to 11.1-3). In November 2010, the BLM approved the construction of the first solar project in the SEZ: Solar Millennium, LCC on Amargosa Farm Road. This project is on 6,320 ac (2,558 ha) of land and will use dry-cooled technology. Total annual operational water usage is 400 ac-ft (493,393 m³) per year, but will require 600 ac-ft (740,089 m³) a year during construction (BLM 2010b, p.4; Service 2010a, p. 4). Application 79699 is an application for a change in the manner of use and place of use of 400 ac-ft under existing Permit 15893 (Certificate 5717). Changing the use of 400 ac-ft (493,393 m³) per year of water from irrigation to industrial use for this solar project and the solar projects that will follow is likely to have an impact on the groundwater supply. Agricultural water use allows some water to percolate back into the groundwater system (return flow). Water used for industrial utility-scale solar energy production likely will evaporate and not recharge to the aquifer. Additionally, no significant return flow is anticipated from solar mirror washing operations or other water uses given the average low humidity and high temperatures in the Mojave Desert. Small declines in spring discharge, changes in water temperature, and adjustments in soil or water chemistry resulting from solar projects groundwater withdrawals in the basin would negatively affect *Enceliopsis nudicaulis* var. *corrugata*. (USFWS, 2011)

Stressor: Predation (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Pavlik and Moore (2010, pp. 38, 52) noted that both jackrabbit (*Lepus californicus*) and insect herbivory had a dramatic effect on *E. nudicaulis* var. *corrugata*. 6.7 percent of marked *E. nudicaulis* var. *corrugata* plants in 2008 and 51.7 percent of marked *E. nudicaulis* var. *corrugata* plants in 2009 had inflorescences removed by jackrabbits, as evidenced by droppings around affected plants (Pavlik and Moore 2010, p. 52). In addition, insect achene predators severely damaged 91.7 percent of infructescences in 2008 and 78.3 percent of infructescences in 2009 (Pavlik and Moore 2010, p. 52). (USFWS, 2011)

Stressor: Stochastic events (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Small, endemic populations with limited geographic distribution like *Enceliopsis nudicaulis* var. *corrugata* have a higher risk of extinction due to demographic and environmental uncertainty and natural catastrophes (Shaffer 1987, pp. 69-75; Lande 1993, pp. 911-927). *Enceliopsis nudicaulis* var. *corrugata* is known only from the Ash Meadows area. All mapped occurrences of *E. nudicaulis* var. *corrugata* are restricted to the Refuge. Drought and wildfire are the most likely stochastic events that could adversely affect *E. nudicaulis* var. *corrugata*, as this species is dependent on groundwater and moisture retained in the soil and susceptible to being destroyed by a single, large fire. We conclude that stochastic events are a threat to *E. nudicaulis* var. *corrugata*. (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: *Enceliopsis nudicaulis* var. *corrugata* is dependent on the springs and seeps of the Refuge. The potential effects of climate change on the regional aquifer system that supports *E. nudicaulis* var. *corrugata* are unclear. Current climatic models are predicting warmer air temperatures due to elevated levels of atmospheric carbon dioxide and increased drought and flood frequency (Intergovernmental Panel on Climate Change (IPCC) 2007, pp. 2-3). Other effects of climate change include, but are not limited to, changes in types of precipitation (Knowles et al. 2006, p. 4557), earlier spring run-off (Stewart et al. 2005, p. 1152), longer and more intense fire seasons (Chambers and Pellant 2008, pp. 31-32), increases in exotic species invasions (Hawkins et al. 2008, p. 37; Bradley et al. 2010, pp. 310-318), and more frequent extreme weather events (IPCC 2007, p. 13). The springs and surface streams that support *Enceliopsis nudicaulis* var. *corrugata* are perennial and originate from a regional aquifer that includes runoff from the Spring Mountains approximately 100 mi (161 km) northeast (USGS 2003, pp. 7-9). As a result of warming, more winter precipitation is falling as rain, and has altered spring stream flow. Snowmelt driven stream flow in spring is about 10 to 15 days earlier than 50 years ago, which increases the frequency of drought by decreasing groundwater recharge and summer water reserves (IPCC 2007; Chambers and Pellant 2008, p. 30). Increasing temperatures and drought frequency could adversely affect *Enceliopsis nudicaulis* var. *corrugata* by causing physiological stress, altering phenology, reducing recruitment events and seedling establishment, and altering fire frequencies. At this time, it is difficult to predict local climate change impacts to *E. nudicaulis* var. *corrugata*; thus, while the information indicates that climate change has the potential to affect and threaten its ecosystem in the long-term, there is much uncertainty regarding the attributes that could be affected and their timing, magnitude, and rate of change. (USFWS, 2011)

Recovery**Reclassification Criteria:**

1. All non-native animals and plant species must be eradicated from essential habitat. These non-native species currently include sailfin mollies, mosquitofish, largemouth bass, black bullheads, bullfrogs, crayfish, turban snails, wild horses, salt cedar, and Russian olive. (USFWS, 2011)

2. Secure and protect the Ash Meadows aquifer so that all spring flows return to historic discharge rates, and the water level in Devil's Hole is maintained at a minimum level of 1.4 feet below the copper washer. (USFWS, 2011)

3. The essential habitat must be secure from detrimental human disturbances including mining, OHVs, and introduction of non-native species. (USFWS, 2011)

Delisting Criteria:

1. Criteria shown above for downlisting from endangered to threatened. (USFWS, 2011)

2. Secure, protect, and maintain in natural vegetation corridors and adjacent buffer areas for gene flow and dispersal of listed plants within the essential habitat. (USFWS, 2011)

3. Native plant communities and aquatic communities have been reestablished to historic structure and composition within all essential habitats. (USFWS, 2011)

4. All of the listed plant species and the four candidate plants species are present in all the sites that they have historically occupied as identified in Appendix A, Table XV, and within each critical habitat unit, the listed plant has a frequency value equal to or greater than the frequency value determined by Task 644 needed as an indicator of a self-sustaining plant population. (USFWS, 2011)

Recovery Actions:

- Secure habitat and water sources for the Ash Meadows ecosystem. (USFWS, 1990)
- Conduct research on the biology of the species. (USFWS, 1990)
- Conduct management activities within essential habitat. (USFWS, 1990)
- Reestablish populations/monitor new & existing populations. (USFWS, 1990)
- Determine/verify recovery objectives. (USFWS, 1990)

Conservation Measures and Best Management Practices:

- The Recovery Plan should be updated using the most recent and best scientific management information available. (USFWS, 2011)
- Surveys for Ash Meadows threatened and endangered plant species, including *Enceliopsis nudicaulis* var. *corrugata*, should be performed in the BLM ACEC to determine species occurrences and habitat locations. In addition, habitat surveys around roads, trails, and dry washes will verify the impact OHV activity has on this species population. (USFWS, 2011)
- Research on the life history strategies of *Enceliopsis nudicaulis* var. *corrugata* should be prioritized. Research should focus on demography, recruitment events, and seed longevity in the seed bank. (USFWS, 2011)
- Seed from all listed plant species, including *Enceliopsis nudicaulis* var. *corrugata*, on the Refuge should be collected and stored for ex situ conservation. Ex situ studies of seed and seedling biology should be conducted to enhance germination and propagation techniques. (USFWS, 2011)
- Additional research is needed on the sensitivity and requirements of the species on groundwater and soil moisture throughout the growing season. (USFWS, 2011)
- The Refuge is implementing many restoration projects that could benefit *Enceliopsis nudicaulis* var. *corrugata*; however minimal monitoring specific to listed plants is conducted. To document

recovery of listed plants, these projects should include pre and post site sampling to verify and quantify the restoration actions as benefiting the species. (USFWS, 2011)

- Environmental analyses on new solar projects in Amargosa Valley should include detailed assessments of the potential effects on the springs and groundwater table within the Refuge. The Service should participate in the review of these documents to ensure that they adequately disclose all potential impacts to *Enceliopsis nudicaulis* var. *corrugata* and the Ash Meadows ecosystem. (USFWS, 2011)
- Long-term funding should be secured for long-term non-native plant species treatments on the Refuge. (USFWS, 2011)
- Mineral rights should be purchased or transferred for perpetuity to the Service or a program needs to be established to renew the mineral withdrawal every 20 years. In addition, existing mining claims should be acquired whenever possible. (USFWS, 2011)
- Property and rights, such as conservation easements, should be acquired on private property that likely contains listed plant species. (USFWS, 2011)
- Research and develop a jackrabbit exclusion study to determine the impacts jackrabbits are having on reproduction of *Enceliopsis nudicaulis* var. *corrugata*. If a significant affect to *E. nudicaulis* var. *corrugata* is found, a jackrabbit control plan should be established. (USFWS, 2011)

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SPECIES ACCOUNT: *Eremalche kernensis* (Kern mallow)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

Annual herb, with erect stem about two to four inches high; white to rose-pink or lavender hollyhock-like flowers (Fish and Wildlife Service 1990). (NatureServe, 2015)

Taxonomy

Treated as *Eremalche kernensis* by some, including the USFWS. The distinctiveness of this taxon is in question (Roxanne Bittman, California Natural Diversity Database, June 2000). (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

California endemic, occurring only in Kern County (Skinner 1997). (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Habitat Type

Adult: Grasslands (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits chenopod scrub, valley and foothill grassland; 70-1000 m (Skinner 1997). (NatureServe, 2015)

Dispersal/Migration

Population Information and Trends

Number of Populations:

6 - 20 (NatureServe, 2015)

Population Narrative:

Known from fewer than twenty occurrences (Skinner 1997). (NatureServe, 2015)

Threats and Stressors

Stressor: Climate change (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: Climate change is a potential threat to *E. kernensis*. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects (USFWS, 2013).

Stressor: Effects of nitrogen deposition (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: Nitrogen is considered a limiting factor in the soils of many terrestrial ecosystems. Nitrogen deposition “hotspots” have been identified downwind of large and expanding metropolitan centers and large agricultural operations in California. Increased soil nitrogen from anthropogenic sources such as automobile exhaust, can lead to increased plant productivity in Nlimited soils. In areas where non-native nitrophilic (i.e., nitrogen-loving) plants have been introduced (such as *Bromus madritensis* ssp. *rubens* or red brome), this increased productivity can result in competitive exclusion, whereby the faster growing nitrophilic species out-compete the native vegetation. Smaller-statured forbs (like *E. kernensis*) can be particularly vulnerable. The increased productivity of non-native annual grasses can also lead to increased fire frequency due to the build-up of fuel. The habitats in which *Eremalche kernensis* occurs are not fire-adapted, and the native vegetation does not recover quickly after burning (USFWS, 2013).

Stressor: Grazing and competition (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: Grazing and competition from non-native plant species are threats to the species, although grazing, when done appropriately, may be an important tool in eliminating competition from both non-native and native competitors of *Eremalche kernensis*(USFWS, 2013).

Stressor: Habitat destruction and modification (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: Threats to habitat of *Eremalche kernensis* include conversion to agriculture (including grazing) and urbanization (on privately owned lands); the occurrences on public lands are protected from direct effects of urbanization and agricultural land conversion, but in some areas are still subject to other threats including oil and gas exploration and conveyance, solar power developments, off-road vehicle use and mineral exploration and extraction (USFWS, 2013).

Stressor: Potential loss of pollinators (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: While it is unknown whether honeybees specifically function as pollinators of *E. kernensis*, if the causes of colony collapse disorder result in a decline in any *E. kernensis* pollinators, the species’ genetic diversity could be further reduced (USFWS, 2013).

Recovery**References**

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5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, CA. 73 pp.

SPECIES ACCOUNT: *Eriastrum densifolium* ssp. *sanctorum* (Santa Ana River woolly-star)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/28/1987; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

Eriastrum densifolium subsp. *Sanctorum* is a subshrub occasionally reaching 1 m (3.3 ft) in height. Plants have gray-green stems and leaves. The light gray-green leaves generally curve upward. The leaves are irregularly divided to the midrib in 2 to 6 narrow lobes and are up to 50 mm (2 in) long (Patterson 1993, p. 826). The bright blue funnel-shaped flowers are usually longer than 25 mm (1.0 in), but may be up to 30 mm (1.4 in) long or occasionally as short as 20 mm (0.8 in). The petals of the flowers (corolla) are lavender-blue becoming pinkish-purple with age (Munoz 1991). The congested inflorescences (flower stalks) contain 20 flowers each. The seeds are contained in capsules. (USFWS, 2010)

Taxonomy

Four other subspecies of *Eriastrum densifolium* have been recognized. A key feature that distinguishes *E. d.* subsp. *Sanctorum* from other subspecies is the length of the tube forming the base of the corolla that is up to 30 mm (1.2 in); corolla tube lengths in the other subspecies do not exceed 20 mm (0.8 in) (Patterson, 1993). (USFWS, 2010)

Historical Range

Historically, *E. d.* subsp. *sanctorum* occupied about 110 km (60 mi) of habitat along the Santa Ana River from elevations of about 150 m (500 ft) in the vicinity of Santa Ana Canyon in Orange County up to about 600 m (2,000 ft) at the base of the San Bernardino Mountains, through Riverside County (USFWS 1987, p. 36266). *Eriastrum densifolium* subsp. *sanctorum* may have occupied alluvial fan sage scrub habitats in Orange County as far downstream as Santiago Canyon (Craig 1934, p. 390; Mason 1945, p. 75; Zembal and Kramer 1984, p. 2). The subspecies is considered extirpated from Orange County and Riverside County (Zembal and Kramer 1985, p. 3; USFWS 1987, p. 36268). At listing, *Eriastrum densifolium* subsp. *sanctorum* occurred in isolated stands along the Santa Ana River in San Bernardino County between 360 and 600 m (1,200 and 2,000 ft) in elevation. (USFWS, 2010)

Current Range

Eriastrum densifolium subsp. *sanctorum* is endemic to the Santa Ana River drainage of southern California. Since listing, 12 new occurrences were detected, and *Eriastrum densifolium* subsp. *sanctorum* was also rediscovered within Riverside County just downstream of the border with San Bernardino County. (USFWS, 2010)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (self-incompatible) (USFWS, 2010)

Lifespan

Adult: 5 to 10 years (USFWS, 2010)

Dependency on Other Individuals or Species

Adult: Many species of insects and birds visit *Eriastrum densifolium* subsp. *sanctorum* flowers, but pollination is effected by comparably few of these. The primary pollinators include the solitary digger bee (*Micranthophora flavocincta*), giant flower-loving fly (*Rhaphiomidas acton* subsp. *acton*), California bumblebee (*Bombus californicus*), white-lined sphinx moth (*Hyles lineata*), black-chinned hummingbird (*Arhilochus alexandri*), and Anna's hummingbird (*Calypte anna*) (Muñoz 1991, p. 59). (USFWS, 2010)

Breeding Season

Adult: May to August (USFWS, 2010)

Reproduction Narrative

Adult: *Eriastrum densifolium* subsp. *sanctorum* flowers between May and August but most heavily in June (Muñoz 1991, p. 22). In artificial crossing experiments, self-pollination produced negligible fruit or seed set, indicating that *E. d.* subsp. *sanctorum* is self-incompatible (Muñoz 1991, p. 9; Brunell 1999, p. 250). Many species of insects and birds visit *Eriastrum densifolium* subsp. *sanctorum* flowers, but pollination is effected by comparably few of these. The primary pollinators include the solitary digger bee (*Micranthophora flavocincta*), giant flower-loving fly (*Rhaphiomidas acton* subsp. *acton*), California bumblebee (*Bombus californicus*), white-lined sphinx moth (*Hyles lineata*), black-chinned hummingbird (*Arhilochus alexandri*), and Anna's hummingbird (*Calypte anna*) (Muñoz 1991, p. 59). *Eriastrum densifolium* subsp. *sanctorum* plants have an average life span of approximately 5 years with some plants surviving at least 10 years (Burk et al. 1998, p. 21). (USFWS, 2010)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Chaparral, coastal scrub (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Flooding provides habitat and seed dispersal (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: Prefers low annual cover, well-lighted areas with slight surface disturbance; found at elevations below 600 m (2,000 ft) (USFWS, 2010)

Spatial Arrangements of the Population

Adult: Patchy (USFWS, 2010)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Habitat Narrative

Adult: *Eriastrum densifolium* subsp. *sanctorum* thrives in open, well-lighted areas of sand alluvial terraces, where shrublands persist between infrequent flood events (Zembal and Kramer 1984, p. 8; Wheeler 1988, p. 3; Burk et al. 1998, p. 20). The perennial vegetative cover is relative low (seldom over 50%); annual cover is also fairly low (Zembal and Kramer 1984, p. 4). This species is found in disjunct stands within this habitat and tends to occupy areas with slight disturbance (Zembal and Kramer 1984, p. 4). *Eriastrum densifolium* subsp. *sanctorum* is known to occur patchily on the higher floodplain terraces. *E. d. ssp. sanctorum* colonizes washed sand deposits created by sporadic stream flow action and its habitat is maintained by periodic flooding, scouring, and sediment deposition (Wheeler 1998, p. 16). It thrives in nutrient poor sands of early seral stage habitat that have more than 97% sand particles. *Eriastrum densifolium* subsp. *austromontanum* occurs at elevations from 1,200 to 1,800 m (4,000 to 8,000 ft). Most commonly associated perennial plants include *Eriogonum fasciculatum*, *Eriodictyon trichocalyx*, *Croton californicus*, and *Lepidospartum squamatum* (Zembal and Kramer 1985). (USFWS, 2010)

Dispersal/Migration**Dispersal**

Adult: Typically low, but may be high during flooding events (USFWS, 2010)

Dispersal/Migration Narrative

Adult: Dispersal of *Eriastrum densifolium* subsp. *sanctorum* seed is limited in the absence of flooding. The majority of seeds fall within 0.3 m (1 ft) of the parent plant and the wetted seed coat forms a mucilaginous mass that readily attaches the seed to the surrounding soil particles (Burk et al. 1989, p. 21). Those seeds not immediately shed from the fruits are retained within capsules that may remain on the plant for several seasons (Wheeler 1991, p. 116). In times of flooding, seeds or capsules may be transported down the floodplain for some distance, thereby facilitating some gene flow between populations. (USFWS, 2010)

Population Information and Trends**Population Trends:**

Long-term trends indicate a rapid decline of 70 to 90%, while short-term trends suggest a decline of 50 to 70% (NatureServe, 2015)

Resiliency:

Moderate (inferred from USFWS, 2010)

Representation:

Low (inferred from USFWS, 2010)

Redundancy:

Low (inferred from USFWS, 2010)

Number of Populations:

21 occurrences (USFWS, 2010)

Population Size:

12,400 but this may easily be an overestimate (NatureServe, 2015)

Population Narrative:

There are 21 extant occurrences of *Eriastrum densifolium* subsp. *sanctorum*. CNDDDB has 12,400 plants recorded from the extant sites, but this may easily be an overestimate due to underreporting of fragmented, degraded and extirpated sites. Trends suggest a long-term rapid decline of 70-90% and a short-term decline of 50 to 70%. (USFWS, 2010; NatureServe, 2015)

Threats and Stressors

Stressor: Floodplain development (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: At listing, urban and agricultural development was identified as a threat impacting habitat occupied by *Eriastrum densifolium* subsp. *sanctorum* (USFWS 1987, p. 36269). Prior to listing, the Devore occurrence (EO 15) was extirpated by agricultural development and discing (CNDDDB 2010a, p. 9). Since listing, additional mainstem and tributary occurrences across the species distribution in San Bernardino, Riverside, and Orange Counties have been directly impacted or extirpated by development related activities: Verdemon (EO 18) in Cajon Creek Wash may have been eliminated when disced in 2005; Highland Avenue (EO 3) in Lytle Creek Wash was extirpated by construction of California Freeway 210 (Foothill Freeway); Jensen Quarry (EO 27) in Sunnyslope was extirpated by construction of the Oak Quarry Golf Club; and the sole Orange County occurrence, Weir Canyon Road (EO 2), may have been extirpated by construction of a nearby subdivision (CNDDDB 2010a, p. 220). Adverse effects from development continue to be a threat to *E. d.* subsp. *sanctorum* occurrences, and impacts from current and planned development projects in the Santa Ana River floodplain habitat. These developments within the floodplain impact the species by displacing it from limited suitable habitat. Floodplain development projects also affecting the hydrological regime. (USFWS, 2010)

Stressor: Aggregate mining (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: At listing, aggregate mining was identified as a threat impacting habitat occupied by *Eriastrum densifolium* subsp. *sanctorum* (USFWS 1987, p. 36268). Aggregate mining activities directly eliminate habitat and can degrade or fragment suitable habitat. Mining operations were quite active at the time of listing and impacted over 1,500 acres (ac) (600 hectares (ha)) of the Santa Ana River wash according to accounts shortly after listing (USFWS 1998, p. 3837). Since listing, threats associated with aggregate mining remain a threat at many mainstem and tributary occurrences. There are mining activities indicated as threats near 4 of the 21 occurrences: Institution Road North (EO 33), Institution Road South (EO 4), and Line Avenue (EO 20) in Cajon Creek Wash, and Santa Ana Wash (EO 5) on the Santa Ana River mainstem (CNDDDB 2010). Though no new aggregate mining is currently planned for the Santa Ana River mainstem, the level of impact to *Eriastrum densifolium* subsp. *sanctorum* associated with ongoing aggregate mining is unknown. (USFWS, 2010)

Stressor: Alteration of hydrology (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: At listing, it was predicted that Seven Oaks Dam would greatly reduce peak flow volumes and sediment loads that would drastically reduce the frequency of scouring and depositional events in the floodplain and allow most of the alluvial fan sage scrub communities on the Santa Ana River Wash to succeed to a uniform mature phase, reducing the seedling establishment of *Eriastrum densifolium* subsp. *sanctorum* in downstream habitats (USFWS 2008, p. 3). Absence of these scouring and depositional events could preclude all but the mature seral stages in the alluvial fan sage scrub. Since listing, this subspecies continues to be threatened rangewide by floodplain modifications that alter hydrology, which directly and indirectly eliminate or impair habitat function. The habitat of the Santa Ana River and its tributaries receives little natural disturbance. Sheet flood flows probably occur once every 100 to 200 years and the scouring of such flows appear to maintain the alluvial fan scrub vegetation (USFWS 1986, p. 12181). Flood events are now confined to trenches and channels in Lytle Creek and the Santa Ana River, replacing the alluvial floodplain and the associated alluvial terraces. Constructed flood control channels prevent water from flowing out onto adjacent banks, providing the scouring and redeposition needed by *Eriastrum densifolium* subsp. *sanctorum*. The deeper water in these channels serves to increase the flow velocity and increases channel incision with less alluvial deposition. Flood control channels serve to promote mature successional stages of alluvial fan sage scrub, which provides poor establishment potential for *E. d.* subsp. *sanctorum* (Wheeler 1991, p. 56). Six occurrences are affected by grading for flood control: Line Avenue (EO 20), Santa Ana Wash (EO 5), Riverside Avenue (EO 21), Alamo Street (EO 22), Fairmont Park Golf Course (EO 24), and Weir Canyon Road (EO 2). Additionally, the construction of Seven Oaks Dam has removed much of the fluvial dynamics from the mainstem of the Santa Ana River and precludes natural scouring and deposition in the future. As discussed in the Habitat section above, the inhibition of flooding events allows for the seral maturation of the alluvial fan sage scrub. This mature scrub then inhibits the establishment of *E. d.* subsp. *sanctorum* seedlings, which could ultimately lead to local extirpations. All 14 occurrences on the Santa Ana River are adversely impacted by altered hydrology resulting from the Seven Oaks Dam. In all, 15 of the 21 extant occurrences are threatened by alterations of hydrology. (USFWS, 2010)

Stressor: Off-highway vehicles (OHVs) (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: OHV use directly damages plant communities and the soil horizon of *Eriastrum densifolium* subsp. *sanctorum* occurrences, thereby degrading habitat. Large flat expanses of alluvial fan sage scrub habitat that support *E. d.* subsp. *sanctorum* are also attractive to recreationists for OHV use. Impacts from OHV use is known to occur throughout the species' range and specifically at 11 of the 21 occurrences in Cajon Creek Wash (EOs 33, 4), Lytle Creek Wash (EO 19), and the Santa Ana River mainstem (EOs 5, 1, 25, 29, 21, 22, 24, and 31) (CNDDDB 2010). Unauthorized OHV use continues to degrade alluvial fan sage scrub habitat areas within Cajon Creek Wash, Lytle Creek Wash, and the mainstem of the Santa Ana River. Control of these activities rests with local landowners and jurisdictions. Three occurrences are conserved and afforded protection under the Western Riverside County Multiple Species Habitat Conservation

Plan (Western Riverside County MSHCP) (EOs 22, 24, and 31). We anticipate that some impacts from OHVs will be ameliorated through active management with future implementation of the Woolly-Star Preserve Area Multiple Species Habitat Management Plan (WSPA). (USFWS, 2010)

Stressor: Hybridization (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Hybridization was not discussed in the listing rule as a threat to *Eriastrum densifolium* subsp. *sanctorum*. Though hybridization, or the occurrence morphological intermediates (with *E. d. subsp. elongatum* or *E. d. subsp. austromontanum*) had been suspected since the 1930s, genetic verification did not occur until the occurrences in Lytle Creek were compared to those in the Santa Ana River utilizing enzyme electrophoresis (Brunell and Rieseberg 1993). Similarly, hybridization was thought to occur with *E. d. subsp. elongatum* near the confluence of Lytle Creek and Cajon Creek (Verdemont (EO 18), Institution Road North (EO 33), and Institution Road South (EO 4)) (Craig 1934, p. 390; Burk et al. 1989, p. 20). The upper reaches of those washes seem to support *E. d. subsp. elongatum* while the listed entity is found downstream toward the Santa Ana River. *Eriastrum densifolium* subsp. *austromontanum* has also been thought to hybridize with *E. d. subsp. sanctorum* at La Cadeña Dr. and Lytle Creek (La Cadeña Drive (EO 29) and La Loma Hills (EO 30)) (DeGroot 2008, p. 1; Brunell and Whitkus 1997, p. 545). Though gene flow between *E. d. subsp. sanctorum* populations in the Santa Ana River and intermediates of Lytle Creek Wash likely took place in the recent past (150 years), they now appear isolated (Brunell and Rieseberg 1993, p. 5). The extent of threat from hybridization remains unknown. Hybrids have been confined to lower Lytle Creek Wash and the Santa Ana River at its confluence with Lytle Creek. Hybridization is a potential threat at 7 of the 21 occurrences. (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Global climate change was not addressed as a threat in the final listing rule for the *Eriastrum densifolium* subsp. *sanctorum*. Since listing, it has become apparent that potential threats exist to biota of the United States from ongoing, accelerated climate change (IPCC 2007). Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying are predicted for the foreseeable future (Field et al. 1999, pp. 1–63; Cayan et al. 2005, pp. 1–47; IPCC 2007). Significant temperature increases create a stressor for endemic species. This stressor enhances pressures from competitors, nonnative species, habitat change, low water supply, and disease. Species must somehow adapt to these pressures in situ (in place) or shift their geographic range (Cayan et al. 2009, p. 45). Such a shift in range for narrow endemic species such as *Eriastrum densifolium* subsp. *sanctorum* could exceed the tolerance of the subspecies. Additionally, there is very little available alluvial fan sage scrub habitat in the Santa Ana River basin to assist this subspecies with a range shift. Though we know little of the adaptive ability of *E. d. subsp. sanctorum*, climate change could potentially pose a significant rangewide threat to the subspecies. (USFWS, 2010)

Recovery

Reclassification Criteria:

Reclassification criteria are not available.

Delisting Criteria:

Delisting criteria are not available.

Recovery Actions:

- Recovery actions are not available.

Conservation Measures and Best Management Practices:

- Work with partners, such as the Service's Partners for Fish and Wildlife Program to identify opportunities for conservation or preservation for *Eriastrum densifolium* subsp. *sanctorum* occurrences on private lands. Property easements or purchases of parcels could also be made through the Act's section 6 funding and other programs. (USFWS, 2010)
- Ensure natural recruitment of *Eriastrum densifolium* subsp. *sanctorum* is sufficiently documented following extreme fluvial events (i.e., floods) to assure long-term sustainability. (USFWS, 2010)
- Determine occurrences where genetic distinctness exists between occurrences in Cajon Creek, Lytle Creek, and the Santa Ana River mainstem that comprise the range of known hybrid of *Eriastrum densifolium* subsp. *sanctorum*. (USFWS, 2010)
- Develop a final recovery outline for *Eriastrum densifolium* subsp. *sanctorum*. (USFWS, 2010)

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SPECIES ACCOUNT: *Erigeron decumbens* (Willamette daisy)

Species Taxonomic and Listing Information

Listing Status: Endangered; 2/24/2000; Pacific Region (R1)

Physical Description

The Willamette daisy is a taprooted perennial herb. It grows 1.5 to 6 cm (0.6 to 2.4 inches) tall, with erect to sometimes prostrate stems at the base. The basal leaves often wither prior to flowering and are mostly linear, 5 to 12 cm (2 to 5 inches) long and 3 to 4 mm (0.1 to 0.2 inches) wide. Flowering stems produce two to five heads, each of which is daisy-like, with pinkish to pale blue ray flowers and yellow disk flowers. The morphologically similar Eaton's fleabane (*E. eatonii*) occurs east of the Cascade Mountains, while the sympatric species Hall's aster (*Aster hallii*) flowers later in the summer. In its vegetative state, the Willamette daisy can be confused with Hall's aster, but close examination reveals the reddish stems of Hall's aster in contrast to the green stems of the Willamette daisy (Clark et al.1993) (USFWS, 2016).

Taxonomy

In the sunflower or daisy family (Asteraceae). Thomas Nuttall (1840) described *Erigeron decumbens* based on a specimen he collected in the summer of 1835. The autonym *E. decumbens* var. *decumbens* was automatically established by Cronquist (1947) when he described *E. decumbens* var. *robustior*. Recent revisions of the *Erigeron* genus (Strother and Ferlatte 1988, Nesom 1989) treat the plant as a variety, *E. decumbens* var. *decumbens*. According to Strother and Ferlatte (1988), *E. decumbens* var. *decumbens* is geographically limited to the Willamette Valley and the morphologically similar *E. decumbens* var. *robustior* is restricted to Humboldt and western Trinity Counties, California. (USFWS, 2010).

Historical Range

See current range/distribution.

Current Range

Occurs only in the southern end of the Willamette Valley, Oregon. Historically had ranged further north near Portland. Generalized range of 7400 sq. km. (USFWS, 2016)

Critical Habitat Designated

Yes; 11/30/2006.

Legal Description

On October 31, 2006, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective November 30, 2006) for *Erigeron decumbens* var. *decumbens* (Willamette daisy) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes nine critical habitat units (CHUs), in Oregon and Washington (71 FR 63862-63977).

Critical Habitat Designation

The critical habitat designation for *Erigeron decumbens* var. *decumbens* includes nine CHUs in Benton, Lane, Linn, Marion, and Polk Counties, Oregon. This species critical habitat encompasses approximately 718 ac (291 ha). Brief descriptions are presented below; detailed coordinates and maps are included in the Final Rule (71 FR 63862-63977; USFWS, 2006).

Units WD–1A and 1B encompass approximately 41.2 ac (16.7 ha) of Federal land occurring in northern Polk County. This unit is located adjacent to Highway 22, approximately 5.6 mi (9 km) northeast of the City of Dallas.

Unit 2 for *Erigeron decumbens* var. *decumbens* (Unit WD–2) Unit WD–2 encompasses approximately 12.2 ac (4.9 ha) of private land occurring in southern Marion County. This unit occurs south of SE Triumph Road and east of SE Boedigheimer Road.

Unit WD–3 encompasses approximately 58.3 ac (23.6 ha) of private land occurring within northern Linn County. This site is located north of SE Kingston Lyons Drive and on both the east and west sides of Huntly Road, and is primarily owned by TNC.

Unit WD–4 encompasses approximately 9.3 ac (3.8 ha) of private and City of Corvallis land occurring in Benton County. This unit is located north of SW Reservoir Avenue and south of NW Oak Creek Drive. Approximately half of the habitat within this unit is located on City of Corvallis land and half on private land.

Unit WD–5 consists of approximately 38.5 ac (15.6 ha) of private land, south of Corvallis, in Benton County. This unit is located along Muddy Creek, just to the west of Cutler Lane.

Unit WD–6 encompasses approximately 85.4 ac (34.6 ha) of critical habitat, with an estimated 89 percent on Federal land and 11 percent occurring on private land. This unit is located in Eugene, along Ken Neilsen Road and West 11th Avenue. The federally owned land includes both BLM and Army Corp of Engineers lands.

Unit WD–7A consists of approximately 22.3 ac (9 ha) of critical habitat, primarily on Federal land, with 2 percent occurring on private land. WD–7A is located to the west of Green Hill Road and to the north of West 11th Avenue, and is managed by the Army Corp of Engineers.

Subunits WD–8A and 8B consist of approximately 135.9 ac (55 ha) of Federal and private lands in West Eugene, Oregon. These subunits are located near the intersection of Willow Creek and West 18th Avenue. An estimated 45 percent of this area occurs on private land with approximately 55 percent occurring on BLM land.

Subunit WD–9A encompasses an estimated 90 ac (36.4 ha) of private land and is located approximately 1.2 mi (2 km) east of the intersection of Pine Grove Road and Crow Road.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Erigeron decumbens* var. *decumbens* critical habitat consists of one component (71 FR 63862-63977):

(i) Early seral upland prairie, wet prairie, or oak savanna habitat with a mosaic of low-growing grasses and forbs, and spaces to establish seedlings or new vegetative growth; an absence of dense canopy vegetation; and undisturbed subsoils.

Special Management Considerations or Protections

Because *Erigeron decumbens* var. *decumbens* does not tolerate the presence of woody vegetation, habitat management will be required for the long-term persistence of this species. Further investigation is needed to determine the most appropriate techniques for managing available habitat. Also, due to the low reproductive capability of the species, conservation of the *E. decumbens* var. *decumbens* will likely depend on artificially augmenting populations in areas where woody vegetation has been removed (Clark 2000, pp. 9-10). (USFWS, 2006)

Expanding *Erigeron decumbens* var. *decumbens* populations will require more investigation into the roles of sexual and vegetative reproduction of this species. If sexual reproduction proves to be most important for population recruitment, managers will need to focus on strategies that promote flowering, seed production, and seedling establishment (Clark 2000, p. 9). However, if vegetative regeneration is predominant, managers will need to focus on activities that promote ramet (refers to individual plants in a clump, each portion of which is identical with the original parent plant) production (Clark 2000, p. 9). Clark et al. (1995b, pp. 22-23) found that vegetative propagation is a viable technique for *E. decumbens* var. *decumbens*; populations may also be increased by sowing seeds under appropriate conditions, although this technique appeared to be less effective than vegetative propagation. (USFWS, 2006)

Erigeron decumbens var. *decumbens* is at risk of inbreeding depression and site extirpation across their respective ranges because populations are small and isolated from one another. This species will benefit from reestablishing prairie plant patches in proximity to core populations. (USFWS, 2006)

Many remaining populations of *Erigeron decumbens* var. *decumbens* populations occur in road rights of ways and are adversely affected by maintenance activities such as mowing or spraying of herbicides at the wrong time of year. (USFWS, 2006)

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (USFWS, 2016)

Breeding Season

Adult: The Willamette daisy typically flowers throughout June and July (USFWS, 2016)

Reproduction Narrative

Adult: The Willamette daisy typically flowers throughout June and July with pollination carried out by syrphid flies and solitary bees (Clark et al.1995). The daisy produces and subsequently disperses large quantities of wind-dispersed seed in July and August. The seeds of the daisy are achenes, like those of other *Erigeron* species, and have a number of small capillary bristles (the pappus) attached to the top, which allow them to be distributed by the wind. Due to the small size and number of these bristles, the seeds do not fly well in the wind, so seed distribution is quite restricted. The Willamette daisy is capable of spreading vegetatively through rhizomes over very short distances of less than 10 cm (4 inches) and is commonly found in large clumps scattered throughout a site (Clark et al.1993). Willamette daisy responds positively to late spring and early summer rains. Studies conducted at the Willow Creek Preserve indicate that

not all individuals of the Willamette daisy bloom every year, and that some individuals may remain dormant for an entire growing season (Kagan and Yamamoto 1987) (USFWS, 2016).

Habitat Type

Adult: Vally Prairie (USFWS, 2016)

Environmental Specificity

Adult: Narrow. Specialist or community with key requirements common. (Natureserve, 2015)

Habitat Narrative

Adult: Deschampsia Caespitosa Valley prairie. Clay soiled prairie in valley bottoms, often by creek drainages. (NatureServe, 2015). The Willamette daisy is typically occurs where woody cover is nearly absent and where herbaceous vegetation is low in stature (Clark et al.1993; USFWS 2010a). It occurs in both wet prairie grasslands and drier upland prairie sites. The wet prairie grassland community, which was historically maintained by periodic flooding and fires, is characterized by the dominance of tufted-hairgrass, California oatgrass, and a number of Willamette Valley endemic forbs. It is a flat, open, seasonally wet prairie with bare soil between the pedestals created by the bunching Deschampsia cespitosa (Kagan and Yamamoto 1987). On drier upland prairie sites, associated species commonly include Symphotrichum hallii, Festuca idahoensis ssp. roemerii and Toxicodendron diversilobum (Meinke 1982, Clark et al.1993). Willamette daisy prefers heavier soils, and has been found on the following soil associations: Bashaw, Briedwell, Chehulpum, Dayton, Dixonville, Dupee, Hazelair, Marcola, Natroy, Nekia, Pengra, Philomath, Salkum, Saturn, Stayton, and Witzel (USFWS, 2016).

Dispersal/Migration**Dispersal**

Adult: Wind dispersed (USFWS, 2016)

Dispersal/Migration Narrative

Adult: The daisy produces and subsequently disperses large quantities of wind-dispersed seed in July and August (USFWS, 2016).

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015; USFWS, 2016)

Resiliency:

Fairly hardy and resistant. Able to slowly invade adjacent disturbed areas if left alone. (NatureServe, 2015)

Number of Populations:

17 (USFWS, 2016)

Population Size:

1000 - 10,000 individuals (NatureServe, 2015)

Population Narrative:

The Willamette daisy is endemic to the Willamette Valley of western Oregon. Herbarium specimens show a historical distribution of Willamette daisy throughout the Willamette Valley; frequent collections were made in the period between 1881 and 1934, yet no collections or observations were recorded from 1934 to 1980 (Clark et al.1993). The species was rediscovered in 1980 in Lane County, Oregon. At the time of listing, 28 occurrences of Willamette daisy were recognized with a total of 286 acres of occupied habitat (USFWS 2000). In 2010, the total acreage considered to be occupied was 233 at 39 sites (USFWS 2010a). In 2010, Willamette daisy was believed to be extant at 37 sites that comprise 17 populations (USFWS 2010b). Of these, 3 populations had been augmented and Willamette daisy had been introduced to 5 new sites since the time of listing. Three of the extant populations are the direct result of recent introductions, and 5 natural populations have been discovered since the time of listing. Willamette daisy is believed to be extirpated or the status is unknown at 11 sites where it was previously documented. Of these sites, 8 were known at the time of listing, including 5 that represented individual populations and 3 that likely contributed to larger populations. Current population estimates are based on available information from 2004 to 2010 (USFWS 2010b). For most sites, long-term data needed to detect population trends is not available. In some cases, documentation of the number of plants at a site is not available. Where sites are within 3 km (2 miles) of each other, they are generally considered to be subpopulations that comprise a larger population (i.e., metapopulation) based on pollinator travel distance (USFWS 2010a). Of the 17 currently known populations, only 2 include protected sites that support relatively large subpopulations (i.e., with over 2,000 plants) known to have been stable for 8 years or more (USFWS 2010b). Trend data is not available for most sites, and many sites are not formally protected. Recovery criteria outlined for downlisting have not been met in any of the recovery zones. Almost all previously identified threats to the species still remain. Significant progress has been made to store genetic material, and efforts to collect and store seed will likely continue. Population size may fluctuate substantially from year to year. Monitoring at the Oxbow West site, near Eugene, found 2,299 Willamette daisy plants in 1999, 2,912 plants in 2000, and only 1,079 plants in 2001 (Kaye and Brandt 2005). The population at Baskett Butte declined to 48% of the original measured population between 1993 and 1999 (Clark 2000; Clark et al.1995). Detecting trends in Willamette daisy populations is complicated by the biology and phenology of the species. For instance, Kagan and Yamamoto (1987) found it difficult to determine survival and mortality between years because of irregular emergence and sporadic flowering from year to year. They suggested that some plants probably lie dormant during some years, as indicated by the sudden appearance of large plants where they were not previously recorded, and the disappearance and later re-emergence of large plants within monitoring plots. In addition, Clark et al.(1993) stated that non-reproductive individuals can be very difficult to find and monitor due to their inconspicuous nature, and that the definition of individuals can be complicated when flowering clumps overlap (USFWS, 2016).

Threats and Stressors

Stressor: Development (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Like many native species endemic to Willamette Valley prairies, the Willamette daisy is threatened by habitat loss due to urban and agricultural development (USFWS, 2016).

Stressor: Encroachment/woody succession (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Secondary successional encroachment of habitat by trees and brush is a threat to this species (USFWS, 2016).

Stressor: Competition (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Competition with non-native weeds is listed as a threat to this species (USFWS, 2016).

Stressor: Small populations (USFWS, 2016)

Exposure:

Response:

Consequence: Extinction/lack of genetic diversity

Narrative: Small population sizes (Kagan and Yamamoto 1987, Clark et al.1993) are listed as a threat to this species (USFWS, 2016).

Stressor: Private land (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The Service (USFWS 2000) estimated that habitat loss is occurring at 80% of remaining 84 remnants of native prairies occupied by Willamette daisy and Kincaid's lupine. The Service (USFWS 2000) also stated that 24 of the 28 extant Willamette daisy populations occur on private lands and, "without further action, are expected to be lost in the near future."

Recovery

Reclassification Criteria:

1. Distribution and abundance. The distribution of populations should reflect the extent of the species' historical geographic distribution to the extent practicable. Subpopulations contributing to larger interacting populations should be within pollinator flight distance (3 kilometers [2 miles]) of each other. See Table IV-3 in the Recovery Plan for distribution and abundance goals for this species. (USFWS, 2010)

2. Population trend and evidence of reproduction. The number of individuals in the population shall have been stable or increasing over a period of at least 10 years. The term "stable" in this context does not mean that the population size is static over time; over a period of 10 years, the number of individuals in the population may exhibit natural year-to-year variability, but the trend must not be declining. Populations must show evidence of reproduction by seed set or presence of seedlings. (USFWS, 2010)

3. Habitat quality and management. Sites supporting populations of listed plants considered in Criterion 1 above must meet these criteria: (a) Prairie quality. Sites supporting populations of

the listed plant species must be managed for high quality prairie habitat. High quality prairie habitat consists of a diversity of native, non-woody plant species, low frequency of aggressive non-native plant species and encroaching woody species, and essential habitat elements (e.g., nest sites and food plants) for native pollinators. See Appendix D of the Recovery Plan for suggested criteria for evaluating prairie quality and diversity. (b) Security of habitat. For each listed species, a substantial portion of the habitat for the populations should either be owned or managed by a government agency or private conservation organization that identifies maintenance of the species and the prairie ecosystem upon which it depends as the primary management objective for the site, or the site must be protected by a permanent or long-term conservation easement or covenant that commits present and future landowners to the conservation of the species. (c) Management, monitoring, and control of threats. Each population must be managed appropriately to ensure the maintenance or restoration of quality prairie habitat for each species and to control threats to the species. Use of herbicides, mowing, burning or livestock grazing in management should be implemented with appropriate methods and timing to avoid impacts to listed plant species. Management should be coordinated with adjacent landowners to minimize effects of pesticide drift, changes in hydrology, timber harvest, or road/utility maintenance. Species that may hybridize with *Sidalcea nelsoniana* or *Lupinus sulphureus* ssp. *kincaidii* should be managed as appropriate to avoid contact with these taxa. Other potential threats relating to scientific research, overcollection, vandalism, recreational impacts, or natural herbivory/parasitism should be successfully managed so as not to significantly impair recovery of the species. (USFWS, 2010)

Delisting Criteria:

Delisting will be considered when all of the following conditions have been met: (USFWS, 2010)

1. Distribution and abundance. The distribution of populations should reflect the extent of the species' historical geographic distribution to the extent practicable. See Table IV-3 in the Recovery Plan for distribution and abundance goals for this species. (USFWS, 2010)
2. Population trend and evidence of reproduction. The number of individuals in the population shall have been stable or increasing over a period of at least 15 years. Stable does not mean that the population size is static over time; over a period of 15 years, the number of individuals in the population may exhibit natural year-to-year variability, but the trend must not be declining. Populations must show evidence of reproduction by seed set or presence of seedlings. (USFWS, 2010)
3. Habitat quality and management. Sites supporting populations of listed plants considered in Criterion 2 above must meet these criteria: (a) Prairie quality. Same as Downlisting Criterion 1. (b) Security of habitat. Same as Downlisting Criterion 1. (c) Management, monitoring, and control of threats. Same as Downlisting Criterion 1. (USFWS, 2010)
4. Genetic material is stored in a facility approved by the Center for Plant Conservation. The stored genetic material in the form of seeds must represent the species' geographic distribution and genetic diversity through collections across the full range of the species. Collections from large populations are particularly important as reservoirs of genetic variability within the species. (USFWS, 2010)

5. Post-delisting monitoring plans and agreements to continue post-delisting monitoring are in place and ready for implementation at the time of delisting. Monitoring of populations following delisting will verify the ongoing recovery of the species, provide a basis for determining whether the species should be again placed under the protection of the Endangered Species Act, and provide a means of assessing the continuing effectiveness of management actions. (USFWS, 2010)

Recovery Actions:

- Details of the Recovery Actions are available in the 2010 Recovery Plan. Presented below is the introductory paragraph only. (USFWS, 2010)
- 1. Preserve, restore, and manage populations and habitat for the listed prairie species covered by this plan. The listed prairie species of western Oregon and southwestern Washington addressed by this plan are now found only in small, highly fragmented upland and wet prairie habitat remnants. The first step in the recovery of these species is to identify and protect the remaining populations with the greatest potential for restoration. The next step is to augment and, if necessary, reintroduce populations to restore connectivity between those that are currently isolated from one another to restore gene flow and create a population structure that provides for resiliency in a dynamic natural environment. Recovery for all of these species will depend upon the successful establishment of a network of protected populations in managed, suitable prairie habitats distributed across their historical range. As a large portion of the remnant prairie habitats within the range of these species is in private ownership, recovery will to a large extent depend upon the successful development of partnerships with private landowners and support of their efforts to protect, restore and manage native prairie habitats in the region. (USFWS, 2010)
- 2. Coordinate recovery actions to benefit other listed species and nonlisted prairie species of conservation concern. The extensive loss of both wet and upland prairie habitats throughout the geographic region addressed by this draft recovery plan has resulted in the concurrent declines of many of the native plants and animals associated with these ecosystems. In this plan we have attempted to focus not only on the recovery of the listed prairie species, but to extend these recovery efforts to the ecosystems upon which they depend. The recommended actions for restoring and reconnecting prairie habitats in western Oregon and southwestern Washington are intended to extend benefits beyond the threatened or endangered species addressed in the plan to all of the native prairie species in these regions, including nonlisted prairie species that are recognized as in decline. Proactive efforts to restore prairie systems should contribute to the arrest or reversal of these declines, thereby preventing the need to list these species in the future. Particularly on sites where listed species co-occur with nonlisted species of conservation concern, landowners or managers should be made aware so as to tailor management actions to avoid inadvertent negative impacts on any such species. Coordination with other agencies, private landowners, or other interested parties will help ensure that the recovery actions outlined in this plan benefit the habitat and populations of other native prairie species. (USFWS, 2010)
- 3. Promote protection of listed species and prairie restoration on private lands. More than 90 percent of the land in the Willamette Valley is in private ownership. The restoration of prairie systems and their native plant and animal communities can therefore only be successful with the participation of private landowners. Without active management, populations of both listed and nonlisted species endemic to prairie habitats are almost certain to experience further declines. Working with private landowners and providing

incentives to participate in the recovery effort for these species are critical elements of the recovery strategy. (USFWS, 2010)

- 4. Cultivate partnerships with both public and private agencies and organizations to promote the conservation of prairie ecosystems and listed prairie species. A diverse group of agencies and organizations are involved in recovery activities for the native prairies in western Oregon and southwestern Washington, including, but not limited to, the U.S. Fish and Wildlife Service, the Willamette Valley National Wildlife Refuge Complex, the U.S. Bureau of Land Management, U.S. Army Corps of Engineers, Confederated Tribes of Grand Ronde, Oregon Department of Transportation, City of Eugene, The Nature Conservancy, Oregon State University, Institute for Applied Ecology, Greenbelt Land Trust, McKenzie River Land Trust, Oregon Oak Communities Working Group, Washington Native Plant Society, Oregon Native Plant Society, Heritage Seedlings, and Berry Botanic Garden. Information regarding the recovery efforts for the prairie species should be shared with city and county planning, parks, and natural resource departments throughout the region covered by this recovery plan. City and county governments are the primary agencies that determine future land uses, and their participation is important for the recovery and restoration of the prairies and their associated listed species. Some local agencies are already making significant contributions toward prairie restoration; the West Eugene Wetlands are an excellent example of a significant conservation accomplishment achieved through a partnership of federal and local governments and private landowners/organizations. Plans, data, and information pertinent to the recovery of the prairie species must be synthesized and shared effectively between all agencies, groups, and individuals to leverage collective conservation efforts and achieve recovery. (USFWS, 2010)
- 5. Revise and update recovery plan as needed. Based on the results of the recommended research and monitoring efforts and the evaluation of the relative success or failure of different management techniques, the recovery plan should be revised periodically as needed to reflect this increased knowledge and improve the efficacy of future recovery actions. The scientific validity of the recovery criteria should also be reviewed and refined, if necessary, as more accurate species-specific data become available to assist with refining recovery criteria. (USFWS, 2010)
- 6. Develop post-delisting monitoring plans for each listed species prior to delisting. To ensure the continuing recovery of the listed species and adequacy of management actions to maintain the species at viable levels into the foreseeable future, a post-delisting monitoring plan must be developed and ready for implementation prior to delisting of any threatened or endangered species. Such a monitoring plan must be designed to be continued for a minimum of 5 years following the delisting action. (USFWS, 2010)
- Recommendation for Future Action from 2019 5-Year Review: Action 1: Survey and Monitor:
 - Maintain information about what is currently known about the locations of extant and extirpated sites.
 - Maintain map with historical and extant populations and potential introduction sites.
 - Survey known and potential extant populations where status of populations or possible extirpation is unknown; identify and assess factors that appear to be driving population trends at occupied sites.
 - Monitor key populations and identify factors that may be driving population trends at occupied sites. (USFWS, 2019)
- Recommendation for Future Action from 2019 5-Year Review: Action 2: Habitat Protection, Management and Restoration:
 - Select populations and lands on which to focus protection, management and restoration recovery actions.
 - Work with landowners to restore, manage and reduce threats to significant sites.
 - Work with partners to explore and develop

- opportunities to protect key populations on private lands. • Work to secure significant unprotected sites. (USFWS, 2019)
- Recommendation for Future Action from 2019 5-Year Review: Action 3: Seed Collection, Propagation and Banking: • Continue on-going seed collection efforts for propagation and banking. • Identify sites for additional seed collection. • Increase seed availability through cultivation and propagation at facilities that can manage genetic diversity and any necessary isolation. (USFWS, 2019)
 - Recommendation for Future Action from 2019 5-Year Review: Action 4: Research: • Conduct demographic studies to determine how Willamette daisy responds to restoration and management treatments. • Research genetic and reproductive biology questions related to progeny fitness, demographic trends and the breeding system for use in developing seed transfer and augmentation guidelines, and to evaluate inbreeding depression concerns. • Research effects of climate change and voles on Willamette daisy populations and develop recommendations for responses to these threats. (USFWS, 2019)
 - Recommendation for Future Action from 2019 5-Year Review: Action 5: Augment Small Populations and Reintroduce Willamette Daisy to Suitable Habitats: • Identify protected populations that would be likely to benefit from augmentation and suitable habitats in strategic locations between secure populations that could be used as reintroduction sites. • Implement augmentation projects; develop management plans with landowners, as needed. • Implement (re)introduction projects; develop management plans with landowners, as needed. (USFWS, 2019)

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SPECIES ACCOUNT: *Erigeron parishii* (Parish's daisy)

Species Taxonomic and Listing Information

Listing Status: Threatened; 08/24/1994; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

Parish's daisy is a small perennial herb in the aster family (Asteraceae) that reaches 4 to 12 inches (10 to 30 centimeters) in height (Nesom 1993, p. 260). The leaves are 1 to 2 inches (2 to 5 centimeters) long, simple, linear and covered with soft, silvery hairs (Nesom 1993, p. 260). Flower heads are solitary and borne at the tips of leafy stems, with bluish to pink or white ray flowers and yellow disk flowers. Grayish-green glandular bracts surround each flower head (USFWS 2002, p. 78571). Parish's daisy generally flowers between May and June (CNPS 2001). (USFWS, 2009)

Historical Range

Historical collections of this plant were made from Rattlesnake Canyon south of Old Woman Springs, and from Long Canyon in the Little San Bernardino Mountains in Joshua Tree National Park (USFWS 1994, p. 43653). (USFWS, 2009)

Current Range

Range extent is about 155 sq mi in 2 main areas. The range is located in Riverside and San Bernardino counties, California, usually on carbonate soils. (NatureServe, 2015)

Critical Habitat Designated

Yes; 12/24/2002.

Legal Description

On December 24, 2002, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Erigeron parishii* (Parish's daisy) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in California (67 FR 78570-78610).

Critical Habitat Designation

The critical habitat designation for *Erigeron parishii* includes one CHU (25 subunits) in San Bernardino County, California (67 FR 78570-78610).

Northeastern Slope Unit, San Bernardino County, California. (i) From USGS 1:24,000 quadrangle maps Fawnskin, Big Bear City, and Onyx Peak, California.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Erigeron parishii* critical habitat consists of three components (67 FR 78570-78610):

(i) Soils derived primarily from upstream or upslope limestone, dolomite, or quartz monzonite parent materials that occur on dry, rocky hillsides, shallow drainages, or outwash plains at elevations between 1,171 and 1,950 m (3,842 and 6,400 ft);

(ii) Soils with intact, natural surfaces that have not been substantially altered by land use activities (e.g., graded, excavated, recontoured, or otherwise altered by grounddisturbing equipment); and

(iii) Associated plant communities that have areas with an open canopy cover.

Special Management Considerations or Protections

The SBNF is planning a revision of their Resource Management Plan in the near future that, among other functions, would provide conservation benefits to the two carbonate plant species and their habitat in this unit. These lands, however, currently do not have approved management provisions for the carbonate plants and their habitat, and habitat degradation may still be occurring due to ongoing activities identified in the final listing rule for these species (see USFWS 2001b). Therefore, the subject lands continue to require special management and protection to ensure the conservation of these species and their habitat. The core occurrences of the two carbonate plants in this unit are important as potential sources for the colonization events (e.g., seed dispersal) necessary to maintain the natural population dynamics of the species. Every carbonate plant occurrence in this unit is important as a seed source to colonize unoccupied sites and therefore maintain an equilibrium between local colonization and extirpation events. Every carbonate plant occurrence in this unit potentially provides important genetic material through pollen and seed dispersal which may help maintain genetic diversity and reduce the likelihood of regional extirpation events.

Life History

Food/Nutrient Resources

Breeding Season

Adult: May to June (USFWS, 2009)

Reproduction Narrative

Adult: Parish's daisy generally flowers between May and June (CNPS 2001).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest/Woodland, Shrubland/chaparral, Woodland - Conifer (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations from 1,171 to 1,950 m (3,842 to 6,400 ft); prefers open canopy cover (USFWS, 2009)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Habitat Narrative

Adult: Parish's daisy is typically found associated with pinyon woodlands, pinyon-juniper woodlands, and blackbush scrub vegetation communities (Neel 2000, p. 162) from 3,842 to 6,400 feet (1,171 to 1,950 meters) in elevation (USFWS 2002, p. 78572). It usually grows on rocky slopes, active washes, and outwash plains on substrate derived from limestone or dolomite with open canopy cover. Some occurrences are found on a granite/limestone interface characterized by a granitic parent material overlain with an outwash of limestone materials (USFWS 1994, p. 43653). At the Burns Pinyon Ridge Reserve and at an adjacent occurrence near Pioneertown, the species occurs on quartz monzonite soils with no apparent limestone alluvium (Neel 2000, p. 186). (USFWS, 2009)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Long-term trends indicate a decline of 50 to 70%, while a short-term trends suggest a decline of 10 to 30% (NatureServe, 2015)

Number of Populations:

32 occurrences (NatureServe, 2015)

Population Size:

16,000 (NatureServe, 2015)

Population Narrative:

Long term trends indicate a population decline of 50 to 70%, while short-term trends suggest a decline of 10 to 30%. According to the final listing rule, Parish's daisy was known from fewer than 25 occurrences with a total population size of about 16,000 individuals (USFWS 1994, p. 43653). There are 32 known occurrences and 2 are historic. (NatureServe, 2015)

Threats and Stressors

Stressor: Mining (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Mining activity remains the primary threat for Parish's daisy (USFWS 2005a, p. 246). Mining can impact habitat through the removal of mined materials, disposal of overburden, and road construction (USFWS 1997, pp. 17–18). (USFWS, 2009)

Stressor: Dust (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Dust can affect Parish's daisy by altering soil chemistry and light penetration into seedbanks (USFWS 1997, p. 17–18). (USFWS, 2009)

Stressor: Artificial lighting (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Artificial lighting may affect Parish's daisy's growing conditions by altering the photoperiod response or the behavior of pollinators or seed dispersers (USFWS 1997, p. 18). (USFWS, 2009)

Stressor: Off-road vehicle (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The final listing rule indicated off-road vehicle use and energy development projects were a threat to Parish's daisy. Such activities could impact the species' habitat through ground disturbance or dust creation. About 6 acres (2 hectares) of occupied habitat and 20 acres (8 hectares) of designated critical habitat for Parish's daisy overlap with roads and motorized vehicle trails (USFWS 2005a, p. 256). The San Bernardino National Forest has closed road 3N77 and placed signs and barriers for the other roads (USFWS 2001, p. 18), which should help limit impacts due to off-road vehicle use. Additionally, road 3N11A is proposed for decommissioning and roads 3N03D, 3N54, 3N88, and 3N88B are proposed for reclassification as administrative use only (USFWS 2009, p. 2), which should reduce vehicle activity in the area and further reduce the threat to the species. We are unaware of any energy development or off-highway vehicle projects occurring since listing that affect Parish's daisy. (USFWS, 2009)

Stressor: Trampling (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Several threats such as dispersed target shooting, dispersed camping areas, fuelwood collection, and fire suppression activities have been identified since listing (USFWS 2001, pp. 4-11). These activities can result in trampling of Parish's daisy and impact its habitat through ground disturbance or dust creation. In addition, fire suppression activities can result in ground disturbance through fire line construction, retardant and water drops, and establishment of fire camps. (USFWS, 2009)

Stressor: Predation (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The threat of predation from burro grazing was identified after listing (USFWS 2001). However, burros are expected to have minimal effects to Parish's daisy due to the low numbers of burros present (about 60), the dispersal of the burros across a large area, the burros preference for wetter habitats, and the short stature and scarce nature of carbonate plants, which makes foraging on them unlikely (USFWS 2001, p. 39). (USFWS, 2009)

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Climate change is a threat that was not mentioned in the final listing rule for Parish's daisy. This issue was also raised in a letter received by the Service on May 6, 2008 (Potter, in litt. 2008). Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (IPCC 2007; Cayan et al. 2005; Field et al. 1999). However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. Parish's daisy is endemic to isolated occurrences of particular carbonate soils in the San Bernardino Mountains and near Pioneertown to the east. Therefore, any combination of environmental conditions, such as those attributed to climate change above, that force an upward shift in the distribution of the species, poses a profound threat to the taxon's persistence and recovery. There will be no suitable habitat when the elevational range exceeds the species' maximum elevation. (USFWS, 2009)

Stressor: Stochastic extinction (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The potential for stochastic extinction is enhanced by habitat loss and fragmentation and drought. Habitat fragmentation can result in areas too limited and isolated to support pollinators or other seed dispersal agents (USFWS 1997, p. 16). (USFWS, 2009)

Recovery

Reclassification Criteria:

1. The priority ranked habitat areas have been protected. Priority for protection shall be determined according but not limited to: 1) population size, 2) habitat quality, 3) manageability/defensibility of site, and 4) connectivity. The initial preserve area should be 2,000 hectares (5,000 acres) based on known areas occupied by the plants and should include protection for the threatened species, *Erigeron parishii* (which is discussed separately under the delisting objective and criteria). (USFWS, 2009)

2. Protect additional lands needed to complete otherwise isolated reserves, to protect new populations that may be discovered in the future, and to provide strategic buffer zones and potential population reintroduction and/or expansion areas. The interim estimate of additional lands needed to secure habitat connectivity, buffers, and natural community context is 1,860 hectares (4,600 acres), including lands to meet Delisting Criterion #2 for *Erigeron parishii*. (USFWS, 2009)

Delisting Criteria:

1. Consistent with Downlisting Criterion #1, essential extant populations of *Erigeron parishii* are conserved on public lands specified in Downlisting Criterion #1 for the endangered carbonate plants, plus lands where *Erigeron parishii* is the only listed plant, in order to represent the southeastern portion of *Erigeron*'s range, with connections to other populations and reserves. Priority of protection will be determined by the ranking factors in Downlisting Criterion #1 for

the four other carbonate plants (excepting the need for *Erigeron parishii* sites to represent the southeastern portion of its range). (USFWS, 2009)

2. Any additional lands necessary to connect otherwise isolated reserve areas, provide strategic buffer zones and potential population reintroduction expansion areas are protected. This criterion may be fulfilled in conjunction with Downlisting Criterion #2 [for the endangered carbonate plants]. (USFWS, 2009)

3. Early detection of problems in the reserve system is assured through adaptive population monitoring/adaptive management programs. Protocols for responding to problems are in place. Ecological restoration of human-disturbed sites (closed OHV [off-highway vehicle] roads, abandoned quarries, etc.) that formerly affected *Erigeron parishii* habitat is in progress. (USFWS, 2009)

Recovery Actions:

- Identify, design, and establish endemic plant species reserves encompassing the extant populations. (USFWS, 1997)
- Identify and conserve additional habitat needed to recover the species. (USFWS, 1997)
- Answer ecological and management questions described in Downlisting Criterion 2. (USFWS, 1997)
- Identify monitoring programs needed to support adaptive management and initiate them. (USFWS, 1997)
- Evaluate recovery efforts and implement corrective measures. (USFWS, 1997)
- Begin to establish a public constituency for the endangered taxa by developing and implementing a public education program. (USFWS, 1997)

Conservation Measures and Best Management Practices:

- Prepare a new threats-based recovery plan specific to Parish's daisy that identifies a recovery strategy, objectives, and criteria for delisting. In the interim, seek implementation of elements of the Carbonate Habitat Conservation Strategy that have direct benefit to the conservation of Parish's daisy. (USFWS, 2009)
- Work with the San Bernardino National Forest to conduct systematic monitoring of Parish's daisy throughout known and potentially occupied sites as necessary to track the status of the species and identify management priorities. There is a need to continue to obtain quantitative information regarding the status of this species to evaluate the effectiveness of conservation efforts over time, especially in light of potential effects associated with global climate change. (USFWS, 2009)
- Work with partners, such as the San Bernardino National Forest, to help conserve Parish's daisy by identifying opportunities to: a) Continue monitoring programs for the effectiveness of measures to protect Parish's daisy from recreational activities and make adjustments to signs, barriers, and roads as necessary. b) Avoid new developments in or near Parish's daisy habitat. (USFWS, 2009)

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SPECIES ACCOUNT: *Erigeron rhizomatus* (Zuni fleabane)

Species Taxonomic and Listing Information

Listing Status: Threatened; 04/26/1985; Southwest Region (R2) (USFWS, 2016)

Physical Description

A perennial herb that produces clumps of stems, about 3 dm in diameter and 2.5-4.5 dm tall. Solitary white (sometimes tinged blue-violet) flower heads bloom at the tops of the stems during May and June (NatureServe, 2015).

Taxonomy

The two species *Erigeron rhizomatus* and *Erigeron lepidopodus* (of Chihuahua and Durango, Mexico) have been sectionally consolidated as *Erigeron* sect. *Geronpternix* Nesom & Noyes. Section *Geronpternix* is the most primitive phylogenetic element of the genus *Erigeron* (Nesom and Noyes 1999). This sectional reclassification indicates the great phylogenetic age of Zuni fleabane and its basal position in the evolution of this large genus (USFWS, 2007).

Historical Range

Zuni fleabane was discovered on the Navajo Nation in 1999 by botanist, Arnold Clifford, in the Chuska Mountains on the New Mexico/Arizona border in northwestern New Mexico and northeastern Arizona (USFWS, 2007).

Current Range

Occurs in the Datil and Sawtooth Mountains in northern New Mexico. McKinley and Catron counties in the Cibola National Forest, and some on Bureau of Land Management public land in Catron County. Also found in Arizona on the east side of the Chuska Mountains in June 1999 (Sue Schuetze pers. comm. to Eric Nielsen 6/2000) (NatureServe, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual: vegetative; sexual (USFWS, 2007)

Lifespan

Adult: 2+ years (inferred from NatureServe, 2015)

Breeding Season

Adult: May - June (USFWS, 1988)

Reproduction Narrative

Adult: It is a perennial species (NatureServe, 2015). Most propagation of Zuni fleabane probably occurs asexually by the spread of rhizomes (Knight 1988). Within populations, isolated plants

can be found many meters from others, which indicates at least some sexual reproduction and propagation by seed (Knight and Cully 1988; Sivinski, unpublished observations 1991, 1999, 2004). Seed production is evident in all populations, but can sometimes be depressed, possibly by abortion or lack of pollination (USFWS, 2007). It generally flowers from May to June, with fruiting from June to July (USFWS, 1988).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Pinyon-juniper woodlands (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: 20 - 40% slopes (USFWS, 1988)

Geographic or Habitat Restraints or Barriers

Adult: 7,500 - 8,400 ft. elevation (USFWS, 2007)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Habitat Narrative

Adult: Occurs in Pinyon-juniper woodlands on steep easily eroded sandstone slopes and clay banks, usually in close association with the Chinle and Baca Formations. The environmental specificity is very narrow (specialist or community with key requirements scarce) (NatureServe, 2015). Zuni fleabane is specialized to nearly barren shale outcrops that have not yet been occupied by any exotic plant or animal species (Sivinski, unpublished observations, 1991, 1999, 2004). Occupied habitats range in elevation from 7,500 to 8,400 feet (USFWS, 2007). The core of most of the population sites is centered on loose, non-crust soil on slopes of 20 - 40% (USFWS, 1988).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Moderate (inferred from USFWS, 2007)

Representation:

Moderate (inferred from USFWS, 2007)

Redundancy:

High (inferred from USFWS, 2007)

Number of Populations:

39 (USFWS, 2007)

Population Size:

2500 - 100,000 individuals (NatureServe, 2015)

Adaptability:

High (inferred from USFWS, 2007)

Population Narrative:

Sites vary in the number of plants from just a few to over 5000 (FWS 2007b). The estimated population size is 2,500 - 100,000 (NatureServe, 2015). The present total for Zuni fleabane is 3 metapopulations in widely separate mountain ranges with a total of 39 local populations. All populations appeared to be healthy and reproductive when located or revisited (Sivinski and Tonne 1999, 2004; Christie 2004). The three regional metapopulations of Zuni fleabane are geographically isolated from one another and morphologically very similar (Sivinski, unpublished observation, 2004). The absence of obvious variability between metapopulations indicates a lack of genetic drift or differentiation since these populations became isolated (USFWS, 2007).

Threats and Stressors

Stressor: Mineral exploration and development (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: All known populations of Zuni fleabane are within Federal or tribal jurisdictions where there are few potential threats at this time. The only significant potential threat to Zuni fleabane at this time is mineral exploration and development. This species is confined to the Chinle and Baca geologic formations, which are known for uranium claims and subsequent mining. Oil and gas exploration and development is currently occurring in the vicinity of a Chuska Mountains local population. No other populations are within known areas of active gas or oil exploration or development. The Energy Bill passed by Congress in 2005 may reinvigorate development plans for new nuclear energy generating stations that would use uranium as fuel. Greater future demand for this mineral could increase its market price and potentially revive the uranium mining industry in New Mexico. The northern-most Chuska Mountain population of Zuni fleabane in Arizona is the only population that has actually been impacted by a mineral prospect, possibly for uranium (Sivinski and Tonne 2004) (USFWS, 2007).

Recovery**Reclassification Criteria:**

Not available

Delisting Criteria:

1. Complete a survey of all potential habitat of Zuni fleabane (USFWS, 2007).

2. Develop and implement a habitat management plan and install permanent monitoring plots within several populations of Zuni fleabane (USFWS, 2007).

3. A demonstrated long-term stability (or increase) in population levels and habitat from the monitoring plots, and a continued assurance that the habitat of Zuni fleabane will not be threatened by mining exploration, leasing, or development (USFWS, 2007).

Recovery Actions:

- Remove threats by coordinating with the Bureau of Land Management and the U.S. Forest Service (USFWS, 1988).
- Enforce existing laws and regulations (USFWS, 1988).
- Assemble documentation on mineral potential or planned development (USFWS, 1988).
- Develop a habitat management plan in cooperation with the involved agencies for the long-term protection of habitat (USFWS, 1988).
- Install permanent monitoring plots at population and initiate biological, ecological and geological studies of the species and its habitat to develop an understanding of the requirements needed to sustain healthy populations (USFWS, 1988).
- Develop public support for the preservation of Zuni fleabane (USFWS, 1988).

Conservation Measures and Best Management Practices:

- The highest priority to facilitate recovery for Zuni fleabane is to revise the recovery plan. Threat assessments and recovery criteria should incorporate new information and clearly define recovery actions. Because the only significant potential threat to Zuni fleabane at this time is uranium mining, the revised recovery plan should contain objective, measurable criteria to alleviate this threat. Administrative actions by Federal land management agencies to reduce the threats from mining activities will be necessary to fully recover the species (USFWS, 2007).
- After the Recovery Plan is revised, the Service should work with the U.S. Forest Service and Bureau of Land Management to develop priorities and protocols for withdrawing current and future mineral claims from portions of Zuni fleabane habitats. Administrative mineral withdrawals should be quickly implemented. Although the recovery priority for this species is low, its potential for recovery is presently high. Should the price of uranium increase in the future, the minerals under significant populations of Zuni fleabane could be claimed again and the opportunity for recovery lost (USFWS, 2007).
- Special management areas, such as Areas of Critical Environmental Concern, may not provide the long-term assurance suitable for recovery criteria. Special management area prescriptions to withdraw minerals from claim are temporary and could be eliminated after Zuni fleabane is removed from the list of threatened species. Should the special management area protections cease, Zuni fleabane may need protection afforded by its current threatened status again. Therefore, the recovery criteria should address the long-term need for special management after Zuni fleabane is removed from the list of threatened species (e.g., Recovery Management Agreement; Scott, et al. 2005) (USFWS, 2007).

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SPECIES ACCOUNT: *Eriodictyon altissimum* (Indian Knob mountain balm)

Species Taxonomic and Listing Information

Listing Status: Endangered; 1/17/1995; California/Nevada (Region 8)

Physical Description

A diffusely-branched, evergreen shrub with a main stem, long narrow leaves (5—9 cm/i .0 in—3 .5 in length, 2—4 mm/0.08—0.16 in width), and lavender bell-shaped flowers (11—16 mm/0.43—0.63 mm length). The species attains heights up to 5.5 m/i 8.0 ft tall and with a basal stem up to 20 cm/7.9 in diameter. Possesses aboveground stems and underground rhizomes. (USFWS, 2019b)

Taxonomy

First collected on Indian Knob by Philip V Wells in 1960, and was described by him two years later (Wells 1962). In the waterleaf family (Hydrophyllaceae). (USFWS, 1998) Recognized by Kartesz (1994 checklist and 1999 floristic synthesis); Kartesz notes (pers. comm. to Larry Morse, 25Nov99) that "this appears to be a large-flowered expression of *Eriodictyon angustifolium*, but is probably worthy of recognition as a species." Skinner and Pavlik (1994) note that its taxonomic relationship to *E. angustifolium* needs clarification. The 2nd edition of The Jepson Manual (Baldwin et al. 2012) accepts it as distinct. (NatureServe, 2015)

Historical Range

Endemic to western San Luis Obispo County, California (USFWS, 2019b)

Current Range

Known from several locations in San Luis Obispo County, California (USFWS, 2019b)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual and asexual (USFWS, 1998)

Lifespan

Adult: Long-lived (USFWS, 1998)

Breeding Season

Adult: June to July (USFWS, 1998)

Reproduction Narrative

Adult: The Indian Knob mountain balm is believed to be relatively long-lived; slow-growing lichens can be found attached to its woody stems. Fruits contain a single ovule and seed set is low in those plants in which it has been recorded (John Chesnut, pers. comm. 1997). It is not known if Indian Knob mountain balm is self-compatible; however, it is possible that some colonies are also composed of a single clone. In addition to sexual reproduction, this species regenerates by root sprouts. (USFWS, 1998)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest/Woodland, Shrubland/chaparral, Woodland - Hardwood (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Prefers sandstone ridges (NatureServe, 2015)

Habitat Narrative

Adult: Indian Knob mountain balm occurs in soils derived from marine sandstones containing tar deposits referred to as “tarsands” and, in the northern part of its range, on Baywoodfine sands and weathered ancient dune soils. This species co-occurs with Morro manzanita in several locations in maritime chaparral. Vanderwier (1987) did a detailed study of the chaparral and oak woodland communities at the type locality for Indian Knob mountain balm. (USFWS, 1998)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Stable (USFWS, 2009)

Number of Populations:

7 (USFWS, 2019b)

Population Size:

>6,400 individuals in 2016 (USFWS, 2019b)

Population Narrative:

In 2019, Indian Knob mountain balm is still known from seven occurrences, six of which are in protected areas and one (the largest) mostly in a protected area, with a total population count of 6,489+ individuals in 2016. Two occurrences are likely extirpated. A figure is available in the 5-Year Review depicting known geographic distribution in western San Luis Obispo County, California. One new occurrence (Occurrence 8) is new. (USFWS, 2019b)

Threats and Stressors

Stressor: Habitat loss (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: At the time of listing, loss of habitat due to development, surface mining, and oil well drilling was identified as the primary threat to *Eriodictyon altissimum*. Since the time of listing, the threat of habitat loss due to development in the Los Osos area and surface mining, and oil well drilling in and around Indian Knob has been reduced to the point that we no longer consider this to be a significant threat to the species. The populations outside of Montaña de Oro State Park, with the exception of element occurrence 1 (Broderon), are now protected. Element occurrences 4 and 6 now are found within a Department ecological reserve and the majority of the plants in occurrence 5 (Indian Knob) are protected under a conservation easement held by the City of San Luis Obispo. (USFWS, 2009)

Stressor: Non-native invasive plants (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Modification of habitat due to the spread of invasive, non-native plant species was also a concern at the time of listing. Absent site-specific information from the implementation of management and monitoring programs, it is difficult to determine the actual severity of invasive, non-native species. No management plans or monitoring programs have been developed and implemented to detect change on conserved lands. Absent the type of information that would be collected and analyzed as part of such programs, it is not possible for us to determine if the occurrences are being adversely affected by competition from non-native invasive plant species. It does appear from anecdotal observations that all occurrences (except element occurrence 1) are stable and have not been significantly affected by competition from non-native invasive plant species. At element occurrence 1, veldt grass (*Ehrharta calycina*) appears to be degrading habitat, but its effect on *Eriodictyon altissimum* is unknown. (USFWS, 2009)

Stressor: Stochastic extinction (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: At the time of listing, we did not discuss stochastic extinction as a threat. The conservation biology literature commonly notes the vulnerability of taxa known from one or very few locations and/or from small and highly variable populations (e.g., Shaffer 1981, 1987; Primack 2006; Groom et al. 2006). In particular, although the plants are long-lived, the small sizes of all but the Indian Knob population may make it difficult for those populations to persist if conditions are not suitable for the establishment of new individuals. (USFWS, 2009)

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). Recently, the potential

impacts of climate change on the flora of California were discussed by Loarie et al. (2008). Based on modeling, they predicted that species' distributions will shift in response to climate change and that the species will "move" or disperse to higher elevations and northward, depending on the ability of each species to do so. Increases in species diversity in these higher elevations and northern locations due to climate change have the potential to result "...in new species mixes, with consequent novel patterns of competition and other biotic interactions..." with unknown consequences to the species which currently exist there (Loarie et al. 2008). While, we lack adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors such as small population size, will affect *Eriodictyon altissimum*; small ranged species, such as *E. altissimum*, are more vulnerable to extinction due to these changing conditions (Loarie et al. 2008). (USFWS, 2009)

Recovery

Reclassification Criteria:

1. At least five occurrences from throughout its range are on lands secure from human-induced threats. (USFWS, 1998)
2. Surrounding habitat is protected in amounts adequate to permit management of the vegetation community using prescribed fire, if it is deemed beneficial to the species. (USFWS, 1998)
3. Populations are projected to be self-sustaining and either stable or increasing as determined by long-term monitoring and research results. (USFWS, 1998)

Delisting Criteria:

When the downlisting criteria have been met for a species, the species can be considered for delisting if:

1. Threats are reduced or eliminated so that occurrences are capable of persisting without significant human intervention or perpetual endowments are secured for management necessary to maintain the continued existence of the species. The most outstanding management needs currently are: a) integrate, or find a replacement for, a fire regime as a means of revitalizing declining or senescing colonies; b) manage adjacent shrub habitat through thinning to provide sufficient space for the species to expand in numbers, and c) educational signing to deter the public from cutting shrubs along trails; (USFWS, 2019a)
2. The occurrences remain viable for at least 15 years to demonstrate long-term viability under a range of environmental conditions. Rangewide surveys in 2016 and 2017 provide a baseline for numbers of stems or individuals, and in some cases, additional information regarding vigor of individuals, as measured by size. These data should provide a basis for monitoring occurrence attributes to determine viability over time; (USFWS, 2019a)
3. An ex situ collection of plant material is established in a Center for Plant Conservation-affiliated botanic garden. A soil seedbank would typically provide a strategy for a species to regenerate populations in the face of stochastic events as well as natural senescence. However, this species is suspected to have low seed production. Research on seed production and viability will be undertaken in the near future. Whether reproduction through banked seed proves to be

efficacious or not, reproduction through vegetative propagation (e.g. cuttings) also holds potential as a means of replenishing occurrences, should it be necessary in the future. (USFWS, 2019a)

Recovery Actions:

- Secure populations and habitat on unprotected lands. Methods for securing lands include in-fee purchase, gifts of easement or fee interest by the property owner, deed restrictions (provided restrictions cannot be changed privately without the knowledge of Federal, State and County agencies), acquisition of property rights (e.g., development rights) or permanent conservation easements. (USFWS, 1998)
- Manage secured lands to control or eliminate other known threats. Although habitat alteration through development is currently the most substantial and irreversible threat facing all of the species in this plan, the management of lands secured from development will remain a formidable task, made more so in those cases where the secured habitats are adjacent to high density residential and urban development. (USFWS, 1998)
- Evaluate potential threats and conduct management-oriented research. Conduct habitat-oriented research for Morro Bay species. Conduct species-specific research. Evaluate research results and use in future management. (USFWS, 1998)
- Determine population dynamics and effects of recovery efforts. Studies should be conducted to learn the number and size of successful self sustaining populations for the species to establish criteria for its reclassification. (USFWS, 1998)
- Develop and implement an education/information program. The benefits of protecting native species and their habitats and maintaining native biological communities should be explained clearly to all concerned parties. (USFWS, 1998)
- Reevaluate recovery criteria and revise recovery plan based on expanded knowledge from research, monitoring, and management. The scientific validity of the recovery criteria and recovery plan should be reviewed and revised as more information becomes available. The criterion of maintaining sufficient numbers of populations or conservation areas should be assessed, and the success or failure of management actions should be evaluated. (USFWS, 1998)
- Recommendations for Future Actions from 2019 5-Year Review: Little is known about the biology and ecology of Indian Knob mountainbalm in 2019. Therefore, coordinated conservation and research are needed to further understand the species, and to restore and maintain the five extant occurrences. These efforts should include: • Management actions to benefit the occurrences. • Searches for additional locations. • Introduction of Indian Knob mountainbalm into living collections at botanic gardens. • Seed collection for seed banking, with a subset of seeds used to investigate germination requirements, including cues associated with fire-following species. • Collection and cultivation of cuttings along with seeds to develop protocols for propagation of the species. • Studies of genetic diversity and reproductive biology, potential barriers to recruitment, and the species' relationship with fire. In particular, genetic diversity within and among the occurrences should be investigated. (USFWS, 2019b)

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SPECIES ACCOUNT: *Eriodictyon capitatum* (Lompoc yerba santa)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/20/2000; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

An evergreen shrub, growing to about 3 m tall with narrow, leathery leaves. Lavender flowers are tubular, borne in head-like, densely hairy clusters. Blooms May-August. (NatureServe, 2015)

Taxonomy

Since the time of listing, a phylogenetic study provided evidence supporting the transfer of the genus *Eriodictyon* from the waterleaf family (Hydrophyllaceae) to the borage family (Boraginaceae) (Jepson Online Interchange 2010). (USFWS, 2011)

Historical Range

According to records available through the CNDDDB (2010) and the Consortium of California Herbaria (Consortium) (2010), all historical collections and unvouchered observations of *Eriodictyon capitatum* are from the southwestern corner of Santa Barbara County. Other studies (Elam 1994, Jacks et al. 1984) recognized seven populations of *E. capitatum* based on the number of "Element Occurrences" (occurrences) at the time and as defined by CNDDDB criteria. five populations are from three geographically distinct areas referred to here as Solomon Hills, west Burton Mesa, and Santa Ynez Mountains (USFWS, 2011)

Current Range

Eriodictyon capitatum is endemic to southwestern Santa Barbara County, California. It is found in three areas of the county: on Vandenberg Air Force Base, on the west crest of the Santa Ynez Mountains on Hollister Ranch, and on Graciosa Ridge in the Solomon Hills southeast of Orcutt. The entire range extent covers about 365 sq mi. (NatureServe, 2015)

Critical Habitat Designated

Yes; 11/7/2002.

Legal Description

On November 7, 2002, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Eriodictyon capitatum* (Lompoc yerba santa) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in California (67 FR 67968-68001).

Critical Habitat Designation

The critical habitat designation for *Eriodictyon capitatum* includes three CHUs in Santa Barbara County, California. This species critical habitat encompasses approximately 9,709 acres (67 FR 67968-68001).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Eriodictyon capitatum* critical habitat consists of two components (67 FR 67968-68001):

Special Management Considerations or Protections

Special management considerations or protections may be needed to maintain the primary constituent elements for the two taxa within the units being designated as critical habitat. In some cases, protection of existing habitat and current ecological processes may be sufficient to ensure that populations of the plants are maintained at those sites, and have the ability to reproduce and disperse in surrounding habitat. In other cases, however, active management may be needed to maintain the primary constituent elements for the two taxa. We have outlined below the kinds of special management and protection that these two taxa would most likely require. These recommendations for management and protection are general in nature. Specific management actions should be developed according to local site conditions. Not all of these will apply to each plant taxon equally. (1) Existing soil conditions should be protected by avoiding activities that cause the erosion or compaction of soils. Maintaining an intact soil profile may be necessary to maintain edaphic features such as a horizon of permeable sandy soils on the surface layer. For example, *Deinandra increscens* ssp. *villosa* is thought to be restricted to acidic, fine sandy loams with a subsurface clay layer that may act as a reservoir of soil moisture. (2) Existing hydrologic conditions should be protected by avoiding activities that cause a change in surface or subsurface water flows upon which the plant taxa depend. For example, development of areas adjacent to a population may result in an increase in runoff and surface water flow. This alteration may affect the soil moisture content to which the local population has adapted. (3) In all plant communities where these taxa occur, invasive, non-native species, such as harding grass (*Phalaris aquaticus*), veldt grass (*Ehrharta calycina*), and iceplant (*Carpobrotus edulis*), should be actively managed. Invasive non-natives pose a serious threat to the survival of *Deinandra increscens* ssp. *villosa* and *Eriodictyon capitatum* and remaining habitat of the taxa. For example, accumulated dead leaves and stems (thatch) from nonnative grass species that dominate the habitat effectively prevent the establishment of *D. increscens* ssp. *villosa* at a site. Iceplant is known to invade native maritime chaparral vegetation occupied by *Eriodictyon capitatum*. Once non-native grasses and other invasive plants (e.g., iceplant) have become established, they cannot be removed without great expenditure of time and effort. (4) The composition of the native plant and animal communities associated with the taxa must be maintained. Native plant diversity may limit the ability of aggressive non-native plants to invade a population (Dukes 2002). In addition, a decline in biodiversity may increase the potential impact of invasive plants on a community (e.g., suppression of growth). Recent research suggests that grassland communities with fewer species may be more likely to decline as a consequence of invasion (Dukes 2001). In addition, native plant diversity may increase pollinator activity and therefore enhance the conservation of a plant species. Biologists have suggested that a plant population may persist as long as it occurs within an area of a diversity of plant species that are attractive to pollinators (Kwak 1988). Habitat fragmentation and isolation of species-rich grasslands, with intervening areas of no or low diversity of native plants, has been found to negatively affect plant-pollinator interactions (Stephann-Dewenter and Tschardt 1999). (5) The local distribution of plant communities should be managed to provide for the physical requirements of the taxa (e.g., space for establishment). For some grassland areas, it may be important to maintain openings within or between coastal scrub communities that might otherwise encroach upon grassland patches that support *Deinandra increscens* ssp. *villosa*. (6) Certain areas where these taxa occur may need fencing to protect them from accidental or intentional trampling by humans and livestock. Portions of three of the five units are currently used by livestock

Life History

Food/Nutrient Resources**Reproductive Strategy**

Adult: Sexual (outcrossing) and asexual (vegetative) (USFWS, 2011)

Dependency on Other Individuals or Species

Adult: While pollination ecology has not been specifically studied for *E. capitatum*, other *Eriodictyon* taxa are known to be pollinated by wasps, butterflies, and a variety of bee taxa, especially from the genera *Anthophora*, *Bombus*, *Chelostoma*, *Hylaeus*, *Osmia*, and *Nomadopsis* (Moldenke 1976). (USFWS, 2011)

Breeding Season

Adult: May to August (USFWS, 2011)

Reproduction Narrative

Adult: *Eriodictyon capitatum* is capable of both sexual and asexual reproduction. The importance of sexual reproduction in maintaining populations is unclear. Research indicates that *E. capitatum* is a self-incompatible species; intentionally cross-pollinated flowers produced a mean of 1.77 seeds per fruit, and intentionally self-pollinated flowers produced a mean of 0.03 seed per fruit (Elam 1994). This species spreads vegetatively through the production of rhizomes (underground stems), and thus producing colonies of ramets (genetically identical stems) from only a few individuals. The lavender flowers are tubular and clustered in heads that bloom from May to August. While pollination ecology has not been specifically studied for *E. capitatum*, other *Eriodictyon* taxa are known to be pollinated by wasps, butterflies, and a variety of bee taxa, especially from the genera *Anthophora*, *Bombus*, *Chelostoma*, *Hylaeus*, *Osmia*, and *Nomadopsis* (Moldenke 1976). (USFWS, 2011)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Shrubland/chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Highly acidic soils with high water-retaining capacity on inland sites (USFWS, 2011)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Habitat Narrative

Adult: *Eriodictyon capitatum* occurs within two different habitat types. Near the coast, it occurs within maritime chaparral and coastal sage scrub on sandstone soils from the Orcutt, Marina, and Oceano series. In this habitat type, it typically occupies disturbed areas near roads or exposed ridgetops (Jacks et al. 1984). On sites that are farther inland, *Eriodictyon capitatum* is found on diatomaceous Monterey shales. The structurally dominant *Pinus muricata* is one species that occurs at these sites. These sites have characteristic soils that are highly acidic and have a high water-retaining capacity (Cole 1974). *Eriodictyon capitatum* apparently can tolerate

and may be encouraged by minor disturbance (Savage 1978, CNPS 1987, Myers 1987). (USFWS, 2011; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Declining by 8.5% since 2006 (USFWS, 2011)

Resiliency:

Low (inferred from USFWS, 2011)

Representation:

Low (inferred from USFWS, 2011)

Redundancy:

Low (inferred from USFWS, 2011)

Number of Populations:

5 (USFWS, 2011)

Population Size:

1,520 (USFWS, 2011)

Population Narrative:

During surveys for *E. capitatum*, approximately 1,520 individuals were documented within known populations (SRS 2010). Overall, since 2006, there was an 8.5 percent decrease in the total number of individuals. This decline in the number of individuals has been attributed to low rainfall in previous years (SRS 2010). (USFWS, 2011)

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The increased use of the launch facilities at Vandenberg AFB due to nationwide Department of Defense base closures was identified as a threat to this species at the time of its listing (Service 2000). According to the final listing rule (Service 2000), increased use of Vandenberg AFB would potentially result in the loss or alteration of *Eriodictyon capitatum* habitat. Wildfires were cited as one example of how habitat could be lost or altered. In 1993, debris from a missile that was intentionally destroyed shortly after launching caused several fires and burned more than 162 ha (400 ac). In September of 1997, a 200-ha (500-ac) fire and a 600-ha (1,500-ac) fire burned near habitat occupied by *E. capitatum* (Los Angeles Times 1997a). In

November of 1997, a 495-ha (1,225-ac) fire was accidentally started on Vandenberg AFB by an Air Force explosives disposal team and was partially contained by setting a backfire through a population of *E. capitatum* (Los Angeles Times 1997b). Although increased use of Vandenberg AFB could result in the loss or alteration of *E. capitatum* habitat (e.g., wildfires), the number of launches per year is restricted. Habitat alteration and loss from development for military and commercial purposes was also identified as a threat to this species at the time of its listing (Service 2000). Habitat fragmentation within the Burton Mesa area continues. The original extent of Burton Mesa chaparral was approximately 9,000 ha (22,000 ac); by 1938, the extent had been reduced to 5,890 ha (14,554 ac), and by 1988, less than 3,500 ha remained (8,649 ac) (Davis et al. 1988). The only population of *Eriodictyon capitatum* on Vandenberg AFB that could be threatened by future development would be the 35th Street population. However, at this time, there are no plans to develop this area (Lum pers. comm. 2010). This population is also subject to disturbance from human activities because of its close proximity to paved and unpaved roads and the cantonment area. At present, it appears that the destruction and alteration of habitat due to an increased use of Vandenberg AFB remains a threat to *E. capitatum*. (USFWS, 2011)

Stressor: Non-native species (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: On Vandenberg AFB, *Ehrharta calycina* (veldt grass) was planted to stabilize sand dunes in the 1950s; with the aid of the prevailing onshore winds, it rapidly spread across Vandenberg AFB and onto Burton Mesa between 1979 and 1996 (Air Force 1996). This species spreads rapidly, both vegetatively and through a persistent seedbank, and is extremely difficult to eradicate once it has become established (Bossard et al. 2000). *Carpobrotus edulis* and *C. chilensis* are other nonnative species that threaten to alter the maritime chaparral habitat by forming dense mats (Odion et al. 1992). The *Eriodictyon capitatum* population located at 35th Street is the only population on Vandenberg AFB whose habitat is actively managed (e.g., removal of nonnative and invasive plant species). This population is located next to paved and unpaved roads and the cantonment area. Nonnative species such as *Cortaderia jubata*, *Pinus radiata* (Monterey pine), and *Eucalyptus globulus* (eucalyptus) have all invaded *E. capitatum* habitat in this area. The alteration of habitat due to an increase in nonnative species is still a threat to *E. capitatum* populations located on Vandenberg AFB. There is no information available on nonnative species that may threaten the populations of *E. capitatum* located in the Solomon Hills and Santa Ynez Mountains. (USFWS, 2011)

Stressor: Altered fire regime (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Habitat for *Eriodictyon capitatum* may be altered by the increase in *Ehrharta calycina* and subsequent increases in the frequency of wildfires. Invasive plants such as *E. calycina* can change the fuel properties of a site, which can in turn affect fire behavior, and ultimately alter fire regime characteristics such as frequency, intensity, extent, and seasonality of fire. If the regime changes subsequently promote the dominance of the invaders, then an invasive plant-fire regime cycle may be established, and restoration to preinvasion conditions becomes more difficult (Brooks et al. 2004). Although the natural fire return interval is unknown, because of its

low elevation and infrequent lightning strikes, it was probably greater than the 20 to 30-year fire return interval found across most of Vandenberg AFB (Hickson 1988). A shorter fire return interval than the one that naturally occurs could negatively impact native plant species by destroying plants before seed set occurs or destroying the seed bank. (USFWS, 2011)

Stressor: Oil extraction and energy activities (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Although we did not discuss it in Factor A in the rule to list *Eriodictyon capitatum*, we discussed elsewhere in the rule that oil extraction and refinement (e.g., maintenance activities, hazardous waste cleanup) are activities taking place at the Solomon Hills site where this species occurs. Since the time of listing, several activities have been conducted within habitat for this species in the Solomon Hills. In 2007 and 2010, projects to maintain well pads and adjacent roads were undertaken by Breitburn Energy Company. The purpose of these projects was to trim or remove *E. capitatum* stems that had encroached onto cleared well pads, oil drilling and processing equipment, wells, power poles, and other areas. During such activities, only stems that are in areas where they pose a fire safety risk or operational constraint are removed. At this time, it does not appear that oil extraction and energy development activities are a threat to *E. capitatum*. (USFWS, 2011)

Stressor: Development of Hollister ranch (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: While development on Hollister Ranch is considered low-density (approximately 50 single-family homes as of 2009), these residential homes are often associated with other development including accessory buildings, agricultural development, reservoirs and roads, all of which have increased the demand on limited water resources and have resulted in the alteration and degradation of portions of the natural landscape (County of Santa Barbara Planning and Development Department 2009). An undated botanical survey (Hollister Ranch Conservancy 2003) indicates that *E. capitatum* occurs on six contiguous parcels in the western portion of Hollister Ranch. Of these six parcels, an undeveloped parcel has been sold and a second parcel has a completed residence and is available for purchase (Hollister Ranch Realty 2010). All six of these parcels are located within designated critical habitat for the species and could be developed. Development on Hollister Ranch is regulated under CEQA and requires the lead agency (i.e., County of Santa Barbara) to avoid or mitigate a project's significant environmental impacts if alternatives or mitigation measures are feasible. However, determination of the adequacy of avoidance or mitigation strategies is at the discretion of the County of Santa Barbara. Therefore, we believe that development is a threat to the population of *E. capitatum* located on Hollister Ranch. (USFWS, 2011)

Stressor: Stochastic extinction (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: As stated in the 2000 final listing rule, we continue to believe that the existence of five populations of *Eriodictyon capitatum* and the species' restricted distribution place this species at

risk of extinction from stochastic events. The conservation biology literature commonly notes the vulnerability of taxa known from very few locations and/or from small and highly variable populations (e.g., Shaffer 1981, 1987; Groom et al. 2006; Primack 2006). This vulnerability can arise due to uncertainty with stochastic events, such as environmental stochasticity, natural catastrophes, genetic stochasticity, and demographic stochasticity. Populations of *E. capitatum* are subject to all of these stochastic events. Elam (1994) found that two of the six populations she studied were uniclonal. Because *E. capitatum* is self-incompatible and cannot produce viable seed, a uniclonal population can be extirpated by both environmental stochasticity (e.g., prolonged drought) and natural catastrophes (e.g., wildfire). Furthermore, genetic stochasticity can result in a loss of genetic variation and subsequently decrease population viability. (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: At the time of listing, we did not discuss the potential effects of climate change on the long-term persistence of *Eriodictyon capitatum*. Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, Intergovernmental Panel on Climate Change 2007). It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to *Eriodictyon capitatum* at this time. (USFWS, 2011)

Recovery

Reclassification Criteria:

Reclassification criteria are not available.

Delisting Criteria:

Delisting criteria are not available.

Recovery Actions:

- Recovery actions are not available.

Conservation Measures and Best Management Practices:

- Complete a Recovery Outline and Species Action Plan for *Eriodictyon capitatum* as a first step in preparing a recovery plan for the species. (USFWS, 2011)
- Develop a survey protocol for *Eriodictyon capitatum*. Because of its clonal habit, surveyors may develop their own methods or may avoid counting the number of individuals. Creating a survey protocol would encourage documentation of the number of plants and would allow comparison across the species range. (USFWS, 2011)
- Work with representatives from Breitburn Energy Company, CDFG, and Hollister Ranch to ensure that management of their lands is consistent with the long-term persistence of *Eriodictyon capitatum* at those sites. In addition, maintain contact with these representatives to ensure that survey information is updated on a regular basis. (USFWS, 2011)

- Conduct genetic testing in collaboration with representatives from the Air Force, Breitburn Energy Company, CDFG, and Hollister Ranch. Genetic testing can determine if a population is uniclonal or multiclonal. This information could aid in developing appropriate management decisions and conservation strategies for each population. (USFWS, 2011)
- Discuss with conservation experts if cross-pollination of uniclonal populations with multiclonal populations would be an appropriate management strategy to increase the amount of viable seed produced. This would aid in increasing genetic diversity within uniclonal populations. (USFWS, 2011)

References

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

USFWS. 2015. Environmental Conservation Online System (ECOS) – Species Profile. <http://ecos.fws.gov/speciesProfile/>. Accessed June 2016.

USFWS. 2011. *Eriodictyon capitatum* (Lompoc yerba santa) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Ventura Fish and Wildlife Office Ventura, California

U.S. Fish and Wildlife Service. 2002. Endangered and Threatened Wildlife and Plants

Designation of Critical Habitat for *Eriodictyon capitatum* (Lompoc yerba santa) and *Deinandra increscens* ssp. *villosa* (Gaviota tarplant)

Final Rule. 67 FR 67968-68001 (November 7, 2002).

NatureServe. 2015. NatureServe Explorer: an encyclopedia of life [web application]. Accessed 06/27/2016

SPECIES ACCOUNT: *Eriogonum apricum* (incl. var. *prostratum*) (lone (incl. Irish Hill) buckwheat)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

Low-growing, herbaceous perennial; Polygonaceae. (NatureServe, 2015)

Historical Range

Known only from an approximate 16-kilometer (km) (10-mile (mi)) stretch along the lone Formation in western Amador County. Although little information is available to determine the historical extent of either *E. apricum* variety, and there has been a loss of natural occurrences within the range, the species still persists throughout its estimated historical range. All of the historical and current occurrences are between the village of Buena Vista in the south and Highway 16 in the north 6 (CNDDDB 2008). At the time of listing, it was suggested that the range of *E. apricum* var. *apricum* may extend to cover portions of Sacramento County (Service 1999, p. 28406); however, surveys conducted in 2001 have placed all of the *E. apricum* var. *apricum* plants in Amador County (Service 2005, p. 15). (USFWS, 2010)

Current Range

lone Formation, Amador Co, California. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Habitat Type

Adult: Chaparral (Natureserve, 2015)

Dependencies on Specific Environmental Elements

Adult: Coarse, very acidic, nutrient-poor soils with cement-like, iron oxide crusts (NatureServe, 2015).

Habitat Narrative

Adult: Species inhabits coarse, very acidic, nutrient-poor soils with cement-like, iron oxide crusts. On these soils - developed under a tropical or subtropical climate 35-57 million years ago - a distinctive, low-growing chaparral community occurs, usually surrounded by taller, more common chaparral types. *Eriogonum apricum* is restricted to otherwise barren red clays within these "lone chaparral" communities. Most populations occur between 90 and 280 m elevation. (NatureServe, 2015)

Dispersal/Migration

Population Information and Trends**Number of Populations:**

6 - 20 (NatureServe, 2015)

Population Narrative:

Occupies a total of approximately 4 hectares (Fish and Wildlife Service 1999). 6 sites ranked above C; 10 total EOs in NDDDB. According to Fish and Wildlife Service (1999), there are nine occurrences. (NatureServe, 2015)

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The primary threat to *Eriogonum apricum* habitat is mining for silica sand, clay, lignite, common sand and gravel. Development for commercial or residential development, clearing for agriculture, and fire protection are lesser threats (USFWS, 2010).

Stressor: Stochastic events and climate change (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Events such as disease outbreaks, reproductive failure, extended drought, landslides, or a combination of several such events, could destroy part of a single population or entire populations. A local catastrophe could also decrease a population to so few individuals that the risk of extirpation due to genetic and demographic problems inherent to small populations would increase. Climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying. However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects (USFWS, 2010).

Recovery**References**

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

USFWS. 2015. Environmental Conservation Online System (ECOS) – Species Profile.
<http://ecos.fws.gov/ecp0/>. Accessed June 2016.

USFWS 2010. *Eriogonum apricum* (inclusive of vars. *apricum* and *prostratum*) (Ione Buckwheat = Irish Hill Buckwheat) *Arctostaphylos myrtifolia* (Ione Manzanita) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Sacramento Fish and Wildlife Office Sacramento, California. Accessed June 2016.

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.”

USFWS. 2010. *Eriogonum apricum* (inclusive of vars. *apricum* and *prostratum*) (lone Buckwheat = Irish Hill Buckwheat)

Arctostaphylos myrtifolia (lone Manzanita)

5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California. 24 pp.

SPECIES ACCOUNT: *Eriogonum codium* (Umtanum Desert buckwheat)

Species Taxonomic and Listing Information

Listing Status: Threatened; 05/23/2013; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

A low, mat-forming woody perennial. Slow-growing and long-lived. Leaves are covered with dense white hairs. Flowers are yellow. (NatureServe, 2015)

Taxonomy

Species from Washington state published in: Reveal, J.L., Caplow, F.E., Beck, K.A. 1997. *Eriogonum codium* (Polygonaceae: Eriogonoideae), A new species from south-central Washington. *Rhodora*. 97: 350-356. (NatureServe, 2015)

Historical Range

Umtanum desert buckwheat was discovered in 1995 during a botanical survey of the Hanford installation (Reveal et al. 1995, p. 353). It is unknown if the historic distribution of Umtanum desert buckwheat was different than the species' current distribution, but it is likely the species has been confined to this location during at least the last 150 years (USFWS, 2013).

Current Range

One ridgeline, Benton County, southeastern Washington. (NatureServe, 2015) Found only on the Hanford Reach of the Columbia River. The only known population of Umtanum desert buckwheat occurs along the top edges of the steep slopes on Umtanum Ridge (USFWS, 2013).

Critical Habitat Designated

Yes; 12/20/2013.

Legal Description

On December 20, 2013, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Eriogonum codium* (Umtanum Desert buckwheat) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Washington (78 FR 76995-77005; 78 FR 24008-24032).

Critical Habitat Designation

The critical habitat designation for *Eriogonum codium* includes one CHU in Benton County, Washington. This species critical habitat encompasses approximately 334 acres (ac) (139 hectares (ha)) (78 FR 76995-77005; 78 FR 24008-24032).

This critical habitat unit was mapped using Universal Transverse Mercator, Zone 11, North American Datum 1983 (UTM NAD 83) coordinates. These coordinates establish the vertices of the unit boundaries. The maps in this entry, as modified by any accompanying regulatory text, establish the boundaries of the critical habitat designation. The coordinates or plot points or both on which the map is based are available to the public at the field office Internet site (<http://www.fws.gov/wafwo/HanfordPlants/FLFCH.html>), <http://www.regulations.gov> at Docket No. FWS-R1-ES-2013-0012, and at the Service's Washington Fish and Wildlife Office. You may

obtain field office location information by contacting one of the Service regional offices, the addresses of which are listed at 50 CFR 2.2.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Eriogonum codium* critical habitat consists of five components (78 FR 76995-77005; 78 FR 24008-24032):

- (i) North- to northeast-facing, weathered basalt cliffs of the Wanapum Formation at the eastern end of Umtanum Ridge in Benton County that contain outcrops, cliff breaks, slopes, and flat or gently sloping cliff tops with exposed pebble and gravel soils.
- (ii) Pebbly lithosol talus soils derived from surface weathering of the top of the Lolo Flow of the Priest Rapids Member of the Wanapum Formation.
- (iii) Sparsely vegetated habitat (less than 10 percent total cover), containing low amounts of nonnative or invasive plant species (less than 1 percent cover).
- (iv) The presence of insect pollinator species.
- (v) The presence of native shrub steppe habitat within the effective pollinator distance (300 m (approximately 980 ft)) around the population.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and that may require special management considerations or protection. All areas designated as critical habitat as described below may require some level of management to address the current and future threats to the physical and biological features essential to the conservation of Umtanum desert buckwheat. In all of the described units, special management may be required to ensure that the habitat is able to provide for the biological needs of the species. Further studies leading to an enhancement or reintroduction plan may be necessary to increase population size and prepare for recovery postwildfire. More research is needed to determine habitats most suitable for expansion of the current population. In summary, special management considerations or protections should address activities that would be most likely to result in the loss of Umtanum desert buckwheat plants or the disturbance, compaction, or other negative impacts to the species' habitat. These activities could include, but are not limited to, recreational activities and associated infrastructure, off-road vehicle activity, dispersed recreation, wildfire, and wildfire suppression activities. Special management considerations or protection will conserve the primary constituent elements for the species. Management activities that could ameliorate these threats include, but are not limited to, the fire management plan that has been completed for the Hanford installation (DOE 2011, p. 93) and recently revised to incorporate more detailed management objectives and standards. Though not intended to specifically address Umtanum desert buckwheat, implementation of this plan will contribute to the protection of the primary constituent elements (and physical or biological features) by: (1) Using a map of "sensitive resources" on the site during implementation, including the location of Umtanum desert buckwheat habitat; (2) requiring a biologist to assist the command staff in protecting these environments during wildfire

suppression efforts; and (3) restricting public access to the entire Umtanum desert buckwheat site, including the pollinator use area. Public access without security clearance is currently prohibited at the Umtanum desert buckwheat site, reducing the risk of trampling or crushing the plants by ORV use. Special management to protect the designated critical habitat areas and the features essential to the conservation of Umtanum desert buckwheat from the effects of the current wildfire regime may include preventing or restricting the establishment of invasive, nonnative plant species, post-wildfire restoration with native plant species, and reducing the likelihood of wildfires affecting the population and nearby plant community components. These actions may be achieved by detailed fire management planning by the DOE, including rapid response and mutual support agreements between the DOE, the Monument, the U.S. Department of the Army, Bureau of Land Management, and the Washington Department of Fish and Wildlife for wildfire control. These agreements should contain sufficient detail to identify actions by all partners necessary to protect habitat for Umtanum desert buckwheat from fire escaping from other ownerships.

Life History

Food/Nutrient Resources

Food/Nutrient Narrative

Adult: Growth rates are also extremely slow, with stem diameters increasing an average of only 0.17 millimeters (mm) (0.007 in) per year (The Nature Conservancy (TNC) 1998, p. 9; Dunwiddie et al. 2001, p. 62) (USFWS, 2013).

Reproductive Strategy

Adult: Sexual: self-pollination, cross-pollination (USFWS, 2013)

Lifespan

Adult: 100+ years (USFWS, 2013)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 2013)

Reproduction Narrative

Adult: Individual plants may exceed 100 years of age, based on counts of annual growth rings on cross sections of the main stems of recently dead plants. Preliminary counts indicate that seed set occurs in approximately 10 percent of flowers observed, potentially limiting reproductive capacity. Based on a pollinator exclusion study (Beck 1999, pp. 25–27), the species is probably capable of at least limited amounts of self-pollination, although the percentage of seed set in the absence of pollinators appears to be low. A variety of insect pollinators were observed on Umtanum desert buckwheat flowers, including ants, beetles, flies, spiders, moths and butterflies (TNC 1998, p. 8). Wasps from the families Vespidae and Typhiidae and a wasp from the species *Criosciolia* have been observed in the vicinity of Umtanum desert buckwheat, but not on the plant itself. A bumble bee, *Bombus centralis*, has been observed by Washington Department of Natural Resources (WDNR) specialists utilizing flowers of Umtanum desert buckwheat plants (Arnett 2011b, pers. comm.) (USFWS, 2013).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliff, grassland/herbaceous (NatureServe, 2015); scarp, scree (USFWS, 2013)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 335 and 390 meters (NatureServe, 2015)

Environmental Specificity

Adult: Narrow. Specialist or community with key requirements common. (NatureServe, 2015)

Habitat Narrative

Adult: Eriogonum codium is restricted to a particular basalt flow, growing on flat or gently sloping areas near the top of the steep basalt cliffs. This species is found at elevations between 335 and 390 meters (Washington Natural Heritage 2002). (NatureServe, 2015) As the basalt of the Lolo Flow weathers, a rocky soil type is formed that is classified as lithosol, a term describing the well-drained, shallow, generally stony soils over bedrock (Franklin and Dyrness 1973, p. 347), and talus slopes associated with eroding outcrops and cliffs. These cliffs (scarps) and loose rock at the base of cliffs or on slopes (defined as scree) are found along the crests and slopes of local hills and ridges, including east Umtanum Ridge, where Umtanum desert buckwheat occurs (USFWS, 2013).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Long-term trends suggest a decline of <30% to an increase to 25%, whereas short-term trends indicate declines of <30% to relatively stable populations (NatureServe, 2015)

Resiliency:

Very low (see current range/distribution)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Population Growth Rate:

Stable (NatureServe, 2015)

Number of Populations:

1 (NatureServe, 2015)

Population Size:

~5,000 (NatureServe, 2015)

Population Narrative:

Long-term population trends suggest a decline of <30% to an increase to 25%, whereas short-term trends indicate declines of <30% to relatively stable populations. The one known occurrence includes about 5,200 individuals (Dunwiddie et al. 2001). In 2011, 5,169 plants were counted at this one known population (USFWS 2012). The one known population has persisted for at least a century, and has been relatively stable (although showing a decline after a fire event) over the past decade. (NatureServe, 2015)

Threats and Stressors

Stressor: Climate change (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: climate change represents a potential ongoing threat based on the best available information, more thorough investigations are needed to better understand the potential impacts of climate change to this species.

Stressor: Habitat destruction and modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Factors adversely affecting habitat of Umtanum Desert buckwheat include wildfire and associated firefighting activities, nonnative plant fuel sources that increase the availability of wildfire fuel sources, and potentially wildfire suppression activities. Unauthorized livestock trespassing, prospecting, and off-road vehicle use represent potential threats, which appear to be presently reduced because of improved boundary integrity, access controls, fencing, and enforcement (USFWS, 2013).

Stressor: Predation (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation of seeds by ants and removal of flower heads by an unknown species has been observed by researchers during demographic monitoring trips. No Umtanum desert buckwheat seedlings have been observed successfully germinating or becoming established near ant colonies. Because seed predation and the removal of flowering structures could significantly reduce the reproductive potential of the species, which is already in gradual decline based on the results of the PVA, these activities are considered to be ongoing threats to Umtanum desert buckwheat (USFWS, 2013).

Stressor: Small population size and low recruitment (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Umtanum desert buckwheat has a small population size and distribution, and suffers from low recruitment. These features make it particularly susceptible to potentially changing climate conditions. The lack of establishment and survival of seedlings is a threat, as few plants are becoming established as replacements for plants that die (USFWS, 2013).

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

References

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

NatureServe. 2015. NatureServe Explorer: an online encyclopedia of life [web application]. Accessed August 2016

USFWS. 2016. Environmental Conservation Online System (ECOS) – Species Profile. <http://ecos.fws.gov/speciesProfile/>. Accessed August 2016

USFWS. 2013. Threatened Status for *Eriogonum cadium* (Umtanum Desert Buckwheat) and *Physaria douglasii* subsp. *tuplashensis* (White Bluffs Bladderpod)

Final Rule. 78 Federal Register 78, April 23, 2013. Pages 23984 - 24005.

U.S. Fish and Wildlife Service. 2013. Endangered and Threatened Wildlife and Plants

Threatened Status for *Eriogonum cadium* (Umtanum Desert Buckwheat) and *Physaria douglasii* subsp. *tuplashensis* (White Bluffs Bladderpod) and Designation of Critical Habitat. Final Rule. 78 FR 76995-77005 (December 20, 2013). U.S. Fish and Wildlife Service. 2013. Endangered and Threatened Wildlife and Plants

Threatened Status for *Eriogonum cadium* (Umtanum Desert Buckwheat) and *Physaria douglasii* subsp. *tuplashensis* (White Bluffs Bladderpod) and Designation of Critical Habitat. Final Rule. 78 FR 24008-24032 (April 23, 2013).

NatureServe. 2015. NatureServe Explorer: an encyclopedia of life [web application]. Accessed August 2016

SPECIES ACCOUNT: *Eriogonum gypsophilum* (Gypsum wild-buckwheat)

Species Taxonomic and Listing Information

Listing Status: Threatened; 02/19/1981; Southwest Region (R2). Proposed for Delisting (USFWS, 2017); Proposed Delisting

Physical Description

This plant is a woody stemmed perennial that grows in dense clumps and is approximately 20 cm high. The leaves are dark green, thick, mainly hairless, 1.5 - 2.5 cm wide and often wider than long, attached at the base, and have an outline like a hen's egg or a kidney. In the fall the leaves turn bright red. The yellow flowers, 1-2 mm long, and in a broad dense cluster, appear from May to July. (USFWS, 1984)

Taxonomy

This species was first collected by E. O. Wooton on August 6, 1909, and described by Wooton and Standley in 1913. There are many species in this genus but *Eriogonum gypsophilum* is not closely related to any other western species (Wooton and Standley 1913). (USFWS, 1984)
Gypsum wild-buckwheat is a distinct species without synonyms or taxonomic controversy. (USFWS, 2016)

Historical Range

See Current Range.

Current Range

In Eddy County, New Mexico. (USFWS, 2016)

Critical Habitat Designated

Yes; 2/18/1981.

Legal Description

On January 19, 1981, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective February 18, 1981) for *Eriogonum gypsophilum* (Gypsum wild-buckwheat) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in New Mexico (46 FR 5730-5733).

Critical Habitat Designation

The critical habitat designation for *Eriogonum gypsophilum* includes one CHU in Eddy County, New Mexico. This species critical habitat encompasses approximately 130 acres. A map is included in the Final Rule (USFWS, 1981; USFWS, 1984).

New Mexico: Eddy County; T20S. R25E. Section 19: N½, N½ NE¼ SE¼, N½ NW¼ SE¼; and T20S, R24E. Section 24: N½ NE¼, N½ S½ NE¼, NE¼ NW¼, N½ SE¼ NW¼; gypsum soils.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Eriogonum gypsophilum* critical habitat are not listed but are thought to be the following (46 FR 5730-5733):

Gypsum soils.

Special Management Considerations or Protections

Any activity which would result in disturbance of the area where *Eriogonum gypsophilum* occurs would probably adversely modify the Critical Habitat. The long-term solution on how to best protect *Eriogonum gypsophilum* may be to develop a protection plan for the species, which would address and remove present threats. In this respect, Critical Habitat designation may affect Federal activities. The Water and Power Resources Service should include in their planning process for the Brantley Dam Project ways to insure the continued existence of *Eriogonum gypsophilum*. These plans should address the problems of slumping of the gypsum soils and ways to protect the habitat of the *Eriogonum gypsophilum* so that it is not used for any activity which would not be compatible with the plant's continued existence. The Bureau of Land Management may need to limit future stocking rates of cattle and offroad vehicle use in the small area where the *Eriogonum gypsophilum* occurs. This increased planning and the steps required by these agencies should not constitute a large impact or hardship on either agency. (USFWS, 1981)

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, asexual: vegetative (USFWS, 2007)

Lifespan

Adult: 2+ (inferred from USFWS, 2007)

Breeding Season

Adult: May - July (USFWS, 1984)

Reproduction Narrative

Adult: Gypsum wild buckwheat is a perennial species that reproduces both by producing seed and also asexually by producing clone rosettes from rhizomes or root sprouts (USFWS, 2007). Flowers appear from May to July (USFWS, 1984).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Grama grassland, creosote bush communities (NatureServe, 2015); Chihuahuan desert scrub (USFWS, 1984)

Geographic or Habitat Restraints or Barriers

Adult: 900 - 1,500 m elevation (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Patchy and linear (USFWS, 2007)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015 and USFWS, 2007)

Habitat Narrative

Adult: Inhabits open, gypsum in grama grassland, at about 1,500 m; semi-arid. Eroded gypsum clay hills and fans, creosote bush communities, 900-1,100 m (Flora of North America Editorial Committee 2005) (NatureServe, 2015). It occupies gypsum soils and gypsum outcrops of the Permian-age Castile Formation. Distribution of gypsum wild buckwheat plants within its populations is patchy and follows geographic patterns of suitable gypsum outcrops, which are generally elongate and narrow (USFWS, 2007). It occurs in the Chihuahuan region of the Desert Scrub Formation (Donart et al. 1978) (USFWS, 1984).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Species Trends:**

Stable (USFWS, 2016)

Number of Populations:

3 (USFWS, 2016)

Population Size:

Estimated to be 50,548 individuals (USFWS, 2016)

Additional Population-level Information:

Distribution of gypsum wild-buckwheat plants within its populations is patchy and follows geographic patterns of suitable gypsum outcrops, which are generally elongate and narrow. The lengths of these occupied outcrops are approximately 2.7 kilometers (km) (1.7 miles (mi)) long for the Seven Rivers Hills population, 1.6 km (1 mi) long for the Black River population, and 3.5 km (2.2 mi) long for the Ben Slaughter Draw population. Patches of gypsum wild-buckwheat within populations are also relatively small. The area of occupied habitat is only 16.3 hectares (ha) (40.3 acres (ac)) at Seven Rivers Hills, little more than 11.9 ha (29.5 ac) at Black River, and 66.4 ha (164.1 acres) at Ben Slaughter Draw (including Hay Hollow) for a total range-wide extent of approximately 94.7 ha (233.9 ac) of habitat occupied by this species (Tonne 2005, Sivinski 2013). (USFWS, 2016)

Population Narrative:

Estimated numbers of individual plants at the three known locations are as follows: Seven Rivers Hills: 14,168; Black River: 16,660; Ben Slaughter Draw (including Hay Hollow): 19,720. Refined mapping techniques resulted in the delineation of 16.3 ha (40.3 ac) actually occupied by

gypsum wild-buckwheat. This is a significant reduction from the approximately 44 ha (109 ac) of occupied habitat identified previously by Spellenberg (1977) and Knight (1993). It appears BLM and Knight used the approximately 109 acres of occupied habitat as the multiplier for an average density estimate, thereby overestimating this population. This original acreage estimate was the basis for the recovery criteria to maintain a population of 10,000 plants at Seven Rivers Hills designated critical habitat area. The Black River and Ben Slaughter Draw populations of gypsum wildbuckwheat also occur as discontinuous patches of plants on the gypsum outcrops. Knight (1993) used belt transects to determine average density of plants within the Black River habitat. He estimated 32 ha (80 ac) of occupied habitat to arrive at a population estimate of 45,280 plants (rosettes). Subsequent GPS mapping (Tonne 2005) of this population significantly reduced the area of occupied habitat on BLM and state- owned lands within this population (the private land portion of this population was not mapped by Tonne). The discrepancies between the population boundaries in Knight's 1993 map and Tonne's 2005 map are more likely the result of the more accurate methods (e.g., use of a Global Positioning System) employed by Tonne than an actual reduction of population coverage between 1993 and 2005. A combination of Knight's (1993) average density estimate of 0.14 plants per m² (0.01 per ft²) and Tonne's map showing 11.9 ha (29.5 ac) of occupied habitat results in a minimum population number of 16,660 plants at Black River. This estimate may increase when the area of occupied habitat on the private land portion of this population is known. The largest population of gypsum wild-buckwheat occurs at Ben Slaughter Draw. Knight (1993) also sampled this population with belt transects to determine an average density of 0.03 plants per m² (0.002 per feet²) within occupied habitat. He arrived at a population estimate of 47,233 plants (rosettes) on 117 ha (288 ac). Subsequent GPS mapping of this population conforms to the general population boundaries of Knight's 1993 map, but significantly decreased the occupied habitat area to a more precise 62.4 ha (154.1 acres) (Tonne 2005). A total population estimate of 18,720 plants is obtained by using Knight's 1993 average density estimate and Tonne's 2005 mapped area of occupied habitat. These calculations for Ben Slaughter Draw do not include the 2013 rediscovery of the Hay Hollow portion of the population that he estimated 1,000-1,500 plants across less than 4.0 ha (10.0 ac) (Sivinski 2013). (USFWS, 2016)

Threats and Stressors

Stressor: Mineral extraction and development (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: All gypsum wild-buckwheat habitats are within areas with high potential for fluid minerals leasing and extraction. Oil and gas well pads, roads, and pipelines are proliferating in this region of New Mexico. The BLM SMA on the designated critical habitat of the Seven Rivers Hills population presently eliminates this threat through the requirement of "no surface occupancy" for mineral leases within the designated critical habitat. Roads and pipelines associated with mineral development also must avoid this area. The Seven Rivers Hills SMA protects about 95 percent of the occupied habitat from this land use. SMAs with "no surface occupancy" stipulations for oil and gas leases were also administratively placed on BLM jurisdictions containing gypsum wild-buckwheat habitats at the Black River and Ben Slaughter Draw populations in 1997 (BLM 1988, BLM 1997). These SMAs protect approximately 50 percent of the total habitat at Black River and Ben Slaughter Draw from oil and gas development (Tonne 2005). Approximately 65 percent of total habitat area in all three gypsum wild-buckwheat

populations is presently protected from surface impacts associated with oil and gas development. Knight (1993) concluded that mineral development for oil and gas, and possibly gypsum, was the only serious potential threat to gypsum wild-buckwheat. At this time, surface disturbance associated with federal mineral development is very unlikely to occur on gypsum wild-buckwheat habitats within the BLM SMAs. Mineral development could potentially affect nearly 50 percent of the Black River population. The private land portion of the Black River population could also be impacted by future minerals development. However, about 50 percent of the Black River habitat, about 95 percent of the Seven Rivers Hills habitat, and approximately 50 percent of Ben Slaughter Draw habitats have been protected by the "no surface occupancy" stipulation of the BLM SMAs (Tonne 2005). Oil and gas may be leased on these lands, but must be extracted by directional drilling from outside the SMAs. Directional drilling allows a company to develop fluid minerals without needing to be directly above (vertical of) the target, meaning this technology may afford greater avoidance options for conserving sensitive habitats. Rights-of-ways for the roads and pipelines associated with oil and gas development must also avoid disturbance of the SMAs. The Seven Rivers Hills and Ben Slaughter Draw SMAs also requires the withdrawal of minerals, such as gypsum, sulfur and salts, from claim and mine development. Mineral claims are not specifically withdrawn from the Black River SMA. The chemical analysis found the gypsum of the Castile Formation to be 85 percent hydric gypsum, which is a suitable quality for mining (Weber and Kottowski 1959, Knight 1993). Potential for gypsum mining of the Castile formation however, is low at this time because of large deposits of higher quality gypsum presently being mined elsewhere in New Mexico (Knight 1993). (USFWS, 2016)

Stressor: Reservoir Development and Flooding (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: The threat of flooding from Brantley Reservoir has not been fully realized, primarily due to the use of a spillway in the central section of the main dam (BOR 2009). The elevation of the spillway is 993.5 m (3,259.5 ft) mean sea level and the maximum water surface elevation of the reservoir is 1,006.9 m (3,303.5 ft) mean sea level. Water level peaked on March 29, 2015 (U.S. Geological Survey 2016) at approximately 4.0 m (13 ft) above the spillway at 997.5 m (3272.5 ft) elevation. Even at this highest level, the pool remained to the east of U.S. Highway 285 and the gypsum wild-buckwheat population. Knight (1993) analyzed the potential impacts from Brantley Reservoir reaching the maximum flood pool with the assumption that the water level would rise similarly across U.S. Highway 285. Under this assumption, the maximum flood event pool in Brantley Reservoir could temporarily flood a few hectares of gypsum wildbuckwheat habitat. He found eight gypsum wild-buckwheat plants at or below the 1,002.8 m (3,290 ft) level on the west side of U.S. Highway 285. The soils in this area would become saturated for a time after a flood and could potentially be invaded by saltcedar (*Tamarix* spp.), an invasive tree that often lines the banks of reservoirs. Knight surveyed another 6 m (20 ft) vertical up to the 1,009 m (3,310 ft) level where saltcedar might become established and located an additional 44 gypsum wild-buckwheat plants. In 1993, there were 52 plants in the hypothetical zone of maximum flood impact. A flood event could potentially impact about 100 plants in this population of several thousand plants. However, at the highest water level recorded in 2015, the water did not reach U.S. Highway 285 and the gypsum wild-buckwheat was not impacted. Therefore, Brantley Reservoir is not a significant threat to gypsum wild-buckwheat. The populations at Black River and Ben Slaughter Draw are not near any existing or proposed

reservoirs and therefore, are not threatened by flooding. The Seven Rivers Hills population is the only known population that could be affected by flooding. (USFWS, 2016)

Recovery

Reclassification Criteria:

Not applicable.

Delisting Criteria:

The criteria for delisting are based upon the designation of the critical habitat as a Bureau of Land Management (BLM) Area of Critical Environmental Concern (ACEC) to maintain the population of 10,000 individuals. Some other special use designation which would secure the area from degradation due to human activities would be acceptable. (USFWS, 1984)

Recovery Actions:

- Prevent further impacts by designating the critical habitat area as an ACEC; develop a management plan; manage livestock grazing and study its effects; regulate recreational use, including Off-Road Vehicle (ORV) traffic, in the habitat; and monitor the effects of raised water level in Brantley Reservoir (USFWS, 2016).
- Maintain healthy populations by studying gypsum wild buckwheat biology and habitat characteristics (USFWS, 2016).
- Inventory suitable habitats for new populations (USFWS, 2016).
- Develop public appreciation and support for gypsum wild buckwheat. (USFWS, 2016)
- Recommendation for Future Action from 2016 5-Year Review: Through Section 4 of the ESA, the Service is required to conduct a 12-month finding to review the petition request to delist the gypsum wild-buckwheat and concurrently propose to delist. A post-delisting monitoring plan will be developed and made available for public review and comment prior to a final rulemaking. (USFWS, 2016)

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SPECIES ACCOUNT: *Eriogonum kennedyi* var. *austromontanum* (Southern mountain wild-buckwheat)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/14/1998; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

Eriogonum kennedyi var. *austromontanum* (southern mountain wild buckwheat) is a woodybased, cushion-like, perennial plant in the buckwheat family (Polygonaceae). Individual plants are 8 to 15 cm (3.1 to 5.9 in) tall, with stems forming loose, leafy mats, 14 to 36 cm (5.5 to 14.1 in) wide. The leaves are oblanceolate (broadest above the middle and tapering toward the base) and 0.5 to 1 cm (0.2 to 0.4 in) long, with dense white hair. The inflorescences (flower clusters) are 8 to 15 cm (3.2 to 5.9 in) high, bearing head-like inflorescences. The perianth is white to rose, and composed of inner and outer lobes that are similar in appearance (Reveal 1989, pp. 326–327; Hickman 1993, p. 874). (USFWS, 2015)

Taxonomy

One of several species in a large and complex genus of western and southern North America. *Eriogonum kennedyi* var. *austromontanum* is distinguished from other members of the species within its range (*E. k.* var. *kennedyi* and *E. k.* var. *alpigenum*) by longer plant parts (inflorescences, leaves, fruits, and involucres) (Reveal 1989, pp. 326–327; Hickman 1993, p. 874). This taxon could also be confused with *Eriogonum wrightii* subsp. *subscaposum*, but *E. w.* subsp. *subscaposum* has branched inflorescences, wider leaves, shorter fruits, and is found in pine forests rather than on pebble plain habitat (Neel and Barrows 1990, p. 51; Rosatti 2013, pp. 1, 3). (USFWS, 2015)

Historical Range

See current range/distribution.

Current Range

Eriogonum kennedyi var. *austromontanum* is found in pebble plain habitat in the northeastern San Bernardino Mountains of southwest San Bernardino County. (USFWS, 2015)

Critical Habitat Designated

Yes; 1/25/2008.

Legal Description

On December 26, 2007, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective January 25, 2008) for *Eriogonum kennedyi* var. *austromontanum* (Southern mountain wild-buckwheat) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 13 critical habitat units (CHUs), in California (72 FR 73092-73178).

Critical Habitat Designation

The critical habitat designation for *Eriogonum kennedyi* var. *austromontanum* includes 13 CHUs in San Bernardino County, California. approximately 904 ac (366 ha) of Federal, State, and private land are being designated as critical habitat (72 FR 73092-73178). Units are grouped by

pebble plain complexes (e.g., Arrastre/Union Flat) as identified in the USFS's 2002 Management Guide. Detailed coordinates and maps are provided in the Final Rule. The 13 units total 904 ac (366 ha).

Units ERKA 1 and ERKA 2. Arrastre/Union Flat, San Bernardino County, California. ERKA 1 contains 69 ac (28 ha); ERKA 2 contains 229 ac (93 ha); the landowner is the U.S. Forest Service. ERKA 1 is USFS Pebble Plain Number 100; ERKA 2 is USFS Pebble Plain Number 87.

Unit ERKA 3, Big Bear Lake, San Bernardino County, California. ERKA 3 contains 6 ac (2 ha). The landowner is the U.S. Forest Service. ERKA 3 is USFS Pebble Plain Number 254.

Units ERKA 4 and ERKA 5. Fawnskin, San Bernardino County, California. ERKA 4 contains 15 ac (6 ha); ERKA 5 contains 24 ac (10 ha). The landowner is the U.S. Forest Service. ERKA 4 is USFS Pebble Plain Number 301; ERKA 5 is USFS Pebble Plain Number 302.

Units ERKA 6, ERKA 7, and ERKA 10. Gold Mountain and North Baldwin Lake, San Bernardino County, California. ERKA 6 contains 62 ac (25 ha); ERKA 7 contains 43 ac (17 ha); ERKA 10 contains 320 ac (129 ha). The landowner is the U.S. Forest Service. ERKA 6 is USFS Pebble Plain Number 188; ERKA 7 is USFS Pebble Plain Number 192.; ERKA 10 is USFS Pebble Plain Number 128.

Units ERKA 8 and ERKA 9. Holcomb Valley, San Bernardino County, California. ERKA 8 contains 28 ac (11 ha); ERKA 9 contains 44 ac (18 ha). The ERKA 8 landowner is the U.S. Forest Service (22 ac) and a private owner (6 ac). The ERKA 9 landowner is the U.S. Forest Service. ERKA 8 is USFS Pebble Plain Numbers 98 and 109; ERKA 9 is USFS Pebble Plain Number 153.

Units ERKA 11 and ERKA 12. Sawmill, San Bernardino County, California. ERKA 11 contains 36 ac (14 ha); ERKA 12 contains 5 ac (2 ha). The ERKA 11 landowner is the U.S. Forest Service (15 ac) and a private landowner (21 ac). ERKA 12 is privately owned. ERKA 11 is USFS Pebble Plain Number 236; ERKA 12 is USFS Pebble Plain Number 224.

Unit ERKA 13. South Baldwin Ridge/Erwin Lake, San Bernardino County, California. ERKA 13 contains 23 ac (9 ha) and is owned by the U.S. Forest Service. ERKA 13 is USFS Pebble Plain Number 212.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Eriogonum kennedyi* var. *austromontanum* critical habitat are the habitat components that provide (72 FR 73092-73178):

(i) Pebble plains in dry meadow-like openings within upper montane coniferous forest, pinyon-juniper woodlands, or Great Basin sagebrush in the San Bernardino Mountains of San Bernardino County, California; at elevations between 5,900 to 9,800 ft (1,830 to 2,990 m) that provide space for individual and population growth, reproduction and dispersal.

(ii) Seasonally wet clay, or sandy clay soils, generally containing quartzite pebbles, subject to natural hydrological processes that include water hydrating the soil and freezing in winter and drying in summer causing lifting and churning of included pebbles, that provide space for

individual and population growth, reproduction and dispersal, adequate water, air, minerals, and other nutritional or physiological requirements to the species.

Special Management Considerations or Protections

Critical habitat does not include manmade structures (such as buildings, aqueducts, airports, roads, and other paved areas) and the land on which they are located existing on the effective date of this rule and not containing one or more of the primary constituent elements.

Threats to listed pebble plains plants throughout their range include land development, off-highway vehicle (OHV) use off of designated routes, road maintenance activities, ground disturbance that affects surface hydrology, mining activities, recreational activities, and nonnative plant species (63 FR 49006; September 14, 1998). Pebble plain habitat is also threatened by vegetation and fuels management, hazard tree removal, and wildfire suppression activities (Eliason 2006). However, of the above threats, land development remains the primary cause of habitat loss on private lands; while on Federal lands, OHV use off of designated routes has historically been, and continues to be, the most significant threat to pebble plains habitat. Increasing residential populations adjacent to pebble plains habitat on private and Federal lands has also resulted in degradation of habitat, as dispersed recreation and unauthorized OHV use increases (Eliason 2006). Also, while forest system road use and maintenance, mining activities, and dispersed recreation continue to have adverse ongoing effects to pebble plain habitat and the species it supports, the magnitude and severity of effects caused by these activities are relatively small compared to the effects of unauthorized motorized vehicle use (Eliason 2006). The primary constituent elements for the listed pebble plains plants may require special management considerations or protection to minimize impacts associated with, (1) vehicle use and road maintenance; (2) recreational activities; and (3) the presence of nonnative species (63 FR 49006, September 14, 1998; USFS 2002, p. 17; USFS 2005, pp. 207, 249, 293).

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (outcrossing) (USFWS, 2015)

Dependency on Other Individuals or Species

Adult: Numerous types of wasps, bees, and flies have been recorded as pollinators on this plant (O'Brien 1979, p. 99; Freas and Murphy 1990, p. 6). (USFWS, 2015)

Breeding Season

Adult: July to September (USFWS, 2015)

Reproduction Narrative

Adult: This taxon flowers from July through September (Neel and Barrows 1990, p. 51).

Eriogonum kennedyi var. *austromontanum* produces seeds by selfing (self-pollinating) and entomophilous (insect-mediated) outcrossing (O'Brien 1979, p. 97). Numerous types of wasps, bees, and flies have been recorded as pollinators on this plant (O'Brien 1979, p. 99; Freas and Murphy 1990, p. 6). (USFWS, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Barrens, Forest - Conifer, Forest Edge, Forest/Woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Prefers no canopy cover, low leaf litter, and sunny areas; found at elevations between 2,000 to 2,200 m (6,557 to 7,213 ft) (USFWS, 2015)

Environmental Specificity

Adult: Narrow/specialist

Site Fidelity

Adult: High (inferred from USFWS, 2015)

Habitat Narrative

Adult: *Eriogonum kennedyi* var. *austromontanum* is restricted to pebble plain habitat (USFS 2002, p. 17), so described because of the layer of orange quartzite pebbles that are pushed to the clay soil surface by frost heaving and thawing (Krantz 1983, p. 10). Pebble plains are treeless, open patches within pine forests and pinyon-juniper woodlands (USFS 2002, pp. 12, 15). They contain unique plant associations and soil characteristics, associated with climatic features (Derby and Wilson 1979, p. 463; USFS 2002, pp. 12, 22–23). The deep clay deposits support an assemblage of small cushion-forming plants, tiny annuals, grasses and succulents that are low growing, sun tolerant and well-spaced (USFS 2005a, p. 100). Pebble plain endemic plants seem to have a specific competitive advantage for their particular specialized habitat, but lack that advantage in adjacent forest and woodland habitat (Derby and Wilson 1979, p. 472). *Eriogonum kennedyi* var. *austromontanum* prefers areas with low levels of shade and leaf litter accumulation (Derby and Wilson 1979, p. 471). Although this taxon typically occupies clay soils with pebbles or cobbles, *E. k.* var. *austromontanum* also occurs on sandy, clay soils (e.g., Burnt Flat) or clay soils lacking pebbles or cobbles (e.g., areas at North Baldwin Lake) (USFS 2002, p. 94). This species is restricted to the San Bernardino Mountains at elevations from 2,000 to 2,200 m (6,557 to 7,213 ft) in San Bernardino County, California. (USFWS, 2015)

Dispersal/Migration**Dispersal**

Adult: Low (USFWS, 2015)

Dispersal/Migration Narrative

Adult: Pollen analog transfer was not detected greater than 4 m (13.1 ft) from marked plants, with more than 90 percent of dye transfer occurring within 1 m (3.3 ft) of each plant (Freas and Murphy 1990, p. 6). Freas and Murphy (1990, pp. 7, 8) state that there is no evidence indicating that either wind- or pollinator-mediated dispersal plays a role in gene flow between pebble plain sites. (USFWS, 2015)

Population Information and Trends

Population Trends:

Not available

Number of Populations:

10 (USFWS, 2015)

Population Narrative:

Currently, *Eriogonum kennedyi* var. *austromontanum* is known to occur in 10 pebble plain complexes, which include Arrastre/Union Flat, Big Bear Lake, Broom Flat, Fawnskin, Gold Mountain, Holcomb Valley, North Baldwin Lake, Sawmill, South Baldwin Ridge/Erwin Lake and Sugarloaf Ridge. (USFWS, 2015)

Threats and Stressors

Stressor: Urbanization (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Much of the habitat of *Eriogonum kennedyi* var. *austromontanum* historically found on private lands has been lost to residential and commercial development (USFS 2012a, p. 31). At the time of listing, the Service indicated that relatively unrestricted development of privately owned parcels of land was a threat to *E. k.* var. *austromontanum* and other pebble plain plants and we specifically described losses due to urbanization in the Big Bear Lake pebble plain complex (USFWS 1998, p. 49013). In the 2008 5-year review, the Service indicated that development continued to be an ongoing threat at several pebble plain complexes including North Baldwin Lake, South Baldwin Ridge/Erwin Lake, Big Bear Lake, Fawnskin, Sawmill, and Gold Mountain (USFWS 2008, p. 6). Urban development (primarily residences) and related recreational development on city, county or private lands within the Big Bear Lake and Baldwin Lake areas continue to represent an ongoing threat to *Eriogonum kennedyi* var. *austromontanum* at six of the pebble plain complexes. Urban development threats to this taxon within portions of the Big Bear Lake and Fawnskin pebble plain complexes result from the effects of residential improvements (e.g., landscaping) and services provided by local entities (e.g., drainage structures), as well as new, proposed residential developments (USFS 2012b, pp. 63–64). Large areas of non-Federal land are also found within the eastern half of Bear Valley, which includes *Eriogonum kennedyi* var. *austromontanum* occurrences found within the Sawmill, North Baldwin Lake, South Baldwin Ridge/Erwin Lake, and Gold Mountain pebble plain complexes. Where this taxon is found on the small lots and private lands in residential neighborhoods within these complexes, potential impacts include those related to home improvements, maintaining defensible space, or administration of County services (USFS 2012b, pp. 75, 80). Threats resulting from development or associated infrastructure within private inholdings managed by San Bernardino County within the Holcomb Valley and Arrastre Pebble Plain complexes are possible, but unknown (USFS 2012b, p. 74). Several utilities operating within the San Bernardino Mountains provide either direct services to urbanized areas in the region or related infrastructure, and their operation and maintenance activities can affect populations of *Eriogonum kennedyi* var. *austromontanum* or its critical habitat. The primary threats to *E. k.* var. *austromontanum* from these utilities include ground disturbance and localized trampling of habitat related to operation and maintenance activities, such as pole replacements. (USFWS, 2015)

Stressor: Roads and trails (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: In our final listing rule, the Service described impacts from Roads and Trails under the category of offroad vehicle activity, citing over 7 miles (mi) (11 kilometers (km)) of USFS roads and 10 mi (16 km) of unauthorized routes that directly impact pebble plain sites (Odell 1988, p. 4). Approximately 2.5 percent of SBNF land consists of roads (USFS 2005b, Vol. 1, p. 114). The SBNF implements a Roads and Trails Management Program that incorporates roads, motorized trails, motorized interpretive trails, and non-motorized trails found within the SBNF (USFS 2012b, pp. 9–10). An estimated 4.3 mi (6.9 km) or 101 ac (41 ha) (using 100 ft (30 m) of centerline) of roads and trails affect *Eriogonum kennedyi* var. *austromontanum* occurrences within an estimated 1,129 ac (456 ha) of occupied habitat located on lands owned and managed by the USFS (USFS 2012b, p. 22). Threats to *Eriogonum kennedyi* var. *austromontanum* from roads and trails include both direct effects, such as habitat alteration, and indirect effects, including alteration of water flow and drainage patterns, sedimentation, deposition of particulates (dust), and effects related to wildfire (USFS 2012b, pp. 21–24). Roads, road construction, and road maintenance can also facilitate the introduction and establishment of nonnative plants by creating open, continually disturbed habitat as well as disrupt hydrological processes within pebble plains habitats. Nonnative plants can be transported along these road corridors by equipment and vehicles, and are often more easily established on exposed cut-and-fill slopes of roads than native plants (USFS 2005b, Vol. 1, p. 114). USFS roads present ongoing threats in the Holcomb Valley area (Holcomb Valley, Arrastre Flat pebble plain complexes), Baldwin Lake area (Gold Mountain pebble plain complex) and the Sugarloaf–Onyx area (Broom Flat pebble plain complex) where *Eriogonum kennedyi* var. *austromontanum* occurs. The SBNF installed fencing, rock barriers, and signage at the most disturbed locations to minimize impacts to the habitat, including effects related to crushing, uprooting or burial of plants (USFS 2012b, pp. 71–72, 77, 82–84). The SBNF also closed unauthorized routes originating from USFS roads in the Baldwin Lake area (Sawmill pebble plain complex) and, following these closures, implemented habitat restoration activities (USFS 2012b, p. 77). Periodic maintenance work on State Routes 18 and 38, and County roads (Holcomb Valley Road) has the potential to impact *E. k.* var. *austromontanum* and its habitat in the Baldwin Lake area (North Baldwin Lake, Sawmill pebble plain complexes) (USFS 2012b, p. 79). Ongoing use and maintenance of USFS trails likely subjects *Eriogonum kennedyi* var. *austromontanum* to occasional localized crushing, uprooting or burial of habitat and individuals in the Big Bear Lake, Baldwin Lake, and Sugarloaf–Onyx areas (USFS 2012b, pp. 59, 76–77, 82). In their biological assessment for the South Big Bear Bike Trails project, the SBNF identified potential threats to *E. k.* var. *austromontanum* habitat including the re-routing and restoration of portions of the Pine Knot trail (USFS 2012a, p. 30). The SBNF determined that, after closure and restoration of the section of trail that currently travels through pebble plain habitat, this project would produce beneficial effects to *E. k.* var. *austromontanum* and other listed species with the potential for re-colonization of the currently disturbed areas (USFS 2012a, pp. 30–34).

Stressor: Collection of wood for fuel (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Associated with OHV activity is unauthorized collection of wood for fuel including removal of downed vegetation or trees. The SBNF has an active, personal use fuel-wood program in which the public can purchase permits for cutting wood from marked, downed logs in designated areas (USFS 2012b, p. 30). However, unauthorized collection of fuel-wood is a current threat in some areas within the SBNF and on private lands (e.g., Sawmill Creek area (S. Eliason, USFS, 2012b, pers. comm.)). This activity reduces natural barriers to sensitive areas and creates additional access for unauthorized OHV activities (Eliason, 2012a, pers. comm.). The Baldwin Lake area (Sawmill, North Baldwin Lake, South Baldwin Ridge/Erwin Lake, and Gold Mountain pebble plain complexes) continues to experience a high intensity of these activities as well as a high frequency of use (USFS 2012b, pp. 77–78). (USFWS, 2015)

Stressor: Recreation (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: The high frequency of OHV activity was described as the most significant and persistent threat in the final listing rule for *Eriogonum kennedyi* var. *austromontanum* and other pebble plain plants and was reiterated as such in our 2008 5-year review (USFWS 1998, p. 49013; USFWS 2008, p. 6). Unauthorized OHV use has impacted all pebble plain complexes to varying degrees (USFS 2002, p. 25). Threats also result from the effects of non-motorized trails and mountain biking due to the proximity of *E. k.* var. *austromontanum* and its habitat to urban areas (USFS 2012b, pp. 60–61). Along with soil compaction, soil erosion resulting from OHV use could significantly alter *Eriogonum kennedyi* var. *austromontanum* habitat. Vehicle traffic during the wet season is of particular concern, as this activity directly disturbs or destroys vegetation and creates deep ruts that change the hydrological patterns over the pebble plain (USFS 2002, p. 20). Vehicle traffic also increases breakdown in natural soil aggregates (structure) (Sadler 1989, pers. comm., cited in USFS 2002, p. 23). (USFWS, 2015)

Stressor: Alteration of hydrology (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: The listing rule identified alteration of hydrological conditions as a threat to *Eriogonum kennedyi* var. *austromontanum* habitat, noting that the majority of pebble plain complexes are directly impacted by vehicle routes that may lead to alterations in the surface hydrology (USFWS 1998, p. 49013). This threat is often the result of OHV activities and direct and indirect impacts from urbanization (USFS 2002, p. 25). As discussed above, vehicle traffic within pebble plains habitats during the wet season is of particular concern because this activity creates deep ruts that change hydrological patterns within pebble plains. Alteration of hydrology can also result from land disturbance due to mining and fire suppression activities, which are discussed as separate threats to *E. k.* var. *austromontanum* below. Normally, surface water flows evenly across the relatively impervious pebble plains (Odell 1988, p. 19). However, changes in the hydrological pattern associated with a disturbed pebble plain could alter the soil composition by allowing for erosion of clay sediments during rainfall events, leaving only large cobbles and pebbles (Neel and Chaney 1992, p. 1). These potential changes to soil morphology and composition could theoretically result in invasion of both native and nonnative plant species that then out-compete *Eriogonum kennedyi* var. *austromontanum* for space and resources. Once established, native trees and shrubs alter the surrounding microhabitat by shading, increasing

leaf litter, and probably by reducing temperature extremes (Derby 1979, pp. 72–73; USFS 2002, p. 15). (USFWS, 2015)

Stressor: Trampling of habitat (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: In our listing rule, the Service described prior moderate-to-heavy degradation of certain sites occupied by *Eriogonum kennedyi* var. *austromontanum* from trampling by cattle and indicated that some pebble plains continued to be impacted by cattle, horses, and feral burros (USFWS 1998, p. 49016). However, the Service anticipated this threat would be reduced with the removal of feral burros from several pebble plain complexes under the provisions of the Big Bear Wild Burro Territory Management Plan (USFWS 1998, p. 49017). At present, the threat of trampling to pebble plain habitat and to individual plants, including *Eriogonum kennedyi* var. *austromontanum*, due to burro activity is estimated to be very minor and the threat of trampling from cattle no longer exists for this taxon (Eliason, 2012a, pers. comm.). In addition to potential impacts from burros, Hitchcock Ranch, a private inholding in the Holcomb Valley area, grazes approximately 30 to 40 horses in the Hitchcock Meadow (located within the Holcomb Valley pebble plain complex), which is occupied by *Eriogonum kennedyi* var. *austromontanum* and other federally listed plants (USFS 2012b, p. 74). The extent and severity of effects of trampling by horses in this portion of the Holcomb Valley to *E. k.* var. *austromontanum* habitat and individual plants is currently unknown. (USFWS, 2015)

Stressor: Non-native plants (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: In our final listing rule, the Service identified exotic (nonnative) plants as a threat to *Eriogonum kennedyi* var. *austromontanum* in the context of disturbances related to grazing, urban and rural development, and various recreational activities (USFWS 1998, p. 49017). These activities can threaten native plants by facilitating the establishment of non-native species and resulting in the alteration of habitat through crowding or competition for resources (USFWS 1998, p. 49017). In our 2008 5-year review, the Service used the assessments provided in the 2002 Pebble Plain Habitat Management Guide (USFS 2002) in determining that nonnative plants, including grasses and forbs, continued to impact *Eriogonum kennedyi* var. *austromontanum* habitat, potentially displacing the taxon through competition for nutrients, water, light, and space (USFWS 2008, p. 10). Treatment activities for nonnative plants under the SBNF's Invasive Species Management program may also threaten *E. k.* var. *austromontanum* through trampling and crushing, but these effects are considered incidental and localized relative to the larger beneficial effects to these and other native species (USFS 2012b, p. 92). In addition, ground disturbance from mining (discussed below) and recreational activities (discussed above) can disturb soils and create the potential for the introduction and spread of nonnative plants. The 2002 Pebble Plain Habitat Management Guide described nonnative plants as a threat to the unique plant communities for the following pebble plain complexes where *Eriogonum kennedyi* var. *austromontanum* occurs: (1) Arrastre Flats, (2) Broom Flat, (3) Fawnskin, (4) Gold Mountain, (5) North Baldwin Lake, (6) Sawmill, and (7) South Baldwin Ridge/Erwin Lake (USFS 2002, pp. 46, 48, 51, 53, 57, 62, 65). *Bromus tectorum* (cheatgrass) represents the primary species of concern for these pebble plain areas. The presence of *Bromus tectorum* within pebble plain habitat can

provide a continuous “flashy” fuel load and the potential to increase the fire return interval (USFS 2005a, p. 101), though it is unclear to what extent fire has affected pebble plain communities (USFS 2005a, p. 100). *Bromus tectorum* as well as *Erodium cicutarium* (filaree), represent very old invasions in the San Bernardino Mountains and are persistent threats within these complexes (Eliason, 2012a, pers. comm.). More recent invasions of nonnative plant species within some of these pebble plain complexes include *Linaria dalmatica* (dalmatian toadflax), *Ranunculus testiculatus* (bur buttercup), and *Lepidium perfoliatum* (clasping pepperweed) (Eliason, 2012a, pers. comm.). (USFWS, 2015)

Stressor: Mining (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: In our listing rule, the Service indicated that mining activities had contributed to the decline of *Eriogonum kennedyi* var. *austromontanum* due to effects from habitat destruction, degradation, and fragmentation of pebble plain habitats (USFWS 1998, p. 49013). However, the Service later described mining as a secondary threat to habitat degradation in our 2008 5-year review (USFWS 2008, p. 6), based on expected implementation of avoidance measures by the USFS for regulated mining activities (USFWS 2005, p. 235). Gold mining in the Holcomb Valley area during the late 1800s greatly affected pebble plains habitat, though the scale of gold mining has been much reduced (USFS 2005b, Vol. 1, p. 107). Small-scale gold mining activities, however, continue to occur in several pebble plain complexes (e.g., Fawnskin, Gold Mountain, and Holcomb Valley; USFS 2005a, pp. 10, 54), and Plans of Operation for mining on the SBNF have the potential to affect pebble plain plant habitat (USFS 2005b, Vol. 1, p. 107). Prospecting has also become more dispersed, and is of concern because of the lack of restrictions governing this activity (USFS 2005b, Vol. 1, p. 107). Unpatented mining claims on USFS lands were previously reported for five pebble plain complexes occupied by *Eriogonum kennedyi* var. *austromontanum*: (1) Holcomb Valley (83 ac (33.6 ha)), (2) Fawnskin (24 ac (9.7 ha)), (3) Arrastre Flats (69 ac (28 ha)), (4) North Baldwin Lake (62 ac (25 ha)), and (5) Broom Flat (0.2 ac (0.08 ha)) (USFS 2002, pp. 42, 46, 48, 57, 65). These claims continue to represent a potential threat of ground disturbance for *E. k.* var. *austromontanum*, specifically, gold prospecting activities or mining operations related to the ownership of mineral rights. The Holcomb Valley area, which includes the Holcomb Valley and Arrastre Flats pebble plain complexes, is a particularly active area for small-scale mining activities (e.g., prospecting by clubs and individuals) and represents an area of concern for pebble plain plants and their habitats (USFS 2012b, p. 74). Small-scale mining activities around Doble in the North Baldwin Lake pebble plain complex could affect a small portion of occupied habitat (USFS 2012b, p. 80). (USFWS, 2015)

Stressor: Fire suppression (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Activities related to management of fire and fuels can also threaten *Eriogonum kennedyi* var. *austromontanum* and its habitat. Although not recognized as a threat at the time of listing, fire suppression was known to impact habitat at one pebble plain complex in 2003, as described in our 2008 5-year review (USFWS 2008, p. 7). However, fuelbreaks and vegetation treatment units are very rarely located in pebble plain habitat due to the scarcity of fuels (USFS 2005c, p. 212). Fire suppression activities typically include fire line construction, fire retardant

and water drops, establishment of temporary fire camps, staging areas, parking sites, safety zones, helipads, and post-fire rehabilitation (USFWS 2005, p. 27). Each of these activities can have negative impacts to *E. k. var. austromontanum* and its habitat. For well-conserved pebble plain habitats, the interior of the plain is highly resistant from high intensity burning because of the large percentage of bare ground, rock cover, and limited and discontinuous fuel (USFS 2005a, p. 100). Pebble plain habitats may therefore function as a natural fuelbreak, with fire moving around the margins of the plain through tree litter and shrubs (USFS 2005a, pp. 100–101). Given the protective mechanisms being implemented to avoid impacts from fire suppression actions to listed species and the limited fuel and vegetation treatment units in pebble plain habitat, we believe that threats to *Eriogonum kennedyi var. austromontanum* and its habitat from these fire suppression activities will be localized, only occasional, and do not constitute a widespread threat to the species or its habitat. (USFWS, 2015)

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Climate change has already altered, and will continue to alter, the water cycle. Changes in the water cycle, which are consistent with the warming observed over the past several decades, include, but are not limited to: (1) changes in precipitation patterns and intensity; (2) changes in the incidence of drought; (3) widespread melting of snow and ice; (4) increasing evaporation; and (5) changes in soil moisture and runoff (USGCRP 2009, p. 41). Although the effects of climate change on *Eriogonum kennedyi var. austromontanum* and its habitat have not been measured and there is uncertainty in future predictions of downscaled climate change models, projected climate change effects mentioned above could significantly alter the hydrology that sustain and characterize pebble plain habitat occupied by *E. k. var. austromontanum*. Considerable erosion of the clay soils can occur with heavy rains when the ground is not covered by protective snow, or held together as a frozen matrix of clay, pebbles, and water. Local erosion can expose the roots of the small pebble plain plants to desiccation and lead to the death of the plants. Although these weather-related erosion events seldom occurred historically, earlier thawing, decreased snowpack, and other changes in precipitation patterns in the future could lead to an increase of these erosion events. Additionally, increased temperatures could reduce the extent of frost heaving, theoretically leading to increased encroachment of native trees and shrubs into pebble plain habitat. (USFWS, 2015)

Recovery

Reclassification Criteria:

Not applicable.

Delisting Criteria:

A Recovery Plan has not been developed for this species.

Recovery Actions:

- Recommendation for Future Action from 2015 5-Year Review: Work with biologists at the SBNF to reduce impacts from recreational use of roads and trails through uncontrolled access to pebble plain habitat occupied by *Eriogonum kennedyi var. austromontanum*. Prioritize protective measures being implemented (or planned) for controlling access to

areas occupied by *E. k. var. austromontanum*. This should include providing comment on biological assessments for proposed activities to support SBNF program of road closures and/or assistance in securing resources for placement of more effective barriers in the areas that receive the highest recreational uses from motorized vehicles. (USFWS, 2015)

- Recommendation for Future Action from 2015 5-Year Review: Conserve or preserve *Eriogonum kennedyi var. austromontanum* occurrences on private lands. Continue to work with the State and local groups to purchase *E. k. var. austromontanum* habitat from willing sellers, particularly within the Sawmill pebble plain complex. (USFWS, 2015)
- Recommendation for Future Action from 2015 5-Year Review: Develop a monitoring plan to provide early detection of downward trends in the populations of pebble plain plants, such as *Eriogonum kennedyi var. austromontanum*, and quality of pebble plain habitat (adapted from USFS 2005a, p. 125). This monitoring plan should identify and prioritize surveys of plant populations, including abundance, and habitat conditions, in those areas most vulnerable to threats (e.g., pebble plain complexes with high levels of recreational activity) and should include remote sensing and mapping of unauthorized OHV trails. (USFWS, 2015)
- Recommendation for Future Action from 2015 5-Year Review: Evaluate reproductive life history characteristics such as seed germination requirements, mechanism of seed dispersal, and seed viability. (USFWS, 2015)
- Recommendation for Future Action from 2015 5-Year Review: Determine the distribution of genetic diversity in the species occurrences and identify the most appropriate means to preserve the diversity. (USFWS, 2015)

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SPECIES ACCOUNT: *Eriogonum longifolium* var. *gnaphalifolium* (Scrub buckwheat)

Species Taxonomic and Listing Information

Listing Status: Threatened; 5/27/1993; Southeast Region (R4)

Physical Description

Eriogonum longifolium var. *gnaphalifolium* is a perennial herb. It has a taproot and one to three above-ground stems up to 1 m tall, but upwards of 10 stems have been observed in vigorous specimens, especially post-fire. It has a basal rosette of leaves that are 15 to 20 cm long, narrow, and white-woolly on the underside. The stem leaves are smaller than the rosette leaves. The stem terminates in a corymb, with each branch of the corymb ending in a cup-shaped involucre that holds a cluster of 15 to 20 small flowers, with each flower hanging on its stalk down below the involucre. The involucre is silvery, silky-pubescent, and the flowers are green with pink anthers (Rickett 1967) (USFWS, 1999)

Taxonomy

The genus *Eriogonum* includes about 150 species, most of them in western North America. Florida has only two species, both native to high pineland. *Eriogonum tomentosum* is common throughout the northern part of the state, as far south as Highlands County. The second species, scrub buckwheat, was named *Eriogonum floridanum* by J.K. Small (1903). Subsequent publications on Florida's flora consistently adopted Small's treatment of *E. floridanum* as a full species (Small 1933, Kral 1983, Ward 1979, Wunderlin 1982), but James Reveal (1968), an expert on the genus, treats the Florida plants as a variety of *Eriogonum longifolium*, a widespread species of the Great Plains that is represented east of the Mississippi by var. *harperi* in northern Alabama, Tennessee, and Kentucky (Kral 1983), and by var. *gnaphalifolium* in Florida (USFWS, 1999).

Historical Range

In Florida, in the following counties: Highlands, Hillsborough, Lake, Orange, Osceola, Marion, Pasco, Polk, and Sumter (USFWS, 1996)

Current Range

In Florida, in the following counties: Highlands, Hillsborough, Lake, Orange, Osceola, Marion, Pasco, and Polk (USFWS, 1996; USFWS, 2018)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (NatureServe, 2015)

Lifespan

Adult: Unknown (NatureServe, 2015)

Breeding Season

Adult: January to November (NatureServe, 2015); May - October (USFWS, 1999)

Key Resources Needed for Breeding

Adult: Disturbance or fire; hunting wasps and bees (NatureServe, 2015); open sand, moist soils (USFWS, 1999)

Reproduction Narrative

Adult: *Eriogonum longifolium* var. *gnaphifolium* is an herbaceous perennial that presumably is long-lived and slowly growing. It flowers and reproduces primarily after fires or other disturbances (e.g. logging, mowing) that increase light availability. Although it readily resprouts after fires or other disturbances such as mowing, it does not reproduce vegetatively. Flowering can occur from January to November, but is usually synchronized with fire or other disturbance; most flowering occurs within the first year after a fire. Although a plant is usually in flower for two to three months, the individual flowers are short-lived and open asynchronously. Typically, a maximum of one to two flowers per involucre are open at any one time. The flowers, although inconspicuous, must be insect-pollinated for seed set to occur. Several types of hunting wasps (families Vespidae, Eumenidae, Sphecoidea, Pompilidae) and a few bee species (Halictidae) visit the flowers. These insects, all with an excellent locational sense, may be "traplining" the plants daily for their nectar. Although the flowers provide a dependable source of nectar, it is thought that these insects are the only potential pollinators able to repeatedly locate the scattered, inconspicuous flowers (Deyrup pers. communication). Seeds have no dormancy, but germinate only in microsites with little or no litter and sufficient moisture (Carrington unpubl. data). Virtually all seedling establishment, therefore, must occur within the first year after a fire; litter buildup is prohibitive afterwards. Seedling establishment tends to be rare, however, probably because moisture conditions are usually not optimal due to high soil surface temperatures and evaporation rates following growing season fires. Most seedling establishment probably occurs in very wet periods after fires. In the low-light conditions of long-undisturbed communities, *Eriogonum longifolium* var. *gnaphifolium* individuals are present as inconspicuous basal rosettes; flowering individuals are rare, and occur only in openings or on edges such as road shoulders or fire breaks (pers. obs.). Plants may be capable of surviving without leaves in undisturbed communities by subsisting on stored carbohydrates in their large roots; this possibility is suggested by the "sudden appearance" of previously undetected adult plants in populations monitored for several years (Menges pers. communication). Longevity of individuals is unknown, but since establishment from seed is extremely rare in long-unburned communities, populations may decline or vanish in sites unburned for several decades. Drought tolerance assumed from habitat. Reproduction is sexual (NatureServe, 2015). Although little information on the reproduction of this species is available, plants in the Ocala NF have been observed with immature flower stalks between April and mid-July and bloom from May to mid-October. Seedlings germinate in summer in open sand (R. Yahr, Archbold Biological Station, personal communication 1998) (USFWS, 1999).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: oak-hickory scrub, turkey oak barrens, and sandhill vegetation communities on the Lake Wales Ridge (USFWS, 2018)

Dependencies on Specific Environmental Elements

Adult: 5 - 20 year fire intervals (USFWS, 2018)

Habitat Narrative

Adult: Scrub buckwheat occurs in oak-hickory scrub, turkey oak barrens, and sandhill vegetation communities on the Lake Wales Ridge from Highlands County north to Lake County. It is also found to a limited extent on the Mount Dora Ridge in the ONF in Marion County and on two parcels of private property in Orange County. Each of the vegetation communities where scrub buckwheat occurs evolved with periodic fire. Demographic modeling suggests population viability is highest when fire return intervals are 5 - 20 years (Satterthwaite et al. 2002). Scrub buckwheat occurs in several xeric plant communities that may be burned at intervals of 1-8 years for sandhill to 5-12 years for oak-hickory scrub. On the ONF, scrub buckwheat occurs within actively harvested timber stands and habitats that are not managed specifically for timber production. (USFWS, 2018).

Dispersal/Migration**Dispersal**

Adult: Low (inferred from NatureServe, 2015)

Dispersal/Migration Narrative

Adult: Seeds have no obvious dispersal mechanism, and usually drop beneath the parent plant; some may be carried a short distance in runoff during a rain (NatureServe, 2015).

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Unknown (USFWS, 2018)

Number of Populations:

48 (USFWS, 2018)

Population Narrative:

The spatial distribution of scrub buckwheat has not changed from that reported in the 1996 recovery plan. However, additional populations have been located on properties that have been subsequently acquired for conservation purposes within the historic range. Turner et- al. (2006) indicated that there are 27 populations of scrub buckwheat on protected public and private lands and 21 populations on unprotected private lands. Scrub buckwheat populations that are located on unprotected lands are susceptible to extirpation because of land use changes. However, periodic censuses are not conducted and it is not possible to quantify the number or location of extirpations that have occurred due to habitat destruction. The Service is aware of

two populations, both in Lake County, that have been extirpated due to issuance of incidental take permits under section 10 of the Endangered Species Act. (USFWS, 2018)

Threats and Stressors

Stressor: Habitat destruction and degradation (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Twenty-seven of the 48 known scrub buckwheat localities occur on private, local, State, or Federal lands that are protected. This number of sites is substantially higher than the nine protected sites specified in recovery criterion number 1. Habitat loss or modification due to land use changes is not anticipated at these 27 sites because most were acquired for conservation purposes. Nonetheless, simply protecting scrub buckwheat habitat is insufficient to ensure long-term persistence because, as discussed above, this species requires periodic habitat management actions. Except for those properties described above, we do not currently have information about the type or frequency of land management activities on public lands where scrub buckwheat occurs. However, in general, it is widely documented that most public land managing agencies have not been able to burn as many acres as are targeted in their management plans. Consequently, most agencies are backlogged in prescribed burning (R. Mulholland, Florida Department of Environmental Protection, personal communication, 2008). Even though we know managing agencies are faced with difficulties in use of prescribed fire in general, we do not know whether specific areas that contain scrub buckwheat habitat on public lands are threatened with modification due to lack of management. - The 21 scrub buckwheat populations occurring on unprotected private lands are susceptible to degradation of habitat due to lack of management and destruction due to land use changes. Habitat degradation will likely continue on these lands because private landowners have no incentives to manage their properties for scrub buckwheat. Even though scrub buckwheat can persist for long periods in fire suppressed conditions, a reduction in flowering and seedling recruitment can be expected in long-unburned habitats (McConnell and Menges 2002, Satterthwaite et al. 2002, Menges 2007). These adverse effects are expected to continue into the future on unprotected and unmanaged parcels. In addition, urban development is projected to increase in Florida in the coming decades (Zwick and Carr 2006), and we expect a commensurate decline in native vegetation communities. Such assessments, however, cannot project absolute risks of habitat destruction, on a parcel-by-parcel basis. Consequently, while we acknowledge the future risks of destruction of unprotected scrub buckwheat populations, we do not know which, if any, of the 20 populations are imminently at risk. - As a result of land acquisition efforts over the past several decades by private entities and local, State, and Federal governments, 27 scrub buckwheat populations have been protected from habitat destruction and this level of conservation has exceeded recovery criterion 1 in the recovery plan. Even though 21 of the known populations of scrub buckwheat are not secure and are vulnerable to destruction or decline, we believe the 77 protected populations represent an adequate number of conserved populations to ensure long-term persistence of this species if protected populations benefit from periodic management activities that create and maintain suitable scrub buckwheat habitat (see Recommendations for Future Actions). While each of the public lands containing scrub buckwheat may undertake management activities, we do not currently have information about what types of management or how frequently management occurs on most public lands. Consequently, scrub buckwheat may still be at risk from habitat modification due to lack of management, but we will not know

the extent of this risk until we evaluate more thoroughly the historic and ongoing management actions on public lands (see Recommendations for Future Actions). (USFWS, 2018)

Recovery

Reclassification Criteria:

Not relevant. (USFWS, 1996)

Delisting Criteria:

1. Complete planned land acquisitions (USFWS, 1996)
2. Protect at least one more site in Lake and/or Pasco counties (one site is protected in Pasco). Demographic monitoring in conjunction with habitat manipulation (prescribed fire or other measures) appears essential, so monitoring is needed for at least five years. (USFWS, 1996)

Recovery Actions:

- 1. Determine current distribution of *E. longifolium* var. *gnaphalifolium*. A survey has not been made of the Lake Wales Ridge for this species, making defining a complete distribution in South Florida difficult. (USFWS, 1999)
- 2. Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties has been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases is isolated. (USFWS, 1999).
- 3. Continue research on life history characteristics of *E. longifolium* var. *gnaphalifolium*. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species more specific biological information is needed. (USFWS, 1999)
- 4. Continue monitoring the existing populations of *E. longifolium* var. *gnaphalifolium*. Evaluate the effectiveness of the monitoring protocol used to assess population trends for *E. longifolium* var. *gnaphalifolium*. Monitor and detect changes in demographic characteristics, such as growth, survival, mortality. Monitor the effects of various land management actions on *E. longifolium* var. *gnaphalifolium*. Continue to work with private landowners. Monitor introduced plants. Monitoring of reintroduced plants will be essential for assessing the status of new plants and their contribution to the population as a whole. (USFWS, 1999).
- It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed. Public outreach efforts must also continue to address the increasing concern that horticultural demand for rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of *E. longifolium* var. *gnaphalifolium* and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999).

Conservation Measures and Best Management Practices:

- Revise the recovery criteria to establish measurable goals for demographic monitoring, including but not limited to: the number of populations that should be monitored, the demographic parameters

that should be measured, and the demographic performance levels/rates that should be met (USFWS, 2018).

- Monitoring of scrub buckwheat populations should be initiated on the ONF to evaluate the response of scrub buckwheat to soil disturbances associated with timber harvesting/site preparation activities and to determine the status of the species on the ONF (USFWS, 2018).
- The demographic status of scrub buckwheat populations may be inferred with minimal additional information. We believe that information regarding the number of individual plants and land management history can allow for a reasonable estimation of the current demographic status of extant scrub buckwheat populations. In this regard, we do not currently know how many plants exist on 23 of the 27 public lands where records indicate scrub buckwheat occurs. Consequently we recommend that surveys be conducted on public lands where no count data are available. Surveys initiated soon after fire would be valuable in assessing post-fire response of scrub buckwheat. We also suggest that a synthesis be conducted of historic and ongoing management actions on the same parcels for which counts are conducted. Knowing the historic and ongoing management strategy will provide information about whether land management strategies are conducive to long-term persistence of scrub buckwheat. (USFWS, 2018)
- The use of temporally and spatially appropriate management actions (e.g., prescribed fire or other disturbance regime) in areas containing scrub buckwheat should be encouraged on all public lands (USFWS, 2018).

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SPECIES ACCOUNT: *Eriogonum ovalifolium* var. *vineum* (Cushenbury buckwheat)

Species Taxonomic and Listing Information

Listing Status: Endangered; 08/24/1994; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

Cushenbury buckwheat is a low, densely-matted perennial plant in the Polygonaceae (buckwheat family). The flowers are whitish-cream, darkening to a reddish or purple color with age, and are borne on flowering stalks reaching 4 inches (10 centimeters) in height. The leaves are 0.3 to 0.6 inches (0.8 to 1.5 centimeters) long, round to ovate, and white-woolly on both surfaces. The diameter of mats is typically 6 to 10 inches (15 to 25 centimeters), but they may reach up to 20 inches (51 centimeters) (USFWS 1994, p. 43653). (USFWS, 2009)

Taxonomy

Three other varieties of *Eriogonum ovalifolium* are distinguished on the basis of floral and leaf characteristics, but none occur in the San Bernardino Mountains (USFWS 1997, pp. 6-7). (USFWS, 2009)

Historical Range

See current range/distribution.

Current Range

Cushenbury buckwheat occurs over about 25 miles (40 kilometers) along the northern edge of the San Bernardino Mountains from the White Knob area east to Rattlesnake Canyon, north and east of Big Bear Lake, San Bernardino County, California. There is currently about 1,213 acres (491 hectares) of occupied habitat for this species (USFWS, 2015).

Critical Habitat Designated

Yes; 12/24/2002.

Legal Description

On December 24, 2002, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Eriogonum ovalifolium* var. *vineum* (Cushenbury buckwheat) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat unit (CHUs), in California (67 FR 78570-78610).

Critical Habitat Designation

The critical habitat designation for *Eriogonum ovalifolium* var. *vineum* includes two CHUs (43 subunits) in San Bernardino County, California (67 FR 78570-78610).

(4) Northeastern Slope Unit, San Bernardino County, California. (i) From USGS 1:24,000 quadrangle maps Fawnskin, Big Bear City, Rattlesnake Canyon, Butler Peak, and Onyx Peak, California.

(5) Bertha Ridge Unit, San Bernardino County, California. (i) From USGS 1:24,000 quadrangle maps Fawnskin and Big Bear City, California.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Eriogonum ovalifolium* var. *vineum* critical habitat consists of three components (67 FR 78570-78610):

(i) Soils derived primarily from the upper and middle members of the Bird Spring Formation and Bonanza King Formation parent materials that occur on hillsides at elevations between 1,400 and 2,400 m (4,600 and 7,900 ft);

(ii) Soils with intact, natural surfaces that have not been substantially altered by land use activities (e.g., graded, excavated, recontoured, or otherwise altered by grounddisturbing equipment); and

(iii) Associated plant communities that have areas with an open canopy cover (generally less than 15 percent cover) and little accumulation of organic material (e.g., leaf litter) on the surface of the soil.

Special Management Considerations or Protections

The SBNF is planning a revision of their Resource Management Plan in the near future that, among other functions, would provide conservation benefits to the two carbonate plant species and their habitat in this unit. These lands, however, currently do not have approved management provisions for the carbonate plants and their habitat, and habitat degradation may still be occurring due to ongoing activities identified in the final listing rule for these species (see USFWS 2001b). Therefore, the subject lands continue to require special management and protection to ensure the conservation of these species and their habitat. The core occurrences of the two carbonate plants in this unit are important as potential sources for the colonization events (e.g., seed dispersal) necessary to maintain the natural population dynamics of the species. Every carbonate plant occurrence in this unit is important as a seed source to colonize unoccupied sites and therefore maintain an equilibrium between local colonization and extirpation events. Every carbonate plant occurrence in this unit potentially provides important genetic material through pollen and seed dispersal which may help maintain genetic diversity and reduce the likelihood of regional extirpation events.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (outcrossing) (NatureServe, 2015)

Breeding Season

Adult: May to June (NatureServe, 2015)

Reproduction Narrative

Adult: Cushenbury buckwheat is primarily outcrossed (Neel et al. 2001) and has limited clonal reproduction within populations (Neel and Ellstrand 2003). (NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Desert, Forest/Woodland, Shrubland/chaparral, Woodland - Conifer (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found between 4,600 and 7,900 feet (1,400 and 2,400 meters) on gentle to steep desert slopes; prefers low canopy cover (USFWS, 2009)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Dependency on Other Individuals or Species for Habitat

Adult: Located within plant communities including Joshua tree woodland and blackbrush scrub with low densities of singleleaf pinyon and Utah juniper in the overstory at low elevations, singleleaf pinyon-Utah juniper woodland at middle elevations, and Jeffrey pine-mountain juniper and singleleaf pinyon-mountain juniper woodlands at high elevations. Associated species include *Fremontodendron californicum* (California Flannelbush), *Arctostaphylos glauca* (Big-Berry Manzanita), *Arctostaphylos patula* (Green-Leaf Manzanita), *Phacelia douglasii* (Douglas' Scorpion-Weed), *Yucca brevifolia*, *Pinus monophylla* (Single-Leaf Pinyon), *Astragalus albens* (Cushenbury Milk-Vetch), and *Erigeron parishii* (Parish's Fleabane). (NatureServe, 2015)

Habitat Narrative

Adult: Cushenbury buckwheat occurs within openings of pinyon woodland, pinyon-juniper woodland, Joshua tree woodland, and blackbrush scrub communities between 4,600 and 7,900 feet (1,400 and 2,400 meters) in elevation on limestone or other carbonate substrates. It occurs in open areas with little accumulation of organic material, vegetation canopy cover generally less than 15 percent, and powdery fine soils with rock cover exceeding 50 percent (USFWS 1994, p. 43654). Cushenbury buckwheat is mainly found on gentle to steep slopes with north or west aspects (Neel 2000, p. 129). Cushenbury buckwheat prefers substrates derived from limestone or dolomite (high soil pH, high percentage of soil calcium). Soils are typically powdery-fine, with little accumulation of organic matter and with numerous interspersed rocks (rock cover exceeding 50%). Often found on or adjacent to unstable talus, colluvium, or rock outcroppings; may benefit from naturally unstable sites. Associated species include *Fremontodendron californicum* (California Flannelbush), *Arctostaphylos glauca* (Big-Berry Manzanita), *Arctostaphylos patula* (Green-Leaf Manzanita), *Phacelia douglasii* (Douglas' Scorpion-Weed), *Yucca brevifolia*, *Pinus monophylla* (Single-Leaf Pinyon), *Astragalus albens* (Cushenbury Milk-Vetch), and *Erigeron parishii* (Parish's Fleabane). (USFWS, 2009; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Declining (NatureServe, 2015)

Resiliency:

Low (inferred from USFWS, 2009)

Representation:

Low (inferred from USFWS, 2009)

Redundancy:

Low (inferred from USFWS, 2009)

Number of Populations:

29 (NatureServe, 2015)

Population Size:

13,000 (USFWS, 2009)

Population Narrative:

At listing, the total population of Cushenbury buckwheat was about 13,000 individuals (USFWS 1994, p. 43653). Only a quarter of the known occurrences had more than 1,000 individuals each (USFWS 1994, p. 43653). Approximately 29 occurrences are believed extant, with an additional 4 historical and 1 of unknown status, when mapped using the separation distance of the California Natural Diversity Database (CNDDDB). Has suffered loss of individuals, loss and reductions of populations, and fragmentation of remaining populations by limestone mining activities (Neel and Ellstrand 2003). Occurrences that are not impacted by human disturbance generally do not appear to be in demographic decline, although seedling recruitment is not common (Neel and Ellstrand 2003). (NatureServe, 2015; USFWS, 2009)

Threats and Stressors

Stressor: Mining (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Mining activity remains the primary threat for Cushenbury buckwheat (USFWS 2005a, p. 246). Mining activities can impact habitat for the plants through the removal of mined materials, disposal of overburden, and road construction. (USFWS, 2009)

Stressor: Dust (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Dust can affect Cushenbury buckwheat's habitat by altering soil chemistry and light penetration into seedbanks (USFWS 1997, pp. 17–18). (USFWS, 2009)

Stressor: Artificial lighting (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Artificial lighting may affect Cushenbury buckwheat's growing conditions by altering the photoperiod response or the behavior of pollinators or seed dispersers (USFWS 1997, p. 18). (USFWS, 2009)

Stressor: Off-road vehicle use and energy development (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The final listing rule indicates that off-road vehicle use and energy development projects were also threats to Cushenbury buckwheat and its habitat. Such activities could impact the species' habitat through ground disturbance or dust creation. About 8 acres (3 hectares) of occupied habitat and 36 acres (15 hectares) of designated critical habitat for Cushenbury buckwheat overlap with roads and motorized vehicle trails (USFWS 2005a, pp. 261-262). The San Bernardino National Forest closed road 3N77 and placed signs and barriers for the other roads (USFWS 2001, pp. 5 and 18), which should limit impacts due to off-road vehicle use. Additionally, road 3N11A is proposed for decommissioning and roads 3N03D, 3N54, 3N88, and 3N88B are proposed for reclassification as administrative use only (USFWS 2009, p. 2), which should reduce vehicle activity in the area and further reduce the threat to the species. We are unaware of any energy development or off-highway vehicle projects occurring since listing that affect Cushenbury buckwheat. (USFWS, 2009)

Stressor: Trampling (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Several threats such as dispersed target shooting, dispersed camping areas, fuelwood collection, and fire suppression activities have been identified since listing (USFWS 2001, pp. 4–11). These activities can result in trampling of Cushenbury buckwheat and impact its habitat through ground disturbance or dust creation. (USFWS, 2009)

Stressor: Fire suppression (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Additionally, fire suppression activities can result in ground disturbance through fire line construction, retardant and water drops, and establishment of fire camps. Suppression of the Willow Fire in 1999 impacted Cushenbury buckwheat through trampling and burning in a backfire operation (D. Volgarino, San Bernardino National Forest, pers. comm. 2002). (USFWS, 2009)

Stressor: Burros (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The threat of predation from burro grazing was identified after listing (USFWS 2001). However, burros are expected to have minimal effects to Cushenbury buckwheat due to the low numbers of burros present (about 60), the dispersal of the burros across a large area, the burros preference for wetter habitats, and the short stature and scarce nature of carbonate plants, which makes foraging on them unlikely (USFWS 2001, p. 39). (USFWS, 2009)

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Climate change was not mentioned as a potential threat in the final listing rule for Cushenbury buckwheat. This concern was raised in a letter received by the Service on May 6, 2008 (Potter, in litt. 2008). Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (IPCC 2007; Cayan et al. 2005; Field et al. 1999). However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. Cushenbury buckwheat is endemic to isolated occurrences of particular carbonate soils in the San Bernardino Mountains. Therefore, any combination of environmental conditions, such as those attributed to climate change above, that force an upward shift in the distribution of the species, poses a profound threat to the taxon's persistence and recovery. If this species is affected by elevational shifts resulting from climate change, then there will be no suitable habitat when the elevational range exceeds the species' maximum elevation. As this occurs, the density and distribution may concentrate the species into a smaller area. This, in turn, may make the species even more susceptible to stochastic extinction. (USFWS, 2009)

Stressor: Stochastic extinction (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The final listing rule identified the potential for stochastic extinction as a threat. This threat still exists and is enhanced by habitat loss, fragmentation, and drought. (USFWS, 2009)

Recovery

Reclassification Criteria:

1. The priority ranked habitat areas have been protected. Priority for protection shall be determined according but not limited to: 1) population size, 2) habitat quality, 3) manageability/defensibility of site, and 4) connectivity. The initial preserve area should be 2,000 hectares (5,000 acres) based on known areas occupied by the plants. (USFWS, 2009)
2. Protect additional lands needed to complete otherwise isolated reserves, to protect new populations that may be discovered in the future, and to provide strategic buffer zones and potential population reintroduction and/or expansion areas. (USFWS, 2009)
3. Adaptive population monitoring/adaptive management programs must be functioning so that early detection is assured for any population instability or other problems in the reserve system. Studies will have shown whether there is a need for reintroductions and/or augmentations of existing populations. Research results to support adaptive management will be available,

including at least preliminary results on pollination ecology, seed dispersal mechanisms, population dynamics, microclimate effects of vegetation removal/bare areas, seedbank dynamics, and fire ecology. (USFWS, 2009)

Delisting Criteria:

1. The reserve system designed to allow downlisting is intended to suffice for delisting, provided that monitoring and research demonstrate that the reserves work as planned to remove the threats identified during the listing process. As monitoring and research results become available, delisting criteria will be established. (USFWS, 2009)

Recovery Actions:

- Identify, design, and establish carbonate endemic plant species reserves encompassing the extant populations. (USFWS, 1997)
- Identify and conserve additional habitat needed to recover the species. (USFWS, 1997)
- Answer ecological and management questions described in downlisting criterion #2. (USFWS, 1997)
- Identifying monitoring programs needed to support adaptive management and initiate them. (USFWS, 1997)
- Evaluate recovery efforts and implement corrective measures. (USFWS, 1997)
- Begin to establish a public constituency for the endangered taxa by developing and implementing a public education program. (USFWS, 1997)

Conservation Measures and Best Management Practices:

- Prepare a new threats-based recovery plan specific to Cushenbury buckwheat that identifies a recovery strategy, objectives, and criteria for reclassification to threatened, objectives and specific criteria for removal from the list of endangered and threatened species, and prioritizes recovery actions. In the interim, seek implementation of elements of the Carbonate Habitat Conservation Strategy that have direct benefit to the conservation of Cushenbury buckwheat. (USFWS, 2009)
- Work with the San Bernardino National Forest to conduct systematic monitoring of Cushenbury buckwheat throughout known and potentially occupied sites as necessary to track the status of the species and identify management priorities. There is a need to continue to obtain quantitative information regarding the status of this species to evaluate the effectiveness of conservation efforts over time, especially in light of potential effects associated with global climate change. (USFWS, 2009)
- Work with partners, such as the San Bernardino National Forest, to help conserve Cushenbury buckwheat by identifying opportunities to: a) Continue monitoring programs for the effectiveness of measures to protect Cushenbury buckwheat from recreational activities and make adjustments to signs, barriers, and roads as necessary. b) Avoid new developments in or near Cushenbury buckwheat habitat. (USFWS, 2009)

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SPECIES ACCOUNT: *Eriogonum ovalifolium* var. *williamsiae* (Steamboat buckwheat)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/7/1986; Pacific Southwest (R8)

Physical Description

Steamboat buckwheat (Figure 2) is a low, densely matted, compact perennial herb, 0.5-4.5 dm across, with numerous, densely-leaved, woody branches. The above-ground portions of the plant arise from a shallow but stout, woody, reddish brown taproot (usually in older plants), or a shallow, fibrous, rhizomatous root system (in younger plants). Each plant bears numerous oval to reniform leaves congested in tight rosettes. Leaf blades are generally 3-8 mm, 5-10 mm wide, and are densely covered with greenish-white to tannish-white hairs. Some leaves exhibit a faint brown margin at maturity. Petioles are generally 3-6 mm long, woolly, and often wavy or curled. Inflorescences are borne on erect, partly woolly stems, up to 2.5 dm (10 in) long, and are enclosed in cone shaped involucre covered with densely-matted, woolly hairs. Five to eight involucre are clustered in a head at the top of each stem. Flowers are generally white with a central greenish-brown rib, turning pinkish-tan with age (Reveal 1981; Williams 1982). Blooms May-early June. (USFWS, 1995)

Taxonomy

Named for Margaret Williams (1917-2000). Genetic analysis by Archibald et al. (2001) revealed var. *williamsiae* has high genetic variability, with levels of variation similar to that typical of a widespread species rather than a narrow endemic; and that all six varieties (note: var. *depressum*, var. *monarchense*, var. *ochroleucum*, var. *pansum*, and var. *vineum* were not sampled for the study) are very similar allozymically with var. *williamsiae* being the most similar to the widespread var. *ovalifolium*. Also, although var. *williamsiae* and var. *ovalifolium* are morphologically distinct, their genetic similarity warrants further study to determine whether or not they should be treated as separate taxa. Further, evidence of male sterility in var. *williamsiae* plus other data led Archibald et al. (2001) to hypothesize that this taxon might be either a hybrid or undergoing cytoplasmic introgression. (NatureServe, 2015)

Historical Range

See Current Range.

Current Range

This species is known from a single population in Washoe County, Nevada, located approximately 10 miles south of Reno. (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual and asexual (NatureServe, 2015)

Dependency on Other Individuals or Species

Adult: Flowers are visited by a diverse group of smallish insects including bees, wasps, flies, and butterflies (Archibald et al., 2001). Some observers have suggested that butterflies pollinate them and that ants disperse the seeds (Soper, 1987). (NatureServe, 2015)

Breeding Season

Adult: May to June (NatureServe, 2015)

Reproduction Narrative

Adult: The plant reproduces by seed and vegetative spread. Clonal propagation may be the primary mode of reproduction in Steamboat buckwheat, coupled with occasional occurrences of seed production through sexual recombination (Ten Knight, TNC and Jim Morefield, NNHP, pers. comm., May 19, 1994). Flowers are visited by a diverse group of smallish insects including bees, wasps, flies, and butterflies (Archibald et al., 2001). Some observers have suggested that butterflies pollinate them and that ants disperse the seeds (Soper, 1987). The plant can spread clonally by rhizomes, so individual genets are difficult to distinguish (Knight, 1993). It is gynodioecious and males are sterile, or female plants produce flowers whose stamens bear anthers that are either small, poorly developed and knob-like, or larger but flattened; neither type produces pollen. The flowers of hermaphroditic plants produce normal, plump anthers that produce pollen. These flowers are self-compatible, but require a pollinator (Archibald et al., 2001). Genotype frequencies indicate mating is random and cloning has been documented but the frequency of this occurrence is not known (Archibald et al., 2001). Individuals were transplanted to containers at the Nevada Division of Forestry nursery and produced seed successfully, suggesting that this species does not depend on the pollination services of a highly specific pollinator. (NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Playa, salt flat (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: The species colonizes the deposits only after precipitation has leached high concentrations of sodium, potassium, and other soluble chemicals from the substrates. Moisture is derived from precipitation rather than spring sources. (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Largely restricted to moderately deep, siliceous hot springs deposits known as sinter. Over time, as soils accumulate and develop on the deposits, other species invade and eventually out-compete the buckwheat (USFWS, 1995). (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Open areas on the slopes of deep (approximately 25 m), dome-shaped, siliceous hot springs deposits in an area that has been intermittently geothermally active for the past 2.5 million years. It is largely restricted to moderately deep, siliceous hot springs deposits known as sinter which originated from the discharge of hot-spring waters and thermal ground water saturated with amorphous silica (USFWS, 1995). The species colonizes the deposits only after precipitation has leached high concentrations of sodium, potassium, and other soluble chemicals from the substrates. Moisture is derived from precipitation rather than spring sources. Over time, as soils accumulate and develop on the deposits, other species invade and eventually out-compete the buckwheat (USFWS, 1995). (NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Williams (1982) suggested that the seeds of Steamboat buckwheat are disseminated by wind. Viability of seeds may be quite low. (USFWS, 1995)

Population Information and Trends**Population Trends:**

Uncertain (USFWS, 2019)

Number of Populations:

1 (USFWS, 2019)

Population Size:

See narrative; difficult to estimate (USFWS, 2019)

Population Narrative:

Various estimates of the abundance of *Eriogonum ovalifolium* var. *williamsiae* have been made over the 32 years since the plant was listed. These estimates have ranged from 10,000 to 15,000 individual plants in the final rule listing the species (Service 1986) to 85,000 plants by Knight (1997), to 200,000 plants by Morefield (2001). Knight 1993 noted that a precise enumeration of individual plants is infeasible because the species is rhizomatous and propagates primarily by vegetative runners. (USFWS, 2019)

Threats and Stressors

Stressor: Development (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: A substantial portion of the Steamboat buckwheat occurs on a private parcel adjacent to U.S. Highway 395, giving it high potential for commercial development. About 60 percent of this 12 ac (4.9 ha) parcel, labeled Moana Lane Nursery in Figure 1, is occupied habitat comprising an estimated 15 percent of the total occupied habitat for the Steamboat buckwheat and over 20 percent of the two-thirds of the entire population that occurs on private land; moreover, the habitat on this property is believed to support dense concentrations of the buckwheat based on observations of similar habitat on adjacent Ormat-leased lands. For these reasons, conservation of this habitat is considered integral to the recovery of the Steamboat buckwheat. The landowner has repeatedly expressed interest in protecting the property either through fee title acquisition or through a conservation easement. The Nevada Department of State Lands has indicated a willingness to accept the property and the NDF has agreed to manage it, but to date no funding has been available to secure this part of the population. Although this private property remains subject to the permitting requirements of NDF (see Factor D, Section II.C.2.d), the development of this property remains a potential threat. (USFWS, 2009)

Stressor: Cessation of hot spring activity (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: As noted in the biological discussion above (Section II.C.1.e.), hot spring activity on the site has ceased, and while the complex geothermal system is still not well understood, the cause is likely related to numerous factors including geothermal production, drawdown of the regional groundwater table resulting from increased domestic and municipal use, and possible lack of recharge due to drought (BLM 1993). It should be noted, however, that surface flow has not reappeared despite several wet/dry climatic cycles since the latter conjecture was made. Nevertheless, there is currently adequate habitat to support a robust population of the Steamboat buckwheat, and while the cessation of sinter creation may pose a long-term threat to its persistence, the species' survival does not appear at current risk due to the cessation of hot spring activity. (USFWS, 2009)

Stressor: Mining (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: An active mining claim exists on a portion of the population on BLM land, but seems unlikely to be developed while the surrounding private lands are in geothermal production. Therefore, mining does not appear to be a significant threat at this time and is unlikely to become significant while the geothermal plant remains in operation. (USFWS, 2009)

Stressor: Off-road vehicles (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Off-road vehicle use has been substantially reduced due to fencing of the industrial areas, vigilance of the geothermal facility staff, and the installation of a right-of-way fence along U.S. Highway 395 by NDOT. The geothermal facility has recently installed a locked gate along their main access road which limits unauthorized access from this point. Occasional off-road vehicle use, usually by motorcycle, still occurs via other access points, but does not constitute a

significant threat to the species. There is no evidence of recent refuse dumping in the area so this activity is no longer considered to be a significant threat. (USFWS, 2009)

Stressor: Moisture availability (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Changes in moisture availability were cited in the final rule based on observations that plants have been observed to die when more than normal moisture, presumably precipitation, is received. This led to speculation that off-road vehicle use and refuse dumping might alter moisture patterns, thereby affecting plants. As noted above, both off-road vehicle use and refuse dumping no longer pose a significant threat to the species. The possibility that geothermal test wells might contribute to changes in water regimes has been discussed above. Some alteration in water flow patterns may have resulted from road and/or facility construction, but their effects are unknown and unlikely to be significant because of their limited extent. (USFWS, 2009)

Stressor: Human activities (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Minor impacts continue to affect small numbers of individuals, usually in peripheral areas adjacent to the highway or industrial sites. For example, in 2002 the NDF reported that a Nevada Department of Transportation (NDOT) project resulted in the loss of one plant. In 2004, NDF reported the transplantation of four plants to avoid loss during construction of a pipeline and geothermal facility, the loss of one plant hit by a snow plow during a storm, and the killing of an estimated 15 plants which were driven over by a crew servicing a billboard. In 2005, NDF reported that NDOT had killed one plant during construction of a right-of-way fence. In 2006, NDF reported that a spill of drilling mud had impacted 107 plants, all of which survived. These impacts, individually or collectively, do not constitute a significant loss of habitat for this variety and are far below a level that would jeopardize its existence. The current transportation plan for the area developed by Washoe County proposes a road that would likely impact occupied habitat, but this action would be subject to permitting by NDF. (USFWS, 2009)

Stressor: Predation (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Some of the poor seed production observed in this variety has been attributed to high seed predation by larvae of a lycaenid butterfly species in the genus *Euphilotes* (Tepedino et al. 2000, p. 9). However, seed tested by the Berry Botanical Garden has shown seed viability of less than 1 percent, which strongly suggests that other factors, including genetic incompatibility factors, may be more significant in limiting sexual reproduction (see, however, the results of seedling monitoring during 2006 discussed in II.C.1.a. above). At this time, there is no evidence that disease or seed predation are significant threats to the species. (USFWS, 2009)

Stressor: Narrow distribution and small population size (USFWS, 2009)

Exposure:

Response:**Consequence:**

Narrative: The final rule listing the Steamboat buckwheat indicated that the narrow distribution and small population size of the Steamboat buckwheat may make it vulnerable to fire or other disturbance in its habitat, and that a loss of individuals may have adverse effects on the reproductive capacity and survival of the species. The vulnerability of the habitat to fire has been addressed above in Section II.C.1.e. in our discussion of weeds. While it appears that the sexual reproductive capacity of the plant is limited, the Steamboat buckwheat does appear to have increased slightly in total area and perhaps numbers due to the control of disturbances caused by public access. No long-term monitoring data are available to precisely evaluate the status of the species, but anecdotal evidence suggests that it has successfully established in disturbed areas where it previously was not present. In addition, areas in which ramets (a unit of clonal growth) were transplanted as mitigation for the original loss of habitat from the cooling tower facility appear to be self-maintaining. Either those ramets have been successful in maintaining individuals through asexual reproduction, or they are successfully reproducing seedlings, or both, in the mitigation areas. (USFWS, 2009)

Recovery**Reclassification Criteria:**

Downlisting for *Eriogonum ovalifolium* var. *williamsiae* can be considered when: (USFWS, 1995)

1. Protective conservation easements or fee acquisitions secure approximately 185 acres of occupied habitat currently in private ownership; (USFWS, 1995)
2. Cooperative agreements are established for approximately 80 acres of occupied public lands and approximately 37 acres of occupied State lands within a highway easement; (USFWS, 1995)
3. Comprehensive management plans have been developed and implemented on all occupied habitat. (USFWS, 1995)

Delisting Criteria:

Delisting Recovery Criteria (amended recovery criteria) Delisting may be warranted when the current downlisting criteria have been met and the species exhibits sufficient resiliency, redundancy, and representation to support long-term viability.

1. Threats are reduced or eliminated so that the species is capable of persisting without substantial human intervention or perpetual endowments are secured for management necessary to maintain the continued existence of the species. Outstanding management needs include: a) implementing the monitoring protocol, b) updating and renewing the Steamboat Buckwheat Management Plan (Knight 1997), c) controlling competition with nonnative weeds, and d) exploring potential methods of restoration of geothermal processes that maintain and create habitat. (USFWS, 2019)
2. All size classes are represented, the population is increasing or stable, and management objectives identified in the monitoring protocol are achieved (Pavlik 2002, Pavlik and Stanton 2003). Monitoring objectives were developed to detect and document 1) trends in the numbers of *Eriogonum ovalifolium* var. *williamsiae* plants in characteristic habitats, 2) the frequency and

contribution of episodic reproduction to population stability, and 3) successional changes in common species that comprise the plant community of Steamboat Hills. Monitoring objectives are as follows: (a) *Eriogonum ovalifolium* var. *williamsiae* in the Main Terrace and Central Drainage habitats are within $\pm 15\%$ of their 2003 baseline levels after five and ten consecutive years of monitoring with a 95% level of confidence. (b) *Eriogonum ovalifolium* var. *williamsiae* in the Main Terrace and Central Drainage habitats each produce a significant cohort of seedlings (20% of the mean density in a given subpopulation in a given year is contributed by “seedlings”) at least once during five consecutive years of monitoring (or twice in ten years) with a 95% level of confidence. (c) Total live absolute cover by subpopulations of common shrubs [e.g. *Artemisia tridentata* (sagebrush), *Atriplex confertifolia* (shadscale), *Chrysothamnus nauseosus* (rabbitbrush), *Purshia tridentata* (bitterbrush)], perennial grasses [e.g. *Poa secunda* (bluegrass), *Leymus cinereus* (Great Basin wildrye)], and weeds [e.g. *Bromus tectorum* (cheatgrass)], as well as *E. ovalifolium* var. *williamsiae* are within $\pm 15\%$ of their 2003 baseline levels after five and ten consecutive years of monitoring with a 95% level of confidence. (USFWS, 2019)

3. The ex situ seedbank is maintained through the collection of fresh seed from *Eriogonum ovalifolium* var. *williamsiae* plants every 10 years. Collections that are spread over time produce lower extinction risk to wild populations, while maintaining a species’ genetic variation within an ex situ seedbank (Menges et al. 2004). The ex situ seedbank is currently maintained with Center for Plant Conservation-affiliated botanic garden, the Rae Selling Berry Seed Bank and Plant Conservation Program at Portland State University (formally the Berry Botanic Garden). Currently, the ex situ seedbank holds approximately 23,000 viable seeds from collections made from 1992-1995 in long-term storage (i.e. freezer). In 1999, a germination trial on a sample of these seeds found greater than 70% germination (E. Guerrant, Rae Selling Berry Seed Bank, pers. comm. 2018a, E. Guerrant, unpubl. data, 2018b). (USFWS, 2019)

Recovery Actions:

- Protect Steamboat buckwheat habitats from adverse physical and biological modifications. The entire population of Steamboat buckwheat is restricted to approximately 100-150 ha (250-375 ac) of private and federally managed lands. Comprehensive management of Steamboat buckwheat will require development of a range-wide protection strategy in cooperation with the property owners, the BLM, FHWA, NDOT, and other concerned or knowledgeable entities such as NDF, NNHP, and TNC. (USFWS, 1995)
- Determine Steamboat buckwheat biology and habitat requirements. Maintenance of a viable, self-sustaining population of Steamboat buckwheat well into the future will require: 1) Implementation of a monitoring program for gauging population trends and habitat conditions; and 2) new research on various aspects of the taxon’s biology and habitat requirements. (USFWS, 1995)
- Provide public information and education. Recovery of Steamboat buckwheat will be dependent, in part, on the interest and willing cooperation of the private property owners and other members of the local community. An effective outreach program would help to deter negative sentiment for the recovery process and create an avenue for involvement and support among property owners, other members of the public, and the resource management agencies. (USFWS, 1995)
- Recommendation for Future Action from 2009 5-Year Review: The highest priority should be given to recovery criterion 1, i.e., securing conservation easements or fee acquisition of the estimated 66 percent of the habitat which occurs on private lands. Given the generally industrial nature of the private lands leased by the geothermal company from the Dorothy

Towne Trust, the purchase of a conservation easement to secure these populations is likely to be the best option for these lands. The only other parcel of private land, roughly 12 ac (4.9 ha) in size with an estimated 7 ac (2.8 ha) of habitat, would most likely be best acquired in fee title and transferred to either Nevada Division of State Lands or the BLM, with a subsequent recovery management agreement for the entire population to be developed with the NDF or other interested entity. Once the recovery management agreement, with adequate provisions for adaptive management, is in place, the species could be proposed for delisting. (USFWS, 2009)

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SPECIES ACCOUNT: *Eriogonum pelinophilum* (Clay-Loving wild buckwheat)

Species Taxonomic and Listing Information

Listing Status: Endangered; 07/13/1984; Mountain- Prairie Region (R6) (USFWS, 2015)

Physical Description

A low, stout, perennial herb, 5-10 cm high, with narrow, inrolled leaves that look like green scrolls. Clusters of white or cream-colored flowers with a rounded greenish-red to brownish-red perianth borne at the ends of the branches (NatureServe, 2015).

Taxonomy

The species was first recognized as its own taxon in 1969, and officially described by James Reveal in 1973 (Reveal 1969, pp. 75-76; 1973, pp. 120-122). The *Eriogonum* genus has undergone rapid evolution in the arid regions of the West, with roughly 250 species. This native North American genus is second only to *Penstemon* (beardtongue) in number of species (Reveal 2005a, p. 1) (USFWS, 2009).

Historical Range

Eriogonum pelinophilum was first collected near Hotchkiss, Colorado, in Delta County in 1958. *Eriogonum pelinophilum* is endemic to the rolling clay (adobe) hills and flats immediately adjacent to the communities of Delta and Montrose, Colorado (USFWS, 2009).

Current Range

Estimated range is 420 square kilometers, calculated in GIS by drawing a minimum convex polygon around the known occurrences. Imprecisely reported occurrences are not included (NatureServe, 2015). The plants extend from near Lazear, east of Delta on the northern end of the species' range, to the southeastern edge of Montrose in Delta and Montrose Counties, Colorado (USFWS, 2009).

Critical Habitat Designated

Yes; 7/13/1984.

Legal Description

On July 13, 1984, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Eriogonum pelinophilum* (Clay-Loving wild buckwheat) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Colorado (49 FR 28562-28565).

Critical Habitat Designation

The critical habitat designation for *Eriogonum pelinophilum* includes one CHU in Delta County, Colorado. This species critical habitat encompasses approximately 119.8 acres (49 FR 28562-28565).

Colorado, Delta County. About 3 miles east of Austin near Highway 92. T14S, R94W 6th P.M. Section 26-west 225 feet of Section 26 lying south of State Highway 92 (5.6 acres). Section 27-

that part of the SE¼ SE¼ lying south of State Highway 92 (35.6 acres]. Section 34-an area bounded by a line beginning at the northeast corner of Section 34, thence south along the section line 200 feet to a point; thence southwesterly to a point 1050 feet south and 550 feet west of the northeast corner of Section 34; thence southwesterly to a point 700 feet north and 900 feet east of center ¼ corner of Section 34; thence westerly 900 feet to the north-south ¼ line; thence northerly 600 feet along the ¼ line to a point; thence northeasterly to a point of the east 1/16 line; thence northerly along the 1/16 line 300 feet to the north section line of Section 34; thence easterly along the north section line to the point of beginning (65.0 acres). Section 35-north 200 feet of the west 225 feet (1.0 acres]. Section 27-west 200 feet of Section 27 lying south of State Highway 92 (4.3 acres]. Section 28-east 400 feet of Section 28 lying south of State Highway 92 (8.3 acres). Total 119.8 acres.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Eriogonum pelinophilum* critical habitat are not specified but are thought to be the following (49 FR 28562-28565):

The primary constituent elements include those factors associated with the whitish alkaline clay soils within the sparsely vegetated badlands of Mancos shale.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual: cross-pollination, self-pollination (NatureServe, 2015)

Lifespan

Adult: 50+ years (inferred from NatureServe, 2015)

Breeding Season

Adult: May - September (USFWS, 2009)

Key Resources Needed for Breeding

Adult: Insect pollinators, cold period (NatureServe, 2015)

Reproduction Narrative

Adult: *E. pelinophilum* requires an insect pollinator in order to set seed (Bowlin et al. 1993). Experimental study showed that the species is self-compatible (sets viable seed when pollen is transferred between flowers on the same plant); the authors believe that "pollinators moving from male-stage to female-stage flowers on the same plant will occasionally effect pollination" (Bowlin et al. 1993). Pollinators also frequently move between plants, resulting in a mixed breeding system with some pollination from other flowers on the same plant and some from flowers on different plants (Bowlin et al. 1993). A wide variety of insects visit and probably pollinate the flowers. Both ants and flying insects appear to be effective pollinators, with a field experiment showing no significant difference in seed set among flowers visited only by ants, only by flying insects, or by both groups (Bowlin et al. 1993). Results from the Colorado Natural Areas Program (CNAP) monitoring program on *E. pelinophilum* (1987, 1988) indicate that *E.*

perlinophilum is a long-lived perennial with a probable population turnover rate of approximately 20-50 years. All Eriogonum species studied thus far have seeds that require a cold period to break dormancy (not necessarily a freeze). Mixed selfing and outcrossing occurs (NatureServe, 2015). Flowering typically occurs from late May to early September with individual flowers lasting fewer than 3 days (Bowlin et al. 1992, p. 298) (USFWS, 2009).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Salt desert shrubland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 1580 - 1950 m elevation (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: 75 - 500 individuals per acre (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Eriogonum pelinophilum is found in substrates derived from the Mancos Formation shales. Inhabits whitish, alkaline clay soils on Mancos shale. Vegetation is a sparse salt desert shrub community. Occurs at 1580 - 1950 m elevation. The entire area is typified by rolling adobe (clay) hills and flats. Generally, the plants are found in a sharply defined soil microhabitat with shadscale (Atriplex confertifolia), on mid to lower slopes of the hills. The soil types are part of the Billings Series, known for its fine texture and weak and unstable structure. These soils are calcareous throughout and in some places have visible accumulations of calcium carbonate or calcium sulfate (Cline et al. 1967). Because of the low moisture availability, communities in which E. pelinophilum occur are characterized by low species diversity, low productivity and minimal canopy cover. Eriogonum pelinophilum is codominant with other xerophytic shrubs or subshrubs such as shadscale, the rare Penstemon retrorsus, Castle Valley clover (Atriplex cuneata), mat saltbush, black sagebrush (Artemisia nova) and Xylorhiza venusta (Neely 1985, O'Kane 1985). The communities are apparently stable, climax associations, judging from the lack of invading species capable of dominating the sites. Densities range from 75 - 500 individuals per acre (180 per acre average) (NatureServe, 2015). Eriogonum pelinophilum plants are generally found within swales or drainages that are moister than surrounding areas (USFWS, 2009).

Dispersal/Migration**Dispersal**

Adult: Low (NatureServe, 2015)

Dispersal/Migration Narrative

Adult: Most seed is dispersed locally (Bowlin et al. 1993). Seed dispersal is usually passive, either being consumed or carried by animals, windblown, or moved by gravity or water (NatureServe,

2015). Some fruits are removed by harvester ants (Bowlin et al. 1992, p. 299); however, no information is available for the species on seed dispersal mechanisms (USFWS, 2009).

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Species Trends:

Relatively stable (NatureServe, 2015)

Resiliency:

Very low (inferred from USFWS, 2009)

Representation:

Unknown (USFWS, 2009)

Redundancy:

Moderate (inferred from USFWS, 2009)

Number of Populations:

14 (USFWS, 2009)

Population Size:

~278,000 (USFWS, 2009)

Adaptability:

High (inferred from NatureServe, 2015)

Population Narrative:

Appears to be susceptible to impacts from grazing. *Eriogonum pelinophilum* appears to be a long-lived plant, with a calculated half-life of nearly 200 years (Carpenter and Schultz 1994). However, it is facing extreme pressure from residential and agricultural development, and occurrences have been extirpated. The long term population trend is unknown. The short term trend is relatively stable. The total area occupied by the mapped occurrences is 959 acres (calculated by the Colorado Natural Heritage Program in 2012). There are 9 occurrences with good or excellent viability (NatureServe, 2015). Today, the species is known from 12 existing (extant) Eos 2 additional populations. The most recent rangewide population estimate for all A through D ranked *Eriogonum pelinophilum* EOs is very roughly 278,000 individuals across 582 occupied ac (233 ha). Genetic variation has not been studied and, therefore, is unknown. When a rectangle is drawn around all known occurrences, it measures roughly 11.5 mi (18.5 km) from east to west and 28.5 mi (46 km) from north to south (CNHP 2009, spatial data) (USFWS, 2009).

Threats and Stressors

Stressor: Agricultural, urban, and residential development (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The growing human population means more houses, more subdivisions, more industrial development, and increased utility and transportation needs that could impact *Eriogonum pelinophilum* occurrences as well as its suitable habitat. All EOs near Olathe and Montrose (EOs 004, 006, 011, 012, 013, 016, 018, 021, 022, 024, and 041) have agricultural fields or development immediately adjacent suggesting that some habitat and plants were lost when these areas were developed. The North Selig, Selig, Peach Valley, East, South, and Loutzenhizer Canals are all large canals that run along the eastern side of the Uncompahgre Valley and through *Eriogonum pelinophilum* habitat. Because of their proximity to *E. pelinophilum* EOs, suitable habitat and plants were likely lost during the construction of these canals. All canals and laterals have roads on at least one side, and most have roads running along both sides. These canals and associated roads support nonnative invasive plants and provide conduits for their spread. To reduce salt loading, a salinity control program was initiated in 1990. This program first eliminated flow through the canals during the winter and is now working to line laterals (Bureau of Reclamation 1994, summary). Because many of the *E. pelinophilum* EOs are located along laterals that are prioritized for lining, further impact to the species from these activities is a possibility. Increasing development continues to fragment and impact *Eriogonum pelinophilum* and its habitat. This development includes residential and industrial buildings, agricultural fields, power lines, canals, and roads (USFWS, 2009).

Stressor: Off-road vehicle use (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Aside from the direct loss of *Eriogonum pelinophilum* individuals, cars, motorcycles, and ORVs (collectively ORVs) may impact *E. pelinophilum* habitat in several ways. One common effect is soil compaction, which diminishes water infiltration, destroys soil stabilizers, and increases erosion from water and wind (ORV effects summarized in Ouren et al. 2007, pp. 1-225). Because of decreased soil moisture and increased compaction, plant size is generally reduced. Soil compaction also increases the potential for invasive, nonnative annuals and other early successional plants to establish rapidly in ORV routes. Other impacts such as edge effects, fragmentation, and dust impacts occur from ORV use. The Mancos shale soils are vulnerable to ORV impacts because the clay is especially vulnerable to compaction and because there are no rocks and little vegetation to resist erosion (USFWS, 2009).

Stressor: Nonnative invasive plants (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Nonnative species documented within or adjacent to *Eriogonum pelinophilum* EOs include: *Acroptilon repens* (Russian knapweed), *Alyssum parviflorum* or *A. simplex* (alyssum), *Bromus inermis* (smooth brome), *Bromus tectorum* (cheatgrass), *Cardaria draba* (whiteweed or hoary cress), *Cardaria pubescens* (hairy whiteweed), *Ceratocephala testiculata* (bur buttercup, hornhead, or curviseed butterwort), *Chorispora tenella* (blue mustard or crossflower), *Cirsium arvense* (Canada thistle), *Descurainia* sp. (tansy mustard), *Elaeagnus angustifolia* (Russian olive), *Erodium cicutarium* (storksbill or redstem filaree), *Erysimum repandum* (spreading wallflower), *Halogeton glomeratus* (halogeton or saltlover), *Lactuca serriola* (prickly lettuce), *Lepidium perfoliatum* (clasping pepperweed), *Melilotus officinale* (yellow sweetclover), *Salsola tragus*

(prickly Russian thistle), *Sisymbrium altissimum* (tall tumble mustard), *Traxacum officinale* (common dandelion) (CNHP 2009, pp. 1-81; USFWS 2009a). Because *Eriogonum pelinophilum* is a long-lived perennial and was established before many of the nonnatives were introduced, impacts may not be immediate and would require longer term monitoring to quantify. However, nonnatives occur at all EOs (USFWS, 2009).

Stressor: Livestock use (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Threats related to livestock use include the eating of individual plants, physical effects of trampling of plants, and the indirect effects of habitat degradation. During the most extensive survey for the *Eriogonum pelinophilum* within the most numerous EO (018), minor impacts from livestock, especially from trampling near sheep bed grounds, were documented (Ferguson 2007, p. 2). At one location near sheep bedding grounds, *Eriogonum pelinophilum* plants were found on root pedestals, apparently due to the increased erosion in the area (Ferguson 2007, p. 8). During 2009, significant livestock impacts occurred within EO 018, the largest *Eriogonum pelinophilum* site containing over two thirds of the known individuals (USFWS, 2009).

Stressor: Herbicide Use (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The proximity of *E. pelinophilum* to agricultural fields and nonnative species makes the species vulnerable to this impact (USFWS, 2009).

Stressor: Herbivory (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Tent caterpillar impacts to *E. pelinophilum* were noted in 2007 (Ferguson 2007, p. 6). Herbivory where several plants were heavily browsed has been documented in two instances, but the herbivore is unknown and the number of individuals impacted was low (Ferguson 2007, p. 7). Herbivory of numerous individuals was documented associated with livestock use in 2009; although, this use has not yet been well quantified (Sharp, in litt. 2009) (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Future projections for the southwest predict increased temperatures, more intense and longer-lasting heat waves, an increased probability of drought that are worsened by higher temperatures, heavier downpours, increased flooding, and increased erosion (Karl et al. 2009, pp. 129-134). These changes will affect fire frequency, community assemblages, and the ability of nonnative species to succeed. The Mancos shale is limited in distribution and the plant is a long-lived perennial, both factors will limit *E. pelinophilum*'s ability to migrate with a changing climate. Climate change likely is and will affect all *Eriogonum pelinophilum* populations (USFWS, 2009).

Recovery**Reclassification Criteria:**

Ten healthy populations are secured in their natural habitat (USFWS, 1988).

Delisting Criteria:

Twenty healthy populations are secured in their natural habitat (USFWS, 1988).

Recovery Actions:

- Initiate scientific research on known and potential habitat and the biology of the species (USFWS, 1988).
- Remove threats to the clay-loving wild-buckwheat and secure populations and tier ecosystems (USFWS, 1988).
- Develop public awareness and appreciation for the "adobes" habitat on which the clay-loving wild-buckwheat grows (USFWS, 1988).

Conservation Measures and Best Management Practices:

- Permanently protect all occupied habitat. On public lands, add additional and expand existing ACECs, remove threats (especially ORV activity and negative impacts from livestock use), and provide more stringent protection within RMPs. On private land, pursue conservation easements, appropriate zoning incentives, and land acquisitions to protect populations (USFWS, 2009).
- Coordinate with local governments to better protect *Eriogonum pelinophilum*. Consider lower densities for new developments, open space, avoidance measures, and other actions to conserve the species. Integrate these actions into county and city land use planning designations (USFWS, 2009).
- Conduct education and outreach efforts for the public. The intent of these efforts will be to secure more *Eriogonum pelinophilum* sites for conservation. Develop and implement permanent conservation agreements and easements for populations on private lands. Provide technical and financial support for conservation actions on private lands (USFWS, 2009).
- Work with all parties to prevent ORV use within *Eriogonum pelinophilum* habitat (USFWS, 2009).
- Consider removing livestock from all *Eriogonum pelinophilum* sites. If livestock use continues, careful monitoring of the species and the livestock use should occur. Research (see below) assessing the effects of livestock use should be conducted (USFWS, 2009).
- Conduct nonnative invasive plant control activities where needed to conserve *Eriogonum pelinophilum*. Control should be conducted with extreme care to reduce impacts to *E. pelinophilum* (USFWS, 2009).
- Recommend at least a 200 m/656 ft. buffer between occupied or suitable habitat and ground disturbance or other activities that may affect *Eriogonum pelinophilum* or its habitat (USFWS, 2009).
- Revise the recovery plan for *Eriogonum pelinophilum* so that it reflects the best scientific and commercial information available. The revised recovery plan should include objective, measurable criteria which, when met, will result in a determination that the species be removed from the Federal List of Endangered and Threatened Plants. Recovery criteria should address all threats impacting the species. The recovery plan also should estimate the time required and the cost to carry out those measures needed to achieve the goal for recovery and delisting (USFWS, 2009).
- Revise critical habitat for *Eriogonum pelinophilum*. "Critical habitat" is defined as: (1) specific areas within the geographical area occupied by the species at the time of listing, if they contain physical or biological features essential to conservation, and those features may require special management

considerations or protection; and (2) specific areas outside the geographical area occupied by the species if the agency determines that the area itself is essential for conservation (USFWS, 2009).

- Develop and implement consistent conservation measures in the Uncompahgre Field Office's RMP revision that will avoid and minimize impacts to *Eriogonum pelinophilum* from all development, ORV, and grazing activities. Include protection for all occupied and suitable habitat in the conservation measures (USFWS, 2009).
- Expand existing ACECs to include contiguous occupied and suitable habitat for the plant and its pollinators. Revise ACEC management guidelines to better protect *Eriogonum pelinophilum*. Consider creating new ACECs to conserve the species, especially in the northern portion of the species' range near the Selig Canal sites (EOs 014 and 025) and unsurveyed land in the area (USFWS, 2009).
- Inventory potential habitat for *Eriogonum pelinophilum* on public and private lands. Report results to CNHP, BLM, and the Service. These surveys will provide better information to guide recovery and conservation actions as well as project planning (USFWS, 2009).
- Initiate range-wide trend monitoring to track the health of *Eriogonum pelinophilum*. Include a component to analyze potential effects from disturbances, nonnatives, and climate change (USFWS, 2009).
- Monitor the effects of development activities located within 200 m/656 ft. of plant populations on plants, pollinators, and habitat. Change buffers as determined by monitoring results (USFWS, 2009).
- Conduct demographic monitoring that determines critical life history stages that will enhance management of the species (USFWS, 2009).
- Conduct research studying demographic parameters that identifies critical life history stages (USFWS, 2009).
- Conduct research studying genetic diversity and taxonomic relations of *Eriogonum pelinophilum*. This research should address what populations are most important to conserve and investigate if genetic diversity is a problem for small isolated populations (USFWS, 2009).
- Conduct research investigating the effects of various threats. For example, impacts of various levels of livestock use, the impacts of ORVs, the impacts of nonnative species, and the effects of various disturbance levels (USFWS, 2009).
- Incorporate demographic, genetic diversity, and threat research into a population viability analysis that addresses minimum population size, and trajectories factoring in effects of threats (USFWS, 2009).

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SPECIES ACCOUNT: *Eriophyllum latilobum* (San Mateo woolly sunflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/06/1995; Pacific Southwest (R8)

Physical Description

An herbaceous (nonwoody) perennial of the aster family (Asteraceae) with leafy stems 30 to 60, exceptionally 90, centimeters (12 to 16 inches) high (J. Mooring, in litt., 1998). The upper surfaces of the deeply cleft leaves are a smooth dark green and the lower surfaces are covered with densely interwoven white hairs. The golden flower heads are borne in loose clusters (Munz and Keck 1959, McGuire and Morey 1992). *Eriophyllum latilobum* differs from *Eriophyllum confertiflorum* (golden yarrow) in having seven to eight ray flowers (the flowers usually located on the edge of the head of members of the aster family) rather than five ray flowers, and a more open inflorescence (Abrams and Ferris 1960, J. Mooring, in litt., 1998). *Eriophyllum lanatum* var. *arachnoideum* (common woolly sunflower) differs from the other two species in having 13 ray flowers and shallowly cleft leaves (Abrams and Ferris 1960, Hickman 1993). San Mateo woolly sunflower can be mistaken for plants from several populations that seem to be of hybrid origin between *Eriophyllum lanatum* and *Eriophyllum confertiflorum*. Plants of these populations have either four or six sets of chromosomes and are located near Black Mountain and Montebello Ridge (Mooring 1994, J. Mooring, in litt., 1996, 1998). (USFWS, 1998)

Taxonomy

Eriophyllum latilobum is a tetraploid (having four sets of chromosomes) (Carlquist 1956, Mooring 1973) and is believed to have originated as a hybrid between *Eriophyllum confertiflorum* var. *confertiflorum* and *Eriophyllum lanatum* var. *arachnoideum* (Constance 1937, Munz and Keck 1959, Hickman 1993, Mooring 1994) (USFWS, 2011). A member of the aster family (Asteraceae) (USFWS, 1998).

Historical Range

San Mateo County, California. (USFWS, 2011)

Current Range

San Mateo County, California. (USFWS, 2011)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 2011)

Breeding Season

Adult: April - June (USFWS, 2011)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 2012)

Reproduction Narrative

Adult: Blooms from April to June. Its pollinators include syrphid flies and bees. *Eriophyllum latilobum* is not a vigorous reproducer; low germination rates and low seedling survival have been observed under greenhouse conditions (John Mooring, in litt., 1992; McGuire and Morey 1992) (USFWS, 2011).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cismontane woodland, Gen oak woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 45 - 150 m elevation (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Dependency on Other Individuals or Species for Habitat

Adult: *Quercus agrifolia* (USFWS, 2011)

Habitat Narrative

Adult: Inhabits moist, steep slopes of serpentine-influenced rocky soil, mostly in shaded spots. Inhabits cismontane woodland (serpentinite, often on roadcuts) at elevations of 45 - 150m (California Native Plant Society 2001) and Gen oak woodland at elevations of 100 - 150m (Hickman 1993). The environmental specificity is very narrow; it is only known from a few sites on serpentine in San Mateo County, California (NatureServe, 2015). *Eriophyllum latilobum* is restricted to shaded moist sites on steep grassy or sparsely wooded slopes. It apparently grows best under or very near coast live oak (*Quercus agrifolia*) (J. Mooring, in litt., 1998) (USFWS, 2011).

Dispersal/Migration**Dispersal**

Adult: Low (USFWS, 2012)

Dispersal/Migration Narrative

Adult: Seed dispersal is by gravity, so most seeds fall close to the parent plant (J. Mooring, pers. comm. as cited in McGuire and Morey 1992) (USFWS, 2011).

Population Information and Trends**Population Trends:**

Decline of 30-50% (NatureServe, 2015)

Species Trends:

Additional occurrences discovered since listing (inferred from USFWS, 2011)

Number of Populations:

4 (USFWS, 2011)

Population Size:

250 - 1000 individuals (NatureServe, 2015); variable from year to year (USFWS, 2011)

Adaptability:

Low (inferred from NatureServe, 2015)

Population Narrative:

Apparently highly vulnerable though the exact biological reasons are unknown. This species has experienced a long-term decline of 30-50%. The main population near Crystal Springs, San Mateo County, has declined from many plants to a few hundred after an unfortunate mowing incident in 2001 (?). However there were about 200 seen in the latest survey. An additional 200 seen at Montara Mtn site in 2004. 3 and possibly a couple more sites known. Only two are currently mapped at CNDDDB; backlog contains a few more. 1 from La Honda is historical. The estimated population size is 250 - 1,000 plants (NatureServe, 2015). Some years the number of plants in some subpopulations ranges from zero to less than five; other years the same subpopulations contain 500 percent more plants. At the time of listing, there was only one known population on Crystal Springs Road. Since then, there have been three additional occurrences discovered (USFWS, 2011).

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The steep slopes along Crystal Springs Road provide a very unstable habitat for *E. latilobum*. The slopes are subject to erosion and soil slippage. After soil slippage occurs, road maintenance crews remove the slumped soil, which may contain mature individuals, seedlings, and/or seeds of *E. latilobum*. The road cut is then reshaped, which may damage plants remaining on the banks. Dumping of garden debris and downhill seepage of pesticides from homeowners living above the population may have negative impacts on *Eriophyllum latilobum* habitat (USFWS, 2011).

Stressor: Nonnative vegetation (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The plant is threatened by competition with nonnative plants; its habitat is more densely populated with *Carduus* sp. and *Bromus* sp. than it was 10 years ago (John Mooring, pers. comm., 1992). In a 2009 report prepared by Nomad Ecology for San Francisco Public

Utilities Commission and M&E/WRE Joint Venture, the non-native invasive plants considered a threat to habitat along Crystal Springs Road included fennel, French broom, and jubata grass. Other non-native invasive plants teasel, poison hemlock, bull thistle, and milk thistle were also present in this area (Nomad 2009). In the natural population, competing species such as plumeless thistle (*Carduus* sp.) may affect germination and seedling establishment (J. Mooring, in litt., 1998). (USFWS, 2011)

Stressor: Low reproductive output (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Germination rates for *E. latilobum* are lower than for any other sunflower, less than 10% (CDFG 1997). In the 2009 seed bank collection report from Rancho Santa Ana Botanic Garden, seed collected from CNDDDB #4 had a germination rate of 28% (USFWS, 2011).

Stressor: Stochastic events (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The small number of populations and low numbers of individual plants are also a factor. Because of the existence of few populations exhibiting low viability and located in an unstable habitat, this species is extremely vulnerable to extinction from random catastrophic events (Menges 1991, Primack 1993, Meffe and Carroll 1994) (USFWS, 2011).

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: A modeling study completed by Loarie et al. (2008) provides an evaluation of potential trends to California's floristic communities under climate change scenarios. In general, plant diversity will shift in two divergent directions: along the coast and northwards at higher elevations; and southwards at higher elevations of the Sierra Nevada. The models suggest that climate change has the potential to break up local floras, resulting in new species combinations, with new patterns of competition and biotic interactions (Loarie et al. 2008). Based on these models, *Eriophyllum latilobum* plants would likely be unable to shift their range because of their dependence on a rare soil type and their supposed limited ability for seed dispersal (USFWS, 2011).

Recovery

Reclassification Criteria:

A/1: A minimum of five colonies¹ of San Mateo woolly sunflower are fully protected and managed with the primary intention of preserving the occurrences in perpetuity. Each protected colony includes occupied habitat along with adjacent unoccupied habitat and a 150-meter (500-foot) buffer at the known site. If genetic research confirms that additional historical and/or extant *Eriophyllum* populations in San Mateo County were/are San Mateo woolly sunflower, these sites are also protected and managed as described above. If additional individuals, sub-populations, or populations are discovered on private lands, they are secured through land

acquisitions, conservation easements, or other means and protected as described above. (USFWS, 2019)

A/2: Management plan(s), approved by the Service, are implemented for the colonies described in A/1 and any occupied or unoccupied habitat identified as essential to survival. The plans include provisions for standardized annual monitoring of populations and provisions for the collection and preservation of viable genetic material that might otherwise be lost because of planned habitat destruction or modification. (USFWS, 2019)

E/1: Each colony described in A/1 contains a minimum of 150 (but preferably more) individuals each year for a minimum of 20 years. (USFWS, 2019)

E/2: Each colony described in A/1 has numbers of individuals that exhibit a stable or increasing trend over a period of 20 years that includes two normal precipitation cycles (or longer if suggested by the results of demographic monitoring). (USFWS, 2019)

E/3: Impacts from competition with native and nonnative species are managed so they do not pose a threat to the persistence of any of the San Mateo woolly sunflower colonies described in A/1. (USFWS, 2019)

E/4: Seeds, representative of the breadth of the species' genetic diversity, are stored in at least two Center for Plant Conservation certified facilities and reliable seed germination and propagation techniques are understood. Unless storage techniques and/or research show otherwise, stored seeds are replenished every 5 years in order to ensure seed viability. (USFWS, 2019)

E/5: If genetic research confirms that CNDDDB occurrences #2 and #3 contained populations of San Mateo woolly sunflower that have since been extirpated, these occurrences are reestablished using appropriate habitat restoration and plant propagation techniques. These additional occurrences are important due to the limited availability of the appropriate habitat. (USFWS, 2019)

Delisting Criteria:

A/1: A minimum of 20 self-sustaining colonies of San Mateo woolly sunflower are established on suitable habitat within or near the plant's known historical range, and are fully protected and managed with the primary intention of preserving the populations in perpetuity. Each protected area includes occupied habitat with adjacent unoccupied habitat and a 150-meter (500-foot) buffer, where possible. If historical and/or extant *Eriophyllum* colonies (outside of the San Mateo Creek Watershed) are determined to be San Mateo woolly sunflower, a minimum of 40 self-sustaining colonies are protected and managed as described above. Additional colonies are protected if indicated by modeling or research. (USFWS, 2019)

A/2: All lands upslope from the colonies described in A/1 are protected from incompatible uses.

A/3: Potential negative effects to San Mateo woolly sunflower habitat from sudden oak death infestations are absent or below a level that threatens colony health and/or persistence. (USFWS, 2019)

E/1: For a minimum of 20 consecutive years that include two normal precipitation cycles each colony described in A/1 exhibits a stable or increasing population trend with a rolling average of at least 300 individuals. During low density years (presumably from natural population fluctuations), each colony described in A/1 contains a minimum of 150 individuals. (USFWS, 2019)

E/4: Impacts from competition with native and nonnative species are managed so they do not pose a threat to the persistence of any of the San Mateo woolly sunflower colonies described in A/1. (USFWS, 2019)

E/5: Long-term management of San Mateo woolly sunflower habitat is both practically and financially sustainable. Financial resources for long-term habitat management are secured. (USFWS, 2019)

Recovery Actions:

- 1. Protect San Mateo woolly sunflower colonies and identify or establish additional colonies.
1.1. Ensure that all road and utility maintenance personnel are aware of San Mateo woolly sunflower along Crystal Springs Road and mark colonies with permanent signs/markers. Implement other protection measures as needed. (Priority 1). 1.2. Secure colonies through land acquisitions, conservation easements, or other means. (Priority 1). 1.3. Identify and protect potential introduction sites. (Priority 1). 1.4. Search for additional colonies on private and city land. Secure additional colonies through land acquisitions, conservation easements, or other means. (Priority 2). 1.5. Implement a seed increase and/or propagation program that may be used to establish new colonies and supplement existing colonies when necessary. (Priority 2). 1.6. Establish new colonies, to the extent described in the recovery criteria, within or near the species' known historical range. Colonies should be established in suitable habitats that exhibit a range of natural environmental conditions. Numerous introductions may be necessary to achieve adequate success rates and determine the range of habitat conditions under which successful establishment can be achieved. (Priority 2). (USFWS, 2019)
- 2. Research San Mateo woolly sunflower life history and conservation strategies. 2.1. Conduct genetic research on existing colonies to determine the species' genetic structure and genetic diversity. (Priority 1). 2.2. Study the historical and extant *Eriophyllum* occurrences that have been classified as San Mateo woolly sunflower to determine accurate species identities. Delineate the actual and historical range of San Mateo woolly sunflower. (Priority 1). 2.3. Research and develop reliable seed germination and propagation techniques. (Priority 1). 2.4. Determine the most effective and efficient habitat management practices to enhance colony health and reduce impacts from competing species and erosion. Experimentally test fire disturbance¹⁰⁴ as a management tool. (Priority 1). 2.5. Research optimal habitat characteristics, factors influencing seed germination, mechanisms of dispersal, impacts of seed predation, and potential impacts from climate change. (Priority 2). 2.6. Study the demography (including seedling survivorship), reproductive biology, and phenotypic plasticity (the capacity for marked variation in observable structural and functional properties of an organism because of environmental influences during development). of colonies. (Priority 3). (USFWS, 2019)
- 3. Monitor and manage San Mateo woolly sunflower colonies. 3.1. Implement site-specific management plans. Manage habitat in occupied areas and in surrounding areas that affect, or could affect, conditions in occupied areas (e.g. weedy species invade from adjacent

areas). . Best habitat management and restoration practices may include complete eradication of nonnative species, planting coast live oak trees, and/or treating sudden oak death infestations. (Priority 1). 3.2. Implement a standardized annual monitoring program with the power to detect population trends. (Priority 2). 3.3. Store seeds in at least two Center for Plant Conservation certified facilities. Unless storage techniques and/or research show otherwise, replenish seed stock every 5 years to ensure seed viability. (Priority 2). 3.4. Establish a Service-approved monitoring plan to cover a minimum of 5 years post-delisting. The plan will be ready for implementation at the time of delisting to ensure the ongoing conservation of the species and the continued effectiveness of management actions. Adequate funding must be dedicated in order to implement the delisting management plan. (Priority 3). (USFWS, 2019)

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SPECIES ACCOUNT: *Eryngium aristulatum* var. *parishii* (San Diego button-celery)

Species Taxonomic and Listing Information

Listing Status: Endangered; 08/03/1993; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial or biennial herb arising from a taproot. The flowers occur on stems and have rigid spiny bracts (NatureServe, 2015).

Taxonomy

A member of the Apiaceae (parsley/carrot family). *Eryngium aristulatum* var. *parishii* is one of three varieties of *Eryngium aristulatum* (Constance 1993, p. 147). *Eryngium aristulatum* var. *parishii* is separated from *Eryngium aristulatum* var. *aristulatum* (common) by having styles in fruit that are about the same length as the calyx (outer whorl of protective structures around the flower) and is separated from *Eryngium aristulatum* var. *hooveri* (Hoover's button-celery) by having bractlets (modified leaves) without callused margins (Constance 1993, pp. 147–148) (USFWS, 2010).

Historical Range

At the time of listing, *Eryngium aristulatum* var. *parishii* was considered extant in Riverside County at Santa Rosa Plateau, in San Diego County at Otay Mesa, Kearny Mesa, Del Mar Mesa, Marine Corps Air Station (MCAS) Miramar, and Marine Corps Base (MCB) Camp Pendleton, and in northern Baja California, Mexico (USFWS 1993, p. 41385). The historical distribution of *Eryngium aristulatum* var. *parishii* habitat included a coastal swath from Mesa de Colonet and San Quintin in Baja California, Mexico, north to Los Angeles County, California in the United States (USFWS, 2010).

Current Range

Eryngium aristulatum var. *parishii* currently occurs in 14 geographic areas in Riverside and San Diego Counties (USFWS, 2010). Occurs in the Santa Rosa Plateau in Riverside Co. and San Diego Co. California, and Baja California, Mexico. This species occurs in a small portion of the southwest portion of Riverside Co., and from San Diego Co. from Camp Pendleton Marine Base south into Baja California, Mexico to Ensenada (USFWS 1998) (NatureServe, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (USFWS, 2010)

Lifespan

Adult: 2+ years (inferred from USFWS, 2010)

Breeding Season

Adult: April - June (USFWS, 2010)

Key Resources Needed for Breeding

Adult: Ephemeral wet conditions; insect pollinators, based on closely related species (USFWS, 2010)

Reproduction Narrative

Adult: Relies on ephemeral wet conditions to reproduce; blooming from April to June. It is an outcrossing taxon that reproduces exclusively by seeds. *E. a. var. parishii* is presumably insect-pollinated (Zedler 1987, pp. 61–64), potentially by bee flies (Bombyliids) (Schiller et al. 2000, pp. 386–396) and solitary bees (Apoidea), as are many vernal pool species (Thorpe 2007, pp. 51–57) (USFWS, 2010).

Habitat Type

Adult: Wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Vernal pool (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Disturbance regime (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: Succession (inferred from USFWS, 2010)

Environmental Specificity

Adult: Very narrow (inferred from USFWS, 2010)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from USFWS, 2010)

Habitat Narrative

Adult: Grows in vernal pools (Smith and Berg, 1988) (NatureServe, 2015). It is a clay soil, surface and non-surface hard pan, vernal pool obligate. *Eryngium aristulatum* var. *parishii* seems more tolerant of peripheral vernal pool habitat than most obligate vernal pool species. It is specifically adapted to surviving in vernal wet conditions due to the presence of aerenchyma tissue (air channels in the roots) that facilitates necessary gas exchange in submerged plants (Keeley 1998, pp. 121–175). Habitat occupied by *Eryngium aristulatum* var. *parishii* is dependent upon some form of disturbance to set back succession (e.g., periodic fire and annual inundation) (USFWS, 2010).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

95 - 97% decline in habitat (USFWS, 2010)

Resiliency:

Low (inferred from USFWS, 2010)

Population Narrative:

It is restricted to southern coastal California, with few occurrences in northern Baja California, Mexico. *Eryngium aristulatum* var. *parishii* can be locally abundant in remnant vernal pools; however, the distribution of this variety has been dramatically reduced due to loss of most (95 to 97 percent) of the vernal pool habitat in San Diego County (USFWS 1998, p. iii) (USFWS, 2010).

Threats and Stressors

Stressor: Urbanization and agricultural development (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Loss of habitat from development is considered a primary contributor to vernal pool loss throughout California (Holland 1988, p. 1013; Barbour et al. 2007, p. 7), and specifically to vernal pools in southern California (Bauder 1986, p. 9-4; Bauder 1987, pp. 209–213). There is no certainty nor is there any likelihood that pools or pool complexes that fall outside the Multiple Habitat Planning Area (MHPA) will ultimately be conserved; these areas are still subject to development pressures. What was once a large, relatively unbroken expanse of patchy but interconnected pool habitat, has become remnant “islands” of vernal pools within an expanse of varying levels of anthropogenic disturbance, and permanently altered landscape (e.g., pools at N 8 General Dynamics site on Kerney Mesa, I 6C Bob Baker 2 on Mira Mesa, and C17– 18 on Mira Mesa; see Appendix 1) (USFWS, 2010).

Stressor: Off-highway vehicle (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Damage can be caused by motorcycles, quads, mountain bicycles, and four-wheel drive vehicles. Bauder (1987, p. 209) indicated that some impacts from OHVs were considered vandalism, while other damage occurred in the course of legitimate activities including fire fighting, security patrols, and military maneuvers. Altered pool hydrology may favor invasion of nonnative plants by allowing nonnatives to encroach in areas where the hydrological conditions had been altered by OHVs; vehicles can also break through the clay hard pan, causing hydrological damage that may not be repaired. The use of OHVs causes fragmentation, degradation, and destruction of vernal pools (Hilty et al. 2006, p. 157; Forman et al. 2003, pp. 113–138; Wilcove et al. 1998, pp. 607–615). Transportation corridors have the potential to spread disease, drain or damage pools, and facilitate the invasion of nonnative species (Hilty et al. 2006, p. 157) as well as mixing of otherwise naturally separated native species and genotypes

(e.g., fairy shrimp lineages). It is likely that OHV use continues to be a nearly rangewide threat to *Eryngium aristulatum* var. *parishii* and its habitat (USFWS, 2010).

Stressor: Trampling (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Habitat destruction associated with livestock and human access was considered to be a threat to *Eryngium aristulatum* var. *parishii* at listing (USFWS 1993, p. 41388) and in the Recovery Plan (USFWS 1998, p. 47). Impacts from this threat include soil compaction and erosion, though this is not a predominant threat. Destruction of *E. a.* var. *parishii* habitat from cattle is dramatically reduced, though some vernal pools continue to be impacted by livestock, such as horses in the J26 vernal pool complex in Otay Mesa (Wynn, pers. comm. 2010) (USFWS, 2010).

Stressor: Mowing and plowing (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Mowing and plowing/discing of habitat has been used to reduce fire hazards and to shorten vegetative cover for birds to reduce bird air-strike hazards and bird air mortality hazards (U.S. Marine Corps 2006, pp. 7-1–7-36; U.S. Marine Corps 2007, pp. F-47–F-49). Restrictions of these activities where there is a Federal or State nexus via INRMP site management plans and overarching MSHCPs have reduced the loss of habitat due to mowing or plowing; however, impacts from this threat have yet to be quantified (USFWS, 2010).

Stressor: Highway construction (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Road development and inter-related actions were classified as a threat to *Eryngium aristulatum* var. *parishii* when it was listed. Roads are closely associated to habitat fragmentation (loss) due to urban and agricultural development. Vernal pools and associated habitat proximal to basins have been eliminated by road and highway construction. Mitigation for roadway development has included the restoration of vernal pool habitat and introduction of key vernal pool species. Restoration of vernal pools has had some degree of success in the short term; however, the long term effectiveness of this mitigation approach is still being studied (Black and Zedler 1998, pp. 195–205). Road development and related construction activities are still a primary threat to the variety (USFWS, 2010).

Stressor: Altered hydrology (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Seasonality (phenology) of vernal pools requires annual hydrologic input during the spring months to moisten and fill pools and basins. Due to urbanization, hydrologic cycles have been affected near vernal pool complexes (Bauder 1987, pp. 209–213). However, impacts from this threat to *Eryngium aristulatum* var. *parishii* appear to have decreased since the time of

listing due to development standards that are intended to prevent runoff from entering vernal pool basins (Wynn, pers. obs. 2009) (USFWS, 2010).

Stressor: Military activities (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Impacts to vernal pool sites resulted from large equipment (e.g., tanks) and civilian use on base (USFWS 1993 p. 41388). Training activities near and adjacent to vernal pool habitat have resulted in site-specific impacts to vernal pool species, such as rutting of pools. Approximately 70 percent of the remaining vernal pool complexes occur on lands within military jurisdiction (USFWS 2008, p. 16). Since listing, conservation efforts on military lands have been in place due to implementation of the Sikes Act and the Sikes Act Improvement Act described below under Factor D, which require military installations to develop INRMPs (USFWS, 2010).

Stressor: Insect herbivory (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Predation was not identified as a threat at listing, but insect herbivory of *E. a. var. parishii* was later considered a disturbance concern in the recovery plan and remains a potential threat to the taxon (USFWS 1993, p. 41388; USFWS 1998, p. 67). This can have considerable effects on plant population dynamics, and may include: (1) Damage to roots, leaves, flowers, and developing seeds; and (2) ultimately reduce living plant fitness and reproductive success in the presence of native and nonnative competitors (Louda 1994, pp. 118–138) (USFWS, 2010).

Stressor: Nonnative plants (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: San Diego County and the range of *Eryngium aristulatum var. parishii* are in a mild, Mediterranean climate zone that makes the potential and rate for nonnative species incursion high. Nonnative plants are documented to alter natural landscapes and available habitat in San Diego County (Bauder 1987, pp. 209–213). Invasive, nonnative plants have long been considered a concern in vernal pool habitat (Holland 1988, p. 1014). Some of these biological impacts include competition with *E. a. var. parishii* for water, soil nutrients, space above and below ground, and displacement of natural pollinators. Bauder (2005, p. 2133) states that *Agrostis avenaca* (Pacific bentgrass) and *Polypogon monspeliensis* (rabbitsfoot grass) are present in San Diego County vernal pools, and that research in the field and under controlled conditions indicates “both grasses negatively affect native pool species in a variety of ways, ranging from survivorship to reproductive success.” (USFWS, 2010).

Stressor: Altered fire regime (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Fire is a natural component for regeneration and maintenance in *E. a. var. parishii* habitat (Bauder 1996, p. 2). However, the taxon faces two seemingly diametrically opposed

forces: lack of fire, and re-introduction of fire (accidental and purposeful) to an altered landscape. Fire in areas where *Eryngium aristulatum* var. *parishii* exist can remove vegetation cover that would otherwise aid in controlling erosion post fire. This may in turn result in local sedimentation of the pools or otherwise disrupt vernal pool ecology. Although habitat occupied by *Eryngium aristulatum* var. *parishii* is dependent upon some form of disturbance to set back succession (e.g., periodic fire and annual inundation), fires at critical times can eliminate populations of *E. a.* var. *parishii* by killing individual plants or seed banks through intense heat, or overheating soil to create hydrophobic conditions (Agee 1993, pp. 1– 493; Keane et al. 2002, pp. 3–11; Keeley 2001, pp. 81–94; Arno and Fiedler 2005, pp. 7–38) (USFWS, 2010).

Stressor: Small population size (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: *Eryngium aristulatum* var. *parishii* is limited by its inherent ecological tolerances and by past and current anthropogenic activities that occur within a vernal pool, in proximity to vernal pool complexes, or within a watershed of a vernal pool or complex. Events outside the range of natural influence or frequency variability, such as floods, fires, contamination, or drought, can substantially reduce or eliminate small populations and increase the likelihood of extinction (Lande 1993, p. 912). Small populations are more vulnerable to natural catastrophes and stochastic demographic, genetic, and environmental events (Barrett and Kohn 1991, pp. 3–30). Genetic effects may further influence population demography via inbreeding depression and genetic drift (Barrett and Kohn 1991, pp. 3–30; Menges 1991, pp. 58–61) (USFWS, 2010).

Stressor: Loss of pollinators (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Cumulative effects of habitat loss, drought, and urbanization on native pollinators contribute to an extant and future threat to *Eryngium aristulatum* var. *parishii*. The National Research Council of the National Academies (2007, pp. 73–74) indicated that “some pollinators in North America representing a diversity of taxa are, in fact, in decline.” When native pollinators are diminished, redundancies in pollinator systems may be disrupted thus impacting the reproductive output of the variety (USFWS, 2010).

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Drought was noted as a threat to *Eryngium aristulatum* var. *parishii* at the time of listing; however, its relationship to climate change has been derived since listing. The effects of an unpredictable precipitation regime on vernal pools, and on vernal pool species will have consequential effects on short and long term persistence of most if not all pools within basins (Bauder 2005, pp. 2129–2135). Ecosystem communities in California are expected to be ‘reshuffled’ due to climate disruption (Stralberg et al. 2009, pp. 1–8). The Service recognizes that climate change is an important issue with potential effects to listed species and their habitats; however, information to make precise oceanographic and atmospheric predictions regarding its

immediate effects to vernal pool species, including *Eryngium aristulatum* var. *parishii* and its habitat, is lacking (USFWS, 2010).

Recovery

Reclassification Criteria:

1. Existing vernal pools and their associated watersheds that contain *Eryngium aristulatum* var. *parishii* should be secured from further loss and degradation in a configuration that maintains habitat functions and species viability (USFWS, 1998).
2. The existing vernal pools and their associated watersheds contained within the complexes identified in Table 5 are secured in a configuration that maintains habitat function and species viability (as determined by recommended research) (USFWS, 1998).
3. Secured vernal pools are enhanced or restored such that population levels of existing species are stabilized or increased (USFWS, 1998).
4. Population trends must be shown to be stable or increasing for a minimum of 10 consecutive years prior to consideration for reclassification. Monitoring should continue for a period of at least 10 years following reclassification to ensure population stability (USFWS, 1998).

Delisting Criteria:

Delisting of the species is conditional on the downlisting criteria shown above, improvement (stabilized or increasing population trends) at all currently known sites; restoration, protection, and management of the minimum habitat area and configuration needed to ensure long-term viability; and establishing historic but locally extirpated species populations when needed to ensure viability (USFWS, 1998).

Recovery Actions:

- Conduct surveys and research essential to the conservation of the species (USFWS, 1998).
- Secure the existing vernal pools and their associated watersheds (USFWS, 1998).
- Where necessary reestablish vernal pool habitat to the historical structure (USFWS, 1998).
- Manage and monitor habitat and listed species (USFWS, 1998).

Conservation Measures and Best Management Practices:

- Conduct rangewide monitoring using species-specific protocol to ascertain distribution and abundance; assimilate monitoring data into a standardized database available to all cooperators, researchers, public, and regulators. Publish results in peer reviewed journal(s) (USFWS, 2010).
- Develop a coordinated interagency invasive species prevention and eradication program for all vernal pool habitat where *Eryngium aristulatum* var. *parishii* is extant (USFWS, 2010).
- Identify *Eryngium aristulatum* var. *parishii* pollinators, their required habitat, and implement measures to ensure their maintenance throughout the range of *E. a. var. parishii* (USFWS, 2010).
- Conduct hydrological monitoring and modeling to ascertain vulnerability of pools and complexes to likely altered hydrological conditions associated with climate change (USFWS, 2010).
- Determine the utility of enhanced and artificially created vernal pools to the conservation of the species and standardize methods of site selection, selection of propagation materials, outplanting protocols, success criteria, and remediation methods (USFWS, 2010).

- Coordinate with partners, such as MCAS Miramar and MCB Camp Pendleton, to help manage and protect vernal pool habitat (USFWS, 2010).

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SPECIES ACCOUNT: *Eryngium constancei* (Loch Lomond coyote thistle)

Species Taxonomic and Listing Information

Listing Status: Endangered; 08/01/1985; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

Loch Lomond button-celery is a perennial herb. Decumbent. Several flowered inflorescence with spiny bracts (NatureServe, 2015).

Taxonomy

Problematic genus, but *E. constancei* seems generally agreed upon as an entity (Bittman 1998) (NatureServe, 2015). A member of the carrot family (Apiaceae). Other common names for this species are Loch Lomond button-celery and Constance's coyote-thistle (Smith et al. 1980) (USFWS, 2005).

Historical Range

For over 5 decades, this species was known only from Loch Lomond, where it was first collected in 1941 (Sheikh 1983). *Eryngium constancei* has always been restricted to the Lake-Napa Vernal Pool Region (Keeler-Wolf et al. 1998) (USFWS, 2005).

Current Range

Eryngium constancei has been reported in Lake and Sonoma Counties in California. Three occurrences have been reported to CNDDDB and an additional locality is known in an unnamed pool near Cobb in Lake County (USFWS, 2009).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: 2+ years (USFWS, 2005)

Breeding Season

Adult: June - August (USFWS, 2005)

Reproduction Narrative

Adult: *Eryngium* species are biennial or perennial, with an overwintering rootstock. *Eryngium constancei* flowers after the water evaporates from the pools, typically between June and August (California Department of Fish and Game 1985, 1994) (USFWS, 2005).

Habitat Type

Adult: Terrestrial, wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Northern volcanic ashflow vernal pool, Northern basalt flow vernal pools (USFWS, 2009)

Geographic or Habitat Restraints or Barriers

Adult: ~463 - 853 m elevation (NatureServe, 2015; USFWS, 2009)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Habitat Narrative

Adult: *Eryngium constancei* grows abundantly within the borders of the meadow-like bed of the Loch Lomond lake at an elevation of 853 m. Rain fills the lake bed in winter, but the water evaporates in spring and early summer, leaving a seasonal meadow-like area in which *Eryngium constancei* and other plants germinate, flower, and set seed. The volcanic soils of the lake basin, together with its particular hydrological characteristics and the surrounding topography, may account for the unique presence of this species. It lives in fragile vernal pool habitat. The environmental specificity is very narrow (NatureServe, 2015). Loch Lomond is a small, intermittent lake with a surface area of about 3.2 hectares (7 acres) at maximum inundation (U.S. Fish and Wildlife Service 1985). This wetland is classified as a Northern Volcanic Ashflow Vernal Pool (Sawyer and Keeler-Wolf 1995; CNDDDB 2007) and is on Collayomi-Aiken-Whispering complex soils. The surrounding area is mountainous and supports a mixed forest. On Diamond Mountain, the pools where *Eryngium constancei* grows are shallow and spring-fed (CNDDDB 2007); they are classified as Northern Basalt Flow Vernal Pools (Sawyer and Keeler-Wolf 1995; CNDDDB 2007). The Dry Lake pool is at an elevation of 463 meters (1,520 feet) and is surrounded by *Quercus douglasii* (blue oak) woodland. (USFWS, 2009). Soils underlying Dry Lake are in the Sobrante-Guenoc-Hambright complex (USFWS, 2005).

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Unknown; presumed decline of < 30% (NatureServe, 2015)

Species Trends:

3 additional occurrences found since listing (USFWS, 2009); stable (NatureServe, 2015)

Resiliency:

Low (inferred from USFWS, 2009; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2009)

Number of Populations:

4 (USFWS, 2009)

Population Size:

> 10,000 (USFWS, 2005); millions (NatureServe, 2015)

Adaptability:

Low (inferred from NatureServe, 2015)

Population Narrative:

This vernal pool plant is vulnerable, though the biological reasons for it are unknown. The long term trend is not known, but is assumed to have been a slight decline (< 30%). The estimated population size is millions of individuals each year (Bittman 1998). The population trend has been stable for the past 10 years (NatureServe, 2015). Since listing in 1986 and proposed downlisting in 1993, three additional occurrences of *Eryngium constancei* were found. There are four extant occurrences (USFWS, 2009). The Dry Lake and Sonoma County populations numbered in the tens of thousands in both 1996 and 1997. However, in 1996, the Loch Lomond population was at least two orders of magnitude larger than in 1997 (California Natural Diversity Data Base 2003). The size of the fourth population has not been reported (USFWS, 2005).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Currently, routine highway maintenance, trash dumping and, to a smaller degree, occasional fence vandalism, vehicle trespass, and trampling still threaten *E. constancei* at the Loch Lomond site. Specific threats to two of the four extant populations are that at least one of the occupied pools at Diamond Mountain may be converted to a vineyard, and the owner of Dry Lake has proposed excavating the pool for a reservoir (CNDDDB 2007). Changes in hydrology threaten three of the four occurrences. In addition, runoff from adjacent roads and swimming pools creates excess water flow, whereas drainage ditches, culverts, and diversion of a natural spring are reducing the flow of water to *E. constancei* habitat (Hrusa and Buckmann 2000; CNDDDB 2007). Existing and potential sources of changes to the hydrology at two sites include adjacent roads, drainage ditches in and adjacent to Loch Lomond, development south of the lake (CNDDDB 2007), and a culvert alongside one of the Diamond Mountain pools. Larger-scale hydrological alterations, including commercial development and timber harvesting, are also occurring in all the watersheds where *Eryngium constancei* grows, thus posing added hydrological threats (U.S. Fish and Wildlife Service 1986, 1993; CDFG 1994; K. Aasen in litt. 1995; B. Hunter in litt. 1996; CNDDDB 2007). Not only does removal of trees and construction of logging roads alter the flow of water, but it also causes erosion, which can bury the plants and affect the hydrology (U.S. Fish and Wildlife Service 1985, U.S. Fish and Wildlife Service 1986, U.S. Fish and Wildlife Service 1993; California Department of Fish and Game 1994; Aasen in litt. 1995; B. Hunter in litt. 1996). The Loch Lomond and Diamond Mountain occurrences are threatened by hydrological alterations within their watersheds. By affecting the amount of runoff entering the pools or the rate at which the pools dry, the depth and duration of inundation can increase or decrease, creating conditions unsuitable for the survival of Loch Lomond coyote thistle. The Dry Lake occurrence is threatened by trash dumping and erosion into the pool; the surrounding slopes have been stripped of vegetation and are eroding (CNDDDB 2007). The Loch Lomond occurrence is also threatened by occasional fence vandalism and vehicle trespass (S. Zalusky, pers. comm. 2008) (USFWS, 2009).

Stressor: Trampling/grazing (USFWS, 2009)

Exposure:**Response:****Consequence:**

Narrative: Currently, the occurrence at Dry Lake is heavily impacted by horse padocking (S. Zalusky, pers. comm. 2008) (USFWS, 2009).

Stressor: Stochastic events (USFWS, 2009)

Exposure:**Response:****Consequence:**

Narrative: The extremely restricted distribution of *Eryngium constancei* is a threat to its long-term viability. Although the individual populations are sufficiently large that intrinsic problems such as genetic drift are not a concern, other random events could cause the species to go extinct. Catastrophic weather events, climate change, or other unforeseen circumstances potentially could eliminate all of the populations. In particular, small numbers of localities makes it difficult for this species to persist while sustaining the impacts from adjacent development, drought, or other unknown factors. Such populations may be highly susceptible to extirpation due to chance events or additional environmental disturbance (Goodman 1987; Gilpin and Soule 1988). If a locality of *E. constancei* has several consecutive years of poor rainfall, or changes in hydrology from adjacent development, it is possible that all individuals within the locality will become extirpated (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)

Exposure:**Response:****Consequence:**

Narrative: Drought or flood conditions will place additional strains on the vernal pool ecosystem supporting *E. constancei* occurrences, some of which are already fragmented or reduced by habitat conversion to wineries and development. Where occurrences persist on only marginal habitat, the addition of extreme drought conditions is likely to result in higher rates of mortality in the short term with the effects of low reproductive output and survivorship persisting after the drought has ceased. The predicted impacts on California's ecosystems projected with a high certainty include (1) higher sea level; (2) decreased suitable habitat for many terrestrial species as climate change intensifies human impacts [for example, isolated patches of vernal pools can be so poorly connected with other patches that migrations required by climate change may be difficult or impossible without human intervention (Field et al. 1999)]; and (3) increased competition among urban, agricultural, and natural ecosystem uses due to decreased precipitation. Although the specific effects of climate change on *Eryngium constancei* are unknown, the effects of increased winter flooding and drought conditions in the spring and summer have the potential to adversely affect this species (USFWS, 2009).

Recovery**Reclassification Criteria:**

See delisting criteria.

Delisting Criteria:

1. Suitable vernal pool habitat within each prioritized core area for the species is protected (USFWS, 2009).
2. Species occurrences distributed across the species geographic range and genetic range are protected. Protection of extreme edges of populations protects the genetic differences that occur there (USFWS, 2009).
3. Reintroductions must be carried out and meet success criteria established in the recovery plan (USFWS, 2009).
4. Additional occurrences identified through future site assessments, GIS and other analyses, and status surveys that are determined essential to recovery are protected. Any newly found occurrences may count towards recovery goals if the occurrences are permanently protected as described in the recovery plan (USFWS, 2009).
5. Habitat protection results in protection of hydrology essential to vernal pool ecosystem function, and monitoring indicates that hydrology that contributes to population viability has been maintained through at least one multi-year period that includes above average, average, and below average local rainfall as defined above, a multi-year drought, and a minimum of 5 years of post-drought monitoring (USFWS, 2009).
6. Habitat management and monitoring plans that facilitate maintenance of vernal pool ecosystem function and population viability have been developed and implemented for all habitat protected, as previously discussed in sections 1A-E (USFWS, 2009).
7. Mechanisms are in place to provide for management in perpetuity and long-term monitoring of 1A-E, as previously discussed (funding, personnel, etc) (USFWS, 2009).
8. Monitoring indicates that ecosystem function has been maintained in the areas protected under 1A-D for at least one multi-year period that includes above average, average, and below average local rainfall, a multi-year drought, and a minimum of 5 years of post-drought monitoring (USFWS, 2009).
9. Seed banking actions have been completed for species that would require it as insurance against risk of stochastic extirpations or that will require reintroductions or introductions to contribute to meeting recovery criteria (USFWS, 2009).
10. Status surveys, 5-year status reviews, and population monitoring show populations within each vernal pool region where the species occur are viable (e.g., evidence of reproduction and recruitment) and have been maintained (stable or increasing) for at least one multi-year period that includes above average, average, and below average local rainfall, a multi-year drought, and a minimum of 5 years of post-drought monitoring (USFWS, 2009).
11. Status surveys, status reviews, and habitat monitoring show that threats identified during and since the listing process have been ameliorated or eliminated. Site-specific threats identified through standardized site assessments and habitat management planning also must be ameliorated or eliminated (USFWS, 2009).

12. Research actions necessary for recovery and conservation of the covered species have been identified (these are research actions that have not been specifically identified in the recovery actions but for which a process to develop them has been identified). Research actions (both specifically identified in the recovery actions and determined through the process) on species biology and ecology, habitat management and restoration, and methods to eliminate or ameliorate threats have been completed and incorporated into habitat protection, habitat management and monitoring, and species monitoring plans, and refinement of recovery criteria and actions (USFWS, 2009).

13. Research on genetic structure has been completed (for species where necessary – for reintroduction and introduction, seed banking) and results incorporated into habitat (USFWS, 2009). protection plans to ensure that within and among population genetic variation is fully representative by populations protected in the Habitat Protection section of this document, described previously in sections 1A-E

14. Research necessary to determine appropriate parameters to measure population viability for each species have been completed (USFWS, 2009).

15. Recovery Implementation Team is established and functioning to oversee rangewide recovery efforts (USFWS, 2009).

16. Vernal pool regional working groups are established and functioning to oversee regional recovery efforts (USFWS, 2009).

17. Participation plans for each vernal pool region have been completed and implemented (USFWS, 2009).

18. Vernal pool region working groups have developed and implemented outreach and incentive programs that develop partnerships contributing to achieving recovery criteria 1-4 (USFWS, 2009).

Recovery Actions:

- Habitat protection (USFWS, 2005).
- Adaptive habitat management and monitoring (USFWS, 2005).
- Status surveys (USFWS, 2005).
- Research (USFWs, 2005).
- Public participation and outreach (USFWS, 2005).

Conservation Measures and Best Management Practices:

- Protect vernal pool habitat from being destroyed or modified by development, agriculture, or other activities. Acquire conservation easements or fee title to habitat lands to help guarantee protection of the species in perpetuity (USFWS, 2009).
- Develop and implement standardized population trend survey protocols to complete updated status surveys at all four occurrences (USFWS, 2009).
- Create and convene regional vernal pool working groups in the Lake-Napa Region where *Eryngium constancei* occurs. Regional vernal pool working groups will be important for the tracking the

progress of recovery efforts, including the amount of suitable habitat protected for each of the species in the core areas (USFWS, 2009).

- Collect seeds from populations from which it has not yet been collected following the Center for Plant Conservation Guidelines (1991). Seed collections should be stored in at least two sites, including the National Center for Genetic Resources in Fort Collins, Colorado, and a facility certified by the Center for Plant Conservation (USFWS, 2009).
- Withdraw the proposal to reclassify *Eryngium constancei* from endangered to threatened (USFWS, 2009).
- Consider modifying the Boggs Lake-Clear Lake core area to incorporate the entire Loch Lomond Vernal Pool Ecological Reserve and adjacent watershed (USFWS, 2009).

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SPECIES ACCOUNT: *Eryngium cuneifolium* (Snakeroot)

Species Taxonomic and Listing Information

Listing Status: Endangered; 2/20/1987; Southeast Region (R4)

Physical Description

Eryngium cuneifolium is an aromatic perennial herb with a long, woody taproot, and persistent rosette of dark green. It usually has several erect, branching, flowering stems. It ranges from 0.25 to 0.5 m in height, rarely reaching as high as 0.9 m. The leaves are clustered at the base of the plant. The basal leaves are long, stalked, and shaped like narrow wedges, with 3 to 5 bristle-tipped teeth at the apex. Stem leaves are smaller and lack leaf stalks. The flowers are small, with white petals, filaments, styles and stigmas but powdery blue anthers form small heads, with bristly bracts. The sepals and petals are each about 1.5 to 2 mm long. The inferior ovary develops into a fruit about 1.5 to 2 mm long. The flowers and bristle bracts form heads 4 to 8 mm in diameter (Bell 1963, Wunderlin et al. 1981). Sterile plants are easily recognized in the field by their basal rosettes (Wunderlin et al. 1981). Flowering is from August to October (other *Eryngium* species, including *E. aromaticum* and *E. baldwinii* have blue flowers). (USFWS, 1999)

Taxonomy

Eryngium cuneifolium, a member of the parsley family (Apiaceae or Umbelliferae), is most closely related to *E. aromaticum* (Bell 1963, Wunderlin et al. 1981). It was described by J.K. Small (1933) and its status as a species was upheld by O.R. Bell's (1963) review of the genus. Preparers of status reports (Wunderlin et al. 1981, Kral 1983) have also concurred that this is a distinct species. There are no synonyms in the botanical literature (Bell 1963, Wunderlin et al. 1981). Other common names for this species include wedged-leaved button-snakeroot (Wunderlin et al. 1981) and semantic variations thereof. (USFWS, 1999)

Historical Range

This species was first collected in 1927 near Sebring. Highlands County, Florida. (USFWS, 1999)

Current Range

Southern Highlands County, Florida, near the town of Lake Placid. It occurs only on the southern Lake Wales Ridge. (USFWS, 1999)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 1999)

Lifespan

Adult: short-lived (less than 10 years) (USFWS, 2019)

Reproduction Narrative

Adult: Reproduction in *E. cuneifolium* is sexual. The species can reproduce readily by seed. There seems to be no special seed-dispersal mechanism (other than gravity) and pollination is likely to be similar to that of other members of Apiaceae, most likely by generalist insects (Wunderlin et al. 1981, Kral 1983). Germination and leafing dates are unknown. Budding is believed to occur in July. The plant flowers vigorously from September through October. Anthesis occurs from August to October. Fruiting and seed dispersal is believed to occur between October and January. Seeds are mature in November. Specimens have been collected in late November and December. (USFWS, 1999)

Habitat Type

Adult: Scrub vegetation

Habitat Narrative

Adult: Snakeroot is found in open sand gaps in rosemary habitats within the Lake Wales Ridge in Highlands County. Nearly every aspect of snakeroot's demography is affected by time-since-fire. The beneficial effects of fire are largely indirect, though removal of litter, competing vegetation, and ground lichens. Snakeroot is sensitive to shrub cover and is dependent on the gaps created between rosemary shrubs immediately after fires. (USFWS, 2019)

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Declining (inferred) (USFWS, 2019)

Number of Populations:

13 occurrences (USFWS, 2019)

Population Narrative:

In the last FNAI Element Tracking Summary (FNAI 2015) there were 13 known occurrences, 10 of which were on 5 managed areas. This was a significant decline (approximately 32 percent) from the 19 reported occurrences in the previous 5-year status review (2010c) (USFWS, 2019).

Threats and Stressors

Stressor: Habitat destruction or modification

Exposure:

Response:

Consequence:

Narrative: This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to

accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 million persons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

Stressor: Lack of adequate fire management

Exposure:

Response:

Consequence:

Narrative: Fire is necessary to maintain the scrub habitats upon which this species depends. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time (Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species. (USFWS, 2019)

Stressor: Limited geographic range

Exposure:

Response:

Consequence:

Narrative: This species occurs occur within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

Recovery

Reclassification Criteria:

1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to assure 20 to 90 percent probability of persistence for 100 years (USFWS, 1999)
2. When these sites, within its historic range, are adequately protected from further habitat loss, degradation, and fragmentation (USFWS, 1999)
3. When these sites are managed to maintain the rosemary phase of xeric oak scrub communities to support *E. cuneifolium* (USFWS, 1999)
4. When monitoring programs demonstrate that populations of *E. cuneifolium* on these sites support the appropriate numbers of self-sustaining populations, and those populations are stable throughout the historic range of the species (USFWS, 1999)

Delisting Criteria:

1. At least 20 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)
2. Populations (as defined in criterion 1) in rosemary scrub habitats are distributed across the known range of the species. (USFWS, 2019)
3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

Recovery Actions:

- Determine current distribution of *E. cuneifolium*. This species has been relatively well surveyed and a distribution has been ascertained. Additional surveys will confirm the species' distribution and locate new sites. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties has been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Conduct research on life history characteristics of *E. cuneifolium*. Continue the study of basic biology and ecology of this species. To effectively recover this species, more specific biological information is needed. (USFWS, 1999)
- Monitor existing populations of *E. cuneifolium*. Develop monitoring protocol to assess population trends for *E. cuneifolium*. Develop a quantitative description of the population structure of *E. cuneifolium*. (USFWS, 1999)
- Provide public information about *E. cuneifolium*. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Care is needed, though, to avoid revealing specific locality information about *E. cuneifolium*. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery

of *E. cuneifolium* and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)

- Develop delisting criteria. Once reclassification is achieved, research and monitoring results may provide data necessary to develop delisting criteria. (USFWS, 1999)
- Habitat-level Recovery Actions: Prevent degradation of existing habitat. Restore areas to suitable habitat. Continue habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

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USFWS. 2019. Amendment 1. Recovery Plan for *Conradina brevifolia* (short-leaved rosemary), *Crotalaria avonensis* (Avon Park harebells), *Dicerandra christmanii* (Garrett's mint), *Dicerandra frutescens* (scrub mint), *Eryngium cuneifolium* (snakeroot), *Hypericum cumulicola* (Highlands scrub hypericum), *Liatris ohlingerae* (scrub blazing star), *Polygala lewtonii* (Lewton's polygala), *Polygonella basiramia* (wireweed), *Polygonella myriophylla* (sandlace), *Warea carteri* (Carter's mustard), and *Ziziphus celata* (Florida ziziphus). U.S. Fish and Wildlife Service, Atlanta, Georgia. 23 pp. September 24, 2019.

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SPECIES ACCOUNT: *Erysimum capitatum* var. *angustatum* (Contra Costa wallflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/27/1978; Pacific Southwest (R8)

Physical Description

a short-lived perennial and monocarpic (individuals die after setting seed) (Service 1984). Pollination is by bees that nest in open banks and may also be by a variety of other unspecified insects (Service 2002). A study in 1987 by Pavlik et al (1998a) determined that seed production for E.c. var. *angustatum* was not a limiting factor and germination of new seeds was considered relatively high, with 40-60% typical, comparable to germination rates in non-endangered relatives. Additional work by Pavlik et al (1988b) determined that, at that time, the growth of E.c. var. *angustatum* populations was not genetically constrained, but was environmentally constrained due to limited habitat, interspecific vegetation competition, and possibly pollination limitations. Seedling emergence (and presumably, germination) was significantly higher in dune soils than unbroken clay soil, and higher (but not significantly) in dune soil than in broken clay soil (Pavlik et al 1988b). The reproductive phenology encompasses germination in October, leafing from October through December, budding in February, flowering in March (peaking in April or May), and fruiting beginning in April and peaking in July (Service 2008). (USFWS, 2019)

Taxonomy

Note that *Erysimum asperum* var. *angustatum* is a different plant, treated as a synonym of the typical *E. capitatum* var. *capitatum* by Kartesz (1994 checklist), recognized as a full species (*E. angustatum*) in Kartesz (Feb. 1999 draft data). Reports of the Contra Costa wallflower from Alaska and Canada are presumably due to confusion of these two similar names (NatureServe, 2015). The Contra Costa wallflower is one of the many varieties of the western wallflower (*Erysimum capitatum*). A member of the Brassicaceae (mustard) family (USFWS 1984) (USFWS, 2008).

Historical Range

The Contra Costa wallflower is endemic to the riverine dune habitat found within and immediately adjacent to the Antioch Dunes NWR in Contra Costa County, California. (USFWS, 2008)

Current Range

This species is only known known from the Antioch Dunes in Contra Costa County, California. (USFWS, 2008)

Critical Habitat Designated

Yes; 8/31/1978.

Legal Description

On August 31, 1978, the U.S. Fish and Wildlife Service, designated critical habitat for *Erysimum capitatum* var. *angustatum* (Contra Costa wallflower) under the authority of the Endangered

Species Act of 1973 (43 FR 39042 - 39044). Critical habitat was designated for one unit in California.

Critical Habitat Designation

One critical habitat unit is designated in California, described as: An area of land, water, and airspace in Contra Costa County with the following components: T. 2 N. R. 2 E. SW 1/4 section 17, E 2/3 of S 1/3 of section 18 (43 FR 39042 - 39044).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements are not described (43 FR 39042 - 39044).

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (inferred from USFWS, 2008)

Lifespan

Adult: 2+ years (USFWS, 2008)

Breeding Season

Adult: March - May (USFWS, 2008)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 2008)

Reproduction Narrative

Adult: This species is a biennial or short-lived perennial. The reproductive phenology of this species encompasses germination in October, leafing from October through December, budding in February, flowering in March (peaking in April or May), and fruiting in April (peaking in July). Unlike other members of the mustard family, pollination of the Contra Costa wallflower is by a variety of unspecialized insects, including bees nesting along the open banks (USFWS 2002) (USFWS, 2008). According to Harper (1977), it may best be thought of as a monocarpic perennial (USFWS, 1984).

Habitat Type

Adult: Terrestrial (NatureServe, 2015); riparian (USFWS, 2008)

Habitat Vegetation or Surface Water Classification

Adult: Grassland, sand dune, savanna, shrubland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Wind disturbance regime (USFWS, 2008)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at 3 - 20 m elevation (NatureServe, 2015)

Environmental Specificity

Adult: Moderate (inferred from USFWS, 2008)

Habitat Narrative

Adult: Inhabits inland dunes at 3 - 20 m elevation (Skinner 1997). More or less consolidated (stabilized) dunes of fine sand and some clay dust, with sparse herbs and shrubs, or less often with pasture grasses, herbs, and scattered *Quercus agrifolia* (Niehaus 1977) (NatureServe, 2015). The wallflower grows in soil types classified as sand to sandy loam. Precise information about the specific requirements of the Contra Costa wallflower are not well known; however, the plant has been observed growing in steep areas of unstable sand, especially on north-facing slopes adjacent to the river (USFWS 1984, 2002; S. Euing, USFWS, pers. comm. 2007). This plant has also been observed growing in a variety of conditions, including stable dunes of fine sand containing some clay and sparsely vegetated with herbs and shrubs; uneven river front bluff faces and edges; flat terrain in excavated areas; and flat hard pan areas 160 to 660 feet from the river where the hard pan is broken and loose, sandy soil is exposed (USFWS 2002). A natural disturbance regime is caused by the wind shifting the sandy environment in which the Contra Costa wallflower thrives (USFWS, 2008).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Seeds are wind-dispersed beginning in mid-May and peaking in September (USFWS, 2008).

Population Information and Trends**Population Trends:**

not considered stable or self-sustaining (USFWS, 2019)

Species Trends:

not considered stable or self-sustaining (USFWS, 2019)

Number of Populations:

4 (USFWS, 2019)

Population Size:

Approximately 9,287 individuals in 2017 (USFWS, 2019)

Population Narrative:

According to the CNDDDB (2018b), *Erysimum capitatum* var. *angustatum* is known from four EOs, all of which are presumed extant (Table 3). Of the four EOs, three are considered natural occurrences and one is considered transplanted outside of native habitat and/or range. The two CNDDDB EOs that occur at the ADNWR (EO #1, which includes the Stamm Unit and EO #3, which includes the Sardis Unit) represent the majority of, and possibly the entire, known range-wide natural/native population. Nearly annual plant counts have been conducted in at least some of the subunits of the Stamm and Sardis Units since about 1985. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat destruction from sand mining, industrial and urban/suburban development, and/or conversion to agriculture (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: Habitat for the this species and pollinators, and area available for habitat restoration is threatened by destruction and conversion to other uses. This threat is largely ameliorated on the ADNWR and other properties with protection/management agreements in place, but not on properties without such agreements. (USFWS, 2019)

Stressor: Habitat degradation due to loss of natural disturbance regime (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: The reduction in sand deposition in Antioch Dunes habitat as a result of water management/use (dams, levees, etc.) in the Sacramento/San Joaquin River Delta system and reduced effectiveness of wind-driven dispersal of sand and disturbance of dunes has and continues to reduce overall size and connectedness of the dune natural community. (USFWS, 2019)

Stressor: Habitat degradation due to non-native and native invasive vegetation (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: Invasive vegetation colonizes open sand habitat, reducing available suitable E.c. var. angustatum, and pollinator, habitat. Invasive plants out-compete native species, including E.c. var. angustatum, for sunlight, space, nutrients, and moisture. They also stabilize the sand/soil, eliminating the natural disturbance regime and may cause soils to become more eutrophic (Thomson 2005a, Thomson 2005b, Chin 2012, McNally 2014). The 2008 Five-Year Review notes that the proliferation of non-native invasive plants has been increasing rapidly since 1998 (Service 2008) and these conditions continue (Chin 2012, McNally 2014, Service 2018a, Service 2018b, Service 2018c, Service 2018d). The use of herbicides to control non-native and native invasive vegetation may also present potential threat to E.c. var. angustatum occurring in the same vicinity. Applying herbicides selected for the target species and using appropriate rates and technique should minimize effects to non-target E.c. var. angustatum. These practices have been instituted at the ADNWR, so this threat is considered largely ameliorated there (Service 2008), but it may pose a risk to current and future occurrences of these listed species elsewhere. (USFWS, 2019)

Stressor: Habitat degradation due to gypsum dust deposition from neighboring plant (facility) (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: The 2008 Five-Year Review reported that gypsum dust building up on plants may reduce exposure to sunlight and decrease photosynthesis. It may also alter soil chemistry due to introduction of calcium and sulphates, which may affect the growth of E.c. var. angustatum and

promote colonization by invasive species. Deposition is noted as affecting mostly the Sardis Unit. The ADNWR staff have met with Georgia-Pacific (G-P) about concerns over the dust and G-P increased efforts to reduce airborne gypsum (beyond the standards for air pollution control) by keeping it wetted down when possible during production activities. At the time of the 2008 Five-Year Review, staff noted a reduction in dust from G-P efforts. The review noted that there was no evidence that gypsum dust was adversely affecting any of the three species (Service 2008). However, it also cited a study that demonstrated that dusts may adversely increase transpiration through the cuticle of insect larvae and cause desiccation and abrasion of the cuticle (Wigglesworth 1945 in Service 2008), which may affect pollinators of *O.d. subsp. howellii* or *E.c. var. angustatum*. The ADNWR staff reported an increase in gypsum dust deposition at ADNWR in 2017-2018 (Susan Euing pers. comm. December 12, 2018). In 2018, staff noted that gypsum was being deposited on the refuge at concentrations that coats plants, leading to cancellation of surveys for the Lange's metalmark in some parts of the refuge (Susan Euing pers. comm. August 17, 2018). In 2019, after several weeks into the Lange's metalmark survey season, ADNWR staff confirmed that no surveys had been canceled due to concerns about gypsum dust deposition (Louis Terrazas pers. comm. September 10, 2019). The magnitude of this potential stressor requires further investigation and Service partnership with G-P is ongoing. (USFWS, 2019)

Stressor: Habitat degradation due to rogue hiking/trails (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: This activity may cause direct injury or mortality *E.c. var. angustatum* from trampling while also increasing potential for accidental introduction of wildfire from hikers. These threats and stressors were significantly reduced when ADNWR was fenced in 1986 and the 2008 Five-Year Review (Service 2008) no longer considered recreational and pedestrian traffic to be a significant threat. However, ADNWR staff note that incidence of trespassing and human encampments at ADNWR has increased in the past several years (Susan Euing pers. comm. December 12, 2018). (USFWS, 2019)

Stressor: Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: These activities represent a threat to the Antioch Dunes species from direct mortality of any individual(s) collected and a reduction in annual recruitment by killing or injuring reproductive individuals. (USFWS, 2019)

Stressor: Disease or predation (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: Three moth taxa are known to prey upon *E.c. var. angustatum*; a fairy moth (*Chalceopla simpliciealla*), an egg-eating moth (*Calculus* spp.), and the diamond back moth (*Plutella xylostella*) (Service 2008). Pavlik et al (1988b) determined that pre-dispersal predation of seeds significantly impacted reproduction during studies conducted in 1987 and 1988. The magnitude of this stressor requires further investigation. (USFWS, 2019)

Stressor: Wildfire (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: Wildfire may cause direct mortality of *E.c. var. angustatum* plants during vulnerable life stages. These stages include the period from germination during the beginning of the wet season in December through the deposition of seeds in mid-summer. However, historical evidence indicates that the native plants may recover rather quickly from a wildfire (Service 2008). Any mortality would also result in reduced annual recruitment by killing or injuring reproductive individuals. The threat extends to pollinators and other pollinator plant species. (USFWS, 2019)

Stressor: Fuelbreak discing (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: Fuelbreak discing may cause direct injury or mortality to *E.c. var. angustatum*. However, it also creates open, disturbed, sand/soil that may be suitable for colonization by *E.c. var. angustatum*, as well as invasive vegetation. The net impact of this activity to listed plant resilience is unquantified. (USFWS, 2019)

Stressor: Loss of pollinators (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: Lange's metalmark is addressed as a pollinator for this discussion of the potential threat posed by possible insecticide drift from mosquito abatement spraying on neighboring properties (Richmond et al 2015). The Mosquito Abatement District allows for spraying of insecticides to reduce the incidence of West Nile Virus at a wetland adjacent to the Stamm Unit of the ADNWR. The spray could drift on to the refuge and affect pollinators, such as Lange's metalmark and those that pollinate *E.c. var. angustatum*. While ADNWR staff have worked with county mosquito control staff to minimize effects from this potential threat, the magnitude of this stressor requires further investigation. As of the 2008 Five-Year Review, there was no evidence that lack or loss of pollinators has negatively impacted or *E.c. var. angustatum* (Service 2008), but the species requires cross-pollination, so an adequate pollinator population is necessary. Bees are suspected pollinators for both species and hawkmoths may also be pollinators for the primrose; however, actual pollinator taxa are unknown. This potential threat requires investigation. (USFWS, 2019)

Stressor: Low population numbers (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: *E.c. var. angustatum* is threatened by few and small populations that are limited to a small and localized distribution, which increases the risk of extirpation and extinction due to: (1) Reduced resiliency (the ability of a species to withstand stochastic disturbance; resiliency is positively related to population size and growth rate and may be influenced by connectivity

among populations); (2) Low redundancy (spreading risk among multiple populations or a large area to minimize the potential loss of the species from catastrophic events); and (3) Low representation (the breadth of genetic and environmental diversity within and among populations that influences the ability of a species to adapt to changing environmental conditions over time). (USFWS, 2019)

Stressor: Climate change (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: E.c. var. angustatum is threatened by multiple environmental effects anticipated with climate change, which may result in loss of habitat, altered temperature and moisture regimes causing direct mortality and/or impaired reproduction, and altered temperature and moisture regimes causing indirect mortality and/or impaired reproduction via phenological mismatches with pollinators and between pollinators and their host and/or other nectar plants (Richmond et al 2015). (USFWS, 2019)

Recovery

Reclassification Criteria:

Erysimum capitatum var. angustatum will be considered for downlisting when: 1. There are at least five separate self-sustaining (all plants are naturally recruiting) populations of: at least three populations, each with a 15-year moving median of at least 7,000 flowering plants; and least two populations, each with a 15-year moving median of at least 4,000 flowering plants. (a) A distance of at least 1,500 feet and a natural and/or man-made firebreak separates individual populations. (b) Populations should be protected and have in place a long-term management plan for the conservation of E.c. var. angustatum and commitment for implementation of the plan. (USFWS, 2019)

Any flowering individuals counted as naturally recruiting would have to be \geq two flowering seasons post-outplanting. This would indicate the individual has completed the life cycle in situ. (USFWS, 2019)

Delisting Criteria:

Erysimum capitatum var. angustatum will be considered for delisting when: 1. There are at least seven separate self-sustaining (all plants are naturally recruiting) populations of: at least five populations, each with a 15-year moving median of at least 7,000 flowering plants; and at least two populations, each with a 15-year moving median of at least 4,000 flowering plants. OR, population viability analysis determines that E.c. var. angustatum has a range-wide 95% probability of persistence over a 100-year period. (a) A distance of at least 1,500 feet and a natural and/or man-made firebreak separates individual populations. (b) Populations should be protected and have in place a long-term management plan for the conservation of E.c. var. angustatum and commitment for implementation of the plan. (USFWS, 2019)

2. A post-delisting monitoring plan for the species has been developed. (USFWS, 2019)

Any flowering individuals counted as naturally recruiting would have to be \geq two flowering seasons post-outplanting. This would indicate the individual has completed the life cycle in situ. (USFWS, 2019)

Recovery Actions:

- Protect Antioch Dunes ecosystem and essential habitat for the Contra Costa wallflower (USFWS, 1984).
- Restore Antioch Dunes ecosystem, and increase numbers and improve habitat for the Contra Costa wallflower (USFWS, 1984).
- Initiate information and education programs (USFWS, 1984).
- Recommended Actions from 2008 5-Year Review: Continue restoration of riverine dune habitat at Antioch Dunes NWR. - Continue research into life history, habitat requirements, and population studies, including annual population monitoring surveys. - Acquire the McCulloch/Kemwater property abutting the eastern boundary of the Sardis Unit of the Antioch Dunes NWR. - Consider revising the Recovery Plan for the three endangered species endemic to Antioch Dunes, California (USFWS, 2008).

References

USFWS. 2008. Lange's metalmark butterfly (*Apodemia mormo langei*) Antioch Dunes evening-primrose (*Oenothera deltoides* subsp. *howellii*) Contra Costa wallflower (*Erysimum capitatum* var. *angustatum*) 5-Year Review: Summary and Evaluation. Sacramento Fish and Wildlife Field Office U.S. Fish and Wildlife Service Sacramento, California.

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USFWS. 2008. Lange's metalmark butterfly (*Apodemia mormo langei*)

Antioch Dunes evening-primrose (*Oenothera deltoides* subsp. *howellii*)

Contra Costa wallflower (*Erysimum capitatum* var. *angustatum*)

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USFWS. 1984. Revised Recovery Plan for Three Endangered Species Endemic to Antioch Dunes, California. U.S. Fish and Wildlife Service. Portland, Oregon.

SPECIES ACCOUNT: *Erysimum menziesii* (Menzies' wallflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/22/1992; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A member of the mustard family and a biennial or a short-lived perennial depending on the particular population. Each plant usually has several flowering stems from 0.5 to 1.5 decimeters tall. The flower petals are usually yellow (light or rich yellow), 15-20 mm long. The flowers are grouped into an inflorescence. Fleshy leaves form a basal rosette and are somewhat spoon-shaped, narrowing abruptly to the leaf stalk. Leaf margins are entire, dentate, or lobed. Fruit is a silique, four-sided when green and flattened when dry (Fish and Wildlife Service 1997) (NatureServe, 2015).

Taxonomy

Erysimum menziesii is a member of the mustard family (Brassicaceae) (USFWS, 2008). As treated here, following FNA (2010, vol. 7), *Erysimum menziesii* includes subspecies *eurekense*, *menziesii*, and *yadonii*, but excludes subspecies *concinnum*. This is the treatment followed by USFWS when the species was listed endangered, Kartesz's 1994 checklist, and the second edition of The Jepson Manual (Baldwin et al. 2012). This treatment is based on Price's 1987 doctoral dissertation. According to FNA, Price's 1993 treatment (followed by Kartesz 1999) accepted four subspecies (*concinnum*, *eurekense*, *menziesii*, and *yadonii*), three of which were never validly published (NatureServe, 2015).

Historical Range

Endemic to California in Monterey, Mendocino, and Humboldt Counties (Fish and Wildlife Service 1997). The range extent is 14,506 sq. km (R. Bittman, pers. comm. 2013) (NatureServe, 2015).

Current Range

It is distributed predominately in the nearshore dune community of four disjunct dune systems in northern and central California: Humboldt Bay in Humboldt County, Ten Mile River in Mendocino County, the Marina Dunes at Monterey Bay, and the Monterey Peninsula in Monterey County (Price 1993) (USFWS, 2008).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: self-pollination, cross-pollination (USFWS, 2008)

Lifespan

Adult: 8 years (USFWS, 2008)

Dependency on Other Individuals or Species

Adult: *Erysimum m. ssp. eurekaense*: *Emphoropsis miserabilis* (USFWS, 2008)

Breeding Season

Adult: February - April (USFWS, 2008)

Key Resources Needed for Breeding

Adult: Fall/early winter rains (USFWS, 2008); insect pollinators (USFWS, 1998)

Reproduction Narrative

Adult: Its life history is that of a semelparous (monocarpic) perennial, meaning that it flowers and produces fruit only once during its life, after which it dies (*E. m. ssp. yadonii* reportedly can flower and fruit twice). The wallflower forms a basal rosette of leaves that may persist for up to 8 years before flowering. Blooming typically occurs from March through April, although it may begin as early as late February. The species is self-compatible; therefore, the reproduction of this species involves selfing and facultative outcrossing (able to produce seed either by self-pollination, or pollination by other plants). *Erysimum m. ssp. eurekaense* is pollinated by a solitary bee species (*Emphoropsis miserabilis*) in Humboldt County (USFWS 1998). The fruits mature by mid-June. Germination follows the first rains in fall or early winter. Fecundity is high, with individual plants producing numerous seeds; however, the wallflower does not have a persistent seed bank in the soil (Carothers 1996), and seedling survivorship is low, with 98.3 percent mortality shown to occur in the first year (Pickart and Sawyer 1998) (USFWS, 2008). The plant's pollinators are thought to be bees, bumblebees, butterflies, and moths (Price 1986) (USFWS, 1998).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Northern foredune or dune mat community, coastal strand (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: High (inferred from NatureServe, 2015 and USFWS, 1998)

Habitat Narrative

Adult: The habitats of the Monterey county populations differ from those of the northern California populations. The plants are generally distributed in clusters or patches. In northern California, the species occurs in northern foredune or dune mat community, on the flanks or crests of dunes, open sand areas, sparsely vegetated dunes, and the borders of lupine scrub. The plants can tolerate some sand movement. The associated vegetation community is composed of low-growing suffrutescent perennial and herbaceous native species. Common

associates are beach sagewort (*Artemisia pycnocephala*), dune goldenrod (*Solidago spathulata*), coast buckwheat (*Eriogonum latifolium*), sand verbena, beach pea (*Lathyrus littoralis*) and seashore bluegrass (*Poa douglasii*). In Monterey County, the species occurs on coastal strand, close to the high tide line, but largely protected from wave action. The species has high exposure to strong wind, salt spray, and occasional wave action from storms and high tides. The substrate is loose sand lacking in organic matter and minerals. Associated species along the Monterey Peninsula include beach primrose (*Camissonia cheiranthifolia*), beach-bur, sea rocket (*Cakile maritima*), beach knotweed (*Polugonum paronychia*), sand verbena and iceplant. Monterey County habitats are relatively free of the invasive *Ammophila arenaria* (Fish and Wildlife Service 1997) (NatureServe, 2015). These habitats are not spatially fixed, and are subject to cycles of erosion, deposition, and re-establishment of plant communities over decades (USFWS, 1998).

Dispersal/Migration

Dispersal

Adult: Low to moderate (USFWS, 1998)

Dispersal/Migration Narrative

Adult: The seeds remain attached to the fruit walls after dehiscence and disperse over a long period, primarily in conjunction with winter storm events that dislodge the mature inflorescences and scatter them by way of a wind-driven tumbling action (Pickart and Sawyer 1998) (USFWS, 2008). Most seed dispersal is restricted to the immediate vicinity of the parent plants. Long distance dispersal of seed may occur by fragmentation of seed-bearing branches breaking off and tumbling with the prevailing wind. Isolated individuals of *E. menziesii* occur on slipfaces of bare, active dunes downwind of vegetated dunes at Ten Mile dunes. This indicates that long-distance seed dispersal may occur where the surface roughness of the dune is minimized (USFWS, 1998).

Population Information and Trends

Population Trends:

Unknown (USFWS, 2008)

Species Trends:

30 - 50% decline (NatureServe, 2015)

Resiliency:

Low (inferred from USFWS, 2008; see current range/distribution)

Redundancy:

Moderate (inferred from USFWS, 2008)

Number of Populations:

16 (USFWS, 2008); 15 (NatureServe, 2015)

Population Size:

Unknown (USFWS, 2008); 33,300 (NatureServe, 2015)

Population Narrative:

The three subspecies of *Erysimum menziesii*: ssp. *eurekense*, ssp. *menziesii*, and ssp. *yadonii*, are known from at least 33,300 individuals (Fish and Wildlife Service 1997). Together, the three rare subspecies of *Erysimum menziesii*, ssp. *eurekense*, ssp. *menziesii*, and ssp. *yadonii* are known from 19 occurrences, 15 of which are presumed to be extant (California Natural Diversity Database, 2012). Subspecies *concinnum* is not included here. This species has experienced a short-term decline of 30 - 50% (NatureServe, 2015). *Erysimum menziesii* is known from at least 16 extant occurrences. With the exception of *Erysimum menziesii* ssp. *eurekense*, no statistically valid population estimates have been made of the subspecies of *E. menziesii*. Therefore, population data are generally inadequate for the purpose of determining trends or assessing response to past management (USFWS, 2008).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Uncontrolled recreational use, such as hang gliders and hikers, continue to impact some populations (Imper pers. obs. 2006). Threats from off-road vehicle use, equestrian use and sand mining remain local threats in some areas. The privately owned occurrences of *E. menziesii*, particularly in Monterey County, are near expanding urban centers subject to growing demand for recreational opportunities (Imper pers. obs. 2006) (USFWS, 2008).

Stressor: Disease and predation (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Deer have significantly impacted a population of *E. m. ssp. eurekense* on the South Spit of Humboldt Bay (Clifford 2006), and nearly all *E. m. ssp. menziesii* occurrences on the Monterey Peninsula Disease caused by the crucifer rust (*Albugo candida*), a pathogenic fungus, affects a significant portion of *E. m. ssp. menziesii* in Humboldt County (Pickart 2004). An unidentified fungus was also observed affecting *Erysimum menziesii* ssp. *yadonii* (Zoger and Pavlik 1987). In *E. m. ssp. eurekense*, disease symptoms are more prevalent on reproductive individuals, where they can decrease fecundity by reducing seed number or viability (Pickart and Sawyer 1998) (USFWS, 2008).

Stressor: Climate change (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher

precipitation events, or other effects. The effects to particular species is unknown at this time (USFWS, 2008).

Stressor: Invasive species (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: The primary threat to *Erysimum menziesii* when it was listed, and which continues to be the major threat for most populations is displacement by invasive non-native plant species. In Humboldt County the primary threats are European beachgrass, yellow bush lupine, iceplant, and jubata grass (*Cortaderia jubata*). European beachgrass and iceplant are the primary threats in Mendocino County, and iceplant in Monterey County. No efforts have yet been made to control or map burclover (*Medicago polymorpha*), ripgut brome (*Bromus rigidus*), or other invasive species that may be competing with *E. m. ssp. menziesii* within MacKerricher State Park.

Recovery

Reclassification Criteria:

1. Habitat occupied by the three endangered subspecies of *Erysimum menziesii* needed to allow delisting has been secured, with long-term commitments and, if possible, endowments to fund conservation of the native vegetation (USFWS, 2008).
2. Management measures are being implemented to address the threats of invasive species and other problems, including grazing, pedestrians, and off-road vehicles at some sites (USFWS, 2008).
3. Monitoring reveals that management actions are successful in reducing threats of invasive non-native species (USFWS, 2008).

Additional restored habitat has been secured, with evidence of either natural or artificial long-term establishment of additional populations, and long-term commitments (and endowments where possible) to fund conservation of the native vegetation (USFWS, 2008).

Delisting Criteria:

1. Studies have elucidated its life history requirements so that it is possible to predict the responses of populations to management and their viability (USFWS, 2008).
2. The dune systems supporting the 3 subspecies are actively protected from recreational violations, particularly by off-road vehicles (guaranteed funding to enforce ordinances), development, invasive weeds (including European beach grass, iceplant, and yellow bush lupine for subspecies *eurekense* in Humboldt County and iceplant for the entire species), and predators (deer in Monterey County) (USFWS, 2008).
3. Each occupied dune system has reasonable numbers of plants distributed widely enough to minimize the risk from accidental or catastrophic events. *Erysimum menziesii* ssp. *eurekense* (Humboldt Bay dune system) Goals: 3 populations with minimum 300 plants each; 2 populations with minimum 5,000 plants; *Erysimum menziesii* ssp. *menziesii* (Ten Mile Dunes system/Monterey Peninsula) Goals: 4 distinct sites and 5 total populations across the range; 3

populations averaging at least 300 plants; 2 populations averaging at least 5,000 plants; *Erysimum menziesii* ssp. *yadonii* (Marina dune system) Goals: Taxon to be present throughout its present range from south of Salinas River to Marina Dunes and potentially the Fort Ord area, with 2 populations averaging at least 5,000 individuals, and 3 populations averaging 300 plants or more (USFWS, 2008).

Recovery Actions:

- Protect existing populations and habitats (USFWS, 1998).
- Minimize the threats to the plant (USFWS, 1998).
- Develop management strategies incorporating ecological and land use strategies (USFWS, 1998).
- Manage populations and habitats to achieve delisting (USFWS, 1998).
- Monitor population trends to evaluate recovery success (USFWS, 1998).
- Coordinate recovery actions to protect other listed and sensitive species (USFWS, 1998).
- Develop and implement an outreach program (USFWS, 1998).

Conservation Measures and Best Management Practices:

- Completion of population estimates for the Monterey and Mendocino County populations of *Erysimum menziesii* (USFWS, 2008).
- Establishment of a uniform reporting protocol for agencies conducting population inventories and habitat restoration across the range (USFWS, 2008).
- Increased Service support, in the form of funding and staff involvement, of habitat restoration and population enhancement efforts along the Marina Dunes on private and public lands (USFWS, 2008).
- completion of a Genetics evaluation and taxonomic review of *E. menziesii* across its range to help resolve outstanding questions on the identity of several large populations (USFWS, 2008).
- Investigation of methods and reliable funding mechanisms for ensuring future invasive species monitoring and control programs at critical sites (USFWS, 2008).

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SPECIES ACCOUNT: *Erysimum teretifolium* (Ben Lomond wallflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/07/1994; Pacific Southwest (R8)

Physical Description

Ben Lomond wallflower is a short-lived perennial plant, or occasionally an annual. Seedlings form a basal rosette of leaves which then wither as the main stem develops a raceme (flowers clustered in a terminal spike). The flowers are a deep yellow with petals 1.3—2.5 centimeters (0.5—1.0 inch) long. The fruit, a slender capsule, reaches 10 centimeters (4.0 inches) in length and is covered with three-parted hairs. Characteristics that separate this plant from other wallflowers include simple, narrowly linear leaves that have small marginal teeth and a purplish cast. (USFWS, 1998)

Taxonomy

In the mustard family (Brassicaceae). *Erysimum teretifolium* was first collected at Glenwood, Santa Cruz County by Horace Davis in 1914. This plant was described by Alice Eastwood in 1938 as *Erysimum filifolium*, not realizing that this combination had already been applied to another plant (Eastwood 1938). Therefore, it was renamed *Erysimum teretifolium* the following year (Eastwood 1939). (USFWS, 1998)

Historical Range

Endemic to Santa Cruz Mtns., Santa Cruz County, California. (USFWS, 2008)

Current Range

Endemic to Santa Cruz Mtns., Santa Cruz County, California. (USFWS, 2008)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (USFWS, 2008)

Lifespan

Adult: 1 - 2+ years (inferred from USFWS, 2008)

Breeding Season

Adult: March - July (NatureServe, 2015)

Key Resources Needed for Breeding

Adult: Insect pollinators, heavy fall rains (USFWS, 2008)

Reproduction Narrative

Adult: Flowers from March to July (NatureServe, 2015). *Erysimum teretifolium* is a short-lived perennial or sometimes annual plant. This species is self-incompatible, and crosspollination is necessary for fertilization to occur. Chalcedon checkerspot butterflies (*Euphydryas chalcedona*), ants, European honeybees, and bumble bees have all been seen on the flowers of this species, but the potential for these insects to achieve pollination is unknown (McGraw 2004b). Observations by McGraw (2004b) indicate that the numbers of siliques produced per plant is quite variable (10- 107) and that seed production is positively correlated to silique length (9-15 centimeters produced 5-65 seeds). Seeds germinate after the first heavy rains in the fall, and were found to germinate at least up to 5 years after reaching maturity (McGraw 2004a and McGraw 2004b) (USFWS, 2008).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Ponderosa pine woodland, northern maritime chaparral (NatureServe, 2015); Zayante sandhills (USFWS, 2008)

Dependencies on Specific Environmental Elements

Adult: Periodic fire (USFWS, 2008)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at 200 - 400 m elevation (NatureServe, 2015); succession (USFWS, 2008)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2008)

Habitat Narrative

Adult: Inhabits inland pockets of sandstone-derived coarse sandy soils; these are uplifted ancient marine terraces persisting in a mountain range of volcanic origin. These coarse sands create drier soil conditions than those in the surrounding substrates and support unusual, open, park-like ponderosa pine woodland and northern maritime chaparral communities. The species occurs preferentially in loose, uncompacted sand in openings between scattered chaparral shrubs, at 200 - 400 m elevation (NatureServe, 2015). The Zayante sandhills is a unique habitat type that is comprised of outcrops of sandy soils derived from marine deposits. Suppression of natural fire regimes has led to habitat conversion via the encroachment of woody invasive and native species and invasive annual grasses (Brunette 1997, USFWS 1998). This encroachment has led to conversion of much of the existing open, sandy soil habitat required by *E. teretifolium* and other shade intolerant sandhills plants, resulting in the establishment of shade-providing species and a build-up of leaf litter. The poor recovery record for sandhills habitat suggests a fragile system where biotic and abiotic factors coevolved in delicate balance over long time periods (USFWS, 2008).

Dispersal/Migration**Dispersal**

Adult: Low (USFWS, 2008)

Dispersal/Migration Narrative

Adult: Seeds usually fall directly below the parent plant (USFWS, 2008).

Population Information and Trends**Population Trends:**

Unknown (USFWS, 2008)

Species Trends:

Declining (USFWS, 2008)

Number of Populations:

17 (USFWS, 2008)

Population Size:

1,000 - 3,000 (USFWS, 2008)

Population Narrative:

There are 17 extant populations. Trends are impossible to determine at many sites since either there are only data from a single survey or no survey data was available. The annual total of individuals over all populations has ranged between 1,000 and 3,000 individuals per year in the most productive recent years. Of the remaining known populations, half are either declining or possibly extirpated (USFWS, 2008).

Threats and Stressors

Stressor: Sand mining (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Current sand mining is still destroying occupied *E. teretifolium* habitat. Unless new mining operations are proposed, future sand mining will be a reduced threat to the remaining habitat of the species because many of the mining operations are either being closed or are nearing closure (McGraw 2004b; B. Davilla, pers. comm. 2006). A substantial amount of the sandhills habitat had already been destroyed by mining operations prior to the listing of *Erysimum teretifolium*.

Stressor: Development and agriculture (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Urban development is not occurring at as rapid a rate as it was in the past, but the lasting effects of past development remain (e.g., habitat fragmentation, habitat alteration from landscaping). There are several sites that are immediately adjacent to existing homes on private property that could provide good preservation opportunities. However, even if these areas were preserved, and little to no further development occurred, fragmentation at these sites would remain an issue. There is some grape production in the Bonny Doon area for winemaking purposes. Recent aerial photos do indicate the existence of exposed sandy soils in the area that

may provide suitable habitat; however, private ownership of most of the surrounding properties has precluded any recent surveys of the area for *Erysimum teretifolium*. Additionally, signs posted in fallow vineyard areas indicate the application of insecticides and/or herbicides to the soil (C. West, pers. obs. 2007). Effects of these applications directly on *E. teretifolium* or on its pollinators are unknown (USFWS, 2008).

Stressor: Recreation (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: At this time, recreational use continues to threaten some populations of *Erysimum teretifolium*. Fences are often cut and neighboring equestrians use the area, resulting in large quantities of erosion (J. McGraw, pers. comm. 2006; C. West, pers. obs. 2007). Another population (EO #14) on private land also shows much erosion due to recreation. This site is visible from nearby public land and supports some large specimens of *E. teretifolium* (C. West, pers. obs. 2007). Although there are “no trespassing” signs in place and wire fencing, there is extensive erosion, apparently from sandboarding (C. West, pers. obs. 2007). The effects of recreational activities are also apparent at the South Ridge site in Quail Hollow Quarry (former EO #1). Recreational activity at this site seems to be limited to hikers and dog-walkers accessing areas on foot, despite fencing and signage (C. West, pers. obs. 2007) (USFWS, 2008).

Stressor: Herbivory (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Observations of herbivory and potential effects at the population level have been noted by researchers (Brunette 1997, McGraw 2004b). Pocket gophers (*Thomomys bottae*) have been shown to consume up to 8 percent of rosettes prior to seed set in monitored populations (McGraw 2004b). Observations indicate that up to 37 percent of adult plants may be browsed by mule deer (*Odocoileus hemionus*), which greatly increases the likelihood of those plants dying without successfully reproducing (J. McGraw, pers. comm. 2007a) (USFWS, 2008).

Stressor: Fire suppression and succession (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Sandhills communities are fire-adapted, and fire plays a major role in resetting soil succession (McGraw 2004b). Fire has also been shown to play a role in the reduction of invasive non-native species in the sandhills parkland and chaparral habitat types (McGraw 2004b). Not only does suppression of fire directly leave leaf litter in place to accumulate, but McGraw (2004a) found that nonnative species prevented sloughing of this litter that otherwise occurs easily during rain and wind events from the bare sandy soil. Even with litter removal via manual methods such as raking, McGraw (2004a) found that the remaining non-native plants reduced soil moisture content, causing an increased risk of desiccation in *E. teretifolium* seedlings. At the time of listing, vegetation succession leading to increased canopy density due to fire suppression was considered a threat to *Erysimum teretifolium*, which is relatively intolerant of shade. Perhaps more importantly, the habitat conversion leading to this increased canopy density will eventually result in a habitat type which cannot support many of the open sand specialists unique to

sandhills parkland (McGraw 2004b, P. Levine, pers. comm. 2006). Many areas where *E. teretifolium* formerly occurred have undergone extensive habitat conversion; in several of these areas, it is doubtful whether the open sandy soil required by this species still exists (USFWS, 2008).

Stressor: Stochastic events (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: With increased successional pressures due to fire suppression, encroachment by nonnative plants, and human development, sandhills “islands” have shrunk in size and become even more fragmented (McGraw 2004b). Because seed dispersal distance is limited in *Erysimum teretifolium* (seeds usually fall directly below the parent plant), fragmented populations are likely to remain isolated. Of the populations surveyed in recent years, most have had very low numbers of individuals, and many had no individuals present. As habitat conversion increases due to various factors and remaining habitat is further fragmented and reduced in size, populations will continue to shrink and the risk of stochastic extinctions will increase (USFWS, 2008).

Recovery

Reclassification Criteria:

1. The 17 currently known populations have been secured through fee-title acquisition, conservation easements, or Habitat Conservation Plans. (USFWS, 1998)
2. Management plans for populations on Quail Hollow Ranch County Park and Bonny Doon Ecological Reserve are developed and being implemented. (USFWS, 1998)
3. Management plans for populations on Quail Hollow Ranch County Park and the adjacent State-owned parcel, Bonny Doon Ecological Reserve, Henry Cowell Redwoods State Park, Big Basin State Park, and Gray Whale Ranch State Park are developed and being implemented.
4. Population numbers are stable or increasing. (USFWS, 1998)

Delisting Criteria:

When the downlisting criteria have been met for a species the species can be considered for delisting if: 1. Threats are reduced or eliminated so that populations are capable of persisting without significant human intervention or perpetual endowments are secured for management necessary to maintain the continued existence of the species. (USFWS, 1998)

Recovery Actions:

- 1. Protect habitat for Santa Cruz Mountains species on private land through Habitat Conservation Plans and landowner agreements. Because of the extremely limited amount of habitat that exists, recovery cannot be achieved by the management of State and County lands alone (see task 2). Habitat Conservation Planning with local governments, quarry owners, and developers will provide additional protection. The long-term survival of these species will depend to a large extent on the protection that can be achieved on private lands (USFWS, 1998)

- 2. Manage habitat for Santa Cruz Mountains species. Management of the seven species included in this recovery plan and the habitats that support them will depend on data gathered from monitoring, threat analyses, and available conservation measures. Development and implementation of management programs should be specific to the species complex, ecological process, landowner, and particular threats to be managed. (USFWS, 1998)
- 3. Conduct research on the life history, ecology, and population dynamics of these species that will contribute to appropriate management strategies. Research is needed to ensure that management actions that are undertaken are appropriate and will contribute to the long-term survival of these species and the habitats on which they depend. (USFWS, 1998)
- 4. Locate additional habitat/populations within the historic range of the species. The status of any new populations of these species that are discovered in the future should be evaluated and an assessment made of appropriate management actions. The value to the recovery strategy for these species of any additional habitat that is located should be assessed. (USFWS, 1998)
- 5. Develop and implement a public outreach program. An educational program should be established for the public, including private landowners whose property supports these taxa or suitable habitat, to encourage conservation and proper management of the taxa. Nongovernmental organizations such as the California Native Plant Society and the Santa Cruz Mountains Biodiversity Task Force should be approached about participating in this effort. (USFWS, 1998)
- 6. Evaluate progress of recovery effectiveness of management and recovery actions and revise management plans. (USFWS, 1998)
- Recommended Action from 2008 5-Year Review: Surveys and monitoring should be undertaken for all known populations and potential habitat to ensure that potential populations are identified and reliable demographic information is collected. Outreach to owners of private holdings with potentially conservable habitat and populations should be attempted and permission should be secured to survey these private holdings where necessary. Specifically, all populations listed in the CNDDDB and McGraw (2004b) should be surveyed to focus future recovery efforts, especially the areas between and surrounding Vista Robles Drive and Marion Avenue in Ben Lomond and the area around the intersection of Pine Flat Road and Bonny Doon Road in Bonny Doon. In addition, coordination of recovery partners and consolidation of population data into the CNDDDB records should be undertaken. Additionally, survey methods should be standardized to insure data accuracy. Methods employed by Brunette (1997) may be suitable for this purpose (USFWS, 2008).
- Recommended Action from 2008 5-Year Review: Expand research efforts focusing on potential causes of reproductive failures and methods to increase reproductive success as mentioned in the "Needed Recovery Actions" section of the recovery plan. As part of these efforts, the effects of predation on the species should be examined and pollination mechanisms should be identified. With clarification of such processes, management of landscape level influences on the species may be undertaken, such as predatory deterrence and management of potential pollinator barriers. Such research may contribute greatly in the form of increased survival, boosting reproductive success, and maintaining interfragment pollination to maximize gene flow, thereby avoiding inbreeding depression (USFWS, 2008).
- Recommended Action from 2008 5-Year Review: More detailed knowledge of populations and completion of management plans should allow active management to prevent

encroachment of both native and non-native species in fire-suppressed areas, which threaten type conversion of the habitat and potential extirpation of individual populations. Prescribed burns mimicking natural fire cycles would be the most effective way to thin vegetation and restore open habitat; however, in many areas the proximity of human habitation precludes this as an option. Mechanical means of vegetation and leaf litter removal (i.e., raking) have proven effective in reducing the chances of habitat type conversion (McGraw 2004a and McGraw 2004b). Effectiveness of this method to improve *Erysimum teretifolium* habitat and increase reproductive success is being examined at Bonny Doon Ecological Reserve. If these studies prove effective, this method should be initiated in occupied habitat where fire would create unacceptable risk to local communities. Outreach to local landowners in such areas may facilitate the implementation of such management strategies over larger, contiguous pieces of occupied habitat and thereby maximize the conservation potential of all remaining populations. Such vegetation clearing efforts should be approached from a fuels reduction angle, which further benefits all parties involved (USFWS, 2008).

- Recommended Action from 2008 5-Year Review: Increased USFWS oversight as time allows may accelerate completion of the draft HCP with the County of Santa Cruz and other management plans under development. These plans need to be completed to help guide implementation of effective recovery efforts (USFWS, 2008).
- Recommended Action from 2008 5-Year Review: We suggest the USFWS consider revising the third criterion for downlisting in the recovery plan. This criterion lists specific HCPs by name. Many HCP projects are abandoned for various reasons. Additionally, entities listed on HCPs may change name and ownership over time. Such changes may in turn lead to alterations of the HCP title or content. For these reasons, including specific HCPs in draft form as downlisting or delisting criteria should be avoided. A blanket statement reflecting the need to include the species in any HCP that covers its occupied range would be more appropriate (USFWS, 2008).

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SPECIES ACCOUNT: *Eugenia bryanii* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

Eugenia bryanii (NCN), a perennial shrub in the Myrtle family (Myrtaceae), is known only from Guam (USFWS, 2015).

Historical Range

Historically, *E. bryanii* occurred on windy, exposed clifflines along the west and east coasts of the island, and from along the Pigua River, in the forest ecosystem (Costion and Lorence 2012, p. 82; Gutierrez 2012, in litt.) (USFWS, 2015).

Current Range

Currently, *E. bryanii* is known from 5 occurrences totaling fewer than 420 individuals (Gutierrez 2014, in litt.) (USFWS, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Habitat Type

Adult: Coastal cliffs (USFWS, 2015)

Habitat Narrative

Adult: Species inhabits windy, exposed clifflines along the west and east coasts of the island, and from along the Pigua River, in the forest ecosystem (Costion and Lorence 2012, p. 82; Gutierrez 2012, in litt.) (USFWS, 2015).

Dispersal/Migration

Population Information and Trends

Population Trends:

Decreasing (USFWS, 2015)

Population Narrative:

Populations of *E. bryanii*, a single island endemic, are decreasing from initial numbers observed on Guam (USFWS, 2015).

Threats and Stressors

Stressor: Agricultural and urban development (USFWS, 2015)

Exposure:**Response:****Consequence:** Loss of habitat/loss of individuals**Narrative:** Agricultural and urban development are listed as threats to this species habitat (USFWS, 2015).**Stressor:** Nonnative plants (USFWS, 2015)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** Nonnative plants are listed as a threat to this species (USFWS, 2015).**Stressor:** Nonnative animals (USFWS, 2015)**Exposure:****Response:****Consequence:** Loss of habitat/loss of individuals**Narrative:** Nonnative animals (deer) are listed as a threat to this species (USFWS, 2015).**Stressor:** Typhoons (USFWS, 2015)**Exposure:****Response:****Consequence:** Loss of habitat/loss of individuals**Narrative:** Typhoons are listed as a threat to this species (USFWS, 2015).**Stressor:** Climate change (USFWS, 2015)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** Climate change is listed as a threat to this species (USFWS, 2015).***Recovery*****Recovery Actions:**

- A recovery plan has not been completed for this species.

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SPECIES ACCOUNT: *Eugenia haematocarpa* (Uvillo)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/25/1994; Southeast Region (R4) (USFWS, 2015)

Physical Description

Uvillo is a small evergreen tree reaching 6 meters (20 feet) tall and 12 - 13 centimeters (4.8 - 5.2 inches) in diameter. The bark is gray or whitish and smooth, shedding in plates. Twigs are hairless, slightly two-angled, and rusty brown (Little et al. 1974). The paired, relatively large, hairless, oblong to elliptical leaves are thick and leathery, 13 - 18 centimeters (5.2 - 7.2 inches) long, 6 - 8 centimeters (2.4 - 3.2 inches) wide and almost stalkless. The upper surface of the leaves is dull dark green with light green beneath. Blades contain many slender, slightly raised veins, forming a prominent network. The flowers, many in clusters, are produced on the trunks with slender, nearly equal stalks. Flowers have a four-lobed rounded calyx 1 millimeter (.04 inch) long, four rounded light pink petals 23 millimeters (.12 inch) long, many stamens, and pistil with an inferior ovary. The fruit is a dark red, round berry, 2.3 - 2.9 centimeters (.9 - 1.1 inches) in diameter and containing a rounded 1.6 centimeter (.6 inch) light brown colored seed (USFWS, 1998).

Taxonomy

Not available

Historical Range

The natural distribution of Chupacallos remains limited to the Luquillo Mountains in El Yunque National Forest and to the Río Abajo Commonwealth Forest (USFWS, 2014).

Current Range

Uvillo was originally reported from the Luquillo Mountains and from a single locality within the Sierra de Cayey. The range within the Cayey region has expanded to include four additional localities, as new populations have been discovered in this area. Therefore, we expect that further populations may occur within this area, including within the boundaries of the Carite Commonwealth Forest. Furthermore, during the last decade, at least three new populations have been reported in the municipality of Isabela, extending its distribution now to the northwestern corner of Puerto Rico (USFWS, 2014).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Dependency on Other Individuals or Species

Adult: Probably *Apis mellifera* (USFWS, 2014)

Breeding Season

Adult: May (USFWS, 1998)

Reproduction Narrative

Adult: A recent site visit to Las Robledas indicates plants flower vigorously and flowers are frequently visited by honeybees (*Apis mellifera*) (Omar Monsegur, USFWS, pers. obs. 2012.) (USFWS, 2014). *Eugenia haematocarpa* has been collected with flower buds and fruits in May (Little et al. 1974) (USFWS, 1998).

Habitat Type

Adult: Terrestrial (USFWS, 2014)

Habitat Vegetation or Surface Water Classification

Adult: Subtropical moist forest, subtropical wet forest (USFWS, 2014)

Habitat Narrative

Adult: It occurs primarily within the subtropical moist forest and the subtropical wet forest life zones (Ewel and Whitmore 1973). It also grows in moist limestone forest (USFWS, 2014).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Unknown (USFWS, 2014)

Species Trends:

Increasing (USFWS, 2014)

Resiliency:

Low (inferred from USFWS, 2014; see current range/distribution)

Redundancy:

Low to moderate (USFWS, 2014)

Number of Populations:

9 (USFWS, 2014). As of 2019: We documented about 17 localities of *uvillo* comprising a total of 1,426 individuals. (USFWS, 2019).

Population Size:

247 (USFWS, 2014). As of 2019: We documented about 17 localities of *uvillo* comprising a total of 1,426 individuals. (USFWS, 2019).

Additional Population-level Information:

Additionally, six new localities (sub-populations) (Isabela-Guajataca; La Robleda, Cayey; Sotomayor del Toro, Caguas; Rio Grande, Las Piedras, and Guayama) with approximately 247 individuals have been reported since listing (USFWS 2014). More recently, Sustache (2016)

assessed three populations in the Rio Grande Municipality at EYNF and on adjacent private lands and one in the municipality of Juncos (Rio Gurabo site). He reported a total of 1,169 individuals, of which 230 individuals are adult trees (Sustache 2016). One of the populations studied contained at least 30 individuals of different size classes with natural recruitment evident. Also, additional individuals were recently found at the CCF (Zegarra 2017, pers. comm.). In 2018, 10 individuals were found in Sierra la Guardarraya, a forest area between Patillas and Maunabo municipalities. This area is known as Marin Alto, a protected land managed for conservation by Para La Naturaleza (Monzon 2018, pers. comm.). New uvillo populations have been found throughout its range, particularly in the southeast part of the Island (i.e., Caguas, Patillas, Maunabo, Juncos, and Cayey). In total, we have documented about 17 localities of uvillo comprising a total of 1,426 individuals. (USFWS, 2019).

Population Narrative:

The species status is improving; several new populations have been recorded and there is evidence of natural recruitment. Uvillo is currently known from approximately 247 individuals in nine natural populations. The Service believes that during the last decade the overall status of these species was uncertain. (USFWS, 2014).

Threats and Stressors

Stressor: Habitat destruction and degradation (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: The largest known population of Uvillo lies within Las Robledas along a ridge that marks the boundary of several private properties and some clusters of individuals lie within neighboring properties that are not managed by the PRCT. Boundary management practices (clearing and fencing) may affect individuals along these areas. Similarly, land clearing for agricultural purposes and urban development may affect the small populations of Uvillo within private properties at the Sierra de Cayey, including the private properties adjacent to Las Robledas. Undetected populations of Uvillo might be affected by deforestation for urban development on the periphery of El Yunque National Forest. In the northern Karst region, suitable habitat for these species may be affected by rock quarries, particularly in the Quebradillas and Isabela area (USFWS, 2014).

Stressor: Stochastic events and climate change (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: The low number of populations and individuals pose a threat to the species by making them more susceptible to stochastic events such as hurricanes. The frequency of landslides is expected to increase, as landslides are triggered by severe rain events or droughts, whose frequency and severity is expected to increase as a result of climate change (Hopkinson et al. 2008). Given the steep slopes on which these species usually grow (associated to remnants of forest that were not cleared due the inaccessibility of the area), massive landslides may extirpate entire populations. Climate change is predicted to increase the frequency and strength of tropical storms and can cause severe droughts (Hopkinson et al. 2008). Vulnerability to climate change impacts is a function of sensitivity to those changes, exposure to those changes, and the adaptive

capacity of the species (Glick et al. 2011). Shifts of vegetation communities are expected as temperatures and moisture regimes are altered by climate change. Under this scenario, populations of Uvillo may be displaced or outcompeted by native or exotic species with wider environmental plasticity. Climate change may also compromise natural recruitment by affecting the survival of seedlings (USFWS, 2014).

Stressor: Genetic variation (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Despite the reports of new populations of Uvillo, this species may be affected by genetic depression due to the low number of individuals in some populations, as it is evident that the species was severely affected by former habitat fragmentation due primarily to extensive deforestation for agriculture. However, the wide distribution and geographical isolation of the species, from the eastern to the northwestern side of the Island (i.e., El Yunque National Forest, Sierra de Cayey, and Guajataca Commonwealth Forest), with different environmental conditions, suggests that the species may show high interpopulation genetic variability (USFWS, 2014).

Recovery

Reclassification Criteria:

1. An agreement between the USFWS and the USFS concerning the protection of Uvillo within the Caribbean National Forest property has been prepared and implemented (USFWS, 2014).
2. An agreement between the USFWS and the PRDNER concerning the protection of this species in Commonwealth Forests, specifically Río Abajo, for Chupacallos, has been prepared and implemented (USFWS, 2014).
3. New populations (the number of which will be determined by appropriate scientific studies) capable of self-perpetuation have been established within protected areas (USFWS, 2014).

Delisting Criteria:

1. Three (3) natural populations of uvillo and two (2) populations of chupacallos exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes, and populations extending onto private lands are protected through a conservation mechanism (addresses Factors A and E). (USFWS, 2019).
2. Establish or discover two (2) new populations of uvillo and seven (7) new populations of chupacallos within the historic range of the species that exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes, and populations extending onto private lands are protected through a conservation mechanism (addresses Factors A and E). (USFWS, 2019).
3. Threat reduction and management activities (e.g., trail maintenance) have been implemented to a degree that the species will remain viable into the foreseeable future (addresses Factor A). (USFWS, 2019).

Recovery Actions:

- Prevent further habitat loss and population decline (USFWS, 1998).
- Collect information on the distribution and abundance of these two endangered trees (USFWS, 1998).
- Conduct research on habitat requirements, reproductive biology, and ecology (USFWS, 1998).
- Establish new populations (USFWS, 1998).
- Refine recovery criteria (USFWS, 1998).
- Refined recovery action for 2019: Monitoring should be conducted on both species' phenology and reproductive biology to address other limiting factors affecting these species (e.g., natural recruitment, lack of pollinators or seed dispersers). This recovery action should be coordinated with Puerto Rico Department of Natural and Environmental Resources and United States Forest Service and be included within Task 121,212,323, 324: Monitor all known populations, Assess periodicity of flower production and pollination activity, Assess seed viability and Evaluate seedling establishment and growth of the approved recovery plan. (USFWS, 2019).

Conservation Measures and Best Management Practices:

- Studies should be conducted on both species' phenology and reproductive biology to address other limiting factors affecting these species (e.g., lack of pollinators or seed dispersers) (USFWS, 2014).
- All known populations should be marked and monitored on a regular basis, and additional visits should be made after hurricanes or other major disturbances to determine any possible adverse effects on the populations (USFWS, 2014).
- The previous ex situ conservation efforts (individuals reintroduced to the wild) should be monitored and further similar efforts should be undertaken to enhance the status of both species (USFWS, 2014).
- The USFS and USFWS should develop a comprehensive survey program to inventory areas with potential habitat. This program should include training to field biologists of both agencies so these personnel is able to recognize listed species on the field (USFWS, 2014).
- The populations that are actively producing seeds need to be identified and monitored to collect seed material for recovery purposes. A protocol to collect seed material should be developed and implemented to avoid altering the natural recruitment of the species. Enhancement of natural populations should be considered particularly for Chupacallos. The development of adequate propagation techniques is essential for the recovery of these species (USFWS, 2014).
- The recovery plan should be revised to establish measurable downlisting and delisting criteria, including how many individuals constitute a self-sustainable population and how many populations would be needed to delist these species (USFWS, 2014).
- Studies should be conducted to determine the patterns of genetic variation within and among populations in order to develop a plan to preserve the species genetic variability (USFWS, 2014).

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SPECIES ACCOUNT: *Eugenia koolauensis* (Nioi)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/28/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

Eugenia koolauensis is a long-lived perennial in the Myrtaceae (myrtle family). This species is a small tree or shrub between 2 to 7 m (7 to 23 ft) tall with branch tips covered with dense brown hairs. The solitary or paired white flowers originate from the leaf axils. The petals are egg-shaped or elliptic in shape, and 4 to 8 mm (0.2 to 0.3 in) long. The yellow to red berries are ovoid-shaped and 0.8 to 2.0 cm (0.3 to 0.8 in) long. *Eugenia koolauensis* is one of two species in the genus that are native to Hawaii. It differs from the other species in having leaves that are densely hairy on the lower surface and leaf margins that curve under the leaves. *Eugenia koolauensis* is known to intergrade with *E. reinwardtiana* in the northern Koolau Mountains and probably derived from this close relative (Wagner et al. 1999).

Taxonomy

Genus primarily in new world tropics and subtropics, species endemic to oahu and molokai. Species intergrades with close relative *eugenia reinwardtiana* in northern koolau mts. Of oahu. (NatureServe, 2015)

Historical Range

Eugenia koolauensis was historically known from Molokai and from Oahu at Kaipapau Valley, Hanaimoa and Kahawainui Gulches, and a gully southeast of Kahuku. *Eugenia koolauensis* may have been extirpated from Molokai as a result of the pineapple industry.

Current Range

Currently, there are 172 known individuals remaining; most occur in the northern Koolau Mountains and one disjunct occurrence is in the vicinity of Papali Loop trail. Locations of occurrences include: Drum Road (1 individual), Hanaimoa (3), Palikea Gulch (2), Pahipahialua (30), Oio (50), Kaunala (59), Aimuu (1), and Kaleleiki (25) (HINHP Database 2001; K. Kawelo, pers comm, 2003; J. Lau, pers. com. 2003; Service 1996, 1998a, 1999b). *Eugenia koolauensis* occurrences are small, in decline, and are widely dispersed. There are seedlings and juveniles found at some occurrences (HINHP Database 2001; Service 1998a; U. S. Army 2003a).

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Eugenia koolauensis* (Nioi) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Eugenia koolauensis* (Nioi) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Eugenia koolauensis* (77 FR 57648-57862). The

critical habitat designation includes 7 critical habitat units, which encompass approximately 7,823 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Eugenia koolauensis* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Eugenia koolauensis* includes two CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Molokai—Lowland Dry—Unit 1 consists of 24 ac (10 ha) of privately owned land, in a small gulch northwest of Mahana, in west-central Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Molokai—Lowland Dry—Unit 1 is not known to be occupied by *Bonamia menziesii*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Hibiscus brackenridgei*, *Kokia cookei*, or *Sesbania tomentosa*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Dry—Unit 2 consists of 589 ac (238 ha) of State land at Kamiloloa on the southern slopes of Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Molokai—Lowland Dry—Unit 2 is not known to be occupied by *Bonamia menziesii*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Hibiscus brackenridgei*, *Kokia cookei*, or *Sesbania tomentosa*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat designation for *Eugenia koolauensis* includes 7 critical habitat units, covering one ecosystem type, which encompasses approximately 7,823 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the

lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Eugenia koolauensis* critical habitat consists of one component. Lowland dry (Molokai) (81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*. Subcanopy: *Chamaesyce*, *Dodonaea*, *Leptecophylla*, *Osteomeles*, *Psydrax*, *Scaevola*, *Wikstroemia*. Understory: *Alyxia*, *Artemisia*, *Bidens*, *Chenopodium*, *Nephrolepis*, *Peperomia*, *Sicyos*.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Eugenia koolauensis* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Eugenia koolauensis* occurs within the indicated ecosystem in the Waianae Mountain caldera complex and the Koolau Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freyinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for

125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–

66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylothea* ssp. *pentamera*, *B. campylothea* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Eugenia koolauensis* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Plants have been observed in flower from February to December. Little else is known about its flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors (Service 1998a). The one disjunct occurrence of *E. koolauensis* in the southeastern Koolau Mountains may have unique environmental adaptations (U.S. Army 2003a).

Habitat Narrative

Adult: *Eugenia koolauensis* is found in dry gulches and on gentle to steep slopes or ridges in mesic or dry forests dominated by *Metrosideros polymorpha* or *Diospyros* sp. from 57 to 437 m (187 to 1,433 ft) in elevation. Other associated native plant species include *Alyxia oliviformis*, *Bobea elatior*, *Carex meyenii*, *Dicranopteris linearis*, *Leptecophylla tameiameia*, *Myrsine lessertiana*, *Nestegis sandwicensis*, *Pittosporum glabrum*, *Pleomele halapepe*, *Pouteria sandwicensis*, *Psydrax odorata*, or *Rauvolfia sandwicensis* (HINHP Database 2001; Service 1998a).

Dispersal/Migration

Population Information and Trends**Population Trends:**

Decreasing

Number of Populations:

8

Population Size:

172

Population Narrative:

Currently, there are 172 known individuals remaining; most occur in the northern Koolau Mountains and one disjunct occurrence is in the vicinity of Papali Loop trail. Locations of occurrences include: Drum Road (1 individual), Hanaimoa (3), Palikea Gulch (2), Pahipahialua (30), Oio (50), Kaunala (59), Aimuu (1), and Kaleleiki (25) (HINHP Database 2001; K. Kawelo, pers comm, 2003; J. Lau, pers. com. 2003; Service 1996, 1998a, 1999b). *Eugenia koolauensis* occurrences are small, in decline, and are widely dispersed. There are seedlings and juveniles found at some occurrences (HINHP Database 2001; Service 1998a; U. S. Army 2003a).

Threats and Stressors**Stressor:****Exposure:****Response:****Consequence:**

Narrative: The major threats to *Eugenia koolauensis* include loss of habitat and degradation of the remaining habitat by non-native plants and feral pigs. The non-native plants such as *Acacia confusa*, *Aleurites moluccana*, *Araucaria columnaris*, *Ardisia elliptica*, *Casuarina equisetifolia*, *Clidemia hirta*, *Cordyline fruticosa*, *Eucalyptus* sp., *Grevillea robusta*, *Hyptis pectinata*, *Lantana camara*, *Melia azedarach*, *Oplismenus hirtellus*, *Panicum maximum*, *Passiflora laurifolia*, *Passiflora suberosa*, *Psidium cattleianum*, *Schinus terebinthifolius*, *Syzygium cumini*, and *Toona ciliata* compete with *E. koolauensis* for nutrients, light, and space. Feral pigs can impact plants of this species by consuming fruits and other plant parts, or by rooting and trampling, which degrades the habitat (HINHP Database 2001; 59 FR 14482). Trampling from foot traffic is also a threat, and one occurrence is threatened by disturbance from an illegal motorbike track. *E. koolauensis* occurrences are declining, and those that remain are small, widely dispersed, and have a limited gene pool, which puts the species at risk of extinction from naturally occurring events and/or lack of reproductive vigor (HINHP Database 2001; 59 FR 14482).

Recovery***Conservation Measures and Best Management Practices:***

- A State-wide management plan should be developed and implemented for the long-term conservation of all known occurrences of *Eugenia koolauensis*. This plan should also include broader landscape actions that are needed for the recovery of this plant throughout its range. The recovery plan for this species identifies important conservation actions. Fenced exclosures should be

constructed around the known occurrences of *E. koolauensis* to reduce impacts from feral pigs. Pigs should be controlled or removed from these areas and in the broader landscape to alleviate their impact on native ecosystems. Specific efforts should be made to immediately fence and protect occurrences that have only a few remaining individuals, if feasible. All occurrences should be weeded, especially those with only a few remaining individuals, if feasible (Service 1998a). Ongoing Conservation Actions: The Waimea Arboretum has seeds of *Eugenia koolauensis*. It has been successfully propagated at Waimea Arboretum and there is a single plant located at the Honolulu Botanical Garden (Service 1998a; Service 2002). The Service is currently not aware of any other conservation efforts for this species.

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Endangered Status for 23 Species on Oahu and Designation of Critical Habitat for 124 Species. Final Rule. 77 FR 57648-57862 (September 18, 2012)

SPECIES ACCOUNT: *Eugenia woodburyana* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 9/9/1994; Southeast Region (R4) (USFWS, 2015); Proposed Reclassification to Threatened

Physical Description

May reach 6 meters in height. The leaves are opposite, obovate, pilose on both sides, glandular-punctate below, and from 1.5 to 2 centimeters long and 1 to 1.5 centimeters wide. The inflorescence is axillary, 2 to 5 flowered and with a peduncle 1 to 3 millimeters long. The calyx is 4-lobed and the petals are white, 4 millimeters long and 3.5 millimeters wide. The striking fruit is red upon maturity, 8-winged and 2 centimeters in diameter (Liogier 1994) (USFWS, 1998).

Taxonomy

This species belongs to the family Myrtaceae, a large family that includes from 100 to 140 genera and 3,000 or more species of trees and shrubs, mostly of tropical and subtropical regions (Cronquist 1981). The largest genus is *Eugenia*, which is very diverse in the Antilles and includes more native species than any other genus of flowering plants in the flora of Puerto Rico (Breckon and Kolterman 1994). *Eugenia woodburyana* was only recently discovered and described by Alain Liogier (Liogier 1980) (USFWS, 1998).

Historical Range

E. woodburyana is endemic to Puerto Rico (USFWS, 1994).

Current Range

Currently known from the range of hills known as the Sierra Bermeja in the municipalities of Cabo Rojo and Lajas, Puerto Rico. Some individuals are located on land recently added to the Laguna Cartagena National Wildlife Refuge and others are located on adjacent private land. The species is also known from the Guánica Commonwealth Forest in Guánica. An additional individual has been reported from the Cabo Rojo National Wildlife Refuge, adjacent to the Sierra Bermeja. Approximately 150 individuals are known from these localities (USFWS, 1998). Currently, *E. woodburyana* is known from about 3,200 individuals in 6 populations along the southern region of Puerto Rico: from the municipality of Cabo Rojo in the south-west, eastward to the municipality of Salinas in the south (USFWS 2017). Additionally, the species has been propagated in tree nurseries and planted at 9 sites: Cabo Rojo National Wildlife Refuge (CRNWR), Laguna Cartagena National Wildlife Refuge (LCNWR), Gabia Farm, Toa Vaca Conservation Area, SCF, Cueva El Convento, Caguas Botanical Garden, Parque Dona Ines, and Rio Piedras Botanical Garden. (USFWS, 2019).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Breeding Season

Adult: October and May (USFWS, 1998)

Reproduction Narrative

Adult: Information obtained from herbarium specimens indicates that buds and flowers were present on specimens collected in October and May from Guánica, but that specimens collected in February and April were sterile. One specimen, collected from the Sierra Bermeja in March, had remnants of old flowers. No flowers or fruit were observed during preliminary studies of several individuals for a 1-year period (USFWS, 1998). New in 2017: This plant has been observed flowering in February, May, June, August, and October (Figure 3; C. Pacheco, Service, pers. obs.). In Sierra Bermeja, not all adult individuals flower at the same time and not all produce fruit. Flowers have been observed 3 to 5 days after rain events of more than 1 inch (25.4 mm) of precipitation in one day. Fruit are observed about three weeks later. (USFWS, 2017).

Habitat Type

Adult: Terrestrial (USFWS, 1998)

Habitat Vegetation or Surface Water Classification

Adult: Subtropical dry forest (USFWS, 1998)

Habitat Narrative

Adult: All areas where these three species are located are found within the subtropical dry forest life zone (Ewel and Whitmore 1973). Fire is common on many soils, and occurs frequently on lands where the plants are located. Soils have been described as Guayama cherty clay loam, 20 to 60 percent slopes, a soil series which covers most of the steep slopes of the Sierra Bermeja. This soil is from 14 to 30 centimeters deep to weathered siliceous rock and is acid in nature. In stony rock outcrop areas (approximately 15 percent of the mapping unit), from 50 to 75 percent of the surface is covered by rock outcrops and hard volcanic cobbles and stones. *Eugenia woodburyana* is found in the semi-evergreen forests of the bottoms of the more mesic canyons in the Guánica Commonwealth Forest. Silty alluvial soils, which retain a greater moisture content, are found among large limestone rock outcrops in these drainage (USFWS, 1998).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Improving (USFWS, 2017).

Resiliency:

Very low (inferred from USFWS, 1994)

Redundancy:

Low (inferred from USFWS, 1994)

Number of Populations:

3 (USFWS, 1994). As of 2019: 6 populations (USFWS, 2019).

Population Size:

~45 (USFWS, 1994). As of 2017, *Eugenia woodburyana* population is estimated at over 2,597 individuals. (USFWS, 2017). As of 2019: 3200 individuals (USFWS, 2019).

Population Narrative:

E. woodburyana is known only from approximately 45 individuals at three locations in southwestern Puerto Rico (USFWS, 1994). Since 1998, additional adult individuals of *Eugenia woodburyana* have been discovered within the Sierra Bermeja area (Laguna Cartagena National Wildlife Refuge - Tinaja Tract, Lozada Farm, Cerro El Conuco and Finca Maria Luisa, Almacigo Bajo - Municipality of Yauco, and Encarnacion Ward - Penuelas) and the Guanica Commonwealth Forest (GCF); and new species' localities have been found in the municipalities of Yauco, Peñuelas, and Salinas. The locality in Salinas expands the natural range of the species along the southern region of Puerto Rico. Additionally, the species has been successfully propagated under tree nursery conditions, producing over 714 individuals. A total of 333 of those individuals have been planted at nine sites in southwest Puerto Rico. At present, we estimate the *Eugenia woodburyana* population at over 2,597 individuals. (USFWS, 2019).

Threats and Stressors

Stressor: Habitat destruction and degradation (USFWS, 1998)

Exposure:

Response:

Consequence:

Narrative: In the Sierra Bermeja, *Eugenia woodburyana* is found on both public (managed by the Fish and Wildlife Service) and privately owned land. The privately owned land is subject to intense pressure for agricultural, rural, and tourist development. The land is currently being cleared for grazing by cattle and goats. Adjacent land is being subdivided for sale in small farms, some destined for tourist and urban development. Both public and private lands in these hills are frequently affected by wildfires, which adversely affect seedling recruitment and habitat restoration efforts (USFWS, 1998). Additional related threats: human-caused fire, landslides, floods, erosion and sediment (USFWS, 2017). As of 2019: The species and their habitats continue to be affected by development of residential and tourist projects, unsustainable agricultural practices, and improvement of existing facilities (e.g., trails, access roads) for recreational uses. (USFWS, 2019).

Stressor: Limited distribution (USFWS, 1998)

Exposure:

Response:

Consequence:

Narrative: One of the most important factors affecting the continued survival of this species is its limited distribution. Because so few individuals are known to occur in a limited area, the risk of extinction is extremely high (USFWS, 1998).

Stressor: Climate change (USFWS, 2017).

Exposure:**Response:****Consequence:**

Narrative: An expected effect of climate change is the increase of hurricanes and tropical storms, followed by extended periods of drought (IPCC 2012). This climate change may alter (modify) the microclimate and the surrounding vegetation around the populations of the *E. woodburyana*. Hurricane effects followed by extended periods of drought may result in change in soil conditions and microclimate and allow other plants (native or non-native, herbaceous or woody) adapted to drier conditions to become established (Lugo 2000). Invasive species (e.g. *Megathyrus maximus*) may spread and colonize the *E. woodburyana* habitat, and it could alter fire regimen, microclimate, and nutrient cycling of the habitat that the species depend. (USFWS, 2017).

Recovery**Reclassification Criteria:**

Not available

Delisting Criteria:

1. A management plan which considers the protection and recovery of the species has been prepared and implemented for the Guernica Commonwealth Forest and for the Cabo Rojo and Laguna Cartagena National Wildlife Refuges (USFWS, 1998).

2. Protection has been provided for those individuals known to occur on privately owned land (USFWS, 1998).

3. New populations (the number of which should be determined following the appropriate studies) capable of self-perpetuation have been established within protected areas, such as other areas in the Guernica Commonwealth Forest (USFWS, 1998).

Amended delisting criterion 1. Threat reduction and management activities have been implemented to a degree that the species will remain viable into the foreseeable future (addresses Factor A and Factor E). (USFWS, 2019).

Amended delisting criterion 2: Existing natural populations of *M. maxwelliae* (2 populations), *M. polycladus* (6 populations) and *E. woodburyana* (6 populations) show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factor E). (USFWS, 2019).

Amended delisting criterion 3. Within the historic range, establish at least three (3) new populations of *M. maxwelliae* and *M. polycladus*, and *E. woodburyana* on lands protected by a conservation mechanism that show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factor A and E). (USFWS, 2019).

Recovery Actions:

- Conduct propagation and enhance existing populations or establish new ones on protected lands (USFWS, 1998).
- Protect the existing populations and their habitat through the development and implementation of a management plan for the Guánica Commonwealth Forest, the Cabo

Rojo National Wildlife Refuge, and the Laguna Cartagena National Wildlife Refuge (USFWS, 1998).

- Protect populations on privately-owned land (USFWS, 1998).
- Monitor known populations (USFWS, 1998).
- Enforce existing Commonwealth and Federal endangered species regulations (USFWS, 1998).
- Educate the public on conservation values and regulations (USFWS, 1998).
- Conduct research on the life history of the species and evaluate propagation techniques (USFWS, 1998).
- 2017 action 1: Develop measurable and objective criteria for the delisting of the species based on the new information available for the species. (USFWS, 2017).
- 2017 action 2: Publish a propose rule to reclassify the species to threatened. (USFWS, 2017).
- 2017 action 3: Continue conducting comprehensive surveys on the species within traditional (e.g., Cerro Mariquita in Sierra Bermeja, GCF, Encarnación Ward in Peñuelas, Camp Santiago in Salinas and Almácigo Bajo in Yauco), and non-traditional sites (e.g., Sierra Bermeja mountain range and SCF) to determine relative abundance and distribution of the species in a wider range. (USFWS, 2017).
- 2017 action 4: Conduct surveys at Peñones de Melones to determine if the species is still present in that area. (USFWS, 2017).
- 2017 action 5: Promote Conservation Agreements with private landowners under the Service's Partners for Fish and Wildlife, and Coastal Programs to protect and enhance existing populations. (USFWS, 2017).
- 2017 action 6: Work closely with the PRDNER and landowners to ensure the protection of the species and its habitat in private lands. (USFWS, 2017).
- 2017 action 7: Continue with the propagation program to enhance the existing populations and establish new populations in protected areas in southwestern Puerto Rico. (USFWS, 2017).
- 2017 action 8: Continue implementing fire prevention practices in Sierra Bermeja, CRNWR and GCF during dry season. (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Conservation measures provided to federally listed species include recognition, recovery actions, requirements for Federal protection, and prohibitions against certain practices. Recognition through listing encourages and results in conservation actions by Federal, State, and private groups and individuals. The Endangered Species Act provides for possible land acquisition in cooperation with the States and requires that recovery actions be carried out for all listed species. Section 7(a) of the Act, as amended, requires Federal agencies to evaluate their actions with respect to any species that is listed as federally endangered or threatened. If a Federal action may affect a listed species or its critical habitat, the responsible Federal agency must enter into formal consultation with the Fish and Wildlife Service (USFWS, 1998).
- Studies of the distribution, abundance, population size and structure, and reproductive biology of these three species are currently ongoing. Some preliminary results have been incorporated into this plan. - The Fish and Wildlife Service works closely with the Puerto Rico Department of Natural and Environmental Resources in their review of development projects in order to avoid adverse effects to the species. The Fish and Wildlife Service recently acquired 270 acres in the Sierra Bermeja, which were added to the Laguna Cartagena National Wildlife Refuge (USFWS, 1998).

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SPECIES ACCOUNT: *Euphorbia* (=Chamaesyce) *celastroides* var. *kaenana* (`Akoko)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/29/1991; Pacific Region (R1) (USFWS, 2016)

Physical Description

A low-growing prostrate or upright shrub approximately 1 to 2 m (3.3 to 6.6 ft) tall. The stems have milky sap and are thick and knobby. The leaves, which fall off during the dry season, are mostly hairless and are arranged in two opposite rows along the stem; they are 20 to 65 mm (0.8 to 2.6 in) long, 8 to 20-mm (0.3 to 0.8 in) wide, and are widest at the tip. The flowers are borne on compact side branches, each of which bears 5 to 10 cyathia (specialized flower-like inflorescences with a single central female flower surrounded by much-reduced male flowers) (USFWS, 2016).

Taxonomy

A member of the spurge family (Euphorbiaceae) (USFWS, 2016). *Chamaesyce celastroides* var. *kaenana* is one of eight currently recognized varieties which are endemic to the main Hawaiian Islands as well as the island of Nihoa in the Northwestern Hawaiian Islands (Koutnik 1990) (USFWS, 2007).

Historical Range

Chamaesyce celastroides var. *kaenana* is endemic to the Hawaiian Islands. Historically *C. celastroides* var. *kaenana* occurred in the northwestern portion of the Waianae Mountains as well as the southeastern portion of the Koolau Mountains on the island of Oahu (as indicated from one collection) (Koutnik 1987; Koutnik and Huft 1990; Hawaii Natural Heritage Program 2004) (USFWS, 2016).

Current Range

Current range: Kaena, Oahu (NatureServe, 2015). It is currently located within the vicinity of Kaena Point and Makua Valley on State and Federal lands (USFWS, 2016).

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Euphorbia* (=Chamaesyce) *celastroides* var. *kaenana* (`Akoko) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Euphorbia* (=Chamaesyce) *celastroides* var. *kaenana* (77 FR 57648-57862). The critical habitat designation includes 17 critical habitat units, which encompass approximately 9,315 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Euphorbia* (=Chamaesyce) *celastroides* var. *kaenana* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by

providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Euphorbia* (=Chamaesyce) celastroides var. kaenana includes 17 critical habitat units, covering three ecosystem types, which encompass approximately 9,315 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Coastal—Units 1, 13, 14, 15; Oahu—Lowland Dry—Units 1, 2, 8, 9, 10, 11; Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7.

Oahu—Coastal—Unit 1 [958 ac (388 ha)]. This area consists of 946 ac (383 ha) of State land, 11 ac (4 ha) of Federal land, and 2 ac (1 ha) of privately owned land in the coastal ecosystem along the northwestern coast of Oahu from Kaena Point east to Kauhao Pali and southeast to Keawaula. This unit is partially within Kaena Point State Park. Oahu—Coastal—Unit 13 [23 ac (10 ha)]. This area consists of 19 ac (8 ha) of City and County land, 1 ac (0.5 ha) of State land, and 3 ac (1 ha) of privately owned land in the coastal ecosystem at Kalaeloa. Oahu—Coastal—Unit 14 [4 ac (2 ha)]. This area consists of 2 ac (1 ha) of City and County of Honolulu land, and 2 ac (1 ha) of Federal land (U.S. Coast Guard) in the coastal ecosystem at Kalaeloa. Oahu—Coastal—Unit 15 [33 ac (13 ha)]. This area consists of 9 ac (4 ha) of State land, 2 ac (1 ha) of privately owned land, and 21 ac (9 ha) of Federal (Pearl Harbor NWR) land at Kalaeloa.

Oahu—Lowland Dry—Unit 1 [102 ac (41 ha)]; This area consists of 49 ac (20 ha) of State land and 53 ac (22 ha) of privately owned land in the Waianae Mountains, extending from Haili Gulch to Kawaipahai. Oahu—Lowland Dry—Unit 2 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland dry ecosystem in the Waianae Mountains, on Federal land within Kaena Point State Park. Oahu—Lowland Dry—Unit 8 [99 ac (40 ha)]. Oahu—This area consists of 96 ac (40 ha) of privately owned land and 3 ac (1 ha) of State land as part of the old railroad right-of-way in the lowland dry ecosystem, at the Kalaeloa Barber's Point Harbor area. Oahu—Lowland Dry—Unit 9 [37 ac (15 ha)]. This area consists of 17 ac (7 ha) of City and County land, 3 ac (1 ha) of privately owned land, 1 ac (0.5 ha) of State land, and 16 ac (6 ha) of Federal (Pearl Harbor NWR) land in the lowland dry ecosystem at Kalaeloa. Oahu—Lowland Dry—Unit 10 [43 ac (17 ha)]. This area consists of 43 ac (17 ha) of State land (DHHL) in the lowland dry ecosystem at Kalaeloa. Oahu—Lowland Dry—Unit 11 [166 ac (67 ha)]. This area consists of 166 ac (67 ha) of federal land (U.S. Navy) in the lowland dry ecosystem at Kalaeloa.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland

mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Euphorbia* (=Chamaesyce) *celastroides* var. *kaenana* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Euphorbia* (=Chamaesyce) *celastroides* var. *kaenana* occurs within the indicated ecosystem in the Waianae Mountain caldera complex in the coastal and lowland dry ecosystems; and is known in the Waianae Mountain caldera complex and was known historically (last observed > 20 yrs ago) from the Lowland mesic ecosystem in the Koolau Mountain caldera complex:

(i) Oahu—Coastal—Units 1, 13, 14, 15. (A) Elevation: <980 ft (<300 m). (B) Annual Precipitation: <20 in (<50 cm). (C) Substrate: Well-drained, calcareous, talus slopes; dunes; weathered clay soils; ephemeral pools; mudflats. (D) Canopy: Hibiscus, Myoporum, Santalum, Scaevola. (E) Subcanopy: Gossypium, Sida, Vitex. (F) Understory: Eragrostis, Jacquemontia, Lyceum, Nama, Sesuvium, Sporobolus, Vigna.

(ii) Lowland Dry—Units 1, 2, 8, 9, 10, 11. (A) Elevation: <3,300 ft (<1,000 m). (B) Annual Precipitation: <50 in (<130 cm). (C) Substrate: Weathered silty loams to stony clay, rocky ledges, little weathered lava. (D) Canopy: Diospyros, Myoporum, Pleomele, Santalum, Sapindes. (E) Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. (F) Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Plumbago, Sicyos, Sida, Waltheria.

Lowland Mesic— Units 1, 2, 3, 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (F) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Euphorbia* (=Chamaesyce) *celastroides* var. *kaenana* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual: cross-pollination (USFWS, 2016)

Lifespan

Adult: 5 - 10 years (USFWS, 1998)

Breeding Season

Adult: Year round (USFWS, 2016)

Reproduction Narrative

Adult: Each flower cluster (cyathia) produces a small, erect capsule which measures 2 to 2.5 mm (0.1 in) long and contains three seeds. *Chamaesyce celastroides* var. *kaenana* is a short-lived perennial that is deciduous in summer. It has been observed flowering and fruiting throughout the year, probably in response to precipitation. Fruits mature in three to four weeks. Little is known about the breeding system of *C. celastroides* var. *kaenana*; however, the genus as a whole is usually monoecious (male and female flowers on different parts of the cyathium) or rarely dioecious (male and female flowers on separate plants). It is not known if the taxon is capable of self-fertilization (U.S. Army Garrison 2003b) (USFWS, 2016). Plants live from 5 to 10 years (USFWS 1995; 1998).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Coastal dry shrublands (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at 30 - 700 ft. elevation (USFWS, 2016)

Habitat Narrative

Adult: Inhabits dry shrublands, usually coastal, rarely inland. Usually on gentle to moderate slopes, rarely on cliffs (NatureServe, 2015). *Chamaesyce celastroides* var. *kaenana* typically grows in coastal dry shrubland on windward talus slopes at an elevation of 9 to 640 m (30 to 700 ft) (Hawaii Natural Heritage Program 1990; Koutnik and Huft 1990) (USFWS, 2016).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Increasing (USFWS, 2016)

Resiliency:

Very low (inferred from NatureServe, 2015; see current range/distribution)

Redundancy:

Low to moderate (inferred from USFWS, 2016)

Number of Populations:

9 USFWS, 2016)

Population Size:

951 mature, 100 immature (USFWS, 2016)

Population Narrative:

About the time of listing this species there were only 300 individuals at five known sites. Today this species appears to be increasing since there are approximately 951 mature plants and 100 immature plants and seedlings in nine occurrences (Service 2006c) (USFWS, 2016).

Threats and Stressors

Stressor: Trampling (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: *C. celastroides* var. *kaenana* is vulnerable to trampling by humans along trails in the Kaena Point Natural Area Reserve (USFWS, 2016).

Stressor: Stochastic events (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: *Chamaesyce celastroides* var. *kaenana* is vulnerable to extirpation from naturally occurring events such as landslides, hurricanes, flooding, and/or reduced reproductive vigor due to small population size and limited distribution (56 FR 55770; Service 1999b) (USFWS, 2016).

Stressor: Hybridization (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: *Chamaesyce celastroides* var. *kaenana* apparently hybridizes with *C. celastroides* var. *amplectens*, which is a common variety of the species. Variety *amplectens* occurs with or near var. *kaenana* in the inland portion of var. *kaenana*'s range. Only a few putative hybrid individuals have been observed in Waianae Kai. However, in part of Punapohaku Gulch on the north side of Kahanahāiki Valley in the Makua Military Reservation, there are many apparent hybrids. These plants are highly variable, and appear to constitute a hybrid swarm. Both varieties of *Chamaesyce*

celastroides occur in other portions of Punapohaku Gulch, but no hybrids between the two varieties have been observed in these areas (Makua Implementation Team 2003; J. Lau, pers. comm. 2006) (USFWS, 2007).

Stressor: Feral goats (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Feral goats (*Capra hircus*) are a threat to the *Chamaesyce celastroides* var. *kaenana*. Feral goats eat native vegetation, trample roots and seedlings, cause erosion, and promote the invasion of alien plants. They are able to forage in extremely rugged terrain and have a high reproductive capacity (Clarke and Cuddihy 1980; van Riper and van Riper 1982; Scott et al. 1986; Tomich 1986; Culliney 1988; Cuddihy and Stone 1990). The population of *C. celastroides* var. *kaenana* in Waianae Kai is located on steep, nearly vertical cliffs and is thus out of reach of the feral goats, however, the goats are negatively affecting the habitat of these unreachable plants. Feral goats are now excluded from Makua valley where *C. celastroides* var. *kaenana* plants are found by an ungulate proof fence that was constructed along Makua Valley's southern and eastern rims (U.S. Army 2005; J. Lau, pers. comm. 2006) (USFWS, 2007).

Stressor: Fire (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: *Chamaesyce celastroides* var. *kaenana* occurs in dry habitats and is not considered fire tolerant (Service 1998; 68 FR 35949). One potential source of fire is from military training activities on the Makua Military Reservation. The Army has addressed the threat of fire from their actions by developing and implementing a fire management plan to minimize the number of ignitions in the reservation, to respond rapidly to any ignitions, and to maintain fire breaks to help contain any ignitions away from the endangered species locations (U.S. Army 2003). *Chamaesyce celastroides* var. *kaenana* is also threatened by fires ignited through arson (Makua Implementation Team 2003). Several populations have been impacted by fires in the past, including the population east of Kaena Point, the populations in northern Kahanahāiki, those in southern Makua Valley, and the population at Waianae Kai (U.S. Army 2005; HBMP 2006) (USFWS, 2007).

Stressor: Nonnative plants (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Competition from and habitat degradation by invasive nonnative plant species is a major threat to *Chamaesyce celastroides* var. *kaenana*. The primary invasive nonnative plant species impacting *C. celastroides* var. *kaenana* include *Acacia con/usa* (Formosan koa), *Grevillea robusta* (silk oak), *Hyptis pectinata* (comb hyptis), *Leucaena leucocephala* (koa haole), *Melinis repens* (natal redtop), *Panicum maximum* (Guinea grass), *Pluchea carolinensis* (sourbush), and *Schinus terebinthifolius* (Christmas berry) (U.S. Army 2005; 68 FR 35949) (USFWS, 2007).

Recovery

Reclassification Criteria:

1. A total of five to seven populations should be documented on Oahu and at least one other island where they now occur or occurred historically (USFWS, 1998).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1998).
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1998).

Delisting Criteria:

1. A total of 8 to 10 populations should be documented on Oahu and at least one other island where they now occur or occurred historically (USFWS, 1998).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1998).
3. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1998).

Recovery Actions:

- Protect habitat and control threats (USFWS, 1998).
- Expand existing wild populations (USFWS, 1998).
- Conduct essential research (USFWS, 1998).
- Develop and maintain monitoring plans (USFWS, 1998).
- Reestablish wild populations within historic range (USFWS, 1998).
- Validate and revise recovery criteria (USFWS, 1998).
- Control competing alien plant species (USFWS, 1998).
- Provide protection from fire (USFWS, 1998).

Conservation Measures and Best Management Practices:

- Since listing, the Makua Implementation Team (2003) has developed stabilization protocols for *Chamaesyce celastroides* var. *kaenana* which are incorporated in the Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). The Hawaii Natural Area Reserves System is managing Kaena Point for the recovery of the native vegetation and bird life. The Division of Forestry and Wildlife has restricted off-road vehicle access to the Kaena Point Natural Area Reserve by constructing a large barrier on the Mokuleia side of the reserve. Access from the Waianae side is prevented by a natural washout. Three individuals were outplanted at the Kaena Point Natural Area Reserve in 1995, and, as of July 1997, only one plant survived. Other management activities in the Kaena Point Natural Area Reserve include outplanting and removal of *Leucaena leucocephala* and *Prosopis pallida* in the vicinity of *C. celastroides* var. *kaenana* (USFWS, 2016).
- At Makua, the Army Natural Resources Staff have been conducting fuel management, weed control, firebreaks, and genetic storage for this species pursuant to the Makua Implementation Plan Addendum. Propagation material for this species is currently held at the following institutions: Army Environmental Division on Oahu, Harold L. Lyon Arboretum, Lyon Arboretum Seed Storage

Facility, National Tropical Botanical Garden, and Waimea Arboretum. The Waianae populations are monitored by the Natural Resources Staff, but are not actively managed due to their location on steep cliffs. In addition, a State-wide strategic plan is being developed by the Hawaii and Pacific Plant Recovery Coordinating Committee that will address the long-term conservation of *Chamaesyce celastroides* var. *kaenana*. This plan will also include broader landscape actions that are needed for the recovery of this species throughout its range (Service 1998a, 2003b; Hawaii and Pacific Plant Recovery Committee 2007). The ex situ collections for *C. celastroides* var. *kaenana* include 16 apical or lateral vegetative buds in micropropagation (Harold L. Lyon Arboretum), 58 cuttings in nurseries (Army Environmental Division, Oahu and Harold L. Lyon Arboretum), nine plants in a botanical garden (Waimea Valley Audubon Center), and 5,516 seeds in seed storage (Lyon Arboretum Seed Storage Facility) (Service 2005b) (USFWS, 2016).

- Search for individuals of *Chamaesyce celastroides* var. *kaenana* in the southeastern Koolau mountains (USFWS, 2007).
- Study *Chamaesyce celastroides* var. *kaenana* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2007).
- Manage other populations of *Chamaesyce celastroides* var. *kaenana* that are not being managed by the U.S. Army staff (USFWS, 2007).

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USFWS 2007. *Chamaesyce celastroides* var. *kaenana* (Akoko) 5- Year Review Summary and Evaluation. U.S. Fish and Wildlife Service Pacific Islands Fish and Wildlife Office Honolulu. Hawaii.

SPECIES ACCOUNT: *Euphorbia* (=Chamaesyce) *deppeana* (`Akoko)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/28/1994; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

An erect to sprawling subshrub with milky sap. Stems 0.1-1.2 m long. Cyathia (specialized flower clusters) are solitary in the leaf axils. (NatureServe, 2015)

Taxonomy

Chamaesyce multiformis. var. *microphylla* differs from *C. deppeana* in many respects, and the two are easily distinguished from one another, even when observed from afar. An individual of *C. multi/armis* var. *microphylla* at this location has been photographically documented (Carlquist 1970). *Chamaesyce multiformis* var. *microphylla* has now almost completely disappeared from the windward side of the ridge. Most of the native *Chamaesyce* there are believed to be *C. deppeana*, with additional plants that appear to represent hybrids between the two *Chamaesyce* taxa. (USFWS, 2007)

Historical Range

Historically, *Chamaesyce deppeana* was known only from “southern Oahu.” (USFWS, 1998)

Current Range

Current range: Nuuanu Pali area of Koolau Mountains, Oahu. (NatureServe, 2015)

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Euphorbia* (=Chamaesyce) *deppeana* (`Akoko) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Euphorbia* (=Chamaesyce) *deppeana* (77 FR 57648-57862). The critical habitat designation includes three critical habitat units, which encompass approximately 4,944 acres on the Island of Oahu, Hawaii. The critical habitat designation for *Euphorbia* (=Chamaesyce) *deppeana* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Euphorbia* (=Chamaesyce) *deppeana* includes three critical habitat units, covering one ecosystem type, which encompasses approximately 4,994 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Wet Cliff—Unit 6, 7, 8.

Oahu—Wet Cliff—Unit 6 [151 ac (61 ha)]. This area consists of 151 ac (61 ha) in the wet cliff ecosystem on State land on the windward side of the Koolau Mountains in Kaipapau Gulch, entirely within the Kaipapau Forest Reserve. Oahu—Wet Cliff—Unit 7 [144 ac (58 ha)]. This area consists of 144 ac (58 ha) in the wet cliff ecosystem in State land on the windward side of the Koolau Mountains in Hauula Gulch, entirely within the Hauula Forest Reserve. Oahu—Wet Cliff—Unit 8 [4,649 ac (1,881 ha)]. This area consists of 1,479 ac (598 ha) of State land, 1,281 ac (519 ha) of City and County of Honolulu land, 5 ac (2 ha) of Federal land, and 1,884 ac (762 ha) of privately owned land, in the wet cliff ecosystem along the summit of the Koolau Mountains, overlapping portions of Sacred Falls State Park, the Waiahole FR (Waiahole and Iolekaa sections), the Kaneohe and Honolulu Watershed FRs, and the Nuana Pali State Wayside.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Euphorbia (=Chamaesyce) deppeana* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Euphorbia (=Chamaesyce) deppeana* occurs within the indicated ecosystem in the Koolau Mountain caldera complex:

Oahu—Wet Cliff—Unit 6, 7, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: >65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. (E) Understory: *Bryophytes*, *Ferns*, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Euphorbia (=Chamaesyce) deppeana* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: This species has been observed in flower in May and September (Bishop Museum herbarium specimens [BISH] 19134 and 504036). (USFWS, 1998)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliff, shrubland/chaparral (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Scattered (USFWS, 1998)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1998)

Habitat Narrative

Adult: The most visible and accessible plants within the only known population of *Chamaesyce deppeana* are confined to a 20-square-meter (200-square-foot) area, portions of which extend to within 5 meters (15 feet) of the Pali Lookout parking lot, and along the ridge crest and cliff faces on the windward side (USFWS 1996a). The remaining plants are scattered on an adjacent steep, exposed, windswept slope growing with alien grasses and shrubs (USFWS 1996a). Associated species include *Carex* sp., *kookoolau*, *ohia*, and *Eragrostis* sp. (*kawelu*). This population is found at an elevation of approximately 300 meters (1,000 feet) (USFWS 1996a). (USFWS, 1998)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from NatureServe, 2015)

Redundancy:

Very low (inferred from NatureServe, 2015)

Number of Populations:

1 (NatureServe, 2015)

Population Size:

<1000 plants (NatureServe, 2015)

Population Narrative:

Currently approximately 50+ plants observed, estimate less than 1000 plants. There is 1 extant (between 1982 and 1997) and no historical occurrences. (NatureServe, 2015)

Threats and Stressors

Stressor: Invasive non-native plant species (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Competition for water, space, light, and nutrients from and habitat degradation by invasive alien plant species is the major threat to *Chamaesyce deppeana*. At the time of listing, the major nonnative plant species impacting *Chamaesyce deppeana* were *Casuarina equisetifolia* (common ironwood), *Paspalum conjugatum* (Hilo grass), and *Schinus terebinthifolius* (Christmas berry) (59 FR 14482). Currently, *C. deppeana* is subject to the same plant threats, with the addition of the nonnative plant species *Ageratina riparia* (Hamakua pamakani), *Citharexylum caudatum* (fiddlewood), *Erigeron karvinskianus* (daisy fleabane), *Kalanchoe pinnata* (air plant), *Psidium guajava* (common guava), and *Scheffler actinophylla* (octopus tree (J. Lau pers. comm. 2006). (USFWS, 2007)

Stressor: Fire (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Fire is considered a potential threat to *Chamaesyce deppeana*, as this species occurs on windswept slopes in the proximity of Nuuanu Pali Wayside State Park, and *C. deppeana* is not considered fire tolerant. (USFWS, 2007)

Stressor: Stochastic events (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: *Chamaesyce deppeana* is threatened by extinction due to stochastic events because of the limited number of individuals and restricted range (Factor E). Species like *C. deppeana* that are endemic to a small portion of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes and disease outbreaks (Service 1998; 68 FR 35949). (USFWS, 2007)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Oahu and at least 1 other island where they now occur or occurred historically. (USFWS, 1998)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)

3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1998)

Recovery Actions:

- Specific efforts should be made to immediately weed and protect the remaining extant population. (USFWS, 1998)
- A coordinated fire protection plan for endangered plants on Department of State Parks land needs to be developed and implemented. (USFWS, 1998)

Conservation Measures and Best Management Practices:

- Search for additional populations of *Chamaesyce deppeana*. There is appropriate habitat for the species in the general area of the Nuuanu Pali Wayside State Park that has not been surveyed for the species. Similar habitat also exists elsewhere in the southeastern Koolau mountains, even though the species was not historically recorded from that area (Joel Lau pers. comm. 2006). (USFWS, 2007)
- Study the known population of *Chamaesyce deppeana* with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats to the species. (USFWS, 2007)
- Investigate the reported expansion in the distribution of the *Chamaesyce deppeana* population. (USFWS, 2007)
- Confirm the putative hybridization between *Chamaesyce deppeana* and *Chamaesyce multifloris* var. *microphylla*. (USFWS, 2007)

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SPECIES ACCOUNT: *Euphorbia (=Chamaesyce) eleanoriae* (`Akoko)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Euphorbia eleanoriae, a member of the spurge family (Euphorbiaceae), is a small shrub endemic to Kauai. It has brittle, dense, erect-ascending (growing upward) branches, and dark gray basal stems. The leaves are elliptical to broadly ovate, with blades 10 to 20 millimeters (mm) (0.4 to 0.8 inches (in)) long and 6 to 14 mm (0.2 to 0.6 in) wide. The leaves are usually pale green, sometimes with a reddish tint on the margins, oppositely arranged with each succeeding pair set at right angles to the previous pair, or sometimes spirally arranged. The inflorescences (flowering clusters) are cyathia (containing unisexual flowers without petals) that are borne either solitary or at the terminal branch tips. The styles and stamens are dark purple. The fruit is a capsule, green with a purple-red apex, and the seeds are 2.2 mm (0.09 in) long and 1.3 mm (0.05 in) in diameter (Lorence and Wagner 1996). (USFWS, 2017)

Taxonomy

This species was described by D.H. Lorence and W.L. Wagner (1996) under the name *Chamaesyce eleanoriae*, based on a specimen collected in 1992. Steinman and Porter (2002) studied the phylogenetic relationship of the tribe Euphorbieae in the Euphorbiaceae (spurge family). As a result of their work, *Chamaesyce* is no longer recognized as a separate genus from *Euphorbia*. This change in genus is recognized in the most recent treatment of the Hawaiian flora (Wagner et al. 2012). In 2015, the Service published a technical correction for this and other plant and wildlife species, recognizing the taxonomic change from *Chamaesyce eleanoriae* to *Euphorbia eleanoriae* (80 FR 35860, June 23, 2015). Therefore, we refer to this species as *Euphorbia eleanoriae*, and the List of Endangered and Threatened Plants (50 CFR 17.12) has been updated to reflect the new taxonomy (USFWS 2015b). The taxonomic change does not affect the range or endangered status of this species. *Euphorbia eleanoriae* differs from the closely related *E. sparsiflora* by its consistently present white, glandular cyathial appendages (Lorence and Wagner 1996). (USFWS, 2017)

Historical Range

Described in 1996, it occurs only in and around Kalalau Valley Rim on Na Pali Coast of Kauai., Hawaii. (USFWS, 2017)

Current Range

Described in 1996, it occurs only in and around Kalalau Valley Rim on Na Pali Coast of Kauai., Hawaii. (USFWS, 2017)

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Chamaesyce eleanoriae* (`Akoko) under the Endangered Species Act of 1973, as amended (Act).

The critical habitat designation includes seven critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Chamaesyce eleanoriae* includes seven CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Lowland Mesic—Section 1: Lowland Mesic—Section 1 consists of 2,006 ac (812 ha) in the lowland mesic ecosystem, including mesic forest extending from Awaawapuhi Trail south to Makaha Ridge, in the Na Pali Kona Forest Reserve and the Kuia NAR (Figure 1-A). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plants *Doryopteris angelica*, *Labordia helleri*, *Platydesma rostrata* and *Psychotria hobbdi*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these four species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic—Section 1 is not known to be occupied by the species *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Dubautiakenwoodii*, *Pittosporum napaliense*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 2: Lowland Mesic—Section 2 consists of 379 ac (154 ha) in the lowland mesic ecosystem, including mesic forest extending from Keanapuka to Kahuamaa Flat along the rim and cliffs of the Kalalau Valley, in the Na Pali Coast State Park (Figure 1-A, above). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plants *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Pittosporum napaliense*, and *Psychotria hobbdi*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these six species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic—Section 2 is not known to be occupied by the species *Doryopteris angelica*, *Dubautiakenwoodii*, *Labordia helleri*, *Platydesma rostrata*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 3: Lowland Mesic—Section 3 consists of 124 ac (50 ha) in the lowland mesic ecosystem, including mesic forest extending from Manono Ridge, Pohakuao Valley, to Kanakuu, within the Na Pali Coast State Park (Figure 1-A, above). The entire section is

Stateownedand within previouslydesignated critical habitat; it falls withinCritical Habitat Unit 11 of 50 CFR17.99(a)(1), Map 66a. This section isoccupied by the plants Canavaliapaliensis, Chamaesyce eleanoriae, and Charpentiera densiflora, andincludes mesic forest, the moistureregime, and canopy, subcanopy, andunderstory native plant speciesidentified as PCEs in the lowland mesicecosystem (Table 3). This section alsocontains unoccupied habitat that isessential to the conservation of thesethree species by providing the physicaland biological features necessary for theexpansion of the existing wildpopulations. Although Lowland Mesic–Section 3 is not known to be occupiedby the species Chamaesyce remyi var. remyi, Doryopteris angelica, Dubautiakenwoodii, Labordia helleri, Pittosporum napaliense, Platydesmarostrata, Psychotria hobdyi, andTetraplasandra bisattenuata, we have determined this area to be essential forthe conservation and recovery of theselowland mesic species because itprovides the physical and biologicalfeatures necessary for thereestablishment of wild populationswithin their historic range. Due to thesmall numbers of individuals or lowpopulation sizes of each of thesespecies, each requires suitable habitatand space for expansion orreintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 4: Lowland Mesic—Section 4 consists of81 ac (33 ha) in the lowland mesicecosystem, including mesic forest at thehead of the Hanakapiai Valley, in the NaPali Coast State Park. The entire section is Stateownedand within previouslydesignated critical habitat; it falls withinCritical Habitat Unit 11 of 50 CFR17.99(a)(1), Map 66a. This section isoccupied by the plant Charpentieradensiflora and includes mesic forest, the moisture regime, and canopy,subcanopy, and understory native plantspecies identified as PCEs in thelowland mesic ecosystem (Table 3). Thissection also contains unoccupiedhabitat that is essential to theconservation of this species byproviding the physical and biologicalfeatures necessary for the expansion ofthe existing wild population. AlthoughLowland Mesic–Section 4 is not known to be occupied by the species Canavaliapaliensis, Chamaesyce eleanoriae, Chamaesyce remyi var. remyi, Doryopteris angelica, Dubautiakenwoodii, Labordia helleri, Pittosporum napaliense, Platydesmarostrata, Psychotria hobdyi, andTetraplasandra bisattenuata, we have determined this area to be essential forthe conservation and recovery of theselowland mesic species because itprovides the physical and biologicalfeatures necessary for thereestablishment of wild populationswithin their historic range. Due to thesmall numbers of individuals or lowpopulation sizes of each of thesespecies, each requires suitable habitatand space for expansion orreintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 5: Lowland Mesic—Section 5 consists of 37 ac (15 ha) in the lowland mesic ecosystem, including mesic forest on the slopes of Mt. Haupu, on privately owned land (Figure 1-B). The entire section is within previously designated critical habitat, and falls within Critical Habitat Unit 7 of 50 CFR 17.99(a)(1), Map 23a. This section is occupied by the plants Chamaesyce remyi var. remyi and Tetraplasandra bisattenuata, and includes mesic forest and shrubland, the moisture regime, and subcanopy and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these two species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic–Section 5 is not known to be occupied by the species Canavalia napaliensis, Chamaesyce eleanoriae, Charpentiera densiflora, Doryopteris angelica, Dubautia kenwoodii, Labordia helleri, Pittosporum napaliense, Platydesma rostrata, and Psychotria hobdyi, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of

individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Dry Cliff—Section 1: Dry Cliff—Section 1 consists of 404 ac (163 ha) in the dry cliff ecosystem, along cliffs from Kalanu to Pihea peak, within the Na Pali Coast State Park (Figure 5). The entire section is within previously designated critical habitat and is State-owned; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 67a. This section is occupied by the plants *Chamaesyce eleanoriae*, *Lysimachia scopulensis*, *Schiedea attenuata*, and *Stenogyne kealiae*. This section includes the dry cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the dry cliff ecosystem (Table 3).

Kauai—Dry Cliff—Section 2: Dry Cliff—Section 2 consists of 309 ac (125 ha) in the dry cliff ecosystem, including cliffs and ridges extending from Kanakou to Keanapuka and along Manono Ridge, surrounding the hanging valley Pohakuao, in the Na Pali Coast State Park (Figure 5, above). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 67a. This section is occupied by the plant *Chamaesyce eleanoriae* and includes the dry cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the dry cliff ecosystem (Table 3). Although Dry Cliff - Section 3 is not known to be occupied by the plants *Lysimachia scopulensis*, *Schiedea attenuata*, and *Stenogyne kealiae*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range of the species. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Chamaesyce eleanoriae* critical habitat consists of two components (Lowland mesic and dry cliff) (75 FR 18960-19165):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<914 m). Annual precipitation: 50–75 in (127–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Ecosystem: Dry Cliff. Elevation: unrestricted. Annual precipitation: < 75 in (<190 cm). Substrate: >65 degree slope, rocky talus. Canopy: None. Subcanopy: *Antidesma*, *Chamaesyce*, *Diospyros*, *Dodonaea*. Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Schiedea*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating

critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the

47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: This species has been observed flowering in January, February, April, May, and October (Perlman 2007; PEPP 2015). (USFWS, 2017)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliff, forest- hardwood, forest/woodland, shrubland/chaparral (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Moist vegetation on narrow ridge crests and outcrops, and less commonly on steep rocky slopes and cliffs. (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Between 270 and 1,100 meters (885 and 3,609 feet) elevation (USFWS, 2017)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: *Euphorbia eleanoriae* is restricted to steep, north-facing, narrow ridge crests, outcrops, and steep rocky slopes and upper portions of basalt cliffs of northern Kauai (Lorence and Wagner 1996; Wood 2007). Documented habitats include *Metrosideros polymorpha* (ohia)—*Diospyros* spp. (lama) mesic forest, *M. polymorpha* cliff and mesic shrubland, and *Eragrostis variabilis* (kawelu) coastal dry cliffs, between 270 and 1,100 meters (885 and 3,609 feet) elevation (Lorence and Wagner 1996; HBMP 2010). When first described, *Euphorbia eleanoriae* occurred in *Metrosideros* shrubland with herbaceous species *Eragrostis* spp., *Poa mannii*, and *Stenogyne campanulata*; and shrubby native taxa including *Coprosma* spp. (pilo), *Dubautia* spp. (naenae), *Lepidium serra* (anaunau), *Lobelia niihauensis* (NCN), *Lysimachia glutinosa* (NCN), *Nototrichium divaricatum* (kului), *Hibiscus kokio* ssp. *saintjohnianus* (kokio), *Bidens sandwicensis* (kookoolau), and *Vaccinium* spp. (ohelo) (Lorence and Wagner 1996; Perlman 2007). Currently, at Pohakuao, *E. eleanoriae* typically occurs with other *Euphorbia* species, *Artemisia australis* (hinahina), *Bidens sandwicensis* (kookoolau), *Boehmeria grandis* (akolea), *Eragrostis variabilis*, *Kadua acuminata* (au), *Leptecophylla tameiameia* (pukiawe), *Lipochaeta connata* ssp. *acris* (nehe), *Lythrum maritimum* (pukamole), *Nototrichium sandwicense* (kului), *Panicum lineale* (panic grass), *Sida fallax* (ilima), *Vaccinium dentatum* (ohelo), *Wikstroemia oahuensis* (akia), and *Wilkesia gymnoxiphium* (iliau). Occasional tree species include *Acacia koa* (koaia), *Antidesma platyphyllum* var. *hillebrandii* (hame), *Bohea*

elatior (ahakea), Diospyros spp. (lama), Dodonaea viscosa (aalii), Hibiscus kokio ssp. saintjohnianus (kokio ulaula), Melicope pallida (alani), Metrosideros polymorpha var. glaberrima, and Psydrax odorata (alahee). Common herbs include Dianella sandwicensis (uki uki), Peperomia spp. (alaala wai nui), Peucedanum sandwicense (makou), Pilea peploides (NCN), and Plectranthus parviflorus (alaala wai nui). Sedges include Carex meyenii (NCN) and Cyperus phleoides (NCN). Occasional ferns are also a component of these cliff regions and include Doodia kunthiana (okupukupu lauui), Doryopteris decipiens (kumuniu), Lepisorus thunbergianus (pakahakaha), Microlepia strigosa (palapalai) Nephrolepis exaltata ssp. hawaiiensis (naniau), Psilotum nudum (moa), and Selaginella arbuscula (lepelepe a moa) (Wood 2007). (USFWS, 2017)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Population Growth Rate:

Unknown (NatureServe, 2015)

Number of Populations:

1 (USFWS, 2017)

Population Size:

26 wild individuals (USFWS, 2017)

Population Narrative:

There are possibly fewer than 300 plants and only 3 extant (1990-2000) occurrences. Population trends are unknown. (NatureServe, 2015); Euphorbia eleanoriae was historically known from 10 populations totaling fewer than 500 individuals when first discovered in 1992 (Wood 2007; Lorence and Wagner 1996). Described in 1996, it occurs only in and around Kalalau Valley Rim on Na Pali Coast of Kauai. In the 1990s, eight populations were known (from Honopu Valley rim, Kalalau Valley rim and cliffs to the hanging valley of Pohakuao), totaling at least 260 individuals. When monitored in 2005, there were three populations totaling fewer than 50 individuals (Perlman 2007; USFWS 2010a). Currently, there is only one population of 26 individuals at Pohakuao (PEPP 2015). (USFWS, 2017)

Threats and Stressors

Stressor: Ungulate degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Feral goats (*Capra hircus*) and black-tailed deer (*Odocoileus hemionus*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil (Lorence and Wagner 1996; Wood 2007; PEPP 2014). (USFWS, 2017)

Stressor: Established ecosystem-altering invasive plant modification and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community. Invasive introduced plants with the greatest impacts on *Euphorbia eleanoriae* are: *Andropogon glomeratus* (bushy beardgrass), *Erigeron karvinskianus* (daisy fleabane), *Kalanchoe pinnata* (air plant), *Lantana camara* (lantana), *Pluchea carolinensis* (sourbush), *Psidium guajava* (common guava), and *Rubus rosifolius* (thimbleberry) (Lorence and Wagner 1996; Wood 2007). (USFWS, 2017)

Stressor: Landslides and flooding destruction or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: The only known individuals of *Euphorbia eleanoriae* occur on cliffs at Pohakuao (PEPP 2015). Large herds of feral goats browse and cause erosion in the area where *E. eleanoriae* occurs (Lorence and Wagner 1996). Landslides, due to natural weathering and ungulate disturbance, destabilize substrates, damage and destroy individual plants, and alter hydrological patterns (Stearns 1985). (USFWS, 2017)

Stressor: Hurricanes—Loss and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu

et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013). (USFWS, 2017)

Stressor: Climate change loss or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Euphorbia eleanoriae* is highly vulnerable to the impacts of climate change with a vulnerability score of 0.783 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2017)

Stressor: Ungulate predation or herbivory (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Herbivory by feral goats and black-tailed deer is a threat to *Euphorbia eleanoriae* (Lorence and Wagner 1996; Wood 2007; PEPP 2014). (USFWS, 2017)

Stressor: Lack of adequate hunting regulations (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: All of the historic and currently known populations of *Euphorbia eleanoriae* occur or occurred in state hunting areas. Feral goats and black-tailed deer and the effects of their activities are noted to be a threat to *E. eleanoriae*. Nonnative feral ungulates pose a major ongoing threat to native species through destruction and modification of habitat, and by direct herbivory or predation. The population of *E. eleanoriae* is not fenced. Public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations are at risk (DLNR 2010). (USFWS, 2017)

Stressor: Lack of adequate biosecurity legislation (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Invasion of the State of Hawaii by invasive nonnative plant species, and destruction of habitat and competition by nonnative plants are threats to *Euphorbia eleanoriae*. Pest species have caused the extinction of native species, the destruction of native forests, and the spread of disease. The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, is authorized to prevent the introduction or dissemination of animal and plant pests on all ships, aircraft, and their cargo and baggage arriving in the U.S. and its territories; however, pest species continue to enter the State. In addition, Federal import

regulations do not address many species that could be pests in Hawaii (CGAPS 2009; Ikuma et al. 2002). (USFWS, 2017)

Stressor: Invasive species—Established invasive plant species competition (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Nonnative plant species including *Andropogon glomeratus* (bushy beardgrass), *Erigeron karvinskianus* (daisy fleabane), *Kalanchoe pinnata* (air plant), *Lantana camara* (lantana), *Pluchea carolinensis* (sourbush), *Psidium guajava* (common guava), and *Rubus rosifolius* (thimbleberry) compete with *Euphorbia eleanoriae* for space, water, light, and nutrients (Lorence and Wagner 1996; Wood 2007). (USFWS, 2017)

Stressor: Stochastic events—Reduced viability due to low numbers (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Small, isolated populations often exhibit reduced levels of genetic variability, which diminishes the species' capacity to adapt and respond to environmental changes, thereby lessening the probability of long-term persistence (Barrett and Kohn 1991; Newman and Pilson 1997). The problems associated with small population size and vulnerability to random demographic fluctuations or natural catastrophes are further magnified by synergistic interactions with other threats, such as anthropogenic impacts like habitat loss from human development or predation by nonnative species. Very small plant populations may experience reduced reproductive vigor due to ineffective pollination or inbreeding depression. Small numbers are noted as a cause of loss of reproductive vigor of *Euphorbia eleanoriae* (Wood 2007). (USFWS, 2017)

Recovery

Reclassification Criteria:

To meet the interim stage of recovery of *Euphorbia eleanoriae*, 300 mature individuals are needed in each of three populations and all major threats must be controlled around the populations designated for recovery at this stage. There should also be demonstrated regeneration of seedlings and growth to at least sapling stage for woody species and documented replacement regeneration within each of the target populations. The populations must be adequately represented in an ex situ collection as defined in the Center for Plant Conservation's guidelines (Guerrant et al. 2004). Adequate monitoring must be in place and conducted to assess individual plant survival, population trends, trends of major limiting factors, and response of major limiting factors to management. (USFWS, 2017)

In addition to achieving 5 to 10 populations with 500 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist.

Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats. (USFWS, 2017)

Delisting Criteria:

In addition to achieving 5 to 10 populations with 500 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis. (USFWS, 2017)

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys. (USFWS, 2010)
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units. (USFWS, 2010)
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys. (USFWS, 2010)
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range. (USFWS, 2010)
- Conduct research on control methods for introduced slugs and avian malaria. (USFWS, 2010)
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction. (USFWS, 2010)
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security. (USFWS, 2010)
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems. (USFWS, 2010)
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations. (USFWS, 2010)

- Surveys and inventories—Survey for populations of *Euphorbia eleanoriae* in areas of potentially suitable habitat. (USFWS, 2017)
- Ungulate monitoring and control—Construct ungulate exclosures around remaining population to protect individuals from the impacts of feral ungulates. Protect all occurrences against browsing and disturbances from feral ungulates. (USFWS, 2017)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. Control invasive nonnative plant species around all populations that compete with the species.(USFWS, 2017)
- Predator and herbivore monitoring and control—Construct small-scale fences strategically at the unprotected population until a larger surrounding area is fenced and ungulate-free. (USFWS, 2017)
- Captive propagation for genetic storage and reintroduction—Collect material for genetic storage and propagation for reintroduction. (USFWS, 2017)
- Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2017)
- Population biology research—Study *Euphorbia eleanoriae* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. (USFWS, 2017)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms. (USFWS, 2017)
- Based on the recovery criteria above, consider development of a recovery plan. (USFWS, 2017)

Conservation Measures and Best Management Practices:

- Conservation measures are not available.

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SPECIES ACCOUNT: *Euphorbia* (=Chamaesyce) *halemanui* (`akoko)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/1992; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

C. halemanui is a scandent (climbing) shrub in the spurge family (Euphorbiaceae) with stems 1 to 4 m (3 to 13 ft) long. The egg-shaped to inversely lance-shaped leaves are decussate (successive pairs of leaves at right angles to the previous pair). The leaves are 4 to 13 cm (1.6 to 5 inches) long and 1 to 4.5 cm (0.4 to 1.8 inches) wide, with persistent stipules (small appendages at the base of the petioles (stem of the leaf)). Groups of flowers (cyathia) are in dense, compact, nearly spherical clusters or occasionally solitary in leaf axils. The stems of cyathia are about 2 mm (0.08 in) long, or if solitary, about 5 mm (0.2 in) long. The fruits are green capsules, about 3 mm (0.1 in) long, on recurved stalks, enclosing gray to brown seeds. (USFWS, 1995)

Taxonomy

Steinman and Porter (2002) studied the phylogenetic relationship of the tribe Euphorbieae, in the Euphorbiaceae (spurge family). As a result of their work, Chamaesyce is no longer recognized as a separate genus from Euphorbia. (USFWS, 2010); In 2015, the Service published a technical correction for this and other plant and wildlife species, recognizing the taxonomic change from Chamaesyce halemanui to Euphorbia halemanui (80 FR 35860, June 23, 2015). The taxonomic change does not affect the range or endangered status of this species. Although no common name was provided for *C. halemanui* when it was listed, it was determined in the technical correction that the common name of akoko is appropriate for this species. (USFWS, 2017)

Historical Range

Historically, this species is only known from Kauai. (USFWS, 1995)

Current Range

Its current range is Kauai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designate critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for Euphorbia (=Chamaesyce) halemanui on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for Euphorbia (=Chamaesyce) halemanui includes three units totaling 3,481 acres in Kauai County, Hawaii. The units are Kauai 11—Chamaesyce halemanui— a, b, c.

Kauai 11—Chamaesyce halemanui—a: This unit is critical habitat for Chamaesyce halemanui and is 108 ha (267 ac) on State land containing Kawaiiki Ridge. This unit provides habitat for one

population of 300 mature, reproducing individuals of the short-lived perennial *Chamaesyce halemanui* and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is essential to the establishment of additional populations on Kauai in order to reach recovery goals. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep slopes of gulches in mesic *Acacia koa* forests. This unit is geographically separated from the other two units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Chamaesyce halemanui*—b: This unit is critical habitat for *Chamaesyce halemanui* and is 17 ha (43 ac) on State land (Kokee State Park) and contains a portion of the east-facing side of Halemanu Valley below the National Aeronautics and Space Administration (NASA) Tracking Station. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Chamaesyce halemanui* and is currently occupied with 30 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep slopes of gulches in mesic *Acacia koa* forests. This unit is geographically separated from the other two units designated as critical habitat for this island endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Chamaesyce halemanui*—c: This unit is critical habitat for *Chamaesyce halemanui* and is 1,283 ha (3,172 ac) on State land (Kuia NAR, and Kokee and Na Pali Coast State Parks). This unit contains Mahanaloa Valley, Kainamanu Summit, and Nualolo, Awaawapuhi, and Honopu Trails. This unit provides habitat for eight populations of 300 mature, reproducing individuals of the short-lived perennial *Chamaesyce halemanui* and is currently occupied with between 50 and 100 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep slopes of gulches in mesic *Acacia koa* forests. This unit is geographically separated from the other two units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

- (i) Steep slopes of gulches in mesic *Acacia koa* forests and containing one or more of the following native plant species: *Asplenium* spp., *Alphitonia ponderosa*, *Antidesma platyphyllum*, *Bobea brevipes*, *Carex meyenii*, *Carex wahuensis*, *Cheirodendron trigynum*, *Coprosma* spp., *Diospyros sandwicensis*, *Dodonaea viscosa*, *Elaeocarpus bifidus*, *Hedyotis terminalis*, *Kokia kauaiensis*, *Leptecophylla tameiameia*, *Microlepia strigosa*, *Melicope haupuensis*, *Metrosideros polymorpha*, *Panicum nephelophilum*, *Pisonia* spp., *Pittosporum* spp., *Pleomele aurea*, *Psychotria greenwelliae*, *Psychotria mariniana*, *Pouteria sandwicensis*, or *Santalum freycinetianum*; and
- (ii) Elevations between 556 and 1,249 m (1,825 and 4,097 ft).

Special Management Considerations or Protections

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- woodland, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations from 660 to 1,100 meters (USFWS, 1995)

Habitat Narrative

Adult: *Charnaesyce halernanui* typically grows on the steep slopes of gulches in mesic *Acacia koa* forests at an elevation of 660 to 1,100 meters (2,160 to 3,600 feet). *Euphorbia halemanui* occurs in the Kuia drainage, below a confluence of upper branches, on a 20-degree north slope, 50 feet above the drainage, on substrate of granular soil with talus and leaf litter, boulders, and in shade 60 percent of the day. *Euphorbia halemanui* occurs in a headwater streamlet of Waialae just south of Kaluahaulu Ridge Trail. Associated native species include *Metrosideros polynorpha* (ohia), *Aiphitonia ponderosa* (kauila), *Antidesma platyphyllum* (hame), *Coprosma* (pilo), *Diospyros sandwicensis* (lama), *Dodonaea viscosa* (aalii), *Elaeocarpus bifidus* (kalia), *Pisonia* (papala kepau), *San talum freycinetianum* (iliahi), and *Styphelia tarneiarneiae* (pukiawe). Associated alien species include *Aleurites moluccana* (kukui), *Lantana camara* (lantana), strawberry guava, *Rubus argutus* (prickly Florida blackberry), and *Stenotaphrum secundatum* (St. Augustine grass) (USFWS 1992a). (USFWS, 1995)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Low (inferred from USFWS, 2010)

Redundancy:

Low (inferred from USFWS, 2010)

Number of Populations:

4 (USFWS, 2010; USFWS, 2017)

Population Size:

85-195 wild individuals (USFWS, 2010; USFWS, 2017)

Minimum Viable Population Size:

50 individuals from each of three populations (USFWS, 2017)

Population Narrative:

The total number of individuals is currently estimated at 300 to 400 individuals in four populations. (USFWS, 2010); In 2010, there were estimated to be 300 to 400 individuals in four populations. Currently, there are four populations totaling between 85 and 195 individuals, based on survey information from 2012 to 2016 (NTBG 2012a-b, 2015a-k, 2016). The Plant Extinction Prevention Program (PEPP) reevaluated this species' status in 2016, as numbers of individuals are decreasing over time, and placed *Euphorbia halemanui* in the "POP" category, a potential PEPP species. PEPP species are those plants with fewer than 50 individuals in the wild. (USFWS, 2017)

Threats and Stressors

Stressor: Small population size and restricted distribution (USFWS, 1995)

Exposure:

Response:

Consequence:

Narrative: With such a small population size and restricted distribution, *Charnaesyce hahemanui* faces an increased potential for extinction resulting from stochastic events. This species' limited gene pool also constitutes a serious potential threat because of the possibility of depressed reproductive vigor (USFWS 1992a). (USFWS, 1995)

Stressor: Animals (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Pigs (*Sus scrofa*), goats (*Capra hircus*), and mule deer (*Odocoileus hemionus*) threaten *Euphorbia halemanui*. Although pigs were considered a threat when the final listing rule, recovery plan, and critical habitat designation were written (USFWS 1992, 1995, 2003), goats and deer are newly reported threats. Pig scat is ample in the Halemanu area, as well as goat droppings. Signs of mule deer have also been noted. Pigs uproot and trample native vegetation and open the area to invasive introduced plant species. (USFWS, 2010)

Stressor: Invasive introduced plants (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species which threaten this species by degrading and modifying its habitat include *Psidium cattleianum* (strawberry guava), *Lantana camara* (lantana), *Rubus argutus* (prickly Florida blackberry), and *Passiflora edulis* (purple passion fruit) (Perlman 2008; N. Tangalin, pers. comm. 2008a). *Rubus argutus* and *Passiflora edulis* are new threats that were not reported when critical habitat was designated in 2003 (USFWS 2003). (USFWS, 2010)

Stressor: Fire and road clearing (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Fire (Factor E) and road clearing or realignment could easily damage this species, which occurs adjacent to the highway going through Kokee State Park (Perlman 2008; N. Tangalin, pers. comm. 2008a). (USFWS, 2010)

Stressor: Climate change loss or degradation of habitat (USFWS, 2010; USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Euphorbia halemanui* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.703 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2017)

Stressor: Hurricanes—Loss and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Hurricanes were accidentally not highlighted in the last five year review. In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event, and 70 percent of all listed plant species on Kauai are endemic to the island. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and

Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013). (USFWS, 2017)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Kauai and at least one other island where they now occur or occurred historically. (USFWS, 1995)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1995)
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1995)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Kauai and at least one other island where they now occur or occurred historically. (USFWS, 1995)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1995)
3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1995)

Recovery Actions:

- In order to prevent this taxon from going extinct, propagation efforts and the maintenance of adequate genetic stock ex situ should be undertaken immediately, as well as the protection of remaining wild individuals from feral pigs and alien weed threats. (USFWS, 1995)
- Protect current populations, control threats and monitor. (USFWS, 1995)
- Expand current populations. (USFWS, 1995)
- Conduct research essential to conservation of the species. (USFWS, 1995)
- Establish new populations as needed to reach recovery objectives. (USFWS, 1995)
- Validate and revise recovery objectives. (USFWS, 1995)
- Devise and implement a public education program. (USFWS, 1995)
- Surveys and inventories—Survey areas where *Euphorbia halemanui* has been observed in the past to obtain a more accurate assessment of populations and numbers. (USFWS, 2017)
- Ungulate monitoring and control—Fence wild populations to prevent further damage by ungulates. Protect all occurrences against browsing, trampling, and disturbances from feral ungulates. (USFWS, 2017)

- Human interaction monitoring and management—Develop and implement effective measures to reduce the impacts of urban development such as road clearing or realignment. (USFWS, 2017)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. Control invasive nonnative species that compete with the species around all populations. (USFWS, 2017)
- Captive propagation for genetic storage and reintroduction—Collect material for genetic storage and propagation for reintroduction. (USFWS, 2017)
- Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2017)
- Predator and herbivore monitoring and control—Implement effective control methods for rodents around all known populations. Study *Euphorbia halemanui* populations to determine the level of threat from invertebrate herbivory and the need for additional recovery actions. (USFWS, 2017)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from drought. (USFWS, 2017)
- Fire monitoring and control—Develop and implement fire management plans for all wild and reintroduced populations. (USFWS, 2017)

Conservation Measures and Best Management Practices:

- Fence to prevent further ungulate damage. (USFWS, 2010)
- Control invasive introduced species around wild populations. (USFWS, 2010)
- Collect material for genetic storage and propagation for reintroduction. (USFWS, 2010)
- Survey areas where *Euphorbia halemanui* has been observed in the past (Mahanaloa Valley, Makaha Valley, and on Waimea Canyon Rim) to obtain a more accurate assessment of population occurrences and numbers. (USFWS, 2010)
- Support incipient invasive species control work by the Kokee Resource Conservation Program in Kokee State Park. (USFWS, 2010)
- Work with Hawaii Division of Forestry and Wildlife and Hawaii State Parks to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2010)

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Final Designation or Nondesignation of Critical Habitat for 95 Plant Species From the Islands of Kauai and Niihau, HI. Final rule. 68 FR 9116 - 9479 (February 27, 2003).

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SPECIES ACCOUNT: *Euphorbia* (=Chamaesyce) *herbstii* (`akoko)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

A tree up to 8 m tall with milky sap. Leaves long and narrow. Cyathia (specialized flower clusters) are borne in open inflorescences (NatureServe, 2015).

Taxonomy

A member of the Euphorbiaceae (spurge family) (USFWS, 2016).

Historical Range

Chamaesyce herbstii is a species endemic to the Waianae Mountains of Oahu. Survey data indicate a historically disjunctive range, with the main portion located in the Mokuleia area of the northern Waianae Mountains (USFWS, 2016).

Current Range

Currently, all known remaining individuals of C. herbstii occur on State and private lands in gulches of the Kapuna to Pahole population unit in the northern Waianae Mountains (U.S. Army Garrison 2006d; 68 FR 35950) (USFWS, 2016).

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Euphorbia* (=Chamaesyce) *herbstii* (Kamanomano) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Euphorbia* (=Chamaesyce) *herbstii* (77 FR 57648-57862). The critical habitat designation includes 11 critical habitat units, which encompass approximately 7,332 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Euphorbia* (=Chamaesyce) *herbstii* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Euphorbia* (=Chamaesyce) *herbstii* includes 11 critical habitat units, covering two ecosystem types, which encompass approximately 7,332 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3; Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae

Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac (105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Euphorbia (=Chamaesyce) herbstii* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Euphorbia (=Chamaesyce) herbstii* occurs within the indicated ecosystem in the Waianae Mountain caldera complex:

(i) Oahu—Lowland Mesic—Units 1, 2, 3 (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

(ii) Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8 (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: *Antidesma*, *Chamaesyce*, *Diospyros*, *Dodonaea*. (F) Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Schiedea*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Euphorbia* (=Chamaesyce) *herbstii* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (inferred from USFWS, 2016)

Lifespan

Adult: 10 - 20 years (USFWS, 2016)

Breeding Season

Adult: August - October (USFWS, 2016)

Key Resources Needed for Breeding

Adult: Presumably bees and flies (USFWS, 2016)

Reproduction Narrative

Adult: Flowering occurs from August to October, with bees and flies as likely pollinators, and seed capsules are produced from October to January. Longevity of *C. herbstii* plants is 10 to 20 years (USFWS, 2016).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Moist forests (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at 1,420 - 3,044 ft. elevation (USFWS, 2016)

Habitat Narrative

Adult: Inhabits moist forests, in gulch bottoms or gulch slopes (NatureServe, 2015). *Chamaesyce herbstii* typically grows in gulch bottoms and slopes at elevations between 433 and 928 m (1,420 and 3,044 ft). It usually occurs in mesic forests dominated by a diverse mix of tree species (USFWS, 2016).

Dispersal/Migration**Dispersal**

Adult: Low (USFWS, 2016)

Dispersal/Migration Narrative

Adult: The sticky seeds are likely dispersed by birds, and probably were dispersed by many now-extinct flightless Hawaiian species. Mature seed capsules split open when dry, flinging the seeds for a short distance (Makua Implementation Team 2003) (USFWS, 2016).

Population Information and Trends**Population Trends:**

Significant decline since 1996 (USFWS, 2016)

Resiliency:

Very low (inferred from USFWS, 2016; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2016)

Number of Populations:

7 (USFWS, 2016)

Population Size:

~87 (USFWS, 2016)

Population Narrative:

Trends in abundance indicate that *Chamaesyce herbstii* has undergone a major decline, and currently totals approximately 87 individuals in the Kapuna to Pahole population unit (U.S. Army Garrison 2006d). Current numbers represent a major decline from almost 200 total individuals in 1996. There are seven population units (USFWS, 2016).

Threats and Stressors

Stressor: Feral pigs (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Habitat degradation and predation by feral pigs (*Sus scrota*) are considered major threats to *Chamaesyce herbstii*. Feral pigs are currently present on Oahu and inhabit both rainforest and grassland. While rooting in the ground in search of the invertebrates and plant material they eat, feral pigs disturb and destroy vegetative cover, trample plants and seedlings, and threaten forest regeneration by damaging seeds and seedlings. They disturb soil and cause erosion, especially on slopes. Alien plant seeds are dispersed on their hooves and coats as well as through their digestive tracts, and the disturbed soil is fertilized by their feces, helping these plants to establish. Pigs are a primary vector in the spread of many introduced plant species (Smith 1985; Stone 1985; Scott et al. 1986; Tomich 1986; Cuddihy and Stone 1990; Wagner et al. 1999; Service 2001 and 2004; U.S. Army 2003; 61 FR 53089) (USFWS, 2007).

Stressor: Invasive plants (NatureServe, 2015)

Exposure:**Response:****Consequence:**

Narrative: Competition with alien plants such as *Grevillea robusta* (silk oak), *Passiflora suberosa* (huehue haole), *Psidium cattleianum* (strawberry guave), and *Schinu terebinthifolius* (christmas berry) (NatureServe, 2015).

Stressor: Stochastic events (NatureServe, 2015)

Exposure:**Response:****Consequence:**

Narrative: Stochastic extinction could occur due to the small number of remaining populations (NatureServe, 2015). Species like *Chamaesyce herbstii* that are endemic to a small portion of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes and disease outbreaks (USFWS, 2007).

Stressor: Fire (USFWS, 2007)

Exposure:**Response:****Consequence:**

Narrative: Fire is considered a potential threat, as *Chamaesyce herbstii* occurs in mesic forests which often become very dry in the summer months and this species is not considered fire tolerant (Service 1998, 2004; 61 FR 53089). Two potential causes of fire are arson and military training activities in Makua Military Reservation. The Army has addressed the threat of fire from their actions by developing and implementing a wildland fire management plan to minimize the number of ignitions in the reservation, to respond rapidly to any ignitions, and to maintain fire breaks to help contain any ignitions away from the endangered species locations (U.S. Army 2003) (USFWS, 2007).

Recovery**Reclassification Criteria:**

1. A total of five to seven populations should be documented on Oahu and at least one other island where they now occur or occurred historically (USFWS, 1998).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population (for long-lived perennials) (USFWS, 1998).
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1998).

Delisting Criteria:

1. A total of 8 to 10 populations should be documented on Oahu and at least one other island where they now occur or occurred historically (USFWS, 1998).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population (for long-lived perennials) (USFWS, 1998).

3. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1998).

Recovery Actions:

- Protect habitat and control threats (USFWS, 1998).
- Expand existing wild populations (USFWS, 1998).
- Conduct essential research (USFWS, 1998).
- Develop and maintain monitoring plans (USFWS, 1998).
- Reestablish wild populations within historic range (USFWS, 1998).
- Validate and revise recovery criteria (USFWS, 1998).
- Construct enclosures to protect populations against feral ungulates (USFWS, 1998).
- Control competing alien plant species within enclosures (USFWS, 1998).

Conservation Measures and Best Management Practices:

- Research is needed on seed storage methods and viability (U.S. Army Garrison 2005b) (USFWS, 2016).
- The Makua Implementation Team (2003) has developed stabilization protocols for *Chamaesyce herbstii*, which are incorporated in the Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). This species is located in two management units where it will benefit from population unit and/or ecosystem-level protection. The Pahole Management Unit is fenced; the Upper Kapuna Management Unit is not fenced but is scheduled for fencing within the near future (2007 thru 2009). *Chamaesyce herbstii* plants have been grown from wild-collected seed and successfully outplanted by State biologists since 1995. Seed storage potential has not been tested, and tissue culture techniques for seed have not been successful. Germination rates of wild-collected seed are quite variable (0-100 percent). Seeds that do not germinate within two months generally rot, suggesting the seeds do not form a soil seed bank. Propagation by cuttings has not been successful for this species (U.S. Army Garrison 2005b). In 2005, *C. herbstii* was represented in ex situ collections that included two cuttings in nurseries (Army Environmental Division, Oahu, and Harold L. Lyon Arboretum), 10 mature fruits in storage at a nursery (Army Environmental Division, Oahu), six ungerminated seeds in a nursery (Harold L. Lyon Arboretum), and 380 seeds in seed storage (Lyon Arboretum Seed Storage Facility) (Service 2005b, U.S. Army Garrison 2005d) (USFWS, 2016).
- Efforts should continue to be made to fence and protect populations of the remaining individuals of *Chamaesyce herbstii* (USFWS, 2007).
- Collection and propagation for complete genetic representation of the remaining individuals of *Chamaesyce herbstii* should be conducted (USFWS, 2007).
- Study the known population of *Chamaesyce herbstii* with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats to the species (USFWS, 2007).
- Reintroduce populations of *Chamaesyce herbstii* within its historical range (USFWS, 2007).

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SPECIES ACCOUNT: *Euphorbia* (=Chamaesyce) *kuwaleana* (`akoko)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/29/1991; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

A milky sapped shrub 0.2-0.9 m tall. Cyathia (specialized flower clusters) are usually solitary in the leaf axils. (NatureServe, 2015)

Taxonomy

The members of the genus Chamaesyce have been moved to the genus Euphorbia. Earlier there was some consensus among taxonomists to remove Chamaesyce from Euphorbia. However, Steinmann and Porter (2002) disagreed that Euphorbia should be divided, and their conclusions were supported by many taxonomists (Bruyns et al. 2006). Steinmann and Porter's solution to the problem of Euphorbiinae classification was to expand Euphorbia to encompass all members of the subtribe, which includes Chamaesyce. They favored this solution as being the least disruptive of current usage, and not requiring the creation of new genera to encompass all the Euphorbia species not within the subgenus Euphorbia, which would be 90 percent of the species currently in the genus (Steinmann and Porter 2002). This is the treatment supported by Wagner, author of the Flora of the Hawaiian Islands (Warren Wagner, Smithsonian Institution, pers. comm. 2009). Therefore, this species will be referred to as Euphorbia kuwaleana. (USFWS, 2011)

Historical Range

Historically, Chamaesyce kuwaleana is known from the central Waianae Mountains and Moku Manu Island off the eastern coast of Oahu (USFWS 1995, Koutnik and Huft 1990). (USFWS, 1998)

Current Range

The current range of C. kuwaleana is restricted to the Waianae Mountains, Oahu. (NatureServe, 2015)

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Euphorbia (=Chamaesyce) kuwaleana (`akoko) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for Euphorbia (=Chamaesyce) kuwaleana (77 FR 57648-57862). The critical habitat designation includes 19 critical habitat units, which encompass approximately 1,764 acres on the Island of Oahu, Hawaii.

Critical Habitat Designation

The critical habitat designation for Euphorbia (=Chamaesyce) kuwaleana includes 19 critical habitat units, covering two ecosystem types, which encompass approximately 1,764 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Coastal—Units 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12; Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Coastal—Unit 2 [12 ac (5 ha)]. This area consists of 12 ac (5 ha) in the coastal ecosystem on Mokuauia, an islet east of Kalanai Point on the northeastern coast of Oahu. This unit is State-owned and is classified as a State Seabird Sanctuary. Oahu—Coastal—Unit 3 [15 ac (6 ha)]. This unit consists of 15 ac (6 ha) in the coastal ecosystem, on the larger of two islets (Moku Manu) off the windward coast of Oahu near Mokapu Peninsula. This unit is State-owned, classified as a State Seabird Sanctuary. Oahu—Coastal—Unit 4 [3 ac (1 ha)]. This area consists of 3 ac (1 ha) in the coastal ecosystem, the smaller of two islets (Moku Manu) off the windward coast of Oahu near Mokapu Peninsula. This unit is State-owned, classified as a State Seabird Sanctuary. Oahu—Coastal—Unit 5 [12 ac (5 ha)]. This area consists of 12 ac (5 ha) in the coastal ecosystem, the larger of two islands (Mokulua Islands) off the windward coast of Oahu near Wailea Point. This unit is State-owned, classified as a State Seabird Sanctuary. Oahu—Coastal—Unit 6 [9 ac (4 ha)]. This area consists of 9 ac (4 ha) in the coastal ecosystem, on the smaller of two islands (Mokulua Islands) off the windward coast of Oahu near Wailea Point. This unit is State-owned, classified as a State Seabird Sanctuary. Oahu—Coastal—Unit 7 [67 ac (27 ha)]. This area consists of 67 ac (27 ha) in the coastal ecosystem, on the larger of two islands (Manana Island) off the windward coast of Oahu near Makapuu Point. This unit is State-owned, classified as a State Seabird Sanctuary. Oahu—Coastal—Unit 8 [10 ac (4 ha)]. This area consists of 10 ac (4 ha) in the coastal ecosystem, on the smaller of two islands (Kaohikaipu Island) off the windward coast of Oahu near Makapuu Point. This unit is State-owned, classified as a State Seabird Sanctuary. Oahu—Coastal—Unit 9 [80 ac (33 ha)]. This area consists of 80 ac (33 ha) of State land in the coastal ecosystem on the leeward side of Makapuu Point (Puukopihua). Oahu—Coastal—Unit 10 [74 ac (30 ha)]. This area consists of 74 ac (30 ha) in the coastal ecosystem, owned by the City and County of Honolulu at Halona Point on the leeward side of Koko Crater, extending from Sandy Beach to Kahauloa. Oahu—Coastal—Unit 11 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) of privately owned land in the coastal ecosystem, at Iihiihilauea on Koko Head (Kaihuokapuaa). Oahu—Coastal—Unit 12 [11 ac (5 ha)]. This area consists of 11 ac (5 ha) of City and County land in the coastal ecosystem, at Nonoula on Koko Head (Kaihuokapuaa).

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac (105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on

the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Euphorbia* (=Chamaesyce) *kuwaleana* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Euphorbia* (=Chamaesyce) *kuwaleana* occurs within the Dry cliff ecosystem in the Waianae Mountain caldera complex, and it was known historically (last observed > 20 yrs ago) from the coastal ecosystem in the Koolau Mountain caldera complex:

Oahu—Coastal—Units 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12. (A) Elevation: <980 ft (<300 m). (B) Annual Precipitation: <20 in (<50 cm). (C) Substrate: Well-drained, calcareous, talus slopes; dunes; weathered clay soils; ephemeral pools; mudflats. (D) Canopy: Hibiscus, Myoporum, Santalum, Scaevola. (E) Subcanopy: Gossypium, Sida, Vitex. (F) Understory: Eragrostis, Jacquemontia, Lyceum, Nama, Sesuvium, Sporobolus, Vigna.

Oahu—Dry Cliff— Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. (F) Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Euphorbia* (=Chamaesyce) *kuwaleana* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Chamaesyce *kuwaleana* bears fruits in spring and early summer and is usually done fruiting by the fall (USFWS 1995). (USFWS, 1998)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Bare rock/ talus/scree (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found on sparsely vegetated steep cliffs at elevations between 180 and 320 meters (USFWS, 1998; NatureServe, 2015)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1998)

Tolerance Ranges/Thresholds

Adult: Moderate (USFWS, 2011)

Habitat Narrative

Adult: Chamaesyce kuwaleana is found on arid basaltic cliffs, exposed rocky dry ridges, with Opuntia, Sida, Portulaca, Cyanosperma, Leucaena leucocephala, ilima, and Dodonaeaviscosa. Also on sparsely vegetated steep cliffs. Chamaesyce kuwaleana typically grows on arid, exposed volcanic cliffs at an elevation of 180 to 320 meters (600 to 1,050 feet) (USFWS 1995). Small leaf area, high leaf mass per area, and low nitrogen concentration indicated that this species has adapted to dry, mostly open habitat. These traits also indicate that this species exhibits slow respiration and growth, and the production of long-lived leaves that function even under harsh xeric conditions (Maggie Sporck, University of Hawaii, pers. comm. 2010). (USFWS, 1998; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Fruits in Euphorbieae subfamily are generally dry capsules, exploding their seed only a few meters from their source. However, there are a few cases of long-distance dispersal within Euphorbieae, which include the genus Chamaesyce. Because many Chamaesyce species possess mucilaginous seeds, their long-distance dispersal may have been accomplished by adhering to animals. This helps to explain why Chamaesyce is one of the few taxa within Euphorbieae that has transoceanic distribution (Steinmann and Porter 2002). (USFWS, 2011)

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Low (inferred from USFWS, 2011)

Redundancy:

Low (inferred from USFWS, 2011)

Number of Populations:

1 (USFWS, 2011)

Population Size:

950 to 1,250 (USFWS, 2011)

Population Narrative:

In 2003, when critical habitat was designated, five populations of 2,000 individuals were reported (USFWS 2003). Currently, only about 250 individuals are known from two subpopulations, with a third subpopulation estimated to still contain 700 to 1,000 individuals. All three subpopulations are on the same ridge within 2.4 kilometers (1.5 miles) of one another, which suggests a total of one population containing 950 to 1,250 individuals (Hawaii Biodiversity and Mapping Program 2010; Wood pers. comm. 2009). (USFWS< 2011)

Threats and Stressors

Stressor: Fire (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Fire is a threat to this species (Perlman 2009; Wood 2009) and has damaged individuals in the Waianae Mountains in the past (Hawaii Biodiversity and Mapping Program 2010). (USFWS, 2011)

Stressor: Invasive introduced plants (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species in this area include *Acacia confusa* (formosa koa), *Acacia farnesiana* (klu), *Ageratina riparia* (spreading mist flower), *Bryophyllum pinnatum* (airplant), *Cenchrus ciliaris* (buffelgrass), *Grevillea robusta* (silk oak), *Lantana camara* (lantana), *Leucaena leucocephala* (haole koa), *Opuntia ficus-indica* (prickly pear), *Psidium cattleianum* (strawberry guava), and *Schinus terebinthifolius* (Christmasberry). (USFWS, 2011)

Stressor: Habitat degradation by feral pigs (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Feral animals including pigs (*Sus scrofa*) and goats (*Capra hircus*) degrade the habitat, causing erosion and landslides which further imperil this species (Perlman 2009; Wood 2009). (USFWS, 2011)

Stressor: Predation (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Seed predation by rats (*Rattus* spp.) and consumption of leaves and stems by slugs (unidentified species) are threats to *Euphorbia kuwaleana* (Perlman 2009; Wood 2009). Yellowing of leaves, believed to be associated with two-spotted leaf hopper (*Sophonia rufofascia*), was observed in the Kauaopuu population (Hawaii Biodiversity and Mapping Program 2010). (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2011)

Recovery**Reclassification Criteria:**

1. A total of five to seven populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1998)

Recovery Actions:

- Specific efforts should be made to immediately weed and protect the remaining extant populations. (USFWS, 1998)
- A coordinated fire protection plan for endangered plant species on State (Waianae Kai Forest Reserve) and Federal (Lualualei Military Reservation) lands needs to be developed and implemented. (USFWS, 1998)

Conservation Measures and Best Management Practices:

- Conduct surveys to determine current status of the species. (USFWS, 2011)
- Collect seeds from each population for genetic storage and potentially, for reintroduction. (USFWS, 2011)
- Determine if augmentation and/or reintroduction are necessary for this species. (USFWS, 2011)
- Control rats in the vicinity of these populations. (USFWS, 2011)
- Develop and implement an effective control method for slugs. (USFWS, 2011)
- Develop and implement effective control methods for the two-spotted leaf hopper. (USFWS, 2011)

- Work with Hawaii Division of Forestry and Wildlife and U.S. Navy to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2011)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2011)
- Update the listed entity on 50 CFR 17 to match the currently recognized taxonomy. (USFWS, 2011)

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SPECIES ACCOUNT: *Euphorbia* (=Chamaesyce) *remyi* var. *kauaiensis* (*`akoko*)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Euphorbia remyi var. *kauaiensis*, a member of the spurge family (Euphorbiaceae), is a shrub with stems erect to scandent (climbing), 0.3 to 2 meters (1 to 6.6 feet) long, and flowering branches 1 to 6 millimeters (mm) (0.04 to 0.24 inch (in)) in diameter. The leaves are oppositely arranged with each succeeding pair set at right angles to the previous pair, and are elliptic to oblong or broadly lanceolate in shape. The blades are 35 to 165 mm (1.4 to 6.5 in) long and 15 to 75 mm (0.6 to 3.0 in) wide. This variety has many-branched cymose (flat-topped flower cluster in 9 which the main and branch stems each end in a flower that opens before those below it or to its side) inflorescences and glabrous (smooth) capsules scarcely protruding beyond the top of the cyathia (an inflorescence consisting of a cuplike cluster of modified leaves enclosing a female flower and several male flowers) (Koutnik 1999). (USFWS, 2017)

Taxonomy

This variety was described by Degener and Sherff as *Euphorbia remyi* var. *kauaiensis* (Sherff 1936). It was later moved to the genus *Chamaesyce* by Degener and Degener (1959), and recognized as a distinct taxon by Koutnik (1999). Steinman and Porter (2002) studied the phylogenetic relationship of the tribe Euphorbieae, in the Euphorbiaceae (spurge family). As a result of their work, *Chamaesyce* is no longer recognized as a separate genus from *Euphorbia*. This change in genus is recognized in the most recent treatment of the Hawaiian flora (Wagner et al. 2012). In 2015, the Service published a technical correction for this and other plant and wildlife species, recognizing the taxonomic change from *Chamaesyce remyi* var. *kauaiensis* to *Euphorbia remyi* var. *kauaiensis*, and the List of Endangered and Threatened Plants (50 CFR 17.12) has been updated to reflect the new taxonomy (USFWS 2015b). This change does not affect the range or status of the species. *Euphorbia remyi* var. *kauaiensis* differs from *E. remyi* var. *hanaleiensis* and *E. remyi* var. *remyi* by its many-branched cymose inflorescences and glabrous capsules scarcely exerted beyond the top of the cyathia (Koutnik 1999). (USFWS, 2017)

Historical Range

Little is known about the historic range of *Euphorbia remyi* var. *kauaiensis*; however, two collections made on private lands at Kaholuamano and near Hanapepe Falls in 1916 and 1926, respectively, indicate that its range likely extended south and west from its currently known locations on Kauai (HBMP 2010). (USFWS, 2017)

Current Range

Endemic to the island of Kauai in the state of Hawaii. (NatureServe, 2015); Currently, *C. remyi* var. *kauaiensis* is found in Lumahai Valley, Wainiha, Wailua River, the "Blue Hole" at the head of Wailua River in the Lihue-Koloa forest reserve, and at Iliiliula (K. Wood, pers. comm. 2005a; HBMP 2007) (USFWS, 2010).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Chamaesyce eleanoriae* ('Akoko) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes nine critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Chamaesyce eleanoriae* includes nine CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Lowland Wet—Section 1: Lowland Wet—Section 1 consists of 1,164 ac (471 ha) in the lowland wet ecosystem (117 ac (47.4 ha) on State land; 1,047 ac (424 ha) on private land), including wet forest extending from Kulanalilia into Limahuli Valley to Honoanapali, in the Halelea Forest Reserve (Figure 2-A). The section includes 1,099 ac (445 ha) of State and privately owned land within previously designated critical habitat and 65 ac (26 ha) of newly designated critical habitat on private land. The area that falls within designated critical habitat lies within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and newly designated Critical Habitat Unit 20, Map 217c. This section is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Labordia helleri*, and *Phyllostegia renovans*. This section also contains unoccupied habitat that is essential to the conservation of these four species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 1 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Cyanea eleleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Melicope paniculata*, *M. puberula*, *Platydesma rostrata*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 2: Lowland Wet—Section 2 consists of 172 ac (70 ha) in the lowland wet ecosystem, including wet forest extending from Alealau to Pohakea, within the Hono o Na Pali NAR and the Na Pali Coast State Park (Figure 2-A, above). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plant *Melicope puberula*. This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 2 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope paniculata*, *Phyllostegia renovans*, *Platydesma rostrata*, *Stenogyne kealiae*, *Tetraplasandra*

bisattenuata, and *T. flynii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 3: Lowland Wet—Section 3 consists of 756 ac (306 ha) in the lowland wet ecosystem, including wet forest in upper Wainiha Valley, on privately owned land in the Halelea Forest Reserve (Figure 2-B). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyrtandra oenobarba*, *Melicope puberula*, *Phyllostegia renovans*, and *Stenogyne kealiae*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 3 is not known to be occupied by the species *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope paniculata*, *Platydesma rostrata*, *Tetraplasandra bisattenuata*, and *T. flynii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 4: Lowland Wet—Section 4 consists of 591 ac (239 ha) in the lowland wet ecosystem, including wet forest at the head of Lumahai Valley, on State (10 ac, 4.1 ha) and privately owned (581 ac, 235 ha) land in the Halelea Forest Reserve (Figure 2-B, above). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyrtandra oenobarba*, *Melicope paniculata*, *Phyllostegia renovans*, and *Platydesma rostrata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 4 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope puberula*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population numbers of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 5: Lowland Wet—Section 5 consists of 1,541 ac (624 ha) in the lowland wet ecosystem, including wet forest extending from the headwaters of the Wailua River at “Blue Hole” south to Iole, on State (442 ac, 179 ha) and privately owned (1,099 ac, 445 ha)

land in the Lihue-Koloa Forest Reserve (Figure 2-C). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36a, and is occupied by the plants *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Melicope paniculata*, *Phyllostegia renovans*, and *Platydesma rostrata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 5 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Labordia helleri*, *Melicope puberula*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 6: Lowland Wet—Section 6 consists of 789 ac (319 ha) in the lowland wet ecosystem, including wet forest extending from Kapalaoa to Kanaele Bog and Lauahihaihai in the Wahiawa Mountains, on State (134 ac, 54 ha) and privately owned (655 ac, 265 ha) land in the Lihue-Koloa Forest Reserve (Figure 2-D). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36a, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Platydesma rostrata*, and *Tetraplasandra bisattenuata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 6 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Labordia helleri*, *Melicope paniculata*, *M. puberula*, *Phyllostegia renovans*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Wet Cliff—Section 1: Wet Cliff—Section 1 consists of 190 ac (77 ha) in the wet cliff ecosystem, including cliffs along the rim of Kalalau Valley from Alealeau to Pihea, on State-owned land in the Na Pali Coast State Park and the Hono o Na Pali NAR (Figure 6-A). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70b, and is occupied by the plant *Chamaesyce remyi* var. *remyi*. This section includes the wet cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the wet cliff ecosystem (Table 3). Although Wet Cliff—Section 1 is not known to be occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyanea dolichopoda*, *Cyrtandra oenobarba*, *C. paliku*, *Dubautia plantaginea* ssp. *magnifolia*, *Lysimachia iniki*, *L. pendens*, *L. venosa*, and *Platydesma rostrata*, we have determined this area to be essential for the

conservation and recovery of these wet cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Wet Cliff—Section 2: Wet Cliff—Section 2 consists of 784 ac (317 ha) in the wet cliff ecosystem, and includes the cliffs at the headwaters of the Wailua River or “Blue Hole,” on State (778 ac, 315 ha) and privately owned (6 ac, 3 ha) land in the LihueKoloa Forest Reserve (Figure 6-B). There are 489 ac (198 ha) within previously designated critical habitat and 296 ac (120 ha) of newly designated critical habitat on State-owned land. The portion of the section that is in previously designated critical habitat falls within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36b. The newly designated portion of the section comprises Critical Habitat Unit 18 of 50 CFR 17.99(a)(1), Map 217a. This section is occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyrtandra oenobarba*, *Dubautia plantaginea* ssp. *magnifolia*, *Lysimachia iniki*, *L. pendens*, and *Platydesma rostrata*. The section includes the wet cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the wet cliff ecosystem (Table 3). Although Wet Cliff—Section 2 is not known to be occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyanea dolichopoda*, *Cyrtandra paliku*, and *Lysimachia venosa*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Wet Cliff—Section 3: Wet Cliff—Section 3 consists of 61 ac (24 ha) in the wet cliff ecosystem, including cliffs below Kekoiki, on State (8 ac, 3 ha) and privately owned (53 ac, 22 ha) land in the Halelea, Moloaa and Kealia forest reserves (Figure 6-C). There are 23 ac (9 ha) of newly designated critical habitat on privately owned land within this section. That portion of the section that falls within previously designated critical habitat is within Critical Habitat Unit 4 of 50 CFR 17.99(a)(1), Map 5a. The newly designated portion of the section comprises Critical Habitat Unit 19 of 50 CFR 17.99(a)(1), Map 217b. This section is occupied by the plant *Cyrtandra paliku*, and includes the wet cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the wet cliff ecosystem (Table 3). Although Wet Cliff—Section 3 is not known to be occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Cyanea dolichopoda*, *Cyrtandra oenobarba*, *Dubautia plantaginea* ssp. *magnifolia*, *Lysimachia iniki*, *L. pendens*, *L. venosa*, and *Platydesma rostrata*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Chamaesyce eleanoriae* critical habitat consists of two components (Lowland wet and wet cliff) (75 FR 18960-19165):

Ecosystem: Lowland Wet. Elevation: <3,000 ft (<914 m). Annual precipitation: >75 in (>190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*,

Metrosideros, Myrsine, Pisonia, Psychotria. Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: Broussaisia, Cheirodendron, Leptecophylla, Metrosideros. Understory: Bryophytes, Ferns, Coprosma, Dubautia, Kadua, Peperomia.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds.

Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: This species has been observed flowering in February and October (NTBG 1992a, 2009, 2015). (USFWS, 2017)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: *Metrosideros polymorpha* wet forest (USFWS, 2010)

Dependencies on Specific Environmental Elements

Adult: Lowland wet and wet cliff ecosystems (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: 1,900 to 2,297 ft. elevation (USFWS, 2010)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: Wet forests in valley bottoms and lower slopes of valleys. (NatureServe, 2015). in the lowland wet and wet cliff ecosystems in *Metrosideros polymorpha* wet forest at elevations between 1,900 and 2,297 ft (579 and 700 m) (Koutnik 1999, pp. 613–614; HBMP 2007; TNCH

2007) (USFWS, 2010).; *Euphorbia remyi* var. *kauaiensis* is found in *Metrosideros polymorpha* (ohia) wet forest at elevations between 600 and 700 meters (1,970 and 2,300 feet) (Koutnik 1999; HBMP 2010). Associated native plant species include *Antidesma platyphyllum* (hame), *Bidens* spp. (kookoolau), *Boehmeria grandis* (akolea), *Broussaisia arguta* (kanawao), *Cheirodendron* spp. (olapa), *Coprosma kauensis* (koi), *Cyanea* spp. (haha), *Cyrtandra* spp. (haiwale), *Dicranopteris linearis* (uluhe), *Diospyros* spp. (lama), *Diplazium sandwichianum* (hoio), *Dubautia* spp. (naenae), *Freycinetia* spp. (ie ie), *Kadua* spp. (manono, uiwi), *Perrottetia sandwichensis* (olomea), *Pipturus* spp. (mamaki), *Polyscias* spp. (ohe), *Psychotria* spp. (kopiko), and *Syzygium sandwichensis* (ohia ha) (NTBG 1992b, 2009, 2015; HBMP 2010). (USFWS, 2017)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Short-term population trends suggest an increase of >10%, whereas long-term trends are unknown (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Population Growth Rate:

Slowly increasing (NatureServe, 2015)

Number of Populations:

5 (USFWS, 2010; USFWS, 2017)

Population Size:

225-325 wild individuals (USFWS, 2017)

Population Narrative:

Short-term population trends suggest an increase of >10%. Observation records range from 1990-2004 (HBMP 2007). (NatureServe, 2015) The total number of individuals is at least 920 and possibly over 1,000 in the 5 populations (USFWS, 2010).; Little is known about the historic range of *Euphorbia remyi* var. *kauaiensis*; however, two collections made on private lands at Kaholuamano and near Hanapepe Falls in 1916 and 1926, respectively, indicate that its range likely extended south and west from its currently known locations on Kauai (HBMP 2010). In the 1990s, *E. remyi* var. *kauaiensis* was known from three locations on Kauai, and totaled approximately 750 individuals. At the time of listing, *E. remyi* var. *kauaiensis* was found in five populations totaling at least 920 to 1,000 individuals (Wood 2005; HBMP 2010). Currently, only three populations have been monitored, with 50 to 100 individuals at Lumahai in 2000, 125 individuals from the "Blue Hole" of Wailua river (down from about 300 individuals in 1992), and

about 50 to 100 individuals currently in Wainiha Preserve (PEPP 2015; Williams 2017, pers. comm.). The status of individuals at Iliiliula Stream, Hanapepe Falls, and Kaholuamano is unknown. Current estimates total 225 to 325 individuals of varying size classes. (USFWS, 2017)

Threats and Stressors

Stressor: Ungulate degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Feral pigs (*Sus scrofa*) and goats (*Capra hircus*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil. Feral pigs and goats are noted to be a threat to individuals of *Euphorbia remyi* var. *kauaiensis* that occur at Lumahai and Wainiha (Wood 2000; HBMP 2010; NTBG 2015). (USFWS, 2017)

Stressor: Established ecosystem-altering invasive plant modification and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community. Invasive introduced plants with the greatest impacts on *Euphorbia remyi* var. *kauaiensis* are: *Andropogon glomeratus* (bushy beardgrass), *Angiopteris evecta* (mule's foot fern), *Axonopus fissifolius* (narrow-leaved carpetgrass), *Buddleja asiatica* (dog tail), *Clidemia hirta* (Koster's curse), *Conyza bonariensis* (hairy horseweed), *Cyperus meyenianus* (NCN), *Erigeron karvinskianus* (daisy fleabane), *Juncus planifolius* (bog rush), *Kalanchoe pinnata* (air plant), *Paspalum conjugatum* (Hilo grass), *P. urvillei* (vasey grass), *Pluchea carolinensis* (sourbush), *Psidium guajava* (common guava), *Rubus rosifolius* (thimbleberry), *Setaria gracilis* (yellow foxtail), and *Sphaeropteris cooperi* (Australian tree fern) (Kokee Resource Conservation Program (KRCP) 2014; NTBG 2009, 2015). (USFWS, 2017)

Stressor: Landslides and flooding destruction or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: The only known individuals of *Euphorbia remyi* var. *kauaiensis* occur on cliffs at Blue Hole and Wainiha (Wood 2000; HBMP 2010; NTBG 2015). Large herds of feral goats browse and cause erosion in the area where *E. remyi* var. *kauaiensis* occurs (Wood 2000; HBMP 2010; NTBG 2015). Landslides destabilize substrates, damage and destroy individual plants, and alter hydrological patterns (Stearns 1985). (USFWS, 2017)

Stressor: Hurricanes—Loss and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013). (USFWS, 2017)

Stressor: Climate change loss or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Euphorbia remyi* var. *kauaiensis* is vulnerable to the impacts of climate change with a vulnerability score of 0.498 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2017)

Stressor: Ungulate predation or herbivory (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Herbivory by feral ungulates is a threat to *Euphorbia remyi* var. *kauaiensis* (Wood 2000; HBMP 2010; NTBG 2015). (USFWS, 2017)

Stressor: Rodent predation or herbivory (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Herbivory by rats is noted to be a threat to *Euphorbia remyi* var. *kauaiensis* at the Wainiha population (HBMP 2010; NTBG 2015). Rats eat virtually every part of plants and at every stage: fleshy fruits, seeds, flowers, stems, leaves, shoot, seedlings, and roots (Russell 1980; Cuddihy and Stone 1990). The effects on plants range from reduced vigor and decreased reproduction to mortality of individuals and complete lack of recruitment. (USFWS, 2017)

Stressor: Lack of adequate hunting regulations (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Historic populations of *Euphorbia remyi* var. *kauaiensis* at Kaholuamano were within a state hunting area. The currently known individuals of this species at Wailua (Blue Hole) are within a state hunting area. Feral pigs and goats and the effects of their activities are noted to be a threat to *E. remyi* var. *kauaiensis*. Nonnative feral ungulates pose a major ongoing threat to native species through destruction and modification of habitat, and by direct herbivory or predation. Only those occurrences within Wainiha Preserve are provided some protection from ungulates by fencing. Public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations are at risk (DLNR 2010). (USFWS, 2017)

Stressor: Lack of adequate biosecurity legislation (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Introduction of invasive nonnative plant species to the State of Hawaii and destruction of habitat and competition by nonnative plants are threats to *Euphorbia remyi* var. *kauaiensis*. Pest species have caused the extinction of native species, the destruction of native forests, and the spread of disease. The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, is authorized to prevent the introduction or dissemination of animal and plant pests on all ships, aircraft, and their cargo and baggage arriving in the U.S. and its territories; however, pest species continue to enter the State. In addition, Federal import regulations do not address many species that could be pests in Hawaii (CGAPS 2009; Ikuma et al. 2002). (USFWS, 2017)

Stressor: Invasive species—Established invasive plant species competition (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Nonnative plant species including *Andropogon glomeratus*, *Angiopteris evecta*, *Axonopus fissifolius*, *Buddleja asiatica*, *Clidemia hirta*, *Conyza bonariensis*, *Cyperus meyenianus*, *Erigeron karvinskianus*, *Juncus planifolius*, *Kalanchoe pinnata*, *Paspalum conjugatum*, *P. urvillei*, *Pluchea carolinensis*, *Psidium guajava*, *Rubus rosifolius*, *Setaria gracilis*, and *Sphaeropteris cooperi* compete with *Euphorbia remyi* var. *kauaiensis* for space, water, light, and nutrients (Australian tree fern) (KRCF 2014; NTBG 2009, 2015). (USFWS, 2017)

Recovery

Reclassification Criteria:

To meet the interim stage of recovery of *Euphorbia remyi* var. *kauaiensis*, 300 mature individuals are needed in each of three populations and all major threats must be controlled around the populations designated for recovery at this stage. There should also be demonstrated regeneration of seedlings and growth to at least sapling stage for woody species and documented replacement regeneration within each of the target populations. The populations must be adequately represented in an ex situ collection as defined in the Center for Plant Conservation's guidelines (Guerrant et al. 2004). Adequate monitoring must be in place and conducted to assess individual plant survival, population trends, trends of major limiting factors, and response of major limiting factors to management. (USFWS, 2017)

In addition to achieving 5 to 10 populations with 500 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats. (USFWS, 2017)

Delisting Criteria:

In addition to achieving 5 to 10 populations with 500 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis. (USFWS, 2017)

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys. (USFWS, 2010)
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units. (USFWS, 2010)
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys. (USFWS, 2010)
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range. (USFWS, 2010)
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction. (USFWS, 2010)
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security. (USFWS, 2010)

- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems. (USFWS, 2010)
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations. (USFWS, 2010)
- Surveys and inventories—Survey for populations of *Euphorbia remyi* var. *kauaiensis* in areas of potentially suitable habitat. (USFWS, 2017)
- Ungulate monitoring and control—Fence wild populations to prevent further damage from feral ungulates. Protect all occurrences against browsing and disturbances from feral ungulates. (USFWS, 2017)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. Control invasive nonnative plant species around all populations that compete with the species. (USFWS, 2017)
- Predator and herbivore monitoring and control—Construct small-scale fences around all currently unprotected populations until larger areas are fenced and ungulate-free. (USFWS, 2017)
- Predator and herbivore monitoring and control—Implement effective measures to control rodents around any populations found. (USFWS, 2017)
- Captive propagation for genetic storage and reintroduction—Collect material for genetic storage for maintenance of genetic stock. (USFWS, 2017)
- Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2017)
- Population biology research—Study *Euphorbia remyi* var. *kauaiensis* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. (USFWS, 2017)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms. (USFWS, 2017)
- Based on the recovery criteria above, consider development of a recovery plan. (USFWS, 2017)

Conservation Measures and Best Management Practices:

- Conservation measures are not available.

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SPECIES ACCOUNT: *Euphorbia* (= *Chamaesyce*) *remyi* var. *remyi* (*`akoko*)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Euphorbia remyi var. *remyi*, is a vine-like, perennial shrub in the spurge family (Euphorbiaceae). Stems are erect to scandent (climbing) and 0.3 to 2 meters (1 to 6.6 feet) long. Leaves are oppositely arranged with each succeeding pair set at right angles to the previous pair, elliptic to oblong or broadly lanceolate in shape, 35 to 165 millimeters (mm) (1.4 to 6.5 inches (in)) long, and 15 to 75 mm (0.6 to 3 in) wide. Inflorescences are solitary cyathia (an inflorescence consisting of a cuplike cluster of modified leaves enclosing a female flower and several male flowers) with glabrous capsules protruding well beyond the top. Seeds are white to brown, 2 to 3 mm (0.08 to 0.12 in) long, and smooth to shallowly rugose (wrinkled) (Wood 1998; Koutnik 1999). (USFWS, 2017)

Taxonomy

First described as *Euphorbia remyi* by Boissier (in de Chandolle 1862), and transferred to *Chamaesyce remyi* in 1936 (Degener and Degener 1960), this species was recognized as *Chamaesyce remyi* var. *remyi* by Koutnik in Wagner et al. (1999). Steinmann and Porter (2002) studied the phylogenetic relationship of the tribe Euphorbieae, in the Euphorbiaceae. As a result of their work, *Chamaesyce* is no longer recognized as a separate genus from *Euphorbia*. This change in genus is recognized in the most recent treatment of the Hawaiian flora (Wagner et al. 2012). In 2015, the Service published a technical correction for this and other plant and wildlife species, recognizing the taxonomic change from *Chamaesyce remyi* var. *remyi* to *Euphorbia remyi* var. *remyi* (80 FR 35860, June 23, 2015b). The taxonomic change does not affect the range or endangered status of this species. (USFWS, 2017)

Historical Range

Euphorbia remyi var. *remyi* is historically known from widely distributed populations on Kauai, Hawaii (HBMP 2010). (USFWS, 2017)

Current Range

Currently, there populations at Awaawapuhi, Iliiliula, Iole, Kalalau-Honopu, Kapalaoa, Lumahai, Waiahi, Wainiha, and the Wahiawa drainage including Kanaele Bog and Laauhihaihai on Kauai, Hawaii (USFWS, 2017)

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Chamaesyce remyi* var. *remyi* (*`Akoko*) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 16 critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Chamaesyce remyi* var. *remyi* includes 16 CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Lowland Mesic—Section 1: Lowland Mesic—Section 1 consists of 2,006 ac (812 ha) in the lowland mesic ecosystem, including mesic forest extending from Awaawapuhi Trail south to Makaha Ridge, in the Na Pali Kona Forest Reserve and the Kuia NAR (Figure 1-A). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plants *Doryopteris angelica*, *Labordia helleri*, *Platydesma rostrata* and *Psychotria hobdyi*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these four species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic—Section 1 is not known to be occupied by the species *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Dubautia kenwoodii*, *Pittosporum napaliense*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 2: Lowland Mesic—Section 2 consists of 379 ac (154 ha) in the lowland mesic ecosystem, including mesic forest extending from Keanapuka to Kahuamaa Flat along the rim and cliffs of the Kalalau Valley, in the Na Pali Coast State Park (Figure 1-A, above). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plants *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Pittosporum napaliense*, and *Psychotria hobdyi*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these six species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic—Section 2 is not known to be occupied by the species *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Platydesma rostrata*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 4: Lowland Mesic—Section 4 consists of 81 ac (33 ha) in the lowland mesic ecosystem, including mesic forest at the head of the Hanakapiai Valley, in the Na Pali Coast State Park (Figure 1-A, above). The entire section is Stateowned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plant *Charpentiera densiflora* and includes mesic forest, the

moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. Although Lowland Mesic—Section 4 is not known to be occupied by the species *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *Chamaesyce remyi* var. *remyi*, *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Pittosporum napaliense*, *Platydesma rostrata*, *Psychotria hobdyi*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 5: Lowland Mesic—Section 5 consists of 37 ac (15 ha) in the lowland mesic ecosystem, including mesic forest on the slopes of Mt. Haupū, on privately owned land (Figure 1-B). The entire section is within previously designated critical habitat, and falls within Critical Habitat Unit 7 of 50 CFR 17.99(a)(1), Map 23a. This section is occupied by the plants *Chamaesyce remyi* var. *remyi* and *Tetraplasandra bisattenuata*, and includes mesic forest and shrubland, the moisture regime, and subcanopy and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these two species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic—Section 5 is not known to be occupied by the species *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *Charpentiera densiflora*, *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Pittosporum napaliense*, *Platydesma rostrata*, and *Psychotria hobdyi*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 1: Lowland Wet—Section 1 consists of 1,164 ac (471 ha) in the lowland wet ecosystem (117 ac (47.4 ha) on State land; 1,047 ac (424 ha) on private land), including wet forest extending from Kulanalilia into Limahuli Valley to Honoonapali, in the Halelea Forest Reserve (Figure 2-A). The section includes 1,099 ac (445 ha) of State and privately owned land within previously designated critical habitat and 65 ac (26 ha) of newly designated critical habitat on private land. The area that falls within designated critical habitat lies within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and newly designated Critical Habitat Unit 20, Map 217c. This section is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Labordia helleri*, and *Phyllostegia renovans*. This section also contains unoccupied habitat that is essential to the conservation of these four species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 1 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Cyanea eleleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Melicope paniculata*, *M. puberula*, *Platydesma rostrata*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the

conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 2: Lowland Wet—Section 2 consists of 172 ac (70 ha) in the lowland wet ecosystem, including wet forest extending from Alealau to Pohakea, within the Hono o Na Pali NAR and the Na Pali Coast State Park (Figure 2-A, above). The entire section is Stateowned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plant *Melicope puberula*. This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 2 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope paniculata*, *Phyllostegia renovans*, *Platydesma rostrata*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 3: Lowland Wet—Section 3 consists of 756 ac (306 ha) in the lowland wet ecosystem, including wet forest in upper Wainiha Valley, on privately owned land in the Halelea Forest Reserve (Figure 2-B). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyrtandra oenobarba*, *Melicope puberula*, *Phyllostegia renovans*, and *Stenogyne kealiae*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 3 is not known to be occupied by the species *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope paniculata*, *Platydesma rostrata*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 4: Lowland Wet—Section 4 consists of 591 ac (239 ha) in the lowland wet ecosystem, including wet forest at the head of Lumahai Valley, on State (10 ac, 4.1 ha) and privately owned (581 ac, 235 ha) land in the Halelea Forest Reserve (Figure 2-B, above). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plants *Chamaesyce remyi* var.

remyi, *Cyrtandra oenobarba*, *Melicope paniculata*, *Phyllostegia renovans*, and *Platydesma rostrata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 4 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhlhewa*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope puberula*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population numbers of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 6: Lowland Wet—Section 6 consists of 789 ac (319 ha) in the lowland wet ecosystem, including wet forest extending from Kapalaoa to Kanaele Bog and Lauahihaihai in the Wahiawa Mountains, on State (134 ac, 54 ha) and privately owned (655 ac, 265 ha) land in the Lihue-Koloa Forest Reserve (Figure 2-D). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36a, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Platydesma rostrata*, and *Tetraplasandra bisattenuata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 6 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhlhewa*, *Labordia helleri*, *Melicope paniculata*, *M. puberula*, *Phyllostegia renovans*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Montane Mesic—Section 1: Montane Mesic—Section 1 consists of 2,423 ac (980 ha) in the montane mesic ecosystem, including the area above Honopu Valley to Mahanaloa Valley, on State owned land in Kokee State Park, the Na Pali-Kona Forest Reserve, and Kuia NAR (Figure 3-A). The entire section is within previously designated critical habitat for the plant species, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70c, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Labordia helleri*, *Myrsine knudsenii*, *Platydesma rostrata*, *Psychotria grandiflora*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*. This section is also occupied by the akekee and the picture-wing fly; maps of critical habitat for these species can be found at 50 CFR 17.95(b) for the akekee and akikiki (Unit 1—Montane Mesic), and at 50 CFR 17.95(i) for the picture-wing fly (Unit 1—Montane Mesic). This section also contains unoccupied habitat that is essential to the conservation of these nine species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the

montane mesic forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane mesic ecosystem (Table 3), as well as species-specific PCEs for the akekee and akikiki (arthropod prey) and picture-wing fly (the larval-stage host plants, *Cheirodendron* sp. and *Tetraplasandra* sp.). Although Montane Mesic–Section 1 is not known to be occupied by the species *Diellia mannii*, *Myrsine mezii*, and the akikiki, we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Montane Mesic—Section 2: Montane Mesic–Section 2 consists of 376 ac (152 ha) in the montane mesic ecosystem and includes a portion of the area surrounding a tributary of Nawaimaka Stream east to Kumuwela Ridge (Figure 3-A, above). The entire section is State-owned within Kokee State Park, and includes 8 ac (3 ha) of newly designated critical habitat. This section is occupied by *Diellia mannii* and the picture-wing fly *Drosophila sharpi*, and includes the montane mesic forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane mesic ecosystem (Table 3), as well as the larval-stage host plants (*Cheirodendron* sp. and *Tetraplasandra* sp.) associated with the picture-wing fly. This section also contains unoccupied habitat that is essential to the conservation of these two species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Montane Mesic–Section 2 is not known to be occupied by the plants *Chamaesyce remyi* var. *remyi*, *Labordia helleri*, *Myrsine knudsenii*, *Myrsine mezii*, *Platydesma rostrata*, *Psychotria grandiflora*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*, or by the birds the akekee and akikiki, we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range, as well as species-specific PCEs for the akekee and akikiki (arthropod prey). Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, that portion of the section that overlies previously designated critical habitat falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70c. The previously undesignated land comprises Critical Habitat Unit 21 of 50 CFR 17.99(a)(1), Map 217d. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 2–Montane Mesic), and for the picture-wing fly at 50 CFR 17.95(i) (Unit 2–Montane Mesic).

Kauai—Montane Mesic—Section 3: Montane Mesic–Section 3 consists of 139 ac (56 ha) in the montane mesic ecosystem, including the upper portion of the Nawaimaka Valley up to Kapukapaia Ridge, on State-owned land in the Na Pali-Kona Forest Reserve (Figure 3-B). This section is not in previously designated critical habitat and includes the only montane mesic forest occupied by the plant *Myrsine mezii*, and the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. Although Montane Mesic–Section 3 is not known to be occupied by the plants *Chamaesyce remyi* var. *remyi*, *Labordia helleri*, *Myrsine knudsenii*, *Myrsine mezii*, *Platydesma rostrata*, *Psychotria grandiflora*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*; by the birds the akekee and akikiki; or by the picturewing fly *Drosophila sharpi*, we have determined this area to

be essential for the conservation and recovery of these montane mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. It also provides for the species-specific PCEs for the akekee and akikiki (arthropod prey) and the larval-stage host plants (*Cheirodendron* sp. and *Tetraplasandra* sp.) associated with *D. sharpi*. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, this section comprises Critical Habitat Unit 22 of 50 CFR 17.99(a)(1), Map 217e. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 3– Montane Mesic), and for the picturewing fly at 50 CFR 17.95(i) (Unit 3– Montane Mesic).

Kauai—Montane Wet—Section 2: Montane Wet—Section 2 consists of 790 ac (320 ha) in the montane wet ecosystem, extending from Kahuamaa Flat south to the edge of Waimea Canyon, on State-owned land in Kokee State Park (Figure 4, above). The entire section is within previously designated critical habitat, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Dubautia kalalauensis*, *Labordia helleri*, *Melicope puberula*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*, and by the akekee. This section includes montane wet forest, potentially some small-scale boggy areas, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and arthropod prey (identified as a species-specific PCE for the akekee). Although Montane Wet—Section 2 is not known to be occupied by the plants *Astelia waialeale*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialeale*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *Myrsine mezii*, and *Phyllostegia renovans*; by the akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. This area also supports the arthropod prey identified as a PCE for the akikiki, and the larval-stage host plants (*Cheirodendron* and *Tetraplasandra* spp.) identified as a PCE for the picturewing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within previously designated Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 5–Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 5– Montane Wet).

Kauai—Wet Cliff—Section 1: Wet Cliff—Section 1 consists of 190 ac (77 ha) in the wet cliff ecosystem, including cliffs along the rim of Kalalau Valley from Alealeau to Pihea, on State-owned land in the Na Pali Coast State Park and the Hono o Na Pali NAR (Figure 6-A). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70b, and is occupied by the plant *Chamaesyce remyi* var. *remyi*. This section includes the wet cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the wet cliff ecosystem (Table 3). Although Wet Cliff—Section 1 is not known to be occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyanea dolichopoda*, *Cyrtandra oenobarbara*, *C. paliku*, *Dubautia plantaginea* ssp. *magnifolia*, *Lysimachia iniki*, *L. pendens*, *L. venosa*, and *Platydesma rostrata*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical

range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Wet Cliff—Section 2: Wet Cliff—Section 2 consists of 784 ac (317 ha) in the wet cliff ecosystem, and includes the cliffs at the headwaters of the Wailua River or “Blue Hole,” on State (778 ac, 315 ha) and privately owned (6 ac, 3 ha) land in the LihueKoloa Forest Reserve (Figure 6-B). There are 489 ac (198 ha) within previously designated critical habitat and 296 ac (120 ha) of newly designated critical habitat on State-owned land. The portion of the section that is in previously designated critical habitat falls within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36b. The newly designated portion of the section comprises Critical Habitat Unit 18 of 50 CFR 17.99(a)(1), Map 217a. This section is occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyrtandra oenobarba*, *Dubautia plantaginea* ssp. *magnifolia*, *Lysimachia iniki*, *L. pendens*, and *Platydesma rostrata*. The section includes the wet cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the wet cliff ecosystem (Table 3). Although Wet Cliff—Section 2 is not known to be occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyanea dolichopoda*, *Cyrtandra paliku*, and *Lysimachia venosa*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Wet Cliff—Section 3: Wet Cliff—Section 3 consists of 61 ac (24 ha) in the wet cliff ecosystem, including cliffs below Kekoiki, on State (8 ac, 3 ha) and privately owned (53 ac, 22 ha) land in the Halelea, Moloaa and Kealia forest reserves (Figure 6-C). There are 23 ac (9 ha) of newly designated critical habitat on privately owned land within this section. That portion of the section that falls within previously designated critical habitat is within Critical Habitat Unit 4 of 50 CFR 17.99(a)(1), Map 5a. The newly designated portion of the section comprises Critical Habitat Unit 19 of 50 CFR 17.99(a)(1), Map 217b. This section is occupied by the plant *Cyrtandra paliku*, and includes the wet cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the wet cliff ecosystem (Table 3). Although Wet Cliff—Section 3 is not known to be occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Cyanea dolichopoda*, *Cyrtandra oenobarba*, *Dubautia plantaginea* ssp. *magnifolia*, *Lysimachia iniki*, *L. pendens*, *L. venosa*, and *Platydesma rostrata*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Chamaesyce remyi* var. *remyi* critical habitat consists of five components (Lowland mesic, Lowland wet, Montane mesic, Montane wet and Wet cliff) (75 FR 18960-19165):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<914 m). Annual precipitation: 50–75 in (127–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*,

Melanthera, Osteomeles, Pleomele, Psydrax. Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Ecosystem: Lowland Wet. Elevation: <3,000 ft (<914 m). Annual precipitation: >75 in (>190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

Ecosystem: Montane Wet. Elevation: 3,000–5,243 ft (914–1,598 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: Acacia, Charpentiera, Cheirodendron, Metrosideros. Subcanopy: Broussaisia, Cibotium, Eurya, Ilex, Myrsine. Understory: Ferns, Carex, Coprosma, Leptecophylla, Oreobolus, Rhynchospora, Vaccinium.

Ecosystem: Montane Mesic. Elevation: 3,300–5,243 ft (914–1,598 m). Annual precipitation: 50–75 in (127–190 cm). Substrate: weathered aa lava, rocky mucks, thin silty loams, deep volcanic ash soils. Canopy: Acacia, Metrosideros, Psychotria, Tetraplasandra, Zanthoxylum. Subcanopy: Cheirodendron, Coprosma, Kadua, Ilex, Myoporum, Myrsine. Understory: Bidens, Dryopteris, Leptecophylla, Poa, Scaevola, Sophora.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: Broussaisia, Cheirodendron, Leptecophylla, Metrosideros. Understory: Bryophytes, Ferns, Coprosma, Dubautia, Kadua, Peperomia.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs

and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: This species has been observed flowering in March, April, June, August, October, and December (NTBG 2009, 2012a, 2013a-b, 2014a, 2015a-b). (USFWS, 2017)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Mesic to wet *Metrosideros polymorpha*/*Dicranopteris linearis* (ohia-uluhe) forest (USFWS, 2010)

Dependencies on Specific Environmental Elements

Adult: Lowland mesic, lowland wet, wet cliff, montane mesic, and montane wet ecosystems (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: 1,200 - 3,000 ft. elevation (USFWS, 2017)

Environmental Specificity

Adult: Unknown (Natureserve, 2015)

Habitat Narrative

Adult: *Euphorbia remyi* var. *remyi* is found in mesic to wet *Metrosideros polymorpha* (ohia)—*Dicranopteris linearis* (uluhe) forest between 366 to 900 meters (1,200 to 3,000 feet) elevation (HBMP 2010; TNCH 2007). At Awaawapuhi to Honopu-Kalalau the associated native plant species include *Acacia koa* (koa), *Alphitonia ponderosa* (kauila), *Alyxia stellata* (maile), *Antidesma platyphyllum* (hame), *Bobea brevipes* (ahakea lau lili), *Chrysodracon aurea* (hala pepe), *Dodonaea viscosa* (aalii), *Ilex anomala* (kawau), *Kadua affinis* (manono), *Leptechophylla tameiameia* (pukiawe), *Melicope* spp. (alani), *Myrsine* spp. (kolea), *Nestegis sandwicensis* (olopua), *Planchonella sandwicensis* (alaa), *Polyscias* spp. (ohe), *Psychotria* spp. (kopiko), *Syzygium sandwicensis* (ohia ha), *Xylosma hawaiiensis* (maua), and *Zanthoxylum dipetalum* (kawau) (HBMP 2010; NTBG 2013c, 2014c, 2015a). At Wainiha to Lumahai the associated native species include a rich fern understory with *Antidesma platyphyllum*, *Cheirodendron* spp. (olapa), *Coprosma* spp. (pilo, koi), *Cyrtandra* spp. (haiwale), *Dubautia* spp. (naenae), *Labordia* spp. (kamakahala), *Perrottetia sandwicensis* (olomea), *Polyscias* spp., *Psychotria* spp., and *Syzygium sandwicensis* (NTBG 2014b). At Iole to Waiahi the associated native plant species include *Alyxia stellata* (maile), *Antidesma platyphyllum*, *Alyxia stellata* (maile), *Broussaisia arguta*, *Coprosma kauaense*, *Cyanea* spp., *Cyrtandra* spp., *Dubautia* spp., *Elaeocarpus bifidus* (kalia), *Freycinetia arborea* (ie ie), *Ilex anomala*, *Kadua affinis*, *Labordia waialealae* (kamakahala lau lili), *Machaerina* spp. (uki, ahaniu), *Melicope* spp., *Myrsine* spp., *Peperomia hesperomannii* (ala ala wai nui), *Perrottetia sandwicensis*, *Pipturus* spp. (mamaki), *Pittosporum glabrum* (hoawa), *Polyscias* spp., *Pritchardia hardyi* (loulu), *Psychotria* spp., *Sadleria* spp. (amau), *Scaevola* spp. (naupaka), *Smilax melastomifolia* (hoi kuahiwi), *Syzygium sandwicensis*, *Touchardia latifolia* (olona), and *Vaccinium calycinum* (ohelo) (NTBG 2012b, 2013a-b, d, f). At Wahiawa, Kanaele Bog, and Laauhihaihai the associated native plant species include *Antidesma platyphyllum*, *Bobea brevipes*, *Broussaisia arguta*, *Cheirodendron* spp., *Cyanea* spp. (haha), *Dicranopteris* spp., *Dubautia* spp., *Freycinetia arborea*, *Gahnia beecheyi* (NCN), *Ilex anomala*, *Kadua affinis*, *Labordia tinifolia*, *Lobelia kauaensis* (pue), *Machaerina angustifolia*, *Melicope* spp., *Metrosideros* spp. (ohia), *Myrsine helleri* (oliko), *Platydesma rostrata* (pilo kea lau lili), *Polyscias* spp., *Pritchardia flynnii* (loulu), *Psychotria mariniana*, *Sadleria pallida*, *Scaevola* spp., *Sphenomeris chinensis* (palaa), *Syzygium sandwicensis*, and *Wikstroemia oahuensis* (akia) (NTBG 2010a-c, 2013e). (USFWS, 2017)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Population Growth Rate:

Unknown (NatureServe, 2015)

Number of Populations:

11 (USFWS, 2017)

Population Size:

300 wild individuals, 28 outplanted (USFWS, 2017)

Population Narrative:

In 2010, *E. remyi* var. *remyi* was found in 10 populations totaling a little more than 350 individuals at Kalalau-Honopu, Koaie Canyon, Limahuli, Limahuli-Hanakapiai, Lumahai, Makaleha, Malamamaiki, Pohakupili, Puu Kolo and Wahiawa Drainage, (Wood 1998; HBMP 2010). Currently, there are approximately 11 populations totaling 300 individuals at Awaawapuhi, Iliiliula, Iole, Kalalau-Honopu, Kapalaoa, Lumahai, Waiahi, Wainiha, and the Wahiawa drainage including Kanaele Bog and Laauhihaihai (Wood 2000; HBMP 2010; NTBG 2009, 2010a-c, 2012a-c, 2013a, c-d, 2014b-c-, 2015a-b). (USFWS, 2017)

Threats and Stressors

Stressor: Ungulate degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Feral pigs (*Sus scrofa*), goats (*Capra hircus*), and black-tailed deer (*Odocoileus hemionus*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil. Feral ungulates are noted to be a threat to individuals of *Euphorbia remyi* var. *remyi* that occur at Honopu-Kalalau, Wainiha, Lumahai, Iliiliula, Iole, Wahiawa, and Laauhihaihai (Wood 2000, HBMP 2010; NTBG 2010b-c, 2012b-c, 2013c, 2014b-c, 2015a-b). (USFWS, 2017)

Stressor: Established ecosystem-altering invasive plant modification and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community. Invasive introduced plants with the greatest impacts on *Euphorbia remyi* var. *remyi* are: *Adiantum hispidulum* (rough maidenhair

fern), *Andropogon glomeratus* (bushy beardgrass), *Axonopus fissifolius* (narrow-leaved carpetgrass), *Blechnum appendiculatum* (NCN), *Buddleja asiatica* (dog tail), *Clidemia hirta* (Koster's curse), *Cyclosorus dentatus* (pauha), *Cyperus meyerianus* (NCN), *Ehrharta stipoides* (meadow ricegrass), *Erigeron karvinskianus* (daisy fleabane), *Hedychium gardnerianum* (kahili ginger), *Juncus planifolius* (bog rush), *Kalanchoe pinnata* (air plant), *Lantana camara* (lantana), *Melastoma septemnerium* (NCN), *Morella faya* (firetree), *Oplismenus hirtellus* (basketgrass), *Paspalum conjugatum* (Hilo grass), *Passiflora tarminiana* (banana poka), *Psidium cattleianum* (strawberry guava), *P. guajava* (common guava), *Pterolepis glomerata* (NCN), *Rhodomyrtus tomentosa* (downy myrtle), *Rubus argutus* (prickly Florida blackberry), *R. rosifolius* (thimbleberry), *Sacciolepis indica* (glenwood grass), *Setaria parviflora* (yellow foxtail), and *Sphaeropteris cooperi* (Australian tree fern) (HBMP 2010; NTBG 2010a, 2012b-c, 2013b-d, f, 2014b-c, 2015b). (USFWS, 2017)

Stressor: Landslides and flooding destruction or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Individuals of *Euphorbia remyi* var. *remyi* occur on cliffs at Lumahai, Kalalau, and Wahiawa (Wood 2000; HBMP 2010; NTBG 2009, 2010b). Large herds of feral ungulates browse and cause erosion in the area where this species occurs (HBMP 2010; NTBG 2009). Landslides destabilize substrates, damage and destroy individual plants, and alter hydrological patterns (Stearns 1985). (USFWS, 2017)

Stressor: Hurricanes—Loss and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013). (USFWS, 2017)

Stressor: Climate change loss or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible

responses necessary for persistence under climate change. This assessment concluded that *Euphorbia remyi* var. *remyi* is vulnerable to the impacts of climate change with a vulnerability score of 0.498 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2017)

Stressor: Rodent predation or herbivory (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Herbivory by rats (*Rattus* spp.) has been noted as a threat to *Euphorbia remyi* var. *remyi* at Honopu, Kalalau, Awaawapuhi, Wainiha, Iole, Waiahi, Kanaele, and Wahiawa (HBMP 2010; NTBG 2009, 2010a, c, 2012a-c, 2013a-b, e-f, 2014a, c, 2015a-b). Rats eat virtually every part of plants and at every stage: fleshy fruits, seeds, flowers, stems, leaves, shoots, seedlings, and roots (Russell 1980; Cuddihy and Stone 1990). The effects on plants range from reduced vigor and decreased reproduction to mortality of individuals and complete lack of recruitment. (USFWS, 2017)

Stressor: Invertebrate predation or herbivory (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Infestation by the nonnative two-spotted leafhopper (*Sophonia rufofascia*) is noted to be a threat to *Euphorbia remyi* var. *remyi* at the Lumahai population (Wood 2000). The effects on plants range from reduced vigor and decreased reproduction to mortality of individuals and complete lack of recruitment. (USFWS, 2017)

Stressor: Slug herbivory (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Herbivory by slugs is noted to be a threat to the Wainiha, Iole, and Waiahi populations of *Euphorbia remyi* var. *remyi* (NTBG 2013b, d, f, 2014b; U.S. Army Garrison 2005). (USFWS, 2017)

Stressor: Lack of adequate hunting regulations (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Historically known populations of *Euphorbia remyi* var. *remyi* at Koaie, Malamalamaiki, Papaa, Kamalii, and Makaleha were within state hunting areas. The currently known individuals of this species at Honopu-Kalalau are within state hunting areas. Feral pigs, goats, and deer, and the effects of their activities are noted to be a threat to *E. remyi* var. *remyi*. Nonnative feral ungulates pose a major ongoing threat to native species through destruction and modification of habitat, and by direct herbivory or predation. Only those occurrences within Wainiha Preserve are provided some protection from ungulates by fencing. Public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape,

regardless of underlying land use designation; therefore, any unfenced populations are at risk (DLNR 2010). (USFWS, 2017)

Stressor: Lack of adequate biosecurity legislation (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Introduction of invasive nonnative plant species to the State of Hawaii, destruction of habitat and competition by nonnative plants and predation by nonnative invertebrates are threats to *Euphorbia remyi* var. *remyi*. The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, is authorized to prevent the introduction or dissemination of animal and plant pests on all ships, aircraft, and their cargo and baggage arriving in the U.S. and its territories; however, pest species continue to enter the State. In addition, Federal import regulations do not address many species that could be pests in Hawaii (CGAPS 2009; Ikuma et al. 2002). (USFWS, 2017)

Stressor: Invasive species (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Established invasive plant species competition—Nonnative plant species including *Adiantum hispidulum*, *Andropogon glomeratus*, *Axonopus fissifolius*, *Blechnum appendiculatum*, *Buddleja asiatica*, *Clidemia hirta*, *Cyclosorus dentatus*, *Cyperus meyenianus*, *Ehrharta stipoides*, *Erigeron karvinskianus*, *Hedychium gardnerianum*, *Juncus planifolius*, *Kalanchoe pinnata*, *Lantana camara*, *Melastoma septemnerium*, *Morella faya*, *Oplismenus hirtellus*, *Paspalum conjugatum*, *Passiflora tarminiana*, *Psidium cattleianum*, *P. guajava*, *Pterolepis glomerata*, *Rhodomyrtus tomentosa*, *Rubus argutus*, *R. rosifolius*, *Sacciolepis indica*, *Setaria parviflora*, and *Sphaeropteris cooperi* compete with *Euphorbia remyi* var. *remyi* for space, water, light, and nutrients (HBMP 2010; NTBG 2010a, 2012b-c, 2013c-d, f, 2014b-c, 2015b).

Recovery

Reclassification Criteria:

To meet the interim stage of recovery of *Euphorbia remyi* var. *remyi*, 300 mature individuals are needed in each of three populations and all major threats must be controlled around the populations designated for recovery at this stage. There should also be demonstrated regeneration of seedlings and growth to at least sapling stage for woody species and documented replacement regeneration within each of the target populations. The populations must be adequately represented in an ex situ collection as defined in the Center for Plant Conservation's guidelines (Guerrant et al. 2004). Adequate monitoring must be in place and conducted to assess individual plant survival, population trends, trends of major limiting factors, and response of major limiting factors to management. (USFWS, 2017)

In addition to achieving 5 to 10 populations with 500 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and

monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats. (USFWS, 2017)

Delisting Criteria:

In addition to achieving 5 to 10 populations with 500 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis. (USFWS, 2017)

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys. (USFWS, 2010)
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units. (USFWS, 2010)
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys. (USFWS, 2010)
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range. (USFWS, 2010)
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction. (USFWS, 2010)
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security. (USFWS, 2010)
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems. (USFWS, 2010)
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various

conservation partnerships funded by State and Federal agencies and private organizations. (USFWS, 2010)

- Surveys and inventories—Survey for populations of *Euphorbia remyi* var. *remyi* in areas of potentially suitable habitat. (USFWS, 2017)
- Ungulate monitoring and control—Protect all occurrences against disturbances from feral ungulates. Continue to construct and maintain fenced exclosures around all populations. (USFWS, 2017)
- Invasive plant monitoring and control - Continue to control established ecosystem-altering nonnative invasive plant species around all populations. Control invasive nonnative plant species around all populations that compete with the species. (USFWS, 2017)
- Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. (USFWS, 2017)
- Predator and herbivore control research—Study *Euphorbia remyi* var. *remyi* populations to determine threat from invertebrate herbivory and need for additional recovery actions. (USFWS, 2017)
- Invertebrate herbivory monitoring and control—Research and implement effective invertebrate control methods. (USFWS, 2017)
- Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2017)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms. (USFWS, 2017)
- Based on the recovery criteria above, consider development of a recovery plan. (USFWS, 2017)

Conservation Measures and Best Management Practices:

- Conservation measures are not available.

References

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

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USFWS. 2010. Endangered and Threatened Wildlife and Plants

Determination of Endangered Status for 48 Species on Kauai and Designation of Critical Habitat. Final rule. 75 FR 18960 - 19165 (April 13, 2010).

USFWS. 2017. *Euphorbia remyi* var. *remyi* ('Akoko) , 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, PIFWO, Honolulu, Hawaii. 19 pp. September, 2017.

U.S. Fish and Wildlife Service. 2010. Endangered and Threatened Wildlife and Plants

Determination of Endangered Status for 48 Species on Kauai and Designation of Critical Habitat

Final Rule . 75 FR 18960-19165 (April 13, 2010).

USFWS. 2010. Recovery Outline for the Kauai Ecosystem. Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii

SPECIES ACCOUNT: *Euphorbia* (=Chamaesyce) *rockii* (`Akoko)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

Chamaesyce rockii is in the Euphorbiaceae (spurge family). It is a short-lived perennial shrub or small tree typically 0.5 to 2 m (1.6 to 6.6 ft) tall, but in protected sites it may reach 4 m (13 ft) in height. The opposite leaves are narrowly oblong or elliptic, leathery, 6 to 17 cm (2.4 to 6.7 in) long and 1.5 to 4.0 cm (0.6 to 1.6 in) wide. The flowers form a head arranged in an open or sometimes condensed cymose inflorescence. The fruit are brilliant red or pink and 14 to 25 mm (0.6 to 1.0 in) long, and the seeds are brown to grayish brown. This species differs from others in the genus in that it has large, red, capsular fruit (Wagner et al. 1999).

Historical Range

Chamaesyce rockii was known historically from scattered occurrences along the Koolau Mountains on the island of Oahu.

Current Range

Currently there are 12 occurrences with a total of between 755 and 867 individuals along the Koolau Mountains at Aiea Ridge trail (two to three individuals), Halawa summit trail (20), Helemano-Opaepa (300), Kaluanui (200 to 300), Kawaiiki and Opaepa (54), north Kaukonahua Gulch (1), north Kaukonahua-Kahana summit Ridge (1), Puu Kainapua (100), south Kaukonahua (25), summit Ridge between Aiea Ridge trail and Waimano trail (1 to 2), Waikakalau (40 to 50), and Waimano (11) (HINHP Database 2001; K. Kawelo, U.S. Army, pers. comm. 2003; J. Lau, HINHP, pers. comm. 2003).

Critical Habitat Designated

No;

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Euphorbia* (=Chamaesyce) *rockii* (`Akoko) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Euphorbia* (=Chamaesyce) *rockii* (77 FR 57648-57862). The critical habitat designation includes 14 critical habitat units, which encompass approximately 30,056 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Euphorbia* (=Chamaesyce) *rockii* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Euphorbia* (=Chamaesyce) *rockii* includes 14 critical habitat units, covering two ecosystem types, which encompass approximately 30,056 acres on the Island

of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; Oahu—Wet Cliff—Units 6, 7, 8.

Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Hauula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikēkē, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet—Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet—Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu—Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamoa Ridge.

Oahu—Wet Cliff—Unit 6 [151 ac (61 ha)]. This area consists of 151 ac (61 ha) in the wet cliff ecosystem on State land on the windward side of the Koolau Mountains in Kaipapau Gulch, entirely within the Kaipapau Forest Reserve. Oahu—Wet Cliff—Unit 7 [144 ac (58 ha)]. This area consists of 144 ac (58 ha) in the wet cliff ecosystem in State land on the windward side of the Koolau Mountains in Hauula Gulch, entirely within the Hauula Forest Reserve. Oahu—Wet Cliff—

Unit 8 [4,649 ac (1,881 ha)]. This area consists of 1,479 ac (598 ha) of State land, 1,281 ac (519 ha) of City and County of Honolulu land, 5 ac (2 ha) of Federal land, and 1,884 ac (762 ha) of privately owned land, in the wet cliff ecosystem along the summit of the Koolau Mountains, overlapping portions of Sacred Falls State Park, the Waiahole FR (Waiahole and Iolekaa sections), the Kaneohe and Honolulu Watershed FRs, and the Nuuanu Pali State Wayside.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Euphorbia* (=Chamaesyce) *rockii* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Euphorbia* (=Chamaesyce) *rockii* occurs within the indicated ecosystem in the Koolau Mountain caldera complex:

Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (E) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Oahu—Wet Cliff—Units 6, 7, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: >65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. (E) Understory: *Bryophytes*, *Ferns*, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Euphorbia* (=Chamaesyce) *rockii* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: *C. rockii* has been observed fruiting in February, and little else is known about its flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors (Service 1998a). The population sizes and the range of *C. rockii* have been declining (U.S. Army 2003a).

Habitat Type

Adult: wet forest/wet shrubland

Habitat Narrative

Adult: *Chamaesyce rockii* typically grows on gulch slopes, gulch bottoms, and ridge crests in wet *Metrosideros polymorpha*-*Dicranopteris linearis* forest and shrubland. The habitat is between 208 and 915 m (682 and 3,000 ft) in elevation and primarily along cloud-swept summit ridges and occasionally along streams (HINHP Database 2001). Associated plant species include *Antidesma platyphyllum*, *Bidens* sp., *Broussaisia arguta*, *Cibotium* sp., *Coprosma longifolia*, *Diplopterygium pinnatum*, *Dubautia laxa*, *Hedyotis terminalis*, *Machaerina* sp., *Melicope* spp., *Myrsine juddii*, *Psychotria* spp., and *Wikstroemia* sp. (HINHP Database 2001).

Dispersal/Migration***Population Information and Trends*****Resiliency:**

Fragility unknown. (NatureServe, 2015)

Representation:

Fragility unknown. (NatureServe, 2015)

Redundancy:

Fragility unknown. (NatureServe, 2015)

Number of Populations:

6 - 20 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Adaptability:

Fragility unknown. (NatureServe, 2015)

Population Narrative:

Fragility unknown. The total number of plants is estimated to be between 200 and 400 plants. 11 current occurrences (between 1982 and 1997), 4 historical records and 2 with current status unknown. (NatureServe, 2015)

Threats and Stressors**Stressor:****Exposure:****Response:****Consequence:**

Narrative: The primary threats to *Chamaesyce rockii* are habitat degradation and destruction by feral pigs; trail clearing; potential impacts from military activities; and competition with non-native plant species such as *Clidemia hirta*, *Leptospermum scoparium*, *Paspalum conjugatum*, *Psidium cattleianum*, and *Pterolepis glomerata* (HINHP Database 2001; Service 1998a; 61 FR 53089).

Recovery

Conservation Measures and Best Management Practices:

- A State-wide management plan should be developed and implemented for the long-term conservation of all known occurrences of *Chamaesyce rockii*. This plan should also include broader landscape actions that are needed for the recovery of this plant throughout its range. The recovery plan for this species identifies the following important conservation actions. Fences should be constructed around the known occurrences of *C. rockii* to exclude pigs, and pigs should be controlled over a larger area to alleviate their impacts on the native ecosystems and to assist in the natural regeneration of *C. rockii*. Non-native vegetation should be removed from the vicinity of known plants. Occurrences that have only a few remaining individuals should be given priority for management actions (Service 1998a). Ongoing Conservation Actions: This species is in genetic storage at the Lyon Arboretum (Service 2002). The Service is currently not aware of any other conservation efforts for this species.

References

USFWS 2016. Status of the Species and Critical Habitat: *Euphorbia* (=Chamaesyce) *rockii* (Akoko). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016.

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

U.S. Fish and Wildlife Service. 2012. Endangered and Threatened Wildlife and Plants

Endangered Status for 23 Species on Oahu and Designation of Critical Habitat for 124 Species. Final Rule. 77 FR 57648-57862 (September 18, 2012)

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.”

SPECIES ACCOUNT: *Euphorbia* (=Chamaesyce) *skottsbergii* var. *skottsbergii* (Ewa Plains `akoko)

Species Taxonomic and Listing Information

Listing Status: Endangered; 08/24/1982; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Chamaesyce skottsbergii var. *skottsbergii* is a perennial, erect to prostrate shrub measuring 0.5 ft (0.2 m) to 3.3 ft (1 m) tall (occasionally reaching as tall as 6.6 ft or 2 m), with brittle, slender, usually jointed branches that are minutely hairy, especially when young. The opposite, two-ranked, oval leaves measure 0.5 to 0.8 in (12 to 20 mm long and 0.1 to 0.5 in (3 to 12 mm) wide, often have toothed margins, and have a hairless upper surface. Each cyathium (flower cluster resembling a single flower) is situated singly in a leaf axil and consists of a female flower made up of one pistil surrounded by several male flowers, each with a single stamen. The green capsules are 0.06 to 0.08 in (1.5 to 2 mm in length, have a curved stalk, and open to release gray to brown seeds measuring from 0.04 to 0.05 inches (1 to 1.3 mm) long. (USFWS, 2007)

Taxonomy

In a taxonomic revision of the native Hawaiian taxa of the genus *Chamaesyce* published in 1990 (Koutnik 1990) two varieties within the species *Chamaesyce skottsbergii* were recognized: var. *skottsbergii* and var. *vaccinioides*. Variety *skottsbergii* was considered to include *Euphorbia skottsbergii* var. *kalaaloana* along with populations of the species from northwestern Molokai. Variety *vaccinioides* included plants from central Molokai, Kahoolawe, and the southern side of East Maui. Currently, DNA sequence analysis indicates that *Chamaesyce skottsbergii* populations on Oahu and Molokai are genetically distinct, and the extent of this differentiation supports the recognition of these populations as distinct varieties. The Molokai population is more closely related to var. *vaccinioides*, and should be recognized by the previously used variety name, *C. skottsbergii* var. *audens* and the Oahu variety should be recognized as *C. skottsbergii* var. *kalaaloana* (Morden and Gregoritz 2006). (USFWS, 2007)

Historical Range

Chamaesyce skottsbergii var. *skottsbergii* has historically been restricted to the arid coral plain of 'Ewa, O'ahu, and arid coastal sites on northwestern Molokai (HHP 1991a). (USFWS, 1994)

Current Range

Its current range includes Ewa plains, Oahu & west Molokai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Euphorbia* (=Chamaesyce) *skottsbergii* var. *skottsbergii* (Ewa Plains `akoko) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Euphorbia* (=Chamaesyce) *skottsbergii* var. *skottsbergii* (77 FR 57648-57862).

The critical habitat designation includes four critical habitat units, which encompass approximately 345 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Euphorbia* (=Chamaesyce) *skottsbergii* var. *skottsbergii* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Euphorbia* (=Chamaesyce) *skottsbergii* var. *skottsbergii* includes four critical habitat units, covering one ecosystem type, which encompasses approximately 345 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3; Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Lowland Dry—Unit 8 [99 ac (40 ha)]. Oahu—This area consists of 96 ac (40 ha) of privately owned land and 3 ac (1 ha) of State land as part of the old railroad right-of-way in the lowland dry ecosystem, at the Kalaeloa Barber's Point Harbor area. Oahu—Lowland Dry—Unit 9 [37 ac (15 ha)]. This area consists of 17 ac (7 ha) of City and County land, 3 ac (1 ha) of privately owned land, 1 ac (0.5 ha) of State land, and 16 ac (6 ha) of Federal (Pearl Harbor NWR) land in the lowland dry ecosystem at Kalaeloa. Oahu—Lowland Dry—Unit 10 [43 ac (17 ha)]. This area consists of 43 ac (17 ha) of State land (DHHL) in the lowland dry ecosystem at Kalaeloa. Oahu—Lowland Dry—Unit 11 [166 ac (67 ha)]. This area consists of 166 ac (67 ha) of federal land (U.S. Navy) in the lowland dry ecosystem at Kalaeloa.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Euphorbia* (=Chamaesyce) *skottsbergii* var. *skottsbergii* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Euphorbia* (=Chamaesyce) *skottsbergii* var. *skottsbergii* occurs within the indicated ecosystem in the Waianae Mountain caldera complex:

Oahu—Lowland Dry—Units 8, 9, 10, 11. Lowland Dry. (A) Elevation: <3,300 ft (<1,000 m). (B) Annual Precipitation: <50 in (<130 cm). (C) Substrate: Weathered silty loams to stony clay, rocky ledges, little weathered lava. (D) Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*, *Sapindes*. (E) Subcanopy: *Chamaesyce*, *Dodonaea*, *Leptecophylla*, *Osteomeles*, *Psydrax*, *Scaevola*, *Wikstroemia*. (F) Understory: *Alyxia*, *Artemisia*, *Bidens*, *Chenopodium*, *Nephrolepis*, *Peperomia*, *Plumbago*, *Sicyos*, *Sida*, *Waltheria*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Euphorbia* (=Chamaesyce) *skottsbergii* var. *skottsbergii* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History**Food/Nutrient Resources****Dependency on Other Individuals or Species**

Adult: Insect pollinators (USFWS, 1994)

Key Resources Needed for Breeding

Adult: Winter rains (USFWS, 1994)

Reproduction Narrative

Adult: Plant growth and flowering occur with the onset of the winter rains and continue through the wet season. The onset of the dry season causes a reduction in these activities, and the plants lose their leaves and become dormant during the peak of the summer drought. Although seed germination rates were found to be rather low (10 to 30 percent), the sheer abundance of seed produced often results in the appearance of many seedlings after the first heavy rains. *Chamaesyce skottsbergii* var. *skottsbergii* plants grow slowly and require insect pollinators for adequate fertilization. (USFWS, 1994)

Habitat Type

Adult: Marine and terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Near shore, forest- hardwood, forest/woodland, shrubland/chaparral, woodland-hardwood (NatureServe, 2015)

Habitat Narrative

Adult: Open or closed *Prosopis* forest on bare, coralline soils (Oahu). Open, mixed shrubs on lithified dunes or raised reef (Molokai). The habitat occupied by *Chamaesyce skottsbergii* var. *skottsbergii* consists of limestone topography characterized by sinkholes and coralline rubble. The population at Mo'omomi is found on lithified and raised limestone and populations along the western coast of Moloka'i occur on basaltic substrata. (USFWS, 1994; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Seeds, distributed by explosive discharge from their capsules, have no germination inhibitors in their seed coats and are not dependent on exposure to sunlight for germination (AECOS 1981). (USFWS, 1994)

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Low (inferred from USFWS, 2007)

Redundancy:

Low (inferred from USFWS, 2007)

Number of Populations:

9 occurrences (NatureServe, 2015)

Population Size:

1,345 (USFWS, 2007)

Population Narrative:

As of 2006, the Navy has outplanted and augmented the *C. skottsbergii* var. *kalaeloana* populations, which currently total 1,345 natural and outplanted adult individuals. There are a total of 9 extant and 5 historical occurrences. (USFWS, 2007; NatureServe, 2015)

Threats and Stressors

Stressor: Loss of habitat (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Direct human-induced loss of habitat is considered the major cause of the decline of *Chamaesyce skottsbergii* var. *skottsbergii* and *Achyranthes splendens* var. *rotundata* on the 'Ewa Plain of O'ahu. The history of direct, human-induced disturbance in this area dates back at least 500 years to the first use of sinkholes for cultivation by native Hawaiians. More intensive disturbances have occurred since the 19th century, when diversified agriculture became widespread throughout the Plain. More recently, urbanization and the establishment of a rock quarry, military bases, Campbell Industrial Park, and the deep draft harbor have contributed to the virtual extinction of the original ecosystem. Today, approximately 90 percent of the Plain is occupied by residential developments, sugar cane fields, an industrial complex, a deep-draft harbor, military installations and recreational areas. As the need for urban and industrial sites on O'ahu increases, the demand for land in the 'Ewa Plain will also increase. Thus, the continued loss of habitat, albeit completely modified, must still be considered the major threat to both taxa. (USFWS, 1994)

Stressor: Encroachment by alien plant species (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: In addition to the physical loss of habitat, all populations of *Chamaesyce skottsbergii* var. *skottsbergii* and *Achyranthes splendens* var. *rotundata* have been adversely affected by habitat degradation caused by invading alien shrubs and trees. Today, intact native plant communities are non-existent in the 'Ewa Plain; only remnant individuals remain. Aggressive species such as kiawe, *Pluchea*, Australian saltbush, *asystasia* and various grasses have altered the natural habitat and are competing with both endangered taxa for space, light, water, and nutrients. Particularly detrimental alien species are: kiawe, which often forms closed-canopied forests; *Pluchea x fosbergii*, which is extremely aggressive; and grasses and *Asvstasia* which can prevent seedling establishment. On Moloka'i, invasion by aggressive weeds is listed by The

Nature Conservancy (1991) as a threat to all rare plants on the Hawaiian Home Lands' Ho'olehua parcel (Population 5), and weed control, specifically kiawe removal, is a part of The Nature Conservancy's management program on the Mo'omomi Preserve on Moloka'i (Populations 6 and 7) (TNCH, 1993). Similar encroachment of alien plants occurs in the Ka'ena Point area. (USFWS, 1994)

Stressor: Parasitism by *Cassytha filiformis* (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: The parasitic native vine, kauna'oa pehu (*Cassytha filiformis*) has been noted as a possible threat to both taxa in the Barber's Point area (AECOS 1981; Nagata 1981). This vine is locally common at Barbers Point where it enshrouds shrubs and smaller trees. Heavy infestations weaken the host plants, leaving them vulnerable to disease-causing organisms and insect predation. (USFWS, 1994)

Stressor: Fire (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Fire must be considered a potential threat for all populations because of the highly localized distribution of both taxa. During long, annual drought periods, vegetation becomes exceptionally dry, particularly in the 'Ewa Plain and in western Moloka'i, and the accumulated litter during these months represents potential fuel for brush fires. In the 'Ewa Plain, residential and industrial development represents an increased threat of fire, although there tends to be a concomitant rise in awareness of such a threat and contingencies for fire are considered in urban planning. (USFWS, 1994)

Stressor: Insect predation (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Potentially damaging insects have been reported on both *Chamaesyce skottsbergii* var. *skottsbergii* and *Achyranthes solandensis* var. *rotundata*. An unidentified borer the croton moth caterpillar (*Aechaea ianata*), and spiralling white fly (*Aleurodicus disoersus*) have been noted on *Chamaesyce skottsbergii* var. *skottsbergii* (AECOS 1981). The croton moth caterpillar is known to denude *Chamaesyce skottsbergii* var. *skottsbergii* of leaves and flowers (AECOS 1981). A severe infestation of white fly is usually debilitating to its host plants (Borrer, et al. 1981). A lack of seed set has been noted on heavily infested plants since the spiralling white fly has become established at Barbers Point (C. Corn, personal communication 1994). An unidentified scale has been noted on *Achyranthes splendens* var. *rotundata* and an unidentified mite seems to be an occasional pest on cultivated specimens (Nagata, unpublished data). Nematodes (*Meloidogyne* spp., *Pratylenchus* spp. *Rotylenchulus reniformis*) are also known to infest cultivated *Achyranthes solandensis* var. *rotundata* (Mew 1987). (USFWS, 1994)

Stressor: Destruction by cattle and feral animals (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Threats on western Moloka'i include destruction of native ecosystems by feral animals and cattle (TNCH, 1991; Nagata, unpublished data). Ungulates at the Mo'omomi Preserve are actively controlled, although they remain a threat. At Ka'ena Point, ungulates are not a threat at present, but do represent a potential threat as the range of goats in neighboring areas continues to expand. (USFWS, 1994)

Stressor: Trampling by humans (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: *Chamaesyce skottsbergii* var. *skottsbergii* is a low, rather inconspicuous shrub with brittle stems. It is especially difficult to discern during the dry season when it is dormant and leafless. Plants have been damaged by persons intruding into some of the populations (AECOS 1981). (USFWS, 1994)

Stressor: Runway disaster (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Populations of *Achyranthes splendens* var. *rotundata* and *Chamaesyce skottsbergii* var. *skottsbergii* occur on either end of one of the runways at NAS Barbers Point. While this location may, in some ways, have protected them by precluding development in these areas, it also leaves them vulnerable to devastation in the case of a runway disaster resulting in fire, a chemical spill or physical destruction of the population. (USFWS, 1994)

Stressor: Natural disasters (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: The 'Ewa Plain is one of very low relief and inundation by tsunamis is thus a threat. Unusually high tides were recorded at Barbers Point during the tsunamis of 1946 and 1960. Although no damage was reported (Pararas-Carayannis 1977), no structures were located near the coast at that time. (USFWS, 1994)

Stressor: Contamination by ambient pollution or chemical spill (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Potential chemical spill or contamination of the soil due to ambient pollution are threats to nearly all populations in the Barbers Paine area due to heavy industrial and military activities, and there is a further potential for spread of contamination within the tsunami zone. (USFWS, 1994)

Stressor: Non-native plants (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Habitat degradation and competition from invasive nonnative plant species are a significant threat to *Chamaesyce skottsbergii* var. *kalaeloana*. The primary nonnative plant species impacting *C. skottsbergii* var. *kalaeloana* include *Prosopis pallida* (kiawe), which often forms closed-canopied forests; *Pluchea xosbergii* (marsh fleabane), *Asystasia gangetica* (Chinese violet), *Cenchrus ciliaris* (buffel grass), and *Leucana leucocephala* (koahaole) (AECOS 1981). Another fast-growing native vine, *Sicyos pachycarpus* (kupala), can sometimes overgrow *C. skottsbergii* var. *kalaeloana*, but these plants are removed when they appear to pose a threat (Guinther 2006). (USFWS, 2007)

Recovery

Reclassification Criteria:

1. There must be at least three self-reproducing populations with a minimum of 1,000 reproductive plants per population in each of the two geographically distinct regions in which they occur. (USFWS, 1994)
2. Populations should be growing beyond or stable at the minimum size and threats should be removed or controlled for at least ten years prior to downlisting. (USFWS, 1994)
3. Land area for each of these populations should be sufficient to provide a buffer of 30-50 meters around the expanded population. (USFWS, 1994)
4. The population containing 30,000 *Chamaesyce skottsbergii* var. *skottsbergii* plants on Moloka'i should be maintained at this number. (USFWS, 1994)

Delisting Criteria:

1. All criteria for downlisting should be met. (USFWS, 1994)
2. At least three populations with a minimum of 1,000 reproductive plants each should be re-established within the taxon's historical range on the island(s) of Lana'i and/or Moloka'i to ensure against losses due to a catastrophic event affecting the island of O'ahu. (USFWS, 1994)
3. All populations should be stable and self-sustaining, with no human manipulation, for a minimum of ten years prior to delisting and expected to remain so into the foreseeable future. (USFWS, 1994)

Recovery Actions:

- Protect and manage existing populations. (USFWS, 1994)
- Augment or re-establish populations, if necessary. (USFWS, 1994)
- Validate recovery objectives. (USFWS, 1994)

Conservation Measures and Best Management Practices:

- Ensure long-term monitoring of in situ and outplanted subpopulations of Oahu *Chamaesyce skottsbergii* var. *kalaeloana*. (USFWS, 2007)
- Determine whether any plants or propagules remain of the subpopulations of *Chamaesyce skottsbergii* var. *kalaeloana* from the Kalaeloa Barbers Point Harbor and West Beach Resort areas. This plant material may be in situ, at outplanting sites, or in nurseries or botanic gardens. Conduct

genetic studies on any remaining plant material in order to assess its genetic value with respect to the conservation of *C. skottsbergii* var. *kalaeloana*. (USFWS, 2007)

- Study Oahu *C. skottsbergii* var. *kalaeloana* subpopulations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. (USFWS, 2007)
- Increase the number of suitable and available outplanting sites for *C. skottsbergii* var. *kalaeloana*. (USFWS, 2007)

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SPECIES ACCOUNT: *Euphorbia haeleeleana* (`Akoko)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

A tree 3 - 14 m tall with thick succulent branches. In drier regions the trees are summer deciduous, with the leaves turning orange-yellow and then dropping before the height of the summer. Fruits large and yellow (NatureServe, 2015).

Taxonomy

A member of the spurge family (Euphorbiaceae) (USFWS, 2016).

Historical Range

See current range/distribution

Current Range

Euphorbia haeleeleana is known historically and currently from 15 populations (between 450 and 625 individuals) from northwestern Kauai and the Waianae Mountains of Oahu (Service 1995a, 1995b, 1999a) (USFWS, 2016).

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Euphorbia haeleeleana* (`Akoko) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Euphorbia haeleeleana* (77 FR 57648-57862). The critical habitat designation includes 9 critical habitat units, which encompass approximately 6,359 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Euphorbia haeleeleana* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

On February 27, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Euphorbia haeleeleana* (`Akoko) under the Endangered Species Act of 1973, as amended (Act).

The critical habitat designation includes three critical habitat units (CHUs), in Hawaii (68 FR 9116-9479).

Critical Habitat Designation

The critical habitat designation for *Euphorbia haeleeleana* includes 9 critical habitat units, covering two ecosystem types, which encompass approximately 6,359 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Dry—Units 1, 2, 8, 9, 10, 11; Oahu— Lowland Mesic—Units 1, 2, 3.

Oahu—Lowland Dry—Unit 1 [102 ac (41 ha)]; This area consists of 49 ac (20 ha) of State land and 53 ac (22 ha) of privately owned land in the Waianae Mountains, extending from Haili Gulch to Kawaipahai. Oahu—Lowland Dry—Unit 2 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland dry ecosystem in the Waianae Mountains, on Federal land within Kaena Point State Park. Oahu—Lowland Dry—Unit 8 [99 ac (40 ha)]. Oahu—This area consists of 96 ac (40 ha) of privately owned land and 3 ac (1 ha) of State land as part of the old railroad right-of-way in the lowland dry ecosystem, at the Kalaeloa Barber's Point Harbor area. Oahu—Lowland Dry—Unit 9 [37 ac (15 ha)]. This area consists of 17 ac (7 ha) of City and County land, 3 ac (1 ha) of privately owned land, 1 ac (0.5 ha) of State land, and 16 ac (6 ha) of Federal (Pearl Harbor NWR) land in the lowland dry ecosystem at Kalaeloa. Oahu—Lowland Dry—Unit 10 [43 ac (17 ha)]. This area consists of 43 ac (17 ha) of State land (DHHL) in the lowland dry ecosystem at Kalaeloa. Oahu—Lowland Dry—Unit 11 [166 ac (67 ha)]. This area consists of 166 ac (67 ha) of federal land (U.S. Navy) in the lowland dry ecosystem at Kalaeloa.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

The critical habitat designation for *Euphorbia haeleeleana* includes three CHUs in Kauai County, Hawaii (68 FR 9116-9479).

Kauai 11—*Euphorbia haeleeleana*—a: This unit is critical habitat for *Euphorbia haeleeleana* and is 262 ha (649 ac) on State land (Kuia NAR). This unit contains portions of Milolii Ridge and Mahanaloa Valley. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial *Euphorbia haeleeleana* and is currently occupied with between 355 and 405 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, lowland mixed mesic or dry *Diospyros* forest that is often co-dominated by *Metrosideros polymorpha* and *Alphitonia ponderosa*. This unit provides for two populations within this multi-island species' historical range on Kauai that are some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Kauai 11—*Euphorbia haeleeleana*—b: This unit is critical habitat for *Euphorbia haeleeleana* and is 193 ha (476 ac) on State land (Na Pali Coast State Park) within Kalalau Valley. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial *Euphorbia haeleeleana* and is currently occupied with over 120 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes

habitat that is important for the expansion of the present population, which is currently considered nonviable. It provides habitat for the westernmost range of the species that is unique to Kauai. The habitat features contained in this unit that are essential for this species include, but are not limited to, lowland mixed mesic or dry *Diospyros* forest that is often codominated by *Metrosideros polymorpha* and *Alphitonia ponderosa*. This unit provides for two populations within this multi-island species' historical range on Kauai that are some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Kauai 11—*Euphorbia haeleeleana*—c: This unit is critical habitat for *Euphorbia haeleeleana* and is 204 ha (505 ac) on State land, containing portions of Kawaiiki Valley. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial *Euphorbia haeleeleana* and is currently occupied with two plants. This unit is important to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. It provides habitat for the westernmost range of the species that is unique to Kauai. The habitat features contained in this unit that are essential for this species include, but are not limited to, lowland mixed mesic or dry *Diospyros* forest that is often co-dominated by *Metrosideros polymorpha* and *Alphitonia ponderosa*. This unit provides for two populations within this multi-island species' historical range on Kauai that are some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Euphorbia haeleeleana* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Euphorbia haeleeleana* occurs within the Lowland dry and Lowland mesic ecosystems in the Waianae Mountain caldera complex:

Oahu—Lowland Dry—Units 1, 2, 8, 9, 10, 11. (A) Elevation: <3,300 ft (<1,000 m). (B) Annual Precipitation: <50 in (<130 cm). (C) Substrate: Weathered silty loams to stony clay, rocky ledges, little weathered lava. (D) Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*, *Sapindes*. (E) Subcanopy: *Chamaesyce*, *Dodonaea*, *Leptecophylla*, *Osteomeles*, *Psydrax*, *Scaevola*, *Wikstroemia*. (F) Understory: *Alyxia*, *Artemisia*, *Bidens*, *Chenopodium*, *Nephrolepis*, *Peperomia*, *Plumbago*, *Sicyos*, *Sida*, *Waltheria*.

Oahu— Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthra*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Euphorbia haeleeleana* critical habitat consists of two components (68 FR 9116-9479):

(i) Lowland mixed mesic or dry *Diospyros* forest that is often codominated by *Metrosideros polymorpha* and *Alphitonia ponderosa* and containing one or more of the following native plant species: *Acacia koa*, *Antidesma platyphyllum*, *Carex meyenii*, *Carex wahuensis*, *Claoxylon sandwicense*, *Diplazium sandwichianum*, *Dodonaea viscosa*, *Erythrina sandwicensis*, *Kokia kauaiensis*, *Pisonia sandwicensis*, *Pleomele aurea*, *Pouteria sandwicensis*, *Psychotria greenwelliae*, *Psychotria mariniana*, *Pteralyxia kauaiensis*, *Rauvolfia sandwicensis*, *Sapindus oahuensis*, *Tetraplasandra kavaensis*, or *Xylosma* spp.; and

(ii) Elevations between 284 and 1,179 m (931 and 3,866 ft).

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Euphorbia haeleeleana* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species and therefore are not included in the critical habitat designations.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (USFWS, 2016)

Lifespan

Adult: < 10 years (USFWS, 2010)

Breeding Season

Adult: August - October (USFWS, 2016)

Reproduction Narrative

Adult: Individual trees of *Euphorbia haeleeleana* bear only male or female flowers, and must be cross-pollinated from a different tree to produce viable seed (Wagner et al 1990). This species sets fruit between August and October (USFWS, 2016). *Euphorbia haeleeleana* is a short-lived perennial (< 10 years) (USFWS, 2010).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Dry and moist forests (NatureServe, 2015); lowland mixed mesic or dry forest (USFWS, 2016)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at 680 - 2,860 ft. elevation (USFWS, 2016)

Habitat Narrative

Adult: Inhabits dry and moist forests on steep rocky gulch slopes (NatureServe, 2015). *Euphorbia haeleeleana* is usually found in lowland mixed mesic or dry forest that is often dominated by ohia, ohia and koa, lama, or kukui. The plant is typically found at elevations between 205 and 670 m (680 and 2,200 ft), but a few populations have been found up to 870 m (2,860 ft) (USFWS, 2016).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Low (inferred from USFWS, 2016)

Redundancy:

Moderate (inferred from USFWS, 2016)

Number of Populations:

15 (USFWS, 2016)

Population Size:

252-404 wild individuals (143-295 on Kauai; 109 on Oahu; USFWS, 2017)

Minimum Viable Population Size:

25 mature, reproducing individuals (USFWS, 2016)

Population Narrative:

On Kauai, 11 populations of approximately 360 to 510 individuals are known from valley slopes and cliffs along Kauai's northwestern coast from Pohakua to Haeleele Valley and Hipalau Valley within Waimea Canyon. All of the Kauai populations occur on State land, including Kauia Natural Area Reserve and the Na Pali Coast State Park (Service 1995b; S. Perlman, pers. comm. 1996). On Oahu, two populations of approximately 90 to 115 individuals are known from the northern Waianae Mountains. One population of 79 individuals occurs at Keawaula in Makua, and one population occurs on privately owned land (B. Totten, pers. comm. 1998; Service 1995a). There are five population of *E. haeleeleana* with more than 25 mature, reproducing individuals (the minimum number suggested in the recovery plan for this species (Service 1999a) (USFWS, 2016). There were 445 wild individuals in 2008 (USFWS, 2010).; In the previous review, there were estimated to be six occurrences on Oahu with as many as 115 individuals. On Oahu, the most current population estimates are from the Oahu Army Natural Resources Program in 2010. In these surveys there are four wild and two reintroduced occurrences totaling about 260 wild individuals and 34 reintroduced individuals (U.S. Army 2016). On Kauai, *Euphorbia haeleeleana* is known from eight locations, totaling approximately 350 individuals (Wood and Ching Harbin 2017, in litt.). (USFWS, 2017)

Threats and Stressors

Stressor: Feral ungulates (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Threats to this species on Kauai and Oahu include habitat disturbance and predation by pigs (*Sus scrofa*) and goats (*Capra hircus*), and on Kauai, mule deer (*Odocoileus hemionus*). More than half of the critical habitat in Puulu to Alaiheie is on private land currently used to raise cattle (*Bos taurus*) and goats (USFWS, 2010).

Stressor: Predation (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Rats eat the seeds of this tree (Hawaii Biodiversity and Mapping Program 2008; Perlman 2008). Browsing by ungulates has been observed (USFWS 2008). Unknown species of leaf hoppers were noted as a threat to individuals on Oahu and Kauai (National Tropical Botanical Garden 2008a). The individuals in Hanakapiai were observed to have signs of goat damage to the bark (USFWS, 2010).

Stressor: Nonnative plants (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species alter the mesic habitats for *Euphorbia haeleeleana* and compete with it for resources. Some of these invasive species on Kauai include *Lantana camara* (lantana), *Adiantum hispidulum* (rough maidenhair fern), *Ageratum conyzoides* (billy goat weed), *Aleurites moluccana* (candlenut), *Andropogon glomeratus* (beardgrass), *Axonopus fissifolius* (narrow-leaved carpetgrass), *Bryophyllum pinnatum* (airplant), *Grevillea robusta* (silk oak), *Hedychium gardnerianum* (kahili ginger), *Passiflora ligularis* (sweet granadilla), *Pinus elliottii*

(slash pine), *Psidium cattleianum* (strawberry guava), *Rubus argutus* (blackberry), *R. rosifolius* (thimbleberry), and *Setaria parviflora* (yellow foxtail) (Hawaii Biodiversity and Mapping Program 2008; National Tropical Botanical Garden 2008b; Perlman 2008; Tangalin 2008). In drier Hipalau population, the primary invasive introduced plant threats are *Melia azedarach* (pride-of-India), *Grevillea robusta*, and *Lantana camara* (National Tropical Botanical Garden 2008b; Perlman 2008). Invasive introduced plants are also a threat to *Euphorbia haeleeleana* on Oahu. Some of the invasive species there include *Caesalpinia decapetala* (wait-a-bit), *Coffea arabica* (Arabian coffee), *Digitaria insularis* (sourgrass), *Grevillea robusta*, *Hyptis pectinata* (comb hyptis), *Lantana camara*, *Leucaena leucocephala* (haole koa), *Psidium cattleianum*, *Panicum maximum* (guinea grass), *Passiflora suberosa* (corky passionflower, huehue haole), *Rivina humilis* (coral berry), *Schinus terebinthifolius* (Christmas berry), and *Toona ciliata* (Australian red cedar) (Hawaii Biodiversity and Mapping Program 2008; Institute of Pacific Islands Forestry 2008; Perlman 2008) (USFWS, 2010).

Stressor: Fire (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Fire is a concern on both islands, but on Oahu the concern is increased by a history of fires in designated critical habitat areas managed by the Army. Threats to *Euphorbia haeleeleana* critical habitat in the military training action areas include fires ignited by the public and military training, and invasion by introduced plant species, some of which, like *Panicum maximum*, are particularly flammable. Up to half of critical habitat in Kaluakauila was burned in 1970, 1984, 1995, and 2003 fires (USFWS, 2010).

Stressor: Climate change (USFWS, 2010; USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Euphorbia haeleeleana* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.661 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2017)

Stressor: Hurricanes—Loss and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Hurricanes were accidentally not highlighted in the last five year review. In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the

canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event, and 70 percent of all listed plant species on Kauai are endemic to the island. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013). (USFWS, 2017)

Recovery

Reclassification Criteria:

1. A total of five to seven populations should be documented on islands where they now occur or occurred historically (USFWS, 1999).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 1999).
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1999).

Delisting Criteria:

1. A total of 8 to 10 populations should be documented on islands where they now occur or occurred historically (USFWS, 1999).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 1999).
3. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1999).

Recovery Actions:

- Protect habitat and control threats (USFWS, 1999).
- Expand existing wild populations (USFWS, 1999).
- Conduct essential research (USFWS, 1999).
- Develop and maintain monitoring plans (USFWS, 1999).
- Reestablish wild populations within the historic range (USFWS, 1999).
- Validate and revise recovery criteria (USFWS, 1999).
- Construct exclosures to protect populations against wild and feral ungulates (USFWS, 1999).
- Control competing alien plant species (USFWS, 1999).
- Maintain adequate genetic stock (USFWS, 1999).
- Enhance wild populations and establish new populations (USFWS, 1999).
- Reduce threat from rats (USFWS, 1999).
- Protect endangered plants from fire (USFWS, 1999).

- Surveys and inventories—Survey for populations of *Euphorbia haeleeleana* in areas of potentially suitable habitat. (USFWS, 2017)
- Ungulate monitoring and control—Continue to construct and maintain fenced exclosures around all populations. Protect all occurrences against browsing and disturbances from feral ungulates. (USFWS, 2017)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. Control invasive nonnative species that compete with the species around all populations. (USFWS, 2017)
- Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. (USFWS, 2017)
- Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2017)
- Predator and herbivore monitoring and control—Implement effective control methods for rodents around all known populations. Study *Euphorbia haeleeleana* populations to determine the level of threat from invertebrate herbivory and the need for additional recovery actions. (USFWS, 2017)
- Fire monitoring and control—Develop and implement fire management plans for all occurrences in fire-prone areas. (USFWS, 2017)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides. (USFWS, 2017)
- Population biology research—Research reproductive biology of *Euphorbia haeleeleana* to enhance seed production and possible propagation and augmentation of wild populations. (USFWS, 2017)

Conservation Measures and Best Management Practices:

- about 200 individuals (30 percent of all remaining individuals) of this species occur in the Kaluakauila Management Unit where they will benefit from population unit and/or ecosystem-level protection. The Nature Conservancy of Hawaii's long-range management plan for Honouliuli Preserve includes management actions to control non-native plants, feral ungulates, and fire, and to recover rare species and restore native habitats; this plan will benefit any *E. haeleeleana* within the preserve. This species is represented in ex situ collections that include 13 embryos in micropropagation (Harold L. Lyon Arboretum), five plants in a nursery (Harold L. Lyon Arboretum), 10 plants in a botanical garden (Waimea Valley Audubon Center), and 17 ungerminated seeds in a nursery (Harold L. Lyon Arboretum) (Service 2005b, U.S. Army Garrison 2005d) (USFWS, 2016).
- Fence to exclude feral ungulates (USFWS, 2010).
- Develop and implement fire management plans for fire-prone populations (USFWS, 2010).
- Control introduced invasive plants (USFWS, 2010).
- Develop and implement rodent control to reduce seed predation (USFWS, 2010).
- Propagate both common and endangered native species for restoration of habitat in the Army managed areas of *Euphorbia haeleeleana* on Oahu (USFWS, 2010).
- Research reproductive biology of *Euphorbia haeleeleana* to enhance seed production and possible propagation and augmentation of wild populations (USFWS, 2010).
- Continue to work with U.S. Army, Hawaii Division of Forestry and Wildlife, and other landowners to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2010).

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SPECIES ACCOUNT: *Euphorbia telephioides* (Telephus spurge)

Species Taxonomic and Listing Information

Listing Status: Threatened; 6/8/1992; Southeast Region (R4) (USFWS, 2015)

Physical Description

Euphorbia telephicoides is a perennial herb with a stout storage root. Stems are numerous, giving the plant a bushy appearance, and are up to 30 cm (1 ft) tall. Stems and leaves are smooth and have latex (milky sap). The largest leaves are 3-6 cm (1-2 in) long, elliptic or oblanceolate, with the midrib and margins usually maroon. The inflorescence is a cyathium (a structure resembling a flower, containing a single stalked female flower and several male flowers, each reduced to a single stamen). Flowering is from April through July (Kral 1983). Clewell (1985) and Kral (1983) provide guidance for distinguishing this species from the most similar species, *Euphorbia inundata*, a taller plant of moister habitats. (USFWS, 1994)

Taxonomy

Euphorbia telephioides is a member of the spurge family (Euphorbiaceae). It was named by Alvin Wentworth Chapman (1860), who provided no explanation for his choice of name, but rather clearly intended to indicate a resemblance to another plant, most likely the garden plant *Sedum telephium* (orpine, live-forever, or stonecrop) or the similar North American *Sedum telephioides*. Small (1933) preferred to split the huge genus *Euphorbia* into smaller genera, renaming this species *Galarhoeus telephioides*. Taxonomists since then have left the genus *Euphorbia* intact. Webster (1967) established a new subsection of the genus *Euphorbia*, *Inundatae*, that includes *Euphorbia telephioides* and two other species native to the Florida panhandle: *Euphorbia floridana* and *E. inundata* (USFWS, 1994).

Historical Range

Endemic to the Florida panhandle and restricted to Bay, Gulf, and Franklin counties. It is unknown whether *E. telephioides* was once continuously distributed throughout the three counties or populations were restricted to local habitat patches (USFWS, 2015).

Current Range

Currently known from Bay, Gulf, and Franklin counties from Panama City Beach to east of Apalachicola (USFWS, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (NatureServe, 2015)

Breeding Season

Adult: April - July (USFWS, 1994)

Reproduction Narrative

Adult: Several staminate flowers surrounding a pistillate flower in a cyathium (Gleason, 1952). The species is monoecious and reproduction is sexual (NatureServe, 2015). Flowering is from April through July (Kral 1983) (USFWS, 1994).

Habitat Type

Adult: Terrestrial (NatureServe, 2015); wetland (USFWS, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Longleaf pine-slash pine savanna/flatwoods (NatureServe, 2015); coastal pinelands (USFWS, 1994)

Dependencies on Specific Environmental Elements

Adult: Periodic fire (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Excessive shade, development (NatureServe, 2015)

Habitat Narrative

Adult: Wiregrass dominated, longleaf pine-slash pine savanna/flatwoods or on contiguous low, sandy rises dominated by pine-scrub oak near the coast. Cannot tolerate shade, needs fire to maintain community structure; can survive initial conversion of flatwoods to pine plantation. Separation barriers are created by clearing and development of habitat; fire-suppressed scrub and flatwoods (NatureServe, 2015). Although uncommon, telephus spurge was observed growing in wetlands with seepage slope species and in small thick clumps of wire grass surrounded by pine or cypress (Rountree et al. 2005). In general, the plants do well on sandy, acidic soil, with no litter, and low organic and moisture content (Peterson & Campbell 2007) (USFWS, 2015). Inhabits poorly-drained coastal pinelands (USFWS, 1994).

Dispersal/Migration**Dispersal**

Adult: Low (USFWS, 2015)

Dispersal/Migration Narrative

Adult: Seeds are not dispersed over large distances (Negrón-Ortiz, 2014, pers. observ.) (USFWS, 2015).

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Stable (USFWS, 2015)

Number of Populations:

41 (USFWS, 2015)

Population Size:

1000 - 2500 individuals

Population Narrative:

The species status is stable; seven populations are properly protected; three new occurrences were documented; recent surveys conducted on several sites found the species in excellent condition. The number of populations has increased to 41 sites based on recent survey work (FNAI 2007; 2013 -2014 FWS surveys; consultation surveys). Trapnell et al. (2012) found species-wide genetic diversity was high, ranking *E. telephioides* among the highest 10% of plant species surveyed. However, genetic differentiation among populations is lower than that observed for other herbaceous outcrossing perennial plant species (USFWS, 2015).

Threats and Stressors

Stressor: Habitat destruction and degradation (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Urban development continues to threaten telephus spurge since most *E. telephioides* documented locations are found in private land. 380,000 acres of land will maintain timber and agriculture uses, included timberlands in Bay, Calhoun, Franklin, Gadsden, Gulf, Jefferson, Leon, Liberty and Wakulla counties. Many *E. telephioides*' locations are found along US 98, and powerline ROW maintenance (removal of existing and installation of new transmission poles), road widening and new roads continue to negatively affect plant abundance and habitat loss. Urbanized land in Florida, statewide, is projected to double by 2060 along with doubling of the population to 36 million. Suppression of fire during the dormant season continues to threaten the pineland and savanna's flora as fire is an important factor in the maintenance of flatwoods (Abrahamson and Hartnett 1990). Fire influences community structure and composition (Abrahamson and Hartnett 1990), and with insufficient frequency in longleaf pine communities, a woody midstory quickly develops (Glitzenstein et al. 1995), negatively affecting the understory diversity (USFWS, 2015).

Stressor: Sea level rise (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Sea level rise (SLR) as a result of climate change is a growing concern for much of Florida's coastline and the endemic species that occur there because about 10% of Florida is less than 1 meter (m) above current sea level. Wolf and Lopez (2014) estimated the potential for inundation of habitat areas for the Telephus spurge at sea level rise projections from 0.305 to 1.83 m (one to six feet) within this century. The projections indicated that coastal habitat areas in Escambia, Bay, Franklin, and Gulf Counties would be largely inundated beginning at 0.305 m (one foot) of SLR. Therefore, SLR projections of changes, under above all scenarios, will most likely affect several coastal populations specifically those located in Gulf and Franklin counties. *Euphorbia telephioides* is at risk of further decline from SLR because its seeds are not dispersed over large distances (Negrón-Ortiz, 2014, pers. observ.), so sea level may rise more quickly than

the species can establish populations further inland. In addition, *E. telephioides* does not respond well to transplantation (Ecological Resource Consultants 2006; Negrón-Ortiz, 2010, pers. observ.). Another major concern is that as more coastline is inundated with water, urban development will expand, decreasing the amount of suitable habitat for *E. telephioides* and impeding the ability of these species to move landward (USFWS, 2015).

Recovery

Reclassification Criteria:

Not defined (USFWS, 1994; USFWS, 2015)

Delisting Criteria:

1. When 15 populations are adequately protected and managed throughout its historic range. Existing public land (mainly the Apalachicola National Forest) does not suffice for recovery (USFWS, 1994; USFWS, 2015).

Recovery Actions:

- Protect populations in Apalachicola National Forest and on other public lands. This includes Management/general monitoring in Apalachicola National Forest, Conduct of population biology studies, and Conduct of botanical inventories on public land, possible purchase areas, and selected private land. (USFWS, 2015)
- Manage rights-of-way. Highway and utility rights-of-way (mostly electric powerlines along highways) harbor populations of all four plant species. Experience with managing *Harperocallis flava* (Harper's beauty), an endangered plant, on a highway right-of-way in Apalachicola National Forest may suggest approaches for conserving these species. (USFWS, 2015)
- Protect and manage populations outside Apalachicola National Forest through purchase, conservation easements, or other means; develop conservation plans for these sites (USFWS, 2015).
- Conduct systematic and other studies; arrange reintroduction where appropriate and feasible (USFWS, 1994).
- Garden propagation and reintroduction. Reintroduction of *Euphorbia telephioides* depends on suitable, protected habitat being available and methods being developed. It is not yet clear whether it would be useful to maintain garden populations of this species. (USFWS, 2015)

Conservation Measures and Best Management Practices:

- Establish monitoring program: i. Identify additional populations of conservation importance based on information from the genetic studies (ongoing). ii. Conduct a demographic population viability analysis to assess whether the species is declining, increasing, or stable, and where in the life cycle the management should be targeted. This is an ongoing action conducted by Ms. Natali Miller, a graduate student from FL State University (USFWS, 2015).
- Collect voucher specimens (e.g., herbarium specimens, samples for DNA analyses, preserve material, seeds and whole plants) from areas proposed to be developed and 1) transplant to suitable sites, and 2) distribute to herbaria, botanical gardens, and interested scientists (USFWS, 2015).

- Expand germination studies. i. Determine seasonal fluctuations that influence germination timing and recruitment and identify traits that correlate with seed viability and dormancy ii. Conduct ex situ germination studies and clarify limits of seed desiccation and cold tolerance (USFWS, 2015).
- Develop a Species Distribution Model (SDM) to assist with locating new populations and identifying prospective sites for reintroductions such as areas that will not be affected by SLR and future development. Sites should be validated or inspected for plants, and then protected by land acquisitions, conservation easements. This is an ongoing action conducted by Ms. Alexa Mainella, a graduate student from Miami University, OH (USFWS, 2015).
- Phenological data (timing, duration and abundance of recurrent biological processes, including reproductive events such as flowering, fruiting, seed dispersal and germination) have emerged as useful tools for studying the impact of climate change on plants. Lacking phenological adaptability may require a stronger signal or may be unable to adapt to climate warming, and therefore may experience greater stress or even extinction during extended climate change. Therefore, phenological studies should include both long-term observations coupled with herbarium specimens' records (USFWS, 2015).
- Since *E. telephioides* occurs in fire prone habitats, the effect of this disturbance on survival and fecundity should be monitored to determine the best frequent fire regimes, on selected areas to maintain optimal conditions of *E. telephioides* populations (USFWS, 2015).
- Continue fostering a working partnership with the St. Joe Company, AgReserves, Inc. and other developing companies and consulting agencies, such as Flatwoods Consulting Group to address and minimize potential impacts associated with development and fire suppression (USFWS, 2015).
- Outreach: Promote the implementation of the recovery actions via academia, private landowners, and public agencies. Develop and distribute information to the general public (USFWS, 2015).
- The recovery plan should be updated to define objective measurable criteria and better address the five factors (USFWS, 2015).

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SPECIES ACCOUNT: *Eutrema penlandii* (Penland alpine fen mustard)

Species Taxonomic and Listing Information

Listing Status: Threatened; 07/28/1993; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

Eutrema penlandii is a small herbaceous perennial plant that grows to 3-8 cm in height. It is a shiny-green glabrous (hairless) plant with long-petioled (long-stemmed) heart-shaped basal leaves that grow up to 3.5 cm long. It also has clusters of small, white flowers atop the stems that grow 2-3.5 mm in length. It has small and rounded hollow fruits. (USFWS, 1993a)

Taxonomy

Rollins (1982) recognized *Eutrema penlandii* at the species level, but Weber (1987) treated it as a subspecies of *E. edwardsii* (*E. edwardsii* ssp. *penlandii*). (USFWS, 1993a)

Historical Range

E. penlandii never has been collected outside the Mosquito Range in Colorado, and it appears unlikely that the plant exists outside of this area. (USFWS, 1993a)

Current Range

The Penland alpine fen mustard is known from Lake, Park, and Summit counties in Colorado. The plant is found only in the Mosquito Range at elevations ranging from 3,625 to 4,050 meters (11,900 to 13,280 feet). The species is known from an area measuring 11 miles from north to south as well as east to west. (USFWS, 2016)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 2016)

Breeding Season

Adult: Flowering from June to August (USFWS, 2016)

Reproduction Narrative

Adult: Flowering of the Penland alpine fen mustard occurs from June into August, depending on snow-melt. Fruits mature from late-July into August and possible September. We are unsure how many seeds are in each seed pod or when seed pods split to release seeds. Mosquito Range mustard reproduces only by seed, with no means of vegetative reproduction (spread by vegetative growth). Little is known about reproduction, pollinators, or seed dispersal. (USFWS, 2016)

Habitat Type

Adult: Alpine tundra (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Peat fens, bogs, or marshes (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Possibly calcareous substrate (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Habitat Narrative

Adult: The species occurs only in alpine meadows at elevations above 11,800 feet in the Mosquito Range of the Rocky Mountains in central Colorado. Plants are most often found along east facing, gentle slopes and basins that are fed moisture by slow-melting snowfields above. However, they can also be found in dryer locations. In either habitat, they are often rooted in tufts of mosses or hidden among short-bladed grasses. (USFWS, 2016)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Little is known about reproduction, pollinators, or seed dispersal. (USFWS, 2016)

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015)

Representation:

Low (NatureServe, 2015)

Redundancy:

Low (NatureServe, 2015)

Population Growth Rate:

Unknown (NatureServe, 2015)

Number of Populations:

6 - 20 (NatureServe, 2015). As of 2018: 26 (USFWS, 2018).

Population Size:

Approximately 20,800 individuals in 12 of 13 occurrences (NatureServe, 2015). As of 2018: at least 30,885 (USFWS, 2018).

Adaptability:

Very low (USFWS, 2016)

Population Narrative:

There are 13 principal occurrences documented by the Colorado Natural Heritage Program. Approximately 20,800 individuals have been documented within 12 of the 13 occurrences. The remaining occurrence does not report the number of individuals. (NatureServe, 2015)

Threats and Stressors

Stressor: Hydrological alterations (USFWS, 1993a)

Exposure:

Response:

Consequence:

Narrative: The most fragile aspect of the Penland alpine fen mustard's habitat is the continuous supply of water needed to maintain peat fens. *E. penlandii* grows in peat mounds along saturated stream margins and small hummocks within streams, and it rarely occurs more than 0.55 yards away from flowing meltwater. Populations of *E. penlandii* are small, and some are found on areas of less than about 1 acre. Some subpopulations occupy only a few square yards. Because stands of the plant are so small, they are vulnerable to surface disturbances that reroute the needed water supply. This can occur from ditching, diking, or other watershed perturbations that alter surface water flow (e.g., roads, trails, ruts of vehicle tracks, footpaths, or mining construction). Desiccation and loss of a peat fen can cause a loss of plants and reduction in the amount of its highly specialized habitat. (USFWS, 1993)

Stressor: Mining (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Mineral extraction could have a significant impact on this taxon. The mining companies contested the Mosquito Range Research Natural Area; mining remains a big threat to plants in the Mosquito Range because of the thousands of mining claims - a change in the economic viability of mining could cause mining to increase there (CNHP 2004). Also, ditching associated with mining could affect the delicate hydrology and could cause water pollution, both of which would adversely affect the species. (USFWS, 2016)

Stressor: Recreational activities (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: Recreational use is also a threat including trampling by ORV's and hikers. Any activity that directly or indirectly alters the surface or ground water supply and alters the wetland habitat required by this species could pose a significant threat. In one occurrence, Jeeps and ATVs were parked directly on top of *Eutrema* plants (NatureServe Element Occurrence data 2011). The impacts of this seemingly benign activity can destroy large areas of this sensitive bog habitat. (NatureServe, 2015)

Stressor: Localized environmental catastrophes such as fungal blight, drought, or insect infestations (USFWS, 1993a)

Exposure:**Response:****Consequence:**

Narrative: The Penland alpine fen mustard has a few small populations on small areas of specialized habitat that makes it particularly vulnerable to localized environmental catastrophes such as fungal blight, drought, or insect infestations. Alpine tundra is a harsh environment for plant growth. If climatic changes (local or global) reduce the amount of persistent snowfields, the habitat might be further reduced. Some occurrences are located in such a small area that they are vulnerable to perhaps a single upslope surface disturbance. (USFWS, 1993)

Stressor: Climate change (USFWS, 2016)

Exposure:**Response:****Consequence:**

Narrative: The effects of climate change are likely to endanger the survival of Penland alpine fen mustard, as well as many other plant and animal species adapted to alpine ecosystems. (USFWS, 2016)

Recovery**Delisting Criteria:**

No information

Recovery Actions:

- Known habitat needs protection. (USFWS, 1993b)
- Suitable habitat should be surveyed for additional populations. (USFWS, 1993b)
- Research is needed to determine life history and habitat parameters controlling the distribution and abundance of the species. General ecological characterization of the species population, biotic community and obvious abiotic and biotic ecosystem interactions should be initiated. (USFWS, 1993b)
- Management techniques need to be developed to optimize the species' viability. (USFWS, 1993b)
- Naturally occurring populations should be monitored. (USFWS, 1993b)
- A Recovery Plan should be developed. (USFWS, 1993b)
- Habitat acquisition may be desirable since approximately half of the known occurrences are, at least partially, on private land with patented mining claims. (USFWS, 1993b)
- Coordination is needed with public and private entities to enhance conservation. Habitat management plans and conservation agreements are desirable. (USFWS, 1993b)

Conservation Measures and Best Management Practices:

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SPECIES ACCOUNT: *Exocarpos luteolus* (Heau)

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/25/1994; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Exocarpos luteolus, a member of the sandalwood family (Santalaceae), is a moderately to densely branched shrub 0.5 to 2 m (1.6 to 6.6 ft) tall with knobby branches. The leaves are of two kinds, minute scales and more typical leaves. The latter, which are usually present, are elliptical, lance-shaped, or oval, usually 5 to 8 cm (2 to 3.2 in) long and 25 to 36 mm (1 to 1.4 in) wide, and lack a leaf stalk. The green flowers have five to six petals about 1 mm (0.04 in) long. The pale yellow fruit is a drupe (single-seeded fleshy fruit), usually 11 to 19 mm (0.4 to 0.7 in) long, with four distinct indentations at the apex. About 6 to 9 mm (0.2 to 0.4 in) of the drupe is exposed above the fleshy, golden-yellow receptacle. This species is distinguished from others of the genus by its generally larger fruit with four indentations and by the color of the receptacle and fruit (Degener 1932a, 1932b; Forbes 1910; Wagner et al. 1990). (USFWS, 1995)

Historical Range

Historically, *Exocarpos luteolus* was known from three locations on Kauai: Wahiawa Swamp, Kaholuamanu and Kumuwela Ridge (HHP 1994). (USFWS, 1995)

Current Range

Current range in Kauai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Exocarpos luteolus* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Exocarpos luteolus* includes five units totaling 12,312 acres in Kauai County, Hawaii. The units are Kauai 10—*Exocarpos luteolus*—a and Kauai 11—*Exocarpos luteolus*—b, c, d, e.

Kauai 10—*Exocarpos luteolus*—a: This unit is critical habitat for *Exocarpos luteolus* and is 401 ha (990 ac) on State (Lihue-Koloa Forest Reserve) and private land. This unit contains Kahili Summit and Kanaele Swamp. This unit provides habitat for one population of 300 mature, reproducing individuals of the shortlived perennial *Exocarpos luteolus* and is currently occupied with three plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, wet places bordering swamps or bogs; open or dry ridges in lowland or montane mesic *Acacia koa*-*Metrosideros polymorpha*-dominated forest communities with *Dicranopteris*. This unit is geographically separated from the

other four units designated as critical habitat for this island-endemic species to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 11—*Exocarpos luteolus*—b: This unit is critical habitat for *Exocarpos luteolus* and is 3,800 ha (9,389 ac) on State (Alakai Wilderness Preserve, Halelea Forest Reserve, and Hono o Na Pali NAR) and private land. This unit contains the Alakai Swamp and Trail, Halehaha and Halepaakai Streams, Kaluahaula Ridge, and Kapoki, Kilohana, Koali, and Pihea Summits. This unit provides habitat for four populations of 300 mature, reproducing individuals of the short-lived perennial *Exocarpos luteolus* and is currently occupied with 19 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, wet places bordering swamps or bogs; open or dry ridges in lowland or montane mesic *Acacia koa*-*Metrosideros polymorpha*-dominated forest communities with *Dicranopteris*. This unit is geographically separated from the other four units designated as critical habitat for this island-endemic species to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 11—*Exocarpos luteolus*—c: This unit is critical habitat for *Exocarpos luteolus* and is 176 ha (438 ac) on State land (Kokee and Na Pali Coast State Parks) within Kalalau Valley. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Exocarpos luteolus* and is currently occupied with over 40 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, wet places bordering swamps or bogs; open or dry ridges in lowland or montane mesic *Acacia koa*-*Metrosideros polymorpha*-dominated forest communities with *Dicranopteris*. This unit is geographically separated from the other four units designated as critical habitat for this island-endemic species to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 11—*Exocarpos luteolus*—d: This unit is critical habitat for *Exocarpos luteolus* and is 83 ha (206 ac) on State land (Kokee State Park) on Kamuela Ridge. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Exocarpos luteolus* and is currently occupied with between five and seven plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, wet places bordering swamps or bogs; open or dry ridges in lowland or montane mesic *Acacia koa*-*Metrosideros polymorpha*-dominated forest communities with *Dicranopteris*. This unit is geographically separated from the other four units designated as critical habitat for this island-endemic species to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 11—*Exocarpos luteolus*—e: This unit is critical habitat for *Exocarpos luteolus* and is 522 ha (1,290 ac) on State land (Kuia NAR, Kokee and Na Pali Coast State Parks). This unit contains Awaawapuhi, Honopu, and Nualolo Trails, and Kainamanu and Kalahu Summits. This unit provides habitat for three populations of 300 mature, reproducing individuals of the short-lived perennial *Exocarpos luteolus* and is currently occupied with six plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to,

wet places bordering swamps or bogs; open or dry ridges in lowland or montane mesic *Acacia koa*/*Metrosideros polymorpha*-dominated forest communities with *Dicranopteris*. This unit is geographically separated from the other four units designated as critical habitat for this island-endemic species to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

- (i) Wet places bordering swamps or open bogs or on open or dry ridges in lowland or montane mesic *Acacia koa*/*Metrosideros polymorpha*-dominated forest communities with *Dicranopteris linearis* and containing one or more of the following native plant species: *Bobea brevipes*, *Cheirodendron trigynum*, *Claoxylon sandwicense*, *Dianella sandwicensis*, *Dodonaea viscosa*, *Dubautia laevigata*, *Elaeocarpus bifidus*, *Hedyotis terminalis*, *Leptecophylla tameiameia*, *Melicope haupuensis*, *Peperomia* spp., *Pleomele aurea*, *Poa sandwicensis*, *Pouteria sandwicensis*, *Psychotria greenwelliae*, *Psychotria mariniana*, *Santalum freycinetianum*, or *Schiedea stellarioides*; and
- (ii) Elevations between 416 and 1,453 m (1,364 and 4,766 ft).

Special Management Considerations or Protections

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Moist environment (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 600 and 1,100 meters (2,000 and 3,600 feet) (USFWS, 2010)

Environmental Specificity

Adult: Low, with few key requirements (USFWS, 2010)

Habitat Narrative

Adult: *Exocarpos luteolus* is found at elevations between 600 and 1,100 meters (2,000 and 3,600 feet) in a variety of habitats. *Exocarpos luteolus* grows in many habitats including both wet and mesic forests, bogs, stream banks, and wind-swept ridges. Populations in forest habitat include Kumuwela (Tangalin 2006a), Waialae; Honopu Trail; Kawaiiki, off Kaluahaula ridge, in the upper forest and drainage to the south of Koaie and north of Waialae. The habitat is *Metrosideros polymorpha* (ohia) – *Dicranopteris linearis* (uluhe) – *Acacia koa* (koa) montane mixed mesic to wet forest. Bog locations include Circle Bog, north of Mohihi Stream, the Waikoali Bogs, and scattered bogs to the northeast. Ridges where *Exocarpos luteolus* occurs include Kalalau Rim and its *Exocarpos* Ridge, Honopu Rim, and Wahiawa ridge between Hanapepe Valley and the Wahiawa Drainage. Stream banks where *Exocarpos luteolus* has been found include Koaie stream and Nawaimaka Stream in *Diospyros* sp. – *Metrosideros polymorpha* – *Acacia koa* montane mesic forest riparian community. (USFWS, 2010)

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2010)

Redundancy:

Very low (inferred from USFWS, 2010)

Number of Populations:

8 (USFWS, 2010). As of 2017: 14 (USFWS, 2017).

Population Size:

39 (USFWS, 2010). As of 2017: 51 (USFWS, 2017).

Population Narrative:

In total, approximately 39 individuals are known in 8 populations. (USFWS, 2010). Each subpopulation consists of only a few individuals, with the largest subpopulation consisting of six individuals. Surveys conducted by NTBG since the last 5-year review show that individuals remain at Awaawapuhi, Hanakapiai, Kohua, Honopu rim, Kahuamaa Flat, Koaie valley and stream headwaters, Kawaiiki ridge, and Kauaikinana gulch areas (NTBG 2011a-e, 2012a-h, 2013a-g, 2015a-b, 2016a-b). (USFWS, 2017).

Threats and Stressors

Stressor: Habitat degradation by feral pigs and goats (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Feral pigs (*Sus scrofa*) degrade the habitat of this species. In Kumuwela, there has been pig rooting near the base of one individual. The Kalalau Valley habitat is degraded by goats (*Capra hircus*). (USFWS, 2010)

Stressor: Invasive plants (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The Kalalau Rim population is threatened by invasive introduced plant species including *Rubus argutus* (prickly Florida blackberry), *Passiflora tarminiana* (banana poka), and *Erigeron karvinskianus* (daisy fleabane) (Wood 2008). The Kalalau Valley habitat has been invaded by the following introduced plant species: *Christella dentata* (pail iha), *Lantana camara* (lantana), *Melinis minutiflora* (molasses grass), *Erigeron karvinskianus* (daisy fleabane), *Andropogon glomeratus* (beardgrass), *Hedychium gardnerianum* (kahili ginger), *Rubus rosifolius* (thimbleberry), *Psidium guajava* (common guava), *Melinis minutiflora* (molasses grass), *Bryophyllum pinnatum* (airplant), and *Aleurites moluccana* (kukui). *Clidemia hirta* (Koster's curse) has also been moving into the area (Wood 2008). In Kumuwela, invasive introduced plant species in this area include *Lantana camara*, *Hedychium gardnerianum*, *Rubus argutus*, and *Passiflora mollissima* (N. Tangalin, pers. comm. 2008b). In the Nawaimaka Stream area, threats are invasive introduced plant species including *Psidium guajava*, *Lantana camara*, and *Buddleia* sp. (smoke bush). (USFWS, 2010)

Stressor: Seed predation by rats (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Seed predation by rats (*Rattus* spp.) is also a threat to *Exocarpos luteolus* (Wood 2008). (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: Climate change may also pose a threat to *Exocarpos luteolus*. However, current climate change models do not allow us to predict specifically what those effects, and their extent, would be for this species. (USFWS, 2010). Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Exocarpos luteolus* is vulnerable to the impacts of climate change, with a vulnerability score of 0.496 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2017).

Stressor: Stochastic events (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: In addition to all of the other threats, species like *Exocarpos luteolus* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding, and disease outbreaks. (USFWS, 2010)

Stressor: Small population size (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: Reduced reproductive vigor may be the result of limited numbers of existing individuals. (USFWS, 2010)

Stressor: Fire destruction or degradation of habitat (USFWS, 2017).

Exposure:**Response:****Consequence:**

Narrative: Increasing episodes of drought, expansion of invasive grass cover, and temperature increases, have led to an increase in the number of wildfires on Kauai (Trauernicht et al. 2015). Fire is a potential threat to *Exocarpos luteolus* (NTBG 2012f-g, 2015a). (USFWS, 2017).

Recovery**Reclassification Criteria:**

1. A total of five to seven populations of each taxon should be documented on Kauai and at least one other island where they now occur or occurred historically. (USFWS, 1995)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived

perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1995)

3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1995)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Kauai and at least one other island where they now occur or occurred historically. (USFWS, 1995)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1995)

3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1995)

Recovery Actions:

- Recent surveys indicate that the Alakai Swamp populations of this taxon are threatened by feral pigs. Fencing of the Waikoali Bog complex will protect several populations of *Exocarpos luteolus* and other rare taxa from pig damage (L. Mehrhoff, personal communication 1995). (USFWS, 1995)
- The plan begins with the protection and management of current habitats of the Kauai cluster taxa. Current threats are addressed through fencing and/or hunting to control ungulates; control of alien plants; protection from fire; control of rodents and slugs; control of insects, pests and disease; protection from human disturbance; collection, storage and maintenance of genetic material; and, a comprehensive monitoring program. (USFWS, 1995)
- A research program is also recommended to study the growth and reproductive viability of each taxon, determine the parameters of viable populations of each taxon, study the reproductive strategy and pollinators of each taxon, study possible pests and diseases, and use the results of such research to improve management practices. (USFWS, 1995)
- A program of augmentation of very small populations and reestablishment of new populations within the historical range of the species is also needed. (USFWS, 1995)
- A public education program is also needed to increase public awareness and support for plant recovery efforts. (USFWS, 1995)
- Finally, the recovery objectives should be refined and revised as new information becomes available. (USFWS, 1995)
- 2017 Recommended Action 1: Captive propagation protocol development—
 - o Develop methods to successfully propagate this species for reintroduction.
 - o Collect seeds and determine storage potential.
 - o Determine propagation methods from seeds and cuttings.(USFWS, 2017).
- 2017 - 2: Invasive plant monitoring and control—
 - o Continue to control established ecosystem-altering nonnative invasive plant species around all populations.
 - o Continue to control invasive nonnative species that compete with the species around all populations.(USFWS, 2017).

- 2017 - 3: Captive propagation for genetic storage and reintroduction—Continue to collect material for genetic storage and propagation for reintroduction. (USFWS, 2017).
- 2017 - 4: Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2017).
- 2017 - 5: Predator and herbivore monitoring and control—Implement effective control methods for rodents around all known populations. (USFWS, 2017).
- 2017 - 6: Population biology research—Investigate techniques to improve natural recruitment. (USFWS, 2017).
- 2017 - 7: Fire monitoring and control—Develop and implement fire management plans for all wild and reintroduced populations. (USFWS, 2017).
- 2017 - 8: Ungulate monitoring and control—Construct small-scale fences around all wild individuals to provide protection from the negative impacts of feral ungulates to prevent imminent extinction. (USFWS, 2017).
- 2017 - 9: Population viability monitoring and analysis—Study *Exocarpos luteolus* populations to determine geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, threats. Determine viable population size and structure after successful reintroductions and augmentations to existing populations have been conducted. (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Continue seed collection for genetic storage and reintroduction. (USFWS, 2010)
- Control introduced invasive plant species around wild plants. (USFWS, 2010)
- Construct large-scale fences around all wild individuals to control feral ungulates. (USFWS, 2010)
- Reintroduce individuals into protected suitable habitat within historical range. (USFWS, 2010)
- Investigate techniques to improve natural recruitment. (USFWS, 2010)
- Assess genetic variability within and between extant populations. (USFWS, 2010)
- Study *Exocarpos luteolus* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. (USFWS, 2010)
- Work with Hawaii Division of Forestry and Wildlife and the Kauai Watershed Alliance to contribute to implementation of ecosystem-level restoration and management to benefit this species in the Alakai Swamp. (USFWS, 2010)

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SPECIES ACCOUNT: *Exocarpos menziesii* (Menzies ballart)

Species Taxonomic and Listing Information

Listing Status: Proposed Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2016)

Physical Description

Exocarpos menziesii (heau) is shrub in the sandalwood family (Santalaceae). Individuals are from 2 to 6.5 ft (0.5 to 2 m) tall. Stems are densely branched toward the ends, with conspicuously maroon-tinged tips. The leaves are usually scale-like, with occasional oblanceolate, foliaceous leaves 0.4 to 0.6 in (10 to 14 mm) long. Flowers are red and drupes are reddish brown to red at maturity, ovoid, 0.3 to 0.4 in (7 to 10 mm) long, with a small terminal beak partially embedded in a yellow, fleshy, receptacle (Wagner et al. 1999, p. 1218) (USFWS, 2015).

Taxonomy

Exocarpos menziesii was recognized as a distinct taxon in the 1999 update to the Manual of Flowering Plants of Hawaii (Wagner et al. 1999, p. 1218) (USFWS, 2014).

Historical Range

Exocarpos menziesii is historically known from the island of Lanai (Kaiholena Gulch) and was formerly more wide-spread on the island of Hawaii (from Kahuku Ranch in the south to Hualalai and Puukapele on the leeward slopes) (Wagner et al. 1999, p. 1218; TNCH 2007; HBMP 2010) (USFWS, 2015).

Current Range

Currently, there is 1 scattered occurrence of fewer than 20 individuals on the slopes of Hualalai and approximately 1,800 individuals in the U.S. Army's Pohakuloa Training Area (PTA) on the island of Hawaii (PEPP 2013, pp. 10, 33; Thomas 2014, in litt.; Evans 2015, in litt.). There are no known occurrences of this species on Lanai today (USFWS, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Habitat Type

Adult: Shrubland/dry forest (USFWS, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 4,600 to 6,900 feet (USFWS, 2015)

Habitat Narrative

Adult: This species occurs in *Metrosideros* shrubland or drier forest areas, and on lava flows with sparse vegetation, from 4,600 to 6,900 ft (1,400 to 2,100 m), in the montane dry ecosystem on the island of Hawaii (Wagner et al. 1999, p. 1218; TNCH 2007; HBMP 2010) (USFWS, 2015).

Dispersal/Migration***Population Information and Trends*****Population Trends:**

No information found.

Representation:

Low

Redundancy:

Low

Number of Populations:

7 (USFWS, 2016)

Population Size:

~1,800 (USFWS, 2016)

Population Narrative:

Currently, there is 1 scattered occurrence of fewer than 20 individuals on the slopes of Hualalai and approximately 1,800 individuals in the U.S. Army's Pohakuloa Training Area (PTA) on the island of Hawaii (PEPP 2013, pp. 10, 33; Thomas 2014, in litt.; Evans 2015, in litt.). There are no known occurrences of this species on Lanai today. (USFWS, 2015; USFWS, 2016)

Threats and Stressors

Stressor: Feral ungulates (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Feral goats, mouflon, and sheep modify and destroy the habitat of *Exocarpos menziesii* on Hawaii Island, with evidence of the activities of these animals reported in the areas where this species occurs (USFWS Rare Taxon Database 2015, in litt.) (USFWS, 2015).

Stressor: Reduced vegetative vigor (USFWS, 2015)

Exposure:

Response:

Consequence: Extinction

Narrative: Occurrences and numbers of individuals have declined on the island of Hawaii (HBMP 2010; Thomas 2014, in litt.), once widely distributed from the south to the west sides of the island, and are now restricted to two locations; consequently *E. menziesii* may experience reduced reproductive vigor due to reduced levels of genetic variability, leading to diminished capacity to adapt to environmental changes, thereby reducing the probability of long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361; HBMP 2010) (USFWS, 2015).

Stressor: Fire (USFWS, 2105)

Exposure:**Response:**

Consequence: Loss of habitat/loss of individuals

Narrative: Fire is a potential threat to this species; although the U.S. Army has constructed firebreaks and has standard operating procedures in place for prevention and suppression of wildfires at PTA, wildfires may encroach from other areas (U.S. Army Garrison 2013, in litt.). The small number of individuals outside the occurrence at PTA may limit this species' ability to adapt to environmental change (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)

Exposure:**Response:**

Consequence: Loss of habitat

Narrative: Climate change may result in alteration of the environmental conditions and ecosystems that support this species. *Exocarpos menziesii* may be unable to tolerate or respond to changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini et al. 2013, p. 76) (USFWS, 2015).

Stressor: Non-native plants (USFWS, 2016)

Exposure:**Response:****Consequence:**

Narrative: Additionally, nonnative plants modify and destroy native habitat and outcompete this and other native species for water, nutrients, light, and space, or a nonnative plant may produce chemicals that inhibit growth of other plants, also negatively affecting habitat of *E. menziesii* (Smith 1985, pp. 180–250; Vitousek et al. 1987 in Cuddihy and Stone 1990, p. 74). (USFWS, 2016)

Recovery**Recovery Actions:**

- A recovery plan has not been completed for this species.

References

USFWS. 2014. U.S. FISH AND WILDLIFE SERVICE SPECIES ASSESSMENT AND LISTING PRIORITY ASSIGNMENT FORM Scientific Name: *Exocarpos menziesii*

USFWS. 2015. Endangered and Threatened Wildlife and Plants

Endangered Status for 49 Species From the Hawaiian Islands

Proposed Rule. FR Vol. 80, No. 189. Pages 58820-58909

USFWS. 2016. Environmental Conservation Online System (ECOS) – Species Profile. <http://ecos.fws.gov/ecp0/>. Accessed August 2016.

Proposed Rule. FR Vol. 80, No. 189. Pages 58820-58909.

USFWS. 2016. Endangered and Threatened Wildlife and Plants

Endangered Status for 49 Species From the Hawaiian Islands. Federal Register Vol. 81, No. 190.
Pages 67786-67860

SPECIES ACCOUNT: *Flueggea neowawraea* (Mehamehame)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/10/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

It is a large dioecious tree (with male and female reproductive parts on separate plants) that can grow to heights of 30 m (100 ft). This species has white oblong pores in its scaly, pale brown bark. The alternately arranged leaves are 4 to 14 cm (1.6 to 5.5 in) long. The tiny, greenish flowers are borne in axillary clusters. The round, reddish brown or black fruits are 3 to 6 mm (0.12 to 0.24 in) in diameter and contain six seeds. *Flueggea neowawraea* is the only member of this genus found in Hawaii and can be distinguished from similar Hawaiian species in the family by the hairless, whitish lower leaf surfaces and round fruits (Wagner et al 1999; Makua Implementation Team 2003) (USFWS, 2016).

Taxonomy

A member of the Euphorbiaceae (spurge) family (USFWS, 2016).

Historical Range

Flueggea neowawraea is a species endemic to the Hawaiian Islands and historically occurred on Oahu, Kauai, Maui, Molokai, and Hawaii. The recorded history of *F. neowawraea* is relatively short for a native Hawaiian tree, as it was not discovered until 1912 (USFWS, 2016).

Current Range

Currently, *F. neowawraea* still exists throughout its recorded range except on Molokai, where the single known tree died before 1939. Only two trees are known to persist on the southern flank of Haleakala, East Maui. Five to seven trees are known on the island of Hawaii. On Oahu, *F. neowawraea* grows in gulches of the northern Waianae Mountains (Makua Implementation Team 2003). In addition, there are 60 to 80 trees known on Kauai (Makua Implementation Team 2003) (USFWS, 2016).

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Flueggea neowawraea* (Mehamehame) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes five detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Flueggea neowawraea* on the island of Kauai (68 FR 9116 - 9479).

On September 18, 2012, the U.S. Fish and Wildlife Service (Service) revised critical habitat for *Flueggea neowawraea* on the island of Oahu (77 FR 57647 - 57862).

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Flueggea neowawraea* on the island of Hawaii.

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Flueggea neowawraea* (Mehamehame) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Flueggea neowawraea* (77 FR 57648-57862). The critical habitat designation includes 11 critical habitat units, which encompass approximately 7,332 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Flueggea neowawraea* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Flueggea neowawraea* includes five CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Molokai—Lowland Mesic—Unit 1 (and) *Palmeria dolei*—Unit 37—Lowland Mesic (and) *Pseudonestor xanthophrys*—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Ctenitis squamigera*, *Cyanea dunbariae*, *C. mannii*, *C. profuga*, *Cyperus fauriei*, *Cyrtandra filipes*, *Gouania hillebrandii*, *Labordia triflora*, *Neraudia sericea*, *Santalum haleakalae* var. *lanaiense*, *Schiedea lydgatei*, *S. sarmentosa*, *Silene alexandri*, *S. lanceolata*, *Spermolepis hawaiiensis*, and *Zanthoxylum hawaiiense*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Mesic—Unit 1 is not known to be occupied by *Asplenium dielirectum*, *Bonamia menziesii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea procera*, *C. solanacea*, *Diplazium molokaiense*, *Festuca molokaiensis*, *Flueggea neowawraea*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Melicope mucronulata*, *M. munroi*, *M. reflexa*, *Phyllostegia haliakalae*, *P. mannii*, *P. pilosa*, *Sesbania tomentosa*, *Stenogyne bifida*, or *Vigna o-wahuensis*, or the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwiku* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 1 consists of 11,465 ac (4,640 ha) of State land, 2,069 ac (837 ha) of federally owned land, and 3 ac (1 ha) of privately owned land, from Kanaio to Kahualau Gulch on the southern slopes of east Maui. This unit is occupied by the plants *Bonamia menziesii*, *Cenchrus agrimonoides*, *Flueggea neowawraea*, *Melicope adscendens*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 1 is not known to be occupied by *Alectryon macrococcus*, *Bidens micrantha* ssp. *kalealaha*, *Canavalia*

pubescens, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Sesbania tomentosa*, *Solanum incompletum*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 2 consists of 1,851 ac (749 ha) of State land at Keokea on the southern slopes of east Maui. This unit is occupied by the plants *Bonamia menziesii*, *Canavalia pubescens*, and *Hibiscus brackenridgei*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 2 is not known to be occupied by *Alectryon macrococcus*, *Bidens micrantha* ssp. *kalealaha*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 3 consists of 188 ac (76 ha) of privately owned land, at Keauhou on the southern slopes of east Maui. This unit is occupied by the plant *Canavalia pubescens*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 3 is not known to be occupied by *Bidens micrantha* ssp. *kalealaha*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 4 consists of 1,266 ac (512 ha) of State land (including the Department of Land and Natural Resources) at Ahihi-Kinohi Natural Area Reserve on the southern slopes of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Maui—Lowland Dry—Unit 4 is not currently occupied by *Bidens micrantha* ssp. *kalealaha*, *Bonamia menziesii*, *Canavalia pubescens*,

Cenchrus agrimonioides, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat designation for *Flueggea neowawraea* includes six units totaling 1,471 acres. The units are Kauai 11—*Flueggea neowawraea*—a, b, c, d, e, f.

The critical habitat designation for *Flueggea neowawraea* includes 11 units totaling 7,332 acres on Oahu. Kauai 11—*Flueggea neowawraea*—a: This unit is critical habitat for *Flueggea neowawraea* and is 51 ha (126 ac) on State land (Na Pali Coast State Park) within Kalalau Valley. This unit, in combination with units 11—*Flueggea neowawraea*—b and 11—*Flueggea neowawraea*—e, provides habitat for one population of 100 mature, reproducing individuals of the longlived perennial *Flueggea neowawraea* and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is essential to the establishment of additional populations on Kauai in order to reach recovery goals. It provides habitat for the westernmost range of the species. The habitat features contained in this unit that are essential for this species include, but are not limited to, dry or mesic forests. This unit together with the two other units, provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event. Kauai 11—*Flueggea neowawraea*—b: This unit is critical habitat for *Flueggea neowawraea* and is 48 ha (117 ac) on State land (Na Pali Coast State Park) within Kalalau Valley. This unit, in combination with units 11—*Flueggea neowawraea*—a and 11—*Flueggea neowawraea*—e, provides habitat for one population of 100 mature, reproducing individuals of the longlived perennial *Flueggea neowawraea* and is currently occupied with one plant. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. It provides habitat for the westernmost range of the species. The habitat features contained in this unit that are essential for this species include, but are not limited to, dry or mesic forests. This unit together with the two other units, provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event. Kauai 11—*Flueggea neowawraea*—c: This unit is critical habitat for *Flueggea neowawraea* and is 152 ha (376 ac) on State land (Alakai Wilderness Preserve), containing portions of Kawaiiki Valley. This unit provides habitat for one population of 100 mature, reproducing individuals of the long-lived perennial *Flueggea neowawraea* and is currently occupied with 30 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. It provides habitat for the westernmost range of the species. The habitat features contained in this unit that are essential for this species include, but are not limited to, dry or mesic forests. This unit provides for one population within this multiisland species' historical range on Kauai

that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event. Kauai 11—*Flueggea neowawraea*—d: This unit is critical habitat for *Flueggea neowawraea* and is 77 ha (191 ac) on State land (Hono o Na Pali NAR and Na Pali Coast State Park). This unit contains Puu Ki Summit and Kaalahina Ridge. This unit provides habitat for one population of 100 mature, reproducing individuals of the long-lived perennial *Flueggea neowawraea* and is currently occupied with nine plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. It provides habitat for the westernmost range of the species. The habitat features contained in this unit that are essential for this species include, but are not limited to, dry or mesic forests. This unit provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event. Kauai 11—*Flueggea neowawraea*—e: This unit is critical habitat for *Flueggea neowawraea* and is 27 ha (67 ac) on State land (Na Pali Coast State Park) within Kalalau Valley. This unit, in combination with units 11—*Flueggea neowawraea*—a and 11—*Flueggea neowawraea*—b, provides habitat for one population of 100 mature, reproducing individuals of the longlived perennial *Flueggea neowawraea* and is currently occupied with one plant. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. It provides habitat for the westernmost range of the species. The habitat features contained in this unit that are essential for this species include, but are not limited to, dry or mesic forests. This unit together with the two other units, provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event. Kauai 11—*Flueggea neowawraea*—f: This unit is critical habitat for *Flueggea neowawraea* and is 240 ha (594 ac) on State land (Kuia NAR). This unit contains portions of Milolii Ridge, and Kuia and Mahanaloa Valleys. This unit provides habitat for one population of 100 mature, reproducing individuals of the long-lived perennial *Flueggea neowawraea* and is currently occupied with four plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. It provides habitat for the westernmost range of the species. The habitat features contained in this unit that are essential for this species include, but are not limited to, dry or mesic forests. This unit provides for one population within this multiisland species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

The critical habitat designation for *Flueggea neowawraea* includes 11 units totaling 7,332 acres in Oahu. The units are Oahu—Lowland Mesic—Unit 1, 2, 3; Oahu—Dry Cliff—Unit 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Lowland Mesic—Unit 1 consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). This unit is occupied by *Flueggea neowawraea* and includes

the mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Oahu—Lowland Mesic—Unit 2 consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Although this unit is not known to be occupied by *Flueggea neowawraea*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Mesic—Unit 3 consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Although this unit is not known to be occupied by *Flueggea neowawraea*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 1 consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. This unit is on State land within the Pahole Natural Area Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. Although this unit is not known to be occupied by *Flueggea neowawraea*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Dry Cliff—Unit 2 consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. This unit is almost entirely within the Makua Keaau Forest Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. Although this unit is not known to be occupied by *Flueggea neowawraea*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Dry Cliff—Unit 3 consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. This unit is partially within the Waianae Kai Forest Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. This unit is

occupied by *Flueggea neowawraea* and contains unoccupied habitat that is essential to the conservation of the species by providing the PCEs necessary for the expansion of the existing wild populations.

Oahu—Dry Cliff—Unit 4 consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. This unit is partially within the Waianae Kai Forest Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. Although this unit is not known to be occupied by *Flueggea neowawraea*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 6 consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. This unit is occupied by *Flueggea neowawraea* and contains unoccupied habitat that is essential to the conservation of the species by providing the PCEs necessary for the expansion of the existing wild populations.

Oahu—Dry Cliff—Unit 7a consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. This unit is occupied by *Flueggea neowawraea* and contains unoccupied habitat that is essential to the conservation of the species by providing the PCEs necessary for the expansion of the existing wild populations.

Oahu—Dry Cliff—Unit 7b consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. Although this unit is not known to be occupied by *Flueggea neowawraea*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 8 consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve. A small portion of this area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. This unit is occupied by *Flueggea neowawraea* and contains unoccupied habitat that

is essential to the conservation of the species by providing the PCEs necessary for the expansion of the existing wild populations.

The critical habitat designation for *Flueggea neowawraea* includes two units totaling 3,645 acres in Hawaii County, Hawaii. The units are Hawaii 17—*Flueggea neowawraea*—a and Hawaii 18—*Flueggea neowawraea*—b. Both units are occupied by individuals of this species. Each unit is essential to the conservation of *F. neowawraea* because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The units are geographically separated from other critical habitat for this multi-island species within its historical range in order to reduce the likelihood of all recovery populations being destroyed by one naturally occurring catastrophic event.

Hawaii 17—*Flueggea neowawraea*—a [327 ha (807 ac)]: This unit contains no named natural features, it lies completely within the Kiilae watershed, and is completely within the South Kona Forest Reserve. The unit provides habitat for 1 population of 100 individuals of *F. neowawraea*, and is currently occupied by 10 individuals.

Hawaii 18—*Flueggea neowawraea*—b [1,148 ha (2,838 ac)]: This unit contains no named natural features and lies completely within the Kauna watershed. The unit also lies almost completely within Manuka NAR except for one State-owned inholding that is nonmanaged land within the conservation district. This unit provides habitat for 1 population of 100 individuals of *F. neowawraea* and is currently occupied by 5 to 11 individuals. This unit provides the southernmost critical habitat within the species' historical range.

The critical habitat designation for *Flueggea neowawraea* includes 11 critical habitat units, covering two ecosystem types, which encompass approximately 7,332 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3; Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac

(10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac (105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Flueggea neowawraea* critical habitat consists of two components. Lowland dry (east Maui) and Lowland mesic (Molokai) (81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*. Subcanopy: *Chamaesyce*, *Dodonaea*, *Leptecophylla*, *Osteomeles*, *Psydrax*, *Scaevola*, *Wikstroemia*. Understory: *Alyxia*, *Artemisia*, *Bidens*, *Chenopodium*, *Nephrolepis*, *Peperomia*, *Sicyos*.

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Dry or mesic forests containing one or more of the following native plant species: *Alectryon macrococcus*, *Antidesma platyphyllum*, *Bidens sandwicensis*, *Bobea timonioides*, *Caesalpinia kawaiensis*, *Charpentiera* spp., *Diospyros* spp., *Diplazium sandwichianum*, *Freycinetia arborea*, *Hibiscus* spp., *Isodendron laurifolium*, *Kokia kauaiensis*, *Melicope* spp., *Metrosideros polymorpha*, *Munroidendron racemosum*, *Myrsine lanaiensis*, *Nesoluma polynesianum*, *Nestegis sandwicensis*, *Pittosporum* spp., *Pouteria sandwicensis*, *Pritchardia minor*, *Psychotria* spp., *Psydrax odorata*, *Pteralyxia kauaiensis*, *Rauvolfia sandwicensis*, *Streblus pendulinus*, *Tetraplasandra* spp., *Xylosma crenatum*, or *Xylosma hawaiiense*; and

(ii) Elevations between 210 and 1,178 m (689 and 3,865 ft).

(i) In units Oahu—Lowland Mesic— Unit 1, Oahu—Lowland Mesic—Unit 2, and Oahu—Lowland Mesic—Unit 3, the physical and biological features of critical habitat are: (A) Elevation: Less than 3,300 ft (1,000 m). (B) Annual precipitation: 50 to 75 in (130 to 190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*,

Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (F) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

(ii) In units Oahu—Dry Cliff—Unit 1, Oahu—Dry Cliff—Unit 2, Oahu—Dry Cliff—Unit 3, Oahu—Dry Cliff—Unit 4, Oahu—Dry Cliff—Unit 6, Oahu—Dry Cliff—Unit 7a, Oahu—Dry Cliff—Unit 7b, and Oahu—Dry Cliff—Unit 8, the physical and biological features of critical habitat are: (A) Elevation: Unrestricted. (B) Annual precipitation: Less than 75 in (190 cm). (C) Substrate: Greater than 65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. (F) Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Habitat features that are essential for this species include, but are not limited to, mesic *Metrosideros polymorpha* forest.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Flueggea neowawraea* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Flueggea neowawraea* occurs within the Lowland mesic and Dry cliff ecosystems in the Waianae Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, *Metrosideros*, *Myrsine*, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (E) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. (E) Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species

that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*,

Bidens campylotheca ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

All critical habitat, except in the coastal ecosystem on Oahu, requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs and goats). Feral ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required during nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat posed by fire to Oahu—Lowland Mesic—Unit 2, Oahu—Lowland Mesic—Unit 3, Oahu—Lowland Mesic—Unit 7, Oahu—Dry Cliff—Unit 2, Oahu—Dry Cliff—Unit 3, Oahu—Dry Cliff—Unit 4, Oahu—Dry Cliff—Unit 6, Oahu—Dry Cliff—Unit 7 (Oahu—Dry Cliff—Unit 7a and Oahu—Dry Cliff—Unit 7b), and Oahu—Dry Cliff—Unit 8. Oahu—Dry Cliff—Unit 1, Oahu—Dry Cliff—Unit 2, Oahu—Dry Cliff—Unit 3, Oahu—Dry Cliff—Unit 4, Oahu—Dry Cliff—Unit 6, Oahu—Dry Cliff—Unit 7 (Oahu—Dry Cliff—Unit 7a and Oahu—Dry Cliff—Unit 7b) may require special management to reduce the threat of landslides, rockfalls, and flooding.

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for these species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Flueggea neowawraea* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (USFWS, 2016)

Lifespan

Adult: > 10 years (USFWS, 2013)

Breeding Season

Adult: Late summer - fall (USFWS, 2016)

Key Resources Needed for Breeding

Adult: Presumably insect pollinators (USFWS, 2016)

Reproduction Narrative

Adult: Flowering of *Flueggea neowawraea* occurs over a brief period in the late summer and fall, depending on local rainfall patterns, and is usually well synchronized among the trees in a given area. The small, inconspicuous flowers are presumably pollinated by insects. Little is known of this species' growth rate and age of maturation in the wild, but it grows rapidly and matures early in cultivation (within three years) (Makua Implementation Team 2003). The need for cross-pollination further constrains this species' recovery, given its low numbers, isolation of mature trees, and separation of male and female trees (Makua Implementation Team 2003) (USFWS, 2016). *Flueggea neowawraea* is a long-lived perennial (> 10 years) (USFWS, 2013).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Moist *Diospyros sandwicensis* and/or *Metrosideros polymorpha* forests (NatureServe, 2015; USFWS, 2016)

Geographic or Habitat Restraints or Barriers

Adult: 1,000 - 2,400 ft. elevation (USFWS, 2016)

Habitat Narrative

Adult: Inhabits moist forests in gulch bottoms and on gulch slopes. On East Maui and Hawaii: grows on old forested lava flows (NatureServe, 2015). *Flueggea neowawraea* typically grows in gulch bottoms or on north-facing lower to mid-gulch slopes in the drier parts of mesic forests dominated by *Diospyros sandwicensis* and/or *Metrosideros polymorpha*, at elevations of 305 to 732 m (1,000 to 2,400 ft) (USFWS, 2016).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: The juicy fruits may be dispersed by fruit-eating birds (USFWS, 2016).

Population Information and Trends**Population Trends:**

Decline since 1994 (USFWS, 2016)

Species Trends:

Declining (USFWS, 2013)

Resiliency:

Moderate (inferred from USFWS, 2016; see current range/distribution)

Representation:

Low reproductive success, reason unknown. (NatureServe, 2015)

Redundancy:

Moderate to high (inferred from USFWS, 2016)

Number of Populations:

28 (USFWS, 2016)

Population Size:

76 (USFWS, 2013)

Minimum Viable Population Size:

50 mature, reproducing individuals (USFWS, 2016)

Adaptability:

Low (inferred from USFWS, 2016)

Population Narrative:

When this species was listed in 1994, there were about 28 occurrences totaling 145 to 162 individuals State-wide, including 15 occurrences totaling 33 individuals on Oahu (59 FR 56333). Trends in numbers indicate a decline since listing to between 132 and 139 currently known individuals at 49 sites State-wide (Service 2004b), including 98 individuals in 10 population units on Oahu. None of the currently known population units or occurrences has met minimum numerical criteria for a stabilization population unit (defined as 50 mature, reproducing individuals per population unit) (USFWS, 2016). Overall, the numbers of individuals have declined from approximately 110 to 130 in the last five-year review to only 76 wild individuals remaining currently (USFWS, 2013).

Threats and Stressors

Stressor: Herbivory (NatureServe, 2015; USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: The black twig borers have affected all known plants (NatureServe, 2015). The Chinese rose beetle also causes partial defoliation in *F. neowawraea* (USFWS, 2016). Evidence of predation on three of the taxonomic ungulates (cattle, deer, goats) is documented on Kauai, Oahu, Lanai, and Maui (USFWS, 1999).

Stressor: Nonnative plants (USFWS, 1999)

Exposure:

Response:

Consequence:

Narrative: The most significant of these aliens appear to be *Schinus terebinthifolius* (Christmas berry), *Psidium cattleianum* (strawberry guava), *Melinis minutiflora* (molasses grass), *Pennisetum setaceum* (fountain grass), *Clidemia hirta* (Koster's curse), *Lantana camara* (lantana), *Leucaena leucocephala* (koa haole), *Rubus rosifolius* (thimbleberry), *Grevillea robusta* (silk oak), *Paspalum conjugatum* (Hilo grass), *Psidium guajava* (common guava), *Ageratina adenophora* (Maui pamakani), and *Ageratina riparia* (Hamakuapamakani) (USFWS 1995, 1996a,b) (USFWS, 1999).

Stressor: Stochastic events (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Occurrences of *Flueggea neowawraea* are vulnerable to extirpation from naturally occurring events such as landslides, hurricanes, flooding, and/or reduced reproductive vigor due to small population size and limited distribution (59 FR 56333; 68 FR 35950; Service 1999b). The science of conservation biology has documented a general pattern of population collapse for a wide range of plant and animal species (Dennis et al 1991; Schemske et al 1994; Morris et al 1999; Menges 2000). According to this pattern, *F. neowawraea* already is in a phase of "quasi-extinction," with numbers that have declined to the point where demographic stochasticity alone can result in extirpation (USFWS, 2016).

Stressor: Climate change (USFWS, 2013)

Exposure:

Response:**Consequence:**

Narrative: Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) funded climate modeling that will help resolve these spatial limitations. High spatial resolution climate outputs are expected to be available sometime in 2013 (USFWS, 2013).

Stressor: Fire (USFWS, 1999)

Exposure:**Response:****Consequence:**

Narrative: On Oahu, military training exercises on the Makua Military Reservation and the Schofield Barracks Military Reservation have resulted in unintentionally ignited fires. Such fires may threaten populations of *Flueggea neowawraea* that grow in dry and mesic forest on those installations (USFWS 1996a). Two populations of *Flueggea neowawraea* located adjacent to the Makua Military Reservation are also possibly threatened by unintentionally ignited fires (HINHP 1995; J. Lau, personal communication 1992). The area has had a history of fires, which may have burned through at least one population of *Bonamia menziesii*, and burned to within a few tens of meters of another (HINHP 1995; USEWS 1996b). Fire is also a threat to this species on Oahu (USFWS, 1999).

Stressor: Feral ungulates (USFWS, 1999)

Exposure:**Response:****Consequence:**

Narrative: Ungulates such as cattle (*Bos taurus*), goats (*Capra hircus*), pigs (*Sus scrofa*), sheep (*Ovis aries*), axis deer (*Axis axis*), blacktailed deer (*Odocoileus hemionus columbianus*), and mouflon (*Ovis musimon*) were introduced either by the early Polynesians or more recently by European settlers for food, recreational hunting, and/or commercial ranching activities. Over the 200 years following their introduction, their numbers increased and the adverse impacts of feral ungulates on native vegetation have become increasingly apparent. Beyond the direct effect of trampling and grazing native plants, feral ungulates have contributed significantly to the heavy erosion still taking place on most of the main Hawaiian Islands (USFWS, 1999).

Recovery**Reclassification Criteria:**

1. A total of five to seven populations should be documented on islands where they now occur or occurred historically (USFWS, 1999).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure with the following minimum numbers of mature individuals per population: 100 for long-lived perennials (USFWS, 1999).
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1999).

Delisting Criteria:

1. A total of 8 to 10 populations should be documented on islands where they now occur or occurred historically (USFWS, 1999).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure with the following minimum numbers of mature individuals per population: 100 for long-lived perennials (USFWS, 1999).
3. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1999).

Recovery Actions:

- Protect habitat and control threats (USFWS, 1999).
- Expand existing wild populations (USFWS, 1999).
- Conduct essential research (USFWS, 1999).
- Develop and maintain monitoring plans (USFWS, 1999).
- Reestablish wild populations within the historic range (USFWS, 1999).
- Validate and revise recovery criteria (USFWS, 1999).
- Conduct further research into, and implement, control methods for the black twig borer (USFWS, 1999).
- Construct exclosures to protect populations against feral ungulates (USFWS, 1999).
- Control competing alien plant species (USFWS, 1999).
- Maintain adequate genetic stock (USFWS, 1999).
- Enhance the wild populations and reestablish the plant in its historic range (USFWS, 1999).
- Cross-pollinate trees to ensure seed set (USFWS, 1999).
- Protect endangered plants from fire (USFWS, 1999).

Conservation Measures and Best Management Practices:

- Population units must be augmented and new occurrences must be reintroduced within the historic range of *F. neowawraea*. To accomplish this, propagation methods must be developed and implemented with material collected from as many *F. neowawraea* individuals as possible, and flowers from isolated male and female trees must be cross-pollinated by hand to produce viable seed (USFWS, 2016).
- The Makua Implementation Team (2003) has developed stabilization protocols for *Flueggea neowawraea*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). The Kahanahaiki to Kapuna and Ohikilolo population units are within fenced or partially fenced management units. In addition, occurrences within some population units are located in five management units (Upper Kapuna, West Makaleha, East Makaleha, Manuwai, and Makaha) where they will benefit from ecosystem-level protection after these management units are fenced in the future. Black twig borer control is being studied by the non-profit Hawaii Agricultural Research Center (funded by the Hawaii Invasive Species Council). Some *F. neowawraea* plants are being grown in ex situ collections at the Army Environmental Greenhouse on Oahu (11 plants), the Nanakuli reintroduction site (10), Leeward Community College (5), and Waimea Audubon Center (14) (U.S. Army Garrison 2005b) (USFWS, 2016).
- *Flueggea neowawraea* is represented in several ex situ collections, including eight air layers in a nursery (Army Environmental Division, Oahu), five vegetative buds in micropropagation (Harold L. Lyon Arboretum), 186 cuttings in nurseries (Army Environmental Division, Oahu, and Harold L. Lyon

Arboretum), eight leaf tissues in micropropagation (Harold L. Lyon Arboretum), 84 plants in a nursery (Volcano Rare Plant Facility), 11 plants in a botanical garden (Waimea Valley Audubon Center), 495 ungerminated seeds in a nursery (Harold L. Lyon Arboretum), 100 seeds in seed storage (Lyon Arboretum Seed Storage Facility), and one seedling in a nursery (Harold L. Lyon Arboretum) (Service 2005b; U.S. Army Garrison 2005d) (USFWS, 2016).

- Surveys / inventories - Survey known occurrences on Kauai and Hawaii Island to determine current status and numbers of individuals (USFWS, 2013).
- Captive propagation for genetic storage and reintroduction - Continue to collect fruit from all wild and any reintroduced individuals that set seed to add to the genetic diversity of the ex situ material (USFWS, 2013).
- Ecosystem-altering invasive plant species control - Control introduced invasive plant species around wild and outplanted individuals (USFWS, 2013).
- Ungulate exclosures - Construct fences around all naturally occurring and reintroduced individuals to control feral ungulates (USFWS, 2013).
- Reintroduction / translocation - Continue reintroducing individuals into protected suitable habitat within historical range (USFWS, 2013).
- Population biology research: Investigate techniques to improve natural recruitment, including development and implementation of methods to control black twig borer and other pests. Assess genetic variability within extant populations. Study *Flueggea neowawraea* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2013).
- Alliance and partnership development - Initiate planning and contribute to implementation of ecosystem-level management and restoration to benefit this species (USFWS, 2013).

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Final Rule . 81 FR 17790-18110 (March 30, 2016).

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Endangered Status for 23 Species on Oahu and Designation of Critical Habitat for 124 Species. Final Rule. 77 FR 57648-57862 (September 18, 2012)

USFWS. 2016. Status of the Species and Critical Habitat: *Flueggea neowawraea* (Mehamehame). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016.

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Ungulates such as cattle (*Bos taurus*), goats (*Capra hircus*), pigs (*Sus scrofa*), sheep (*Ovis aries*), axis deer (*Axis axis*), blacktailed deer (*Odocoileus hemionus columbianus*), and mouflon (*Ovis musimon*) were introduced either by the early Polynesians or more recently by European settlers for food, recreational hunting, and/or commercial ranching activities. Over the 200 years following their introduction, their numbers increased and the adverse impacts of feral ungulates on native vegetation have become increasingly apparent. Beyond the direct effect of trampling and grazing native plants, feral ungulates have contributed significantly to the heavy erosion still taking place on most of the main Hawaiian Islands.

U.S. Fish and Wildlife Service. 1999. Recovery Plan for Multisland Plants. U.S. Fish and Wildlife Service, Portland, OR. 206 pages + appendices.

SPECIES ACCOUNT: *Fremontodendron californicum ssp. decumbens* (Pine Hill flannelbush)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/18/1996; Pacific Southwest (R8)

Physical Description

A branched spreading shrub of the cacao family (Sterculiaceae) growing to 1.3 meters (4 feet) tall. Dense star-shaped hairs cover the leaves and the younger twigs and branchlets. Its leaves are elliptic-ovate to ovate, shallowly or deeply palmately lobed with 5 to 7 lobes.

Fremontodendron californicum ssp. decumbens produces flower buds in late winter. Showy light-orange to reddish-brown flowers appear from late April to early July. Its fruit is a capsule. *Fremontodendron californicum ssp. decumbens* can be distinguished from *F. californicum ssp. californicum* and *F. mexicanum* (Mexican flannelbush) by its decumbent growth habit (stems lying on the ground and growing upward only at the tip), its relatively long peduncles (stalks that support the inflorescence), and its copper-orange flowers. (USFWS, 2002)

Taxonomy

Beecher Crampton made the first collection of *Fremontodendron californicum ssp. decumbens* in 1956. Robert M. Lloyd (1965) described *F. californicum ssp. decumbens* as *F. decumbens* based on the type specimen he collected in May 1964 from "California, El Dorado Co., Pine Hill, ca. 3 kilometers north of Rescue." Munz (1968) reduced *F. decumbens* to a subspecies of *F. californicum*. Kelman (1991), in his revision of *Fremontodendron*, recognized *F. californicum ssp. decumbens* as a full species based upon morphological variation. This taxon currently is known as *Fremontodendron californicum ssp. decumbens* (Whetstone and Atkinson 1993). (USFWS, 2002) Although Pine Hill flannelbush is currently considered a subspecies by the Service, Kelman et al. (2006) found that the Pine Hill flannelbush at the Pine Hill Preserve was genetically distinguishable from the California flannelbush (*F. californicum*) sampled. This distinction, coupled with unique morphology and ecology, was enough for Kelman et al. (2006) to support the treatment of *F. decumbens* as a species. (USFWS, 2019a)

Historical Range

Endemic to the Pine Hill formation in western El Dorado County, California (USFWS, 2019a).

Current Range

Restricted to the Pine Hill Preserve and immediate vicinity in El Dorado County, California; however, there is compelling ongoing research which may indicate it also occurs in Yuba and Nevada Counties (USFWS, 2019a)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 2002)

Dependency on Other Individuals or Species

Adult: Tetralonia stretchii (USFWS, 2002)

Breeding Season

Adult: April - July (USFWS, 2002)

Key Resources Needed for Breeding

Adult: Fire (NatureServe, 2015); solitary bees (USFWS, 2002)

Other Reproductive Information

Adult: Pine Hill flannelbush resprouts from its crown after a fire (Wilson et al. 2009) and relies on fire or other heat treatment for the establishment of seedlings. (USFWS, 2019a)

Reproduction Narrative

Adult: Heat (fire) is needed to scarify seed coats for germination and to clear the area for seedling development (NatureServe, 2015). *Fremontodendron californicum* ssp. *decumbens* produces flower buds in late winter. Showy light-orange to reddish-brown flowers appear from late April to early July. Native solitary bees pollinate the flowers (Boyd 1994). Seventy percent of the developing fruit is destroyed by insects prior to maturing. The remaining fruit dehisces (opens up) during summer and releases seeds onto the soil. The seeds are eaten by rodents and dispersed by harvester ants (*Messor andrei*). Boyd and Serafini (1992) found the production of seeds in *F. californicum* ssp. *decumbens* was severely limited by insect predation. Over 98 percent of flower buds failed to produce fruit because of predation by insects. In addition, rodents destroyed 90 percent of seeds under shrubs within 8 to 10 months (Boyd and Serafini 1992). Boyd (1994) studied pollination biology of *Fremontodendron californicum* ssp. *decumbens*. Studies showed that insects were required for pollination. The primary floral visitor to the flowers was an anthrophorid bee (*Tetralonia stretchii*) (89.4 percent of the visits) (USFWS, 2002).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Chaparral, woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Fire (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Succession (inferred from NatureServe, 2015)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Habitat Narrative

Adult: Tops of rocky ridges and on scattered rock outcrops of gabbro in chaparral communities or in the ecotone between chaparral and woodland. Heat (fire) is needed to scarify seed coats for germination and to clear the area for seedling development. The environmental specificity is very narrow; it is narrowly endemic to gabbro soils in Eldorado and Nevada counties, California (NatureServe, 2015).

Dispersal/Migration

Dispersal

Adult: Low (inferred from USFWS, 2002)

Dispersal/Migration Narrative

Adult: The seeds are eaten by rodents and dispersed by harvester ants (*Messor andrei*) (Boyd 1996). Seeds were carried up to 12 meters (39 feet) from the *F. californicum* ssp. *decumbens* shrubs (Boyd 1996) (USFWS, 2002).

Population Information and Trends

Population Trends:

Stable (USFWS, 2019a)

Number of Populations:

12 populations; two are stable, the remainder are presumed extant. (USFWS, 2019a)

Population Size:

Greater than 104 individuals (USFWS, 2019a)

Population Narrative:

In general, a direct comparison of species abundance now versus at the time of listing is not possible due mainly to lack of abundance data at the time of listing. Contributing to that challenge is that there is not consistent current abundance data for many of the populations, especially those on private lands. It is unlikely that abundance of Pine Hill flannelbush has increased since listing, due to a further reduction in their range, lack of suitable habitat, and the fact that both species are long-lived. However, as noted below, with the increased protection of habitat, it is likely that no further significant decline in abundance of these species has occurred. (USFWS, 2019a)

Threats and Stressors

Stressor: Development (USFWS, 2002)

Exposure:

Response:

Consequence:

Narrative: Historically, gold rush activities and clearing for agriculture reduced and fragmented habitat in western El Dorado County. More recently, vegetation on the Pine Hill formation has changed significantly due to commercial and residential development, road construction, and fragmentation. Between 1960 and 1990, the human population in El Dorado County increased 428 percent (California Department of Finance 1998). Nearly 23 percent of the gabbro formation

is urbanized (J. Horenstein unpublished data 1994). Commercial or residential developments have partially or completely destroyed occurrences of all of the species (California Natural Diversity Data Base 1998; California Department of Fish and Game 1990a, 1990b; G. Clark in litt. 1993). Proposed residential or commercial development within the Pine Hill formation threatens most of the remaining sites within the Pine Hill formation and adjacent serpentine in western El Dorado County, and either directly or indirectly will adversely affect most of the range of this species. Edge effects, which occur at the interfaces of any two or more habitat types, typically increase with habitat fragmentation and are more pronounced for natural communities bordered by human disturbances (USFWS, 2002).

Stressor: Alteration of natural fire regime (USFWS, 2002)

Exposure:

Response:

Consequence:

Narrative: Changes in fire frequency threatens *Fremontodendron californicum* ssp. *decumbens*. This plant occurs within a fire-adapted plant community, either within chaparral or on the ecotone between chaparral and woodland. Fire suppression policies have altered natural processes within several plant communities in California. Longer than normal fire frequencies leads to the loss of some plant species from the chaparral plant community. Land development and multiple ownership complicate the planning and implementation of controlled burns at the appropriate fire frequency necessary for maintenance of chaparral (USFWS, 2002).

Stressor: Dumping (USFWS, 2002)

Exposure:

Response:

Consequence:

Narrative: Habitat degradation from garbage dumping on ridge-tops around Pine Hill and on undeveloped parcels surrounded by higher density development degrades the habitat and is a minor threat to *Fremontodendron californicum* ssp. *decumbens* (J. Wilson pers. comm. 1993, L. Eng in litt. 1999) (USFWS, 2002).

Recovery

Reclassification Criteria:

1. Secure and protect specified recovery areas from incompatible uses: (i) Pine Hill preserve and occupied habitat along with sufficient adjacent unoccupied habitat for fire management and a 150- meter (500-foot) buffer at 8 known sites. See Table III-4 for acreage of preserves. (j) The decumbent *Fremontodendron* within Nevada and Yuba Counties should be secured and protected unless determined not to be the listed *Fremontodendron*. (USFWS, 2002)
2. Management plan approved and implemented for recovery areas, including survival and recovery of the species as the objective: For all sites and any adjacent occupied or unoccupied habitat identified as necessary for continued survival. (USFWS, 2002)
3. Monitoring in all recommended preserves shows: (a) Stable or increasing over 60 years (two fire cycles or longer if suggested by results of demographic monitoring). (b) Habitat monitoring of recommended preserves shows a mosaic of multiage class stands and habitat fragmentation has not appreciably increased (less than 5 percent) within any preserves over current (2000)

conditions. (c) Spatially and temporally, the establishment of occurrences must continue to be greater than the extirpation of occurrences. (USFWS, 2002)

4. Other actions: (a) Ameliorate or eliminate; (b) Fire management studies; (c) seeds stored in at least two Center for Plant Conservation certified facilities; (d) research on seed germination and propagation techniques; (e) successful introduction onto Salmon Falls/Martel Creek preserve. (f) Maintain metapopulation dynamics of at least 1 very large, 3 medium, and 4 small occurrences on the Pine Hill formation. (USFWS, 2002)

Delisting Criteria:

C/1: For the 8 years following achievement of populations targets for Pine Hill flannelbush, herbivory by insects and rodents must not occur in two consecutive years at levels which cause a population decline at any of the sites contributing to recovery. (USFWS, 2019b)

E/1: Number of populations with specific geographic distribution. The 8 flannelbush populations must persist in at least two different preserve units. Populations species must persist at the size described in E/2, for at least two full fire cycles. (USFWS, 2019b)

E/2 Number of plants per population: Of the 8 populations of flannelbush required for down and delisting, small, medium, large, and very large populations must contain the number of plants described as follows. Based on the size of each population, the minimum number of mature plants in each population are: Small (at least four populations): 15; Medium (at least three populations): 83; Very Large (at least one population): 480; Total number of plants 789. (USFWS, 2019b)

Recovery Actions:

- 1. Develop and implement a cooperative program and participation plan. A cooperative program is needed to coordinate local public and private land use planning with State and Federal land use and recovery planning for gabbro species. A cooperative program needs to be developed focusing on western El Dorado County. A participation plan produced from this program will increase the chances of recovery for listed species. (USFWS, 2002)
- 2. Protect and secure existing populations. Natural lands that contain this species need to be protected in perpetuity. Protection of these lands includes identification and minimization of threats in perpetuity and application of appropriate and adaptive management (see Task 3) to ensure species survival and recovery. Natural lands that need protection can be categorized into two types: (1) blocks of land that contain occupied or potential habitat for two or more this species and (2) blocks of land that contain occupied or potential habitat for one this species. All potential preserve areas should be evaluated based on current mapping information and ground-truthed prior to purchase to confirm their value for recovery. (USFWS, 2002)
- 3. Manage Habitat Managing habitat is essential to the recovery of the listed species. Habitat management includes preparation and implementation of management plans for all areas inhabited by special status species being proposed for preservation, and periodic monitoring of populations in each of these areas. Within western El Dorado County, a multi-constituent committee should be formed to oversee the management of preserves located on the Pine Hill formation. The preserve management committee should include, at a minimum, representatives from the California Department of Fish and Game, U.S. Fish and Wildlife Service, Bureau of Land Management, El Dorado County, California Department of

Forestry and Fire Protection, California Native Plant Society, American River Conservancy, and a private landowner representative. (USFWS, 2002)

- 4. Survey historical locations and other potential habitat where this species may occur. Recovery of listed species may often require relocating historic populations or locating new populations of these species. Historical locations should be surveyed to determine whether suitable habitat remains, the species persists at the sites, and/or the sites may be suitable for repatriation. Suitability of historical locations for repatriation would depend upon: (1) whether potential habitat exists, (2) the presence and magnitude of threats, and (3) whether the sites can be secured and managed for the long-term protection of the species. Surveys should also include other potential gabbro or serpentine habitat to determine whether undiscovered populations may exist. If new populations are discovered, they need to be protected and managed as discussed above. During the surveys, potential introduction sites should also be identified. (USFWS, 2002)
- 5. Conduct necessary biological research and use results to guide recovery/conservation efforts. - Develop propagation techniques for listed plant species for which enhancement, repatriation, or introductions would be appropriate. Geographic area research is outlined in the Recovery Plan. Species-specific research is described as follows: Habitat Survey Research: Serpentine and Gabbro soil areas in Nevada and Yuba Counties if decumbent *Fremontodendron* is determined to be the listed *Fremontodendron*. Reproduction and Demography Research: Yes, including age of seed banks for determining when to burn, limiting life stages if Nevada County specimen is determined to be the listed *Fremontodendron*, seed production and survival in soil to determine appropriate fire return period. Systematics and Genetics research (identify Yuba County and Nevada County material) Other Research Needs: Propagation techniques; fire management techniques; metapopulation analysis; determine efficacy of other types of disturbance regimes for species and habitat management; feasibility of habitat restoration/ enhancement; study of disease if necessary. Management Actions Needed: Burning; general surveys; baseline monitoring; monitoring for trends of populations, success of management actions and threats at all populations identified for protection; monitoring for habitat fragmentation, major shifts in vegetation type, and tracking of occurrence establishment, and extirpation; assessment of disease as threat; introduction; seed banking.
- 6. Undertake artificial enhancement, repatriation, or introduction efforts where necessary. Where it is deemed necessary, artificial enhancement, repatriation, or introduction efforts for sensitive plants should be undertaken. Prior to repatriation or introduction of sensitive plants, genetics studies are needed (see Task 5) to ensure that new populations will not disrupt unique local gene complexes. Plant repatriation or introduction efforts should be undertaken using collected seeds or plant propagules. (USFWS, 2002)
- 7. Determine possible prescribed burning management strategies and incorporate the strategies into the management plans (Priority 1). Possible prescribed burning management strategies need to be evaluated, peer reviewed, and incorporated into management plans. (USFWS, 2002)
- 8. Perform metapopulation-type analyses for this species (Priority 2). The results of a metapopulation-type analysis may be useful in clarifying uncertainties, data needs, and research, management priorities, and delisting criteria. Metapopulation-type analyses should be based on the results of monitoring and research. (USFWS, 2002)

- Conduct controlled burns at all appropriate preserve units to maintain multiple populations of flannelbush within a shifting mosaic of woodland and chaparral that contains early, middle and late seral vegetation stages. Priority 1 (USFWS, 2019b)
- Conduct outreach to private landowners residing adjacent to existing preserves and/or other private landowners within suitable habitat of these species to provide education on avoiding degradation of habitat and to encourage the voluntary sale of conservation easements by willing landowners. Priority 1 (USFWS, 2019b)
- Conduct genetic analyses to determine areal size of individuals/extent of clonality and population structure in order to define individuals of flannelbush. Priority 2 (USFWS, 2019b)
- Conduct population viability analyses for flannelbush. Priority 2 (USFWS, 2019b)
- Conduct research into the regeneration ecology of flannelbush. Priority 2 (USFWS, 2019b)
- Conduct research to determine effective means of mechanical and other non-fire related control of chaparral to benefit gabbro soil species. Priority 2 (USFWS, 2019b)
- Protect habitat through acquisition of fee title or purchase of conservation easement at the Nevada and Yuba County populations of flannelbush, if they are determined through future research to be the listed flannelbush. Priority 2 (USFWS, 2019b)
- Conduct outplantings of flannelbush, specifically at the Salmon Falls/Martel Creek unit where substantial suitable habitat exists. Priority 2 (USFWS, 2019b)
- Develop a monitoring plan to span 5 years post-delisting of flannelbush and implement the plan at the time of delisting to measure the (USFWS, 2019b)

Conservation Measures and Best Management Practices:

- Attempts to set up an ecological reserve have been ongoing for more than 20 years. In the fall of 1977, the California Native Plant Society learned of plans to dispose of surplus California Department of Forestry and Fire Protection lands located on Pine Hill in El Dorado County (Howard 1979). Beginning in late fall of 1977, the California Native Plant Society united with other environmental groups to encourage the State of California to begin a coordinated effort to preserve significant natural areas. Through 1978 and into 1979, a multi-constituent committee, including the California Native Plant Society, Audubon Society, and California Resources Agency, met to set up a significant natural area for Pine Hill. Pine Hill Ecological Reserve (97 hectares [240 acres]) was established in 1979 to protect the gabbro plants located on the summit of Pine Hill (USFWS, 2002).
- The State of California listed *Fremontodendron californicum* ssp. *Decumbens* as rare in 1979. In 1987, a management plan was written for the Pine Hill Ecological Reserve (Baad and Hanna 1987) (USFWS, 2002).
- In the late 1980's, the California Department of Fish and Game brought to the attention of El Dorado County that many of the development projects in western El Dorado County would likely have significant direct or cumulative effects on eight rare plant species (Economic & Planning Systems, Inc. 1997). At the same time, the development community became aware of the California Department of Fish and Game's concerns regarding these plants. Private developers and El Dorado County contracted a report to determine potential preserve sites (USFWS, 2002).
- In 1992, the California Department of Fish and Game, Bureau of Land Management, and Bureau of Reclamation signed a memorandum of understanding to protect the gabbro plant habitat along the South Fork of the American River (California Department of Fish and Game 1992) (USFWS, 2002).
- In 1992, following an El Dorado County Board of Supervisors' hearing and an informational workshop, the El Dorado County Board of Supervisors requested the formation of the El Dorado County Rare Plant Advisory Committee, consisting of members from the development community, various agencies (California Department of Fish and Game, Bureau of Land Management, U.S. Fish

and Wildlife Service), El Dorado County planning staff, California Native Plant Society, Center for Sierra Nevada Conservation (formerly Friends Aware of Wildlife Needs), American River Conservancy, and others. This committee was established to identify feasible preserve sites, funding mechanisms, and management strategies for these preserves. The Rare Plant Advisory Committee used evaluations from the EIP Associates 1991 report and recommendations from California Department of Fish and Game, and overlaid land use considerations on the biological information to arrive at their own set of recommendations to the Board of Supervisors (USFWS, 2002).

- In 1993, the California Department of Fish and Game applied for and received a section 6 grant from us to investigate funding mechanisms for land acquisition. A draft economic feasibility study for acquiring the rare plant preserves, prepared by Economic & Planning Systems, Inc., was published in 1997 (USFWS, 2002).
- Our February 27, 1995, biological opinion on the interim renewal by Bureau of Reclamation of 67 water service contracts on the Central Valley Project (including water contracts for El Dorado County) identified implementation of a preserve system for the five federally listed gabbro plants as a critical need (U.S. Fish and Wildlife Service 1995). A critical need was defined as those actions needed immediately to avoid extinction or preclusion of recovery. The critical needs analysis for these plants specifically noted the importance of a preserve in the southern zone (Cameron Park) of the Pine Hill formation. During meetings held for technical review of the draft critical needs plan from the February 27, 1995, biological opinion for the Central Valley Project Interim Water Contract renewals, invited experts recommended all five of the preserves identified by the Rare Plant Advisory Committee as the critical need for the five federally listed gabbro species (which were proposed at the time of the meeting) (USFWS, 2002).
- From 1997 through January 2002, 184 hectares (454 acres) were purchased in the Cameron Park area through a multi-agency effort (Table II-6). The American River Conservancy and California Department of Fish and Game submitted a proposal in February 1997, requesting funds from the Central Valley Project Improvement Act (b)(1)“other” program to assist in the acquisition of habitat within the Cameron Park area. In October 1997, the El Dorado County Board of Supervisors approved El Dorado County’s participation in the purchase of 47 hectares (117 acres) in the Cameron Park area to protect rare plants. Also in October 1997, the El Dorado County Board of Supervisors approved in concept the adoption of a rare plant mitigation in-lieu fee that would include all new development within the El Dorado Irrigation District Sphere of Influence, excluding the City of Placerville, to help pay for part of the acquisition of the Cameron Park Preserve (El Dorado County 1998) (USFWS, 2002).
- During May 1997, the El Dorado County Board of Supervisors approved an agreement with Economic & Planning Systems to prepare an economic feasibility study for their approved ecological preserve program. On July 28, 1998, the El Dorado County Board of Supervisors adopted Ordinance 4500, which established an ecological preserve mitigation requirement or an in-lieu fee for certain development projects in western El Dorado County. El Dorado County is currently implementing this impact fee program to augment the funds needed to fund the acquisition and administration of the preserve system (El Dorado County 1998). The fees range from \$885 to \$386 per dwelling unit equivalent (El Dorado County 1998). El Dorado County also has successfully lobbied the El Dorado Irrigation District to jointly participate with the County to help fund the acquisition of the Cameron Park Preserve (El Dorado County 1998) (USFWS, 2002).
- With Congressman John Doolittle’s support, Congress appropriated \$5,000,000 of Land and Water Conservation Fund money to be administered starting in fiscal year 2001 by the Bureau of Land Management. In fiscal year 2002, an additional \$3,000,000 of Land and Water Conservation Fund money were allocated. As shown in Table II-6, \$4,008,400 of Land and Water Conservation Funds have been used for land acquisition in the Cameron Park area as of January 2002 (USFWS, 2002).

- In 2001, a cooperative management agreement for the Pine Hill Preserve in El Dorado County was signed by three Federal agencies (Bureau of Land Management, U.S. Fish and Wildlife Service, and U.S. Bureau of Reclamation), two State agencies (California Department of Fish and Game and California Department of Forestry and Fire Protection), El Dorado County, El Dorado Irrigation District, and the American River Conservancy. With this agreement, the signatories agreed to pool their resources to conserve the rare plant species and ecosystems that they inhabit. The primary goal of the Pine Hill Preserve is the preservation in perpetuity of the rare plant species and communities of the western El Dorado County gabbro formation. By separate agreement, El Dorado County and the Bureau of Land Management, have created funding to employ an interim preserve manager (USFWS, 2002).
- Dedicate more resources toward the investigation of best management approaches for the Pine Hill listed plant species, even at the cost of a temporary hiatus in land acquisition efforts. Investigation should be made into fire-related and non-fire related methods of disturbance to maintain listed plant species habitat. (USFWS, 2019a)
- Once the best management strategy (in terms of technique, frequency, timing, and intensity) is determined at each site, implement these management practices to achieve and maintain a habitat mosaic that enables the attainment of recovery criteria for the species. (USFWS, 2019a)
- Conduct conclusive genetic research to determine a) whether flannelbush in Yuba and Nevada Counties are truly Pine Hill flannelbush and b) whether Pine Hill flannelbush should be treated as a species (as *Fremontodendron decumbens*). (USFWS, 2019a)
- Should flannelbush of Yuba and Nevada Counties be determined to be Pine Hill flannelbush, action should be taken immediately to bring those lands under conservation ownership and management. (USFWS, 2019a)

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SPECIES ACCOUNT: *Fremontodendron mexicanum* (Mexican flannelbush)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/13/1998; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A small evergreen tree or shrub, < 7 m tall. The palmately lobed leaves are thick and leathery. Flowers (March-July or August) lack petals, but have showy, orange sepals (NatureServe, 2015).

Taxonomy

A member of the Malvaceae (mallow family) (in the Sterculiaceae (cacao family) when listed. *Fremontodendron* is thought to be a relic genus left over from a time period approximately 60 million years ago when California had a more tropical climate (Kelman 1991, p. 15) (USFWS, 2009).

Historical Range

Fremontodendron mexicanum is endemic to southern California and northwestern Baja California, Mexico. At the time this species was listed, only one occurrence containing fewer than 100 plants was known in the United States, and one occurrence in Mexico with no information on the number of plants (USFWS, 2009).

Current Range

Since listing, two additional occurrences have been discovered in the United States (both within 2 miles of the known occurrence), and one additional occurrence has been located in Mexico. It is now known to occur in three canyons in the United States and one canyon in Baja California (USFWS, 2009). Found in Imperial, Kern, Monterey, and San Diego Counties, California and Baja California, Mexico (Smith and Berg, 1988). According to the California Natural Diversity Database, *Fremontodendron mexicanum* is distributed from the border south to Arroyo Seco (North of San Quintin) in Mexico (NatureServe, 2015).

Critical Habitat Designated

Yes; 9/27/2007.

Legal Description

On September 27, 2007, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Fremontodendron mexicanum* (Mexican flannelbush) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in California (72 FR 54984-55010).

Critical Habitat Designation

The critical habitat designation for *Fremontodendron mexicanum* includes one CHU (2 sub-units) in San Diego County, California. This species critical habitat encompasses approximately 228 acres (ac) (93 hectares (ha)) (72 FR 54984-55010).

Subunit 1A, Cedar Canyon, Otay Mountain, San Diego County, California Subunit 1A, Cedar Canyon, consists of 145 ac (59 ha) of public land managed by the BLM. Subunit 1A contains CNDDDB element occurrences 1, 13, and 16. Land in this subunit is entirely within the Cedar Canyon Area of Critical Environmental Concern (ACEC) and a Research Natural Area (RNA) (BLM 1994, pp. 1, 19, 22). The BLM has not yet developed a specific management plan that outlines how the species will be managed in the Cedar Canyon ACEC and RNA. This subunit was occupied at the time of listing and contains all of the features essential to the conservation of the species. In 1998, when *Fremontodendron mexicanum* was federally listed, less than 100 individual plants were documented from Cedar Canyon. This occurrence was thought to be the only location where *F. mexicanum* occurred naturally in the United States. Prior to the 2003 Otay fire, the canyon was dominated by *Cupressus forbesii* (Tecate cypress) and riparian vegetation. In late 2005 and early 2006 when this canyon was surveyed for *F. mexicanum* by Service biologists, over 1,000 plants were found (Snapp-Cook 2006). This increase in the number of plants may be a result of the 2003 Otay fire that burned Cedar Canyon as this species is a facultative resprouter (i.e., resprouts and produces seedlings after fire). The phenomenon of *F. mexicanum* resprouting following fire was also recorded following a 1979 fire in Cedar Canyon (CNDDDB 2005 p. 1). The PCEs in this subunit may require special management considerations or protection to address negative impacts related to fire fighting activities (PCE 1) and negative impacts from the growth of nonnative species that may affect the space available for this species (PCE 1, 2, and 3). Subunit 1B, Little Cedar Canyon, Otay Mountain, San Diego County, California Subunit 1B, Little Cedar Canyon, consists of 83 ac (34 ha) of public land managed by the BLM. Little Cedar Canyon is located approximately 1.9 mi (3 km) to the west of Cedar Canyon. The land in this subunit is part of the Otay Mountain Wilderness Area. This site was not discovered until after the species was listed; however, we believe that it was occupied at the time of listing. Thirty-one healthy plants were documented in Little Cedar Canyon in the summer of 2006, and evidence of mature seed was detected (Martin 2006). Although this occurrence is small when compared to the more than 1,000 plants observed in Cedar Canyon in early 2006 (Snapp-Cook 2006), the Little Cedar Canyon occurrence will help to stabilize the existence of *F. mexicanum* in the United States and the discovery of *F. mexicanum* in Little Cedar Canyon almost doubles the amount of known occupied habitat for this species in the United States. The PCEs in this subunit may require special management considerations or protection to minimize impacts related to fire fighting activities and to the invasion of nonnative species that may affect the space available for this species (PCE 1, 2, and 3).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Fremontodendron mexicanum* critical habitat consists of three components (72 FR 54984-55010):

- (i) Alluvial terraces, benches, and associated slopes within 500 feet (152 meters) of streams, creeks, and ephemeral drainages where water flows primarily after peak seasonal rains with a gradient ranging from 3 to 7 percent; and stabilized north- to east-facing slopes associated with steep (9 to 70 percent) slopes and canyons that provide space for growth and reproduction.
- (ii) Silty loam soils derived from metavolcanic and metabasic bedrock, mapped as San Miguel—Exchequer Association soil series that provides the nutrients and substrate with adequate drainage to support seedling establishment and growth.

(iii) Open *Cupressus forbesii* and *Platanus racemosa* stands at elevations of 900 feet (274 meters) to 3,000 feet (914 meters) within a matrix of chaparral (such as *Dendromecon rigida* ssp. *rigida* and *Malosma laurina*) and riparian vegetation that provides adequate space for growth and reproduction.

Special Management Considerations or Protections

Fremontodendron mexicanum does not face direct threats from urban development; however, the PCEs for this species may require special management considerations or protection to address the threat from nonnative species. Nonnative plant species such as *Tamarix* spp. (salt cedar) and *Cortaderia selloana* (Pampas grass) could reduce the amount of space available to *F. mexicanum* (PCE 1 and 2) and alter the vegetation community (PCE 3) if they become well established in either Cedar Canyon or Little Cedar Canyon. In addition, the PCEs for this species may require special management considerations or protection to address negative impacts related to fire fighting activities. Fire fighting activities may alter the alluvial terraces and benches that *F. mexicanum* grows on (PCE #1) if activities occur directly in the streambed adjacent to where *F. mexicanum* occurs. Special management may be needed to insure that fire fighting activities do not alter these areas or that measures are in place to restore damage to habitat after the activities occur. Likewise, future fuel breaks should be designed such that they do not create situations where extra run off is channeled into the canyons thus increasing the scouring that occurs in the creek bottoms and eroding the terraces and benches where *F. mexicanum* grows (PCE #1). In our unit descriptions for this designation, we further describe the threats requiring special management considerations or protection for each subunit.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, asexual: vegetative (USFWS, 2009)

Lifespan

Adult: 2+ years (inferred from USFWS, 2009)

Breeding Season

Adult: March - June (USFWS, 2009)

Key Resources Needed for Breeding

Adult: Presumably insect pollinators (USFWS, 2009)

Reproduction Narrative

Adult: *Fremontodendron mexicanum* is a perennial plant species that flowers from March to June (Munz 1974, p. 843); however, no studies on the longevity of this species have been conducted. The showy nature of the flower and the presence of nectar pits at the base of the sepals suggest that pollen is transferred from flower to flower by insect pollinators, but a focused pollination study has not been conducted. *Fremontodendron mexicanum* reproduces, at least partially, by the regrowth from underground roots and runners (USFWS, 2009).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Southern mixed chaparral, closed cone coniferous forest dominated by Tecate cypress (*Cupressus forbesii*) (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Periodic fire (USFWS, 2009)

Geographic or Habitat Restraints or Barriers

Adult: 0 - 3,000 ft., elevation (USFWS, 2009)

Habitat Narrative

Adult: Inhabits slopes covered with southern mixed chaparral, closed cone coniferous forest dominated by Tecate cypress (*Cupressus forbesii*), and canyons (NatureServe, 2015). This species grows in chaparral habitat, a habitat type that is adapted to periodic fires, and *F. mexicanum* is associated with species such as *Callitropsis forbesii* (*Cupressus forbesii*, Tecate Cypress), that require fire as a part of their life cycle (Dunn 1987, p. 367). It is often found in association with metavolcanic soils (Oberbauer 1991, pp. 1-9; Reiser 1996, pp. 92-92). *Fremontodendron mexicanum* grows on alluvial benches associated with ephemeral drainages and also on the associated canyon slopes. The elevation range of this species is now considered to range from sea level to 1,000 meters (3,000 feet) (USFWS, 2009).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: When fully ripened, the capsule splits open at the tip and the seed are cast from the plant when shaken by wind, hail, or animal disturbances (NatureServe, 2015).

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Increasing (USFWS, 2009)

Resiliency:

Very low (inferred from USFWS, 2009)

Redundancy:

Low (inferred from USFWS, 2009)

Number of Populations:

3 (inferred from USFWS, 2009)

Population Size:

6,000 (USFWS, 2009)

Population Narrative:

F. mexicanum occurs in three canyons on the northwestern slope of Otay Mountain and that there are approximately 6,000 plants in these three canyons, compared to fewer than 100 plants known at listing (USFWS, 2009).

Threats and Stressors

Stressor: Nonnative plants (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Following the 2007 fire on Otay Mountain, hundreds of seedling and sapling tamarisk plants were found growing throughout Cedar Canyon (Gasser 2007, p. 201). Goodwin and Sheley (2001, p. 15) noted that as a result of fire, open areas containing high levels of nutrients in full sun, favor the invasion and spread of weedy nonnative species. Additionally, *Tamarix* ssp. has been shown to decrease the water available to native plants in riparian habitats (DeLoach et al. 2000, pp. 835–844). At this time, the infestation of tamarisk is in its initial phase and can be controlled in the canyons where *Fremontodendron mexicanum* grows. This threat could increase in magnitude if left unchecked (USFWS, 2009).

Stressor: Border control activities (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The area where *F. mexicanum* occurs (i.e., Otay Mountain Wilderness Area) is heavily patrolled by DHS. Although the Otay Mountain Wilderness Area is off-limits to most road construction and vehicle use, the DHS is allowed to conduct operations for border control. *Fremontodendron mexicanum* could be impacted by road construction and vehicle use. Possible impacts associated with DHS activities could alter the habitat for *F. mexicanum*, such as (1) the use of all-terrain vehicles in canyon bottoms; (2) construction of roads in canyon bottoms; and (3) cut and fill work associated with road construction (USFWS, 2009).

Stressor: Stochastic events (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: In addition to the genetic concerns associated with small population size, the Service is concerned that a single catastrophic event could threaten this species. The three occurrences that we know of are all in close proximity and lack the geographic separation that could provide protection from catastrophic events. As seen in 2003 and 2007, when this area experienced fire, all three of the known occurrences were impacted to some degree. Other events, such as disease or insect infestation, might easily impact all three of these occurrences (USFWS, 2009).

Stressor: Altered fire regime (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: *Fremontodendron mexicanum* grows in mixed chaparral and closed-cone coniferous forest dominated by *Callitropsis forbesii*. Both of these vegetation types are susceptible and naturally adapted to naturally occurring fires. These habitat types show evidence of time-dependent, self-regulating fire cycles under natural conditions (Minnich 2001, p. 1549). Fires that occur at longer or shorter intervals than the natural cycle or during the reproductive seasons may imperil fire-adapted species in these ecosystems. A change in the frequency of the natural fire regime can impact the effectiveness of these adaptations to fire. If *F. mexicanum* relies on seed to regenerate such frequent fires may not allow time for a substantial seed bank to collect. If *F. mexicanum* reproduces mostly by resprouting, then repeated fires at a short interval may be limiting the ability of the population to adapt and react to environmental changes (Keeley 1986, pp. 95–112) (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: One study has predicted that 5 to 10 percent of California's native plant species would no longer find suitable habitat within the state, and thus be vulnerable to extinction, if average temperatures warmed 5–6° F (Morse et al. 1995, p. 393). Whether or not this would include *Fremontodendron mexicanum* is unknown (USFWS, 2009).

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- Resurvey historical occurrences and survey potential habitat to determine if there are any other native occurrences of *Fremontodendron mexicanum* that are extant (USFWS, 2009).
- Determine the breeding system and pollinators for the taxon. This will assist us in determining what, if any, bottlenecks in reproductive output are due to these factors (USFWS, 2009).
- Determine the distribution of genetic diversity at the various occurrences. This will assist us in identifying higher priority occurrences for potential translocation source materials. This will help us to better understand how this species will be able to adapt to future environmental changes and how this species will withstand possible catastrophic events (USFWS, 2009).
- Establish site and species monitoring protocols to identify how this species is impacted by future fires and how the occurrences regenerate following fire. This will help us understand the species' responses to the change in fire frequency and what management actions are appropriate (USFWS, 2009).
- Support and provide assistance to the San Diego National Wildlife Refuge in their efforts to introduce new populations of *Fremontodendron mexicanum* to suitable unoccupied habitat. These

efforts are described in the “United States Fish and Wildlife Service Preventing Extinction Grant” discussion above (USFWS, 2009).

- Establish a working group that will coordinate conservation efforts for this species. This group should focus on coordination between Federal agencies (e.g., Service, BLM, DHS), MSCP staff (e.g., County of San Diego), Otay Ranch, and Mexico (USFWS, 2009).

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SPECIES ACCOUNT: *Galactia smallii* (Small's milkpea)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/19/1985; Southeast Region (R4)

Physical Description

Galactia smallii is a small, trifoliolate, perennial legume with small, purple flowers and a prostrate habit. The stems are grayish, due to a covering of short hairs, and grow up to 2 m long. The stem internodes are well-developed and have long, straight, soft hairs. The 1 to 2.2 cm long leaflets are broadly ovate to elliptic. The undersides of the leaves have long, soft, wavy hairs lying almost flat against the surface. The upper surface of the leaves are either hairless (glabrate) or have sparse, stiff hairs, lying flat on the surface (strigose). The inflorescences are 2 to 6 cm long with one to five flowers at the apex or along the axis. The flower buds are 5 to 7 mm long, and the calyx is about 7 mm long and loosely strigulose. The corolla is 11 to 12 mm long and pinkish purple or lavender. The legume is 3 to 4 cm by about 4 m in size and is strigulose or villosulous (Isley 1990). (USFWS, 1999)

Taxonomy

Small's milkpea was originally described as *G. prostrata* by Small in 1933. However, H.J. Rogers (unpublished dissertation, Duke University, 1949) discovered that this name is a homonym, unavailable for use, and suggested *G. smallii*. Since Rogers' proposal was never published, the incorrect name persisted. Herndon (1981) published Rogers' finding and proposed the name change to *G. smallii*. (USFWS, 1999)

Historical Range

The historic range of Small's milkpea is not well known. When this species was listed, it was known from two sites near Homestead in Miami-Dade County. (USFWS, 2010)

Current Range

Miami-Dade County, Florida, in a narrow region across a 6.5-mile area, and the Homestead Air Reserve Base (USFWS, 2019).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Small's milkpea is a perennial legume that usually flowers during the summer months. However, numerous flowers may occur following a burn at anytime throughout the year (Small 1933, and Long and Lakela 1971). Fire may synchronize and intensify flowering of plants in the burned area (A. Herndon, personal communication 1998). Its pollinators include three species of bees, one species of wasp, and the Cassius blue butterfly (*Leptotes cassius theonus*). (USFWS, 1999)

Habitat Type

Adult: Pine rocklands/rockland hammocks (USFWS, 1999)

Habitat Narrative

Adult: Preliminary results of a study of the abundance, distribution, and habitat preferences of *Galactia* species in Miami-Dade County pine rocklands indicate that *G. smallii* prefers higher elevations and lower shrub cover than the more common *Galactia* species (O'Brien 1994). The distribution of *G. smallii* is correlated with soil depth and color in Redland pine rocklands. It does not occur in sites with a high amount of exotic plant cover, specifically, *Schinus terebinthifolius* and *Neyraudia reynaudiana* (O'Brien and Koptur 1995). (USFWS, 1999)

Dispersal/Migration***Population Information and Trends*****Number of Populations:**

24 sites (USFWS, 2019)

Population Size:

~120,000 (USFWS, 2019)

Population Narrative:

Galactia smallii is only known from the pine rocklands of Miami-Dade County. The remaining *G. smallii* populations occur entirely within a narrow region of pine rockland fragments that includes 24 sites – 8 public and 16 private (Bradley, 2010b; Lange, pers. comm. 2017; Possley, pers. comm. 2017) across a 6.5-mile (10.5 km) area within Miami-Dade County. However, a single population at Homestead Air Reserve Base (HARB), contains up to 100,000 individuals (Bradley 2009). Miami-Dade County owns seven of the public sites, purchased for conservation purposes, and is working to restore and manage these lands through their Environmentally Endangered Lands (EEL) program. The final public site, HARB, is seeking to develop their lands, however, they are also coordinating with the Service and IRC to retain and manage the population at this site. *G. smallii* populations on the 16 private sites range in size from 3 to 1,000 individuals per site (Bradley, 2010b; Lange, pers. comm. 2017; Possley, pers. comm. 2017a). (USFWS, 2019)

Threats and Stressors

Stressor: Habitat loss and fragmentation

Exposure:

Response:

Consequence:

Narrative: The pine rockland community of south Florida is critically imperiled globally (FNAI 2010b). In Miami-Dade County, development and agriculture have reduced pine rockland habitat by 90 percent. Continued habitat loss (Factor A) and fragmentation threaten the existence of this species, and less than 1 percent of the original acreage of pine rockland habitat remains outside of Everglades National Park (Herndon 1998). Populations on private sites remain threatened with destruction or habitat modification due to improper or lack of management (Factors A and E). (USFWS, 2019)

Stressor: Inadequacy of existing regulatory mechanisms

Exposure:

Response:

Consequence:

Narrative: Currently, regulatory mechanisms (Factor D) provide limited protections for this species. The Florida Department of Agriculture and Consumer Services designated these species as endangered under Chapter 5B-40, Florida Administrative Code. This law regulates the taking, transport, and sale of listed plants. This law does not prohibit private property owners from destroying listed plants, nor does it require them to manage habitats to maintain populations. The Natural Forest Communities (NFC) program was established by Miami-Dade County to encourage but not require private landowners to protect forested lands by making it necessary to apply for a permit with the County prior to working in designated NFCs (i.e., pinelands, hammocks). (USFWS, 2019)

Stressor: Inadequate fire management

Exposure:

Response:

Consequence:

Narrative: Fire suppression continues to affect *Amorpha crenulata* (Factor E). Historically, frequent (approximately twice per decade), lightning-induced fires were a vital component in maintaining native vegetation and ecosystem functioning within south Florida pine rocklands. A period of just 10 years without fire may result in a marked decrease in the number of herbaceous species due to the effects of shading and litter accumulation (FNAI 2010b). The majority of extant populations of this species is affected by some degree of inadequate fire management, with the primary threat being shading by hardwoods (Bradley and Gann 1999; Bradley and Gann 2005). (USFWS, 2019)

Stressor: Nonnative invasive plants

Exposure:

Response:

Consequence:

Narrative: Invasion by exotic plant species continue to affect *Amorpha crenulata* (Factor E). Nonnative invasive plants compete with native plants for space, light, water, and nutrients, and make habitat conditions unsuitable for this species, which prefers open conditions (Factor E). Bradley and Gann (1999) indicated that the control of nonnative plants is one of the most important conservation actions for the pine rockland species and a critical part of habitat maintenance. Nonnative plants have significantly affected pine rocklands and negatively impacted all occurrences of this species to some degree (Bradley and Gann 1999; Bradley 2006; Bradley and Saha 2009; Bradley and van der Heiden 2013). (USFWS, 2019)

Recovery

Reclassification Criteria:

Not developed (USFWS, 1999; USFWS, 2010)

Delisting Criteria:

1. Existing natural populations achieve and maintain a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (addresses Factors A and E) (USFWS, 2019)
2. A network of 5 new populations are either discovered or reintroduced that exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (addresses Factors A and E) (USFWS, 2019)
3. All populations (criteria 1 and 2) are protected by a conservation mechanism. (addresses Factors A, D, and E) (USFWS, 2019)
4. Threats have been reduced or eliminated to the degree that this species will remain viable for the foreseeable future. (addresses Factors A, D, and E) (USFWS, 2019)

Recovery Actions:

- Conduct surveys to determine distribution of pine rockland plants. Pine rockland plants have been thoroughly surveyed in Miami-Dade County. However, other populations may be noted during acquisition and restoration program implementation. Fire may eliminate litter concealing listed species, or enable seeds in the seed bank to germinate. For that reason, pine rocklands that did not contain listed species when unmanaged should be resurveyed after fire events. (USFWS, 1999)
- Protect and enhance existing populations. It is imperative for the recovery of pine rockland plants that populations not be lost. (USFWS, 1999)
- Conduct research on the biology of *G. smallii*. Additional information on the ecology and life history of pine rockland plants needs to be collected. Determine size and viability of all populations. Known populations of the listed pine rockland plants should be evaluated. Population viability needs to be investigated and determined for each listed plant species. (USFWS, 1999)
- Develop standardized monitoring. Standardized monitoring needs to be developed for listed pine rockland species in order to determine the effect of management actions on these species. Use existing standardized monitoring protocols developed by the Florida Natural Areas Inventory to record baseline data regarding the biology and ecology of *G. smallii*. Initiate quarterly monitoring program. (USFWS, 1999)
- Continue to provide public information about pine rocklands and their unique flora. Public support will increase the chances of recovery for these species. Informational and educational materials have been produced. DERM and Miami-Dade County Natural Areas Management have developed flyers, displays, newsletters, and press releases, and have held workshops with the general public. Organizations best able to carry out information and education programs include: Miami-Dade County Parks and Recreation Department, the Florida Native Plant Society, Everglades NP, and Miami-Dade County DERM. Support of local press coverage should continue. DERM has developed a web page that will also aid in disseminating information about this endangered plant community to the public. (USFWS, 1999)
- Habitat-level Recovery Actions: Continue to protect and prevent degradation of pine rockland plant habitat. Restore areas to suitable habitat. Continue to investigate and refine the habitat needs of each species. Monitor habitat and ecological processes. Continue implementation of the fire education program and modify as necessary any fire management education program that has been developed. (USFWS, 1999)

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SPECIES ACCOUNT: *Galium buxifolium* (Island bedstraw)

Species Taxonomic and Listing Information

Listing Status: Endangered; 07/31/1997; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A small shrub, usually 3-6 dm tall, with numerous leafy branches, the leaves arranged in whorls of 4. Flowers are whitish and occur in clusters at the ends of short woody stems (NatureServe, 2015).

Taxonomy

A member of the madder family (Rubiaceae) (USFWS, 2009). In 1958, Dempster included the taxon as a variety of *Gatium catatinense* (Dempster 1958). Ferris (1960) suggested that the taxon was subspecifically distinct from *Gatium catatinense*. In 1973, Dempster recognized the taxon as a separate species based on differences in the nutlet hairs between it and *Galium catatinense* (Dempster 1973) (USFWS, 2000).

Historical Range

Known from Santa Cruz and San Miguel Islands (USFWS, 2009). California endemic, Santa Cruz Island, San Miguel Island, and Santa Rosa Island, Santa Barbara county (NatureServe, 2015).

Current Range

It is restricted to Santa Cruz and San Miguel Islands off the coast of southern California (USFWS, 2009).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, asexual: vegetative (USFWS, 2009)

Breeding Season

Adult: March - July (USFWS, 2009)

Key Resources Needed for Breeding

Adult: Coastal north-facing slopes, canopy cover, mesic conditions (USFWS, 2009)

Reproduction Narrative

Adult: The plant has been observed to be slow growing (Wilken pers. comm. 2009), and plants reproduce mainly from seed although individuals have the ability to sprout numerous stems from a basal root crown when damaged. North-facing slopes near the sea (Junak pers. comm. 2009) and the intact canopy cover of native plant species on mesic sites (Service 2007, McEachern pers. comm. 2009) provide the moist and shaded conditions *G. buxifolium* requires

for germination. Flowering occurs between March and July (Junak et al. 1995, Hochberg et al. 1980) (USFWS, 2009).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Coastal sage scrub, closed-cone pine forest vegetation (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits sea cliffs, bluffs, and dry, rocky slopes in coastal sage scrub and closed-cone pine forest vegetation (NatureServe, 2015).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Seeds or stems adhere to animals or are consumed (NatureServe, 2015).

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Very low (inferred from USFWS, 2009; see current range/distribution)

Redundancy:

High (inferred from USFWS, 2009)

Number of Populations:

27 (USFWS, 2009)

Population Narrative:

There are currently 21 known populations of *G. buxifolium* on Santa Cruz Island and 6 known populations on San Miguel Island (McEachern et al. 2008) (USFWS, 2009).

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Historically, large-scale habitat alteration caused by large numbers of non-native mammals on the islands resulted in significant loss of soils, as well as changes in the structure, composition, and richness of plant communities (Service 1997). Although some plant species have increased in number following the removal of non-native herbivores and omnivores from the islands, other aspects of recovery of the native habitats can be slow (Hochberg et al. 1979, Lovich and Bainbridge 1999). In particular, community composition can be altered by the spread

of non-native plants that were able to gain a foothold during the period of disturbance. For *Galium buxifolium*, a woody subshrub that relies on a microclimate provided by native vegetative cover, the presence of non-native plants in the landscape is a substantial barrier to dispersal and subsequent recovery (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Global climate change has the potential to diminish the habitat of *Galium buxifolium* because of the species' precarious occurrences on sea cliffs. As storm intensities are expected to increase with climate change, coastal bluffs and cliff faces where the species occurs are more susceptible to deleterious erosion. *Galium buxifolium* populations are found at 7 feet (2 meters) and 16 feet (5 meters) of elevation at Eagle Canyon and Cueva Valdez, 20 feet (6 meters) of elevation near Prisoners Harbor, and between 10 feet (3 meters) and 26 feet (8 meters) of elevation at Tinkers Cove on Santa Cruz Island (CCH 2009). The low elevation of these occurrences, combined with the fragile nature of the individual plants, make *G. buxifolium* particularly vulnerable to increased wave action and more intense storm events that are predicted with climate change (USFWS, 2009).

Stressor: Habitat fragmentation (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Years of grazing have restricted *Galium buxifolium* to small, fragmented habitat patches that were protected from the pressures of herbivory by their inaccessibility. Although these pressures have been relieved with the removal of feral livestock from the islands, undergrowth structure and species composition altered by years of grazing will be slow to recover. However, in some areas where the shrub canopy has begun to reestablish its connectivity, such as on north-facing slopes where there is deeper soil and more moisture, understory plants have a greater potential for recovery in these isolated patches (McEachern et al. 2008) (USFWS, 2009).

Stressor: Nonnative species (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Competition from non-native species currently threatens the existence of *Galium buxifolium* and its habitat. *Vinca major*, an aggressive ornamental groundcover known for its competitive displacement of natives at sites across North America (DiTomaso and Healy 2007), is growing in one of the largest populations of *G. buxifolium* at Pelican Bay on Santa Cruz Island (USFWS, 2009).

Stressor: Stochastic events (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: As noted in the recovery plan, *Galium buxifolium* is threatened by the risk of stochastic extinction due to small population size and limited distribution (Service 2000). Only one individual plant was observed at each of three populations surveyed on Santa Cruz Island in 2005 and 2006 (McEachern et al. 2008). Demographic studies have suggested that the variable nature of the seed bearing pattern of *G. buxifolium* can lead to a loss of viability in isolated populations over time (McEachern pers. comm. 2009) (USFWS, 2009).

Recovery

Reclassification Criteria:

1. Stabilize or increase populations on Santa Cruz and San Miguel Islands with evidence of natural recruitment for a period of 20 years that includes the normal precipitation cycle. A precipitation cycle includes periods of drought and wet years, with annual rainfall starting at 100 to 135 percent of average, dropping below 65 percent of average, and returning to at least average (Service 2000) (USFWS, 2009).
2. Reintroduce plants to historic locations (USFWS, 2009).

Delisting Criteria:

1. Discover or establish five additional populations per island (San Miguel and Santa Cruz) (USFWS, 2009).
2. No decline after downlisting for 10 years (USFWS, 2009).

Recovery Actions:

- Support and intensify active control programs where herbivory or habitat alteration by alien animals exists (USFWS, 2000).
- Develop and implement a plan to achieve the goals and standards of the Conservation Strategy. The Conservation Strategy is a draft strategy for conservation of island resources prepared by biologists from the National Park Service, U.S. Fish and Wildlife Service, and the U.S. Geological Survey, Biological Resources Division. This Strategy is essentially a primer or guide that provides the basis for the recovery of the species in this recovery plan and should be referred to as a supporting document (USFWS, 2000).
- Restore habitats and control competitive weeds for long-term management of the listed species and their habitats (USFWS, 2000).
- Conduct thorough surveys for all species in the recovery plan (USFWS, 2000).
- Conduct research that aids in the conservation and recovery of the species in the recovery plan (USFWS, 2000).
- Store seeds at facilities certified by the Center for Plant Conservation and develop successful seed germination and propagation techniques (USFWS, 2000).
- Develop successful outplanting techniques (USFWS, 2000).

Conservation Measures and Best Management Practices:

- The USGS and NPS should seek additional funding to continue field surveys and monitoring, demographic monitoring, population viability analyses, and further investigations into recovery projects. Specifically, studies that track germination and individual growth rates to determine

variability in fruit and seed set and differential germination success across floral types should be expanded to include more plants from more populations (USFWS, 2009).

- Establish an ex situ seed bank for research and outplanting experiments (USFWS, 2009).
- Comprehensive field surveys of *Galium buxifolium* populations on San Miguel Island are needed to fully assess the species' status in its known range (USFWS, 2009).
- The Service should work cooperatively with NPS and USGS to refine downlisting and delisting criteria to emphasize long-term population growth trends rather than short-term gains or declines in the species (USFWS, 2009).
- The USGS and NPS should investigate the community-level factors that influence population abundance, distribution, and demographic trends of the species (USFWS, 2009).

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SPECIES ACCOUNT: *Galium californicum* ssp. *sierrae* (El Dorado bedstraw)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/18/1996; Pacific Southwest (R8)

Physical Description

A softly hairy perennial herb in the coffee family (Rubiaceae). Four narrow leaves are arranged at each node. The pale yellow flowers, which are clustered at the tips of stems, appear in May and June. Minute hairs cover the fleshy fruit. *Galium aparine* (stickywilly), *G. bolanderi* (Bolander's bedstraw), *G. divericatum* (Lamarck's bedstraw), *G. porrigens* var. *tenue* (graceful bedstraw), *G. parisiense* (wall bedstraw), and *G. pubens* (limestone bedstraw) also occur on gabbro-derived soils in the Pine Hill area (Wilson 1986). *Galium californicum* ssp. *sierrae* is not easily confused with any other species of *Galium* (Dempster 1977) and can be distinguished from other subspecies of *G. californicum* by its very narrow leaves. (USFWS, 2002)

Taxonomy

The type specimen for *Galium californicum* ssp. *sierrae* was collected 1.7 kilometers (1 mile) north of Pine Hill Lookout in western El Dorado County, California. Dempster and Stebbins (1968) described *G. californicum* ssp. *sierrae*. (USFWS, 2002).

Historical Range

Restricted to the Pine Hill formation in western El Dorado County, California. (USFWS, 2002)

Current Range

Restricted to the Pine Hill Preserve and immediate vicinity in El Dorado County, California. (USFWS, 2019a)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 1996)

Lifespan

Adult: 2+ years (inferred from USFWS, 2002)

Breeding Season

Adult: May - June (USFWS, 2002)

Key Resources Needed for Breeding

Adult: Periodic fire (USFWS, 1996)

Other Reproductive Information

Adult: Little is known about the reproductive biology, ecology and demography of El Dorado bedstraw; however, the species was documented to have resprouted post-wildfire (Wilson et al. 2009). (USFWS, 2019a)

Reproduction Narrative

Adult: Flowers appear in May and June. This species is a perennial (USFWS, 2002). Fire is important for seed germination and seedling reestablishment by eliminating competition and shading, as well as replenishing nutrients to the soil. Without periodic fires, the previously mentioned plants either do not reproduce by seed or may become shaded by other plants (USFWS, 1996).

Habitat Type

Adult: Terrestrial (USFWS, 2002)

Habitat Vegetation or Surface Water Classification

Adult: Oak and oak-pine woodland (USFWS, 2002)

Dependencies on Specific Environmental Elements

Adult: Periodic fire (USFWS, 1996)

Geographic or Habitat Restraints or Barriers

Adult: 453 - 2,060 ft. elevation (USFWS, 1996)

Habitat Narrative

Adult: *Galium californicum* ssp. *sierrae* inhabits oak woodland areas, including sites with *Pinus ponderosa* (ponderosa pine) and *Pinus sabiniana* (foothill pine) (Wilson 1986). It occurs within black oak woodland on Pine Hill and Cameron Park and within live oak woodland in Shingle Springs and Salmon Falls (L. Eng in litt. 1999). (USFWS, 2002)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: No information is available regarding dispersal.

Population Information and Trends**Population Trends:**

Increasing (USFWS, 2019a)

Number of Populations:

16 (USFWS, 2019a)

Population Size:

Greater than 21,000 individuals (USFWS, 2019a)

Population Narrative:

There have been numerous newly discovered populations of El Dorado bedstraw reported to CNDDDB since listing. In general, a direct comparison of species abundance in 2019 versus at the time of listing is not possible due mainly to lack of abundance data at the time of listing. Contributing to that challenge is that there is not consistent current abundance data for many of the populations, especially those on private lands. However, given the increase in the number of populations of El Dorado bedstraw, it is likely that overall abundance has increased for those species (CNDDDB 2018). (USFWS, 2019a)

Threats and Stressors

Stressor: Habitat loss and fragmentation (USFWS, 2002)

Exposure:

Response:

Consequence:

Narrative: Historically, gold rush activities and clearing for agriculture reduced and fragmented habitat in western El Dorado County. More recently, vegetation on the Pine Hill formation has changed significantly due to commercial and residential development, road construction, and fragmentation. Commercial or residential developments have partially or completely destroyed occurrences of the species (California Natural Diversity Data Base 1998; California Department of Fish and Game 1990a, 1990b; G. Clark in litt. 1993). Proposed residential or commercial development within the Pine Hill formation threatens most of the remaining sites within the Pine Hill formation and adjacent serpentine in western El Dorado County, and either directly or indirectly will adversely affect most of the range of this species. Additionally, habitat fragments may be too small to support viable populations of animals serving as pollinators or seed dispersal agents for the species. Edge effects, which occur at the interfaces of any two or more habitat types, typically increase with habitat fragmentation and are more pronounced for natural communities bordered by human disturbances (USFWS, 2002).

Stressor: Land use activities (USFWS, 2002)

Exposure:

Response:

Consequence:

Narrative: The increasing number of people and changes in land uses will continue to place an increasing strain on undeveloped areas through activities such as off-road vehicle traffic, unauthorized garbage dumping, and changes in the pattern of wildfires. Horse paddocking in rural residential areas within the central and northern portions of the Pine Hill formation threatens *Galium californicum* ssp. *sierrae*. The horses, when confined, severely graze or trample most available vegetation. The herbaceous gabbro plants are especially likely to be grazed (J. Van Ess pers. comm. 1993) (USFWS, 2002).

Stressor: Alteration of the natural fire regime (USFWS, 2019a)

Exposure:

Response:

Consequence:

Narrative: The primary overall threat is encroachment of native vegetation due to succession, even on lands in conservation ownership, in the absence of the natural fire regime. The long fire return interval due to fire suppression is preventing the formation of necessary clearings for El

Dorado bedstraw establishment and possibly the scarification of seeds needed for germination. (USFWS, 2019a)

Stressor: Invasive plant competition (USFWS, 2019a)

Exposure:

Response:

Consequence:

Narrative: Invasive plants continue to present a minor threat to gabbro plant species. Populations within the Pine Hill Preserve are not significantly threatened by invasive plants and any small infestations identified are largely reduced or eliminated by mechanical means (BLM 2008). (USFWS, 2019)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2019a)

Exposure:

Response:

Consequence:

Narrative: The State's authority to conserve rare wildlife and plants is comprised of four major pieces of legislation: the California Endangered Species Act, the Native Plant Protection Act, the California Environmental Quality Act, and the Natural Community Conservation Planning Act. The State may authorize permits for scientific, educational, or management purposes, and to allow take that is incidental to otherwise lawful activities. Landowners are exempt from the prohibition for plants to be taken in the process of habitat modification. Protection of listed species through California Environmental Quality Act is dependent upon the discretion of the lead agency involved. The National Environmental Policy Act (NEPA) does not require that adverse impacts be fully mitigated, only that impacts be assessed and the analysis disclosed to the public. More details about existing protections are provided in the 2019 5-Year Review. (USFWS, 2019a)

Recovery

Reclassification Criteria:

1. Secure and protect specified recovery areas from incompatible uses: (a) Pine Hill preserve, Salmon Falls/Martel Creek preserve; (b) Cameron Park preserve north of Highway 50; and (c) Specialty Galium preserve and occupied habitat; along with adjacent unoccupied habitat and a 150-meter (500-foot) buffer at all known sites. (USFWS, 2002)
2. Management plan approved and implemented for recovery areas, including survival and recovery of the species as the objective: For all populations and any occupied or unoccupied habitat identified as necessary for survival. (USFWS, 2002)
3. Monitoring in all recommended preserves shows: (a) Stable or increasing with evidence of natural recruitment for a period of 60 years (or longer if suggested by the results of demographic monitoring). (b) Habitat monitoring of recommended preserves shows a mosaic of multiage class stands and habitat fragmentation has not appreciably increased (less than 5 percent) over current (2000) conditions. (c) Spatially and temporally, the establishment of occurrences must be greater than the extirpation of occurrences. (USFWS, 2002)
4. Other actions: (a) Ameliorate or eliminate threats; (b) Ecological studies; (c) seeds stored in at least two Center for Plant Conservation certified facilities; (d) research on seed germination and

propagation techniques; (e) effects of fire studied; (f) successful enhancement, repatriation, or introduction at Salmon Falls/Martel Creek. (g) Maintain metapopulation dynamics of at least 1 large, 6 medium occurrences, and 5 small occurrences at any given time throughout the range of the species. (USFWS, 2002)

Delisting Criteria:

E/1: Number of populations with specific geographic distribution. The 12 bedstraw populations must persist in at least four different preserve units. Populations species must persist at the size described in E/2, for at least two full fire cycles. (USFWS, 2019b)

E/2 Number of plants per population: Of the 12 populations of bedstraw required for down and delisting, small, medium, large, and very large populations must contain the number of plants described as follows. Based on the size of each population, the minimum number of mature plants in each population are: Small (at least five populations): 1,750; Medium (at least six populations): 8,400; Large (at least one populations) 14,875; Total number of plants: 74,025. (USFWS, 2019b)

Recovery Actions:

- 1. Develop and implement a cooperative program and participation plan. A cooperative program is needed to coordinate local public and private land use planning with State and Federal land use and recovery planning for gabbro species. A cooperative program needs to be developed focusing on western El Dorado County. A participation plan produced from this program will increase the chances of recovery for listed species. (USFWS, 2002)
- 2. Protect and secure existing populations. Natural lands that contain this species need to be protected in perpetuity. Protection of these lands includes identification and minimization of threats in perpetuity and application of appropriate and adaptive management (see Task 3) to ensure species survival and recovery. Natural lands that need protection can be categorized into two types: (1) blocks of land that contain occupied or potential habitat for two or more this species and (2) blocks of land that contain occupied or potential habitat for one this species. All potential preserve areas should be evaluated based on current mapping information and ground-truthed prior to purchase to confirm their value for recovery. (USFWS, 2002)
- 3. Manage Habitat Managing habitat is essential to the recovery of the listed species. Habitat management includes preparation and implementation of management plans for all areas inhabited by special status species being proposed for preservation, and periodic monitoring of populations in each of these areas. Within western El Dorado County, a multi-constituent committee should be formed to oversee the management of preserves located on the Pine Hill formation. The preserve management committee should include, at a minimum, representatives from the California Department of Fish and Game, U.S. Fish and Wildlife Service, Bureau of Land Management, El Dorado County, California Department of Forestry and Fire Protection, California Native Plant Society, American River Conservancy, and a private landowner representative. (USFWS, 2002)
- 4. Survey historical locations and other potential habitat where this species may occur. Recovery of listed species may often require relocating historic populations or locating new populations of these species. Historical locations should be surveyed to determine whether suitable habitat remains, the species persists at the sites, and/or the sites may be suitable for repatriation. Suitability of historical locations for repatriation would depend upon: (1) whether potential habitat exists, (2) the presence and magnitude of threats, and (3)

- whether the sites can be secured and managed for the long-term protection of the species. Surveys should also include other potential gabbro or serpentine habitat to determine whether undiscovered populations may exist. If new populations are discovered, they need to be protected and managed as discussed above. During the surveys, potential introduction sites should also be identified.
- 5. Conduct necessary biological research and use results to guide recovery/conservation efforts. - Develop propagation techniques for listed plant species for which enhancement, repatriation, or introductions would be appropriate. Geographic area research is outlined in the Recovery Plan. Species-specific research is described as follows: Habitat Survey Research: Cameron Park Area, northwest part of Salmon Falls, and Martel Creek . Reproduction and Demography Research: Including determining limiting life stages and reproductive biology, seed production and survival in soil to determine appropriate fire return period. Genetics research. Other Research Needs: Effects of fire; fire management techniques; germination requirements and propagation techniques; metapopulation analysis; determine efficacy of other types of disturbance regimes for species and habitat management; feasibility of habitat restoration/ enhancement. Management Actions Needed: General surveys; baseline monitoring; monitoring for trends of populations, success of management actions, and threats at all populations identified for protection; monitoring for habitat fragmentation, major shifts in vegetation type, and tracking of occurrence establishment, and extirpation; enhancement and introduction; seed banking. (USFWS, 2002)
 - 6. Undertake artificial enhancement, repatriation, or introduction efforts where necessary. Where it is deemed necessary, artificial enhancement, repatriation, or introduction efforts for sensitive plants should be undertaken. Prior to repatriation or introduction of sensitive plants, genetics studies are needed (see Task 5) to ensure that new populations will not disrupt unique local gene complexes. Plant repatriation or introduction efforts should be undertaken using collected seeds or plant propagules. (USFWS, 2002)
 - 7. Determine possible prescribed burning management strategies and incorporate the strategies into the management plans (Priority 1). Possible prescribed burning management strategies need to be evaluated, peer reviewed, and incorporated into management plans. (USFWS, 2002)
 - 8. Perform metapopulation-type analyses for this species (Priority 2). The results of a metapopulation-type analysis may be useful in clarifying uncertainties, data needs, and research, management priorities, and delisting criteria. Metapopulation-type analyses should be based on the results of monitoring and research. (USFWS, 2002)
 - Conduct controlled burns at all appropriate preserve units to maintain multiple populations of bedstraw within a shifting mosaic of woodland and chaparral that contains early, middle and late seral vegetation stages. Priority 1 (USFWS, 2019b)
 - Conduct outreach to private landowners residing adjacent to existing preserves and/or other private landowners within suitable habitat of these species to provide education on avoiding degradation of habitat and to encourage the voluntary sale of conservation easements by willing landowners. Priority 1 (USFWS, 2019b)
 - Conduct genetic analyses to determine areal size of individuals/extent of clonality and population structure in order to define individuals of bedstraw. Priority 2 (USFWS, 2019b)
 - Conduct population viability analyses for bedstraw. Priority 2 (USFWS, 2019b)
 - Conduct research into the regeneration ecology of bedstraw. Priority 2 (USFWS, 2019b)

- Conduct research to determine effective means of mechanical and other non-fire related control of chaparral to benefit gabbro soil species. Priority 2 (USFWS, 2019b)
- Conduct outplantings of bedstraw, specifically at the Salmon Falls/Martel Creek unit where substantial suitable habitat exists. Priority 2 (USFWS, 2019b)
- 8. Develop a monitoring plan to span 5 years post-delisting of bedstraw and implement the plan at the time of delisting to measure the (USFWS, 2019b)

Conservation Measures and Best Management Practices:

- Pine Hill Ecological Reserve (97 hectares [240 acres]) was established in 1979 to protect the gabbro plants located on the summit of Pine Hill (USFWS, 2002).
- The California Natural Diversity Data Base, James Wilson's masters thesis (Wilson 1986), survey reports prepared by environmental consultants, interviews with local botanists, and EIP Associates' field surveys were used to determine the location of clusters of rare plants occurring on the Pine Hill formation (EIP Associates 1991). Twenty-two clusters of rare plant species were initially identified. This study, completed in November 1991, identified 12 potential preserve sites (EIP Associates 1991) (USFWS, 2002).
- In 1992, the California Department of Fish and Game, Bureau of Land Management, and Bureau of Reclamation signed a memorandum of understanding to protect the gabbro plant habitat along the South Fork of the American River (California Department of Fish and Game 1992) (USFWS, 2002).
- The Rare Plant Advisory Committee recommended three main preserve sites--Salmon Falls, Pine Hill, and Cameron Park/Shingle Springs--and two smaller satellite preserve areas--Martel Creek and Penny Lane. The total acreage of the five preserves that the Rare Plant Advisory Committee proposed was approximately 1,416.6 hectares (3,500 acres) (USFWS, 2002).
- In 1993, the California Department of Fish and Game applied for and received a section 6 grant from us to investigate funding mechanisms for land acquisition. A draft economic feasibility study for acquiring the rare plant preserves, prepared by Economic & Planning Systems, Inc., was published in 1997 (USFWS, 2002).
- Our February 27, 1995, biological opinion on the interim renewal by Bureau of Reclamation of 67 water service contracts on the Central Valley Project (including water contracts for El Dorado County) identified implementation of a preserve system for the five federally listed gabbro plants as a critical need (U.S. Fish and Wildlife Service 1995). The critical needs analysis for these plants specifically noted the importance of a preserve in the southern zone (Cameron Park) of the Pine Hill formation (USFWS, 2002).
- From 1990 to 1996, California Department of Fish and Game and the American River Conservancy purchased approximately 123 hectares (305 acres) in the Salmon Falls area for \$1,600,000. In 1990, the Wildlife Conservation Board approved the purchase of a 16.2-hectare (40-acre) parcel near Salmon Falls with Proposition 70 funds. Proposition 117 funds were used to acquire 16.2 hectares (40 acres) in the Salmon Falls area in 1991 (California Department of Fish and Game 1992). An additional six parcels totaling about 91 hectares (225 acres) in the Salmon Falls Area have been purchased from willing sellers with grant funds raised by the American River Conservancy and the California Department of Fish and Game, as well as funding from mitigation for a private development in Cameron Park. These properties are managed by California Department of Fish and Game (USFWS, 2002).
- On July 28, 1998, the El Dorado County Board of Supervisors adopted Ordinance 4500, which established an ecological preserve mitigation requirement or an in-lieu fee for certain development projects in western El Dorado County. El Dorado County is currently implementing this impact fee

program to augment the funds needed to fund the acquisition and administration of the preserve system (El Dorado County 1998) (USFWS, 2002).

- With Congressman John Doolittle's support, Congress appropriated \$5,000,000 of Land and Water Conservation Fund money to be administered starting in fiscal year 2001 by the Bureau of Land Management. In fiscal year 2002, an additional \$3,000,000 of Land and Water Conservation Fund money were allocated. \$4,008,400 of Land and Water Conservation Funds have been used for land acquisition in the Cameron Park area as of January 2002 (USFWS, 2002).
- In 2001, a cooperative management agreement for the Pine Hill Preserve in El Dorado County was signed by three Federal agencies (Bureau of Land Management, U.S. Fish and Wildlife Service, and U.S. Bureau of Reclamation), two State agencies (California Department of Fish and Game and California Department of Forestry and Fire Protection), El Dorado County, El Dorado Irrigation District, and the American River Conservancy. The primary goal of the Pine Hill Preserve is the preservation in perpetuity of the rare plant species and communities of the western El Dorado County gabbro formation (USFWS, 2002).
- Dedicate more resources toward the investigation of best management approaches for the Pine Hill listed plant species, even at the cost of a temporary hiatus in land acquisition efforts. Investigation should be made into fire-related and non-fire related methods of disturbance to maintain listed plant species habitat. (USFWS, 2019a)
- Once the best management strategy (in terms of technique, frequency, timing, and intensity) is determined at each site, implement these management practices to achieve and maintain a habitat mosaic that enables the attainment of recovery criteria for the species. (USFWS, 2019a)

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USFWS. 2019a. Stebbins' morning-glory (*Calystegia stebbinsii*), Pine Hill ceanothus (*Ceanothus roderickii*), Pine Hill flannelbush (*Fremontodendron californicum* ssp. *decumbens*), El Dorado bedstraw (*Galium californicum* ssp. *sierrae*), Layne's butterweed (*Packera layneae*), 5-Year Review Summary and Evaluation. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office. May 2, 2019. https://ecos.fws.gov/docs/five_year_review/doc6009.pdf

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USFWS. 2019b. Amendment 1. Recovery Plan for Gabbro Soil Plants of the Central Sierra Nevada Foothills: El Dorado bedstraw (*Galium californicum* ssp. *sierrae*) and Pine Hill flannelbush (*Fremontodendron californicum* ssp. *decumbens*). U.S. Fish and Wildlife Service, Sacramento, California. 20 pp. September 26, 2019.

SPECIES ACCOUNT: *Gardenia brighamii* (Hawaiian gardenia (=Na`u))

Species Taxonomic and Listing Information

Listing Status: Endangered; 08/21/1985; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Gardenia brighamii is a small tree up to 20 feet (6.096 m) in height. Trunks are up to 12 in (30.48 cm) in diameter and somewhat smooth. The shiny, dark green leaves are oval-shaped and measure from 1 to 4 in (2.2 to 10.5 cm) long and 1/2 to 2 in (1.5 to 5.5 cm) wide. The solitary flowers are white and very fragrant. The flowers range in size from 1 to 1 1/2 in (2.54 to 3.81 cm) in diameter. Fruits are hard, round, greenish, and moderate in size - about 1 1/2 in (3.81 cm) in diameter. The inside of the fruit is fleshy and contains many small seeds. *Gardenia brighamii* is not known to reproduce vegetatively in the wild, but can be air-layered using horticultural techniques. (USFWS, 1993)

Taxonomy

There are three gardenia species native to Hawaii: *G. brighamii*, *G. manni*, and *G. remyi*. All three are also endemic to Hawaii. (USFWS, 1993)

Historical Range

Historical records from Maui and Hawaii. (NatureServe, 2015)

Current Range

Current populations from Oahu, Lanai and Molokai. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (NatureServe, 2015)

Lifespan

Adult: >65 years (USFWS, 1993)

Dependency on Other Individuals or Species

Adult: Insect pollinators (USFWS, 1993)

Breeding Season

Adult: Primarily in spring (March through May) (USFWS, 1993)

Key Resources Needed for Breeding

Adult: Flowering is correlated with rainfall (USFWS, 1993)

Reproduction Narrative

Adult: *Gardenia brighamii* reproduces sexually. Growth rates and longevity are not known, though the single tree at Kuua, Oahu, has been under observation since at least 1925, a period of over 65 years. Flowering and fruiting times vary among the populations. On Oahu and Hawaii, flowering is primarily from October through December. On Maui, Molokai, and Lanai, flowering is primarily in the spring (March, April, and May) with sporadic flowering in December and July. It has been suggested that flowering is positively correlated with rainfall (John Obata, Hawaii Plant Conservation Center, personal communication to Gagne 1982). The original pollen vector is not known, but the flowers would suggest an insect. *Gardenia brighamii* is apparently self-compatible and seedlings resulting from self pollination have shown high survivability. (USFWS, 1993; NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- mixed, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 1,000 to 1,800 feet; rainfall from 15 to 35 in per year; and vegetation is low and windswept (below 20 ft in height) (USFWS, 1993)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1993)

Habitat Narrative

Adult: *Gardenia brighamii* is found in dry scrub and forests on the leeward sides of the main Hawaiian islands. The populations receive 15 to 35 in (38.1 to 88.9 cm) of rain per year and experience a summer drought (Gagne 1982, Spence and Montgomery 1976). Sites are generally located at low to mid elevation (1,000 to 1,800 ft; 304.8 to 548.6 m) with well drained, lateritic soils of low fertility (Gagne 1982). Slope ranges from gradual to steep and the aspect is variable. The surrounding vegetation is usually low and windswept, rarely exceeding 20 ft (6.096 m) in height (Gagne 1982). *Gardenia brighamii* is a component of the *Diospyros sandwicensis*, and *Erythrina sandwicensis* dry forest communities (Gagne and Cuddihy 1990). Associated native species include: *Diospyros sandwicensis*, *Nestegis sandwicensis*, *Erythrina sandwicensis*, *Nototrichium sandwicensis*, *Nesoluma polynesianum*, *Bobea sandwicensis*, *Santalum freycinetianum*, *Nothocestrum latifolium*, *Pouteria sandwicensis*, *Rauvolfia sandwicensis*, *Dodonaea viscosa*, *Waltheria indica*. (USFWS, 1993)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: The original dispersal agent is not known, but was most likely a bird. (USFWS, 1993)

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2014)

Redundancy:

Very low (inferred from USFWS, 2014)

Number of Populations:

4 (USFWS, 2014)

Population Size:

13 wild, ~100 reintroduced (USFWS, 2014)

Population Narrative:

In 2011, there were five wild mature individuals, 81 reintroduced seedlings, and 58 augmented seedlings on Lanai; and a single wild mature individual, single mature reintroduced individual, and 20 immature reintroduced individuals on Oahu (PEPP 2011). In 2012, a single wild mature individual remained on Oahu (PEPP 2012). On Lanai, there are 3 populations containing 12 wild individuals (PEPP 2012). (USFWS, 2014)

Threats and Stressors

Stressor: Drought (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Unprecedented drought conditions threaten the survival of *G. brighamii* on Maui and Oahu (PEPP 2009, 2011, 2013), and Lanai (PEPP 2010, 2011, 2012, 2013). (USFWS, 2014)

Stressor: Herbivory by the black twig borer (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Herbivory by black twig borer has been identified as a threat to this species on Lanai (PEPP 2013). (USFWS, 2014)

Stressor: Herbivory by slugs (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Herbivory by slugs is a threat to the reintroduced individual on Molokai (PEPP 2012). (USFWS, 2014)

Stressor: Overutilization (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Overutilization for commercial, recreational, scientific, or educational purposes – *Gardenia brighamii* that originated from natural populations, but is now grown from seed or vegetative propagules produced in nurseries, is available for sale by multiple nurseries and home improvement stores only within the State of Hawaii. (USFWS, 2014)

Stressor: Climate change (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Climate change degradation of habitat – Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Gardenia brighamii* is moderately vulnerable to the impacts of climate change. Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2014)

Stressor: Herbivores (USFWS, 1993)

Exposure:

Response:

Consequence:

Narrative: Numerous species of mammalian herbivores have been introduced into Hawaii, notably cattle, goats, pigs and deer. Their introduction (and continued existence) has been the single most destructive aspect of European contact. These animals destroy *Gardenia brighamii* and other native species not only by grazing, browsing, and trampling, but also indirectly by increasing erosion and soil compaction, dispersing the seed of alien plants, and creating disturbances which allow alien plant competitors to become established. (USFWS, 1993)

Stressor: Land conversion (USFWS, 1993)

Exposure:

Response:

Consequence:

Narrative: The clearing of dry forest for agricultural and urban uses was without question an important contributor to the endangerment of *Gardenia brighamii*. However, this activity is not known to be a threat to the existing sites. (USFWS, 1993)

Stressor: Fire (USFWS, 1993)

Exposure:

Response:

Consequence:

Narrative: The early Hawaiians apparently used fire to clear forests and to maintain desired habitats (Cuddihy and Stone 1990). European colonization also resulted in an increased frequency of fire, though most fires were, and are, unintentional. Fire poses a serious threat to *Gardenia brighamii* by killing trees outright and by creating disturbances which generally favor alien plant invaders over the slower-growing native species. Because the remaining individuals of *G. brighamii* are in small, localized populations, fire should be viewed as a catastrophic event

from which the populations would probably not recover. None of the populations or fenced exclosures are protected by firebreaks. (USFWS, 1993)

Stressor: Predation by rats (USFWS, 1993)

Exposure:

Response:

Consequence:

Narrative: Reportedly, rats climb into *C. brighamii* trees and eat or damage the fruits (Gagne 1982). (USFWS, 1993)

Stressor: Fungus (USFWS, 1993)

Exposure:

Response:

Consequence:

Narrative: Gagne (1982) reported that the *C. brighamii* trees on Lanai were affected by some sort of fungal infection or rust. The effect of this rust on growth, reproduction, or survival is not known. (USFWS, 1993)

Stressor: Insects (USFWS, 1993)

Exposure:

Response:

Consequence:

Narrative: Gagne (1982) also reported that various scale insects are attracted to *G. brighamii*. The impact of this factor on *C. brighamii* is not known. (USFWS, 1993)

Stressor: Alien plants (USFWS, 1993)

Exposure:

Response:

Consequence:

Narrative: Alien plants pose a serious threat to the existence of *Gardenia brighamii*. These species probably compete with *G. brighamii* for light, water, space, and/or nutrients. In addition, some alien weeds may release allelopathic substances or alter the soil chemistry. Many alien species also increase the threat of fire at *C. brighamii* sites, because they greatly increase the fuel load of these areas. The most important alien weeds at the existing *C. brighamii* sites are: *Lantana camara*, *Leucaena leucocephala*, *Panicum maximum*, *Tecoma stans*, *Grevillea robusta*, and *Schinus terebinthifolius*. (USFWS, 1993)

Stressor: Soil erosion (USFWS, 1993)

Exposure:

Response:

Consequence:

Narrative: The toppling of plants due to erosion is a problem at the Molokai site, where several plants were lost due to erosion of the gully walls (Herbst 1985). (USFWS, 1993)

Recovery

Reclassification Criteria:

1. The species may be downlisted when it is represented by three naturally reproducing, healthy, fenced populations, each with 50 mature plants, on each of Lanai, Molokai, Oahu, Hawaii and Maui. (USFWS, 1993)
2. *Gardenia brighamii* is represented by 750 plants in: Three healthy, naturally reproducing, fenced populations, each with 50 mature plants on each of Lanai, Molokai, and Oahu. This would be a total of 450 wild plants. Three healthy, naturally reproducing, fenced populations, each with 50 mature plants on each of Maui and Hawaii. This would be a total of 300 wild plants. (USFWS, 1993)

Delisting Criteria:

1. *Gardenia brighamii* is represented by at least 3 populations, each with at least 100 mature, healthy, reproductive plants, on secure lands on each of Oahu, Hawaii, Maui, Molokai, and Lanai. (USFWS, 1993)
2. These 15 populations must be unfenced unmanipulated, self-reproducing, and stable over a period of 10 years. (USFWS, 1993)

Recovery Actions:

- Secure habitat of current populations and manage threats. (USFWS, 1993)
- Conduct research on limiting factors. (USFWS, 1993)
- Increase numbers and monitor. (USFWS, 1993)
- Reestablish in former range. (USFWS, 1993)
- Validate recovery objectives. (USFWS, 1993)

Conservation Measures and Best Management Practices:

- Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. (USFWS, 2014)
- Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change. (USFWS, 2014)
- Continue augmenting populations as genetically appropriate individuals become available in nurseries and as habitat is protected. (USFWS, 2014)
- Continue to survey the geographical and historical range of *G. brighamii* to assess the status of known populations and possible additional populations. (USFWS, 2014)
- Continue to fence wild and reintroduced populations to protect them from the impacts of feral ungulates. Maintain fencing to exclude browsing by ungulates. (USFWS, 2014)
- Control invasive introduced plants within the vicinity of *G. brighamii* populations and maintain the habitat free of invasive introduced plants. (USFWS, 2014)
- Continue to control rodents and mites within the vicinity of all known *G. brighamii* populations. (USFWS, 2014)
- Control slugs at the reintroduction site on Molokai. (USFWS, 2014)
- Continue to irrigate individuals of *G. brighamii* and maintain water storage tanks on Lanai to alleviate the impacts of drought. (USFWS, 2014)
- Continue to monitor all known wild, augmented, and reintroduced individuals. (USFWS, 2014)
- Develop and implement a fire management plan for populations impacted by fire. (USFWS, 2014)
- Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. (USFWS, 2014)

- Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2014)

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USFWS. 2014. *Gardenia brighamii* (Hawaiian gardenia, na'u) 5-Year Review Short Form Summary. Pacific Islands Fish and Wildlife Office (PIFWO), Honolulu, Hawaii

SPECIES ACCOUNT: *Gardenia mannii* (Nanu)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

Gardenia mannii, is a short-lived perennial in the Rubiaceae (coffee family). This species is a tree 5 to 15 m (16 to 50 ft) tall with lance-shaped leaves, 6 to 27 cm (2.4 to 11 in) long, and 3.5 to 10.0 cm (1.4 to 3.9 in) wide. The solitary white flowers are fragrant, open in the late afternoon, and last about two days. The corolla tube of the flower is 17 to 27 mm (0.7 to 1.1 in) long, and the lobes are 16 to 22 mm (0.6 to 0.9 in) long. The fruit is yellow to orange, broadly ellipsoid, and 1.8 to 4.5 cm (0.7 to 1.8 in) in diameter. This species is distinguished from others in the genus by the shape and number of the calyx spurs. *G. mannii* and *G. brighamii* are the only two species in the Waianae Mountains from the genus *Gardenia* (Wagner et al. 1999).

Historical Range

Historically, *Gardenia mannii* was known from seven widely scattered occurrences in the Waianae Mountains and 39 occurrences distributed along almost the entire length of the Koolau Mountains of Oahu.

Current Range

Currently, there are 23 occurrences of 93 to 105 *G. mannii* individuals. However, there may be a number of unrecorded plants, particularly in the wet forests of the Koolau Mountains. The majority of the known occurrences contain fewer than five individuals. They are distributed along a 42-km (26-mi) length of the Koolau Mountains, from Kaunala Gulch and Kaunala-Waimea Ridge in the north to Palolo in the south and along a 7-km (4-mi) distance in the Waianae Mountains from north Haleauau Valley to Kaluaa Gulch. Known occurrences are: Malaekahana-Waimea Summit Area (13 individuals), Pamalu (2), upper Kawainui (2), Kawailoa trail (12), Poamoho to Helemano (22), Opaaula (11 to 22), Kaiwai-Koele (1), south Kaukonahua Gulch (2), north Haleauau Gulch (4), Hanaimoa (1 to 2), Kaipapau (1), Kaluaa and Manauna (6), Kaluanui (1), Kapakahi Gulch (3), Laie trail (2), Makaua (2), Manana to Waimano Ridge (1), Papali (1), Pia Gulch (1), Pukele (1), lower Waimano (1), upper Waimano (2), and Puu Hapapa-Waieli Gulch (1). *G. mannii* occurrences are declining, and those that remain are small and widely dispersed, which puts the species at risk of extinction from naturally occurring events and/or lack of reproductive vigor (HINHP Database 2001; K. Kawelo, U.S. Army, pers. comm. 2003; J. Lau, HINHP, pers. comm. 2003; Service 1998a; U.S. Army 2003a).

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003 (Revised September 18, 2012), the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Gardenia mannii* (Nanu) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Gardenia mannii* (77 FR 57648-57862). The critical habitat designation includes 23 critical habitat units, which encompass approximately 33,624 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Gardenia mannii* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Gardenia mannii* includes 23 critical habitat units, covering two ecosystem types, which encompass approximately 33,624 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7; Oahu—Lowland Wet—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

Oahu—Lowland Wet—Unit 1 [541 ac (219 ha)]. This area consists of 428 ac (173 ha) of State land and 112 ac (46 ha) of City and County of Honolulu land in the lowland wet ecosystem on the windward side of the Waianae Mountains, and partially within the Mokuleia and Waianae Kai Forest Reserves. Oahu—Lowland Wet—Unit 2 [20 ac (8 ha)]. This area consists of 19 ac (8 ha) of State land in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puuhapapa. Oahu—Lowland Wet—Unit 3 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puukanehoa. Oahu—Lowland Wet—Unit 4 [27 ac (11 ha)]. This area consists of 27 ac (11 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains on State land at Puukaua. Oahu—Lowland Wet—Unit 5 [74 ac (30 ha)]. This area consists of 74 ac (30 ha) of State land in the lowland wet ecosystem, on the windward side of the Waianae Mountains at Palikea. Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihihi, Wailele, and Koloa gulches. Oahu—Lowland Wet—

Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Haula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikēē, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet—Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet—Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu—Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamo Ridge.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Gardenia mannii* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Gardenia mannii* occurs within the Lowland mesic and Lowland wet ecosystems in the Waianae Mountain caldera complex and the Koolau Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy:

Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (E) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Oahu— Lowland Wet—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. (E) Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. (E) Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Gardenia mannii* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Habitat Type

Adult: Mesic or wet forests

Habitat Narrative

Adult: *Gardenia mannii* is usually found on moderate to moderately steep gulch slopes, ridge crests, in gulch bottoms, and on stream banks in mesic or wet forests between 82 and 1,050 m (269 and 3,444 ft) in elevation. Associated native plant species include *Acacia koa*, *Alyxia oliviformis*, *Antidesma platyphyllum*, *Bobea* sp., *Boehmeria grandis*, *Broussaisia arguta*, *Cheirodendron trigynum*, *Cibotium glaucum*, *Coprosma foliosa*, *Dicranopteris linearis*, *Elaeocarpus* sp., *Freycinetia arborea*, *Hedyotis acuminata*, *Ilex anomala*, *Melicope* sp., *Metrosideros polymorpha*, *Perottetia sandwicensis*, *Pipturus albidus*, *Pisonia* sp., *Pouteria sandwicensis*, *Psychotria marianiana*, *Syzygium sandwicensis*, and *Thelypteris* sp. The two occurrences located in the Waianae Mountains (Kaluaa Gulch and SBMR) may represent unique environmental adaptations. *G. mannii* plants have been observed with fruit and flowers throughout the year. Little else is known about its flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors (HINHP Database 2001; Service 1998a).

Dispersal/Migration

Population Information and Trends

Population Trends:

Decreasing

Number of Populations:

23

Population Size:

~ 93 - 105

Population Narrative:

Currently, there are 23 occurrences of 93 to 105 *G. mannii* individuals. However, there may be a number of unrecorded plants, particularly in the wet forests of the Koolau Mountains. The majority of the known occurrences contain fewer than five individuals. They are distributed along a 42-km (26-mi) length of the Koolau Mountains, from Kaunala Gulch and Kaunala-Waimea Ridge in the north to Palolo in the south and along a 7-km (4-mi) distance in the Waianae Mountains from north Haleauau Valley to Kaluaa Gulch. Known occurrences are: Malaekahana-Waimea Summit Area (13 individuals), Pamalu (2), upper Kawainui (2), Kawailoa trail (12), Poamoho to Helemano (22), Opauala (11 to 22), Kaiwai-Koele (1), south Kaukonahua Gulch (2), north Haleauau Gulch (4), Hanaimoa (1 to 2), Kaipapau (1), Kaluaa and Manauna (6), Kaluanui (1), Kapakahi Gulch (3), Laie trail (2), Makaua (2), Manana to Waimano Ridge (1), Papali (1), Pia Gulch (1), Pukele (1), lower Waimano (1), upper Waimano (2), and Puu Hapapa-Waieli Gulch (1). *G. mannii* occurrences are declining, and those that remain are small and widely dispersed, which puts the species at risk of extinction from naturally occurring events and/or lack of reproductive vigor (HINHP Database 2001; K. Kawelo, U.S. Army, pers. comm. 2003; J. Lau, HINHP, pers. comm. 2003; Service 1998a; U.S. Army 2003a).

Threats and Stressors**Stressor:****Exposure:****Response:****Consequence:**

Narrative: The major threats to *Gardenia mannii* are habitat degradation and/or destruction by nonnative plants and animals and impacts from military activities. The non-native plants such as *Clidemia hirta*, *Leptospermum scoparium*, *Passiflora suberosa*, *Psidium cattleianum*, *Psidium guajava*, *Rubus argutus*, *Schinus terebinthifolius*, and *Toona ciliata* threaten *G. mannii* by altering its habitat and competing with it for nutrients, light, and space. Feral pigs can impact this species by consumption of plant parts, including fruits, or by rooting the soil, which degrades the habitat. Rats also pose a threat to this species due to consumption of fruits and other plant parts (HINHP Database 2001; Service 1998a; 61 FR 53089). Another threat to *G. mannii*, especially in Kapakahi Gulch, is the black twig borer. The black twig borer burrows into the branches and introduces a pathogenic fungus, pruning the host severely and often killing branches or whole plants. This pest causes slight to severe defoliation and reduced vigor (HINHP Database 2001; Service 1998a; 61 FR 53089). Occurrences of *G. mannii* located on military lands are threatened by fire caused by military actions and trampling from foot maneuvers. The wide distribution and small numbers of remaining individuals make this species extremely vulnerable to inbreeding depression and destruction due to the occurrence of a catastrophic event (HINHP Database 2001; Service 1998a; 61 FR 53089).

Stressor:**Exposure:**

Response:
Consequence:
Narrative:

Recovery

Conservation Measures and Best Management Practices:

- A State-wide management plan should be developed and implemented for the long-term conservation of all known occurrences of *Gardenia mannii*. This plan should also include broader landscape actions that are needed for the recovery of this plant throughout its range. The recovery plan for this species has identified important conservation needs. Exclosures should be constructed around the known occurrences of *G. mannii* to reduce impacts from feral pigs, especially those occurrences containing a few individuals. Subsequent control or removal of pigs from these areas will alleviate their impact on native ecosystems. The black twig borer has been identified as a threat to one occurrence of *G. mannii*. It is not known how this plant will be affected by defoliation or reduced vigor due to infestations of this non-native insect. A number of parasitic invertebrates have been introduced to control the beetle, though none of them have become established. Further research on biological control of the beetle will need to proceed cautiously as a number of rare native Hawaiian scolytids are closely related to the black twig borer. A coordinated fire protection plan for endangered plant species on City and County of Honolulu, Federal, and private lands needs to be developed and implemented. Occurrences of this species are seriously threatened by rat predation. Rats are a threat to *G. mannii* and should be controlled in the vicinity of all known occurrences using approved rodenticides and ultimately an aerial dispersal of rodenticide (Service 1998a; U.S. Army 2003a). Ongoing Conservation Actions: The Army is currently experimenting with different methods to control pigs in areas adjacent to *Gardenia mannii* in SBMR. The Lyon Arboretum and the National Tropical Botanical Garden have successfully propagated and stored the seeds of this species. The Honolulu Botanical Garden has a living collection of *G. mannii* (Service 1998a; Service 2002). The Service is currently not aware of any other conservation efforts for this species.

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SPECIES ACCOUNT: *Gardenia remyi* (Nanu)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2016b)

Physical Description

Tree

Historical Range

Historically, this species was found on the island of Hawaii at Wao Kele O Puna NAR, Waiakea Forest Reserve, Pahoa, and Hakalau Nui. (USFWS, 2016)

Current Range

Found on the Hawaiian Islands of Kauai, Molokai, Maui, and Hawaii. (USFWS, 2014)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Habitat Type

Adult: Mesic to wet forests

Geographic or Habitat Restraints or Barriers

Adult: Found between 190 and 3,000 feet (USFWS, 2016)

Habitat Narrative

Adult: Typical habitat for *G. remyi* is mesic to wet forest from 190 to 3,000 ft (60 to 760 m), in the lowland mesic (Kauai, Molokai, and Hawaii Island) and lowland wet ecosystems (Kauai, Molokai, Maui, and Hawaii Island) (Wagner et al. 1999, p. 1133; TNCH 2007; HBMP 2010; Oppenheimer 2015, in litt.). (USFWS, 2016)

Dispersal/Migration

Population Information and Trends

Redundancy:

Low

Number of Populations:

16 (USFWS, 2016)

Population Size:

~90 (USFWS, 2016)

Population Narrative:

Currently, *G. remyi* is known from 16 occurrences totaling approximately 90 individuals on the islands of Hawaii, Maui, Molokai, and Kauai (Wood 2005b, in litt.; Oppenheimer 2006, in litt.; Perry 2006, in litt.; Welton 2008, in litt.; Agorastos 2010, in litt.; HBMP 2010; Perlman 2010, in litt.). An occurrence on east Maui has been observed to decline from 14 individuals in 1992, to only 1 individual by 2015 (Duvall 2015, in litt.). (USFWS, 2016)

Threats and Stressors

Stressor: Feral pigs, goats, and deer (USFWS, 2016)

Exposure: Habitat degradation and destruction

Response:

Consequence:

Narrative: Habitat modification and destruction by feral pigs, goats, and axis deer negatively affects *Gardenia remyi* and areas suitable for its reintroduction (Perry, in litt. 2006; PEPP 2008, p. 102; HBMP 2010). Feral pigs and signs of their activities have been reported at occurrences of *G. remyi* on the island of Hawaii, on Kauai, on east and west Maui, and on Molokai. Goats and signs of their activities are reported at the occurrences *G. remyi* on Kauai and Molokai. Axis deer and signs of their activities are reported at the occurrences of *G. remyi* on Molokai (HBMP 2010). Herbivory by these ungulates is a threat to *G. remyi*, as they browse on leaves and other parts of almost any woody or fleshy plant species. (USFWS, 2016)

Stressor: Hurricanes (USFWS, 2016)

Exposure: Predation

Response:

Consequence:

Narrative: Landslides are a threat to occurrences and habitat of *G. remyi* on Hawaii Island (Perry 2006, in litt.). (USFWS, 2016)

Stressor: Nonnative plants

Exposure: Compete and displace

Response:

Consequence:

Narrative: Nonnative plants, such as *Clidemia hirta*, *Hedychium gardnerianum*, *Psidium cattleianum* (strawberry guava), and *Tibouchina herbacea* on Hawaii Island (Perry 2006, in litt.); *Lantana camara* (lantana), *Psidium guajava*, and *Rubus argutus* on Kauai (Wood 2004, in litt.); *Ageratina adenophora* (Maui pamakani), *Rubus rosifolius* (thimbleberry), and *T. herbacea* on Maui (HBMP 2010); and *C. hirta* and *P. cattleianum* on Molokai (HBMP 2010), modify and destroy native habitat of *G. remyi* and outcompete this and other native plants for water, nutrients, light, and space in areas where *G. remyi* occurs on these islands. (USFWS, 2016)

Stressor: Lack of pollination (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Lack of pollination was suggested as the cause for abortion of immature fruits that were seen among plants on Hawaii Island (PEPP 2010, p. 73). Similarly, Agorastos (2011, in litt.) reported no viable seed production in the wild or within ex situ collections and no recruitment in

the wild among the 14 individuals observed on the island of Hawaii, Maui, and Molokai, for unknown reasons (Duvall 2015, in litt.; Oppenheimer 2015, in litt.). Some species of *Gardenia* are dioecious (male and female flowers on separate plants) and although the breeding system of *G. remyi* is currently unknown, this may be a cause of failure to produce viable seed in isolated individuals (Lorence 2015, in litt.). (USFWS, 2016)

Stressor: Predation by rats (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Predation of seeds by rats is reported as a threat to individuals on Kauai (NTBG 2008, in litt.). Fortini et al. (2013, p. 76) found that, as environmental conditions are altered by climate change, *G. remyi* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions. (USFWS, 2016)

Stressor: Low numbers (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Low numbers of individuals (90 total individuals distributed across 4 islands) makes this species more vulnerable to extinction because of the higher risks from genetic bottlenecks, random demographic fluctuations, and localized catastrophes. (USFWS, 2016)

Recovery

Recovery Actions:

- Outplant individuals within ungulate-proof exclosures.
- Construct ungulate-proof exclosures around existing populations/individuals.
- Control nonnative plants.
- Maintain ex situ collections.

Conservation Measures and Best Management Practices:

- Outplant individuals within ungulate-proof exclosures.
- Construct ungulate-proof exclosures around existing populations/individuals.
- Control nonnative plants.
- Maintain ex situ collections.

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USFWS 2014. Endangered and Threatened Wildlife and Plants

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SPECIES ACCOUNT: *Geocarpon minimum* (No common name)

Species Taxonomic and Listing Information

Listing Status: Threatened; 6/16/1987; Southeast Region (R4) (USFWS, 2017)

Physical Description

A small (1-4 cm tall), ephemeral, succulent winter annual that usually completes its life cycle within a 4-week period in the spring. Young plants are grayish; mature plants reddish-purple. Flowers are inconspicuous. This unusual species comprises the monotypic genus *Geocarpon* (NatureServe, 2015).

Taxonomy

Kartesz & Kartesz (1980) had placed this genus in Aizoaceae but Kartesz (1994 checklist) subsequently placed it in Caryophyllaceae (NatureServe, 2015).

Historical Range

Historically found in St. Clair & Jasper Counties, Missouri (NatureServe, 2015).

Current Range

Found in southwestern Missouri (Dade, Polk, Greene, and Lawrence Counties). Found in three southeastern counties in Arkansas (Cleveland, Drew, and Bradley) and one Northwestern County (Franklin). Also found at two locations in Louisiana (Wynn Parish). This species was discovered in Texas in 2004 in Anderson County (Keith et al. 2004) (NatureServe, 2015). The range of *Geocarpon* has been extended farther west within the Arkansas River Valley and the habitat at this site appears similar to that described for the other known site within this region (Baker and Witsell 2015) (USFWS, 2016).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from NatureServe, 2015)

Lifespan

Adult: 4 - 6 weeks (NatureServe, 2015)

Breeding Season

Adult: February - June (USFWS, 2016)

Key Resources Needed for Breeding

Adult: Spring temperature and moisture patterns, possibly centipede pollinators (NatureServe, 2015)

Reproduction Narrative

Adult: Geocarpon minimum has been variously described as an annual (Tucker 1983, Palmer and Steyermark 1950) and as a winter annual (Mackenzie 1914, Bridges 1986, Morgan 1986), and this question has not been fully resolved to date. The timing of emergence in the spring can vary widely from year to year with temperature having the greatest influence on initiation of growth. Winter rosettes at Bona Glade begin producing flowering stems anywhere from March to mid April (Morgan 1986). Tucker (1983) lists March 23 to April 23 as flowering dates for Geocarpon in Arkansas; however, following a warm winter, Bridges (1986) found plants on the Warren Prairie site producing stems in late January, flowering by mid-February, and dead or dying by April 1. Although the initiation of growth in the spring is controlled by temperature, Morgan (1986) suggests that the vigor of plants and the number of flowers and seeds produced is probably dependent on soil moisture and temperature conditions experienced after the initiation of growth in the spring. Tucker (1983) states that the life cycle of individual plants is completed in a four week period, and Morgan (1986) indicates that a period of 4-6 weeks passes from the initiation of growth in spring to senescence. To date, no insect pollinators have been observed; however, Shephard (pers. comm.) has observed numerous small centipedes within Geocarpon populations and suggests that they be considered as possible pollinators. Flower production varies from plant to plant with some plants producing 5-7 stems with 2-4 flowers per stem and other plants being single stemmed with only 1-2 flowers produced (Morgan 1986). Shephard (pers. comm.) observed that even in apparently good years, a high percentage (ca. 90%) of the plants produced on the Warren Prairie site were one stemmed, one flowered individuals. Morgan (1986) collected 16 capsules and found from 9 to 72 seeds produced per capsule with a mean of 27 seeds per capsule. Groups of seedlings have been observed growing from capsules produced the previous season (Morgan 1986). Although it is apparent that seeds do survive in seed banks since plants are produced in years following poor seed production, little is known about seed viability and longevity. Tucker (1983) suggests that slight disturbance of the soil surface is necessary for Geocarpon seed germination and seedling establishment. This annual species is also known to have good seed set, with lots of capsules (pers. comm. E. Keith) (NatureServe, 2015). The flowering and fruiting period when the plant is usually most visible ranges from late February to early June (Bates 1994; McInnis and Larke 1997; Smith in litt. 1998; MDC 2000; TNC 2004, 2005) (USFWS, 2016).

Habitat Type

Adult: Terrestrial, palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Sandstone glades, saline prairie, riparian (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits sandstone glades and saline prairies. In Missouri, Geocarpon grows on moist, sandy soils on exposed sandstone outcrops or glades, where ledges of fine sandstone, interbedded with shale, are exposed along small streams. The surrounding area, where deeper soils prevail, is savannah. Sites in Arkansas and Louisiana are characterized by very thin soils that are high in sodium and magnesium. Woody plants are nearly absent. In these saline prairies, the species occurs mostly in very thinly vegetated, barren-like areas. The presence of high

concentrations of magnesium in the soil may be a critical factor in Geocarpon distribution, since the soils of Geocarpon sites in Arkansas are characteristically high in magnesium and/or sodium. All of the Geocarpon sites currently known from Arkansas occur on saline soil prairies on natric or saline soils. Geocarpon is very sensitive to competition from other species of vascular plants and occurs only in very open areas. The environmental specificity of this species is very narrow as it is a specialist only growing in salt prairies of one kind (NatureServe, 2015).

Dispersal/Migration**Dispersal**

Adult: Low (NatureServe, 2015)

Dispersal/Migration Narrative

Adult: Seeds remain in dead capsules and are most likely dispersed near the parent plant by wind or rain or by plants simply falling over). Results of monitoring in Missouri (Morgan 1986) and Arkansas (Shephard 1987) indicate that Geocarpon appears in the same areas from year to year and has low vagility. Tucker (1983) suggests that ants be considered as a possible secondary dispersal mechanism since ant mounds are often found in the vicinity of Geocarpon populations in Arkansas (NatureServe, 2015).

Population Information and Trends**Population Trends:**

Decline of <30% to increase of 25% (NatureServe, 2015)

Species Trends:

Stable (USFWS, 2009)

Resiliency:

Moderate to high (inferred from USFWS, 2009)

Representation:

High (inferred from NatureServe, 2015)

Redundancy:

High (inferred from USFWS, 2016)

Number of Populations:

40 (USFWS, 2016)

Population Size:

2500 - 100,000 individuals (NatureServe, 2015)

Adaptability:

High (inferred from NatureServe, 2015)

Population Narrative:

Survives fairly harsh environmental conditions. Although the long term trend of this species isn't documented, it is suspected that it has been stable (pers. comm. E. Keith). This species has experienced a long-term decline of <30% to increase of 25%. As with many annual species, the size of *Geocarpon* populations varies greatly from year to year. Shephard (1987) indicates that 2033 plants were found within plots in 1986 (Warren Prairie, Arkansas) and 6761 plants were found within the same plots in 1987. Similarly, Morgan (1986) found 1900 plants in plots (Bona Glade, Missouri) in 1984 and 4055 plant present in the same plots 1986. There are at least 13 occurrences with good viability (NatureServe, 2015). Population surveys indicate that the species status is stable. Populations are currently documented to occur at a total of 37 sites (including three plantings in Missouri) within 17 counties in four states (Osborne in litt. 2005; Smith in litt. 2006a, 2006c; Reid in litt. 2009; Singhurst in litt. 2009) (USFWS, 2009). Populations are currently documented to occur at a total of 40 sites (including three plantings in Missouri) within 19 counties in four states (Baker in litt. 2015; Baker and Witsell 2015; Briggler in litt. 2015; Reid in litt. 2015; Singhurst in litt. 2015) (USFWS, 2016).

Threats and Stressors

Stressor: Habitat destruction and degradation (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The primary threat continues to be soil development on suitable sites within saline prairies (slick spots) and sandstone glades (shallow sandy soils) (Logan 1998; Witsell 2004a; Smith and Ely 2006). *Geocarpon* thrives in these harsh conditions that exclude competing plant species. Accumulation of more suitable soils quickly leads to an invasion of other plants that shade *Geocarpon*. Such soil development may be facilitated by lack of disturbances such as fire and use by large mammals (Witsell 2004a; Smith and Ely 2006). Excessive soil development and subsequent colonization by competitive plants may also occur when excessive soil movement occurs due to dense cattle use, ATV use, or other factors. Movement of dirt can also alter the microhydrology of sites which may lead to localized extirpation of subpopulations (TNC 2004; Witsell pers. comm. 2006) (USFWS, 2009).

Stressor: Small, isolated populations (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: *Geocarpon* is vulnerable to local extirpations because it occurs in isolated populations and depends on the presence of specific microhabitats in order to compete with other plants. Although extirpations of subpopulations due to encroachment of other vegetation have been observed (Witsell 2004), no known populations have disappeared due to this factor (USFWS, 2009).

Stressor: Climate change (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Climate change may affect *Geocarpon*, although the exact mechanisms and whether these effects will be negative or positive is unknown. Some authors have suggested that plant

diversity, species phenology and distribution, and increases in extinction risk are all potential outcomes of climate change (Iverson and Prasad 2002; Bertin 2008; and Maclean and Wilson 2011). Changes in localized weather patterns associated with climate change may lead to more frequent and long-lasting droughts (Rind et al. 1990; Seager et al. 2007; and Rahel and Olden 2008). Climate warming may also increase the spread of non-native species (Rahel and Olden 2008). Changes in drought cycles and increases in air and soil temperatures could have effects on seed set, germination, and general fitness of *Geocarpon* (USFWS, 2016).

Recovery

Reclassification Criteria:

Not available

Delisting Criteria:

1. A total of 15 viable populations, representing the diversity of habitats and the geographic range of the species, are protected as necessary to ensure their continued existence (USFWS, 2009).
2. Populations include the wide spectrum of current genetic variation (USFWS, 2009).
3. Population viability is confirmed through periodic monitoring for at least a 15-year period (USFWS, 2009).

Recovery Actions:

- Protect viable populations across the species' geographic range (USFWS, 1993).
- Evaluate potential habitat and search for additional populations (USFWS, 1993).
- Continue to monitor known sites to determine population trends (USFWS, 1993).
- Support basic research investigating the chemical characterization of the plant's substrate and species biology, dispersal ecology, and population genetics (USFWS, 1993).
- Determine the effects of disturbance factors (natural and manmade) and incorporate findings into management prescriptions (USFWS, 1993).
- Preserve genetic stock (USFWS, 1993).
- Establish additional populations in the Arkansas Valley Natural Division, if deemed necessary (USFWS, 1993).

Conservation Measures and Best Management Practices:

- Seek funding to complete an investigation into the genetic variability of *Geocarpon* throughout the range, including the newly discovered populations in Texas and Louisiana (USFWS, 2009).
- Continue to investigate the role of disturbance in the distribution and success of *Geocarpon* in sandstone glades and saline prairies (USFWS, 2009).
- Initiate studies to determine the mode of seed dispersal. Promising theories include movement by water, insects, and large mammals (USFWS, 2009).
- Continue to search for new populations in suitable sandstone glade habitats in Missouri and Arkansas and saline prairie habitats in the Arkansas River Valley of Arkansas and Oklahoma and other saline prairie sites in Arkansas, Louisiana, and Texas (USFWS, 2009).
- Continue to monitor known sites (USFWS, 2009).

- Work cooperatively with landowners to conserve privately owned sites through fee title or easement purchases or development of management agreements (USFWS, 2009).
- Complete the investigation into the genetic variability of *Geocarpon* throughout the plant's range (funded in 2015 with completion expected in 2017) to get a better understanding on possible completion of recovery criteria #2 (USFWS, 2016).
- Continue to investigate the role of disturbance in the distribution and success of *Geocarpon* in sandstone glades and saline prairies. The impacts of extreme disturbance due to feral hogs should be incorporated into these studies. As an understanding develops regarding the role of disturbance, a threats assessment should be conducted to determine which threats should be addressed first (USFWS, 2016).
- Develop standardized monitoring protocols and reach consensus among states regarding the delimitation of populations and sub-populations (USFWS, 2016).
- Continue to search for new populations in suitable sandstone glade habitats in Missouri and Arkansas and saline prairie habitats in the Arkansas River Valley of Arkansas and Oklahoma and other saline prairie sites in Arkansas, Louisiana, and Texas (USFWS, 2016).
- Select sites throughout the range to be demographically monitored. Where it is already occurring this should continue and it should be instituted at other representative sites throughout the range that are currently only monitored opportunistically for presence/absence or rough estimations of population (USFWS, 2016).
- Develop a long-term management plan based on the results of studies on genetics, the role of disturbance, and other life history studies. Specific recovery criteria that address the long-term protection and viability of *Geocarpon* should be developed as new information becomes available (USFWS, 2016).
- Work cooperatively with landowners to conserve privately owned sites through fee title or easement purchases or development of management agreements (USFWS, 2016).

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SPECIES ACCOUNT: *Geranium arboreum* (Nohoanu)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/1992; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Geranium arboreum, a member of the geranium family (Geraniaceae), is a large, branched, spreading shrub 2-4 m (6.6-13.1 ft) tall. The green and somewhat hairy leaves, alternating closely after one another on the stem, are oval- or heart-shaped, usually 4-7 cm (1.6-2.8 in) long and 2.5-4.5 cm (1.0-1.8 in) wide with 5-8 noticeable veins and 8-14 small teeth on each edge. The leaf stalks (petioles) are 1-3 cm (0.4-1.2 in) long and are encircled beneath (subtended) by tiny (12-14 mm [0.5-0.6 in]), hairy, leaf-like appendages (stipules), which persist after the leaves have fallen. Magenta flowers 20-25 cm (7.9-9.8 in) long occur in short-stalked groups of usually one to four, originating from the point of attachment of leaves to the stem. The upper three petals are erect, and the lower two petals are bent abruptly backward. Its flowers are the only ones in the genus that are zygomorphic (not symmetrical like pie slices around a central point). A single dark purple, net-surfaced 2.5 mm (0.1 in) seed is produced in each of five cells of the elongated fruit. (USFWS, 1997)

Historical Range

Historically no additional range. (NatureServe, 2015)

Current Range

Current range is in East Maui. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Geranium arboreum* (Hawaiian red-flowered geranium) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Geranium arboreum* includes four CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Montane Mesic—Unit 1 (and) *Palmeria dolei*—Unit 18—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 18— Montane Mesic This area consists of 6,593 ac (2,668 ha) of State land, 707 ac (286 ha) of privately owned land, and 3,672 ac (1,486 ha) of federally owned land (Haleakala National Park), from Kealahou to Puualae, nearly circumscribing the summit of Haleakala on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Asplenium dielerectum*, *A. peruvianum* var. *insulare*, *Clermontia lindseyana*, *Cyanea horrida*, *C. obtusa*, *Cyrtandra ferripilosa*, *C.*

oxybapha, *Diplazium molokaiense*, *Geranium arboreum*, *G. multiflorum*, *Huperzia mannii*, *Melicope adscendens*, and *Neraudia sericea*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 1 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Cyanea glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. mceldowneyi*, *Phyllostegia bracteata*, *P. mannii*, *Santalum haleakalae* var. *lanaiense*, *Wikstroemia villosa*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Dry—Unit 1 consists of 2,962 ac (1,199 ha) of State land, and 563 ac (228 ha) of federally owned land (Haleakala National Park), from Kanaio to Naholoku and Kaupo Gap along the southern slopes of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane dry ecosystem (see Table 5). Although Maui—Montane Dry—Unit 1 is not known to be occupied by the plants *Alectryon macrococcus*, *Geranium arboreum*, *Melicope knudsenii*, *M. mucronulata*, *Santalum haleakalae* var. *lanaiense*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these montane dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Subalpine—Unit 1 (and) *Palmeria dolei*—Unit 24—Subalpine (and) *Pseudonestor xanthophrys*—Unit 24— Subalpine This area consists of 10,785 ac (4,365 ha) of State land, 1,622 ac (656 ha) of privately owned land, and 3,568 ac (1,444 ha) of federally owned land (Haleakala National Park), from Kanaio north to Puu Nianiau on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the subalpine ecosystem (see Table 5). They are occupied by the plants *Bidens micrantha* ssp. *kalealaha* and *Geranium arboreum*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Subalpine—Unit 1 is not known to be occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Asplenium peruvianum* var. *insulare*, *Geranium multiflorum*, *Phyllostegia bracteata*, *Schiedea haleakalensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these subalpine species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Subalpine—Unit 2 (and) *Palmeria dolei*—Unit 25—Subalpine (and) *Pseudonestor xanthophrys*—Unit 25— Subalpine This area consists of 50 ac (20 ha) of privately owned land,

and 9,836 ac (3,981 ha) of federally owned land (Haleakala National Park), from the summit north to Koolau Gap and east to Kalapawili Ridge on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the subalpine ecosystem (see Table 5). They are occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Geranium multiflorum*, and *Schiedea haleakalensis*, and by the forest bird, the akohekohe (*Palmeria dolei*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui— Subalpine—Unit 2 is not known to be occupied by the plants *Asplenium peruvianum* var. *insulare*, *Bidens micrantha* ssp. *kalealaha*, *Geranium arboreum*, *Phyllostegia bracteata*, or *Zanthoxylum hawaiiense*, or by the forest bird, the kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these subalpine species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Geranium arboreum* critical habitat consists of three components. Montane mesic (east Maui), Montane dry (east Maui) and Sub-alpine (east Maui) (81 FR 17790-18110):

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: *Acacia*, *Ilex*, *Metrosideros*, *Myrsine*, *Nestegis*, *Nothocestrum*, *Pisonia*, *Pittosporum*, *Psychotria*, *Sophora*, *Zanthoxylum*. Subcanopy: *Alyxia*, *Charpentiera*, *Coprosma*, *Dodonaea*, *Kadua*, *Labordia*, *Leptecophylla*, *Phyllostegia*, *Vaccinium*. Understory: *Ferns*, *Carex*, *Peperomia*.

Ecosystem: Montane Dry. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Dry cinder or ash soils, loamy volcanic sands, blocky lava, rock outcroppings. Canopy: *Acacia*, *Metrosideros*, *Myoporum*, *Santalum*, *Sophora*. Subcanopy: *Chamaesyce*, *Coprosma*, *Dodonaea*, *Dubautia*, *Leptecophylla*, *Osteomeles*, *Wikstroemia*. Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Vaccinium*.

Ecosystem: Subalpine. Elevation: 6,500–9,800 ft (2,000–3,000 m). Annual precipitation: 15–40 in (38–100 cm). Substrate: Dry ash, sandy loam, rocky, undeveloped soils, weathered lava. Canopy: *Chamaesyce*, *Chenopodium*, *Metrosideros*, *Myoporum*, *Santalum*, *Sophora*. Subcanopy: *Coprosma*, *Dodonaea*, *Dubautia*, *Geranium*, *Leptecophylla*, *Vaccinium*, *Wikstroemia*. Understory: *Ferns*, *Bidens*, *Carex*, *Deschampsia*, *Eragrostis*, *Gahnia*, *Luzula*, *Panicum*, *Pseudognaphalium*, *Sicyos*, *Tetramolopium*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special

management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-

Lowland Mesic— Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; MauiWet Cliff—Units 6 and 7; and MolokaiMontane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Dependency on Other Individuals or Species**

Adult: Bird pollinators (USFWS, 1997)

Reproduction Narrative

Adult: *Geranium arboreum* is the only species in its genus that appears to be bird-pollinated. Native honeycreepers appear to be a major pollination vector. (USFWS, 1997)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Shrublands/chaparral (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Damp and partially shaded environments (USFWS, 1997)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 1,525 and 2,135 meters (5,000 to 7,000 feet) (USFWS, 1997)

Spatial Arrangements of the Population

Adult: Small isolated populations (USFWS, 1997)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1997)

Habitat Narrative

Adult: Typical habitat of this rare shrub is in moist gulches near the upper limit of native forest growth. The remaining isolated populations of *Geranium arboreum* grow in steep, narrow canyons on the north and west outer slopes of Haleakala Volcano at 1,525-2,135 meters (5,000-7,000 feet) elevation in a narrow band (0.25 x 14 kilometers [0.16x 8.7 miles]). The environment of these gulches is damp and shaded part of the day and often in clouds, as a result of the coincidence of this band with the layer just below the trade-wind inversion, an important meteorological phenomenon in the Hawaiian Islands. Fog drip is frequent. The climate zone just above is substantially drier and supports native shrubland, not forest. *Geranium arboreum* plants appear to obtain a significant portion of their water requirement by “combing” moisture out of the drifting fog (Funk 1982). Currently, vegetation in the ravines is often quite dense and consists mainly of mostly medium-sized woody shrubs, alien grasses and weeds, and mixed ferns (Funk 1982). Associated native species include *Sophora chrysophylla*, *Vaccinium reticulatum*, *Dodonaea*, *Styphelia*, *Rubus hawaiiensis*, *Dryopteris wallichiana*, *Metrosideros*, *Myrsine lessertiana*, and *Coprosma* (HPCC 1994). Associated alien species include *Ageratina adenophora*, *Holcus lanatus*, redwood, and pines (HPCC 1994; A.C. Medeiros, personal observation 1994). *Geranium arboreum* is a minor component of the vegetation occurring in small isolated populations in the gulches. (USFWS, 1997)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2011)

Redundancy:

Very low (inferred from USFWS, 2011)

Number of Populations:

5 (USFWS, 2011)

Population Size:

~50 (USFWS, 2011)

Population Narrative:

As of 2010, the total number of individuals of *Geranium arboreum* is less than 50 individuals in perhaps five populations on East Maui (USFWS, 2011). In 2011, the 5-year review reported

about five populations of *Geranium arboreum* totaling fewer than 50 individuals on east Maui. In 2012, PEPP reported three populations totaling 42 individuals; and in 2014, seven populations totaling 48 individuals (PEPP 2012, 2014). In 2015, Chau et al. reported eight subpopulations totaling 40 individuals. Currently, there are wild populations in five locations on east Maui consisting of the following reported individuals: Kanaio (1), Waiohuli (48), Pōhakuokala (5), Waikamoi Gulch (2), and Waiakoa (4) (HBMP 2010; Oppenheimer 2018, in litt.; PEPP 2016, 2017a, 2018). Haleakalā National Park reports two occurrences of two individual clumps (Robertson 2016, in litt.). In 2016, four critical habitat units were designated in three ecosystems (montane mesic, montane dry, and subalpine) on east Maui for *Geranium arboreum* (40,358 ac; 16,333 ha) (81 FR 17790, March 30, 2016) (USFWS 2018).

Threats and Stressors

Stressor: Alien plants (USFWS, 1997; USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Displacement by alien plant species, primarily grasses and trees, poses the current primary threat to the long-term survival of *Geranium arboreum*. Mats of alien grasses cover ground that would otherwise be available to *Geranium* seedlings. Alien tree species (e.g., *Acacia mearnsii* and *Myrica faya*) eventually form such dense stands that they virtually exclude native species, including *Geranium arboreum*. In the Polipoli Springs area at certain times of the year, pollen from alien pine trees completely covers the stigmas of *G. arboreum* and precludes any fertilization by its own species. *Geranium arboreum* does, however, have a longer flowering period than do the alien pines (Funk 1982, 1988; USFWS 1992b). Invasive introduced plant species such as *Ageratina adenophora* (sticky snakeroot), *A. riparia* (billy goat weed), *Bidens pilosa* (beggartick), *Epilobium billardierianum* (willow herb), *Geranium homeanum* (NCN), *Holcus lanatus* (common velvet grass), *Lythrum maritimum* (loosestrife), *Oenothera stricta* (evening primrose), *Passiflora tarminiana* (banana poka), *Pennisetum clandestinum* (Kikuyu grass), *Rubus niveus* (Mysore raspberry), *R. argutus* (blackberry), *Senecio madagascariensis* (fireweed), and *Sporobolus indicus* (West Indian dropseed) which alter the habitat and compete for resources (Oppenheimer 2009; Perlman 2009; Wood 2009). (USFWS, 1997; USFWS, 2011)

Stressor: Impacts of feral pigs, cattle, and goats (USFWS, 1997; USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Feral animals continue to exert negative impacts on *Geranium arboreum*. On East Maui where *Geranium arboreum* is found, the threats include feral ungulates such as pigs (*Sus scrofa*), deer (*Axis axis*), goats (*Capra hircus*), and cattle (*Bos taurus*) which disturb the ground and uproot plants. (USFWS, 1997; USFWS, 2011)

Stressor: Fire (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: Fires in the habitat of *Geranium arboreum* continue to be of concern. (USFWS, 1997)

Stressor: Limited gene pool (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: The scattered distribution of the species has the positive effect of reducing the chance that a single natural or human-caused environmental disturbance could affect all populations. However, since the approximately 300 extant individuals occur in about 21 sites (grouped into four populations), each with only 1 to 25 plants, the limited local gene pools may depress reproductive vigor. (USFWS, 1997)

Stressor: Human impacts (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: Illegal collecting for scientific or horticultural purposes or excessive visits by individuals interested in seeing rare plants could result from increased publicity, and could seriously impact *Geranium arboreum*. The species is attractive and could become the subject of increased collection in the future (USFWS 1992b). (USFWS, 1997)

Stressor: Rabbits (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: Rabbits almost became established on East Maui within Haleakala National Park in 1990 as a result of release of pet rabbits by a careless pet owner. Rapid response by Park management to the problem is apparently all that prevented a catastrophe. The site where the incipient rabbit population existed was adjacent to habitat of *Geranium arboreum*. It is almost certain that similar incidents will occur in the future. If rabbits were to establish, they would pose a severe threat to the survival of this species. (USFWS, 1997)

Stressor: Herbivory or predation (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Insect-bored holes were observed in the flowers of *Geranium arboreum* observed near Puu Nianiau (Perlman 2009). Slugs (unidentified species), rats (*Rattus* spp.), and ants (unidentified species) also threaten these plants by eating plant parts and seeds (Perlman 2009). A loss of native pollinators may also be a problem preventing reproduction of this species (Perlman 2009). (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently

funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2011)

Stressor: Small population size (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: In addition to all of the other threats, species like *Geranium arboreum* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding, and disease outbreaks. The extent of these natural processes on this single island endemic are exacerbated by anthropogenic threats, such as habitat loss for human development or predation by introduced species (USFWS 1992). (USFWS, 2011)

Stressor: Drought degradation of habitat (USFWS 2018).

Exposure:

Response:

Consequence:

Narrative: Drought is reported to be a threat to populations of *Geranium arboreum* at Pōhakuokala, Waikamoi Gulch, and Waiakoa (PEPP 2011, 2013, 2017a). Over the last 100 years, the Hawaiian Islands have experienced an annual decline in precipitation of over 9 percent, increasing to as much as 15 percent within the last 20 years (US-NSTC 2008; Chu and Chen 2005; Diaz 2005). Drought affects plants directly by desiccation. The increase in drought frequency and intensity leads to a self-perpetuating cycle of increase in cover of nonnative plants, increase in the number of fires, and an increase of erosion (US-GCRP 2009; Warren 2011). Recent episodes of drought have also driven deer farther into urban and forested areas in search of food, increasing their negative impacts to native vegetation from herbivory and trampling (Waring 1996, in litt; Nishibayashi 2001, in litt.) (USFWS 2018).

Stressor: Lack of adequate hunting regulations (USFWS 2018).

Exposure:

Response:

Consequence:

Narrative: Two of the five populations of *Geranium arboreum* occur in State hunting areas on east Maui. Habitat destruction and modification, and predation by pigs, goats, axis deer, and cattle have been noted as threats to the species. A few individuals in these areas are fenced; however, fences must be continually monitored and repaired. In addition, public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations are at risk (DLNR 2010). (USFWS 2018).

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)

3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1997)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)

2. Each population must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)

3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1997)

Recovery Actions:

- Protect extant populations of this species by constructing a series of five to eight exclosures from leeward Haleakalato Puu Koolau, northwestern Haleakala. (USFWS, 1997)
- Conduct/encourage work on pollinators and reproductive biology. (USFWS, 1997)
- Surveys and population monitoring (USFWS 2018).
- Invasive plant monitoring and control (USFWS 2018).
- Ungulate, predator, and herbivore monitoring and control (USFWS 2018).
- Captive propagation for genetic storage and reintroduction (USFWS 2018).
- Fire monitoring and control (USFWS 2018).
- Reintroduction and translocation (USFWS 2018).
- Population biology research (USFWS 2018).
- Climate change adaptation strategy (USFWS 2018).
- Alliance and partnership development (USFWS 2018).

Conservation Measures and Best Management Practices:

- Further studies are needed to clarify by what mechanisms predators of this species are affecting its ability to regenerate in the wild, and to mitigate these threats. (USFWS, 2011)
- Monitor known populations and collect any available seed for genetic storage and reintroduction. (USFWS, 2011)
- Fence all known populations to provide protection from the negative impacts of feral ungulates. (USFWS, 2011)
- Control invasive introduced plant species around known populations. (USFWS, 2011)
- Control rats in the vicinity of these populations. (USFWS, 2011)
- Develop and implement methods to control ants and slugs. (USFWS, 2011)
- Propagate to augment the existing populations. (USFWS, 2011)
- Establish additional populations within protected suitable habitat. (USFWS, 2011)
- Develop and implement a wildfire management plan. (USFWS, 2011)

- Work with Hawaii Division of Forestry and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2011)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2011)

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SPECIES ACCOUNT: *Geranium hanaense* (Nohoanu)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Decumbent shrubs, 3-5 dm or (rarely) up to 15 dm tall. Flowers 3-6 or (rarely) up to 9 in compound cymes. Petals white, streaked with purple or purplish magenta, or sometimes in smaller flowers pure white. (NatureServe, 2015)

Taxonomy

Genus 300 worldwide, throughout temperate and warm temperate zones. Six species endemic to the Hawaiian Islands. Species endemic to East Maui. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Endemic to two adjacent bogs on Haleakala (volcano), east Maui, state of Hawaii. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Geranium hanaense* (Nohoanu) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes five detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Geranium hanaense* includes five CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Montane Wet—Unit 1 (and) *Palmeria dolei*—Unit 10—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 10— Montane Wet This area consists of 1,313 ac (531 ha) of State land and 798 ac (323 ha) of privately owned land, at Haiku Uka on the northern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Cyanea duvalliorum*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *Phyllostegia pilosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 1 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp.

haleakalaensis, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 11—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 11— Montane Wet This area consists of 4,075 ac (1,649 ha) of State land, 9,633 ac (3,898 ha) of privately owned land, and 875 ac (354 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Puukaukanu and upper Waihoi Valley, on the northern and northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Geranium hanaense*, *G. multiflorum*, and *Wikstroemia villosa*, and by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 2 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea glabra*, *C. maritae*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, and *Schiedea jacobii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 3 (and) *Palmeria dolei*—Unit 12—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 12— Montane Wet This area consists of 2,228 ac (902 ha) of federally owned land (Haleakala National Park) in Kipahulu Valley, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. maritae*, and *Melicope ovalis*, and by the forest bird, *kiwikiu* (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 3 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea duvalliorum*, *C. glabra*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P.*

mannii, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest bird, the akohekohe (*Palmeria dolei*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 4 (and) *Palmeria dolei*—Unit 13—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 13— Montane Wet This area consists of 180 ac (73 ha) of State land and 1,653 ac (669 ha) of federally owned land (Haleakala National Park), in Kaapahu Valley on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *Cyrtandra ferripilosa*, and *Huperzia mannii*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 4 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea duvalliorum*, *C. glabra*, *C. mceldowneyi*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 5 (and) *Palmeria dolei*—Unit 14—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 14— Montane Wet This area consists of 222 ac (90 ha) of State land, and 165 ac (67 ha) of federally owned land (Haleakala National Park), near Kaumakani on the eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plant *Bidens campylotheca* ssp. *pentamera*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 5 is not currently occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the

reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Geranium hanaense* critical habitat consists of one component. Montane wet (east Maui). Species- specific physical or biological features: Bogs (81 FR 17790-18110):

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: *Ferns*, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative

ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial and palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Bog/fen, forest- hardwood (NatureServe, 2015)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: *G. hanaense* occurs in “Big Bog” and “Mid Camp Bog” in the montane wet ecosystem on the northeast rift of Haleakala. (USFWS, 2016)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Resiliency:

Low (inferred from USFWS, 2016)

Redundancy:

Low (inferred from USFWS, 2016)

Population Growth Rate:

Stable (USFWS, 2016)

Number of Populations:

1 (NatureServe, 2015)

Population Size:

500 to 700 (USFWS, 2016)

Population Narrative:

Recorded from only a single occurrence from two bog areas on Maui (1990's). At that time of listing, there were an estimated 500 to 700 individuals (Medeiros and St. John 1988, pp. 214–220). Currently, *G. hanaense* occurs in “Big Bog” and “Mid Camp Bog” in the montane wet ecosystem on the northeast rift of Haleakala, with the same number of estimated individuals (Welton 2008, in litt.; Welton 2010a, in litt.; Welton 2010b, in litt.). (NatureServe, 2015; USFWS, 2016)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs), nonnative plants, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs) is considered an ongoing threat to *Geranium hanaense* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

Final Rule . 81 FR 17790-18110 (March 30, 2016).

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species. Federal Register 81(61): 17790-18110

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Final Rule. 78 Federal Register 102, May 28, 2013. Pages 32014 - 32065.

SPECIES ACCOUNT: *Geranium hillebrandii* (Nohoanu)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Decumbent subshrubs, with stems 5-10 dm long, often rooting at the nodes. (Other recently found plants on leeward West Maui are erect shrubs up to about 0.75 m tall.) Cymes terminal, projecting beyond the leaves. Petals white, apparently always with purple veins. (NatureServe, 2015)

Taxonomy

Originally described as *Geranium humile*. Aedo and Garmendia (1997), found that this name was illegitimate and published the change to *Geranium hillebrandii*. The U.S. Fish and Wildlife Service used the name *G. humile* in the candidate list of the Oct. 25, 1999 Notice of Review, but switched to *G. hillebrandii* in the Oct. 30, 2001 Notice. Wagner and Herbst (1999) accept the change to *G. hillebrandii*. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Known only from the west Maui mountains, state of Hawaii. Extent of occurrence is approximately 10 sq km (EO data in the NatureServe central database as of November 2010). (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Geranium hillebrandii* (Nohoanu) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Geranium hillebrandii* includes three CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Montane Wet—Unit 7 (and) *Palmeria dolei*—Unit 16—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 16— Montane Wet This area consists of 80 ac (32 ha) of State land near Hanaula and Pohakea Gulch on the southeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). They are occupied by the plants *Cyrtandra oxybapha* and *Platanthera holochila*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane

Wet—Unit 7 is not known to be occupied by the plants *Acaena exigua*, *Bidens conjuncta*, *Calamagrostis hillebrandii*, *Cyanea kunthiana*, *Geranium hillebrandii*, *Huperzia mannii*, *Myrsine vaccinioides*, *Phyllostegia bracteata*, or *Sanicula purpurea*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 3 (and) *Palmeria dolei*—Unit 20—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 20— Montane Mesic This area consists of 174 ac (70 ha) of State land at Lihau on the southwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plant *Geranium hillebrandii*, and contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 3 is not known to be occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Huperzia mannii*, *Lysimachia lydgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 4 (and) *Palmeria dolei*—Unit 21—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 21— Montane Mesic This area consists of 72 ac (29 ha) of State land at Halepohaku on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). Although Maui—Montane Mesic—Unit 4 is not known to be occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Geranium hillebrandii*, *Huperzia mannii*, *Lysimachia lydgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Geranium hillebrandii* critical habitat consists of two components. Montane wet (west Maui) and Montane mesic (west Maui). Species- specific physical or biological features: Bogs (81 FR 17790-18110):

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed

plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial and palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Bog/fen, forest- hardwood, forest/woodland, shrubland/chaparral (NatureServe, 2015)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: Formerly known only as decumbent subshrub growing in montane bogs in wet forests, in the cloud zone at upper elevations of West Maui. In recent years, however, erect shrubs that

have been referred to this species have been found in moist shrublands on steep-sided ridges on leeward West Maui. (NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Resiliency:

Medium (inferred from USFWS, 2016)

Redundancy:

Low (inferred from USFWS, 2016)

Population Growth Rate:

Unknown (NatureServe, 2015)

Number of Populations:

4 (USFWS, 2016)

Population Size:

>10,000 (USFWS, 2016)

Population Narrative:

Currently, 4 occurrences total over 10,000 individuals, with the largest 2 occurrences in the west Maui bogs, from Puu Kukui to East Bog and Kahoolewa ridge. A third occurrence is at Eke Crater and the surrounding area, and the fourth occurrence is at Lihau (HBMP 2010; Oppenheimer 2010h, in litt.). (USFWS, 2016)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs), nonnative plants, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Hurricanes adversely impact native

Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013))

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, and slugs) is considered an ongoing threat to *Geranium hillebrandii* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

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SPECIES ACCOUNT: *Geranium kauaiense* (Nohoanu)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (R1) (USFWS, 2016)

Physical Description

A sprawling subshrub. Stems are 5 - 10 dm long and often root at the nodes. Flowers usually 3 - 4 in terminal cymes that project beyond the leaves. Petals are white, apparently always with purple veins (NatureServe, 2015). *Geranium kauaiense* is a decumbent (reclining) subshrub in the geranium family (Geraniaceae). Stems are reddish brown, often rooting at the nodes, growing embedded in moss mats or other bog plants, 49 to 100 centimeters (cm) (1.6 to 3.3 feet (ft)) long, with branches covered by persistent stipules (leaf-like appendages) and leafy only at the ends. Leaves are alternate, oblong to oblong cuneate (longer than broad, parallel sided, sometimes tapering to a point at the base), 1.1 to 2.9 cm (0.4 to 1.1 in) long, 0.4 to 0.8 cm (0.2 to 0.3 in) wide, with the upper surface glabrous (hairless), the lower surface densely silky strigose (with stiff, flattened hairs), and margins entire (edges continuous) except four- to five-toothed at the apex. Flowers are usually three to four in terminal cymes that project beyond the leaves. Petals are white with purple veins, narrowly obovate (egg-shaped and attached at the narrow end), and 9 to 16 millimeters (mm) (0.4 to 0.6 in) long. Immature carpel bodies are 2 to 7 mm (0.08 to 0.3 in) long and densely pubescent (hairy) (Wagner et. al. 1999). (USFWS 2017)

Taxonomy

A member of the geranium family (Geraniaceae) (USFWS, 2010b). This genus is widespread in temperate, warm temperate, and tropical montane areas, species endemic to Kauai (NatureServe, 2015). First described by Joseph Rock as *Geranium humile* var. *kauaiense* (Rock 1911), this entity was elevated to full species status as *G. kauaiense* by St. John (1984) and is recognized by Wagner et al. (1999), the most recently accepted Hawaiian plant taxonomy. (USFWS 2017).

Historical Range

Historically, *G. kauaiense* was known from montane bogs on the island of Kauai, ranging from North Bog to as far south as the summit of Waialeale (HBMP 2007) (USFWS, 2010b).

Current Range

It currently occurs in the Halehaha Bogs of the Alakai Wilderness Preserve and the Waialeale Summit Bog (Kauai) (USFWs, 2010b).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Geranium kauaiense* (Nohoanu, Kauai Crane's-bill) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Geranium kauaiense* includes three CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Montane Wet—Section 1: Montane Wet—Section 1 consists of 13,055 ac (5,257 ha) in the montane wet ecosystem, extending across the Alakai Plateau from Hanakoa to Mount Waialeale, on State (12,628 ac, 5,110 ha) and privately owned (427 ac, 173 ha) land in the Na Pali Coast State Park, the Alakai Wilderness Preserve, the Na Pali Kona and Halelea forest reserves, and Hono o Na Pali NAR (Figure 4). It is occupied by the plants *Astelia waialealae*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *K. helenae*, *Labordia helleri*, *L. pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, and *Platydesma rostrata*; by the akekee and akikiki; and by the picture-wing fly. This section also contains unoccupied habitat that is essential to the conservation of these 18 species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the montane wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and the species-specific PCEs including (1) bogs (identified as PCEs for *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*) (2) bog hummocks (identified as PCEs for *Astelia waialealae* and *Lysimachia daphnoides*); (3) arthropod prey (identified as PCEs for the akekee and the akikiki); and (4) larval-stage host plants, *Cheirodendron* and *Tetraplasandra* sp., (identified as a PCE for the picture-wing fly). Although Montane Wet—Section 1 is not known to be occupied by the plants *Dubautia kalalauensis*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, those portions of the section that overlie previously designated critical habitat fall within two existing Critical Habitat Units of 50 CFR 17.99(a)(1): Unit 10, Map 35a; and Unit 11, Map 64a. The previously undesignated land comprises Unit 23, Map 217f; and Unit 24, Map 217g. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 4—Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 4—Montane Wet).

Kauai—Montane Wet—Section 2: Montane Wet—Section 2 consists of 790 ac (320 ha) in the montane wet ecosystem, extending from Kahuamaa Flat south to the edge of Waimea Canyon, on State-owned land in Kokee State Park (Figure 4, above). The entire section is within previously designated critical habitat, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Dubautia kalalauensis*, *Labordia helleri*, *Melicope puberula*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*, and by the akekee. This section includes montane wet forest, potentially some small-scale boggy areas, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and arthropod prey (identified as a species-specific PCE for the akekee). Although Montane Wet—Section 2 is not known to be occupied by the plants *Astelia waialeale*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialeale*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *Myrsine mezii*, and *Phyllostegia renovans*; by the akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within

their historical range. This area also supports the arthropod prey identified as a PCE for the akikiki, and the larval-stage host plants (*Cheirodendron* and *Tetraplasandra* spp.) identified as a PCE for the picturewing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within previously designated Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 5—Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 5—Montane Wet).

Kauai—Montane Wet—Section 3: Montane Wet—Section 3 consists of 413 ac (167 ha) in the montane wet ecosystem, encompasses the summit of Namolokama, on State (156 ac, 63 ha) and privately owned (257 ac, 104 ha) land in the Halelea Forest Reserve (Figure 4, above). It is entirely within previously designated critical habitat, and is occupied by the plants *Keysseria erici* and *Labordia pumila*. This section includes the montane wet forest, the moisture regime, and the canopy, subcanopy, and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and bogs (identified as a species-specific PCE for *K. erici*). Although Montane Wet—Section 3 is not known to be occupied by the plants *Astelia waialeale*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia kalalauensis*, *D. waialeale*, *Geranium kauaiense*, *Keysseria helenae*, *Labordia helleri*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*; by the akekee and akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. It also supports the arthropod prey identified as a PCE for the akekee and akikiki, and the larval-stage host plants (*Cheirodendron* and *Tetraplasandra* spp.) identified as a PCE for the picture-wing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 6—Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 6—Montane Wet).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Geranium kauaiense* critical habitat consists of one component (Montane wet). Species-specific PCEs include: Bogs (75 FR 18960-19165):

Ecosystem: Montane Wet. Elevation: 3,000–5,243 ft (914-1,598 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: *Ferns*, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed

throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are

designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available

Habitat Type

Adult: Wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Montane bog (NatureServe, 2015); Metrosideros-Rhynchospora bogs, montane wet ecosystem (USFWS, 2010b)

Geographic or Habitat Restraints or Barriers

Adult: 4,000 - 4,080 ft. elevation (USFWS, 2010b)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits montane bogs in wet forest. The environmental specificity is unknown (NatureServe, 2015). It occurs in the montane wet ecosystem in Metrosideros-Rhynchospora bogs and bog margins at elevations between 4,000 and 4,080 ft. (1,219 and 1,463 m) (Wagner et al. 1999, p. 733; HBMP 2007; TNCH 2007) (USFWS, 2010b).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Species Trends:

Stable (NatureServe, 2015)

Resiliency:

Very low (inferred from USFWS, 2010b; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2010a)

Number of Populations:

3 (USFWS, 2010a)

Population Size:

140 (USFWS, 2010a)

Additional Population-level Information:

Historically, *Geranium kauaiense* was known from Kauai at the Kilohana bogs in the north to as far south as Kauluwehi Bog (HBMP 2010). By the early 1990s, this species was no longer found at Kilohana, Kauluwehi, or at the Waialeale summit, but only in the central Alakai bogs (HBMP 2010). In 1994, there were as many as 25 individuals at Sincok Bog 1, 20 individuals at Sincok Bog 2, and approximately 100 individuals at Sincok Bog 3 (i.e. Geranium Bog; NTBG 1994a-c; Perlman and Wood 1995; HBMP 2010). These subpopulations have been monitored annually by USFWS and DOW personnel since 1996 and the number of individuals has fluctuated very little due to their longevity and vegetative reproduction (Bruegmann et al. 2015, in litt.; PEPP 2013, 2015). Currently, *G. kauaiense* is reported at four “subpopulations” (considered “populations” by USFWS) in the Alakai totaling approximately 120 individuals (Tangalin 2015). The largest population, Geranium Bog, now only has 50–75 individuals. The other two to three locations only have a several individuals each (Williams 2017, pers. comm.). (USFWS 2017).

Population Narrative:

The long term population trend is unknown. USFWS monitoring showed that population numbers fluctuated very little from 2001 to 2004 (Russell 2004) (NatureServe, 2015). There are 3 populations totaling 140 individuals (USFWS, 2010a).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from non-native plants, pigs, hurricanes, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species.

Stressor: Predation and herbivory (USFWS, 2010)

Exposure:

Response:**Consequence:**

Narrative: Predation and herbivory by nonnative animal species present an immediate and significant threat to *Geranium kauaiense* throughout its range due to documented browsing and trampling by pigs, goats, and deer (USFWS, 2010).

Stressor: Hurricanes - Loss and degradation of habitat (USFWS 2017)

Exposure:**Response:****Consequence:**

Narrative: In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013).

Stressor: Climate change loss or degradation of habitat (USFWS 2017)

Exposure:**Response:****Consequence:**

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Geranium kauaiense* is extremely vulnerable to the impacts of climate change with a vulnerability index of 0.926 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change) and is also classified as a “wink-out” species. “Wink-out” species are those species with no future climate envelope; no projected suitable climate areas exist for the species to persist in the future. *Geranium kauaiense* only occurs in high elevation bogs on Kauai.

Stressor: Inadequacy of existing regulatory mechanisms (USFWS 2017)

Exposure:**Response:****Consequence:**

Narrative: Lack of adequate hunting regulations—Historic populations of *Geranium kauaiense* at Kilohana, Kauluwehi, and the Waialeale summit are extirpated. Three of the four subpopulations of this species at the Alakai bogs are fenced (TNCH 2015), but are within a state hunting area. Feral pigs, goats, and deer, and the effects of their activities are noted to be a threat to *G. kauaiense* and have been observed inside and outside the fenced areas. Nonnative feral ungulates pose a major ongoing threat to native species through destruction and modification of

habitat, and by direct herbivory or predation. Public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations are at risk (DLNR 2010). Lack of adequate biosecurity legislation—Introduction of invasive nonnative plant and animal species to the State of Hawaii and destruction of habitat and competition by nonnative plants are threats to *Geranium kauaiense*. The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, is authorized to prevent the introduction or dissemination of animal and plant pests on all ships, aircraft, and their cargo and baggage arriving in the U.S. and its territories; however, pest species continue to enter the State. In addition, Federal import regulations do not address many species that could be pests in Hawaii (CGAPS 2009; Ikuma et al. 2002).

Recovery

Reclassification Criteria:

In addition to achieving 5 to 10 populations with 500 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats (USFWS 2017).

Delisting Criteria:

In addition to achieving 5 to 10 populations with 500 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis (USFWS 2017).

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys (USFWS, 2010a).

- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units (USFWS, 2010a).
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys (USFWS, 2010a).
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range (USFWS, 2010a).
- Conduct research on control methods for introduced slugs and avian malaria (USFWS, 2010a).
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction (USFWS, 2010a).
- Identify threats and prioritize which ones to address first for the two birds (USFWS, 2010a).
- Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program (USFWS, 2010a).
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security (USFWS, 2010a).
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems (USFWS, 2010a).
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations (USFWS, 2010a).
- To prevent extinction of *Geranium kauaiense* (a short-lived subshrub with no specific characteristics known) the species needs a minimum of three populations consisting of 50 mature individuals per population. In addition to achieving the numbers of reproducing individuals, all major threats must be controlled in the immediate vicinity of the populations, each population must show evidence of some stage of natural reproduction (i.e., viable seeds or seedlings), and 50 mature individuals from each of three populations, or total number of individuals if fewer than 50 remain, must be represented in an ex situ collection that is secure and well managed (USFWS 2017).
- To meet the interim stage of recovery of *Geranium kauaiense*, 300 mature individuals are needed in each of three populations and all major threats must be controlled around the populations designated for recovery at this stage. There should also be demonstrated regeneration of seedlings and growth to at least sapling stage for woody species and documented replacement regeneration within each of the target populations. The populations must be adequately represented in an ex situ collection as defined in the Center for Plant Conservation's guidelines (Guerrant et al. 2004). Adequate monitoring must be in place and conducted to assess individual plant survival, population trends, trends of major limiting factors, and response of major limiting factors to management (USFWS 2017).

Conservation Measures and Best Management Practices:

- Not available

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SPECIES ACCOUNT: *Geranium multiflorum* (Nohoanu)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/15/1992; Pacific Region (Region 1) (USFWS, 2017)

Physical Description

A compact, many-branched shrub typically 10-20 dm tall, but reaching up to 30 dm tall. Attractive flowers are white, usually having purple veins and purple centers, or are pink to dark purple. (NatureServe, 2015)

Taxonomy

A member of the geranium family (Geraniaceae) (USFWS, 2016).

Historical Range

Historically, *Geranium multiflorum* was known from Ukulele, Waieleele, and Waianapanapa on East Maui. (USFWS, 2011)

Current Range

Current range is East Maui at Haleakala National Park, Hanawi Natural Area Reserve, Koolau Forest Reserve, Waikamoi Preserve, and Kula Forest Reserve. (USFWS, 2011)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Geranium multiflorum* (Nohoanu) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 12 detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Geranium multiflorum* includes 12 CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Montane Wet—Unit 1 (and) *Palmeria dolei*—Unit 10—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 10— Montane Wet This area consists of 1,313 ac (531 ha) of State land and 798 ac (323 ha) of privately owned land, at Haiku Uka on the northern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Cyanea duvalliorum*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *Phyllostegia pilosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 1 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp.

haleakalaensis, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 11—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 11— Montane Wet This area consists of 4,075 ac (1,649 ha) of State land, 9,633 ac (3,898 ha) of privately owned land, and 875 ac (354 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Puukaukanu and upper Waihoi Valley, on the northern and northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Geranium hanaense*, *G. multiflorum*, and *Wikstroemia villosa*, and by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 2 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea glabra*, *C. maritae*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, and *Schiedea jacobii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 3 (and) *Palmeria dolei*—Unit 12—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 12— Montane Wet This area consists of 2,228 ac (902 ha) of federally owned land (Haleakala National Park) in Kipahulu Valley, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. maritae*, and *Melicope ovalis*, and by the forest bird, *kiwikiu* (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 3 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea duvalliorum*, *C. glabra*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P.*

mannii, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest bird, the akohekohe (*Palmeria dolei*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 4 (and) *Palmeria dolei*—Unit 13—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 13— Montane Wet This area consists of 180 ac (73 ha) of State land and 1,653 ac (669 ha) of federally owned land (Haleakala National Park), in Kaapahu Valley on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *Cyrtandra ferripilosa*, and *Huperzia mannii*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 4 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea duvalliorum*, *C. glabra*, *C. mceldowneyi*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 5 (and) *Palmeria dolei*—Unit 14—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 14— Montane Wet This area consists of 222 ac (90 ha) of State land, and 165 ac (67 ha) of federally owned land (Haleakala National Park), near Kaumakani on the eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plant *Bidens campylotheca* ssp. *pentamera*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 5 is not currently occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the

reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 1 (and) *Palmeria dolei*—Unit 18—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 18— Montane Mesic This area consists of 6,593 ac (2,668 ha) of State land, 707 ac (286 ha) of privately owned land, and 3,672 ac (1,486 ha) of federally owned land (Haleakala National Park), from Kealahou to Puualae, nearly circumscribing the summit of Haleakala on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Asplenium dielirectum*, *A. peruvianum* var. *insulare*, *Clermontia lindseyana*, *Cyanea horrida*, *C. obtusa*, *Cyrtandra ferripilosa*, *C. oxybapha*, *Diplazium molokaiense*, *Geranium arboreum*, *G. multiflorum*, *Huperzia mannii*, *Melicope adscendens*, and *Neraudia sericea*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 1 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Cyanea glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. mceldowneyi*, *Phyllostegia bracteata*, *P. mannii*, *Santalum haleakalae* var. *lanaiense*, *Wikstroemia villosa*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Subalpine—Unit 1 (and) *Palmeria dolei*—Unit 24—Subalpine (and) *Pseudonestor xanthophrys*—Unit 24— Subalpine This area consists of 10,785 ac (4,365 ha) of State land, 1,622 ac (656 ha) of privately owned land, and 3,568 ac (1,444 ha) of federally owned land (Haleakala National Park), from Kanaio north to Puu Nianiau on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the subalpine ecosystem (see Table 5). They are occupied by the plants *Bidens micrantha* ssp. *kalealaha* and *Geranium arboreum*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Subalpine—Unit 1 is not known to be occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Asplenium peruvianum* var. *insulare*, *Geranium multiflorum*, *Phyllostegia bracteata*, *Schiedea haleakalensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these subalpine species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Subalpine—Unit 2 (and) *Palmeria dolei*—Unit 25—Subalpine (and) *Pseudonestor xanthophrys*—Unit 25— Subalpine This area consists of 50 ac (20 ha) of privately owned land,

and 9,836 ac (3,981 ha) of federally owned land (Haleakala National Park), from the summit north to Koolau Gap and east to Kalapawili Ridge on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the subalpine ecosystem (see Table 5). They are occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Geranium multiflorum*, and *Schiedea haleakalensis*, and by the forest bird, the akohekohe (*Palmeria dolei*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Subalpine—Unit 2 is not known to be occupied by the plants *Asplenium peruvianum* var. *insulare*, *Bidens micrantha* ssp. *kalealaha*, *Geranium arboreum*, *Phyllostegia bracteata*, or *Zanthoxylum hawaiiense*, or by the forest bird, the kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these subalpine species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 1 (and) *Palmeria dolei*—Unit 26—Dry Cliff (and) *Pseudonestor xanthophrys*—Unit 26—Dry Cliff This area consists of 755 ac (305 ha) of federally owned land (Haleakala National Park), from Pakaoao to Koolau Gap on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). Although Maui—Dry Cliff—Unit 1 is not known to be occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Diplazium molokaiense*, *Geranium multiflorum*, *Plantago princeps*, or *Schiedea haleakalensis*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 2 consists of 688 ac (279 ha) of federally owned land (Haleakala National Park) from Haupaakea Peak to Kaupo Gap on east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). It is occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Geranium multiflorum*, *Plantago princeps*, and *Schiedea haleakalensis*, and contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Dry Cliff—Unit 2 is not known to be occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, or *Diplazium molokaiense*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 3 (and) *Palmeria dolei*—Unit 27—Dry Cliff (and) *Pseudonestor xanthophrys*—Unit 27— Dry Cliff This area consists of 200 ac (81 ha) of federally owned land (Haleakala National Park) near Papaanui on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). It is occupied by the plant *Plantago princeps*, and contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Dry Cliff—Unit 3 is not currently occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Diplazium molokaiense*, *Geranium multiflorum*, or *Schiedea haleakalensis*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 4 (and) *Palmeria dolei*—Unit 28—Dry Cliff (and) *Pseudonestor xanthophrys*—Unit 28— Dry Cliff This area consists of 315 ac (127 ha) federally owned land (Haleakala National Park), along Kalapawili Ridge on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). Although Maui—Dry Cliff— Unit 4 is not currently occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Diplazium molokaiense*, *Geranium multiflorum*, *Plantago princeps*, or *Schiedea haleakalensis*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Geranium multiflorum* critical habitat consists of four components. Montane wet (east Maui), Montane mesic (east Maui), Sub-alpine (east Maui) and Dry cliff (east Maui) (81 FR 17790-18110):

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: *Ferns*, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: *Acacia*, *Ilex*, *Metrosideros*, *Myrsine*, *Nestegis*, *Nothocestrum*, *Pisonia*, *Pittosporum*, *Psychotria*, *Sophora*, *Zanthoxylum*. Subcanopy: *Alyxia*, *Charpentiera*, *Coprosma*, *Dodonaea*, *Kadua*, *Labordia*, *Leptecophylla*, *Phyllostegia*, *Vaccinium*. Understory: *Ferns*, *Carex*, *Peperomia*.

Ecosystem: Subalpine. Elevation: 6,500–9,800 ft (2,000–3,000 m). Annual precipitation: 15–40 in (38–100 cm). Substrate: Dry ash, sandy loam, rocky, undeveloped soils, weathered lava. Canopy: Chamaesyce, Chenopodium, Metrosideros, Myoporum, Santalum, Sophora. Subcanopy: Coprosma, Dodonaea, Dubautia, Geranium, Leptecophylla, Vaccinium, Wikstroemia. Understory: Ferns, Bidens, Carex, Deschampsia, Eragrostis, Gahnia, Luzula, Panicum, Pseudognaphalium, Sicyos, Tetramolopium.

Ecosystem: Dry Cliff. Elevation: unrestricted. Annual precipitation: <75 in (<190 cm). Substrate: >65 degree slope, rocky talus. Canopy: None. Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of

these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland, grassland/herbaceous, shrubland/chaparral (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Subalpine, montane mesic, montane wet, and dry cliff ecosystems (USFWS, 2016)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 1,580 and 2,260 meters; range of rainfall between 60 and 500 cm (USFWS, 1997)

Environmental Specificity

Adult: Low, with few key requirements (inferred from USFWS, 1997)

Tolerance Ranges/Thresholds

Adult: High (USFWS, 1997)

Habitat Narrative

Adult: The habitat of *Geranium multiflorum* encompasses diverse vegetation types, with a range of mean annual precipitation from as low as 60 centimeters (23.6 inches) to over 500 centimeters (16.4 feet). Occurring primarily on the windward side of East Maui, this species is found mostly within wet forests. Substrates range from lava flows to rich soils. *Geranium multiflorum* grows at 1,580-2,260 meters (5,183-7,415 feet) in elevation—in montane grasslands, montane bog edges, fog-swept lava flows, gulch slopes of montane wet forests, and occasionally in subalpine shrublands. The largest, loosely contiguous population of this species occurs in the tangled shrub ecotone between *Metrosideros* forest and *Deschampsia* grasslands on the northern outer slopes of Haleakala. Here, *Geranium multiflorum* is a distinctive and characteristic part of the area's vegetation. It also occurs in much drier habitats in Haleakala Crater and in Koolau Gap on sparsely vegetated lava. In these sites, the leaves of the species are much smaller and more down-covered (canescent) than in wetter locales. Associated native species include *Vaccinium reticulatum*, *Vaccinium calycinum*, *Metrosideros polymorpha*, *Coprosma*, *Styphelia tameiameia*, and *Sadleria cyatheoides*. Associated alien species include *Dactylis glomerata*, *Holcus lanatus*, *Hypochoeris radicata*, *Juncus planifolius*, and *Rubus argutus*. (USFWS, 1997) It occurs in the subalpine, montane mesic, montane wet, and dry cliff ecosystems (USFWS, 2016).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Declining (USFWS, 2016)

Resiliency:

Low (inferred from current range/distribution)

Redundancy:

Low (inferred from USFWS, 2016)

Number of Populations:

9 (USFWS, 2016)

Population Size:

500 - 1,000 wild, 150 outplanted (USFWS, 2016)

Population Narrative:

In 2003, there were 13 occurrences. Currently, *G. multiflorum* is found in nine occurrences. It is estimated there may be as many as 500 to 1,000 individuals (Bily et al. 2003, pp. 4–5; TNC 2007; Perlman 2009h, in litt.; Wood 2009h, in litt.; HBMP 2010; Oppenheimer 2010b, in litt.; HNP 2012, in litt.). One hundred and fifty plants have been outplanted at eight locations within Haleakala National Park (NPS 2012, in litt.) (USFWS, 2016). In 2010, Haleakala National Park staff estimated that approximately 500 individuals are found throughout the Park's boundary and approximately 100 individuals are located in the Koolau Gap (USFWS 2010), for a total of approximately 600 individuals. It is now known from Haleakala National Park, Hanawi Natural Area Reserve, Koolau Forest Reserve, Waikamoi Preserve, and Kula Forest Reserve. (USFWS, 2011). In 2011, the 5-year review reported about 600 individuals in five locations on Haleakalā Crater on east Maui. Currently, there are about nine populations totaling more than 500 individuals on east Maui at Honomanū, Pu'u Ko'olau, Ko'olau Gap, Pu'uo Mālei, upper Kīpahulu, Greensword Bog, Kūhiwa Stream, Hanawī Stream, Pu'u'ālea, and Waikamoi Preserve (Oppenheimer 2007 and 2018, in litt.; Robertson 2016, in litt.). (USFWS 2018)

Threats and Stressors

Stressor: Invasive plants (NatureServe, 2015; USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The major threat to this species is nonnative plant species, especially *Rubus argutus* (prickly Florida blackberry) (USFWS 2003). Invasive introduced plant species have altered the habitat for *Geranium multiflorum* and compete for resources, these species include *Ageratina adenophora* (sticky snakeroot), *Anthoxanthum odoratum* (sweet vernal grass), *Dactylis glomerata* (cocksfoot), *Holcus lanatus* (common velvet grass), *Hypochoeris radicata* (hairy cat's ear), *Lapsana communis* (nipplewort), *Lythrum maritimum* (loosestrife), *Prunella vulgaris* (selfheal), *Rubus argutus* (blackberry), *R. niveus* (Mysore raspberry), and *R. rosifolius* (thimbleberry) (Perlman 2009; Wood 2009). (NatureServe, 2015; USFWS, 2011)

Stressor: Feral ungulates (NatureServe, 2015; USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The browsing of feral goats and rooting of feral pigs continue to threaten this taxon. Feral pigs and goats in unfenced areas pose a potential threat, as well (USFWS 2003). Feral ungulates such as deer (*Axis axis*) and pigs (*Sus scrofa*) degrade the habitat for *Geranium multiflorum* and thereby hamper regeneration of the species. (USFWS, 2011; NatureServe, 2015)

Stressor: Small population size (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: Other threats include naturally caused events due to the species' restricted range and the small population size (USFWS 2003). (NatureServe, 2015)

Stressor: Predation by rats, deer, slugs, and ants (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Seed predation by rats (*Rattus* sp.) and consumption of leaves, stems, and seeds by deer, slugs (unidentified species), and ants (various species) are threats to *Geranium multiflorum* (Perlman 2009; Wood 2009). (USFWS, 2011)

Stressor: Loss of pollinators (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Loss of pollinators is probably contributing to a decline in this species, which is now propagated from cuttings rather than seed (Perlman 2009; Wood 2009). (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to *Geranium multiflorum*. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2011)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)

3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1997)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)

2. Each population must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)

3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1997)

Recovery Actions:

- Maintain control of feral goats and pigs in Haleakala National Park, TNCH's Waikamoi Preserve and upper Hanawi NAR. (USFWS, 1997)
- Control invasive alien plants, especially blackberry. If these threats are kept under control and populations remain stable or increase over the next five years, this taxon may be considered for down-listing. (USFWS, 1997)
- Surveys and population monitoring—Staff of Haleakalā National Park (HNP) and The Nature Conservancy (TNC) monitor populations of *Geranium multiflorum* (NPS 2012; TNC 2014). (USFWS 2018)
- Captive propagation for genetic storage and reintroduction. The Lyon Seed Conservation Laboratory reports 55 seeds in storage from a collection pooled from 10 plants and collected in 2011 (Lyon Arboretum 2017). Between 2013 and 2017, Haleakalā National Park has propagated over 12 plants representing seven wild individuals and has outplanted at least 28 individuals at Honokahua (HNP 2013, 2015, 2017; NPS 2014). (USFWS 2018)
- To prevent extinction, which is the first step in recovering the species, the taxon must be managed to control threats (e.g., fenced) and have 50 individuals (or the total number of individuals if fewer than 50 exist) from each of three populations represented in ex situ (secured off-site, such as a nursery or seed bank) collections. In addition, a minimum of three populations should be documented on east Maui. Each of these populations must be naturally reproducing (viable seeds, seedlings, saplings) and increasing in number, with a minimum of 25 mature, reproducing individuals per population. The preventing extinction goals for this species have not been met as, although there are two populations of at least 25 individuals (100 at Greensword Bog in 2009 and about 200 at Hanawī Stream in 2011), genetic representation is incomplete (Table 1), and all threats are not being sufficiently managed throughout the range of the species (USFWS 2018).
- Reintroduction and translocation—Continue reintroduction of individuals into suitable habitat within historic range that is managed for known threats to this species. (USFWS 2018)
- Population biology research—Research pollinators and seed distributors to determine limiting factors and investigate techniques to improve natural recruitment. (USFWS 2018)

- Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use this information to determine future landscape needed for the recovery of the species. (USFWS 2018)
- Alliance and partnership development—Continue to work with land managers to implement of ecosystem-level restoration and management to benefit this taxon. (USFWS 2018)

Conservation Measures and Best Management Practices:

- Survey known localities and suitable habitat areas in East Maui to determine current status of all populations of *Geranium multiflorum*. (USFWS, 2011)
- Collect propagules from all known populations for propagation and genetic storage. (USFWS, 2011)
- Consider long term tissue culture storage for some material, as no seed appears to be stored at this time. (USFWS, 2011)
- Fence all known populations to provide protection from the negative impacts of feral ungulates. (USFWS, 2011)
- Control invasive introduced plant species around all known populations. (USFWS, 2011)
- Control rats in the vicinity of these populations. (USFWS, 2011)
- Develop and implement methods to control ants and slugs. (USFWS, 2011)
- Establish additional populations within protected suitable habitat. (USFWS, 2011)
- Research pollinators and seed distributors to determine limiting factors; investigate techniques to improve natural recruitment. (USFWS, 2011)
- Work with Hawaii Division of Forestry and Wildlife, National Park Service, and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2011)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2011)

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SPECIES ACCOUNT: *Gesneria pauciflora* (No common name)

Species Taxonomic and Listing Information

Listing Status: Threatened; 3/7/1995; Southeast Region (R4) (USFWS, 2015)

Physical Description

A small gregarious shrub which may reach 30 centimeters in height and 8 millimeters in diameter. Stems may be erect or decumbent and the bark is smooth, gray-brown, and glabrous. The leaves are alternate, and the terets or flattened petioles are from 2 to 7 millimeters long. Leaf blades are shaped like a narrow trowel, 2.8 centimeters long and .9 to 2.3 centimeters wide, membranous, dark green and glossy above, and pilose along the prominent veins. The margin is subentire toward the cuneate base and serrate to sublobate above. The inflorescences are one to few flowered, and the peduncles are from 6.1 to 15.3 centimeters long and slightly curved. The pedicels are 1 to 2 centimeters long, reddish-brown, and pilose to glabrescent. The corolla is tubular, curved, 2 to 2.3 centimeters long, 4 millimeters wide at the base, narrowing to 3 millimeters but widening to 5 millimeters at the middle and again narrowing to 4 millimeters at the mouth. The five-lobed corolla is yellow to yellow-orange and densely pilose outside but glabrous inside. The fruit is a capsule containing numerous small seeds, approximately 4 millimeters long and wide, gray-brown, and glabrescent with 5 to 10 not prominent ridges (Liogier 1994, Proctor 1991) (USFWS, 1998).

Taxonomy

Belongs to the family Gesneriaceae (USFWS, 1998).

Historical Range

Known to occur only on serpentine soils in the western mountains of Puerto Rico (USFWS, 1998).

Current Range

At the time of listing and when the recovery plan was signed, only three populations of this small shrub were known to exist in the western mountains of Maricao and Sabana Grande municipalities. Two of the three known populations are located in the Maricao Commonwealth Forest (MCF). The third locality lies on a Lajas River tributary outside of the MCF boundaries. Herbarium specimens indicate that the species has also been collected in the past from the Yagüez River and from "Cerro Las Mesas" in the Mayagüez municipality, but these sites have not been intensively surveyed (USFWS, 1998).

Critical Habitat Designated

Yes;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual, self-fertilization (USFWS, 2013)

Breeding Season

Adult: Throughout the year (USFWS, 1998)

Key Resources Needed for Breeding

Adult: Possibly hummingbird pollinators (USFWS, 2013); wet conditions (USFWS, 1998)

Reproduction Narrative

Adult: Preliminary data suggests that this species is not apomictic (incapable of asexual reproduction through flowers) and that instead flowers need to undergo the process of pollination to develop fruits. Hummingbirds are the only flower visitors so far observed but visit rates, however, are very low (e.g. maximum visitation rate was 0.004 flower visited/time observation/flower observed) and so is natural fruit production (32.5% of fruits end up maturing fruits). Flowers seem to be capable of some autogamy (self-fertilization) but the rate of this process is low (10.6%) (USFWS, 2013). Field observations during a 2-year study of the species' phenology indicate that flowering and fruiting occur throughout the year. Nevertheless, there appear to be more abundant flowering and fruiting during the rainy months of August, September, and October. Flowering becomes less frequent and patchy during drier periods (Breckon and Kolterman 1994) (USFWS, 1998).

Habitat Type

Adult: Terrestrial, semi-aquatic (USFWS, 2013)

Habitat Vegetation or Surface Water Classification

Adult: Riparian; pool; subtropical wet forest, subtropical moist forest, subtropical lower montane wet forest (USFWS, 1998)

Dependencies on Specific Environmental Elements

Adult: Shade (USFWS, 1998)

Spatial Arrangements of the Population

Adult: Clumped, colonial (USFWS, 2013)

Environmental Specificity

Adult: Narrow (USFWS, 2013)

Tolerance Ranges/Thresholds

Adult: High (USFWS, 1998)

Habitat Narrative

Adult: This species is known to occur only on serpentine derived substrates with little or no soil formation and associated with wet habitats. At the Maricao River locality, all colonies observed were associated with wet environments and most were on steep rock faces. *G. pauciflora*'s highly specific habitat where few other species occur, suggests that its restriction to serpentine is due to the combination of tolerance (to low nitrogen and calcium levels, and to high levels of heavy metals) and poor competitive ability (Breckon and Kolterman 1994). It is not clear how many distinct individuals of *G. pauciflora* occur in one colony. It is uncertain if a large aggregate of *G. pauciflora* plants contains several different individuals or is simply one individual with lots of offshoots (USFWS, 2013). At all known localities, the plants are associated with wet habitats,

which are on steep rock faces with little or no soil formation. They are within the spray zone of waterfalls or near deep pools. Most are in shady situations where direct sun is not received. Most individuals are found within 1 meter of water and may actually be submerged for brief periods of time. At each locality, a number of clusters or colonies grow appressed to the wet rocks. The plant appears to be tolerant of low nitrogen and calcium and to toxicity of high levels of heavy metals found in serpentine (Breckon and Kolterman 1994). The Maricao Forest falls within three life zones: subtropical wet forest, subtropical moist forest, and subtropical lower montane wet forest (Ewel and Whitmore 1973) (USFWS, 1998).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Stable (USFWS, 2013)

Resiliency:

Very low (inferred from USFWS, 2013)

Redundancy:

Low (USFWS, 2013)

Number of Populations:

4 (USFWS, 2013)

Population Size:

> 800 - 1,500 (USFWS, 2013)

Population Narrative:

The species is only known from three localities in Puerto Rico. Each locality is considered one population. The species status is stable; no new threats have been identified for the species. The Service recorded between 800 to 1,500 individuals in the two visited populations. The number of individuals in the remaining two known populations is unknown (USFWS, 2013).

Threats and Stressors

Stressor: Recreation (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Two of the twelve colonies of *G. pauciflora* at the Maricao River watershed were found off an unmarked trail that runs almost parallel to the river. If that trail is improved without

implementing protective measures, it can adversely affect these colonies. The dirt road leading up to the Lajas River tributary is open to the public and the Service observed five all-terrain vehicles heading up the road, possibly contributing to erosion on that locality. This locality is adjacent to a highly visited waterfall and natural pool area known as “Salto Curet”. The human activities in the area may contribute to erosion of the small tributary and may modify the habitat conditions needed by the species. If the access to the “Salto Curet” area is expanded, or amenities are developed, these activities may affect the individuals at this locality (USFWS, 2013).

Stressor: Stochastic weather events (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Landslides, storm damage, and floods are natural occurrences that may affect the steep, unstable slopes associated with *G. pauciflora* habitat and may result in loss of individuals, as they may be smothered, washed or simply ripped off their substrate and rock faces. These effects are further aggravated by tropical storms and hurricanes in Puerto Rico. After the last known *G. pauciflora* investigation report (Breckon and Kolterman 1996), two hurricanes have affected the island. Hurricane Hortense passed in September 1996 and Hurricane Georges in September 1998 significantly affecting the islands landscape. On November 2012, one of the colonies in the Maricao River watershed was observed to have been almost completely extirpated because of a natural landslide that occurred in that area. This demonstrates the vulnerability of the species to such natural events, as most of the remaining colonies seem to be susceptible to landslides (USFWS, 2013).

Recovery

Reclassification Criteria:

Not available

Delisting Criteria:

1. A management plan that considers the protection and recovery of the species has been prepared and implemented for the Maricao Commonwealth Forest (MCF) (USFWS, 2013).
2. New populations capable of self-perpetuation have been established within protected areas, such as other areas in the MCF or in the Susúa Commonwealth Forest (USFWS, 2013).

2019 Amended Criteria 1. The existing six (6) populations of *G. pauciflora* within the Maricao Commonwealth Forests and adjacent private lands exhibit a stable or increasing population trend, evidenced by natural recruitment, and multiple age classes (addresses Factor A and E). (USFWS, 2019).

2019 - 2. Of the six (6) currently known natural populations, the three (3) populations extending onto private lands adjacent to the MCF are protected through a long-term conservation mechanism (addresses Factors A and E). (USFWS, 2019).

2019 - 3. Threats due to forest management activities (e.g., trail and dirt roads maintenance and improvements in areas adjacent drainage crossings) have been addressed and/or managed to the extent that the species will remain viable for the foreseeable future. (USFWS, 2019).

Recovery Actions:

- Protect the existing population and its habitat through the development and implementation of a management plan for the Maricao Commonwealth Forest (USFWS, 2013).
- Monitor known populations (USFWS, 1998).
- Enforce existing Commonwealth and Federal endangered species regulations (USFWS, 1998).
- Educate the public on conservation values and regulations (USFWS, 1998).
- Conduct research on the life history of the species and evaluate propagation techniques (USFWS, 1998).
- Conduct propagation and enhance existing populations or establish new ones on protected lands (USFWS, 2013). 2019 Refinement: In collaboration with partners (e.g., UPRRP, KEW, Fairchild Tropical Botanic Garden and PRDNER), implement a project to propagate and reintroduce *G. pauciflora* to re-establish populations after Hurricane Maria. The project should address the feasibility of seed banking this species, and if deemed necessary, seed material should be stored at authorized institutions (e.g., Millennium Seed Bank (KEW) and USDA National Laboratory for Genetic Resources Preservation (NLGRP) in Ft. Collins). (USFWS, 2019).
- New in 2019 - 2: Refine and validate an existing GIS-based habitat predictability model to identify and further explore additional areas to locate more reintroduction sites for the species. (USFWS, 2019).
- New in 2019 - 3: Continue post hurricane monitoring of the eleven (11) colonies studied within the MCF, and expand it to other colonies in order to assess potential long-term effects of canopy cover loss on plant mortality, the potential effect of co-existing fast growing and exotic invasive species, and the colony recovery rates following canopy regeneration. (USFWS, 2019).
- New in 2019 - 4: Studies in the species' population genetics should be conducted to determined patterns of genetic diversity across the species natural distribution, to provide baseline information for a sound management of *G. pauciflora* actions (e.g., need for enhancement of populations with material from different watersheds). (USFWS, 2019).

Conservation Measures and Best Management Practices:

- Establish the number of populations and number of individuals per population needed in order to consider delisting the species (USFWS, 2013).
- Develop propagation techniques, establish ex situ populations in botanical gardens, and introduce individuals in protected areas (USFWS, 2013).
- Model potential suitable habitat using GIS tools to search for new populations and continue searching within known localities for new colonies (USFWS, 2013).
- Mark and protect colonies 11 and 12 located at the Maricao River watershed to minimize possible effects, if the trail is improved (USFWS, 2013).
- Establish a once a year monitoring schedule for known populations and after any significant weather event (i.e. hurricanes) (USFWS, 2013).

- Conduct studies of the known populations to determine intra- and inter-population genetic diversity (USFWS, 2013).
- Investigate pollination and seed dispersal mechanisms to determine the species strategies for dispersal (USFWS, 2013).
- Evaluate seed viability and germination and growth requirements (USFWS, 2013).
- Conduct studies to evaluate the degree of threat that flower predation in *G. pauciflora* represents a potential risk for this species (limiting fruit production) (USFWS, 2013).
- Conduct studies to evaluate if common pioneer species of riparian areas are potential habitat competitors for *G. pauciflora* (USFWS, 2013).
- Select appropriate sites for population introduction (USFWS, 2013).
- Explore the opportunity to enter into a Service Partner's for Fish and Wildlife Agreement with the landowner to conserve the area and restore suitable habitat for the species (USFWS, 2013).

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SPECIES ACCOUNT: *Geum radiatum* (Spreading avens)

Species Taxonomic and Listing Information

Listing Status: Endangered; 4/5/1990; Southeast Region (R4) (USFWS, 2015)

Physical Description

A perennial herb with stems that grow up to 5 dm tall from a large basal rosette of leaves. The stems are topped with showy, bright yellow flowers during most of the summer. There is no other *Geum* in the southeastern U.S. that remotely resembles this species. It is taxonomically closest to *G. peckii*, a species whose southernmost range is in the White Mountains of New Hampshire - about 900 km north of *G. radiatum*'s range (NatureServe, 2015).

Taxonomy

Geum radiatum is a distinct species, sibling to *Geum peckii* of New England and Nova Scotia, or may be conspecific with that (in which case the older name *Geum radiatum* would apply to the collective species) (NatureServe, 2015).

Historical Range

This species is endemic to a few scattered mountaintops in western North Carolina and eastern Tennessee (USFWS, 1993).

Current Range

The range of *G. radiatum* consists of populations distributed across Ashe, Avery, Buncombe, Mitchell, Transylvania, Watauga and Yancey counties, North Carolina and Carter and Sever counties, Tennessee (USFWS, 2013)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, asexual (USFWS, 1993)

Breeding Season

Adult: June - September (USFWS, 1993)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 1993)

Reproduction Narrative

Adult: Flowering occurs from June through September; fruiting occurs from August through October. New plants can be produced through sexual or asexual means. Morgan (1980) reported observing many insects visiting the flowers, but these were not identified. Massey et al. (1980) also reported observations of Hymenoptera visiting the flowers. F. Brackley (Keene

State College, personal communication, 1992; Brackley and Burger 1980) has observed flies on this species (USFWS, 1993). This species has low rates of seedling recruitment (NatureServe, 2015).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliffs, talus slopes, heath balds (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Consistent moisture (USFWS, 1993)

Geographic or Habitat Restraints or Barriers

Adult: Does not occur < 1310 m elevation (NatureServe, 2015)

Habitat Narrative

Adult: A pioneer species. Occurs on exposed, high elevation situations in the southern Appalachians. Primarily in the crevices of northwest-facing cliffs. Also at the bases of talus slopes, or, rarely, in openings in heath balds. Found only at elevations over 1310 m (NatureServe, 2015). These rocky summits and cliffs usually appear as smaller-scale, patchy habitats embedded within a larger forested landscape consisting of spruce-fir or northern hardwood forest, or occasionally high elevation red oak forest (USFWS, 2013). The soils on which spreading avens grows (typic haplumbrepts, udorthents, and entisols) are generally shallow and acidic (pH 4-5), uniform, dark brown, and coarse-loamy. Consistent moisture may be one of the most important habitat requirements of this species (USFWS, 1993).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Unknown (USFWS, 2013)

Species Trends:

Stable (USFWS, 2013)

Resiliency:

Moderate (inferred from USFWS 2013; see current range/distribution)

Representation:

Moderate (inferred from USFWS, 2013)

Redundancy:

Moderate (inferred from USFWS, 2013)

Number of Populations:

15 (USFWS, 2013)

Population Size:

Unknown (NatureServe, 2015)

Population Narrative:

The species status is stable; eleven of the 15 extant populations occur on publicly owned lands or lands otherwise managed for conservation. Population trends are lacking for most occurrences of *G. radiatum*. Genetic diversity within five *G. radiatum* populations was found to be comparable to the mean of other endemics, and positively associated with population size. The authors characterize the level of population differentiation as “moderate” (USFWS, 2013).

Threats and Stressors

Stressor: Recreation (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: protection through public ownership can have unintended adverse consequences, in that areas can become subject to increased visitation by the recreating public. Trampling when recreating, rock climbing and rappelling is a significant threat to *G. radiatum*, having resulted or contributed to declines at portions of four populations (USFWS, 2013).

Stressor: Climate change (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Accelerated global climate change is likely to disrupt patterns of climate variability to which *G. radiatum* has become adapted, and as such is likely to exacerbate threats already mentioned. However, the current scale of most global models of climate change offers little insight into the changes that will likely occur on southern Appalachian high peaks. While a net warming trend could exceed the tolerances of species adapted to cool, moist conditions, the current range of *G. radiatum* spans a range of conditions which vary widely in their degree of overall sun exposure, humidity, precipitation and soil moisture. Thus most available data suggest that climatic disruptions significantly affecting the availability of soil moisture or above-ground seepage are likely to further threaten the long term viability of this high elevation rock outcrop endemic (USFWS, 2013).

Recovery

Reclassification Criteria:

Not available

Delisting Criteria:

There are at least 16 self-sustaining populations that are protected to such a degree that the species no longer qualifies for protection under the Endangered Species Act (USFWS, 1993).

Recovery Actions:

- Survey suitable habitat for additional populations (USFWS, 1993).
- Monitor and protect existing populations (USFWS, 1993).
- Conduct research on the biology of the species (USFWS, 1993).
- Establish new populations or rehabilitate marginal populations to the point where they are self-sustaining (USFWS, 1993).
- Investigate and conduct necessary management activities at all key sites (USFWS, 1993).

Conservation Measures and Best Management Practices:

- Continue annual demographic monitoring at as many sites as possible, including (but not limited to) those nine populations already included in ongoing monitoring efforts (Recovery Tasks 2.1, 2.3 and 2.5) (USFWS, 2013).
- Work with NCNHP and TNNHP to satisfactorily incorporate results from prior survey efforts into their respective databases (Recovery Task 1.2) (USFWS, 2013).
- Conduct reconnaissance surveys to verify population sizes at exceptionally large sites (e.g., Phoenix Mountain, Three Top, The Peak) and to verify apparent or suspected declines at other sites (e.g., Cliff Top, Potato Hill, Grassy Ridge east of Carvers Gap (Big Roan Ridge subpopulation)) (USFWS, 2013).
- Work with TNC and other appropriate partners to evaluate protection alternatives at remaining unprotected sites (e.g., Hanging Rock, Phoenix Mountain, Potato Hill, Yellow Mountain (Raven Cliffs)), including the use of voluntary landowner agreements (Recovery Task 1.4) (USFWS, 2013).
- Compile quantitative data summarizing transplant survivorship across all previously attempted introduction or augmentation efforts involving this species, and evaluate causes for success/failure (Recovery Task 2.7) (USFWS, 2013).
- Work with appropriate partners to place representative genetic material in long-term storage, and to evaluate long-term storage requirements for this species (Recovery Task 3) (USFWS, 2013).
- Collaborate with appropriate partners to begin stepping down global climate change models to a meaningful scale for purposes of projecting impacts to high elevation southern Appalachian rocky summits and cliffs. Devise and evaluate potential adaptation scenarios for *G. radiatum* (Recovery Task 1.4) (USFWS, 2013).

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SPECIES ACCOUNT: *Gilia tenuiflora ssp. arenaria* (Monterey gilia)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/22/1992; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An erect, densely pubescent herb with basal rosette leaves and funnel-shaped purple flowers (NatureServe, 2015).

Taxonomy

A member of the phlox family (Polemoniaceae). It has been observed that in the more inland areas of its distribution, *Gilia tenuiflora ssp. arenaria* has morphological characteristics that intergrade with *G. t. ssp. tenuiflora* (Dorrell-Canepa, 1994) (USFWS, 2008).

Historical Range

This subspecies is endemic to the Monterey Bay and Peninsula dune complexes (USFWS, 2008).

Current Range

Restricted to isolated sites within two coastal dune scrub communities along Monterey Bay and the Monterey Peninsula (NatureServe, 2015). Occurrences are distributed in discontinuous populations from Spanish Bay on the Monterey Peninsula north to Moss Landing in Monterey County, CA (USFWS 2008).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (NatureServe, 2015); self-pollination (USFWS, 1998)

Lifespan

Adult: 1 year (USFWS, 2008)

Key Resources Needed for Breeding

Adult: Insect pollinators (NatureServe, 2015); soils seed bank, semi-open areas (USFWS, 2008)

Reproduction Narrative

Adult: Entirely animal pollinated; mixture of bees, butterflies, moths, long-tongued flies, hummingbirds (NatureServe, 2015). It is an annual plant. A recent study has shown that *Gilia tenuiflora ssp. arenaria* may have long-lived seeds which create a relatively persistent soil seed bank (Fox et al. 2005). *Gilia t. ssp. arenaria* requires semi-open areas of sandy soil to germinate and to thrive (L. Madison, pers. comm. 2006; B. Collins, pers. comm. 2006; B. Delgado, pers. comm. 2006) (USFWS, 2008). The species is thought to be primarily self-pollinating based on its

stamens not protruding from the flower, no observations of pollinators, and very viable seed (Dorrell-Canepa, in litt., 1995) (USFWS, 1998).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Coastal strand (NatureServe, 2015); dune scrub, coastal sage scrub, maritime chaparral (USFWS, 2008)

Geographic or Habitat Restraints or Barriers

Adult: Dense vegetation (USFWS, 2008); occurs at or below 100 ft. elevation (USFWS, 1998)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from USFWS, 1998)

Habitat Narrative

Adult: Inhabits coastal strand (sandy beaches and dunes) (NatureServe, 2015). *Gilia t. ssp. arenaria* is typically associated with sandy soils of dune scrub, coastal sage scrub, and maritime chaparral vegetation types. The taxon is generally found in sparse scrub communities, and does not compete well in the denser vegetation structure often exhibited by many non-native species. (USFWS, 2008). The species occurs at elevations no higher than 30 meters (100 feet). The species is usually tolerant of small amounts of drifting sand, but tends to occur in stable sites with minimal sand accretion or deflation (USFWS, 1998).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Dust-like seeds in many desert species, assumed to be wind dispersed (NatureServe, 2015).

Population Information and Trends**Population Trends:**

Not available

Species Trends:

3 populations extirpated since listing (USFWS, 2008)

Resiliency:

Very low (inferred from USFWS, 2008; see current range/distribution)

Redundancy:

Moderate to high (inferred from USFWS, 2008)

Number of Populations:

24 (USFWS, 2008)

Population Size:

Variable from year to year; 1,665 - 25,000 depending on location (USFWS, 2008)

Population Narrative:

There are likely 24 currently extant occurrences of *Gilia tenuiflora* ssp. *arenaria*. Three coastal populations have likely been extirpated since the time of listing. As an annual plant, *Gilia tenuiflora* ssp. *arenaria* can go through large changes in number of individuals from year to year, and late-season rainfall can markedly affect germination and growth (Dorrell-Canepa 1994; Fox et al. 2005). Population censuses that span at least 10 years have been conducted at only a few locations. The number of individuals at Marina State Beach has fluctuated from a low of 5,000 individuals in 1987 to a high of 25,000 individuals in 1993; the number of individuals at Salinas River State Beach has fluctuated from a low of 1,665 individuals in 1987 to a high of 13,500 individuals in 1993 (CNDDDB 2006) (USFWS, 2008).

Threats and Stressors

Stressor: Development (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: One of the greatest current threats to this subspecies is continuing destruction of habitat due to development. While future development will be precluded at some sites by virtue of being transferred to entities that will manage for their conservation (e.g., Big Sur Land Trust, University of California, and BLM at former Fort Ord), other sites are slated for future development. The western areas of former Fort Ord that are to be developed are relatively small in acreage, but contain a high density of individuals. Six of 11 inland occurrences (55%) on public lands are under threat of at least partial development (USFWS, 2008).

Stressor: Herbivory (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Herbivory has been observed by individuals conducting surveys and research on this subspecies (L. Fox in litt. 2006; T. Hyland pers. com. 2006). This poses a potentially serious threat to this subspecies (Service 1998), but actual effects are currently unknown. Herbivory has been found to increase with an increase in cover for small herbivorous species such as rabbits (McGraw 2004) (USFWS, 2008).

Stressor: Nonnative plants (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: One of the main threats to this taxon is competition from invasive, non-native species (57 FR 27848). These species are typically able to colonize disturbed habitats and quickly reach high densities. In coastal areas, iceplant (*Carpobrotus* spp.) and exotic annual grasses are the most problematic invasive species for *Gilia tenuiflora* ssp. *arenaria*. In inland areas, jubata grass (*Cortaderia jubata*), iceplant, and annual grasses (*Festuca* spp., *Avena* spp., and others) are the most problematic invasive species for *G. t.* ssp. *arenaria* (Mactec Engineering and Consulting

Incorporated 2002, 2003, and 2004). Annual grasses are particularly difficult to remove once they have colonized an area. Non-native grasses decrease the suitability of habitat for *G. t. ssp. arenaria* due to excessive soil stabilization and litter accumulation (Pickart 1997, Russo et al. 1988) (USFWS, 2008).

Stressor: Inadequate vegetation management (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Other human-caused factors that could affect the inland occurrences at former Fort Ord, aside from those previously mentioned, are vegetation management activities that fail to create or maintain the open, sandy conditions necessary for continued survival and colonization by *Gilia tenuiflora ssp. arenaria*. These include the elimination of fire from chaparral communities, poorly timed (e.g., wet season) prescribed fires, the use of pre-fire treatments that result in increases in non-native species, and the use of mechanical vegetation clearing that leaves the chipped vegetation on the soil surface (Zander and Associates 2007) (USFWS, 2008).

Recovery

Reclassification Criteria:

1. Habitat occupied by the taxon that is needed to allow delisting has been secured with long-term commitments and, if possible, endowments to fund conservation of the native vegetation (USFWS, 2008).
2. Management measures are being implemented to address the threats of invasive species and other problems, including grazing, pedestrians, and off-road vehicles at some sites (USFWS, 2008).
3. Monitoring indicates that management actions are successful in reducing threats of invasive non-native species (USFWS, 2008).
4. Additional restored habitat has been secured, with evidence of either natural or artificial long-term establishment of additional populations, and long-term commitments (and endowments, where possible) to fund conservation of the native vegetation (USFWS, 2008).

Delisting Criteria:

1. Habitat throughout this taxon's range is protected from encroachment of non-native species, recreational activity (including off-road vehicles [ORVs] and horses), and development (USFWS, 2008).
2. Habitat throughout this taxon's range is restored to native vegetation at proper densities to allow natural colonization by this plant (USFWS, 2008).
3. Habitat throughout this taxon's range is monitored sufficiently to assure that local threats are spotted promptly (USFWS, 2008).
4. Enough plants are at enough locations throughout this taxon's range and within the protected vegetation to reasonably assure the viability of the taxon (USFWS, 2008).

5. (Re)introduced populations should be naturally reproducing in vegetation that also appears to be persisting without excessive maintenance or “gardening” (USFWS, 2008).

6. The determination that delisting is possible must be based on at least 15 years of monitoring for the endangered taxa, to include wet and drought years (USFWS, 2008).

Recovery Actions:

- Protect existing populations and habitats (USFWS, 1998).
- Minimize the threats to the plant (USFWS, 1998).
- Develop management strategies incorporating ecological and land use strategies (USFWS, 1998).
- Manage populations and habitats to achieve delisting (USFWS, 1998).
- Monitor population trends to evaluate recovery success (USFWS, 1998).
- Coordinate recovery actions to protect other listed and sensitive species (USFWS, 1998).
- Develop and implement an outreach program (USFWS, 1998).

Conservation Measures and Best Management Practices:

- A reworking of the recovery criteria listed in the recovery plan should be undertaken. The specific population sizes recommended in delisting criteria #4 are difficult to correlate with the observed distribution of occurrences in the field. Using specific numbers for annual species with persistent seed banks, as previously discussed, is not necessarily valuable as an indicator of species status. A more useful indicator should be identified to indicate the quality and status of the habitat that is supporting the various populations (USFWS, 2008).
- Improved coordination between State and Federal agencies and local landowners would increase information sharing and maximize conservation and recovery efforts. Aside from the work being done for the re-use of former Fort Ord properties, very little communication is currently occurring between different parties involved with the management of this subspecies. Little or no information was available for many of the privately owned parcels of land believed to support occurrences of this subspecies. Attempts to establish conservation easements or acquire properties containing coastal dune habitat that supports this and other rare and endangered species should be made. Conducting surveys of these lands to determine whether or not extant populations still exist would be valuable. Directed oversight through coordination of information, overall strategies, and implementation of uniform methodologies would allow for implementation of much more powerful adaptive management techniques (USFWS, 2008).
- Long-term monitoring programs at more known occurrences of *Gilia tenuiflora* ssp. *arenaria* should be undertaken. Due to the strong influence of annual precipitation on observable population size, this monitoring should be habitat-based or in another way address the issue of dormant soil seed banks. This monitoring should include monitoring of pre-fire vegetation and herbivory rates on portions of former Fort Ord that will be burned under the prescribed burn plan in the Fort Ord draft HCP. Information regarding control of non-native plants, community structure, herbivory, and germination of *G. t.* ssp. *arenaria* from persisting seed banks or new colonization in cleared areas may provide invaluable information for future management efforts (USFWS, 2008).
- Initiate surveys to locate suitable habitat for out-planting sites in areas that are managed for conservation and that could support *Gilia tenuiflora* ssp. *arenaria*. For instance, outplantings to areas such as Salinas River National Wildlife Refuge could complement recovery efforts elsewhere. If

populations were to become established in such areas, they could also function as seed bank sources or reserves for other populations that are at risk of extirpation (USFWS, 2008).

- Seed collection should be initiated where populations are at risk of extirpation, including at former Fort Ord. Seeds should be stored at appropriate facilities, such as the Rancho Santa Ana Botanic Garden, for future greenhouse seed production, genetic analyses, or direct recovery plantings. In conjunction with this, genetic analyses should be initiated to determine the geographic boundaries of *Gilia tenuiflora* ssp. *arenaria* and *G. t.* ssp. *tenuiflora* and the level of interbreeding, if any, occurring in the wild populations. This should be done prior to out-plantings from questionable populations in order to maintain genetic distinctiveness and accurately assess habitat requirements for each taxon (USFWS, 2008).
- Initiate controlled burn studies on former Fort Ord to determine the recovery potential of inland populations lost to unnaturally dense shrub communities. This should be undertaken to determine the conservation value of potential reserve areas prior to the finalization of proposed HCPs (USFWS, 2008).

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SPECIES ACCOUNT: *Gilia tenuiflora ssp. hoffmannii* (Hoffmann's slender-flowered gilia)

Species Taxonomic and Listing Information

Listing Status: Endangered; 07/31/1997; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An annual herb, 6-12 cm tall. Flowers (April) are purplish and funnel-shaped, the top of the "funnel" widening to flat, pink lobes (NatureServe, 2015).

Taxonomy

A member of the phlox family (Polemoniaceae) (USFWS, 2009). In 1959, Munz included the varieties of *tenuiflora* as subspecies, including *ssp. hoffmannii*, as per a 1956 treatment by the Grants (Munz and Keck 1973). This nomenclature was used in the latest treatment of the genus (Day 1993). Of the four subspecies of *G. tenuiflora*, the subspecies *hoffmannii* is the only one that occurs in southern California (USFWS, 2000).

Historical Range

Known from three locations on Santa Rosa Island of the northern Channel Islands. A collection was made by Reid Moran from the "arroyo between Ranch and Carrington Point" in 1941 (Rutherford and Thomas 1994). In 1994, Kathy Rindlaub located a population of 88 individuals covering 2 square meters (m) (21 square feet (ft.)) that reasonably corresponded to Moran's site, and was grazed by cattle (Rindlaub 1994). The other historical location is at the type locality near East Point, where the species is still found today. It was not until 1994 surveys that Rindlaub discovered a third population that was 5 comprised of three colonies at Skunk Point on Santa Rosa Island. This population was comprised of approximately 3,000 to 3,500 individuals in 1994 and had been cropped by cattle (Rindlaub 1994) (USFWS, 2009).

Current Range

It is restricted to Santa Rosa Island off the coast of southern California. A third population was discovered in 1994 at Skunk Point (Rindlaub 1994) (USFWS, 2009).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 2009)

Lifespan

Adult: 1 year (USFWS, 2009)

Breeding Season

Adult: April - May (USFWS, 2009)

Key Resources Needed for Breeding

Adult: Winter and spring rains (USFWS, 2009); insect pollinators (USFWS, 2000)

Reproduction Narrative

Adult: This is an annual plant. Plants germinate with winter or spring rains, primarily in January or February, and flowers and produces seed by late April or early May. An individual can produce from 200 to several hundred seeds (Faulkner and Chaney 2007) (USFWS, 2009). A small bee fly (*Otiodranes* spp., Bombyliidae) was observed to be the most numerous and effective pollinator, and a soft-winged flower beetle (Melyridae) was observed as a casual visitor in a pollination study on south coast range *Gilia tenuiflora* populations (Grant and Grant 1965). It is unknown if these species or their counterparts occur on Santa Rosa Island (USFWS, 2000).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Dune scrub (NatureServe, 2015); lupine scrub (USFWS, 2000)

Habitat Narrative

Adult: Inhabits sandy soils with dune scrub vegetation. (NatureServe, 2015). *Gilia tenuiflora* ssp. *hoffmannii* thrives in open patches of habitat where bare ground ranges from about 50 to 95 percent (Faulkner and Chaney 2007). *Gilia tenuiflora* ssp. *hoffmannii* can be found growing on ancient stabilized sand dunes on the northeastern side of Santa Rosa Island where soil textures are characterized by loamy sand. The species prefers open habitat among other low herbaceous vegetation where competition for resources is low (Faulkner and Chaney 2007) (USFWS, 2009). Hoffmann's slender-flowered gilia is also a component of lupine scrub vegetation (USFWS, 2000).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Stable (USFWS, 2009)

Resiliency:

Very low (inferred from USFWS, 2009)

Redundancy:

Very low (inferred from USFWS, 2009)

Number of Populations:

2 (USFWS, 2009)

Population Size:

Variable depending on year; East Point: 20,000 - 256,000; Skunk Point: 3,000 - 3,500 (USFWS, 2009)

Population Narrative:

At the time of listing, three populations of *Gilia tenuiflora* ssp. *hoffmannii* were known on Santa Rosa Island; currently there are two known populations. *Gilia tenuiflora* ssp. *hoffmannii* populations exhibit large inter-annual fluctuations. The East Point and Skunk Point populations appear to be relatively stable since the time of listing (USFWS, 2009).

Threats and Stressors

Stressor: Grazing (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: In response to browsing, *Gilia* forms multiple side branches, and although a branched plant may produce a greater number of flowers, this does not necessarily increase the fecundity of the plant (Painter and Belsky 1993). Flowers produced later in the season out of synchrony with pollinator activity results in lower seed productivity (Painter in litt. 1997 as referenced in Service 1997). In the step-down narrative portion of the recovery plan, effective elimination of habitat damage from nonnative animals, particularly the deer and elk on Santa Rosa Island, was considered one of the most important management tasks needed for recovery of this species and other listed plant taxa (Service 2000). Some progress has been made toward eliminating nonnative animals from Santa Rosa Island since the time of listing. Although habitat conditions on Santa Rosa Island show the effects of long-term grazing, the USGS believes that at the landscape level, conditions are improving (McEachern in litt. 2007) (USFWS, 2009).

Stressor: Stochastic events (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: *Gilia tenuiflora* ssp. *hoffmannii* is threatened by the risk of stochastic extinction due to small population size and limited distribution (Service 2000). In particular, the small size of each population makes it difficult for this species to persist while sustaining the impacts of soil damage and habitat alteration from nonnative species. The species remains vulnerable to extirpation due to its small population size, high inter-annual variability in plant numbers, and limited distribution (USFWS, 2009).

Stressor: Nonnative species (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Competition from nonnative grasses currently threatens the existence of *Gilia tenuiflora* ssp. *hoffmannii* and its habitat. An invasive annual grass, false brome (*Brachypodium distachyon*), was recently discovered within *Gilia tenuiflora* ssp. *hoffmannii* habitat on East Point on Santa Rosa Island. Both false brome and *Gilia tenuiflora* ssp. *hoffmannii* prefer open patches of habitat. The invasive grass has the potential to displace *Gilia* as it fills in the open areas of habitat (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: *Gilia tenuiflora* ssp. *hoffmannii* may be particularly threatened by climate change because its geographic distribution is so narrow and its current range is unlikely to overlap regions that would be climatically favorable in the future (Levine et al. 2008). This potential threat is particularly acute for species on islands because they are unable to disperse to more favorable habitat as the environment changes. Sea level rise as a result of climate change has the potential to adversely affect *Gilia tenuiflora* ssp. *hoffmannii* and its habitat. In particular, ocean bluffs along the coast will be subject to greater and more frequent wave attack, resulting in erosion and shoreline retreat (CCC 2001). In addition, *Gilia tenuiflora* ssp. *hoffmannii* may also be threatened by climate change because of its germination cues. According to the study conducted by Levine et al. (2008), *Gilia tenuiflora* ssp. *hoffmannii* exhibited the highest germination rates in the years of the coldest germination-inducing storms (USFWS, 2009).

Recovery

Reclassification Criteria:

Establish 10 populations on Santa Rosa Island that are stable or increasing for a period of 15 years that includes the normal precipitation cycle. A precipitation cycle includes periods of drought and wet years, with annual rainfall starting at 100 to 135 percent of average, dropping below 65 percent of average, and returning to at least average (Service 2000) (USFWS, 2009).

Delisting Criteria:

1. Discover or establish five additional populations (USFWS, 2009).
2. No decline after downlisting for 10 years (USFWS, 2009).

Recovery Actions:

- Support and intensify active control programs where herbivory or habitat alteration by alien animals exists (USFWS, 2000).
- Develop and implement a plan to achieve the goals and standards of the Conservation Strategy. The Conservation Strategy is a draft strategy for conservation of island resources prepared by biologists from the National Park Service, U.S. Fish and Wildlife Service, and the U.S. Geological Survey, Biological Resources Division. This Strategy is essentially a primer or guide that provides the basis for the recovery of the species in this recovery plan and should be referred to as a supporting document (USFWS, 2000).
- Restore habitats and control competitive weeds for long-term management of the species and its habitats (USFWS, 2000).
- Conduct thorough surveys for the species (USFWS, 2000).

- Conduct research that aids in the conservation and recovery of the species (USFWS, 2000).
- Store seeds at facilities certified by the Center for Plant Conservation and develop successful seed germination and propagation techniques (USFWS, 2000).
- Develop successful outplanting techniques (USFWS, 2000).

Conservation Measures and Best Management Practices:

- The USGS and NPS should seek additional funding to continue field surveys and monitoring, demographic monitoring, population viability analyses, and further investigations into recovery projects (USFWS, 2009).
- The Service should work cooperatively with NPS and USGS to refine the generalized downlisting criteria to take into consideration new information. Attaining the recovery criteria outlined in the recovery plan is unrealistic for this species (USFWS, 2009).
- The Service should work cooperatively with NPS and USGS to refine delisting criteria to emphasize long-term population growth trends rather than short-term gains or declines in the species (USFWS, 2009).
- The USGS and NPS should investigate the community-level factors that influence population abundance, distribution, and demographic trends of the species (USFWS, 2009).

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SPECIES ACCOUNT: *Goetzea elegans* (Beautiful goetzea)

Species Taxonomic and Listing Information

Listing Status: Endangered; 4/19/1985; Southeast Region (R4) (USFWS, 2015)

Physical Description

An evergreen shrub or small tree reaching 30 feet (9 meters) in height with a stem diameter of 5 inches (13 centimeters). The leaves are simple, alternate, and elliptic, with entire margins and shiny dark green upper surfaces. The species generally flowers and sets fruit between April and August. The perfect (bisexual) funnel-shaped flowers are yellow-orange in color, and borne singly on curved stalks arising from the leaf axils. The fruit is an orange, one-seeded berry up to 1 inch (2.5 centimeters) in diameter, and is reputed to be poisonous (USFWS, 1987).

Taxonomy

Matabuey is a member of the nightshade family Solanaceae. The genus *Goetzea* comprises two species, one endemic to Hispaniola and the other endemic to Puerto Rico (USFWS, 2013).

Historical Range

Historically known from Quebradillas (type locality), the foothills of the Luquillo Mountains in Río Grande and Canóvanas, and from the Cambalache Commonwealth Forest in Arecibo (Vivaldi et al. 1981, USFWS 1987) (USFWS, 2013).

Current Range

The species is present in ten localities within the municipalities of Isabela and Quebradillas, one locality in Fajardo, and five localities in the island of Vieques (USFWS, 2013).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Primarily sexual but capable of self-fertilization (USFWS, 2013)

Dependency on Other Individuals or Species

Adult: Probably the bananaquit (USFWS, 2013)

Breeding Season

Adult: Year round, especially February and July (USFWS, 2013)

Key Resources Needed for Breeding

Adult: Shaded, moist conditions, followed by adequate sunlight for growth; bird and insect pollinators (USFWS, 2013)

Reproduction Narrative

Adult: Matabuey is a canopy species that requires an intact understory for successful recruitment of seeds and saplings. Matabuey is mainly self-incompatible (mechanism that prevents self-fertilization) and requires outcrossing (pollination required between two different flowers) for successful seeding and fruiting. Germination and establishment of matabuey were better in shaded and mesic environments, and seeds do not tolerate high light incidence and dry conditions, such as open pastures, and seed dormancy is absent (Santiago-Valentín 1995). Maturity is achieved when the plant reaches the canopy with higher light levels. Santiago-Valentín (1995) reported that trees produce flowers throughout the year, but most frequently in February and in July. Fruits were found mainly between March and August, showing a maximum number of fruits in July. Santiago-Valentín (1995) found that the bananaquit or reinita común (*Coereba flaveola*) was the most frequent bird visitor to the flowers, and the European honeybee (*Apis mellifera*) was the most frequent insect visiting matabuey. The bananaquit is the most frequent visitor with 94.7% of the flower visits (USFWS, 2013).

Habitat Type

Adult: Terrestrial (USFWS, 2013)

Habitat Vegetation or Surface Water Classification

Adult: Subtropical moist forest (USFWS, 2013); foothills, mogotes (USFWS, 1987)

Geographic or Habitat Restraints or Barriers

Adult: Occurs below 660 ft. elevation (USFWS, 1987)

Habitat Narrative

Adult: In Isabela and Quebradillas populations occur in the Subtropical Moist Forest Life Zone as described by Ewel and Whitmore (1973). The plants were growing in a semi-evergreen seasonal forest with an almost continuous upper canopy, having few emergent trees, and vines and lianas were frequent. All locations were on the Aymamón limestone formation; hence, plants were growing on limestone-derived upland soil association (Santiago-Valentín 1995) (USFWS, 2013). It has been found only below 660 ft. elevation in foothills and mogotes (USFWS, 1987).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Santiago-Valentín (1995) observed the stripe-headed tanager or reina mora (*Spindalis zena*) was the only animal he observed manipulating the fruits of matabuey, picking the fruits from the canopy, not from the forest floor. It has been observed that rats occasionally consumed immature fruits in Quebrada Bellaca in Quebradillas, especially when the tree had many fruits (M. Caraballo-Ortiz, pers. comm., 2013). In addition, there is some evidence that livestock probably predate on small trees (M. Caraballo-Ortiz pers. comm., 2013) (USFWS, 2013).

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Increasing (USFWS, 2013)

Resiliency:

Low (inferred from USFWS, 2015)

Redundancy:

Moderate (inferred from USFWS, 2015)

Number of Populations:

16 (USFWS, 2015)

Population Size:

1,700 (USFWS, 2013)

Population Narrative:

The species status is increasing; there is evidence of recruitment in the localities where the species occurs. Currently, there are 16 populations in Quebradillas, Isabela, Fajardo, and the Island of Vieques. The most recent estimate of at least 1,200 individuals in Vieques, added to the known individuals from other sites in Puerto Rico, result in about 1,700 naturally occurring matabueys in Puerto Rico (USFWS, 2013).

Threats and Stressors

Stressor: Habitat destruction and degradation (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: All known populations in mainland Puerto Rico are located in privately owned lands or rights-of-way of existing roads periodically maintained by the local government. Although these areas may have limited use, all of them are privately-owned and human activities, such as harvesting of tubers and selective cutting of matabuey for fence posts, firewood and pathways were documented. Cattle grazing farms surround the majority of the areas and sometimes cattle are present within the habitat. Cattle grazing activities may modify the habitat, affecting the possibility of successful recruitment of seedlings. The Puerto Rico Highway and Transportation Authority is proposing the expansion of the highway PR 22 from Aguadilla to Hatillo, and two of the proposed alternative routes may affect an undetermined number of matabuey in locality 9 and 10 of Figure 2. In addition, indirect effects related to commercial, residential and tourist development associated with the expansion of the highway may affect the species and its habitat. In Vieques, the species is located along creeks in the western portion of the Island and in one locality in the Monte Pirata area within the Vieques National Wildlife Refuge. The populations located along creeks are outside of the refuge. This land was transferred by the Navy to the municipality for residential and tourism development (USFWS, 2013).

Stressor: Small isolated populations (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Research has demonstrated this species is mainly self-incompatible, and that pollinator visits and fruit set and seed germination is adversely affected by low blooming intensity and high distances to nearest reproductive neighbors. Furthermore, the frequency of sterile adults is high (about 53%). Low fecundity and isolation may affect genetic diversity of the species. The currently known populations also face dispersal limitation and fragmentation. Since the majority of the currently known populations are surrounded by pasturelands, small residential areas and existing roads, the chances for these populations to be expanding are very limited (USFWS, 2013).

Recovery

Reclassification Criteria:

1. The principal population in Quebrada Bellaca (Isabela) is placed under protective status (USFWS, 2013).
2. At least three new populations capable of self-perpetuation have been established within protected units of the Commonwealth Forest System in the karst region (e.g., Cambalache or Guajataca), or on Federal land within the Caribbean National Forest, if suitable habitat exists (USFWS, 2013).

Delisting Criteria:

1. The three (3) existing populations on privately owned lands (Guajataca Gorge, Fajardo, and Vieques) are protected through a conservation mechanisms (addresses Factor A). (USFWS, 2019).
2. The three (3) existing populations in Guajataca Gorge, Fajardo, and Vieques show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factor A and E). (USFWS, 2019).
3. Establish three (3) new populations in areas protected through a conservation mechanisms within the known geographical range that demonstrate a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factors A and E). (USFWS, 2019).
4. Threat reduction and management activities have been implemented to a degree that the species will remain viable into the foreseeable future (addresses Factor A and E). (USFWS, 2019).

Recovery Actions:

- Prevent further habitat loss and population decline (USFWS, 1987).
- Continue to gather information on distribution and abundance of *Goetza elegans* in norther Puerto Rico (USFWS, 1987).
- Research (USFWS, 1987).
- Refine recovery goals (USFWS, 1987).
- New in 2019: Current propagation efforts of matabuey should be re-evaluated to ensure those efforts are consistent with the biological and ecological limiting factors of the species, and to ensure establishment of self-sustaining populations in protected areas as recommended by SantiagoValentin (1995). Trees should be planted approximately 4.5 m (15 ft) apart to obtain a high germination rate (Santiago-Valentin 1995). This recovery action

should be coordinated with the Puerto Rico Department of Natural and Environmental Resources and be included within Tasks 33 and 34: Evaluate feasibility of artificial propagation, and Select appropriate sites for population enhancement, reintroduction, or introduction using artificially propagated material, respectively, of the approved recovery plan. (USFWS, 2019).

Conservation Measures and Best Management Practices:

- The recovery plan should be revised to establish measurable reclassification criteria and develop delisting recovery criteria as more information is learned on this plant (USFWS, 2013).
- Further studies on pollination and seed dispersal are needed to determine the pollination and seed dispersal strategies in Vieques Island. We should assess if any of these dispersal mechanisms are limiting population growth and distribution expansion (USFWS, 2013).
- Isolated populations may require conservation efforts to augment number of individuals and ensuring interchange of genetic representation from other localities (USFWS, 2013).
- The Quebrada Bellaca area in Isabela should be acquired and a buffer zone established to reduce the impacts of the adjacent and upstream activities to the integrity of the system (USFWS, 2013).
- The Service needs to work with the municipality of Vieques to implement conservation measures on creeks and ravines, including the protection of watersheds by zoning. A private-lands initiative is needed to further protect the adjacent land and streams (USFWS, 2013).
- Both DNER and the Service should re-evaluate propagation efforts and introduction requirements for the species. Current efforts should be carefully evaluated to ensure that these efforts are consistent with the biological and ecological limiting factors of the species, and to ensure establishment of viable populations in protected areas. Santiago-Valentín recommended that reintroductions efforts for the recovery of the species must target the establishment of new populations on protected lands following reproductively functional spatial patterns of planting. Based on his study, trees could maintain up to 100% germination (in the case of few-flowered trees) if they are separated by 4.5 m (15 ft.) or less. Other considerations should include the presence and abundance of the bananaquit and the striped-headed tanager as the main pollinator and the seed dispersers, respectively. An interesting research project would be to determine seed shadows (an area on the ground where seeds do not fall due to canopy for example), time of gut passage, and viability of seeds (USFWS, 2013).
- Isolated populations should be enhanced with propagated material with genetic representation from other localities (USFWS, 2013).
- Efforts should continue to protect privately-owned populations (USFWS, 2013).

References

USFWS. 2015. Environmental Conservation Online System (ECOS) – Species Profile. <http://ecos.fws.gov/speciesProfile/>. Accessed April 2016.

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U.S. Fish and Wildlife Service. 1987. Beautiful *Goetzea* Recovery Plan. U.S. Fish and Wildlife Service, Atlanta, GA. 35 pp.

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USFWS. 2019. Beautiful *Goetzea* (*Goetzea elegans*) Recovery Plan, Amendment 1. USFWS, Atlanta, Georgia. 5 pp.

USFWS 2013. Matabuey (*Goetzea elegans*) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Southeast Region. Caribbean Ecological Services Field Office, Boquerón, Puerto Rico.

SPECIES ACCOUNT: *Gonocalyx concolor* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/9/2014; Southeast Region (R4) (USFWS, 2015)

Physical Description

A small evergreen shrub, mainly epiphytic (grows on the trunks of trees) or clambering (uses other vegetation as support), which may reach 15 ft. (4.7 m) in length (Acevedo 2005, p. 227) (USFWS, 2014a). The stems are highly branched, slender, cylindrical, and dark brown in color. The twigs are pubescent (covered with fine short hairs). Young leaves and branches are brilliantly rose-colored, but become green with age. Flowers are bisexual, 5-merous (floral part in multiples of 5 in each whorl), regular, and uniformly vivid red. Fruit is a bright red berry with many seeds inside (Lioger 1995, p. 105) (USFWS, 2013).

Taxonomy

Gonocalyx concolor was described in 1970, as a new species of the genus *Gonocalyx*, family Ericaceae, for Puerto Rico (Nevling 1970, p. 221). *G. concolor* is similar to *G. portoricensis*, differences in distribution and flower morphology indicate that they are well-differentiated species (Nevling 1970, p. 224) (USFWS, 2014a).

Historical Range

Gonocalyx concolor is a Puerto Rican endemic plant species that has been found growing only in the elfin and ausubo (*Manilkara bidentata*) forests within the Carite Commonwealth Forest, which lies within the municipalities of Cayey, Patillas, and San Lorenzo in east-central Puerto Rico (USFWS, 2014b).

Current Range

It currently occurs at Cerro La Santa and Charco Azul, both in the Carite Commonwealth Forest (Pacheco and Monsegur, Service, unpubl. report, 2013, p. 2) (USFWS, 2013).

Critical Habitat Designated

Yes; 9/9/2014.

Legal Description

On September 9, 2014, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Gonocalyx concolor* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in Puerto Rico (79 FR 53315-53344).

Critical Habitat Designation

The critical habitat designation for *Gonocalyx concolor* includes two CHUs in Espino Ward, between the Municipalities of Cayey and San Lorenzo, and Espino Ward, between the Municipalities of Cayey and San Lorenzo, Puerto Rico. This species critical habitat encompasses approximately 198 acres (ac) (80.1 hectares (ha)) (79 FR 53315-53344).

Unit 1: Cerro La Santa: Unit 1 consists of 18.8 ac (7.6 ha) of elfin forest located on exposed peaks and ridges of Cerro La Santa, above 2,890 ft (880 m) in elevation from sea level. This unit is

located in the Sierra de Cayey on Road PR 184, Km 27.1 in Espino Ward, between the Municipalities of Cayey and San Lorenzo. This unit is within the geographical area occupied by the species at the time of listing. This unit contains all PCEs. The PCEs in this unit may require special considerations to address threats of habitat modification resulting from maintenance and potential expansion of existing telecommunication facilities, humaninduced fires, invasive species, and degradation of forest quality.

Unit 2: Charco Azul: Unit 2 consists of 179.2 ac (72.5 ha) of ausubo forest located along the Rio Grande de Patillas River basin between 2,030 ft (620 m) and 2,330 ft (720 m) in elevation from sea level. This unit is approximately 2.0 mi (3.2 km) southeast of Unit 1. This unit is within the geographical area occupied by the species at the time of listing. This unit contains all PCEs. The PCEs in this unit may require special considerations and protection to address threats of habitat modification resulting from humaninduced fires, invasive species, and degradation of forest quality.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Gonocalyx concolor* critical habitat consists of three components (79 FR 53315-53344):

(1) Elfin forest at elevations over 2,900 ft (880 m) in Cerro La Santa, Puerto Rico, which includes:

(a) Forest with single canopy layer with trees seldom exceeding 22 ft (7 m) in height. (b) Associated native vegetation dominated by species such as *Tabebuia schumanniana*, *Tabebuia rigida*, *Ocotea spathulata*, *Eugenia borinquensis*, *Clusia minor*, and *Prestoea acuminata* var. *montana*, native ferns, and dense cover with epiphytes, including bromeliads and mosses.

(2) Ausubo forest at elevations between 2,000 to 2,300 ft (620 to 720 m) in the Charco Azul, which includes: (a) Forest with single canopy layer with trees exceeding 22 ft (7 m) in height. (b) Plant association comprised by few species of native trees and associated native vegetation (e.g., *Manilkara bidentata*, *Dacryodes excelsa*, *Guarea guidonia*, and *Cyrilla racemiflora*), native ferns, and dense cover with epiphytes, including bromeliads and mosses.

(3) The type locations described in PCEs (1) and (2), above, for this species should have mean annual precipitation of 88.7 in (225.3 cm), mean annual temperature of 72.3 °F (22.7 °C), and Los Guineos type of soil (i.e., very deep, acidic, clayey, well-drained soils on side slopes of mountains).

Special Management Considerations or Protections

The primary threats to the PBFs that *G. concolor* depends on include: (1) Habitat destruction and modification by development of telecommunication towers and associated facilities on the mountain top of Cerro La Santa; (2) vegetation management; (3) hurricanes and tropical storms; (4) landslides; (5) invasive species; and (6) humaninduced fire. The majority of these threats can be addressed by special management considerations or protection while others (e.g., hurricanes, landslides, and climate change) are beyond the control of land owners and managers.

Management activities that could ameliorate these threats include, but are not limited to, implementation of conservation measures with DNER to reduce threats to the species in the Carite Commonwealth Forest; minimization of habitat disturbance, fragmentation, and

destruction resulting from maintenance of telecommunication facilities; prevention of fires; and controlling invasive plant species.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Primarily sexual; self-pollination (USFWS, 2013)

Breeding Season

Adult: December - January, April (USFWS, 2013)

Key Resources Needed for Breeding

Adult: Possibly hummingbird pollinators (USFWS, 2013)

Reproduction Narrative

Adult: Gonocalyx concolor has been observed flowering in December, January, February, and April (Nevling 1970, p. 224). Preliminary studies of the species' reproductive biology indicate that the plant is predominantly outcrossed, and that outcrossed flowers produce twice the number of seeds than self-pollinated flowers (S. Flores, Universidad del Turabo, pers. comm. 1996). The low number of individuals per population may suggest that Gonocalyx concolor has highly specialized ecological requirements to grow and that production of viable seeds rarely occurs (C. Pacheco, Service, pers. obs., 2013). Gonocalyx concolor has vivid red, semipendent flowers, which apparently are hummingbird pollinated (USFWS, 2013).

Habitat Type

Adult: Terrestrial (USFWS 2014a)

Habitat Vegetation or Surface Water Classification

Adult: Lower montane wet forest: elfin forest, ausubo forest (USFWS, 2014a)

Dependencies on Specific Environmental Elements

Adult: mean annual precipitation of 88.7 in, mean annual temperature of 72.3 °F (USFWS, 2014b)

Habitat Narrative

Adult: It has been described as endemic from the elfin forest type at Cerro La Santa and from the ausubo (Manilkara bidentata) forest type at Charco Azul, both within the lower montane (an altitudinal zone in mountainous region characterized by distinctive flora and forest structure) very wet forest life zone in the Carite Commonwealth Forest (Ewel and Whitmore 1973, p. 41) (USFWS, 2014a). The Service identifies mean annual precipitation of 88.7 in (225.3 cm), mean annual temperature of 72.3 °F (22.7 °C), and Los Guineos type of soil (i.e., very deep, acidic, clayey, well-drained soils on side slopes of mountains) to be physical or biological features for this species. The Service identifies the remnants and late successional vegetation of elfin and ausubo forests with a single canopy layer of about 22 ft. (7 m) in height to be physical or biological features for this species (USFWS, 2014b).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Very low (inferred from USFWS, 2013)

Representation:

Low (inferred from USFWS, 2014a; see threats and stressors)

Redundancy:

Low (inferred from USFWS, 2013)

Number of Populations:

3 (USFWS, 2013)

Population Narrative:

Currently, *Gonocalyx concolor* is known from three populations. The species shows a limited distribution in its habitat, occupying only 0.75 ac (0.3 ha) at Cerro La Santa (Pacheco and Monsegur Service, unpubl. report, 2013, p. 3) and approximately 0.12 ac (0.05 ha) at Charco Azul (O. Monsegur, UPRM, unpubl. report, 2006, p.2) (USFWS, 2013).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2014a)

Exposure:

Response:

Consequence:

Narrative: George Proctor (1992, p. 3) stated that the construction of a paved road and gigantic telecommunication towers on the summit ridge of Cerro La Santa destroyed much of the natural population of this species. Currently, the telecommunication tower and its associated facilities (i.e., access roads, security fences, guy wires) occupy approximately 6.1 acres (ac) (2.5 hectares (ha)) of the elfin forest in Cerro La Santa. Although the populations at Cerro La Santa are located within a Commonwealth forest, this area is subjected to development for expansion of telecommunication infrastructure because permits to build new communication facilities or expand currently existing ones within or near Commonwealth forests are prevalent (DNER 2004a, p. 2). Expansion of the existing telecommunication facilities may result in loss of 27 individuals of *G. concolor* and their habitat. In Puerto Rico, towers for cellular communication, radio, television, and military and governmental purposes have represented a threat to those plant species that happen to occur only on mountaintops. Construction of a new access road and improvement of the existing access road to the existing communication facilities have been identified as a factor that could directly (destruction of individuals) or indirectly (slope instability and habitat

degradation) reduce the number *Gonocalyx concolor* and its habitat at Cerro La Santa (Proctor 1992, p. 3; C. Pacheco and O. Monsegur, Service, unpubl. report, 2013, p. 3). Additionally, clearing the native vegetation along the road may facilitate and accelerate colonization of invasive vegetation towards *G. concolor* habitat. Vegetation management around the existing telecommunication towers and associated facilities and along the existing power lines that energize these facilities is a threat to *Gonocalyx concolor* and its habitat (C. Pacheco and O. Monsegur, Service, unpubl. report, 2013, p. 3) (USFWS, 2014a).

Stressor: Invasive plant species (USFWS, 2014a)

Exposure:

Response:

Consequence:

Narrative: Invasive native plants, such as the ferns *Gleichenella pectinata* and *Sticherus bifidus*, may invade and alter diverse native communities, often resulting in plant monocultures that support few wildlife species (Walker et al. 2010, p. 627). These ferns can colonize disturbed areas faster than other native plants and may grow into dense mats, thereby excluding native plants (Walker et al. 2010, p. 634). Additionally, the mats formed by these species serve as fuel for fires and, in fact, seems to be fire-tolerant. The invasive, nonnative grass *Pennisetum purpureum* (elephant grass) is a fire adapted species that, in dense growth, can suppress most grasses, herbs, and tree seedlings (J. K. Francis, ITF, internet data, 2013). These invasive ferns and grass are currently found occupying areas disturbed by fire, landslides, and road construction in Cerro La Santa, and have the potential to affect *Gonocalyx concolor* by increasing fire incidences, microclimate, and nutrient cycling of the habitat on which this species depends (USFWS, 2014a).

Stressor: Fire (USFWS, 2014a)

Exposure:

Response:

Consequence:

Narrative: Human-induced fire is a current threat to *Gonocalyx concolor* at Cerro La Santa. Areas adjacent to (less than 33 ft. (10 m) from) a population of this species have been affected by such fires (O. Monsegur, UPRM, unpubl. data, 2006). Fire effects could accelerate the colonization of invasive plants and change the vegetation composition of Cerro La Santa (see discussion under Factor A, above). Currently, *Pennisetum purpureum*, a nonnative grass, is occupying these areas, making them vulnerable to human-induced fires. During the dry season (March through May), the fern *Gleichenella pectinata*, and other fern species that have colonized landslides and roadsides, form dense mats of dry material that serve as fuel for fires. Although Cerro La Santa is located in the wet forest, fires still occur in the area, particularly along roads, during the dry season (C. Pacheco, USFWS, pers. obs. 2013) (USFWS, 2014a).

Stressor: Small isolated populations (USFWS, 2014a)

Exposure:

Response:

Consequence:

Narrative: The limited distribution and low number of populations (3) and individuals (172 historically reported) of *Gonocalyx concolor* may exacerbate its vulnerability to natural events such as hurricanes and landslides, and compromise its continued existence. Damage to higher elevation forested habitat is usually greater during hurricane events (Weaver 2008, p. 150). *Gonocalyx concolor* is extremely vulnerable due to its habitat requirements and the fact that it is

usually found growing on the canopy of the tallest trees in Cerro La Santa and Charco Azul. Therefore, damage to the forest canopy may result in a direct impact to individuals of *G. concolor* that may fall to the ground and probably be outcompeted by pioneer plant species that get established during early successional stages after hurricanes. Small and isolated populations of rare plants often display reduced fitness as reduced reproductive output, seedling performance, or pollen viability (Holmes et al. 2008, p. 1031). Additionally, given the extremely limited geographic distribution of *G. concolor*, it is likely that its genetic variability is low (USFWS, 2014a).

Recovery**Reclassification Criteria:**

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- Gonocalyx concolor populations occur on public lands managed for conservation by the Puerto Rico DNER. The DNER develop a management plan for all Commonwealth Forests in 1976; however, specific measures to protect this species are not included in the plan (DNR 1976, pp. 168–181) (USFWS, 2013).

References

USFWS. 2015. Environmental Conservation Online System (ECOS) – Species Profile. <http://ecos.fws.gov/speciesProfile/>. Accessed April 2016

USFWS 2014a. Endangered and Threatened Wildlife and Plants

Endangered Species Status for *Agave eggersiana* and *Gonocalyx concolor*, and Threatened Species Status for *Varronia rupicola*. 79 Federal Register 174. September 9, 2014. Pages 53303 - 53315

USFWS 2014b. Endangered and Threatened Wildlife and Plants

Designation of Critical Habitat for *Agave eggersiana*, *Gonocalyx concolor*, and *Varronia rupicola*. 79 Federal Register 174. September 9, 2014. Pages 53315 - 53344

USFWS 2013. Endangered and Threatened Wildlife and Plants

Endangered Status for *Agave eggersiana* and *Gonocalyx concolor*, and Threatened Status for *Varronia rupicola*. 78 Federal Register 204. October 22, 2013. Pages 62560 - 62579.

U.S. Fish and Wildlife Service. 2014. Endangered and Threatened Wildlife and Plants

Designation of Critical Habitat for *Agave eggersiana*, *Gonocalyx concolor*, and *Varronia rupicola*.
Final Rule. 79 FR 53315-53344 (September 9, 2014).

USFWS. 2014a. Endangered and Threatened Wildlife and Plants

Endangered Species Status for *Agave eggersiana* and *Gonocalyx concolor*, and Threatened Species
Status for *Varronia rupicola*. 79 Federal Register 174. September 9, 2014. Pages 53303 - 53315.

SPECIES ACCOUNT: *Gouania hillebrandii* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/09/1984; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Gouania hillebrandii is a shrub up to 6 feet tall, often comprised of a single unbranched or sparingly branched stem when less than 2 feet but becoming more branched and rounded with increased height. Branches are slender and covered with a rust or ash-colored fuzz. The dark green leaves are oval, 2 to 3 inches long by 1 inch wide. The small flowers are white and the tiny seeds are brown. Small flowers have a sweet, strong fragrance. (USFWS, 1990; NatureServe, 2015). A short-lived perennial erect to sprawling shrub in the Rhamnaceae (buckthorn) family. (USFWS, 2018).

Taxonomy

Genus pantropical, species endemic to hawaiian islands. The nomenclatural history is complicated, wagner et al. Are maintaining this species name & have synonymized the following spp. W/ this one: *G. pilata*, *G. lydgatei*, *G. fauriei*, *G. mannii*. (NatureServe, 2015)

Historical Range

Gouania hillebrandii was historically known from Molokai, Lanai, and East and West Maui. (USFWS, 2011)

Current Range

Current populations from Maui and Molokai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Gouania hillebrandii* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Gouania hillebrandii* includes three CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Kahoolawe—Lowland Dry—Unit 2 consists of 3,205 ac (1,297 ha) of State land from Lua o Kealialuna to Puu o Moaulaiki and Luamakika on the eastern side of Kahoolawe. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Kahoolawe—Lowland Dry— Unit 2 is not known to be occupied by *Gouania hillebrandii*, *Hibiscus brackenridgei*, *Kanaloa kahoolawensis*, *Neraudia sericea*, *Sesbania tomentosa*, or *Vigna o-wahuensis*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs

necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Mesic—Unit 1 (and) *Palmeria dolei*—Unit 37—Lowland Mesic (and) *Pseudonestor xanthophrys*—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Ctenitis squamigera*, *Cyanea dunbariae*, *C. mannii*, *C. profuga*, *Cyperus fauriei*, *Cyrtandra filipes*, *Gouania hillebrandii*, *Labordia triflora*, *Neraudia sericea*, *Santalum haleakalae* var. *lanaiense*, *Schiedea lydgatei*, *S. sarmentosa*, *Silene alexandri*, *S. lanceolata*, *Spermolepis hawaiiensis*, and *Zanthoxylum hawaiiense*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Mesic—Unit 1 is not known to be occupied by *Asplenium dielerectum*, *Bonamia menziesii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea procera*, *C. solanacea*, *Diplazium molokaiense*, *Festuca molokaiensis*, *Flueggea neowawraea*, *Isodendrion pyrifolium*, *Kadua laxiflora*, *Melicope mucronulata*, *M. munroi*, *M. reflexa*, *Phyllostegia haliakalae*, *P. mannii*, *P. pilosa*, *Sesbania tomentosa*, *Stenogyne bifida*, or *Vigna o-wahuensis*, or the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 5 consists of 3,615 ac (1,463 ha) of State land, and 43 ac (17 ha) of privately owned land, from Panaewa to Manawainui on the western and southern slopes of west Maui. This unit is occupied by the plants *Asplenium dielerectum*, *Bidens campylothea* ssp. *pentamera*, *Cenchrus agrimonioides*, *Gouania hillebrandii*, *Kadua coriacea*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and *Tetramolopium capillare*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 5 is not known to be occupied by *Ctenitis squamigera*, *Cyanea obtusa*, *Hesperomannia arbuscula*, *Hibiscus brackenridgei*, *Lysimachia lydgatei*, *Neraudia sericea*, *Schiedea salicaria*, *Sesbania tomentosa*, or *T. remyi*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Gouania hillebrandii* critical habitat consists of

two components. Lowland dry (west Maui and Kahoolawe) and Lowland mesic (Molokai) (81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: Diospyros, Myoporum, Pleomele, Santalum. Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Sicyos.

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative

ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (NatureServe, 2015)

Reproduction Narrative

Adult: *Gouania hillebrandii* is known to sexually reproduce. (NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland, shrubland/chaparral, woodland- hardwood (NatureServe, 2015)

Environmental Specificity

Adult: Medium, with some key requirements (NatureServe, 2015)

Habitat Narrative

Adult: *Gouania hillebrandii* is found in dry to moist shrublands and forests. Ridgetops and gulch slopes. On West Maui, *Gouania hillebrandii* occurs in lowland dry shrubland habitat on leeward slopes. On Molokai, *Gouania hillebrandii* is located in *Metrosideros polymorpha* mixed mesic and lowland mesic forest habitat. (USFWS, 2011; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

6 (NatureServe, 2015)

Population Size:

2,000-3,000 (NatureServe, 2015). Currently, there are about 200 individuals in the same location on west Maui, and no known individuals remaining on Moloka'i (Bakutis 2018, in litt.; Oppenheimer 2018, in litt.). (USFWS, 2018).

Population Narrative:

Currently, it is known to be extant only on Molokai and Maui, with 6 occurrences containing fewer than 3,000 plants. In 2008, the Lihau subpopulation was estimated to contain approximately 1,000 individuals (USFWS 2010). As of 2010, total population estimates on Molokai are at least 1,000 individuals of *G. hillebrandii*. (USFWS, 2011; NatureServe, 2015)

Threats and Stressors

Stressor: Invasive plants (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species on Maui include *Opuntia* sp. (NCN), *Acacia farnesiana* (klu), *Leucaena leucocephala* (koa haole), and *Rhynchelytrum repens* (natal redtop) (Perlman 2009; USFWS 2009; Wood 2009). On Molokai, invasive introduced plant species alter and degrade the habitat of *Gouania hillebrandii* such as *Fraxinus uhdei* (tropical ash), *Ricinus communis* (castor bean), *Melinis minutiflora* (molasses grass), and *Lantana camara* (lantana) (Perlman 2009; USFWS 2009; Wood 2009). (USFWS, 2011)

Stressor: Browsing and trampling by feral animals (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Threats that modify habitat on Maui include feral goats (*Capra hircus*) which degrade the habitat. Threats on Molokai including browsing and trampling by cattle (*Bos taurus*), feral deer (*Axis axis*), and goats. (USFWS, 2011)

Stressor: Predation (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Rats (*Rattus* spp.), slugs (unidentified species), cattle, and possibly goats are reported to eat the leaves and seeds of this species (Perlman 2009; USFWS 2009; Wood 2009). The leaf-feeding introduced insect hibiscus snow scale (*Pinnaspis strachani*) is also a threat to *Gouania hillebrandii* (USFWS 2009), although the degree of threat to the species is unclear. (USFWS, 2011)

Stressor: Fire (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Fire destroyed much of the population on West Maui in 2007(Wood 2009). Fire is also a threat on Molokai (Wood 2009). (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on

impacts to this species. The Pacific Islands Climate Change Cooperative has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2011). Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai'i using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Gouania hillebrandii* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.67 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). (USFWS, 2018).

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

1. Secure the 2 presently known subpopulations, each with at least 500 reproductive plants for down-listing. (USFWS, 1990)
2. Discover or establish 3 additional subpopulations and secure these, each with 500 reproductive plants. (USFWS, 1990)

Recovery Actions:

- Secure the habitat for the 2 existing subpopulations. (USFWS, 1990)
- Identify insects and alien plants and develop control methods. (USFWS, 1990)
- Conduct necessary management activities at existing sites. (USFWS, 1990)
- Establish/discover 3 additional subpopulations. (USFWS, 1990)
- Verify/determine recovery objectives. (USFWS, 1990)
- Identified in 2011, reiterated in 2018 - 1: Population viability and monitoring—Survey known localities and suitable habitat areas on west Maui and Moloka'i to determine the current status of all populations of *Gouania hillebrandii*. (USFWS, 2019).
- 2011/2018 - 2: Ungulate monitoring and control—Construct and maintain exclusion fences to protect *G. hillebrandii* from the impacts of feral ungulates. (USFWS, 2018).
- 2011/2018 - 3: Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. (USFWS, 2018).
- 2011/2018 - 4: Fire destruction or degradation of habitat and fire mortality—Develop and implement fire prevention management plans. (USFWS, 2018).
- 2011/2018 - 5: Predator and herbivore monitoring and control—
 - o Implement effective control methods for rodents at wild and reintroduced populations.
 - o Develop and implement effective control methods for slugs.
 - o Research the effects of predation by the introduced insect, hibiscus snow scale (*Pinnaspis strachani*) on *G. hillebrandii* and determine if effective control measures are required. (USFWS, 2018).
- 2011/2018 - 6: Captive propagation for genetic storage and reintroduction—
 - o Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range.
 - o Evaluate genetic resources currently in storage to determine the need to place additional material into long-term storage due to this species' vulnerability to climate change. (USFWS, 2018).

- 2011/2018 - 7: Reintroduction and translocation—Augment current populations and reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2018).
- 2011/2018 - 8: Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use this information to determine future landscape needed for the recovery of the species. (USFWS, 2018).
- 2011/2018 - 9: Alliance and partnership development—Work with land managers to implement of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2018).

Conservation Measures and Best Management Practices:

- Monitor known populations and collect any available seed for genetic storage and reintroduction. (USFWS, 2011)
- Survey and monitor West Maui and Molokai populations for current status. (USFWS, 2011)
- Maintain or build fences around existing populations to protect them from the negative impacts of ungulates. (USFWS, 2011)
- Control invasive introduced plant species around known populations. (USFWS, 2011)
- Control rats in the vicinity of these populations. (USFWS, 2011)
- Determine the impact of hibiscus snow scale to the species and whether control is necessary. (USFWS, 2011)
- Develop and implement methods to control slugs. (USFWS, 2011)
- Propagate for augmentations of wild populations. (USFWS, 2011)
- Establish ex-situ or inter-situ populations that can be managed for genetic preservation. (USFWS, 2011)
- Coordinate fire prevention and response efforts between land managers and County fire departments. (USFWS, 2011)
- Work with Hawaii Division of Forestry and Wildlife, Hawaii State Parks, West Maui Mountains Watershed Partnership Program, and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2011)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2011)

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SPECIES ACCOUNT: *Gouania meyenii* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/29/1991; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

An erect to spreading shrub with stems 0.5-2.2 m long. Flowers are small and white. (NatureServe, 2015). A short-lived, erect to spreading shrub in the Rhamnaceae family. (USFWS, 2017).

Historical Range

Historically, *Gouania meyenii* was known from central and southern areas of the Waianae Mountains, from Kamaileunu Ridge to Honouliuli (USFWS 1995, Wagner et al. 1990).

Current Range

Gouania meyenii is found in Northern Waianae Mountains, Oahu and Kalalau Valley, Kauai. (NatureServe, 2015). As of 2017, there are no known individuals remaining on Kauai (Ching Harbin 2017, pers. comm.). (USFWS, 2017).

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Gouania meyenii* under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Gouania meyenii* (77 FR 57648-57862). The critical habitat designation includes 18 critical habitat units, which encompass approximately 8,109 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Gouania meyenii* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

On February 27, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Gouania meyenii* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in Hawaii (68 FR 9116-9479).

Critical Habitat Designation

The critical habitat designation for *Gouania meyenii* includes 18 critical habitat units, covering three ecosystem types, which encompass approximately 8,109 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Dry—Units 1, 2, 6, 8, 9, 10, 11; Oahu—Lowland Mesic—Units 1, 2, 3; Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Lowland Dry—Unit 1 [102 ac (41 ha)]; This area consists of 49 ac (20 ha) of State land and 53 ac (22 ha) of privately owned land in the Waianae Mountains, extending from Haili Gulch to Kawaipahai. Oahu—Lowland Dry—Unit 2 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the

lowland dry ecosystem in the Waianae Mountains, on Federal land within Kaena Point State Park. Oahu—Lowland Dry—Unit 6 [287 ac (116 ha)]. This area consists of 287 ac (116 ha) of State land in the lowland dry ecosystem, on the outer rim of Leahi (Diamond Head) Crater within Diamond Head State Monument. Oahu—Lowland Dry—Unit 8 [99 ac (40 ha)]. Oahu—This area consists of 96 ac (40 ha) of privately owned land and 3 ac (1 ha) of State land as part of the old railroad right-of-way in the lowland dry ecosystem, at the Kalaeloa Barber's Point Harbor area. Oahu—Lowland Dry—Unit 9 [37 ac (15 ha)]. This area consists of 17 ac (7 ha) of City and County land, 3 ac (1 ha) of privately owned land, 1 ac (0.5 ha) of State land, and 16 ac (6 ha) of Federal (Pearl Harbor NWR) land in the lowland dry ecosystem at Kalaeloa. Oahu—Lowland Dry—Unit 10 [43 ac (17 ha)]. This area consists of 43 ac (17 ha) of State land (DHHL) in the lowland dry ecosystem at Kalaeloa. Oahu—Lowland Dry—Unit 11 [166 ac (67 ha)]. This area consists of 166 ac (67 ha) of federal land (U.S. Navy) in the lowland dry ecosystem at Kalaeloa.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac (105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

The critical habitat designation for *Gouania meyenii* includes three CHUs in Kauai County, Hawaii (68 FR 9116-9479).

Kauai 11—*Gouania meyenii*—a: This unit is critical habitat for *Gouania meyenii* and is 442 ha (1,094 ac) on State land (Kuia NAR), and containing portions of Mahanaloa Valley. This unit provides habitat for one population of 300 mature, reproducing individuals of the shortlived perennial *Gouania meyenii* and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is important to the establishment of additional populations on Kauai in order to reach recovery goals. It provides habitat for the westernmost range of the species that is unique to Kauai. The habitat features contained in this unit that are essential for this species include, but are not limited to, rocky ledges, cliff faces, and ridge-tops in dry shrubland or *Metrosideros polymorpha* lowland diverse mesic forest. This unit provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Kauai 11—*Gouania meyenii*—b: This unit is critical habitat for *Gouania meyenii* and is 128 ha (316 ac) on State land (Na Pali Coast State Park) within Kalalau Valley. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial *Gouania meyenii* and is currently occupied with eight plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. It provides habitat for the westernmost range of the species that is unique to Kauai. The habitat features contained in this unit that are essential for this species include, but are not limited to, rocky ledges, cliff faces, and ridge-tops in dry shrubland or *Metrosideros polymorpha* lowland diverse mesic forest. This unit provides for two populations within this multi-island species' historical range on Kauai that are some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Kauai 11—*Gouania meyenii*—c: This unit is critical habitat for *Gouania meyenii* and is 215 ha (532 ac) on State land, and containing portions of Kawaiiki Valley. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial *Gouania meyenii* and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is important to the establishment of additional populations on Kauai in order to reach recovery goals. It provides habitat for the westernmost range of the species that is unique to Kauai. The habitat features contained in this unit that are essential for this species include, but are not limited to, rocky ledges, cliff faces, and ridge-tops in dry shrubland or *Metrosideros polymorpha* lowland diverse mesic forest. This unit provides for two populations within this multi-island species' historical range on Kauai that are some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Gouania meyenii* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Gouania meyenii* occurs within the Lowland dry, Lowland mesic and Dry cliff ecosystems in the Waianae Mountain caldera complex and was known historically (last observed > 20 yrs ago) from the Lowland dry ecosystem in the Koolau Mountain caldera complex:

Oahu—Lowland Dry—Units 1, 2, 6, 8, 9, 10, 11. (A) Elevation: <3,300 ft (<1,000 m). (B) Annual Precipitation: <50 in (<130 cm). (C) Substrate: Weathered silty loams to stony clay, rocky ledges, little weathered lava. (D) Canopy: Diospyros, Myoporum, Pleomele, Santalum, Sapindes. (E) Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. (E) Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Plumbago, Sicyos, Sida, Waltheria.

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (E) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. (E) Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Gouania meyenii* critical habitat consists of two components (68 FR 9116-9479):

(i) Rocky ledges, cliff faces, and ridge tops in dry shrubland or *Metrosideros polymorpha* lowland diverse mesic forest and containing one or more of the following native plant species: *Bidens* spp., *Carex meyenii*, *Chamaesyce* spp., *Dodonaea viscosa*, *Diospyros* spp., *Eragrostis variabilis*, *Euphorbia haeleleana*, *Hedyotis* spp., *Hibiscadelphus* spp., *Lysimachia* spp., *Melicope pallida*, *Neraudia kauaiensis*, *Nestegis sandwicensis*, *Nototrichium divaricatum*, *Panicum lineale*, *Poa mannii*, *Psychotria* spp., *Senna gaudichaudii*, or *Wilkesia gymnoxiphium*; and

(ii) Elevations between 375 and 1,179 m (1,231 and 3,867 ft).

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Gouania meyenii* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and

regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species and therefore are not included in the critical habitat designations.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (NatureServe, 2015)

Lifespan

Adult: 10 to 18 years (USFWS, 1998)

Breeding Season

Adult: March to May (USFWS, 1998)

Reproduction Narrative

Adult: *Gouania meyenii* is known to sexually reproduce. *Gouania meyenii* flowers from March to May. Seed capsules develop in about 6 to 8 weeks. Plants appear to live about 10 to 18 years in the wild (USFWS 1995). (USFWS, 1998; NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliff, forest- hardwood, forest/woodland, shrubland/chaparral, woodland- hardwood (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 17 and 1,179 meters (USFWS, 1998)

Habitat Narrative

Adult: *Gouania meyenii* typically grows on rocky ledges, cliff faces, gulch slopes, and ridge tops in dry or moist shrubland or ohia lowland mesic forest at an elevation of 580 to 820 meters (1,900 to 2,700 feet) (USFWS 1995). In Oahu, *Gouania meyenii* typically grows on moderate to steep slopes in dry or mesic shrubland and lowland forest at elevations between 17 to 930 meters (56 to 3,050 feet). On Kauai, this species typically grows on rocky ledges, cliff faces, and ridge tops in dry shrubland or in *Metrosideros polymorpha* lowland diverse mesic forest at elevations between 375 and 1,179 meters (1,231 and 3,867 feet). Associated plants include aalii, akoko, kopiko, manono, alani, olopua, kookoolau, *Carex meyenii*, lama, kolokolo kuahiwi, and *Senna gaudichaudii* (kolomona) (USFWS 1995). (USFWS, 1998; USFWS, 2010)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Resiliency:

Low (inferred from USFWS, 2010)

Redundancy:

Low (inferred from USFWS, 2010)

Number of Populations:

7 (USFWS, 2010). As of 2017: There is only one location of *Gouania meyenii* remaining (USFWS, 2017).

Population Size:

~100 (USFWS, 2010). As of 2017: 21 individuals remaining, representing 15 wild and 6 reintroduced plants. (USFWS, 2017).

Adaptability:

Unknown (NatureServe, 2015)

Additional Population-level Information:

In 2016, Keir et al. reported occurrences of this species on Oahu at two locations totaling 32 individuals. Currently, there is one wild occurrence of *Gouania meyenii* on Oahu (Makaha), totaling 15 individuals, and two nearby outplantings, one with five individuals and another with one individual (Ching Harbin 2017, pers. comm.). There are 135 seeds in storage at Lyon Arboretum and two plants at the Pahole Rare Plant Facility. Efforts to germinate a few of the stored seeds for propagation are currently underway. There are no known individuals remaining on Kauai (Ching Harbin 2017, pers. comm.). There is a 2013 record of four seeds collected from up to four individuals in 1992 at the last known population at Kalalau (NTBG 2013, 2014). Seed viability is uncertain. (USFWS, 2017).

Population Narrative:

Currently, this species is found on Oahu and Kauai in seven occurrences. There were three populations of *Gouania meyenii* on Kauai. Currently, the total number of individuals on Kauai is estimated between 18 and 23, and the overall total number of individuals between 38 and 63. On Oahu, it is found on the Makaha Waianae Kai Ridge on State, private, and City and County lands. USFWS estimated 63 individuals in these four known populations on Oahu in 2003 (USFWS 2003b). Population numbers for Oahu appear to be based on surveys that have not been repeated for as much as ten years, and may not reflect the current status of the species. The actual number of individuals on Oahu is more likely between 20 and 40 individuals. (USFWS, 2010; NatureServe, 2015)

Threats and Stressors

Stressor: Invasive plants (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The major threats to *Gouania meyenii* on Oahu are competition from invasive introduced plant species such as *Ageratina riparia* (spreading mist flower), *Blechnum appendiculatum* (NCN), *Grevillea robusta* (silk oak), *Bryophyllum pinnatum* (airplant), *Lantana camara* (lantana), *Leucaena leucocephala* (haole koa), *Lythrum maritimum* (loosestrife), *Melinis minutiflora* (molasses grass), *Oplismenus hirtellus* (basketgrass), *Pimenta dioica* (allspice), *Psidium cattleianum* (strawberry guava), *Psidium guajava* (common guava), *Rubus* sp. (blackberry), and *Schinus terebinthifolius* (Christmas berry) (National Tropical Botanical Garden 2009a; USFWS 2003b). On Kauai, threats to *Gouania meyenii* include competition from invasive introduced plant species such as *Melinis minutiflora*, *Psidium cattleianum*, and *Schinus terebinthifolius* (USFWS, 2010)

Stressor: Fire, pigs, and goats (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Other threats include fire; habitat degradation by feral pigs (*Sus scrofa*) and goats (National Tropical Botanical Garden 2009a; USFWS 2003b). (USFWS, 2010)

Stressor: Small population size (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The small number of extant populations and individuals is also a threat to *Gouania meyenii* on Kauai and Oahu (National Tropical Botanical Garden 2009a; USFWS 2003a). There is a risk of extinction from naturally occurring events and/or reduced reproductive vigor due to the small number of remaining occurrences and individuals. (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to *Gouania meyenii*. However, current climate change models do not allow us to predict specifically what those effects, and their extent, would be for this species. (USFWS, 2010)

Stressor: Drought loss or degradation of habitat (USFWS, 2017).

Exposure:

Response:

Consequence:

Narrative: Drought is reported to be a threat to the Makahapopulation of *Gouania meyenii* (PEPP 2011, 2014, 2015). Over the past 100 years, the Hawaiian Islands have experienced an annual decline in precipitation from just over 9 percent, increasing to as much as 15 percent within the last 20 years (US-NSTC 2008; Chu and Chen 2005; Diaz 2005). The increase in drought frequency and intensity leadsto a self-perpetuating cycle of increasing cover of nonnative plants, increasing

numbers of fires, and an increasing amount of erosion (D'Antonio and Vitousek 1992; Giambelluca et al. 1991; US-GCRP 2009; Warren 2011). (USFWS, 2017).

Stressor: Landslides and flooding destruction or degradation of habitat (USFWS, 2017).

Exposure:

Response:

Consequence:

Narrative: Landslides are reported to be a threat to the Makaha population of *Gouania meyenii* (Keir et al. 2016; PEPP 2010). Landslides and erosion due to ungulate disturbance and natural weathering destabilize substrates, damage and destroy individual plants, and alters hydrological patterns (Stearns 1985). (USFWS, 2017).

Stressor: Rodent predation or herbivory (USFWS, 2017).

Exposure:

Response:

Consequence:

Narrative: Herbivory by rats is noted to be a threat to *Gouania meyenii* at the Makaha population (Keir et al. 2016; PEPP 2010). Rats eat virtually every part of plants and at every stage: fleshy fruits, seeds, flowers, stems, leaves, shoot, seedlings, and roots (Russell 1980; Cuddihy and Stone 1990). The effects on plants range from reduced vigor and decreased reproduction to mortality of individuals and complete lack of recruitment. (USFWS, 2017).

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1998)

Recovery Actions:

- Enclosures should be constructed around the known populations of *Gouania meyenii* to reduce impacts from feral ungulates. Subsequent control or removal of ungulates from these areas will alleviate their impact on native ecosystems. Specific efforts should be made to immediately fence and protect populations that have only a few remaining individuals, such as within the Waianae Kai Forest Reserve on Oahu and those in the Na Pali-Kona Forest Reserve on Kauai. A commitment should be developed for long-term stewardship and conservation of these areas once they have been enclosed. (USFWS, 1998)
- Populations that have only a few remaining individuals should be immediately weeded and protected. (USFWS, 1998)
- A coordinated fire protection plan needs to be developed for endangered plant species on State forest reserves (Waianae Kai on Oahu and Na Pali-Kona on Kauai) and Federal lands. (USFWS, 1998)
- New in 2017 - 1: Surveys and inventories—Survey historical populations on Oahu and Kauai to determine current status. (USFWS, 2017).
- 2017 - 2: Ungulate monitoring and control—Maintain fences to protect populations from negative impacts of feral ungulates to prevent imminent extinction. (USFWS, 2017).
- 2017 - 3: Invasive plant monitoring and control—Remove ecosystem-altering invasive plant species from the immediate vicinity of populations. (USFWS, 2017).
- 2017 - 4: Captive propagation for genetic storage and reintroduction—
 - o Study limiting factor to viable seed production.
 - o Continue to collect material for genetic storage and propagation for reintroduction, as well as research to determine storage protocols if needed. (USFWS, 2017).
- 2017 - 5: Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2017).
- 2017 - 6: Predator and herbivore monitoring and control—Implement effective control methods for rodents. (USFWS, 2017).
- 2017 - 7: Fire monitoring and control—Develop and implement fire management plans for each population. (USFWS, 2017).
- 2017 - 8: Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from drought and landslides and storms. (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Collect material for genetic storage and propagation for reintroduction. (USFWS, 2010)
- Construct exclosures to protect populations from negative impacts of feral ungulates. (USFWS, 2010)
- Control competing invasive introduced plant species within exclosures. (USFWS, 2010)
- Develop and implement fire management plans for each population. (USFWS, 2010)
- Survey current and historical populations on Oahu to determine current species status. (USFWS, 2010)
- Work with Hawaii Division of Forestry and Wildlife and Hawaii State Parks to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2010)

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SPECIES ACCOUNT: *Gouania vitifolia* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 6/27/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

A climbing shrub with tendrils. Tiny flowers are white (NatureServe, 2015). *Gouania vitifolia* is a perennial vine in the Rhamnaceae (buckthorn family). It is a climbing shrub or woody vine with tendrils and elliptic, papery leaves that have toothed or lobed margins. The leaves are 3 to 8 cm (1.2 to 3.2 in) long, with a moderate to dense covering of short soft hairs on both surfaces. Small white flowers are arranged in axillary spikes 0.8 to 7 cm (0.3 to 2.8 in) long. The winged fruits are 9 to 10 mm (0.4 in) long and contain small, dark, glossy seeds (Wagner et al 1999) (68 FR 35950) (USFWS, 2016).

Historical Range

Gouania vitifolia is a species endemic to the Hawaiian Islands. Historic data indicate the species was known from the islands of Oahu, Maui, and Hawaii. On Oahu, *G. vitifolia* historically was known from the northwest Waianae Mountains, in the Makaleha, Keaau, and Waianae Kai valleys (59 FR 32932; 68 FR 35959). When the species was listed in 1994, the only known occurrences were two patches of about eight individuals in the Waianae Kai area of Oahu (59 FR 32932; Service 1998a) (USFWS, 2016).

Current Range

Currently, three population units for this species contain approximately 81 individuals state-wide (Table SB 18). The two population units on Oahu total approximately 79 individuals (K. Kawelo, pers. comm. 2005, 2007), and comprise 95 percent of the total state-wide numbers for this species and 98 percent of its numbers on Oahu. All population units are found on State and private lands (68 FR 35950). Since listing, trends in abundance and distribution indicate an increase in individuals at the Keaau population unit on Oahu, owing almost entirely to increased survey effort. Numbers in the Waianae Kai population unit are very low and have declined since listing. The Keaau population unit appears to have attained the numerical criterion for a stabilization unit, generally defined for perennials as 50 mature, reproducing individuals (Makua Implementation Team 2003). Plants in the Keaau population unit are located in a zone at very low risk from training-related wildfire. On the island of Hawaii, this species appears to have declined from 18 individuals in the mid-1990s to only two known individuals in 2006. Thus, *Gouania vitifolia* on Oahu comprises about 98 percent of the state-wide population and is characterized by one population unit meeting numerical criterion for stabilization and two population units at very low numbers of individuals (USFWS, 2016). Waianae Mountains, Oahu, West Maui, and Kau District, Hawaii (NatureServe, 2015).

Critical Habitat Designated

Yes; 5/14/2003.

Legal Description

On May 14, 2003 (Revised March 30, 2016), the U.S. Fish and Wildlife Service (Service) designated revised critical habitat for *Gouania vitifolia* under the Endangered Species Act of

1973, as amended (Act). The critical habitat designation includes three detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

On September 18, 2012, the U.S. Fish and Wildlife Service (Service) designated revised critical habitat for *Gouania vitifolia* on the island of Oahu, Hawaii.

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Gouania vitifolia* on the island of Hawaii (68 FR 39623 - 39722).

Critical Habitat Designation

The critical habitat designation for *Gouania vitifolia* includes three CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Wet Cliff—Unit 6 (and) *Palmeria dolei*—Unit 35—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 35—Wet Cliff This area consists of 1,858 ac (752 ha) of State land, and 253 ac (102 ha) of privately owned land, at the summit ridges of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plants *Alectryon macrococcus*, *B. conjuncta*, *Ctenitis squamigera*, *Cyrtandra munroi*, *Remya mauiensis*, and *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 6 is not known to be occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Bonamia menziesii*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyriformis*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, or *Tetramolopium capillare*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 7 (and) *Palmeria dolei*—Unit 36—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 36—Wet Cliff This area consists of 556 ac (225 ha) of State land along Honokowai ridge on the northwestern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units are occupied by the plants *Cyrtandra filipes* and *C. munroi*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 7 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyriformis*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the

reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 8 consists of 337 ac (137 ha) of State land along Kahakuloa ridge on the north side of west Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff—Unit 8 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendrion pyrifolium*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat designation for *Gouania vitifolia* includes 22 units totaling 8,497 acres on Oahu. The units are Oahu—Lowland Dry—Unit 1, 2, 8, 9, 10, 11; Oahu—Lowland Mesic—Unit 1, 2, 3; Oahu—Lowland Wet—Unit 1, 2, 3, 4, 5; Oahu—Dry Cliff—Unit 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Lowland Dry—Unit 1 consists of 49 ac (20 ha) of State land and 53 ac (22 ha) of privately owned land in the Waianae Mountains, extending from Haili Gulch to Kawaipahai. Although this unit is not known to be occupied by *Gouania vitifolia*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Dry—Unit 2 consists of 29 ac (12 ha) in the lowland dry ecosystem in the Waianae Mountains, on Federal land within Kaena Point State Park. Although this unit is not known to be occupied by *Gouania vitifolia*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Dry—Unit 8 consists of 96 ac (40 ha) of privately owned land and 3 ac (1 ha) of State land as part of the old railroad right-of-way in the lowland dry ecosystem, at the Kalaeloa Barber's Point Harbor area. Although this unit is not known to be occupied by *Gouania vitifolia*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Dry—Unit 9 consists of 17 ac (7 ha) of City and County land, 3 ac (1 ha) of privately owned land, 1 ac (0.5 ha) of State land, and 16 ac (6 ha) of Federal (Pearl Harbor NWR) land in the lowland dry ecosystem at Kalaeloa. Although this unit is not known to be occupied by *Gouania vitifolia*, the Service has

determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Dry—Unit 10 consists of 43 ac (17 ha) of State land (DHHL) in the lowland dry ecosystem at Kalaeloa. Although this unit is not known to be occupied by *Gouania vitifolia*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Dry—Unit 11 consists of 166 ac (67 ha) of federal land (U.S. Navy) in the lowland dry ecosystem at Kalaeloa. Although this unit is not known to be occupied by *Gouania vitifolia*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Mesic—Unit 1 consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Although this unit is not known to be occupied by *Gouania vitifolia*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Mesic—Unit 2 consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Although this unit is not known to be occupied by *Gouania vitifolia*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Mesic—Unit 3 consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Although this unit is not known to be occupied by *Gouania vitifolia*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Wet—Unit 1 consists of 428 ac (173 ha) of State land and 112 ac (46 ha) of City and County of Honolulu land in the lowland wet ecosystem on the windward side of the Waianae Mountains, and partially within the Mokuleia and Waianae Kai Forest Reserves. This unit is occupied by *Gouania vitifolia* and includes the wet forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland wet ecosystem. This unit also contains unoccupied habitat that is essential to the conservation of the species by providing the PCEs necessary for the expansion of the existing wild populations. Oahu—Lowland Wet—Unit 2 consists of 19 ac (8 ha) of State land in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puuhapapa. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Although this unit is not known to be occupied by *Gouania vitifolia*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Wet—Unit 3 consists of 29 ac (12 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puukanehoa. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Although this unit is not known to be occupied by *Gouania vitifolia*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Wet—Unit 4 consists of 27 ac (11 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains on State land at Puukaua. A portion of this area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Although this unit is not known to be occupied by *Gouania vitifolia*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Wet—Unit 5 consists of 74 ac (30 ha) of State land in the lowland wet ecosystem, on the windward side of the Waianae Mountains at Palikea. A portion of this area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Although this unit is not known to be occupied by *Gouania vitifolia*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 1 consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. This unit is on State land within the Pahole Natural Area Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. Although this unit is not known to be occupied by *Gouania vitifolia*, the Service has determined this area to be essential for the conservation and recovery of this species because it

provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Dry Cliff—Unit 2 consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. This unit is almost entirely within the Makua Keaau Forest Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. This unit is occupied by *Gouania vitifolia* and contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Oahu—Dry Cliff—Unit 3 consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. This unit is partially within the Waianae Kai Forest Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. Although this unit is not known to be occupied by *Gouania vitifolia*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Dry Cliff—Unit 4 consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. This unit is partially within the Waianae Kai Forest Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. Although this unit is not known to be occupied by *Gouania vitifolia*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Dry Cliff—Unit 6 consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. Although this unit is not known to be occupied by *Gouania vitifolia*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Dry Cliff—Unit 6 consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. Although this unit is not known to be occupied by *Gouania vitifolia*, the Service has determined

this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Dry Cliff—Unit 7a consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. Although this unit is not known to be occupied by *Gouania vitifolia*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Dry Cliff—Unit 7b consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. Although this unit is not known to be occupied by *Gouania vitifolia*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Dry Cliff—Unit 8 consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve. A small portion of this area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. Although this unit is not known to be occupied by *Gouania vitifolia*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

The critical habitat designation for *Gouania vitifolia* includes one unit totaling 4,412 acres in Hawaii County, Hawaii. The unit is Hawaii 18—*Gouania vitifolia*—a.

Hawaii 18—*Gouania vitifolia*—a [1,785 ha (4,412 ac)]: This unit contains no named natural features, it lies completely within the Kauna watershed, and is completely within Manuka NAR; provides habitat for 2 populations of 300 mature, reproducing individuals of *G. vitifolia*; and is currently occupied by 4 individuals. This unit is essential to the conservation of *G. vitifolia* because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. This unit provides the southeasternmost critical habitat within the species' historical range. This unit is

geographically separated from other critical habitat for this multi-island species within its historical range in order to reduce the likelihood of all recovery populations being destroyed by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Gouania vitifolia* critical habitat consists of one component. Wet cliff (west Maui)) (81 FR 17790-18110):

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. Understory: *Bryophytes*, *Ferns*, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

(i) In units Oahu—Lowland Dry—Unit 1, Oahu—Lowland Dry—Unit 2, Oahu—Lowland Dry—Unit 8, Oahu—Lowland Dry—Unit 9, Oahu—Lowland Dry—Unit 10, and Oahu—Lowland Dry—Unit 11, the physical and biological features of critical habitat are: (A) Elevation: Less than 3,300 ft (1,000 m). (B) Annual precipitation: Less than 50 in (130 cm). (C) Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. (D) Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*, *Sapindus*. (E) Subcanopy: *Chamaesyce*, *Dodonaea*, *Leptecophylla*, *Osteomeles*, *Psydrax*, *Scaevola*, *Wikstroemia*. (F) Understory: *Alyxia*, *Artemisia*, *Bidens*, *Chenopodium*, *Nephrolepis*, *Peperomia*, *Sicyos*.

(ii) In units Oahu—Lowland Mesic—Unit 1, Oahu—Lowland Mesic—Unit 2, and Oahu—Lowland Mesic—Unit 3, the physical and biological features of critical habitat are: (A) Elevation: Less than 3,300 ft (1,000 m). (B) Annual precipitation: 50 to 75 in (130 to 190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

(iii) In units Oahu—Lowland Wet—Unit 1, Oahu—Lowland Wet—Unit 2, Oahu—Lowland Wet—Unit 3, Oahu—Lowland Wet—Unit 4, and Oahu—Lowland Wet—Unit 5, the physical and biological features of critical habitat are: (A) Elevation: Less than 3,300 ft (1,000 m). (B) Annual precipitation: Greater than 75 in (190 cm). (C) Substrate: Clays; ashbeds; deep, well-drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (F) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepis*.

(iv) In units Oahu—Dry Cliff—Unit 1, Oahu—Dry Cliff—Unit 2, Oahu—Dry Cliff—Unit 3, Oahu—Dry Cliff—Unit 4, Oahu—Dry Cliff—Unit 6, Oahu—Dry Cliff—Unit 7a, Oahu—Dry Cliff—Unit 7b, and Oahu—Dry Cliff—Unit 8, the physical and biological features of critical habitat are: (A) Elevation: Unrestricted. (B) Annual precipitation: Less than 75 in (190 cm). (C) Substrate: Greater than 65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: *Antidesma*, *Chamaesyce*, *Diospyros*, *Dodonaea*. (F) Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Schiedea*.

Habitat features that are essential for this species include, but are not limited to, dry, rocky ridges and slopes in dry shrubland or dry to mesic *Nestegis*-*Metrosideros* forests on old substrate kipuka.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special

management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkiei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

All critical habitat, except in the coastal ecosystem on Oahu, requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs and goats). Feral ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required during nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat posed by fire to Oahu—Lowland Dry—Unit 1, 2, 8, 9, 10, 11; Oahu—Lowland Mesic—Unit 2, 3; Oahu—Dry Cliff—Unit 2, 3, 4, 6, 7, 8. Oahu—Lowland Wet—Unit 1, 2, 3, 4 and Oahu—Dry Cliff—Unit 1, 2, 3, 4, 6, 7 may require special management to reduce the threat of landslides, rockfalls, and flooding.

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for this species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Lifespan

Adult: < 10 years (USFWS, 2012)

Breeding Season

Adult: Flowering has been observed from March to May (68 FR 35950) and from late November to January (Service 1995a) (USFWS, 2016).

Reproduction Narrative

Adult: The main vine produces new young side shoots in winter and spring, which soon die. Flowering has been observed from March to May (68 FR 35950) and from late November to January (Service 1995a), probably in response to rainfall; seed capsules develop in about six to eight weeks. Plants appear to live about 10 to 18 years in the wild, and are likely to form large clonal viney mats. Other demographic information for *G. vitifolia* in the wild is unknown, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, pollination and seed dispersal, vegetative reproduction, and specific environmental requirements (USFWS, 2016). *Gouania vitifolia* is a short-lived perennial (< 10 years) (USFWS, 2012).

Habitat Type

Adult: Dry to dryish moist forest in gulches. (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Dry to dryish moist forest in gulches. (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Dry to dryish moist forest in gulches. (NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits dry to dryish moist forest in gulches (NatureServe, 2015). *Gouania vitifolia* on Oahu occurs on the sides of ridges and gulches in dry to mesic forests at elevations of 39 to 978 m (128 to 3,208 ft) (68 FR 35950). Plants tend to occur in patches, which may consist of clones of a single or few individuals (USFWS, 2016).

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Not available

Number of Populations:

1 - 5 (NatureServe, 2015); 2 (USFWS, 2016)

Population Size:

74 wild (USFWS, 2012)

Population Narrative:

Fragility unknown. Currently known from 5 individuals. 1 current (last observed in 1995) and 4 historical records. (NatureServe, 2015). The two population units on Oahu total approximately 79 individuals (K. Kawelo, pers. comm. 2005, 2007), and comprise 95 percent of the total state-wide numbers for this species and 98 percent of its numbers on Oahu. All population units are found on State and private lands (68 FR 35950) (USFWS, 2016). In 2010, there were a total of 62 wild mature individuals of *Gouania vitifolia* (U.S. Army Garrison 2010). As of 2012, there are 62 wild individuals on Oahu, 12 wild on Hawaii, and 1 outplanted individuals on Hawaii (USFWS, 2012).

Threats and Stressors

Stressor: Alien plants (NatureServe, 2015)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Threats to this species include alien plant species (NatureServe, 2015). The most significant aliens appear to be *Schinus terebinthifolius* (Christmas berry), *Psidium cattleianum* (strawberry guava), *Melinis minutiflora* (molasses grass), *Clidemia hirta* (Koster's curse), *Lantana camara* (lantana), *Leucaena leucocephala* (koa haole), *Rubus argutus* (prickly Florida blackberry), *Grevillea robusta* (silk oak), *Erigeron karvinskianus* (daisy fleabane), *Myrica faya* (firetree), *Paspalum conjugatum* (Hilo grass), *Casuarina equisetifolia* (common ironwood), *Passiflora suberosa* (huehue haole), *Ageratina adenophora* (Maui pamakani), *Ageratina riparia* (Hamakua pamakani), *Kalanchoe pinnata* (air plant), *Tibouchina herbacea* (a relative of Koster's curse), and *Ardisia elliptica* (shoebutton ardisia). (USFWS 1995, 1996a, 1996b) (USFWS, 1998).

Stressor: Feral pigs (NatureServe, 2015)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Threats to this species include habitat destruction by feral pigs (NatureServe, 2015). Feral pigs have been in the Koolau and Waianae Mountains for about 150 years. They are major modifiers of wet forest habitats (Stone 1985). While foraging, pigs root and trample the forest floor, encouraging the establishment of alien plants in the newly disturbed soil. Pigs also disseminate alien plant seeds through their feces and on their bodies, accelerating the spread of alien plants through native forest (Cuddihy and Stone 1990; Stone 1985) (USFWS, 1998).

Stressor: Stochastic events (NatureServe, 2015; USFWS, 2016)

Exposure:

Response:

Consequence: Extinction

Narrative: Threats to this species include stochastic extinction. (NatureServe, 2015). *Gouania vitifolia* was listed as endangered because of major, ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E. Population units also are vulnerable to extirpation from naturally occurring events and/or reduced reproductive vigor due to small population size and limited distribution (59 FR 32932; 68 FR 35950; Service 1995a; Service 1998a). The science of conservation biology has documented a general pattern of population collapse for a wide range of plant and animal species (Dennis et al 1991; Schemske et al 1994; Morris et al 1999; Menges 2000). According to this pattern, *G. vitifolia* already is in a phase of "quasi-extinction" with numbers that have declined to the point where demographic stochasticity alone can result in extirpation of one or more populations units or result in the extinction of the species in the wild. Thus, *G. vitifolia* has a very high background risk of species extinction, and protection from existing and additional threats is needed to ensure its long-term persistence (USFWS, 2015).

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate High spatial resolution climate outputs are anticipated by 2013 (USFWS, 2012).

Recovery

Reclassification Criteria:

1. For downlisting, a total of five to seven populations should be documented on Oahu and at least one other island where they now occur or occurred historically.
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1998).
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1998).

Delisting Criteria:

1. A total of 8 to 10 populations should be documented on Oahu and at least one other island where they now occur or occurred historically.
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1998).
3. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1998).

Recovery Actions:

- Protect habitat and control threats (USFWS, 1998).
- Expand existing wild populations (USFWS, 1998).
- Conduct essential research (USFWS, 1998).
- Develop and maintain monitoring plans (USFWS, 1998).
- Reestablish wild populations within historic range (USFWS, 1998).
- Validate and revise recovery criteria (USFWS, 1998).
- Construct enclosure to protect populations against feral pigs (USFWS, 1998).
- Control competing alien plant species within enclosures (USFWS, 1998).

Conservation Measures and Best Management Practices:

- Protect habitat and control threats (USFWS, 1998).
- Expand existing wild populations (USFWS, 1998).
- Conduct essential research (USFWS, 1998).
- Develop and maintain monitoring plans (USFWS, 1998).
- Reestablish wild populations within historic range (USFWS, 1998).
- Validate and revise recovery criteria (USFWS, 1998).
- Captive propagation for genetic storage and reintroduction: Continue to collect seeds from tagged individuals, keeping close track of the maternal source for use in ex situ propagation. Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation (USFWS, 2012).
- Reintroduction / translocation implementation: Continue to reintroduce the species back into its known historical range on Hawaii Island. On Oahu, initiate reintroductions of this species back into its known historical range once areas are protected from threats (USFWS, 2012).
- Ungulate exclosures: Continue to construct fenced exclosures around existing and reintroduced populations to provide protection from feral ungulates. Monitor fenced exclosures for evidence of breaching by feral ungulates (USFWS, 2012).
- Ungulate control – Continue to protect all populations against disturbances from feral ungulates (USFWS, 2012).
- Ecosystem-altering invasive plant species control – Control invasive introduced plant species around all populations (USFWS, 2012).
- Surveys / inventories – Conduct thorough surveys of all suitable habitats where *Gouania vitifolia* was historically seen (USFWS, 2012).
- Fire protection – Develop and implement a fire management plan for all populations of *Gouania vitifolia* (USFWS, 2012).

- Alliance and partnership development – Work with the U.S. Army, Hawaii Division of Forestry and Wildlife, and other land managers to continue planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2012).
- Threats research – Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2012).

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SPECIES ACCOUNT: *Grindelia fraxinipratensis* (Ash Meadows gumplant)

Species Taxonomic and Listing Information

Listing Status: Threatened; 05/20/1985; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

It is an erect biennial or more commonly a perennial herb, reaching 25 to 40 inches in height and has yellow flowers with heads measuring 0.3 to 0.4 inches in diameter (Mozingo and Williams 1980). The gumplant genus is so named because of their very sticky (gummy) flower heads (USFWS, 2007).

Taxonomy

Kartesz (1999) used the spelling 'fraxinopratensis'. According to comments in the Index to California Plant Names (part of the Jepson Interchange for California Floristics, April 2012) "fraxinipratensis" is the correct spelling. It is a member of the Asteraceae (sunflower family) (NatureServe, 2015).

Historical Range

It is endemic to the greater Ash Meadows region in Nye Co., Nevada and Inyo Co., California. (NatureServe, 2015). Cochrane (1981) believes that its distribution was continuous prior to perturbation for agriculture (USFWS, 1990).

Current Range

Most of its distribution is within the Ash Meadows National Wildlife Refuge (Refuge). One population occurs outside the Refuge boundary in the Carson Slough, primarily within the Ash Meadows Area of Critical Environmental Concern (ACEC) managed by Bureau of Land Management (BLM) in Nevada. Based on anecdotal observations and assessments of biologists, it appears Ash Meadows gumplant distribution has likely increased since the species was listed (Service 2001) (USFWS, 2008).

Critical Habitat Designated

Yes; 5/20/1985.

Legal Description

On May 20, 1985, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Grindelia fraxinipratensis* (Ash Meadows gumplant) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in California and Nevada (50 FR 20777-20794).

Critical Habitat Designation

The critical habitat designation for *Grindelia fraxinipratensis* includes two CHUs in Inyo County, California and Nye County, Nevada (50 FR 20777-20794).

Nevada, Nye County, Ash Meadows.

California, Inyo County, Ash Meadows.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Grindelia fraxinipratensis* critical habitat consists of one component (50 FR 20777-20794):

Known primary constituent elements include saltgrass meadows along streams and pools or drier areas with alkali clay soils.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (inferred from USFWS, 2008)

Lifespan

Adult: 2+ years (NatureServe, 2015)

Breeding Season

Adult: Summer - fall (USFWS, 1990)

Reproduction Narrative

Adult: It is a biennial or more commonly a perennial plant (NatureServe, 2015). In a good year, each plant may produce several hundred seeds (Lane 1993) (USFWS, 2008). It flowers during the summer and autumn (USFWS, 1990).

Habitat Type

Adult: Terrestrial, riparian, wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Saltgrass meadows (NatureServe, 2015); ash-screwbean mesquite woodlands, desert shadscale scrub, clay barrens (USFWS, 2008)

Environmental Specificity

Adult: Very narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Inhabits saltgrass meadows along streams and pools; occasionally occurs in alkali clay soils in drier areas. Dependent on moisture available from streams (NatureServe, 2015). Ash Meadows gumplant is found primarily in the vicinity of ash-screwbean mesquite woodlands and desert shadscale scrub vegetation. It occasionally occurs sparsely in drier shadscale habitats or in the unique clay barrens. Over 30 percent of the Refuge has been mapped as wet meadow and is dependent on flows from several dozen springs and seeps (Otis Bay 2006). These springs and seeps are fed by an extensive groundwater system (USFWS, 2008). Extant populations are scattered throughout the area at sites that have not been disturbed or have been allowed to restabilized from disturbance for extended periods (USFWS, 1990).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Dispersal of the small seed is most likely accomplished by strong winds because they could be blown for some distance. Those seeds which fall within close proximity of the parent plant could be further transported by water during the winter rainy season or during summer flash floods. Mammals and birds may also be responsible for dispersal of seeds (Cochrane 1981) (USFWS, 2008).

Population Information and Trends**Population Trends:**

Unknown (USFWS, 2008)

Resiliency:

Low (inferred from USFWS, 2008)

Redundancy:

Low (inferred from USFWS, 2008)

Number of Populations:

~7 (USFWS, 2008)

Population Size:

Unknown (USFWS, 2008)

Population Narrative:

The Ash Meadows gumplant is concentrated in three main populations and several smaller ones over an area of approximately 2,260 acres (BLM and Service 2000). There is little quantitative population or demographic data to describe trends for the Ash Meadows gumplant. The 2000 Environmental Assessment to withdraw lands from mineral entry estimated the entire Ash Meadows gumplant population to contain 81,000 plants within 2,260 acres (BLM and Service 2000). This number, based on visual estimates, is a serious underestimate of the total number of plants because a 2002 survey of the California population, which used transects to develop a population estimate, estimated $241,514 \pm 69,660$ plants within 88 acres (Soil Ecology and Restoration Group 2004) (USFWS, 2008).

Threats and Stressors

Stressor: Groundwater pumping (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Groundwater availability is a regional phenomenon; thus groundwater pumping in the vicinity would impact the entire Ash Meadows ecosystem, including habitat that supports the Ash Meadows gumplant. Groundwater rights in Nevada are regulated by the State Engineer. In theory, the water rights owned by the Refuge are protected. However, in recent hearings, the

National Park Service testified the number of water rights issued by the State of Nevada for the Amargosa Valley has grossly exceeded sustainable withdrawal levels and the resource is over-allocated (Baldino 2006a). It is important that current groundwater monitoring continues to ensure regional extractions do not affect the species (USFWS, 2008).

Stressor: Nonnative species (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: As in the case of noxious agricultural weeds present on the Refuge, many invasive species have adaptations that allow them to outcompete native vegetation and colonize previously undisturbed habitat. The wet meadows that support Ash Meadows gumplant provide an especially favorable environment for invasive species that would not otherwise be able to survive in the desert. On the Refuge, there are an estimated 4,460 acres of former agricultural fields previously used for crop production and livestock grazing (Service, 2006). These fields, situated adjacent to two of the largest Ash Meadows gumplant populations, are now largely monocultures of Russian knapweed, bassia and Malta star thistle. In many parts of the Refuge, these non-native species are expanding beyond the fields into surrounding Ash Meadows gumplant habitat (Service 2006). Fire facilitated by non-native species is a new threat to Ash Meadows gumplant not identified in the original listing. Non-native species are known to alter fire regimes and are a threat to biodiversity (Brooks et al. 2004). In some areas of the Refuge, non-native salt cedar trees (*Tamarix* sp.) and red brome grass (*Bromus madritensis*) increase the ease with which fire spreads through riparian corridors and along the spring channels that comprise Ash Meadows gumplant habitat. In the past two years, three major fires (the Meadows Fire, Longstreet Fire, and Ash Fire) have burned 144 acres (roughly 6%) of Ash Meadows gumplant habitat. Following the Meadows Fire, Russian knapweed populations exploded to create monocultures that now likely prevent regrowth and colonization of native vegetation, including the Ash Meadows gumplant (Baldino 2006a). Ash Meadows gumplant habitat is extremely vulnerable to being altered by non-native species. If left untreated the consequences would likely be decreases in the population of Ash Meadows gumplant, both due to competitive exclusion, and additional population reductions resulting from increased fire frequencies (USFWS, 2008).

Stressor: Surface mining (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Active mineral claims within Ash Meadows could cause direct loss of habitat, as well as indirect impacts to the species by diverting or draining water away from habitat during mining activities. There are 29 active mining claims on BLM lands in and near the Refuge and critical habitat for the species (BLM 2007). Approximately 45 percent of the occupied Ash Meadows gumplant habitat within the Refuge boundary is on BLM and Service lands with a high mineral potential and are open to public minerals (BLM and Service 2000) (USFWS, 2008).

Stressor: Off-highway vehicles (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Illegal OHV activity has recently become a problem again on the Refuge, possibly due to a fence in need of repair (Baldino 2006b). Repairs to the fence and monitoring of OHV activity will be an ongoing necessity at the Refuge (USFWS, 2008).

Stressor: Stochastic events (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Small populations have an inherent risk of extinction due to stochastic and natural catastrophic events. Fire and flooding are natural catastrophic events that occur within Ash Meadows gumplant range. Given the species' distribution on the Refuge, fire is the catastrophic event most likely to affect the Ash Meadows gumplant. Although possible, it is unlikely that any one fire could affect a major portion of the Ash Meadow gumplant distribution throughout its entire range. However, increased fuel loads from non-native species can lead to more frequent fires in the Mojave Desert (Brooks and Pyke 2001) (USFWS, 2008).

Recovery

Reclassification Criteria:

Not available

Delisting Criteria:

1. Secure, protect, and maintain the species in natural vegetation corridors and adjacent buffer areas for gene flow and dispersal of the species within essential habitat (USFWS, 2008).
2. Native plant communities and aquatic communities have been reestablished to historic structure and composition within all essential habitat (USFWS, 2008).
3. The species is present in all the sites that it has historically occupied (USFWS, 2008).
4. The listed plant has a frequency value equal to or greater than the frequency value determined by comparison with unaltered reference sites as an indicator of a self-sustaining plant populations (USFWS, 2008).

Recovery Actions:

- Secure habitat and water sources for the Ash Meadows ecosystem (USFWS, 1990).
- Conduct research on the biology of the species (USFWS, 1990).
- Conduct management activities within essential habitat (USFWS, 1990).
- Reestablish populations/monitor new & existing populations (USFWS, 1990).
- Determine/verify recovery objectives (USFWS, 1990).

Conservation Measures and Best Management Practices:

- The population monitoring described in the Recovery Plan should be carried out (USFWS, 2008).
- The Refuge is implementing many restoration projects that could benefit the Ash Meadows gumplant. To document recovery of the Ash Meadows gumplant, these projects should include pre- and post-site sampling to verify and quantify that restoration actions are benefiting the species (USFWS, 2008).

- Non-native weeds are a major threat to the Ash Meadows gumplant, and the IPM Plan is an important step towards addressing this problem. Long-term funding should be secured for non-native species control on the Refuge (USFWS, 2008).
- Interactions between fire and non-native weeds within Ash Meadows gumplant habitat and effects on the Ash Meadows gumplant need to be studied (USFWS, 2008).
- Surface mining remains a threat to the Ash Meadows gumplant. Service and BLM lands with a high mineral potential must be withdrawn from future mineral entry. In addition, existing mining claims should be acquired when possible. Unless these mineral rights are purchased or transferred to the Service, a program needs to be put in place to renew existing mineral withdrawals every 20 years (USFWS, 2008).

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SPECIES ACCOUNT: *Hackelia venusta* (Showy stickseed)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/08/2002; Pacific Region (Region 1)

Physical Description

Hackelia venusta is a moderately stout perennial plant, 20-40 cm (8-16 inches) tall, with numerous flowering stems arising from a slender taproot. Large showy flowers are white or white washed with blue, with five lobes topping the end of a short corolla tube. Flowering occurs in April or May. Leaves are basal and numerous on the flowering stem. The fruit consists of four prickly nutlets which drop near the plant but the spurred fruit can be dispersed by clinging to the hair of passing animals (USFWS 2007). (NatureServe, 2015)

Taxonomy

This species was first described within the genus *Lappula* (annual plants) but later transferred to the genus *Hackelia* (perennial plants). Carr (1974) undertook a taxonomic study of the genus in western North America and recognized *Hackelia venusta* as a morphologically uniform, distinct species that exhibited little variability. A further taxonomic review (Harrod et al 1999) indicated that certain high elevation populations previously assigned to *H. venusta* were a distinct undescribed species, *Hackelia taylori* (Harrod et al. in review). Harrod and his colleagues (1999) further outline that no affinities exist between the low and high elevation taxon, nor with nearby populations of *H. diffusa* var. *arida*. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

This species is known from one location only in Chelan County, Washington. (USFWS, 2011)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (outcrossing) (USFWS, 2007)

Lifespan

Adult: >10 years (USFWS, 2007)

Dependency on Other Individuals or Species

Adult: Insect pollinators (USFWS, 2007)

Breeding Season

Adult: April to June (USFWS, 2007)

Reproduction Narrative

Adult: *Hackelia venusta* is perennial, and individual plants can live for at least 10 years. Flowers begin to open in late April, and new flowers are continuously added to each inflorescence until late June. By mid-June, the lowest flowers have nearly mature fruits. Dispersal begins with the lowest flowers and continues for several weeks into early July (Gamon 1997). It is possible that *H. venusta* could be pollinated by moths; however, this is unlikely because the relatively long tongues of moths are an apparent mismatch with the short corolla tube length of *H. venusta*. If the species is insect pollinated, bee and fly species appear to be the most likely candidates, as they have shorter tongues that better match the corolla tube length of *H. venusta*. In the past, *H. venusta* has been assumed to be an obligate outcrosser (Harrod 1999). Three pollinators were verified on the *H. venusta* plants: two bees, *Andrena nigroaerulea* and *Protosmia rubifloris*, and one fly, *Eulonchus* sp. This work has indicated *H. venusta* is primarily outcrossing, with the possibility of geitonogamous selfing (pollination by other flowers on the same plant); autogamous selfing (pollination within a single flower) is possible since the stigma and anthers do appear to be in close proximity with one another at anthesis, but is unlikely to be a major contributor because most of a flower's pollen is produced before its stigma is receptive (J. Taylor, pers. comm. 2005, 2007). (USFWS, 2007)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Bare rock/talus/scree, cliff, forest- conifer, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 472 meters (1,550 feet) to 823 meters (2,700 feet); prefers open, sparsely vegetated areas (shade intolerant) (USFWS, 2007)

Spatial Arrangements of the Population

Adult: Scattered (USFWS, 2007)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Habitat Narrative

Adult: *Hackelia venusta* is shade-intolerant (R. Carr, pers. comm. 1998) and grows in openings within *Pinus ponderosa* (ponderosa pine) and *Pseudotsuga menziesii* (Douglas-fir) forest types. This vegetation type is described as the Douglas-fir zone by Franklin and Dyrness (1973). Common associates include *Penstemon subseratus* (finetooth beardtongue), *Phacelia hastata* (silverleaf phacelia), *Lomatium triternatum* (nineleaf biscuitroot), *Lupinus wyethii* (Wyeth's lupine), *Eriogonum compositum* (arrowleaf buckwheat), *Eriogonum umbellatum* var. *hypoleium* (sulphur-flower buckwheat), *Hieracium cynoglossoides* (houndstongue hawkweed), and *Pseudoroegneria spicata* (bluebunch wheatgrass). *Hackelia venusta* is found on open, steep slopes (minimum 80 percent inclination) of loose, well-drained, granitic weathered and broken rock fragmented soils, and on ledges and cracks on granitic cliff faces, at elevations between 472 meters (1,550 feet) to 823 meters (2,700 feet). Aspect ranges from 192 degrees (south-southwest [SSW]) to 310 degrees (west-northwest [WNW]), with most plants at an aspect of 265

degrees (west [W]). Plants are found on concave, convex, or flat slopes. The primary subpopulation is on an area of slope between drainages, but a number of the smaller subpopulations occur along the steep south-facing sides of dry drainages or on vertical cliff faces. *Hackelia venusta* appears to be somewhat adapted to natural and possibly human-caused substrate disturbance (R. Carr, pers. comm. 1998), and occurs within the right of way along both sides of Highway 2. Although potential habitat for this species exists elsewhere in Tumwater Canyon, and occasionally single plants are seen elsewhere along Highway 2, no other populations have yet been found. Wildfires play a role in maintaining open, sparsely vegetated sites as suitable habitat for *Hackelia venusta*, a requirement of this shade-intolerant plant (R. Carr, pers. comm. 1998, in litt. 2000). The range of *Hackelia venusta* has been reduced to a small single population occurring in a scattered distribution across roughly 16 hectares (40 acres) in Tumwater Canyon. (USFWS, 2007)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Most nutlets seem to fall directly to the ground around the parent plant, but the topography is so steep and unstable that many nutlets are carried downslope. Small concave areas near parent plants often have seedlings (L. Malmquist, pers. comm. 2003). The prickly nutlets are also well adapted for dispersal by adhesion to the coats of passing animals (Gamon 1997). (USFWS, 2007)

Population Information and Trends

Population Trends:

Short-term trends suggest declines of 10-30% (NatureServe, 2015)

Number of Populations:

1 (USFWS, 2011)

Population Size:

~700 (USFWS, 2011)

Population Narrative:

Short-term trends suggest declines of 10-30%. The original discovery site at Tumwater Canyon is the only location for the species (USFWS 2002, Guerrant 2010). In 2004, the entire population was censused, including the core and outlying plants, for a total of 572-772 individuals, or, an estimate of approximately 700 individuals for the total population. The careful counts of the core population (a subpopulation of what was censused in 2004) completed in 2009 and 2010 give an average of around 200. (NatureServe, 2015; USFWS, 2011)

Threats and Stressors

Stressor: Plant succession (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: The primary loss of habitat for *Hackelia venusta* has resulted from changes in habitat due to plant succession in the absence of fire. Fire suppression has been a factor in reducing the extent of the Tumwater Canyon population (Gamon 1988a, b; D. Werntz, in litt. 2000), and most likely the few hundred acres of occupied habitat recorded in 1968 (Gentry and Carr 1976) represented a population that had already been reduced in both numbers and range due to fire suppression activities that had been ongoing for many years. Historically, fuels in the forest type where *H. venusta* is found were rarely at high levels because of the frequent fires that consumed forest floor fuels and pruned residual trees (Agee 1993). In the past, fires suppressed the encroachment of woody vegetation and maintained open areas presumably more conducive to *H. venusta* reproduction and growth. As described above, wildfires play a role in maintaining open, sparsely vegetated sites as suitable habitat for this shade-intolerant species (R. Carr, pers. comm. 1998; D. Werntz, in litt. 2000). (USFWS, 2007)

Stressor: Non-native plants (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Two nonnative, Washington State-listed noxious weeds (Washington Administrative Code Chapter 16-750 and Revised Code of Washington Chapter 17-10) occur within the habitat of *Hackelia venusta* in Tumwater Canyon. *Linaria dalmatica* (dalmatian toadflax) and *Centaurea diffusa* (diffuse knapweed) are present along the roadside, and the former also occurs above the main portion of the population (F. Caplow, pers. obs. 2004). During visits to the *H. venusta* population in 1995 through 1998, U.S. Fish and Wildlife Service staff noted that the cover and distribution of the noxious weeds had increased over this time period (T. Thomas, pers. obs. 1998). Both of these noxious weeds outcompete many native plant species through uptake of water and nutrients, interference with photosynthesis and respiration of associated species, and production of compounds that may directly affect seed germination and seedling growth and development. Without intervention, these species have the ability to outcompete *H. venusta* and replace native vegetation, and eventually dominate the site (J. Wentworth, King County Noxious Weed Control Board, in litt. 2001). (USFWS, 2007)

Stressor: Highway maintenance (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Highway maintenance activities are an ongoing threat to the population of *Hackelia venusta*. The highway is sanded during winter months, and de-icers are also occasionally applied, affecting the immediate roadside habitat where *H. venusta* is found. Since 1998, the Washington Department of Transportation has been using de-icers on the roadway during winter months. The de-icer used by the Department is called CalBan, a formulation of calcium chloride, which is a salt. Solutions of the salts accumulate in the soil and are retained on soil particles. The decline of *H. venusta* along the roadcut and right of way corresponds to an increase in noxious weeds and the Washington Department of Transportation's use of de-icers starting in 1998. De-icers may be associated with the decline of individual plants in the right-of-way and it is now considered a threat to the species. A study of the effect of de-icers used by the Washington Department of Transportation on surrogate species found deleterious effects on survival and biomass at concentrations above 1:100 (Chalker-Scott and Brickey 2004), although the authors do not believe concentrations this high occur at the *H. venusta* site. The Washington

Department of Transportation is aware of the potential threat to *H. venusta*, and has been actively cooperating with the U.S. Fish and Wildlife Service, U.S. Forest Service, and the Washington Department of Natural Resources to plan and manage their maintenance activities so as to minimize impacts on the rare plant species of Tumwater Canyon (Washington Department of Transportation [WDOT] 2000; see Section G, Conservation Measures, for further details). (USFWS, 2007)

Stressor: Herbicides (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Although the roadsides have not been sprayed with herbicides in recent years by the Washington Department of Transportation, spraying did occur for a considerable period of time prior to 1980. The residual effect of herbicide spraying on *Hackelia venusta* is unknown. Some herbicides are known to reside in the soil for long periods of time, affecting the plants that persist there. In 1999 and 2000, the application of herbicides by U.S. Forest Service personnel was used as a method for reducing the amount and distribution of nonnative, noxious weeds (L. Malmquist, pers. comm. 2003). Although they were used with great caution by U.S. Forest Service staff with knowledge of *H. venusta*'s presence, the threat from herbicide drift and residue remains. (USFWS, 2007)

Stressor: Erosion and landslides (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Small surface erosion events and large landslides on the unstable slope where the *Hackelia venusta* population is located are a continuing threat to the species. The steepness of the slope exceeds 100 percent (45 degree) inclination in many places, and the slope's instability constitutes a significant threat as a major landslide could bury most of the population (Gamon 1997). The last time a large landslide occurred, in 1992, the road was closed for emergency repairs by the Washington Department of Transportation. The repairs undercut the slope and at least 50 *H. venusta* plants were destroyed (R. Harrod, pers. comm. 2001). The population census numbers continued to decrease for several years after the landslide. (USFWS, 2007)

Stressor: Burying, trampling, or dislodging of plants by soil releases (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: The threat of soil being dislodged and the burying, trampling, or dislodging of plants below these soil releases has been witnessed as more people visit the habitat to photograph or collect *Hackelia venusta* (S. Ballinger, Biologist in litt. 2000; P. Camp, Bureau of Land Management, in litt. 2000; F. Caplow, in litt. 2000; J. Frazee, U.S. Forest Service, in litt. 2000; K. Robson, Cowlitz and Wahkiakum Conservation Districts, in litt. 2001). The potential for slumping (deep-seated mass movement) at the site has increased since 1994, when wildfires burned through the forest in Tumwater Canyon where the species is located. The increased potential for landslides occurs when water uptake by trees and other vegetation that were killed by the 1994 fire is reduced, along with transpiration, so there is more soil water, which increases instability. This is a case where the response to fire may have negative consequences. Another contributing

factor is that when tree roots decompose, their ability to bind soil particles and water is decreased. When this happens, the potential for landslides increases. A large landslide in the location of the Tumwater Canyon population of *H. venusta* would severely degrade the habitat and reduce the plant population. (USFWS, 2007)

Stressor: Automobile emissions (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Although there are no data regarding the effects of automobile emissions on *Hackelia venusta* specifically, such emissions should be considered a potential threat, given the proximity of the road to the population. The highway is heavily used, with between 3,900 to 5,200 automobiles traveling daily through Tumwater Canyon, which is very narrow (WDOT 1996). Automobile emissions are likely to increase along this heavily traveled corridor. These emissions, containing ozone and sulphur and nitrate oxides, are known to negatively affect photosynthesis of coniferous and herbaceous plants (Bega 1979), and may increase nitrogen in the soil, thereby increasing the cover and vigor of competing vegetation. (USFWS, 2007)

Stressor: Collection pressure

Exposure:

Response:

Consequence:

Narrative: There is a long history of collection pressure on *Hackelia venusta*. (R. Carr, in litt. 2000; L. Malmquist, in litt. 2000; J. Brickey, University of Washington, in litt. 2001; R. Crawford, Washington Department of Natural Resources, in litt. 2001; E. Guerrant, in litt. 2001; K. Robson, in litt. 2001). *H. venusta* is very showy and has been collected by scientists, amateur wildflower enthusiasts, and other visitors to the population for more than 30 years. The availability of highway turnouts, and a general increase in knowledge and interest in the species are likely to have increased collecting pressure. Collecting activities may have reduced the number of plants in the population and have also degraded the habitat (Gamon 1997; R. Carr, in litt. 2000; R. Crawford, in litt. 2000, 2001; R. Harrod, in litt. 2000; G. Hoffman, U.S. Forest Service, in litt. 2000; F. Caplow, in litt. 2001). (USFWS, 2007)

Stressor: Human activities (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: An associated and serious threat is physical disturbance to the habitat and the individual plants from people trampling the slope to collect or see plants, photograph the plants, and monitor the population. Physical disturbance to the substrate increases instability, may damage the root systems of adult plants, and may also cause higher mortality of germinants (F. Caplow, pers. obs. 2003). (USFWS, 2007)

Stressor: Biocontrol agent (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: However, there is a potential threat from a new biocontrol agent. *Mogulones cruciger* is a weevil that attacks the nonnative hound's-tongue, *Cynoglossum officinale* (gypsyflower), which is also in the borage family. *Cynoglossum officinale* is known from Chelan County. The biocontrol agent has not been formally released in the United States, but has been released in Canada. (USFWS, 2007)

Stressor: Predation by weevils (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: A laboratory-based study, using tissue-culture clones of *H. venusta*, found that *M. cruciger* was able to develop and feed to a limited extent on *H. venusta*. However, in both laboratory and field experiments *M. cruciger* demonstrated a strong preference for *Cynoglossum* (J. Andreas, University of Idaho, in litt. 2004). The investigator concluded that *M. cruciger* could pose some risks to native species of Boraginaceae and recommended that the weevil not be released in the United States. However, the weevil may spread from Canada and has been identified in the Okanagan Region of British Columbia (S. Reichard, pers. comm. 2003). (USFWS, 2007)

Stressor: Low seed production (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Low seed production is a factor in the decline of *Hackelia venusta*. At the Tumwater Canyon site, an estimated high proportion (60 to 70 percent) of *H. venusta* seeds did not develop in 1984 (Barrett et al. 1985). Fruit development was poor on many plants; only a few individuals exhibited mature fruit development. Low fruit production has been observed in other years as well (L. Malmquist, pers. comm. 2002). This low or variable reproductive potential may be a major factor in the small number of plants at the type locality. The age structure of the extant population at Tumwater Canyon, poor seed production and germination of new seedlings, and historical estimates of population size indicate that the population has been in decline (Barrett et al. 1985; Gamon 1997), although recent monitoring of the population shows that the population has increased during the period from 1995 to 2004. The increase in population size can likely be attributed to the improved habitat conditions brought on by restoration activities and the effects of a wildfire that burned through Tumwater Canyon in 1994. (USFWS, 2007)

Stressor: Small population size (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: The small size of the only known population of *Hackelia venusta* is a major problem for recovery. Seedling establishment is most critical, and trampling may significantly affect the germination of seedlings (R. Carr, pers. comm. 1998, in litt. 2000; K. Robson, in litt. 2001). The small number of individuals (roughly 600 plants) remaining in the sole population located in Tumwater Canyon makes *H. venusta* vulnerable to extinction due to random events such as slope failure (mass wasting or surface erosion) or drought. A single random environmental event could extirpate a substantial portion or all of the remaining individuals of this species, leading to extinction. Also, changes in gene frequencies within small, isolated populations can lead to a loss

of genetic variability and a reduced likelihood of long-term viability (Franklin 1980; Soulé 1980; Lande and Barrowclough 1987; R. Carr, in litt. 2000). (USFWS, 2007)

Recovery

Reclassification Criteria:

Hackelia venusta may be considered for downlisting to threatened status when all of the following conditions have been met to address the threats to the species: (USFWS, 2019)

1. Listing/Recovery Factor A: The present or threatened destruction, modification, or curtailment of its habitat or range. In order to ensure the long-term recovery needs of *Hackelia venusta*, threats to the species habitat must be reduced or removed. This will have been accomplished if the following have occurred: (a) Tree and shrub cover in all populations is maintained at a level equal to or more open than that present in 2007 in the original population, through manual removal or controlled burns. (b) Noxious weed populations are not present within any populations or close enough to them to pose a significant threat of invasion, or are annually removed. (c) Herbicide and de-icer use continues to be minimized within all populations or close enough to them that individuals may be affected. (d) All population sites have been evaluated for mass wasting potential and plans have been developed and implemented to minimize the effects of landslides on *H. venusta*. (USFWS, 2019)

2. Listing/Recovery Factor B: Overutilization for commercial, scientific, or educational purposes. *Hackelia venusta* is vulnerable to overcollecting of seeds or plants, and to habitat damage through substrate disturbance. In order to ensure the long-term recovery of *H. venusta*, threats to the species through collecting and visitation must be reduced or removed. This will have been accomplished if the following have occurred: (a) Seed collection guidelines are established. (b) A guideline of not sharing specific site information with the public or the press has been accepted by the U.S. Forest Service. * The quantitative measure of tree and shrub cover must be determined (Recovery Action 1.7.1). (c) The pullout across the highway from the population has been modified or removed to discourage the public from stopping their vehicles and crossing the highway. (d) The U.S. Forest Service has an entry log in place and all permitted entries into the population are logged. (e) All research within the population is approved by the U.S. Fish and Wildlife Service and the U.S. Forest Service after review by the recovery team. (USFWS, 2019)

3. Listing/Recovery Factor C: Disease or predation. The viability of *Hackelia venusta* could be compromised by the presence of the borage-specific biocontrol weevil, *Mogulones cruciger*. In order to ensure the long-term recovery needs of *H. venusta*, threats to the species through predation by the biocontrol agent must be reduced or removed. This will have been accomplished if the following have occurred: (a) A monitoring program is in place to inspect *H. venusta* and identified populations of *Cynoglossum officinale* (gypsyflower) in Chelan County on an annual basis for the presence of the biocontrol weevil, *Mogulones cruciger*. (b) A written plan is in place for actions to undertake if the weevil is found and determined to have negative effects on *H. venusta*. (USFWS, 2019)

4. Listing/Recovery Factor D: Inadequacy of existing regulatory mechanisms. In order to ensure the long-term recovery needs of *Hackelia venusta*, regulatory mechanisms need to be strengthened. This will have been accomplished if the following have occurred: (a) Habitat

management plans have been developed and implemented by the U.S. Forest Service. Management plans will include provisions, as appropriate, for habitat maintenance and restoration, noxious weed control, fire management, recreational activities, monitoring, and research. (b) A revised management plan has been developed and implemented by the Washington Department of Transportation. The management plan will include provisions, as appropriate, for habitat maintenance and restoration, noxious weed control, and highway maintenance activities. (c) All *H. venusta* populations on public lands are within management areas where maintenance of the species is a primary management goal. (USFWS, 2019)

5. Listing/Recovery Factor E: Other natural or manmade factors affecting its continued existence. The long-term recovery needs of *Hackelia venusta* require more populations that are stable and self-sustaining. The genetic resources of the species must also be adequately protected through seed storage, in case of catastrophic events in Tumwater Canyon. This will have been accomplished if the following have occurred: (a). At least three stable, self-sustaining populations are present within Tumwater Canyon on protected sites (owned or managed by a government agency or private conservation organization that identifies maintenance of *H. venusta* as the primary management objective for the site), separated by at least 2 kilometers (1.2 miles) or by the Wenatchee River. These populations could be the result of identification through further inventory, or through reintroduction or augmentation. If a new population is discovered outside of Tumwater Canyon, it may contribute to meeting this criterion. To be deemed stable and self-sustaining, a population must maintain a 5-year average of at least 1,000 adult plants, must show evidence of positive or neutral population growth over the same 5-year period, and must show evidence of natural reproduction and establishment. b. Genetic material, in the form of seeds adequately representing the geographic distribution and genetic diversity within the species, is stored in at least one facility approved by the Center for Plant Conservation. (USFWS, 2019)

6. Monitoring. In order to ensure the efficacy of recovery actions and allow for adaptive management, as necessary, population and habitat monitoring will have been established for all populations of the taxon at appropriate intervals. Habitat monitoring should include census, monitoring of *Hackelia venusta*, and of shrub and tree cover and nonnative species. Monitoring must be planned and conducted to minimize the potential negative impacts on the species and its habitat. Written agreements to continue monitoring after downlisting must be in place. (USFWS, 2019)

Delisting Criteria:

Delisting of *Hackelia venusta* may be considered when all of the following conditions, in addition to the downlisting criteria set in the Recovery Plan (USFWS 2007), have been met to address threats to the species: (USFWS, 2019)

Criterion A/1: The primary threats are removed or adequately managed in all five populations counted toward recovery in delisting criteria (see also Criterion E/1). (USFWS, 2019)

Criterion B/1: Threats to the species through visitation should be removed. (USFWS, 2019)

Criterion E/1: There are at least five stable, self-sustaining populations typically separated by 1.5 miles or by a geographical barrier such as the Wenatchee River on protected sites where protection of the species is a priority. (USFWS, 2019)

Criterion E/2: To be deemed stable and self-sustaining, a population should maintain a 20- year running average of at least 2,000 adult plants, show evidence of positive or neutral population growth over the same 20-year period, and be sustained through natural regeneration. (USFWS, 2019)

Recovery Actions:

- Maintain the current geographic distribution of the species through maintaining habitat integrity. There is only 1 known native population of *Hackelia venusta*, of about 572 to 772 plants, covering approximately 16 hectares (40 acres). Because there are threats from the presence of the nearby State highway, continuing and increasing coordination between the U.S. Forest Service and the Washington Department of Transportation will be necessary. Planning for the future maintenance of this habitat is essential to facilitate the timely implementation of recovery actions. (USFWS, 2007)
- Continue surveys in Tumwater Canyon and other appropriate areas; identify potential habitat for reintroductions. Although considerable inventory work has been undertaken for this species, the discovery in the last few years of previously unknown sites, and the highly convoluted terrain of the Wenatchee Mountains, suggests that other populations may yet be discovered. (USFWS, 2007)
- Establish if necessary, new populations of *H. venusta* within the estimated historical range of the species. Further field inventory may reveal previously unknown populations which meet the criteria for recovery. If so, reintroduction efforts will not be necessary. However, if no other large populations are found through further inventory work, reintroduction may be necessary to ensure the viability of the taxon into the foreseeable future. A carefully prepared reintroduction plan and propagation and reintroduction research will be necessary before reintroduction is undertaken. Reintroduction may only take place in the Tumwater Canyon watershed, which is the only watershed known to have supported populations of the species, based on historical collections. Based on habitat surveys to date, there appear to be few locations suitable for reintroduction having all habitat attributes necessary to support *H. venusta*. (USFWS, 2007)
- Collect seed adequately representing the genetic diversity within the species and store in a Center for Plant Conservation approved facility. The single known population, small number of individuals, and extremely restricted distribution of *Hackelia venusta* make this species highly vulnerable to random environmental and human-caused events. As a hedge against the loss of significant genetic material, seed representing the diversity within the taxon should be collected and stored in at least one Center for Plant Conservation approved facility. The stored seed could also be used in efforts to establish new populations. Periodic testing will be necessary to estimate the rate of viability loss of stored seed. This will help estimate the correct interval and adequate quantity of seed to recollect for storage. (USFWS, 2007)
- Establish a technical working group to periodically review the status of the species and assess the effectiveness of management plans and other recovery actions. Annual review of all progress toward recovery and all ongoing research and monitoring is critical for successful implementation of this plan and for modifications to the plan that may be needed in future. (USFWS, 2007)

- Determine the suitability for establishing appropriate delisting criteria (Priority 3). As more information becomes available over time, the conditions necessary for delisting *Hackelia venusta* should become apparent. (USFWS, 2007)
- Recommendation for Future Actions from 2011 5-Year Review: Continue efforts for establishing additional populations of *H. venusta*. This work will require refining propagation and reintroduction methods, and continuing to search for potential sites for outplanting the species. This includes continuing to collect and store genetically representative samples of seeds and determining optimal germination requirements. (USFWS, 2011)
- Recommendation for Future Actions from 2011 5-Year Review: Dr. Darlene Zabowski, Soil Science Professor at the University of Washington, has proposed a study of soil requirements for *H. venusta*. This study may help to clarify the substrate requirements of this species. As researchers have shown with other species, the success or failure of small outplantings in different sites may also provide a useful indicator of habitat requirements for the species (Dunwiddie 2010, Lawrence and Kaye 2009), Taylor 2008, WNHP 2007). (USFWS, 2011)
- Recommendation for Future Actions from 2011 5-Year Review: As the next step in monitoring, it would be useful to establish a yearly record of temperature, rainfall, and soil moisture. Together with annual pollinator censuses and assessments of the general condition of plants, it might then be possible to find patterns of pollinator abundance or scarcity, and relate them to seed set on *H. venusta* in the context of environmental conditions. (USFWS, 2011)
- Recommendation for Future Actions from 2011 5-Year Review: Continue the examination of life history: reproductive/pollination biology, seed production, germination requirements, seedling establishment, life span. (USFWS, 2011)
- Recommendation for Future Actions from 2011 5-Year Review: Investigate the natural history of *H. venusta* - What was its potential historic range? Could the white-flowered population have been at higher elevations at one time? (USFWS, 2011)
- Recommendation for Future Actions from 2011 5-Year Review: Continue to study the effects road de-icer formulas have on *H. venusta*. (USFWS, 2011)
- Recommendation for Future Actions from 2011 5-Year Review: Resolve the taxonomy of *H. venusta* and *H. "taylori"* and provide an appropriate name for these high elevation plant populations of conservation concern. (USFWS, 2011)
- Recommendation for Future Actions from 2011 5-Year Review: Continue work to improve the existing population and reduce the threats to the species sufficient to accomplish increases in population size and geographic distribution across its presumed historical range so that the species is no longer in danger of extinction. (USFWS, 2011)
- Recommendation for Future Actions from 2011 5-Year Review: Continue investigations for potential suitable habitat for *H. venusta* to find potential reintroduction sites, with emphasis on studying sites that have been found to be promising such as Icicle Canyon, and other sites within a two miles radius of the extant site. (USFWS, 2011)

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SPECIES ACCOUNT: *Haplostachys haplostachya* (Honohono)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/29/1979; Pacific Region (R1) (USFWS, 2016)

Physical Description

Haplostachys haplostachya is in the Lamiaceae, or mint family. It is an erect short-lived subshrub and grows to 3 to 6 decimeters (12 to 24 inches) tall. The leaves are fleshy, narrowly cordate and the upper surface is green, rugose, and densely puberulent. Leaf lower surfaces are densely white tomentose. The inflorescence is a raceme with white and tubular flowers. Reproduction is by seed and basal sprouts. The taxon is distinguished by its densely white tomentose stems (U.S. Army 2003a).

Historical Range

Haplostachys haplostachya was once present on the islands of Kauai (mountains), Maui (sands of the low isthmus and at Kaula), and Hawaii (slopes of Mauna Kea, Nohonaohae cinder cone, and the plains of Waimea).

Current Range

Currently, the species is only known from 458 occurrences totaling approximately 13,956 individuals on the island of Hawaii (U.S. Army 2003a). All these occurrences are located within the action area (see Figure 38 in the Transformation Biological Assessment).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: The species is present on the Keamuku parcel as vegetative plants, juveniles and mature plants, and in fruit and flower in July. Pollination vectors, longevity, seed viability, and dispersal mechanisms are unknown (U.S. Army 2003a).

Habitat Type

Adult: Lava/lava outcrops

Habitat Narrative

Adult: *Haplostachys haplostachya* grows in dry exposed areas on ash-veneered lava, very stony, shallow soils, and lava outcrops. It often establishes in large cracks on rocky ridges and on cinder cones (puu). *Haplostachys* was noted in 1880 as a component of the upper forest zone along with stunted vegetation, and in 1942 the taxon was described as being in the open forest and scrub zone. In 1990, the species was described as part of the *Dodonaea montane* shrubland habitat. On Hawaii, *H. haplostachya* is found in *Chamaesyce* Treeland, Open *Metrosideros* Treeland with dense shrub understory, open *Dodonaea* Shrubland, *Dodonaea* Mixed Shrubland, *Myoporum* Shrubland, and *Myoporum-Dodonaea* Shrubland vegetation types. The taxon occurs

almost exclusively on old Mauna Kea flows, with one population on Mauna Loa pahoehoe lava (U.S. Army 2003a). *Haplostachys haplostachya* may be sensitive to drought. Plants can survive low and moderate intensity fires (i.e., the plants appear to be fire resistant). The success of the species following fire is due to its ability to resprout and its frequent location on rocky slopes. Fire in rocky areas tends to occur at low intensities because of low fuel load. However, fire coupled with drought appears to affect the species' ability to maintain population numbers. Life history information is limited.

Dispersal/Migration***Population Information and Trends*****Resiliency:**

Fragility unknown. (NatureServe, 2015)

Representation:

Fragility unknown. (NatureServe, 2015)

Redundancy:

Fragility unknown. (NatureServe, 2015)

Number of Populations:

458

Population Size:

approximately 13,956

Adaptability:

Fragility unknown. (NatureServe, 2015)

Population Narrative:

Currently, the species is only known from 458 occurrences totaling approximately 13,956 individuals on the island of Hawaii (U.S. Army 2003a). All these occurrences are located within the action area (see Figure 38 in the Transformation Biological Assessment).

Threats and Stressors**Stressor:****Exposure:****Response:****Consequence:**

Narrative: The primary threats to *Haplostachys haplostachya* are feral sheep and goats that browse on the flowers; rooting by feral pigs; competition for light, space, and nutrients by *Pennisetum setaceum* and other non-native plants; and invasion by and conversion of habitat to a fire-based vegetation community. Army training such as mounted and dismounted off-road maneuvers, bivouac, and live-fire training, increase the risk of fire, habitat fragmentation and alien plant seed spread. Off-road and on-road driving and training increases the level of dust (that can compromise plant health and vigor) due to the fine soils in northern Pohakuloa Training

Area (PTA). Aphids and the introduction of mildew have been noted on the plants in the Keamuku parcel and on plants in greenhouse conditions. In addition, due to the very limited distribution of this species, a single natural or human-caused environmental disturbance could be catastrophic (U.S. Army 2003a).

Recovery

Conservation Measures and Best Management Practices:

- The following conservation actions are needed: fenced exclosures around all known occurrences of *Haplostachys haplostachya* to reduce impacts from feral ungulates; control and/or eradication of non-native plants, particularly *Pennisetum setaceum*; control of aphids and other non-native invertebrates and mildew in areas where these organisms threaten *H. haplostachya*; research on habitat requirements, population characteristics, viable population sizes and structure, and reproductive biology; and, establishment of additional viable occurrences within the historic range of the species (Service 1993). In addition, a State-wide management plan that identifies areas and landscapes for the long-term conservation of all known occurrences of *H. haplostachya* is needed. As part of this management plan, landowners and managers should delineate management units to conserve this species and other native species through threat control and habitat restoration. Propagation and maintenance of genetic stock ex situ, and surveys to identify individuals and/or occurrences that may exist in former habitats should be included in the management plan for this species.

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NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

SPECIES ACCOUNT: *Harrisia (=Cereus) aboriginum (=gracilis)* (Aboriginal Prickly-apple)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/25/2013; Southeast Region (R4) (USFWS, 2015)

Physical Description

Harrisia aboriginum is a sprawling cactus, usually with multiple stems arising from a single base. The stems are erect, slender, and cylindrical. They possess 9 to 11 longitudinal ribs, and may reach 6 m (20 ft) in height. Spines are 1.0 cm (0.4 in) long and originate in clusters of 7 to 9 spines, with up to 20 spines in a cluster at the base of the stem. Flowers are funnel-shaped, white, up to 18 cm (7.1 in) long; have a slight scent; and are nocturnal, lasting only one night. The bracts on the outside of the flower has sparse white hairs. Fruits are yellow, round in shape, and 6.1 to 7.6 cm (2.4 to 3.0 in) in diameter. (USFWS, 2013)

Taxonomy

Harrisia aboriginum (Family: Cactaceae) was described by John Kunkel Small, after he discovered it in Manatee County in 1919. The most recent revision of the genus *Harrisia* supports *H. aboriginum* as a morphologically and genetically distinct species endemic to the west coast of Florida (USFWS, 2013).

Historical Range

Harrisia aboriginum was known historically from coastal areas of southwest Florida along the Gulf coast in Manatee, Charlotte, Sarasota, and Lee Counties. The species was documented on six keys along approximately 125 km (78 mi) of Gulf of Mexico coastline (USFWS, 2013).

Current Range

Currently occurs along the Gulf Coast of Florida, in Sarasota, Lee, and Charlotte Counties (NatureServe, 2015).

Critical Habitat Designated

Yes; 2/22/2016.

Legal Description

On January 22, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective February 22, 2016) for *Harrisia aboriginum* (Aboriginal Prickly-apple) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 11 critical habitat units (CHUs), in Florida (81 FR 3866-3925).

Critical Habitat Designation

The critical habitat designation for *Harrisia aboriginum* includes eleven CHUs in Manatee, Charlotte, Sarasota, and Lee Counties, Florida. This species' critical habitat encompasses approximately 3,444 acres (ac) (1,394 hectares (ha)). Nine of these units (approximately 44 percent of the area) were occupied by the species at the time of listing; the remaining two units (approximately 56 percent of the area) were unoccupied. The critical habitat includes lands under Federal (11 percent), State (48 percent), county (15 percent), and private or other (26

percent) ownership. General descriptions are presented below. Maps depicting the CH units are available in the Final Rule (81 FR 3866-3925).

Unit APA1: Terra Ceia, Manatee County, Florida: Unit APA1 consists of approximately 222 ac (90 ha) in Manatee County, Florida. This unit is composed of State lands within Madira Bickel Mound State Historical Park, Terra Ceia Preserve State Park, Cockroach Bay State Buffer Preserve, and the Tampa Bay Estuarine System (66 ac (27 ha)); Manatee County lands at Emerson Point Preserve and parcels owned by the Manatee County Port Authority (70 ac (28 ha)); and parcels in private or other ownership (87 ac (35 ha)). This unit includes lands west of Highway 41 extending from just south of South Dock Street south to Snead Island. The unit also includes areas of Harbor Key, Mariposa Key, Horseshoe Key, Joe Island, Skeet Key, Paradise Island, Ed's Key, and Rattlesnake Key.

Unit APA2: Longboat Key, Sarasota County, Florida: Unit APA2 consists of approximately 54 ac (22 ha) in Sarasota County, Florida. This unit is composed entirely of parcels in private or other ownership. This unit includes lands west of Gulf of Mexico Drive, extending from 0.40 mi (0.6 km) south of the intersection of Bay Isles Parkway and Gulf of Mexico Drive, to the southern tip of Longboat Key. It also includes lands on the north side of Gulf of Mexico Drive, east of Longboat Club Key Drive, on the northwest tip of Longboat Key.

Unit APA3: Osprey, Sarasota County, Florida: Unit APA3 consists of approximately 116 ac (47 ha) in Sarasota County, Florida. This unit is composed of Sarasota County lands within Palmer Point County Park (50 ac (20 ha)) and parcels in private or other ownership (66 ac (27 ha)). This unit extends along the barrier island (Casey Key) from the south terminus of Blind Pass Road, south for approximately 1.2 mi (1.9 km) along North Casey Key Road. On the mainland, the unit includes lands bordered on the north by Vamo Way, to the east by Highway 41, and to the south by Palmetto Avenue.

Unit APA4: Manasota Key, Sarasota and Charlotte Counties, Florida: Unit APA4 consists of approximately 415 ac (168 ha) in Sarasota and Charlotte Counties, Florida. This unit is composed of State lands within Stump Pass Beach State Park (58 ac (23 ha)); County lands within Blind Pass Park, Brohard Beach and Paw Park, Manasota Beach Park, Casperson Beach Park, and Service Club Park (111 ac (45 ha)); and parcels in private or other ownership (245 ac (99 ha)). This unit extends from Beach Road in the City of Venice, south along Manasota Key to the barrier islands southern tip, including a portion of Peterson Island.

Unit APA5: Charlotte Harbor, Charlotte County, Florida: Unit APA5 consists of 51 ac (21 ha) in Charlotte County, Florida. This unit is composed entirely of State lands within the Charlotte Harbor Preserve State Park. This unit includes the Big Mound, Boggess Ridge, and a shell mound located on the east side of Charlotte Harbor, south of the City of Charlotte Park.

Unit APA6: Gasparilla North, Charlotte and Lee Counties, Florida: Unit APA6 consists of approximately 98 ac (40 ha) in Charlotte and Lee Counties, Florida. This unit is composed of State land (0.006 ac (0.02 ha)), county land (22 ac (9 ha)), and parcels in private or other ownership (77 ac (31 ha)). This unit includes most of Kitchen Key (Live Oak Key) and the area east of Gasparilla Road, from the intersection of Grouper Hole Road and Grouper Hole Court, south to 0.15 mi (0.24 km) north of Snail Island Court, from approximately 0.10 mi (0.21 km) south of 35th Street

to 23rd Street, including the small island separated from Gasparilla Island by a canal; and from 22nd Street to 20th Street.

Unit APA7: Gasparilla South, Lee County, Florida: Unit APA7 consists of approximately 92 ac (37 ha) in Lee County, Florida. This unit is composed of Federal land owned by the Service and Bureau of Land Management (3 ac (1 ha)), State lands within Gasparilla Island State Park (69 ac (28 ha)), Lee County lands (12 ac (5 ha)), and parcels in private or other ownership (8 ac (3 ha)). This unit includes lands located from south of 1st Street to the southern tip of Gasparilla Island.

Unit APA8: Cayo Pelau, Charlotte and Lee Counties, Florida: Unit APA8 consists of approximately 25 ac (10 ha) in Charlotte and Lee Counties, Florida. This unit is composed of Lee County lands within Cayo Pelau Preserve, and parcels in private or other ownership (0.6 ac (0.2 ha)). This unit includes lands located from 0.13 mi (0.21 km) south of the northern tip of Cayo Pelau, extending south to the southeastern tip of Cayo Pelau.

Unit APA9: Cayo Costa, Lee County, Florida: Unit APA9 consists of approximately 1,702 ac (689 ha) in Lee County, Florida. This unit is composed of State lands within Cayo Costa State Park (1,379 ac (558 ha)), lands owned by Lee County (94 ac (38 ha)), and parcels in private or other ownership (230 ac (93 ha)). This unit includes lands located from the northern tip to the southern tip of Cayo Costa.

Unit APA10: Bocilla, Lee County, Florida: Unit APA10 consists of approximately 33 ac (13 ha) in Lee County, Florida. This unit is composed of Lee County lands within the Bocilla Preserve (32 ac (13 ha)) and parcels in private or other ownership (0.7 ac (0.3 ha)). This unit includes lands located on the undeveloped portion of Bokeelia Island from 0.02 mi (0.03 km) west of the terminus of Ebttide Way, extending south and west to the northwestern and southeastern corners of Bokeelia Island.

Unit APA11: Sanibel Island and Buck Key, Lee County, Florida: Unit APA11 consists of approximately 635 ac (257 ha) in Lee County, Florida. This unit is composed of Federal lands owned by the Bureau of Land Management, and Service lands within the J.N. 'Ding' Darling National Wildlife Refuge (NWR) (373 ac (151 ha)), State lands (47 ac (19 ha)), lands owned by Lee County (90 ac (36 ha)), and parcels in private or other ownership (126 ac (51 ha)). This unit includes lands on Buck Key, Runyan Key, and Sanibel Island. On Sanibel Island, the unit includes a portion of Bowman's Beach, from just south of Silver Key to the western terminus of Water's Edge Lane; uplands within J.N. 'Ding' Darling NWR; and a shell mound located near the northern terminus of Tarpon Bay Road.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Harrisia aboriginum* critical habitat consists of the following components (81 FR 3866-3925):

(i) Areas of upland habitats consisting of coastal berm, rockland hammocks, and buttonwood forest. (A) Coastal berm habitat that contains: (1) Open to semi-open canopy, subcanopy, and understory; and (2) Substrate of coarse, calcareous, and storm-deposited sediment. (B) Rockland hammock habitat that contains: (1) Canopy gaps and edges with an open to semi-open canopy, subcanopy, and understory; and (2) Substrate with a thin layer of highly organic soil covering

limestone or organic matter that accumulates on top of the limestone. (C) Buttonwood forest habitat that contains: (1) Open to semi-open canopy and understory; and (2) Substrate with calcareous marl muds, calcareous sands, or limestone rock.

(ii) A plant community of predominately native vegetation with no invasive, nonnative animal or plant species or such species in quantities low enough to have minimal effect on survival of *Consolea corallicola*.

(iii) A disturbance regime, due to the effects of strong winds or saltwater inundation from storm surge or infrequent tidal inundation, that creates canopy openings in coastal berm, rockland hammocks, and buttonwood forest.

(iv) Habitats that are connected and of sufficient size to sustain viable populations in coastal berm, rockland hammocks, and buttonwood forest.

(v) Habitats that provide populations of the generalist pollinators that visit the flowers of *Consolea corallicola*.

Special Management Considerations or Protections

Management considerations or protection are necessary throughout the critical habitat units to avoid further degradation or destruction of the habitat that provides those features essential to the species' conservation. The primary threats to the physical or biological features that *Harrisia aboriginum* depends on include: (1) Habitat destruction and modification by development and sea level rise; (2) Competition with nonnative, invasive plant species; (3) Herbivorous nonnative animal species; (4) Wildfire; and (5) Hurricanes and storm surge. Some of these threats can be addressed by special management considerations or protection while others (e.g., sea level rise, hurricanes, storm surge) are beyond the control of landowners and managers. However, even when landowners or land managers may not be able to control all the threats, they may be able to address the results of the threats. Management activities that could ameliorate these threats include the monitoring and minimization of impacts from recreational activities, nonnative species control, and protection from development. Precautions are needed to avoid the inadvertent trampling of *Harrisia aboriginum* in the course of management activities and public use. Development of recreational facilities or programs should avoid impacting these habitats directly or indirectly. Ditching should be avoided because it alters the hydrology and species composition of these habitats. Sites that have shown increasing encroachment of woody species over time may require efforts to maintain the open nature of the habitat, which favors these species. Nonnative species control programs are needed to reduce competition, predation, and prevent habitat degradation. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All critical habitat units require active management to address the ongoing threats above and those presented in the Summary of Factors Affecting the Species sections in the proposed and final listing rules. The Service, State of Florida, and Manatee, Sarasota, Charlotte, and Lee Counties own and manage conservation lands within the historical range of *Harrisia aboriginum*. The CCP for J.N. 'Ding' Darling National Wildlife Refuge (JDDNWR) promotes the enhancement of wildlife populations by maintaining and enhancing a diversity and abundance of habitats for native plants and animals, especially imperiled species. This CCP provides specifically for maintaining populations of *H. aboriginum*. The State Management Plans for Charlotte Harbor Preserve, Cayo Costa, Stump Pass Beach, DelnorWiggins Pass, and Gasparilla Island State Parks

and Bocilla Preserve promote the protection of habitats and native species. The Service, State of Florida, and Manatee, Sarasota, Charlotte, and Lee Counties conduct nonnative species control efforts on sites that support, or have suitable habitat for, *H. aboriginum*. The Service monitors the population of *H. aboriginum* at JDDNWR. FDEP monitors the *H. aboriginum* population at Charlotte Harbor Preserve State Park. Nonnative species control is currently lacking at Manasota Beach Park and Kitchen Key in areas that support *H. aboriginum*. Poaching, vandalism, and wildfire have been observed at Manasota Beach Park. Most populations are at elevations close to sea level and may require assisted migration as sea level rise continues to drive the transition toward salt-tolerant plant species in these areas. Reintroduction is needed to restore the species' historical distribution on Cayo Costa and Madira Bickell Mound State Historical Park. Augmentation of small populations at Longboat Key, Terra Ceia, Lemon Bay Preserve, Kitchen Key, Gasparilla Island, and Cayo Pelau would reduce the risk of population loss to hurricanes, storm surge, or wildfire. *Harrisia aboriginum* is listed on the Regulated Plant Index as endangered under chapter 5B–40, Florida Administrative Code. Florida Statutes 581.185 sections (3)(a) and (b) prohibit any person from willfully destroying or harvesting any species listed as endangered or threatened on the Regulated Plant Index, or growing such a plant on the private land of another, or on any public land, without first obtaining the written permission of the landowner and a permit from the Florida Department of Plant Industry.

Life History**Food/Nutrient Resources****Breeding Season**

Adult: May - September (USFWS, 2013)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 2016)

Reproduction Narrative

Adult: Insect visitors recorded on other species of *Harrisia* include hawk moths (Nitidulidae), stingless bees (Meliponidae), and several types of beetles. Flowers are produced May through September. Ripe fruits have been observed from June through October (USFWS, 2013). Generalist pollinators (e.g., bees, butterflies, and beetles) pollinate *H. aboriginum* (USFWS, 2016).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Coastal hammocks, shell middens (NatureServe, 2015); tropical savanna: berm, grassland (USFWS, 2013)

Dependencies on Specific Environmental Elements

Adult: High sunlight exposure, disturbance regime (USFWS, 2016)

Geographic or Habitat Restraints or Barriers

Adult: Dense canopy cover, elevations significantly above sea level (USFWS, 2016)

Spatial Arrangements of the Population

Adult: Linear (inferred from NatureServe, 2015)

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Habitat Narrative

Adult: Open coastal hammocks and shell middens at low elevations. This species has a narrow environmental specificity (NatureServe, 2015). The climate of south Florida where *Harrisia aboriginum* occurs is classified as tropical savanna. *Harrisia aboriginum* occurs in coastal berm, coastal strand, coastal grassland, and maritime hammock. It also occurs on shell mounds with a calcareous shell substrate (Bradley et al. 2004, pp. 4, 14) (USFWS, 2013). *Harrisia aboriginum* requires adequate rainfall and does not tolerate freezing temperatures. Substrates supporting *Harrisia aboriginum* include sand and calcareous shell material (Bradley et al. 2004, pp. 4, 14). *Harrisia aboriginum* requires upland habitats that occur above the daily tidal range, but are potentially subject to flooding by seawater during extreme tides and storm surge. *H. aboriginum* will not tolerate hydric or saline soils. The species occurs in habitats that have a vegetation composition and structure that allows for adequate sunlight. Disturbance regimes, including hurricanes, and infrequent inundation events that maintain the habitat suitability for *H. aboriginum* (USFWS, 2016).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Studies on the pollination biology of *Harrisia aboriginum* are unknown. Insect visitors recorded on other species of *Harrisia* include hawk moths (Nitidulidae), stingless bees (Meliponidae), and several types of beetles. *Harrisia* fruits are sweet and fleshy, suggesting that seed dispersal by birds may be important. (USFWS, 2013)

Population Information and Trends**Population Trends:**

Decline of <30% to increase of 25% (NatureServe, 2015)

Species Trends:

Relatively stable (NatureServe, 2015)

Number of Populations:

12 (USFWS, 2013)

Population Size:

300 - 500 (USFWS, 2015)

Adaptability:

Low (inferred from USFWS, 2013)

Population Narrative:

The long-term population trend is a decline of <30% to an increase of 25%. Recently the species appears to be relatively stable (NatureServe, 2015). In total, the species was represented by an estimated 300 to 500 individuals in 2007, when population sizes were last estimated. The current range of *Harrisia aboriginum* spans a small geographic area (100-km (62-mi) stretch of coastline north to south). Of 12 extant populations, all but 2 have fewer than 100 plants (USFWS, 2013).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Destruction and modification of habitat from development throughout the species' range continue to be a threat to *Harrisia aboriginum*. The coastal habitats of this species have been heavily impacted by development over the past 50 years. Despite the recent downturn in residential construction, coastal development is ongoing in the habitat of *H. aboriginum*. Populations on private land or non-conservation public land are most vulnerable to habitat loss. Threats include residential development, road widening, and landscape maintenance. Suitable habitat within the species' range was recently destroyed by encroachment from a private development onto State land (FNAI 2011, pp. 207–208). The threats of habitat loss, modification, and degradation are expected to increase with increased human population, development pressure, and infrastructure needs. Sarasota, Charlotte, and Lee Counties, where this plant currently occurs, are expected to build out before 2060, placing further pressure on remaining natural areas. Populations located on public lands are better protected than those on private land, but still may face the threat of habitat loss through development of park facilities such as new buildings, parking lots, and trails (USFWS, 2013).

Stressor: Poaching (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Overutilization (collection by hobbyists, also known as poaching) is a major threat to *Harrisia aboriginum*. The rarity of *H. aboriginum*, coupled with its showy flowers, makes this cacti particularly desirable to collectors. Evidence of poaching was recently observed at a site in Sarasota County that has high public visitation (USFWS, 2013).

Stressor: Disease and predation (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: An as yet unidentified pathogen can attack *Harrisia aboriginum* and cause stems to rot and die within about a week. However, no signs of this disease were observed at several sites visited in 2011. Herbivory of flowers by iguanas (*Iguana* sp.) and stems by gopher tortoises (*Gopherus polyphemus*) has been noted. Scale insects have been observed in some *H. aboriginum* populations, occasionally causing severe damage to plants. Overall, evidence indicates disease and predation are relatively minor stressors to *H. aboriginum* at present, but

could become threats in the future if they become more prevalent in the cacti populations (USFWS, 2013).

Stressor: Fire (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: At a site in Sarasota County, a large illegal bonfire pit is located within the habitat that supports one of the larger populations of *H. aboriginum*. The bonfires occur just a few yards from the plants (Bender 2011, pp. 5–6). At least one plant was killed by an escaped fire that affected part of this site in 2006 (Woodmansee et al. 2007, p. 108), and should another fire escape into occupied habitat in the future, it is reasonable to conclude this could result in the loss of individuals or extirpation of populations (USFWS, 2013).

Stressor: Nonnative plant species (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: *Schinus terebinthifolius* can dramatically change the structure of rockland hammocks, coastal berms, and shell mounds, making habitat conditions unsuitable for *Harrisia aboriginum*, which prefer moderate to full sun exposure. For example, at more than one site, numerous *H. aboriginum* plants occurring in the shade of *S. terebinthifolius* were observed to have died. *Casuarina equisetifolia* forms dense stands that exclude all other species through dense shade and a thick layer of needles that contain substances that leach out and suppress the growth of other plants. Coastal strand habitat that once supported *Harrisia aboriginum* has experienced dramatic increases in *C. equisetifolia* over the past 30 years. Other invasive plant species that are a threat to *Harrisia aboriginum* include *Scaevola taccada* (beach naupaka), *Neyraudia reynaudiana* (Burma reed), *Cupaniopsis anacardioides* (carrotwood), *Thespesia populnea* (Portia tree), *Manilkara zapota* (sapodilla), *Hibiscus tiliaceus* (hau), and *Hylocereus undatus* (night blooming cactus). (USFWS, 2013)

Stressor: Vandalism and recreation (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Vandalism is a threat to *Harrisia aboriginum*, and has caused population declines in both species. At a Sarasota County site, the Service has documented numerous *H. aboriginum* plants that have been uprooted, trampled, and hacked with sharp implements. This population is impacted by people who use the coastal berm and hammock interface to engage in a variety of recreational (including unauthorized) activities as evidenced by a very large bonfire site and vast quantities of garbage, bottles, and discarded clothing. Due to their historic significance and possible presence of artifacts, shell mounds are susceptible to vandalism by artifact hunters. Despite regulations that protect these sites on State lands (Florida Statute 267.13), there is a long history of artifact hunters conducting unauthorized excavation of shell mounds in Florida, including some mounds where *Harrisia aboriginum* has been found, causing erosion and opening areas for invasion by nonnative plants (USFWS, 2013).

Stressor: Small population size and limited distribution (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: The current range of *Harrisia aboriginum* spans such a small geographic area that all populations could be affected by a single event (e.g., hurricane). Six of the 12 remaining populations have 10 or fewer individual plants. Threats exacerbated by small population size include hurricanes, storm surges, freezing temperatures, recreation impacts, wildfires, and poaching. Due to ongoing and pervasive threats, the number and size of existing populations of this species are probably not sufficient to sustain it into the future (USFWS, 2013).

Stressor: Sea level rise (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: Downscaled projections suggest that sea level rise is the largest climate-driven challenge to low-lying coastal areas and refuges in the subtropical ecoregion of southern Florida. The current occurrences of *Harrisia aboriginum* at Live Oak Key (1), Gasparilla Island (2), Bokeelia Island (1), Cayo Pelau (1), Lemon Bay Preserve (1), and Buck Key (1) would be inundated by a 1.8-m (5.9-ft) sea level rise, leading to the loss of these populations. Occurrences at Longboat Key (1), North Manasota Key (2–3), and on a coastal berm in Charlotte Harbor Preserve (1) would not be completely inundated, but would experience significant loss and modification of habitat, and what remains would be highly susceptible to further losses to storm surge and salinization (USFWS, 2013).

Recovery**Reclassification Criteria:**

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- The Service; National Park Service (NPS); State of Florida; Manatee, Sarasota, Charlotte, Lee, Miami-Dade, and Monroe Counties; and several local governments own and manage conservation lands within the range of *Harrisia aboriginum* (USFWS, 2013).
- The Service; NPS; State of Florida; Sarasota, Charlotte, Lee, Miami-Dade, and Monroe Counties; and several local governments conduct nonnative species control efforts on sites that support *Harrisia aboriginum* (USFWS, 2013).

References

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

USFWS. 2015. Environmental Conservation Online System (ECOS) – Species Profile.
<http://ecos.fws.gov/speciesProfile/>. Accessed April 2016

USFWS 2013. Endangered and Threatened Wildlife and Plants

Determination of Endangered Status for *Chromolaena frustrata* (Cape Sable Thoroughwort),
Consolea corallicola (Florida Semaphore Cactus), and *Harrisia aboriginum* (Aboriginal Prickly-Apple)

Final Rule. 78 Federal Register 206. October 24, 2013. Pages 63795 - 63821.

U.S. Fish and Wildlife Service. 2016. Designation of Critical Habitat for *Consolea corallicola* (Florida Semaphore Cactus) and *Harrisia aboriginum* (Aboriginal Prickly-Apple). Final Rule. 81 FR 3866-3925 (January 22, 2016).

Final Rule. 78 FR 63795 - 63821 (October 24, 2013).

USFWS. 2016. Endangered and Threatened Wildlife and Plants

Designation of Critical Habitat for *Consolea corallicola* (Florida Semaphore Cactus) and *Harrisia aboriginum* (Aboriginal Prickly-Apple)

Final Rule. 81 Federal Register 14. January 22, 2016. Pages 3865 - 3925.

USFWS. 2013. Determination of Endangered Status for *Chromolaena frustrata* (Cape Sable Thoroughwort), *Consolea corallicola* (Florida Semaphore Cactus), and *Harrisia aboriginum* (Aboriginal Prickly-Apple)

USFWS. 2013. Endangered and Threatened Wildlife and Plants

SPECIES ACCOUNT: *Harrisia portoricensis* (Higo Chumbo)

Species Taxonomic and Listing Information

Listing Status: Threatened; 8/8/1990; Southeast Region (R4) (USFWS, 2015)

Physical Description

A slender, upright, columnar cactus which is usually unbranched and may reach up to 2 meters (in) in height and 7 centimeters (cm) in diameter (Vivaldi and Woodbury 1981). Nevertheless, more recent observations indicate that the cactus may reach more than 4.5 m in height and may have as many as 40 branches. In addition, the branches may become thicker with age, particularly towards the base (Breckon and Kolterman 1994). It has from 8 to 11 ribs separated by shallow grooves. Spines from 2 to 7 cm long occur in groups about 1 to 2 cm apart (Vivaldi and Woodbury 1981) (USFWS, 1996).

Taxonomy

Harrisia portoricensis or higo chumbo belongs to the family Cactaceae, subfamily Cactoideae. The genus *Harrisia* was described in 1908 and Britton and Rose (1937) assigned the genus to the tribe Cereeae, subtribe Cereinae (USFWS, 1996).

Historical Range

Collected for the first time from an area to the west of Ponce, known as Las Cucharas, by Britton and Cowell. The specimen was taken back to the New York Botanical Garden, and the specimen now considered to be the type was collected from that living plant (Britton and Wilson 1924; Vivaldi and Woodbury 1981). Historically the cactus was reported from the main island of Puerto Rico near Ponce, but urban, industrial, and agricultural expansion resulted in the elimination of this population (USFWS, 1996).

Current Range

Currently known only from three islands located to the west of Puerto Rico in the Mona Passage: Mona, Monito, and Desecheo (USFWS, 1996). As of 2018: *Harrisia portoricensis* or Higo Chumbo was extirpated from the main island of Puerto Rico. The only known natural populations are found on the offshore islands of Mona and Monito, and the Desecheo National Wildlife Refuge (DNWR), all west of Puerto Rico (USFWS 1996). The species has been reintroduced to Cabo Rojo National Wildlife Refuge (1 plant), Caja de Muertos Natural Reserve (5 plants), Boquerón Commonwealth Forest, Los Morillos area (25 plants). (USFWS, 2018).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, autogamy (USFWS, 2010)

Dependency on Other Individuals or Species

Adult: Pearly-eyed thrasher (USFWS, 2010)

Breeding Season

Adult: Year round, especially May - July (USFWS, 2010)

Key Resources Needed for Breeding

Adult: Canopy cover providing shade, insect pollinators (USFWS, 2010); bat pollinators (USFWS, 1996)

Reproduction Narrative

Adult: The apparent paucity of pollination and the species' ability to form viable seeds without pollination, suggest to the author that higo chumbo is either self-compatible, and capable of auto-pollination or that it is apomictic. Julissa Rojas-Sandoval and Elvia Meléndez-Ackerman (2009b) concluded that suitable conditions for germination and establishment of higo chumbo seedlings occur in shaded areas beneath the canopy of native shrubs. They also found that More than 76 percent of seeds in the population studied were produced through selfing. Santiago-Vélez (2000) documented that the species may flower any time during the year; however, peak flowering typically was from May to July. Bud production appeared to be triggered by rainfall. Small flower buds would persist for weeks before expanding and opening usually after a heavy rain. Observations indicate that the species does not have to open its flowers to set fruit with viable seeds, thus indicating it is not an obligate outcrosser, and is capable of either apomixis or autopolllination. She observed moth and caterpillars visiting flowers in Mona. Only seeds collected from droppings of the pearly-eyed thrasher (*Margarops fuscatus*) feeding on higo chumbo's fruits in Mona germinated (USFWS, 2010). Although not observed during the study period, bats are believed to be the principal pollinator (USFWS, 1996).

Habitat Type

Adult: Terrestrial (USFWS, 1996)

Habitat Vegetation or Surface Water Classification

Adult: Subtropical dry forest: cactus forest, plateau forest, depression forest, cliffside forest, plateau scrub (USFWS, 1996)

Habitat Narrative

Adult: The soil type, limestone outcrop, covers almost the entirety of the island of Mona; nevertheless in the central part of the plateau, or in the bajuras, reddish soils which include silt loams, clay loams, and clays are found. All three islands fall within the Subtropical Dry Forest Life Zone (Ewel and Whitmore 1973). *Harrisia portoricensis* as a dominant species in the canopy of the cactus forest type (Cintron and Rogers, 1974). The cactus has also been reported from the plateau forest, depression forest, cliffside forest, and plateau scrub vegetation types (USFWS, 1996).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: The majority of mature fruits on the plants were observed to have been depredated upon by birds. Fruits which fall beneath the plants are fed upon by the threatened Mona ground iguana (*Cyclura stejnegeri*). Preliminary observations of distribution of higo chumbo show that

plants are abundant near the entrances to caves, suggesting that bats that roost in the caves or birds that roost near them may be dispersing the seeds to these areas. The yellow-shouldered blackbird, as well as the pearly-eyed thrasher (*Margarops fuscatus*), have been observed feeding on mature fruits of higo chumbo (Breckon and Kolterman 1994). During ongoing studies of reproductive biology, the germination of higo chumbo seeds in the excrement of a small, unidentified bird, was observed, indicating that seeds of the cactus can retain viability after passing through a bird's digestive system (Breckon and Kolterman 1994) (USFWS, 1996).

Population Information and Trends

Population Trends:

Not available

Species Trends:

Stable (USFWS, 2013)

Resiliency:

Low (inferred from USFWS, 2013)

Representation:

Very low (inferred from USFWS, 2010)

Redundancy:

Low (inferred from USFWS, 2013)

Number of Populations:

3 (USFWS, 2013)

Population Size:

~20,000 - 50,000 (USFWS, 2013). As of 2018: 59,000 on Mona island, 136 on Monito Island, 72 on DNWR. (USFWS, 2018).

Population Narrative:

The species status is stable; in 2009, changes in species distribution and habitat conditions had not been reported. Population genetics for the species was examined by Santiago-Vélez (2000); genetic variability at the individual, population, and species level in higo chumbo is absent. At present time, three populations of this endemic cactus are known to occur in three discrete and protected islands. The species is considered very abundant on Mona (between 20,000 to 50,000 individuals), but in low numbers in Monito (less than 150 individuals) and very rare in Desecheo (USFWS, 2010).

Threats and Stressors

Stressor: Disease and predation (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: In Desecheo National Wildlife Refuge, Breckon (2000) documented predation of higo chumbo by rhesus macaques. The monkeys were observed breaking off and eating the upper parts of a young stem during a severe dry spell in March 1996. Individuals of higo chumbo cultivated at Cabo Rojo National Wildlife Refuge have been infected by mealybug and introduced plants have died rapidly. Although this pest has not been observed within the islands harboring the natural population of higo chumbo, personnel from the Puerto Rico Department of Agriculture understand that the insect may reach these islands in the near future. Julissa Rojas-Sandoval (CATEC, personal communication, 2009) observed that 40 percent of adult individuals of higo chumbo marked in Mona Island and 88 percent of individuals marked in Monito Island, present tissue lesions caused by the infestation by a non-identified insect. She observed that infested plants die in four months (USFWS, 2013). Feral invasive species (i.e., goats, pigs) continue to be present on Mona Island, impacting its ecosystem and the native flora and fauna of the Island (Rojas-Sandoval 2010). (USFWS, 2018). In 2010, lesions in Higo Chumbo caused by hemipteran *Leptoglossus* sp. were reported on Mona Island (Rojas-Sandoval 2010). This insect has been observed laying eggs and feeding on branches and main stems of this cactus, causing damages that eventually led to bacterial and fungal infections, which may kill Higo Chumbo plants within a few months (Rojas-Sandoval 2010, Rojas-Sandoval and Meléndez-Ackerman 2013a). A total of 85% of adult plants (total plant length > 50 cm) and 32% of juvenile plants (total plant length > 10 cm) were affected in different forms (e.g., tunnels, holes, rotting, or dry tissues) (Rojas-Sandoval 2010, Rojas-Sandoval and Meléndez-Ackerman 2013a). Lesions increased progressively, resulting in necrosis of branches and main stems that drop off entirely, causing an adult mortality rate of 93% (Rojas-Sandoval and Meléndez-Ackerman 2013a). (USFWS, 2018).

Stressor: Guinea grass (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Julissa Rojas-Sandoval and Elvia Meléndez-Ackerman (2009b) identified the spreading of exotic guinea grass (*Megathyrsus maximus*) as a threat to the species in the south eastern side of Mona Island. Based on experiments conducted by the authors, they found that only 15 percent of the seedlings growing beneath the shade of the guinea grass survived and the diameter of seedlings growing beneath the guinea grass was significantly lower than seedlings growing under native shrubs. The authors concluded that habitat microenvironmental conditions beneath the canopies may play a primary role in the germination, establishment and growth of higo chumbo on Mona. Effects to these habitat conditions may affect the recruitment of higo chumbo on the island (USFWS, 2013).

Stressor: Climate change (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: At present time, Julissa Rojas-Sandoval and Elvia Meléndez-Ackerman (CATEC, personal communication, 2009) are conducting research on the possible effects of climate change on higo chumbo on Mona Island. Results of these studies are pending for publication in 2010. They have observed that recruitment stages (seeds, seedlings and juveniles) are very vulnerable to changes to microclimatic conditions. For that reason, the authors believe that higher temperatures caused by climate change in Mona may adversely affect natural

recruitment. Additionally, increased rainfall events may affect flower development. The authors reported abortion of 30 percent of the flower buds after heavy rains in September 2009 (associated to storm Omar) (USFWS, 2013).

Recovery

Reclassification Criteria:

Not available

Delisting Criteria:

1. An agreement among the Service and the Puerto Rico Department of Natural and Environmental Resources (DNER) has been prepared and implemented for the protection of the species on Mona and Monito Islands (USFWS, 2010).

2. The Service has incorporated measures to protect and recover the cactus into management plans available for the Desecheo National Wildlife Refuge (USFWS, 2010).

3. New populations (the number of which should be determined following the appropriate studies) capable of self-perpetuation have been established within protected areas such as the Guánica Commonwealth Forest or the Cabo Rojo National Wildlife Refuge (USFWS, 2010).

2019 Amended Delisting Criteria - 1: The existing three (3) populations on Monito, Mona, and Desecheo islands show a stable or increasing population trends, evidenced by natural recruitment and multiple age classes. (USFWS, 2019).

2019 - 2: Within the historic range, establish one (1) additional population with a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factor C and E). (USFWS, 2019).

2019 - 3: Threat reduction and management activities have been implemented to a degree that the species will remain viable into the foreseeable future (addresses Factor C). (USFWS, 2019).

Recovery Actions:

- Protect the existing population and its habitat through inter- and intra-agency agreements (USFWS, 1996).
- Develop or modify management plans for the species in cooperation with entities such as DNER (USFWS, 1996).
- Monitor known populations (USFWS, 1996).
- Enforce existing Commonwealth and Federal endangered species regulations (USFWS, 1996).
- Provide information to the public on *Harrisia portoricensis* (USFWS, 1996).
- Conduct research on the life history of the species and evaluate propagation techniques (USFWS, 1996).
- Conduct propagation and enhance existing populations or establish new ones on lands within protected areas in southwestern Puerto Rico (USFWS, 1996).
- New in 2018 - 1: Implementation of biosecurity measures in order to avoid transporting the *Harrisia cacti* mealybug or other pests into the islands where it occurs. (USFWS, 2018).

- 2018-2: Continue monitoring the recovery of the species in DNWR. (USFWS, 2018).
- 2018-3: Establish a surveillance program for early detection of the *Harrisia cacti* mealybug (HCM) in case it invades the Mona, Monito, or Desecheo Islands. (USFWS, 2018).
- 2018 - 4: Conduct a study to characterize the pathology causing the lesions found in the Higo Chumbo population of Mona and Monito Islands to determine implications of this threat for the species. (USFWS, 2018).
- 2018 - 5: Establish a management strategy designed to control or eradicate the invasive Guinea grass. (USFWS, 2018).
- 2018 - 6: Continue monitoring the known populations to determine its long-term status. (USFWS, 2018).

Conservation Measures and Best Management Practices:

- Establish the number of self-sustainable populations needed to delist the species (USFWS, 2010).
- Continue control of exotic species in Desecheo and Mona (USFWS, 2013).
- Continue propagation efforts to introduce individuals in Desecheo to augment existing population, and establish additional populations in protected areas. Due to the current threat of infestation of wild populations with the *Harrisia cacti* mealybug, priority should be given to the establishment of a seedbank to ensure the availability of healthy plants (USFWS, 2013).
- Continued monitoring of current populations is needed to detect presence of infestation with *Harrisia cacti* mealybug (USFWS, 2013).
- Conduct surveys in Monito and Desecheo to establish the current population number (USFWS, 2013).

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SPECIES ACCOUNT: *Hedeoma todsenii* (Todsens pennyroyal)

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/18/1981; Southwest Region (R2)

Physical Description

Todsens pennyroyal is a perennial rhizomatous herb 10- 20 centimeters (cm) (4 to 8 inches (in)) tall and somewhat woody at the base. The rhizomes are slender and unbranched. The leaves are opposite, 0.8 to 1.5 cm (0.3 to 0.6 in) long, 0.25 to 0.5 cm (0.1 to 0.2 in) wide, lance-shaped, margins smooth, tip rounded to acute, and the lower surface glandular-dotted. The flowers occur singly in the axils of the upper stem leaves. The calyx is 1 .3 cm (0.5 in) long and two-lipped; the five calyx teeth are lance-shaped. The corolla is of five united petals, two-lipped, 3.6 cm (1.4 in) long, and orange-red to yellow. Yellow-flowered plants are less common, but have been seen at several places in the Sacramento Mountains. The corollas of the San Andres Mountains plants are slightly longer than those of the Sacramento Mountains plants (New Mexico Forestry and Resources Conservation Division [NMFRCD] 1991). There are two stamens. The fruits are of four nutlets; usually one or two develop to maturity, but all four may reach maturity (NMFRCD 1992; Huenneke 1993). The oblonglanceolate leaves and long, bright red-orange corolla easily distinguish Todsens pennyroyal from other members of the genus (Irving 1979). (USFWS, 2001)

Taxonomy

Dr. Thomas Todsens discovered the first Todsens pennyroyal population on August 18, 1978. Dr. Todsens and Dr. Robert Irving found a second population in the San Andres Mountains later in 1978. Todsens pennyroyal was described as a new species in 1979; Dr. Todsens collected the type specimen, "2 miles south of Hardin Ranch, 2000 m" (collection #SA 1-78). The holotype is deposited at the New York Botanical Garden Herbarium; isotypes are deposited in herbaria at New Mexico State University, the University of Texas, and the U.S. National Herbarium (Irving 1979). Todsens pennyroyal is a member of the mint family (Lamiaceae). Within its genus, it is placed in the subgenus *Cifatum*, a group of morphologically distinct, restricted endemics of southern New Mexico, western Texas, and Nuevo Leon, Mexico (Irving 1979). (USFWS, 2001)

Historical Range

Endemic mint that occurs in the San Andres Mountains of Sierra County, and the Sacramento Mountains in Otero County in south-central New Mexico. (USFWS, 2011)

Current Range

Endemic mint that occurs in the San Andres Mountains of Sierra County, and the Sacramento Mountains in Otero County in south-central New Mexico. (USFWS, 2011)

Critical Habitat Designated

Yes; 2/18/1981.

Legal Description

On January 19, 1981, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective February 18, 1981) for *Hedeoma todsenii* (Todsens pennyroyal) under the

Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in New Mexico (46 FR 5730-5733; USFWS, 1981).

Critical Habitat Designation

The critical habitat designation for *Hedeoma todsenii* includes one CHU in Sierra County, New Mexico. A description is provided below; the Final Rule contains a map depicting the location of the CHU (46 FR 5730-5733).

In New Mexico: Sierra County; the Critical Habitat of *Hedeuma todsenii* is best defined by two one-square kilometer sections on the 1000 m2 Universal Transverse Mercator Grid, Zone 13. The more northern critical habitat lies between 76,000 and 77,006 m N and 39,000 and 40,000 m E. The southern area lies between 74,000 and 75,000 m N and 40,000 and 41,000 m E.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Hedeoma todsenii* critical habitat are explicitly defined in the Final Rule, but are thought to be the following (46 FR 5730-5733):

Gypsum limestone soils.

Special Management Considerations or Protections

Any activities which would result in increased trampling or disturbance of the extremely fragile areas where *Hedeoma todsenii* occurs would probably adversely modify the Critical Habitat. The long-term solution on how to best protect *Hedeoma todsenii* may be to greatly reduce all traffic in the area where this plant occurs. In this respect, Critical Habitat designation may affect Federal activities within the 2 square kilometer area of *Hedeoma todsenii*'s Critical Habitat, which is administered by the Department of the Army. (USFWS, 1981)

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Asexual: vegetative, sexual: self-fertilization (USFWS, 2011); sexual: cross-pollination (USFWS, 2001)

Lifespan

Adult: 2+ years (inferred from NatureServe, 2015; see physical description)

Dependency on Other Individuals or Species

Adult: *Selasphorus platycercus* (USFWS, 2011)

Breeding Season

Adult: June - September (USFWS, 2001)

Key Resources Needed for Breeding

Adult: High rainfall (USFWS, 2001)

Reproduction Narrative

Adult: Nutlets remain inside the calyx which has a mucilaginous surface when wet. Plants typically have a low seed set which seems to be a genetic characteristic of the species (USFWS 2011h; NatureServe, 2015). Recent efforts to study pollination and reproductive success in the populations in the San Andres Mountains found that broad-tailed hummingbirds (*Selasphorus platycercus*) were using the flowers of *H. todsenii* and were relatively frequent visitors (Sikula 2009, Tonne 2009). Tonne (2009) also observed broad-tailed hummingbirds as the primary visitors of *H. todsenii* flowers in the Sacramento Mountains. Tonne (2009) noted two other wasp visitors (Sphecidae) were observed. The distribution of age classes indicates a normally aging group of long-lived perennial plants that are actively recruiting new individuals to the population. The plant perpetuates patches of stems by asexual reproduction and sexual inbreeding (USFWS, 2011). Field observations of seed set per fertile flower have been 1.6 nutlets/flower (Irving 1979), 1.8 nutlets/flower (NMFRCD 1991), 2.3 nutlets/flower (NMFRCD 1992), and 2.3 nutlets/flower (Ulaszek 1993). Todsen's pennyroyal flowers from June to September. Most flowers are produced from late August to early September, concurrent with the period of highest rainfall. Although the sample sizes were small, self-pollination, pollination between flowers in a patch, and pollination between patches of a population all resulted in some seed production (Huenneke, 1993) (USFWS, 2001).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Pinyon-juniper woodland (NatureServe, 2015); ponderosa pine and Douglas fir woodlands (USFWS, 2011)

Geographic or Habitat Restraints or Barriers

Adult: Occurs ~2,000 m elevation (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 2001)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Inhabits steep gravelly north- and east-facing slopes with loose, gypseous-limestone soils at about 2000 m elevation. The surrounding plant community is an open pinyon-juniper woodland (USFWS 2001d, NMNP PAC 1984) (NatureServe, 2015). It also occurs in scattered ponderosa pine and Douglas fir woodlands in the Sacramento Mountains. All habitats occur on the Permian-age Yezo Formation and are associated with strata that produce gypseous, sandy loam soils, often with loose limestone gravel and cobble (USFWS 2001). Populations have hundreds to thousands of separate clumps of plants (USFWS, 2001).

Dispersal/Migration**Dispersal**

Adult: Low (NatureServe, 2015)

Dispersal/Migration Narrative

Adult: The sticky calyx sticks to surfaces, therefore limiting long distance dispersal (USFWS 2001d; NatureServe, 2015).

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Narrow (inferred from NatureServe, 2015; see current range/distribution)

Redundancy:

High (inferred from NatureServe, 2015)

Number of Populations:

32 (NatureServe, 2015)

Population Size:

Unknown (USFWS, 2011)

Population Narrative:

There are 32 populations documented (USFWS 2011h; NatureServe, 2015). Exact numbers of individual *H. todsenii* plants are not known (USFWS, 2011).

Threats and Stressors

Stressor: Low reproduction (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Inbreeding depression in this species could be a contributing factor to the very low level of seed set observed throughout all populations of *H. todsenii*. If inbreeding and long-term asexual reproduction have caused an accumulation of lethal alleles in a population, many embryos would fail to survive and would be aborted. The possibility of increasing genetic variability by purposely out crossing distant populations with pollen or seed transfers would run the risk of breaking up co-adapted gene complexes that confer adaptation to local environmental conditions, i.e. out breeding depression. Purposeful transfer of gene complexes between populations may further reduce embryo survival in ways that have not yet been identified. Huenneke (1993) showed that self-pollination and transfers of pollen between individuals within a patch and between nearby patches produced at least a few seeds. However, her hand-pollen transfers between two distant populations in canyons 1.2 km apart failed to produce any seeds. Infrequent seed set likely may be a genetic characteristic of the species as a whole and probably cannot be modified by a few attempts to purposely transfer gene complexes between the various inbred populations. The continuing inability of *H. todsenii* to produce an abundance of seeds will severely limit its ability to recolonize habitats where populations may be extirpated or to migrate to new habitats if climate change renders current habitats unsuitable (USFWS, 2011).

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: *Hedeoma todsenii* is a relict species persisting as small, scattered patches of plants in a few places where gypseous soils and topographic aspect create cooler, moister microclimates in a relatively hot and arid region. These microclimate habitats and the *H. todsenii* populations they contain would probably expand if the regional climate became cooler or wetter. Conversely, a climatic change that made these microclimate habitats drier could shrink or eliminate *H. todsenii* populations. Localities in the San Andres Mountains may be vestiges of relict populations and incapable of spreading: whereas, colonies in the Sacramento Mountains inhabiting more mesic areas could hold more promise for the species' persistence, making their protection all the more imperative (P. Tonne 2011, pers. comm.). If predicted warming is accompanied by less precipitation over the longer term, or no increase in precipitation, it is possible that *H. todsenii* populations could be diminished (USFWS, 2011).

Stressor: Fire (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Most *H. todsenii* populations occur within piñon-juniper woodlands that are becoming more dense due to a history of fire prevention, and more susceptible to wildfire due to current drought conditions. The proximity of *H. todsenii* populations to each other increases the chances that any given fire could affect multiple populations. However, the ground cover in more arid habitats, particularly in the San Andres Mountains, might not be dense enough to carry a fire a great distance. The underground rhizomes of *H. todsenii* would probably survive a moderate fire, but the suitability of burned habitat for this species is not known because woodland canopy removal by fire might actually increase *H. todsenii* vigor, but could also result in hotter and drier habitat with eliminated colonies (depending on fire severity and on climatic conditions) or a smaller overall population (USFWS, 2011).

Recovery

Reclassification Criteria:

1. Plans are developed and implemented to permanently protect occupied *Hedeoma todsenii* habitat from human degradation or destruction (USFWS, 2001).
2. The responsible land management agencies verify through monitoring that protective management is successful (USFWS, 2001).

Delisting Criteria:

1. Research identifies the factors responsible for the low sexual reproduction and restricted distribution of *H. todsenii* (USFWS, 2001).
2. Measures are taken to correct any factors within management control (USFWS, 2001).

3. Monitoring and further research demonstrate *H. todsenii* can sustain itself indefinitely at present or higher population levels (USFWS, 2001).

Recovery Actions:

- Remove any threats to existing Todsen's pennyroyal populations. Protection of Todsen's pennyroyal will require enforcement of existing laws, prevention of habitat disturbance, control of land use impacts through implementation of management plans, and monitoring to verify management effectiveness. (USFWS, 2001)
- Study populations and natural habitat. Past studies have revealed much about the biology of Todsen's pennyroyal. Further investigations are needed, however, to determine if extant populations are self-sustaining, and to develop sound management practices for the species. The land management agencies may be able to use their research divisions for some studies and contract with independent researchers for others. (USFWS, 2001).
- Use information from previous studies to identify potential habitat and search these areas for Todsen's pennyroyal. The discovery of new populations has reduced the vulnerability of the species. The discovery of any more populations will further decrease the chance that Todsen's pennyroyal will become more endangered. (USFWS, 2001).
- Establish a working group to help coordination and communication between the various agencies, organizations, and interested citizens playing a role in recovery of Todsen's pennyroyal. Recovery will go more smoothly if everyone communicates about recovery activities. Public support will be enhanced if elected officials, county public land users groups, conservation groups, and other interested citizens are included. (USFWS, 2001).
- Recommended Action from 2011 5-Year Review; There are additional suitable habitats in the northern San Andres Mountains in and around the Gyp Hills and Chalk Hills that still need to be surveyed on both WSMR and adjacent BLM lands. There are also potential habitats on the Mescalero Apache Reservation in the Sacramento Mountains that have not been surveyed. A partnership with the Mescalero Apache Tribe should be established to survey and manage any extant populations in a manner consistent with their sovereign authorities (USFWS, 2011).
- Recommended Action from 2011 5-Year Review; Permanent monitoring plots have been established in two canyons in the Sacramento Mountains on LNF and BLM lands and at five *H. todsenii* locations on WSMR in the San Andres Mountains. However, monitoring has not occurred at the LNF or BLM locations since the plots were established in the 1990s. Additional plots should be established and monitored in the Sacramento Mountains to assess differences in plant density and vigor under varying degrees of piñon-juniper woodland canopy closure. To achieve recovery criteria for downlisting, standardized monitoring should occur at approximately five year intervals to detect any trends. Population trends need to be compared with climatic data obtained from the nearest permanent weather stations to investigate relationships to climate change. Monitoring dates should coincide with flower maturation (September) for an assessment of sexual reproduction success (USFWS, 2011).
- Recommended Action from 2011 5-Year Review; At least one patch of *H. todsenii* should be burned by prescribed fire to determine the effects of fire on plant density and vigor. This population should occur in woodlands of sufficient density to carry a fire of at least moderate intensity. Permanent monitoring plots should be established and assessed prior to the fire and for at least five years after being burned. Additionally, any permanent

- monitoring plots that are unexpectedly burned by wildfire should be monitored annually for five years to determine the effects of the fire (USFWS, 2011).
- Recommended Action from 2011 5-Year Review; Low sexual reproduction, poor seed viability, and limited seed dispersal are considered to be inherent threats to this species. The only pollinators documented for this plant are broad-tailed hummingbirds, a mating system supported by the red, tubular flowers of this plant species. Other, undocumented pollinators could be important to reproduction or simply absent due to pollinator limitation or an overall lack of conspicuous flowering plants in the community. Field studies in each mountain range documenting pollinator species and activities should be undertaken with the goal of improving pollination, fertilization, and seed set (USFWS, 2011).
 - Recommended Action from 2011 5-Year Review; The Federal permitting and consultation requirements and oversight under the Endangered Species Act, along with NEPA are adequate to protect known Todsens's pennyroyal habitats from serious land use impacts. Monitoring plans that are specific to this species need to be adopted by all three Federal agencies with *H. todsenii* populations. These plans should commit agency time and personnel to establishing and monitoring permanent monitoring plots and at least one agency should prescribe a fire across monitoring plots in *H. todsenii* habitat. If monitoring data indicate a need for active woodland treatments specific to *H. todsenii* habitats, plans for woodland thinning or prescribed fire could be implemented by these agencies (USFWS, 2011).
 - Recommended Action from 2011 5-Year Review; To ensure that the recovery plan for *H. todsenii* continues to be a current, living document, the recovery criteria should be updated to reflect the current number of colonies, upcoming results from genetic studies, and the recent status of threats to provide measurable standards by which the species can be quantified in the San Andres and Sacramento Mountains populations (USFWS, 2011).

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SPECIES ACCOUNT: *Hedyotis megalantha* (Paudedo)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/02/2015; Pacific Region (R1) (USFWS, 2016)

Physical Description

A perennial herb (USFWS, 2015).

Taxonomy

A member of the coffee family (Rubiaceae) (USFWS, 2015).

Historical Range

Historically, *H. megalantha* was reported solely from Guam. Between 1911 and 1966, this species ranged from the mid-central mountains and west coast of Guam, south to Mt. Lamlam (Bishop Museum 2013—Online Herbarium Database) (USFWS, 2015).

Current Range

It currently occurs on southern Guam (USFWS, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available

Habitat Type

Adult: Terrestrial (USFWS, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Savanna (USFWS, 2015)

Spatial Arrangements of the Population

Adult: Scattered individuals (USFWS, 2015)

Habitat Narrative

Adult: It occurs in the savanna ecosystem. *Hedyotis megalantha* typically occurs as lone individuals rather than in patches or groups (Gutierrez 2013, in litt.) (USFWS, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Decreasing (USFWS, 2015)

Resiliency:

Very low (inferred from USFWS, 2015)

Redundancy:

Very low (inferred from USFWS, 2015)

Number of Populations:

1 (USFWS, 2015)

Population Size:

< 1,000 (USFWS, 2015)

Population Narrative:

Currently, *H. megalantha* is known from one large scattered occurrence totaling fewer than 1,000 individuals on southern Guam (Costion and Lorence 2012, pp. 54, 86; Gutierrez 2012, in litt.; Bishop Museum 2013—Online Herbarium Database; Gutierrez 2013, in litt.). In sum, the single known occurrence of *H. megalantha*, a single island endemic, is decreasing from initial numbers observed on Guam (USFWS, 2015).

Threats and Stressors

Stressor: Urbanization (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: On Guam, a housing development is proposed for the Sigua highlands, where this species occurs (USFWS, 2015).

Stressor: Feral pigs (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: The destruction or degradation of habitat due to nonnative feral pigs is currently a threat to this species. Feral pigs are extremely destructive and have both direct and indirect impacts on native plant communities. While rooting in the earth in search of invertebrates and plant material, pigs directly impact native plants by disturbing and destroying vegetative cover, and trampling plants and seedlings (USFWS, 2015).

Stressor: Fire (USFWS, 2015)

Exposure:

Response:**Consequence:**

Narrative: Fire is a human-exacerbated threat to native species and native ecosystems throughout the Mariana Islands, particularly on the island of Guam. Fire can destroy dormant seeds of native species as well as plants themselves, even in steep or inaccessible areas. Successive fires that burn farther and farther into native habitat destroy native plants and remove habitat for native species by altering microclimate conditions to those favorable to alien plants (USFWS, 2015).

Stressor: Recreational vehicles (USFWS, 2015)

Exposure:**Response:****Consequence:**

Narrative: The savanna areas of Guam are popular for use of recreational vehicles. Damage and destruction caused by these vehicles are a direct threat to this species and its habitat. This species is particularly at risk, as the only known individuals are scattered on the savanna and local biologists have observed recreational vehicle tracks directly adjacent to these individuals (Gutierrez 2013, in litt.; Guam DAWR 2013, pers. comm.) (USFWS, 2015).

Recovery**Reclassification Criteria:**

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- Not available

References

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USFWS 2015. Endangered and Threatened Wildlife and Plants

Endangered Status for 16 Species and Threatened Status for 7 Species in Micronesia

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USFWS. 2015. Endangered and Threatened Wildlife and Plants

SPECIES ACCOUNT: *Hedyotis purpurea* var. *montana* (Roan Mountain bluet)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/07/1990; Southeast Region (R4)

Physical Description

A caespitose perennial herb with erect or ascending, unbranched or weakly terminally branched stems to 21 centimeters (cm) tall from a basal winter rosette. Cauline leaves are opposite, sessile, and typically ovate, 0.8 to 3.0 cm long and 0.6 to 1.3 cm wide. Flowers are reddish purple and funnel-shaped; the corolla has four lobes that are shorter than the 8- to 12-millimeter (mm)-long tube. Like other bluets, this species is heterostylous with two flower morphs. In the pin form, the pistil style is longer than the stamen filaments; whereas, in the thrum form, the style is shorter than the filaments. The inflorescence is few-flowered, consisting of a terminal simple cyme, and sometimes having from one to four lateral simple cymes arising from the uppermost stem nodes. Flowering occurs from late May through August or September, with peak flowering usually in June and July. The mature fruits are subglobose capsules, 2.0 to 4.0 mm long and 2.0 to 4.0 mm wide, semi-inferior and bilocular, with axial placentae bearing as many as 24 ovules. Capsules dehisce along a single apical suture in late August through September (Terrell 1959; Fosberg 1954; Kral 1983; Radford et al. 1968; Boyer 1990; B. Saunders, personal observations). This variety is easily distinguished from other bluets by its relatively large reddish purple flowers, relatively small sessile ovate leaves, compact stature and clump-forming growth habit, and its exposed mountaintop habitat. (USFWS, 1996)

Taxonomy

The recovery plan discusses the taxonomy of this taxon at length. It acknowledges numerous disagreements ranging from the generic name (*Hedyotis* or *Houstonia*) to the issue of whether the taxon should be recognized as a full species or as a variety of *purpurea*. The USFWS listed the taxon as *Hedyotis purpurea* (L.) Torrey & Gray var. *montana* (Small) Fosberg, but the recovery plan acknowledged that the emerging consensus favoring treatment as a full species, *Houstonia montana* Small. Weakley (2008) treats the taxon as *Houstonia montana* Small. Glennon et al. (2011) conclude that the patterns of genetic variation, morphological differences, and distribution along an elevational gradient (with *H. purpurea* occurring lower than 4,400 ft and *H. montana* higher than 4,800 ft in their sampled populations) support recognition of *H. montana* as a distinct species. The USFWS submitted a technical revision to the list of Endangered and Threatened Species to the Regional Office in 2008 (Currie 2008, pers. comm.) proposing to recognize this taxon as a full species (*Houstonia montana* Small). To date, this change has not been published in the Federal Register and has not taken effect. (USFWS, 2017)

Historical Range

Endemic to a few scattered mountaintops north of the Asheville Basin in North Carolina and, formerly, Tennessee (USFWS, 1996).

Current Range

The current county distribution of *H. montana* includes Ashe, Avery, Mitchell, Watauga, and Yancey Counties, North Carolina; Carter County, Tennessee; and Grayson County, Virginia. (USFWS, 2017)

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual, vegetative (USFWS, 1996)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 1996)

Other Reproductive Information

Adult: On grassy slopes, growth began earlier in the season and led to taller plants occupying greater ground area, but neither reproductive output, number of leaves, or patterns of mycorrhizal associations differed consistently between these habitat types. *H. montana* emerged at least eight weeks earlier than all other species except *Solidago glomerata*, which suggests a strategy for minimizing light competition (*S. glomerata* was not co-dominant with *H. montana* in any plots examined for this study). However, the study confounds differences in habitat with large geographic distances between populations: the two grassy slope sites were at Roan Mountain (Mitchell and Avery Counties, NC), whereas the rock outcrop sites were at Grandfather Mountain (Avery and Watauga Counties, NC) and Bluff Mountain (Ashe County, NC). Thus, it is quite possible that the differences observed in growth pattern and life-history traits are the result, at least in part, of factors other than differences in grassy slope or rock outcrop habitat conditions. This study raises many interesting observations and bears repeating using subpopulations within populations in which grassy slope and rocky outcrop conditions can be directly compared. (USFWS, 2017)

Reproduction Narrative

Adult: The four main flower visitors, listed in decreasing order of probable pollination effectiveness (based on field observations of frequency, pollen loads, and movement distances), were small staphylinid beetles, bumblebees, syrphid flies, and ants. A hand pollination study suggested that this population of Roan Mountain bluet is self-incompatible, as is expected in a heterostylous breeding system. Moreover, plants that were hand-pollinated, using neighboring pollen donors, set seeds just as well as naturally pollinated plants and just as well as plants that were hand-pollinated using distant, presumably unrelated, pollen donors. Asexual propagation occurs in late summer when Roan Mountain bluets begin to produce basal rosettes from rhizome buds (USFWS, 1996).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliff, talus (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Low sunlight exposure (USFWS, 1996)

Geographic or Habitat Restraints or Barriers

Adult: Occurs > 1370 m elevation (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Habitat Narrative

Adult: *H. montana* occupies high elevation (over 5,000¹¹ above sea level) rocky summits and cliffs in the southern Appalachian mountains of western North Carolina, extreme eastern Tennessee, and southwestern Virginia. These rocky summits and cliffs usually appear as smaller-scale, patchy habitats usually embedded within a larger forested landscape consisting of spruce-fir or northern hardwood forest (occasionally high elevation red oak forest). But, they can also appear as smaller outcrops; or over patches of talus or scree embedded within a grassy or heath bald habitat. (USFWS, 2017)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

See narrative.

Number of Populations:

17 (USFWS, 2017)

Population Size:

Uncertain (see narrative) (USFWS, 2017)

Additional Population-level Information:

Hedyotis purpurea var. *montana* is an herbaceous, caespitose (growing in tufts or clumps) perennial that grows in clumps of one to several hundred stems (TNC 1996). The taxon is known to spread by horizontal rhizomes up to 5cm long; therefore, a stem does not usually, or is not likely, to represent a genetically distinct individual. Site observations and accompanying estimates of abundance in this taxon are widely inconsistent. Some observers estimate abundance in terms of stems, others in terms of clumps or patches, and still others counting or estimating "plants" without defining whether they were counting stems or clumps (NCNHP 2009, TNNHP 2009). Saunders (1992) offered two definitions for defining an individual in this taxon: a "stem bundle", defined as a bundle of stems radiating from a single crown < 5cm in diameter, and a "bounded clump", defined as a circumscribed cluster of stem bases. The Nature Conservancy (TNC, 1996) later proposed a single, common definition for clumps, which adopted

Saunders's "bounded clump" accompanied by a categorical assessment of stem density (classes of 1-10, 11-25, 25-50, 51-100, and > 100 stems). Donaldson (assisted early on by Smith) followed a slightly modified version of TNC monitoring protocols during a multi-year monitoring project involving several populations (Donaldson 1999a, 1999b, 2002a, 2002b). However, Donaldson does not consistently provide stem counts (or stem classes) and occasionally forgoes clump estimates altogether in areas where he found *H. montana* to be especially dense. In this situation, observations were reported in terms of percent cover (within quadrats). (USFWS, 2017)

Population Narrative:

There are currently 17 populations of *H. montana*, ten of which occur on publicly owned lands or lands otherwise managed for conservation (Appendix A, Table A.1). Objective, measurable criteria have not been developed for self-sustaining populations. A lack of adequate monitoring data precludes a robust or meaningful assessment as to whether or not these populations have been stable over the past several years. It is also difficult to determine if the populations would be self-sustaining for the foreseeable future. Anecdotal observations suggest declines (some significant) at some populations, which make it unlikely that these populations are self-sustaining. It is currently unknown whether or not the declines reported at some sites are representative of trends within populations across the taxon's range. Eight populations are characterized by insufficient data to allow a meaningful inference of short term trends, whereas two other populations appear to be in decline. At seven other populations where the taxon occurs at more than one subpopulation, trends are inconsistent. Some subpopulations appearing stable while others are either declining (two subpopulations), increasing (two subpopulations), or stable (three subpopulations). No populations appear to be increasing. (USFWS, 2017)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: The principal source of habitat destruction affecting *H. montana* is the recreating public, who seek out high elevation views, adventurous rock climbing, boulder-hopping, or even just a flat and sparsely vegetated picnic spot. Trampling compacts the plant's rhizome and can shear plants from the rocks in which they are anchored. In the process, soils that have developed over geologic time frames can also be destroyed, making recolonization of these sites (by this or other taxa) exceedingly difficult. Trampling is a significant threat to *H. montana*, having contributed to significant declines at one subpopulation and continues to threaten the long-term viability of several others. A related concern stems from the construction of facilities intended to control or direct visitor use. These facilities must be sited and constructed appropriately in order to avoid impacts to *H. montana*. (USFWS, 2017)

Stressor: Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: This factor was mentioned in the listing rule as a potential threat. A poaching incident was documented for this species in the summer of 2014 (Estep 2014, pers. comm.). Ten to 20 percent (two clumps) of USE= WS population number eight (Table A.1) in Watauga County was dug and removed in July of 2014. The USFWS has no additional information to suggest overutilization has become a significant threat to the continued existence of *H. montana*. (USFWS, 2017)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: This factor was acknowledged as a threat in the listing rule and recovery plan, and remains a threat to the taxon. State laws protecting rare plant species have limited authorities, and neither North Carolina, Tennessee, nor Virginia rare plant statutes protect the species from habitat destruction from recreational use of federal lands (where four populations occur and remain vulnerable to this threat). (USFWS, 2017)

Stressor: Other natural or manmade factors affecting its continued existence (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: The listing rule identified woody succession and natural rock slides as additional threats to the taxon. In reality, natural rock slides may also serve to open up additional areas of newly available habitat for an early successional taxa like *H. montana*. Thus, as with many factors, the frequency and severity of these disturbance events needs to be better understood for a meaningful evaluation of their effects upon the continued existence of this taxon. Accelerated global climate change is likely to disrupt patterns of climate variability to which *H. montana* has become adapted and as such is likely to exacerbate threats already mentioned. However, the current scale of most global models of climate change offers little insight into the specific changes that will likely occur on southern Appalachian high peaks. (USFWS, 2017)

Recovery

Reclassification Criteria:

Not defined. (USFWS, 1996)

Delisting Criteria:

At least nine self-sustaining populations are protected to such a degree that the species no longer qualifies for protection under the Endangered Species Act. A self-sustaining population is self-regenerating and maintains sufficient genetic variation to enable it to survive and respond to natural habitat changes. A population will be considered adequately protected when landowners and cooperating agencies have implemented the management actions necessary for population persistence and when the population is protected from present or foreseeable natural and human-related threats that might jeopardize its persistence. (USFWS, 1996)

Recovery Actions:

- Protect existing populations and essential habitat. Because of increasing threats to Roan Mountain bluet and its highly fragmented distribution at all sites, all eight extant

populations should be protected. A careful census of each population is needed in order to establish interim protection, monitoring, and management priorities. (USFWS, 1996)

- Determine and implement necessary management for long-term reproduction, establishment, maintenance, and vigor. New subpopulations may need to be established periodically in order to replace any that may eventually die out. For all populations, plant numbers, reproduction, and electrophoretic variation should be monitored. Within selected population units, the following management efforts should occur: (1) census the life-cycle stages and follow individual plants to estimate population size and rates of vegetative survival, reproduction, and recruitment; (2) test for reproductive or recruitment limitations that jeopardize local persistence; (3) characterize buffering or compensatory processes that reduce the long-term impact of short-term reductions in survival, reproduction, or recruitment; and, (4) identify habitat and seed characteristics that permit colonization, germination, and establishment in new habitat. (USFWS, 1996)
- Maintain and expand cultivated sources for the species and provide for the long-term maintenance of selected populations in cultivation. Horticultural studies can contribute to recovery efforts in three ways. First, they provide valuable insight into the developmental patterns and growth habits of individual plants--difficult observations to obtain from field populations in natural habitats. Second, horticultural studies test the true environmental requirements of a species and help distinguish habitat preferences from habitat requirements. Third, horticultural studies eventually generate plant material that can be used directly to replenish or reintroduce the species into native habitat. The same material may also be used to establish experimental populations in natural habitat for perturbation studies of novel threats or natural factors. (USFWS, 1996)
- Establish new populations in former habitat or rehabilitate marginal populations to the point where they are self-sustaining (USFWS, 1996).
- Enforce laws protecting the species and/or its habitat. Federal and State enforcement agents whose jurisdiction includes the known range of *Hedyotis purpurea* var. *montana* should be made aware of the threats to the species and be able to identify specimens. Wherever collecting is a potential problem, signs should be posted explaining the prohibitions against taking of these plants (without specifying the species, so as not to draw undesirable attention). (USFWS, 1996)
- 5. Develop materials to inform the public about the status of the species and the recovery plan objectives. Public support for the conservation of Roan Mountain bluet could greatly encourage landowner assistance in conservation efforts, particularly at those sites that may be adversely affected by the creation or expansion of resorts and recreation facilities. However, informational material should not identify the plant's precise locations in order to discourage vandalism to, or collection of wild populations. (USFWS, 1996)
- Recommendations for Future Actions from 2017 5-Year Review: 1. Work with appropriate partners to evaluate protection alternatives at unprotected populations, including the use of voluntary landowner agreements. - 2. Develop interim research and management plans in conjunction with cooperative landowners, especially the U.S. Forest Service (in affirmation of their Section 7(a)(1) and 7(a)(2) responsibilities as a federal agency under the Act). - 3. Implement monitoring at a representative number of populations and subpopulations, for purposes of assessing status and trends and acquiring life-history information needed to inform future recovery efforts. - 4. Use monitoring data to define criteria for self-sustaining populations and implement appropriate management techniques. - 5. Develop techniques to reestablish populations within suitable habitat and provide for long-term maintenance of

selected populations in cultivation (long-term seed storage). - 6. Collaborate with appropriate partners to begin stepping down global climate change models to a meaningful scale for purposes of projecting impacts to high elevation southern Appalachian rocky summits and cliffs. Devise and evaluate potential adaptation scenarios for *H. montana*. (USFWS, 2017)

Conservation Measures and Best Management Practices:

- In North Carolina, the Natural Heritage Program, the North Carolina chapter of The Nature Conservancy (TNC), and the Service are working with landowners to protect and manage Roan Mountain bluet sites. The TNC owns part of one cliff-side site and is monitoring and protecting its populations by limiting public visitation. The U.S. Forest Service owns the Roan Mountain site (and the historic Big Bald site) and is trying to protect the species by placing new recreational facilities away from known locations and by creating innocuous natural barriers to discourage access and trampling at heavily used locations (USFWS, 1996).
- The North Carolina Arboretum in Asheville recently became an allied facility of the Center for Plant Conservation. They have proposed to serve as the seed-storage and plant-propagation facility for Roan Mountain bluet and have established a collection of specimens in cooperation with the North Carolina Plant Conservation Program (USFWS, 1996).

References

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SPECIES ACCOUNT: *Helenium virginicum* (Virginia sneezeweed)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/03/1998; Northeast Region (R5) (USFWS, 2015)

Physical Description

A perennial herb, 7-11 dm tall. Some Missouri plants reach 17 dm in height (Tim Smith, Missouri Dept. of Conservation, pers. comm. 2006). Basal leaves form a rosette and may be broad in the middle tapering toward the ends, but otherwise may appear oblong. Stem leaves are lanceolate and become progressively smaller from the base to the tip of the stem. Stems are winged, wings being continuous with the base of the stem leaves. Flower ray petals are yellow and wedge shaped with three lobes at the ends. Central disk is nearly ball-shaped. Clusters of golden-yellow flower heads bloom from July to September (NatureServe, 2015).

Taxonomy

A member of the Asteraceae (Aster family) (USFWS, 2000). Knox et al. (1995) determined that *H. virginicum* is distinct from *H. autumnale* morphologically and ecologically. Genetic work by Simurda and Knox (2000) supported treating *H. virginicum* and a Pomona, Missouri, *Helenium* sp. as a monophyletic group. Additional genetic work with a larger number of *Helenium* populations over a broader geographic range strengthened this conclusion and determined a narrow-leaved *Helenium autumnale* population from the Bruce Peninsula in Ontario, Canada, to be a sister group to the *virginicum* group (Simurda et al. 2005) (NatureServe, 2015).

Historical Range

It was first found in Augusta County, Virginia, in 1935 (Blake 1936) and the known range was expanded to Rockingham County by C. E. Stevens in 1967 (Roe 1977) (USFWS, 2000).

Current Range

As of 2000, 23 populations have been documented in Augusta county and 7 in Rockingham County. Recent studies from a sinkhole pond in southern Missouri suggest that it may represent a disjunct population, but further studies are needed to resolve this (USFWS, 2000).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual: vegetative; sexual: cross-pollination (USFWS, 2000)

Lifespan

Adult: 5 years (USFWS, 2000)

Breeding Season

Adult: July - October (NatureServe, 2015)

Key Resources Needed for Breeding

Adult: Insect pollinators, abundant soil moisture, seed bank (NatureServe, 2015)

Reproduction Narrative

Adult: Flowers from early July to October, with peak flowering occurring in late July to early August at most sites. The pollination biology has not been studied in detail; however, cursory observations conducted at Kennedy Mountain Meadow suggest that the primary insect pollinators are bees, wasps (Hymenoptera: Apidae, Halictidae, Sphecidae), butterflies (Lepidoptera: Hesperidae and Lycaenidae, among others), and hoverflies (Diptera: Syrphidae) (C. Williams, pers. obs.). During favorable years at Kennedy Mountain Meadow, approximately one quarter of the population may flower (Knox and Williams 1988). Flowering appears to correlate with water availability during late spring and early summer, a critical period for bolting and flower formation (Knox et al. 1987). Seasonal water fluctuation, particularly inundation, is probably a key factor affecting recruitment and maintenance of populations (J. Knox, unpubl.). For example, extensive periods of inundation during the growing season may greatly limit recruitment and result in high levels of mortality in established plants. Reestablishment of inundation-depleted populations may be facilitated by a soil seed bank; viable seeds can persist in the soil for at least two years (J. Knox, pers. obs.). Thus *H. virginicum* appears to be a "boom-bust" species in which recruitment is keyed by water fluctuations: population peaks occur in years of abundant soil moisture and troughs in years of excessive and persistent inundation. In addition, seasonal water fluctuations may also modulate populations of co-occurring plants that compete with *H. virginicum* for space and resources. (NatureServe, 2015). In a nine year demographic field study at one population, plants were found to live up to five years and flower two to three times (Knox 1997). Individual plants identified in the field are nearly always genets (Knox 1997). Research by Messmore and Knox (1997) determined that plants from at least one site have a self-incompatible breeding system (USFWS, 2000).

Habitat Type

Adult: Wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Ephemeral pond, wet meadow (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Seasonal inundation (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Shade (USFWS, 2000)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: In Virginia, *Helenium virginicum* is a wetland plant restricted to shallow, seasonally inundated ponds (which are in or near sinkholes) in Augusta and Rockingham Counties, Virginia (Blake 1936; Roe 1977; Harvill et al. 1986). The pond basins in which this species occurs are usually flooded from January to July. The substrate at most *H. virginicum* sites consists of poorly

drained, acidic, low fertility Purdy silt loams (USDA 1979) underlain by gray clays and dolomitic bedrock (Werner 1966; Rader 1967). The level of disturbance present at the sinkhole ponds includes relatively undisturbed ponds surrounded by forest, more meadow-like habitats around farm ponds actively used by cattle, a backyard seasonal wetland maintained in an open state by the landowner, a seasonally wet mowed lawn, and a seasonal wetland degraded by severe cattle trampling and an ongoing attempt to fill the site. In Missouri it is found on sinkhole pond margins and wet meadows in the Ozark Highlands (Rimer and McCue 2005). The plant has been found to prefer open growing conditions and is found in a variety of sites in addition to the less disturbed sinkholes and wet meadows including rural airports, roadside ditches, and cattle ranches (R. Rimer and J. Summers, pers. comm. 2005). It appears to be less confined to discrete wetlands in Missouri and can occur in a temporarily wet portion of a hayfield or in roadside ditches (Tim Smith pers. comm.) (NatureServe, 2015). Data from one site indicate that *H. virginicum* is shade intolerant (USFWS, 2000).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Resiliency:

Low to moderate (inferred from USFWS, 2000; see current range/distribution)

Redundancy:

High (inferred from USFWS, 2000)

Number of Populations:

26 - 30 (USFWS, 2000)

Population Size:

10,000 - 100,000 individuals (NatureServe, 2015); 1 - 500,000 per occurrence (USFWS, 2000)

Population Narrative:

Species exhibits high tolerance to mechanical disturbance. Surprisingly, it appears to benefit from grazing. The stems and leaves of this species are extremely bitter in taste and apparently unpalatable, thus selective grazing by cattle may eliminate competing plants (John Knox, pers. obs.). Moreover, the largest (100,000 - 1,000,000 plants) and densest *H. virginicum* population (> 400 plants/m²) grows at a site that is mowed yearly. The estimated population size in Virginia is 2500-10,000; in Missouri over 10,000. Widely fluctuating population numbers have been taken into consideration: a population of 10,000 one year may be reduced to a handful in years of drought or prolonged inundation. The long term population trend is unknown (NatureServe, 2015). As of 2000, 30 populations have been documented, four of which have not been seen since the late 1970's and may be locally extirpated. Population sizes documented among the different occurrences range from one individual to 500,000 (USFWS, 2000).

Threats and Stressors

Stressor: Habitat destruction and modification (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: In Virginia the long-term viability of existing populations is primarily threatened by human-induced disruptions of hydrologic regimes, particularly by encroaching agriculture, residential land development, and logging (Van Alstine 1991; J. Knox, C. Williams pers. obs.). In addition, a private site and adjacent sites on the George Washington National Forest are sporadically impacted by off road vehicles (e.g., during summer 1991 on the private land; J. Knox, C. Williams, pers. obs.). The following paragraphs are taken, with modifications, from U.S. Fish and Wildlife Service (2000): The most serious threat to *H. virginicum* appears to be habitat loss, most often arising from changes in the natural hydrological regime of the sinkhole pond habitat. Four of the sites, three of which are grazed by cattle, have had a portion of the wetland deepened to create a permanent pond; prior to being excavated, much of this section once undoubtedly supported *H. virginicum* and so loss of some habitat has occurred. Input from groundwater sources may be decreased by withdrawals for wells for adjacent developments such as subdivisions. Overland surface water flow may be altered by activities such as timber harvesting or road building in upslope areas. A variety of site-specific threats to *H. virginicum* from habitat loss have appeared over the last ten years. The Virginia Department of Transportation (VDOT) has proposed to widen to four lanes Route 340, a currently two lane north-south corridor on the east side of the Shenandoah Valley. A portion of one site in Augusta County is immediately east of Route 340. Another *H. virginicum* population is near the site of silos built in the early 1990's that are used to store septic waste. Mowing occurs in at least 3 of the Virginia sites. Repeated mowing before seed is set and the seed bank is replenished, may lead to local extinction as vegetative plants die out and the seed bank ultimately becomes depleted. As the soils of the *H. virginicum* sites have been found to be nutrient-limiting (Knox 1997), long-term nutrient enrichment from cattle could ultimately create more favorable habitat for other plant species (NatureServe, 2015).

Stressor: Nonnative species (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: Exotic organisms may pose threats to *H. virginicum* populations in the near future. Purple loosestrife, *L. salicaria*, is slowly spreading through Virginia and may eventually invade some *H. virginicum* sites, especially following disturbances to hydrologic regime and/or substrate. The gypsy moth, *L. dispar*, is currently defoliating large areas of the George Washington National Forest and adjacent lands but it is unclear whether the gypsy moth will negatively impact *H. virginicum* populations. For example, as *H. virginicum* is shade-intolerant, defoliation of trees and shrubs that grow on the periphery of sinkholes may increase light availability and allow *H. virginicum* to expand into areas from which it was formerly excluded (NatureServe, 2015).

Stressor: Stochastic events (USFWS, 2000)

Exposure:

Response:**Consequence:**

Narrative: Extremes in the fluctuating hydroperiod of the ponds could, when preceded by a low investment in the seed bank, result in local extirpations of populations. The self-incompatible breeding system may eventually lead to local extinction at sites with low population numbers (Messmore and Knox 1997) (USFWS, 2000).

Recovery**Reclassification Criteria:**

Not available

Delisting Criteria:

1. Twenty self-sustaining populations and their habitats have received permanent protection across the species' Virginia range (USFWS, 2000).
2. Monitoring over a 15-year period indicates that populations in the 20 sites are viable (USFWS, 2000).
3. Life history and ecological requirements are understood sufficiently to allow for effective protection, monitoring, and, as needed, management (USFWS, 2000).
4. Seeds representing the range of genetic diversity in *H. virginicum* are placed in long-term storage to provide a source of genetic material in the event of extinction (USFWS, 2000).
5. If determined to be *H. virginicum*, the Missouri population and its habitat are permanently protected and seeds placed in long-term storage (USFWS, 2000).

Recovery Actions:

- Protect the extant populations and their habitat (USFWS, 2000).
- Monitor extant populations (USFWS, 2000).
- Definitively identify the range and distribution of the species (USFWS, 2000).
- Continue investigations into the life history and ecology of *Helenium virginicum* (USFWS, 2000).
- Maintain seed sources for the species (USFWS, 2000).
- Develop informational materials to create more awareness of *H. virginicum* and its status (USFWS, 2000).

Conservation Measures and Best Management Practices:

- *H. virginicum* has been listed as endangered by the Commonwealth of Virginia since 1989 under the Endangered Plant and Insect Species Act. This law protects listed plant and insect species from take in the form of collection or translocation, except by the landowner (USFWS, 2000).
- Site-specific conservation planning, funded by the U.S. Fish and Wildlife Service and the Virginia Department of Agriculture and Consumer Services, was conducted by the Virginia Department of Conservation and Recreation's Division of Natural Heritage at five privately-owned sites (Erdle 1996, Erdle 1997) (USFWS, 2000).

- If the Missouri *Helenium* sp. is confirmed to be *H. virginicum*, sinkhole pond habitat in Missouri, intervening states, and other areas of Virginia will need to be targeted for surveys to determine the distribution of this species (USFWS, 2000).
- A fact sheet on *H. virginicum* was developed by the Virginia Department of Conservation and Recreation's Division of Natural Heritage in 1995 (USFWS, 2000).
- Six of the sites that have been documented to support populations of *H. virginicum* are on land managed by the U.S. Forest Service (USFWS, 2000).
- A number of studies are underway or planned for the near future by J.S. Knox and associates at Washington and Lee University (USFWS, 2000).

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SPECIES ACCOUNT: *Helianthemum greenei* (Island rush-rose)

Species Taxonomic and Listing Information

Listing Status: Threatened; 07/31/1997; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A small evergreen shrub, up to 0.5 m tall. Produces yellow flowers March-May (NatureServe, 2015).

Taxonomy

Combination in *Crocanthemum* published by Sorrie (2011) (NatureServe, 2015). A member of the rock rose family (Cistaceae) (USFWS, 2010).

Historical Range

At the time of listing, *Helianthemum greenei* had been reported from four of the Channel Islands off the coast of southern California: San Miguel (McMinn 1932; Thorne 1967), Santa Rosa (Wallace 1985), Santa Cruz (Hochberg et al. 1980; McEachern and Wilken 1996), and Santa Catalina (Thorne 1967; Takara, Catalina Island Conservancy, pers. comm. in Service 1994). The species was believed to be extirpated on Santa Rosa Island and San Miguel Island by the time of listing; the known historical occurrences could not be relocated. *Helianthemum greenei* was extant in at least 10 occurrences on Santa Cruz Island and at least 1 occurrence on Santa Catalina (USFWS, 2010).

Current Range

Currently known to occur on Santa Cruz Island, Santa Catalina Island, and Santa Rosa Island. The species is believed to be extirpated from San Miguel Island (USFWS, 2010).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination, self-pollination (USFWS, 2010)

Breeding Season

Adult: March - May (NatureServe, 2015)

Key Resources Needed for Breeding

Adult: Fire/disturbance (USFWS, 2010)

Reproduction Narrative

Adult: Flowers from March to May (NatureServe, 2015). When the flowers are insect pollinated, the plant produces a maximum of 12 seeds per fruit; seed production is reduced when the plants are self-pollinated (Service 2000). *Helianthemum greenei* has been known to germinate in

open space in the absence of fire; however, researchers have documented large increases in the number and size of occurrences after fires where occurrences were thought to be small or non-existent (McEachern and Wilken 1996; Knapp 2005; Ratay in litt. 2009) and no new germination several years after the fire event. This suggests that the species may not require fire for germination, but fire appears to increase germination efficiency (USFWS, 2010).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Chaparral (NatureServe, 2015); coastal sage scrub, cismontane woodland, island pine forest (USFWS, 2010)

Dependencies on Specific Environmental Elements

Adult: Periodic fire (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: 0 - 1,608 ft. elevation (USFWS, 2010)

Habitat Narrative

Adult: Inhabits dry, open, rocky areas, mostly in chaparral vegetation. (NatureServe, 2015). The species is found in open, exposed areas in chaparral, coastal sage scrub, cismontane woodland, and island pine forest, up to 1,608 ft. elevation (California Native Plant Society (CNPS) 2009). *Helianthemum greenei* is likely fire-dependent, as the number and size of occurrences increased dramatically soon after fire events, with little to no recruitment observed absent of fire (McEachern and Wilken 1996, Service 2000). *Helianthemum greenei* can grow in a variety of dry, rocky substrates including fine-grained shales, rocky volcanic soils, and alluvial deposits in ephemeral stream channels (Junak 1995; Center for Plant Conservation 2009). (USFWS, 2010).

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Not available

Species Trends:

Increasing (USFWS, 2010)

Resiliency:

Low (inferred from USFWS, 2010; see current range/distribution)

Redundancy:

Very high (inferred from USFWS, 2010)

Number of Populations:

87 (USFWS, 2010)

Population Size:

~7,400 (USFWS, 2010)

Population Narrative:

Since listing, the number of occurrences on the islands has increased from 15 to 87. The total number of individuals has increased from perhaps a few hundred in 1980, to approximately 3,000 at the time of listing (Service 1997), to approximately 7,400 by 2009 (McEachern et al. 2008, Ratay in litt. 2009, McEachern in litt. 2009) (USFWS, 2010).

Threats and Stressors

Stressor: Nonnative mammals (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The large-scale loss of topsoil caused by non-native mammal activity was the primary cause for the decline of *Helianthemum Greenei*. Although feral pigs have been removed from Santa Catalina Island, soil loss is still a threat on Santa Catalina Island, as deer and bison continue to disturb the soil. On Santa Catalina Island, *H. Greenei* is still threatened by consumption by deer. Bison are not considered predators of *H. Greenei*, but they affect the habitat of the species through trampling. Deer and elk remain on Santa Rosa Island as part of a private hunting operation, and they impact *Helianthemum Greenei* in a similar manner to the ungulates on Santa Catalina Island (USFWS, 2010).

Stressor: Nonnative plants (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Non-native plants have the potential to disrupt native habitats and displace native species (Service 1997). The listing rule included *Helianthemum Greenei* as one of the species most susceptible to lack of recruitment and habitat displacement by non-native plants. The removal of non-native ungulates released predation pressure on both native and nonnative plants. Without management, non-native plants that have a competitive advantage could increasingly affect the distribution and recruitment of *H. Greenei* (USFWS, 2010).

Stressor: Stochastic events (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The few occurrences on Santa Rosa Island could be extirpated by any number of circumstances, including low genetic diversity and demographic imbalance, and unforeseen events such as climatic phenomena (USFWS, 2010).

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Predictions of climatic conditions for small sub-regions such as the California Channel Islands remain uncertain. Given the narrow geographic range of *Helianthemum greenei*, the species will have limited ability to disperse in response to climate change. *Helianthemum greenei* may be able to take advantage of significant altitudinal gradients on Santa Catalina Island, Santa Rosa Island, and Santa Cruz Island, and an increased frequency of wildfires may actually benefit the species (USFWS, 2010).

Recovery

Reclassification Criteria:

Not available

Delisting Criteria:

Maintaining existing stable occurrences on Santa Cruz Island and Santa Catalina Island for a period of 15 years that includes the normal precipitation cycle (USFWS, 2010).

Recovery Actions:

- Support and intensify active control programs where herbivory or habitat alteration by alien animals exists (USFWS, 2000).
- Develop and implement a plan to achieve the goals and standards of the Conservation Strategy. The Conservation Strategy is a draft strategy for conservation of island resources prepared by biologists from the National Park Service, U.S. Fish and Wildlife Service, and the U.S. Geological Survey, Biological Resources Division. This Strategy is essentially a primer or guide that provides the basis for the recovery of the species and should be referred to as a supporting document (USFWS, 2000).
- Restore habitats and control competitive weeds for long-term management of the species and its habitats (USFWS, 2000).
- Conduct thorough surveys for the species (USFWS, 2000).
- Conduct research that aids in the conservation and recovery of the species (USFWS, 2000).
- Store seeds at facilities certified by the Center for Plant Conservation and develop successful seed germination and propagation techniques (USFWS, 2000).
- Develop successful outplanting techniques (USFWS, 2000).

Conservation Measures and Best Management Practices:

- Revise the recovery criterion to include maintenance of existing occurrences on Santa Rosa Island. Because the historic distribution and abundance of the species is unknown on Santa Rosa Island, the first need is to establish a baseline for the species over the first 10 years after non-native mammal removal (USFWS, 2010).
- Manage the habitat throughout the geographic range of *Helianthemum greenei* to conserve and replenish topsoil. This should include (1) removal of bison, deer, and elk, and (2) revegetation efforts (USFWS, 2010).
- Eliminating non-native predation pressure on *Helianthemum greenei*. Ideally this means removing all non-native herbivorous mammals from Santa Catalina and Santa Rosa Islands. In the interim, reinforced fencing may serve to maintain existing occurrences that can repopulate the islands as predation pressure is reduced (USFWS, 2010).
- Land managers should expand the distribution of the species by establishing fence-protected occurrences on the west end of Santa Catalina Island, by establishing occurrences inside any other

currently fenced *Arctostaphylos confertiflora* occurrences on Santa Rosa Island, and by reestablishing the species on San Miguel Island (USFWS, 2010).

- Land managers should experiment with controlled burns as a means of increasing the size and number of occurrences of the species, within a framework of restoring ecosystem health (USFWS, 2010).
- Land managers should continue monitoring all known occurrences of *Helianthemum greenei* (USFWS, 2010).

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SPECIES ACCOUNT: *Helianthus paradoxus* (Pecos (=puzzle, =paradox) sunflower)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/20/1999; Southwest Region (R2) (USFWS, 2016)

Physical Description

An annual herb with stems 1-2 m tall. Flower heads have yellow rays and are 3-5 cm across (NatureServe, 2015).

Taxonomy

Puzzle sunflower is a species of hybrid origin (Rieseberg et al. 1990; Rieseberg 1991). The parental species are the common sunflower and the prairie sunflower, *H. petiolaris*. These two species occupy different habitats from puzzle sunflower (NatureServe, 2015).

Historical Range

Historically there were six other locations within Pecos and Reeves Counties; however all except one of these sites have not been relocated due to imprecise locality data and the lack of access to private land. The relocated site was heavily invaded by salt cedar and had little water left. No puzzle sunflowers were found, although the entire site was not searched (NatureServe, 2015).

Current Range

At present puzzle sunflower occurs in two general areas in Pecos and Reeves Counties in west Texas and four general areas in New Mexico (NatureServe, 2015). Pecos sunflower populations occur at alkaline wetlands in the arid regions of west Texas, lower Pecos River of eastern New Mexico, and the Rio Grande and Rio San Jose of west-central New Mexico (USFWS, 2015).

Critical Habitat Designated

Yes; 4/1/2008.

Legal Description

On April 1, 2008, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Helianthus paradoxus* (Pecos (=puzzle, =paradox) sunflower) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes five critical habitat units (CHUs), in New Mexico and Texas (73 FR 17762-17807).

Critical Habitat Designation

The critical habitat designation for *Helianthus paradoxus* includes five CHUs (ten sub-units) in Chaves, Cibola, and Guadalupe counties, New Mexico, and in Pecos County, Texas. This species critical habitat encompasses approximately 1,305 acres (ac) (528 hectares (ha)) (73 FR 17762-17807).

Unit 1: West-Central New Mexico: Subunit 1a is located at Rancho del Padre Spring Cienega. This subunit is 26 ac (10 ha) in Cibola County, New Mexico. The subunit consists of an area of Rancho del Padre Spring Cienega from the spring on the south side of I-40 then northeast approximately 0.5 mi (0.8 km) to the Rio San Jose. This population consists of large patches of several thousand

plants on areas owned by two private landowners (23 ac (9 ha)) and the Pueblo of Acoma (3 ac (1 ha)). This site was known to be occupied at the time of listing and has been visited or observed from a public right-of-way by species experts during four or more seasons. These experts have found the site occupied by *H. paradoxus* on every visit (Sivinski 2007a, p. 3). This unit is currently occupied, contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by water withdrawal, wetland filling and development, and livestock grazing during *H. paradoxus*'s growing and flowering season. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address *H. paradoxus* in this area. Subunit 1b is located at Grants Salt Flat Wetland. This subunit is 63 ac (25 ha) of private land in Cibola County, New Mexico. The subunit consists of an area of wet alkaline playa (i.e., a seasonal, shallow desert lake) between railroad tracks and I-40 and west of Hwy 122 (Road from Interstate to downtown Grants). Playas are nearly level areas at the bottom of undrained desert basins that are sometimes covered in water. This population consists of large patches of several thousand plants mostly on private property. This site was occupied at the time of listing and has been visited or observed from a public right-of-way by species experts during four or more seasons. These experts have found the site occupied by *Helianthus paradoxus* on every visit (Sivinski 2007). This unit is currently occupied, contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by wetland filling and development, encroachment by nonnative vegetation, and livestock management not compatible with *H. paradoxus* physiology. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address *H. paradoxus* in this area. Subunit 1c is located at the Pueblo of Laguna. This subunit's acreage is undefined in Valencia County, New Mexico. The subunit consists of an area along the Rio San Jose, South Garcia, New Mexico. At this site, *Helianthus paradoxus* plants are located in patches at springs along the Rio San Jose. Each patch consists of several hundred to several thousand plants, and a few scattered plants grow along the river (Sivinski 1995, p. 4). The entire site belongs to the Pueblo of Laguna. This site was occupied at the time of listing, is currently occupied, contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by water withdrawal, encroachment by nonnative vegetation, and livestock grazing during *H. paradoxus*' growing and flowering season. The Pueblo has developed a management plan for *H. paradoxus*. On the basis of this plan and our partnership with the Pueblo of Laguna, we are excluding this area from the final critical habitat designation pursuant to section 4(b)(2) of the Act (see "Application of Section 4(b)(2) of the Act" section below for additional information).

Unit 2: La Joya Wildlife Management Area: Unit 2 is located in the La Joya Wildlife Management Area. This unit is 854 ac (346 ha) in Socorro County, New Mexico. This population is located about 7 mi (11 km) south of Bernardo within Socorro County near the confluence of the Rio Grande and the Rio Puerco. The La Joya population is bounded to the west by I-25 and to the east by the Unit 7 Drain. The north boundary is adjacent to River Mile 126 of the Rio Grande and the south boundary is adjacent to River Mile 123. One of the largest populations of *Helianthus paradoxus* occurs adjacent to the Rio Grande at La Joya. This Rio Grande population consists of 100,000 to 1,000,000 plants and occurs on the La Joya Wildlife Management Area (Service 2005, p. 4). It is within the La Joya Unit of the Ladd S. Gordon Waterfowl Complex. This property is owned by the New Mexico State Game Commission. It is managed by the NMDGF for migratory waterfowl habitat, which is compatible with preservation of wetlands for *H. paradoxus*. We believe this area was not occupied at the time of listing. It was discovered in 2004. This site has been found to be occupied every year since then and represents one of the largest populations of *Helianthus paradoxus* in the range of the species (Hirsch 2006, p. 1). This unit is currently

occupied by a stable population (Blue Earth Ecological Consultants, Inc. 2007c, p. 3), contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by encroachment of nonnative vegetation. We have determined this site to be essential to the conservation of the species because it is currently occupied by a stable, very large population of *Helianthus paradoxus*, and is sufficiently distant (over 40 mi (64 km)) from other populations to serve as an additional locality that contributes to the conservation of genetic variation. This population may prevent extirpation of the species resulting from encroachment of nonnative species, degradation of habitat, or a catastrophic event because it is the sole representative located in an area distinct from any other population in the range of the species. As such, it may contain genetic variation not found anywhere else in the range of the species. Because the water source for this population is stable, this population can be expected to persist in very large numbers every year. As described below, we are excluding Unit 2, the La Joya Wildlife Management Area, from the critical habitat designation for *Helianthus paradoxus* (see “Exclusions Under Section 4(b)(2)” section).

Unit 3: Santa Rosa: Subunit 3a is located at Blue Hole Cienega/Blue Hole Fish Hatchery Ponds. This subunit is 134 ac (54 ha) in Guadalupe County, New Mexico. The Blue Hole Fish Hatchery Ponds population of *Helianthus paradoxus* is part of the same population as and nearly contiguous with the Blue Hole Cienega in Santa Rosa, New Mexico. The Blue Hole Fish Hatchery Ponds population is immediately north of Blue Hole Road and the Blue Hole Cienega is immediately south. This subunit was occupied at the time of listing and has been visited by species experts during four or more seasons. These experts found the subunit to be occupied by *Helianthus paradoxus* on every visit (Sivinski 2007a, p. 2). This subunit is currently occupied (Blue Earth Ecological Consultants, Inc. 2006, p.1), contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by encroachment of nonnative vegetation, wetland filling, and park maintenance activities. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address *H. paradoxus* in this area. The part of this population at Blue Hole Cienega consists of 100,000 to 1,000,000 plants and is the largest population of *Helianthus paradoxus* in the upper Pecos River basin. A nontraditional section 6 grant was awarded to the State of New Mexico in 2004 for acquisition of the Blue Hole Cienega, which was finalized in July 2005. At this site, shallow ground water seeps to the surface to create cienega communities. This subunit is currently occupied, contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by encroachment by nonnative vegetation. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address *H. paradoxus* in this area. The part of this population at the Blue Hole Fish Hatchery Ponds is owned and administered by the City of Santa Rosa and consists of approximately 1,000 plants. This site is maintained as a recreational area. City of Santa Rosa park maintenance staff have voluntarily stopped mowing and cutting *Helianthus paradoxus* during the months of August and September. An information kiosk on endangered wetland plants is being planned for the bike/foot path along the creek at Blue Hole Park. This subunit was confirmed to be occupied in 2006 (Blue Earth Ecological Consultants, Inc. 2006, p. 4), contains all of the PCEs, and is threatened by encroachment from nonnative vegetation, wetland filling, and park maintenance activities. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address *Helianthus paradoxus* in this area. Subunit 3b is located at Westside Spring. This subunit is 6 ac (3 ha) of private land in Santa Rosa, Guadalupe County, New Mexico. The subunit consists of an area along an unnamed spring on the west side of the Pecos River, located to the west of River

Road and 1 mi (1.6 km) east of Highway 54. We believe this area was not occupied at the time of listing. It was discovered in 2005, and contained thousands of plants. This site was found to be occupied again in 2006 by a species expert observing from a public right-of-way (Sivinski 2007). This subunit is currently occupied by a stable population, contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by water withdrawal, wetland filling and development, and encroachment of nonnative vegetation. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address *Helianthus paradoxus* in this area. We have determined this site to be essential to the conservation of the species because it is currently occupied by a stable, large population of *Helianthus paradoxus*, and is one of only two stable, large populations in Unit 3. This subunit is sufficiently distant (over 40 mi (64 km)) from other populations to serve as an additional locality that contributes to the conservation of genetic variation. This population may prevent extirpation of the species resulting from encroachment of nonnative species, degradation of habitat, or a catastrophic event that could occur to the other subunit in Unit 3. It may also contain genetic variation specific to this Unit. Because the water source for this population is stable and not anticipated to be subject to any known future water withdrawals, this population can be expected to persist in large numbers every year.

Unit 4: Roswell/Dexter: Subunit 4a includes 576 ac (233 ha) of Bitter Lake National Wildlife Refuge and City of Roswell land located in Chaves County, New Mexico. This subunit is located approximately 5 mi (8 km) northeast of the city of Roswell. One of the largest *Helianthus paradoxus* populations occurs on the Bitter Lake National Wildlife Refuge in New Mexico on Federal lands managed by the Service. Several hundred thousand to a few million plants occur nearly continuously along the shores and small islands of all the artificial lakes in the southern unit of the refuge. Also, a few small patches of plants occur on the west side of Bitter Lake Playa and adjacent springs on the Lost River. This area was occupied at the time of listing and has been visited by species experts during four or more seasons. These experts found the site occupied by *Helianthus paradoxus* on every visit (Ulibarri 2006a, p. 1; Sivinski 2007a, p. 2; Blue Earth Ecological Consultants, Inc. 2007a, p. 3). This area is currently occupied, contains all of the PCEs essential to the conservation of the species, and is threatened by water withdrawal and encroachment of nonnative vegetation. Additional threats occurring on the City of Roswell lands include wetland filling and development, and incompatible livestock management. Therefore, special management or protections may be required to minimize these threats. Subunit 4b includes 96 ac (39 ha) of land within the Bitter Lake National Wildlife Refuge Farm (Refuge Farm). This subunit is located in Chaves County, New Mexico, approximately 5 mi (8 km) east of Roswell on the west side of the Pecos River. Subunit 4b consists of a few large patches with several thousand plants on alkaline seeps behind the dikes on the western edge of the Refuge Farm south of Highway 380. This land is owned and managed by the Service as a grain farm and feeding area for migratory birds. The eastern portion of the Refuge Farm is a marshy spring-seep area that contains a large population of *Helianthus paradoxus*. The wet soils in this population are not cultivated. This area was known to be occupied at the time of listing and has been visited by species experts during four or more seasons. The experts found the site occupied by *Helianthus paradoxus* on every visit (Ulibarri 2006b, p. 1; Sivinski 2007a, p. 2; Blue Earth Ecological Consultants, Inc. 2007a, p. 3). This subunit is currently occupied and contains all of the PCEs in the appropriate spatial arrangement and quantity essential to the conservation of the species. Subunit 4c is located at the Oasis Dairy. This subunit is 104 ac (42 ha) of private land in Chaves County, New Mexico. The subunit is located on the east side of Roswell, west side of Pecos River Valley, approximately 4 mi (7 km) southeast of the Hwy 380 bridge, and beside an

unnamed spring approximately 0.6 mi (1 km) west of the Pecos River and 6 mi (9 km) south of Highway 380. This site contains a very large, dense patch of several thousand *Helianthus paradoxus* in a low alkaline sink area approximately 0.5 mi (0.8 km) west of the Pecos River on private land. It also contains a large patch with many thousands of *H. paradoxus* in a low area below a spring, also on private land. This site was occupied at the time of listing and has been visited by species experts during at least three seasons. These experts found the site occupied by *H. paradoxus* on every visit (Sivinski 2007a, p. 3). This subunit is currently occupied, contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by livestock grazing during *H. paradoxus*' growing and flowering season, water withdrawal, and wetland filling and development. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address *H. paradoxus* in this area.

Subunit 4d is located at Lea Lake at Bottomless Lakes State Park. This subunit is 20 ac (8 ha) in Chaves County, New Mexico. It includes the wet margins of Lea Lake. This site contains a few thousand plants on the riparian margins of Lea Lake. This land belongs to the State of New Mexico and is managed by the New Mexico Parks and Recreation Division. The lands adjacent to Lea Lake are used as a picnic area and campground for the State Park. This site was occupied at the time of listing and has been visited by species experts during four or more seasons. These experts found the site occupied by *Helianthus paradoxus* on every visit (Sivinski 2007a, p. 3). This subunit is currently occupied (Sivinski 2007a, p. 3; Blue Earth Ecological Consultants, Inc. 2007a, p. 3), contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by encroachment of nonnative vegetation, and recreational and park maintenance activities. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address *H. paradoxus* in this area.

Cienega. This subunit is 41 ac (17 ha) of private land in Chaves County, New Mexico. The subunit is located in a small valley west of the Pecos River, east of the Hagerman Irrigation Canal, and 3 mi (5 km) north of Dexter. This site consists of several thousand plants on private land along a wide, boggy drainage bottom. This site was known to be occupied at the time of listing based upon observations from a public right-of-way by species experts during at least three seasons (Sivinski 2007a, p. 2). This subunit is currently occupied, contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by water withdrawal, wetland filling and development, and livestock grazing during *Helianthus paradoxus*' growing and flowering season. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address *H. paradoxus* in this area.

Unit 5: West Texas Unit 5 includes 240 ac (97 ha) of private land located on Diamond Y Spring in Pecos County, Texas. The unit is located approximately 12 mi (20 km) north-northwest of Fort Stockton, Texas. Unit 5 consists of several hundred thousand to one million plants found on The Nature Conservancy's Diamond Y Spring Preserve and a contiguous parcel of private land. This site was occupied at the time of listing and has been visited by species experts during four or more seasons. These experts found the site occupied by *Helianthus paradoxus* on every visit (Poole 2006, p. 2). This unit is currently occupied (Blue Earth Ecological Consultants, Inc. 2007b, p. 3) and contains all of the PCEs essential to the conservation of the species. The land within The Nature Conservancy's Diamond Y Spring Preserve was purchased to protect Diamond Y Spring Preserve and other rare or endangered aquatic species in the Diamond Y Spring system. This habitat is managed for the conservation of such species (Service 2005, p. 12). Diamond Y Spring Preserve has recently expanded from 1,500 ac (607 ha) to 4,000 ac (1,618 ha). However, *Helianthus paradoxus* on the Preserve is threatened by water withdrawal occurring outside the

Preserve. On the adjacent private land, *H. paradoxus* is also threatened by water withdrawal, wetland filling and development, and livestock grazing during the growing and flowering season. As a result, special management or protections may be required to minimize these threats. At this time, we are not aware of any completed management plans that address *H. paradoxus* in this area.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Helianthus paradoxus* critical habitat consists of two components (73 FR 17762-17807):

- (i) Silty clay or fine sand soils that contain high organic content, are saline or alkaline, are permanently saturated within the root zone (top 50 cm (19.7 in) of the soil profile), and have salinity levels ranging from 10 to 40 parts per thousand; and
- (ii) A low proportion (less than 10 percent) of woody shrub or canopy cover directly around the plant.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the areas occupied by the species at the time of listing contain the physical and biological features essential to the conservation of the species, and whether these features may require special management consideration or protections. As stated in the final listing rule (64 FR 56582), threats to *Helianthus paradoxus* and its physical and biological features include drying of wetlands from groundwater depletion, alteration of wetlands (e.g., wetland fills, draining, impoundment, and development), competition from nonnative plant species, overgrazing by livestock during *H. paradoxus*' flowering season, impacts from recreational activities, mowing, and highway maintenance. The loss or alteration of wetland habitat continues to be the main threat to *Helianthus paradoxus*. The scattered distribution of cienegas makes them aquatic islands of unique habitat in an arid-land matrix (Hendrickson and Minckley 1984, p. 169). There is evidence these habitats have been historically, and are presently being, reduced or eliminated by aquifer depletion, and severely impacted by agricultural activities and encroachment by exotic plants (Poole 1992, pp. 1–2; Sivinski 1995, p. 11). The lowering of water tables through aquifer withdrawals for irrigation and municipal use, diversion of water from wetlands for agriculture and recreational uses, and wetland filling for conversion to dry land uses destroy or degrade desert wetlands. In Grants, New Mexico, *Helianthus paradoxus* has been observed in close proximity to building sites that may have contained suitable wetland habitat prior to filling (Service 2005, p. 8). A cienega containing *H. paradoxus* near Dexter, New Mexico, was dried when a wellhead was placed on the spring and the water diverted for other uses (Service 2005, p. 8). Springs that have fed *H. paradoxus* habitats have been converted to swimming pools and fishing ponds in the towns of Roswell and Santa Rosa, New Mexico (Service 2005, p. 8). Groundwater withdrawals for agriculture in Pecos and Reeves counties in Texas have had an especially severe impact on desert springs (Service 2005, p. 8). Of the 61 historical desert springs in these two counties, only 13 were still flowing in 1980 (Brune 1981 in Poole 1992, p. 5). Beginning around 1946, groundwater levels fell as much as 400 feet (ft) (120 meters (m)) in Pecos County and 500 ft (150 m) in Reeves County. Groundwater pumping has lessened in more recent years due to the higher cost of removing water from deeper aquifers, but rising water tables and resumption of spring flows are not expected (Poole 1992, p. 5). We are not aware of any protections afforded by Texas water

law for the remaining springs that support *H. paradoxus* populations on The Nature Conservancy properties, which limits options for addressing this threat. Livestock will eat *Helianthus paradoxus* when other green forage is scarce, and when the buds are developing and abundant (Service 1999, p. 56587). Cattle and horses tend to pull off the flower heads, which can reduce seed production (Bush and Van Auken 1997, p. 416). However, well-managed grazing during non-flowering months may have a beneficial effect on *H. paradoxus* populations by decreasing the density and biomass of potentially competing plant species in these habitats. This sunflower germinates earlier than most associated plants and grows vigorously on wet, bare, highly insolated soils (Service 2005, p. 9). Actions that remove shading grass cover, such as grazing, appear to enhance growth and reproduction of sunflower plants that are later protected from grazing while they are reproductively maturing. Therefore, properly managed livestock grazing can be compatible with *H. paradoxus* conservation. Livestock grazing operations that are not managed to protect *H. paradoxus* occur in populations in the Grants and Roswell areas of New Mexico (Service 2005, p. 9). Although water contamination is a significant threat for the Roswell springsnail, Koster's springsnail, Noel's amphipod, and the Pecos assiminea found on Bitter Lake National Wildlife Refuge (70 FR 46304), we have no information on whether contamination of water would affect *Helianthus paradoxus*. We did not find that reduced water quality was a threat to the species when it was listed in 1999 (64 FR 56582). Moreover, we are not aware of any research or information that documents the species' response to elevated nutrients or contaminants. For these reasons, we do not believe that water contamination is a significant threat to *H. paradoxus* at this time. We have determined that each area included in this designation meets the definition of critical habitat for the reasons described in our unit descriptions below.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (inferred from NatureServe, 2015)

Lifespan

Adult: 1 year (inferred from USFWS, 2015)

Breeding Season

Adult: August - October (USFWS, 2015)

Key Resources Needed for Breeding

Adult: Possibly ground disturbance (inferred from NatureServe, 2015); pollinators unknown - likely various insects (USFWS, 2005)

Reproduction Narrative

Adult: No specific research has been conducted on the reproduction of this species. The reproductive biology is likely to be very similar to that of the common sunflower, *H. annuus*. Cattle disturbance of the surrounding vegetation may supply puzzle sunflower with light gaps for germination and growth, and lessen competition (Bush and Van Auken 1997). Numerous experiments have been conducted both in and ex situ on competition between puzzle sunflower and its associates (Van Auken and Bush 1993, 1994, 1995). With competitors removed, puzzle

sunflower exhibited greater basal stem diameter, more flower heads, and greater flower head, leaf, and stem dry mass (Bush and Van Auken 1997). Annual species of sunflowers hybridize in cultivation, but have reduced pollen viability and seed fertility (Heiser 1965, 1969). Hybrids of puzzle and common sunflower have been observed at Diamond Y Preserve in west Texas and in the Santa Rosa area of New Mexico (NatureServe, 2015). The Pecos sunflower is an annual plant that must re-establish each population by seeds produced during preceding years. It is annual plant that germinates in the spring, and flowers and makes seed from late August through October (USFWS, 2015). Pollination vectors for the Pecos sunflower have not been studied. However, most radiate-headed plants in the aster family are generalists in attracting a variety of insect pollinators (USFWS, 2005).

Habitat Type

Adult: Wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cienega (NatureServe, 2015), wet meadow, spring seeps (USFWS, 2015)

Dependencies on Specific Environmental Elements

Adult: Disturbance regime, 10 - 40 ppt soil salinity, < 10% canopy cover (USFWS, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 3,280 - 6,561 ft. elevation (USFWS, 2015)

Spatial Arrangements of the Population

Adult: Patches of dozens to thousands (USFWS, 2005)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 2015)

Habitat Narrative

Adult: *Helianthus paradoxus* is the only sunflower in the Southwest United States that requires permanent wetlands for its survival. Puzzle sunflowers grow in saline soils that are permanently saturated. Areas that maintain these conditions are commonly called cienegas (desert wetlands) associated with springs. However, the required conditions may also be found at stream margins and at the margins of impoundments. Where plants are associated with the latter the impoundments have replaced the natural cienegas. Van Auken and Bush (1995) tested puzzle sunflower to determine if it was mycorrhizal. The greenhouse experiments, done with non-native soil, indicated that puzzle sunflower was an obligate mycorrhizal species (NatureServe, 2015). This species is associated with spring seeps and desert cienegas, or wet meadows, which are very rare in the dry regions of New Mexico and Texas. The cienega climax community has been described as mid-elevation, 3280.84 to 6561.68 feet (ft.). Disturbance regimes, such as fire or tillage, which eliminate vegetation thatch and expose bare ground surface tend to increase Pecos sunflower cover and productivity (Van Auken and Bush 2004; New Mexico Forestry Division 2008). Based on knowledge of the life history, biology, and ecology of the Pecos sunflower and the habitat requirements for sustaining the essential life history functions of the

species, the PBFs for Pecos sunflower are the desert wetland or riparian habitat components that provide: (1) Silty clay or fine sand soils that contain high organic content, are saline or alkaline, are permanently saturated within the root zone in the top 19.69 inches (in) (50 centimeters (cm)) of the soil profile, and have salinity levels ranging from 10 to 40 parts per thousand; and (2) low proportion (less than 10 percent) of woody shrub or canopy cover directly around the plant (U.S. Fish and Wildlife Service 2008b). The Pecos sunflower is intolerant of habitats that are too wet at the surface and prefers soils that are relatively dry at the surface and wet in the lower root zone (Bush 2006) (USFWS, 2015). Populations tend to grow in crowded patches of dozens or even thousands of individuals (USFWS, 2005).

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 2015)

Dispersal/Migration Narrative

Adult: Limited seed mobility restricts the ability of the Pecos sunflower to disperse to other suitable habitats or away from habitat that becomes unsuitable (USFWS, 2015).

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Resiliency:

Low (inferred from USFWS, 2015)

Redundancy:

Low (inferred from USFWS, 2005)

Number of Populations:

7 (USFWS, 2005)

Population Size:

< 100 to > 200,000 per site, fluctuates yearly (USFWS, 2015)

Adaptability:

Low (inferred from USFWS, 2015)

Population Narrative:

At some occurrences it is locally abundant - maybe > 3000 individuals in total - but some New Mexico occurrences are small and nonviable. At present there are six general areas where the species occurs: four in New Mexico and two in Texas. There are between 1 and 11 sites at each of these six general locations for a total of 25 sites. Ten of the 11 Pecos River sites occur within a 22 mile (36 km) stretch of the Pecos River Valley. All eight observations in the Santa Rosa area occur within a four square-mile area. The two sites in Grants are near the San Jose River and separated from the Laguna population by approximately 44 miles (73 km). The two Diamond Y sites are within three miles of each other. The Diamond Y and East Sandia Springs Preserves are

within 50 miles (80 km) of each other. The Texas sites are approximately 150 miles (241 km) south of the most southerly New Mexico site. The overall trend for the species is unclear as the historical distribution, with few exceptions, is unknown (NatureServe, 2015). The Pecos sunflower has a small, localized range, such that either a natural (e.g., drought) or anthropogenic (e.g., water withdrawal) perturbation can eliminate many or all of the existing populations. The number of sunflowers per site varies from less than 100 to several hundred thousand. Because Pecos sunflower is an annual, the number of plants per site can fluctuate greatly from year to year with changes in precipitation and depth to ground water. The Pecos sunflower has a small, localized range, such that either a natural (e.g., drought) or anthropogenic (e.g., water withdrawal) perturbation can eliminate many or all of the existing populations (USFWS, 2015). Pecos sunflower occurs in seven populations; two occur in west Texas and five are located in New Mexico (USFWS, 2005).

Threats and Stressors

Stressor: Reduction of water in springs (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Loss or alteration of spring habitat continues to be the main threat to Pecos sunflower. Lowering water tables from aquifer withdrawals for irrigation and municipal use has degraded many desert spring habitats. The primary threat to the Pecos sunflower in west Texas is the potential failure of spring flow due to excessive groundwater pumping or drought or both, which would result in total habitat loss for the species. There is evidence that spring habitats have been historically reduced or eliminated by aquifer depletion on the Bitter Lake NWR (Jones and Balleau 1996). In addition, recent drought years may have impacted the size of Pecos sunflower populations on La Joya WMA (Hirsch 2012). Here, the total number of acres occupied by Pecos sunflower fell from 261 ac (105.622 ha) in 2010, to 224 ac (90.65 ha) in 2011, to 200 ac (80.94 ha) in 2012, as the drought in New Mexico intensified (USFWS, 2015).

Stressor: Nonnative plants (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Exotic plants have potential to seriously impact the native plant community composition and ecological integrity of arid land springs and cienegas. Exotic trees, especially salt cedar and Russian olive can almost completely convert a treeless cienega to a dense woodland with little understory vegetation. Aggressive, rhizomatous non-native grasses and forbs compete with, and replace, native cienega plants, especially in areas of soil disturbance. Herbaceous exotics that are currently degrading some arid land springs and cienegas include Persoon (Johnsongrass) (*Sorghum halepense*), Hudson meadow fescue and perennial pepperweed (USFWS, 2015).

Stressor: Water contamination (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Water contamination, particularly from oil and gas operations, could be a potential threat for Pecos sunflower, but the effects on this species have not been studied. In order to assess the potential for contamination, a study was completed in September 1999 to delineate the area that serves as sources of water for the springs on Bitter Lake NWR (Balleau Groundwater, Inc. 1999). This study reported that the sources of water that will reach Bitter Lake NWR's springs include a broad area beginning west of Roswell near Eightmile Draw, extending to the northeast to Salt Creek, and southeast to Bitter Lake NWR. This area represents possible pathways from which contaminants may enter the groundwater that feeds the springs on the Refuge. This broad area is located within a portion of the Roswell Basin and contains a mosaic of Federal, State, City, and private lands with multiple land uses, including expanding urban development. There are 378 natural gas and oil wells in the 12-township area encompassing the source-water capture zone for the Middle Tract of Bitter Lake NWR that are potential sources of contamination (Go-Tech 2010). The Diamond Y Springs Complex is within an active oil and gas extraction field. At this time, there are still many active wells and pipelines located within approximately 330 ft. (100 m) of the surface waters at the springs. In addition, a natural gas refinery is located within 0.5 mi (0.8 km) upstream of Diamond Y Spring (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Increased air temperatures lead to higher evaporation rates, which may reduce the amount of runoff, groundwater recharge, and consequently spring discharge. Increased temperatures across the Southwest may also increase the extent of area influenced by drought (Lenart 2003), decreasing groundwater recharge regionally, and thereby reducing spring discharge. Prolonged drought leading to diminishment or drying of springs would have a negative impact on Pecos sunflower. Springs would not have to dry out completely to have an adverse effect. In addition, as water becomes increasingly scarce, conflict over its use becomes more intense. The proportion of human and livestock consumption of water would be expected to increase during drought. Any of these factors, alone or in combination, could lead to either the reduction or extirpation of Pecos sunflower populations. Therefore, climate change is a significant threat to the Pecos sunflower into the foreseeable future (USFWS, 2015).

Recovery

Reclassification Criteria:

Not available

Delisting Criteria:

1. Identify and establish at least one core conservation area for Pecos sunflower in each of the four distinct recovery regions that would collectively, if protected, ensure the long-term survival of the species. Each core habitat must occur on wetlands that are not threatened by depletion of the contributing aquifer and have demonstrated a self-perpetuating stand of Pecos sunflowers of greater than 5,000 individuals for a minimum of 7 out of 10 years. In addition to the core conservation area, each region should have at minimum one isolated stand of protected Pecos sunflowers with greater than 1,600 individuals for at least 7 out of 10 years to protect against catastrophic loss of the regional population (USFWS, 2015).

2. Assure long-term protection of designated core conservation areas and designated isolated stands in perpetuity through the implementation of appropriate management plans, conservation easements, or land acquisitions (USFWS, 2015).

Recovery Actions:

- Identify and establish core conservation areas and isolated stands (USFWS, 2005).
- Identify and address information gaps, compatible uses, and management actions regarding Pecos sunflower distribution, biology and aquifer stability (USFWS, 2005).
- Protect core conservation areas and isolated stands through landowner education, implementation of management plans, conservation easements, and land acquisition (USFWS, 2005).
- Monitor Pecos sunflower conservation areas and management actions as needed to satisfy delisting criteria (USFWS, 2005).

Conservation Measures and Best Management Practices:

- Habitat protection through land acquisition or conservation agreements with landowners is the most important remaining recovery task. The development of management plans for the different agencies, as outlined in the recovery plan, should continue to be pursued. Government programs that acquire cienegas or assist landowners with their management are greatly needed (USFWS, 2015).
- Non-native tree species and thatch should continue to be removed in occupied and potential Pecos sunflower habitats. Pecos sunflowers should be re-seeded in suitable areas with willing land owners or managers within the range of the species to expand occupied habitats. The Pecos sunflower would also make an excellent focal species for public education and awareness of the importance of wetlands and the recovery of listed species. These opportunities should be explored and implemented where appropriate (USFWS, 2015).
- The recovery criteria in the Pecos Sunflower Recovery Plan (U.S. Fish and Wildlife Service 2005) should be collectively re-evaluated to determine if they constitute the most effective strategy for conservation and recovery of the species. Of most significance, the actual size of existing core populations is between 50 and 100 times, or even higher multiples in some years of, the minimum number required in the recovery plan. The current recovery criteria may not have considered this much higher number of plants extant throughout the range of the species (USFWS, 2015).
- Survey efforts in occupied and potential habitats should be increased and improved, and surveys should employ an agreed-upon standardized protocol. Surveys should cover the entire range of the species and be repeated at least every 3 years. Existing populations should be monitored to document population trends in response to habitat restoration and maintenance (USFWS, 2015).

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SPECIES ACCOUNT: *Helianthus schweinitzii* (Schweinitz's sunflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 5/7/1991; Southeast Region (R4) (USFWS, 2015)

Physical Description

A perennial herb that produces solitary stems, up to 2 m tall and bears yellow flower heads in late summer and early autumn (NatureServe, 2015).

Taxonomy

Heiser et al. (1969), in the most recent monograph of the genus *Helianthus*, placed *H. schweinitzii* in Section *Divaricati*, Series *Gigantel*. Its closest relatives include other members of the *Gigantei* series, such as *H. giganteus* Linnaeus, *H. maximiliani* Schrader, *H. resinosus* Small, and *H. grosseserratus* Martens. The small heads, however, make *H. schweinitzii* anomalous in the *Gigantei* (USFWS, 1994).

Historical Range

Endemic to Piedmont (and central Plateau) of North Carolina and South Carolina (NatureServe, 2015). Past reports known from other parts of North and South Carolina, including Columbus County, North Carolina, and Horry County, South Carolina (both in the outer Coastal Plain), and Stokes County, North Carolina (in the upper Piedmont of North Carolina near the Virginia border) (USFWS, 1994).

Current Range

The species' distribution includes 13 NC counties (the original five plus Anson, Davidson, Gaston, Montgomery, Randolph, Richmond, Stokes, Surry) and two SC counties (Lancaster and York) (USFWS, 2010).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, vegetative (USFWS, 1994)

Lifespan

Adult: > 10 years (USFWS, 1994)

Breeding Season

Adult: August - first frost (USFWS, 1994)

Reproduction Narrative

Adult: It is a long-lived perennial with individuals probably living for decades. The species blooms from late August to frost. The relative importance of sexual (by seed) and asexual (by

rhizome) reproduction is not known in this species. Schweinitz's sunflower can also be propagated from pieces of the tubers. New plants readily sprout from entire or partial tubers (Creel, personal communication, 1992) (USFWS, 1994).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Oak-pine-hickory woods, piedmont longleaf pine forests (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Full to partial sun (NatureServe, 2015); periodic fire (USFWS, 1994)

Geographic or Habitat Restraints or Barriers

Adult: Dense vegetation (USFWS, 1994)

Spatial Arrangements of the Population

Adult: Clumped (see population narrative)

Habitat Narrative

Adult: Clearings in, and edges of, upland oak-pine-hickory woods and piedmont longleaf pine forests in moist to dryish sandy loams. Requires the full to partial sun of an open habitat, which was formerly maintained over the species' range by wildfires and grazing by herds of bison and elk. Now most occurrences are confined to roadsides and powerline clearings. (NatureServe, 2015). Although *H. schweinitzii* substrates in the Carolina Slate Belt are primarily mafic rocks (of either volcanic, plutonic, or sedimentary origin), the species also appears to occur on intermediate and even felsic rocks. With fire operating in the landscape to maintain open and semi-open habitats (Piedmont prairies and oak barrens or oak savannas), it is possible that Schweinitz's sunflower had a wider ecological amplitude than is apparent to us in the modern landscape. They also appear to be detrimentally affected by growing in dense competing vegetation, even if the other vegetation does not shade them (Bradford-Clebsch. personal communication. 1992) (USFWS, 1994).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Low to moderate (inferred from USFWS, 2010; see current range/distribution)

Representation:

Low (inferred from USFWS, 2010)

Redundancy:

High (inferred from USFWS, 2010)

Number of Populations:

~86 (USFWS, 2010)

Population Size:

5,000 - 10,000 individuals (NatureServe, 2015)

Population Narrative:

Fire suppression in region has detrimental effect on occurrences; local species adaptations. One North Carolina occurrence has more than 3000 stems, but difficult to define individual. Two populations have more than 1000 stems (2005) (NatureServe, 2015). The species status is uncertain; the majority of sites are not monitored annually, or in any manner capable of assessing year-to-year fluctuations in status and trends. Matthews and Howard (1999) reviewed genetic variation in 25 sites occupied by the species, as detected by allozyme loci. Low levels of genetic variation among populations were detected, and genetic differentiation among sites was not correlated with geographic distance. The total known range consists of some 86 populations (USFWS, 2010).

Threats and Stressors

Stressor: Habitat destruction and degradation (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Threats to the species continue to escalate with rapid urbanization and suburban sprawl in the greater Charlotte area. Throughout the species' range, over 90% of known sites occur in managed ROW, where vegetation management practices occasionally mimic patterns of natural disturbance (from fire or native grazers) now largely absent from the present day landscape. However, these same vegetation management practices pose a threat to these occurrences, in that inappropriately timed mowing (e.g., during the growing season, prior to seed set) or excessive herbicide application have adversely impacted the species at several of these locations. Many of these ROW occurrences are along existing roads which are subject to widening and improvement projects which disturb or eliminate the existing adjacent ROW. The NCDOT has a program in which roadside occurrences of federally listed plant species are posted with signs prohibiting growing season mowing or herbicide application. Despite these efforts, 28 of 63 NCDOT sites containing *H. schweinitzii* were reportedly adversely impacted at least once as of 2003 (USFWS, 2010).

Recovery**Reclassification Criteria:**

1. 10 geographically distinct, self-sustaining populations are protected in at least 4 counties in North Carolina and one in South Carolina (USFWS, 2010).
2. Managers have been designated for each population (USFWS, 2010).

3. Management plans have been developed and implemented (USFWS, 2010).

4. Populations have been maintained for 5 years (USFWS, 2010).

Delisting Criteria:

1. 15 geographically distinct, self-sustaining populations are protected in at least 4 counties in North Carolina and one in South Carolina (USFWS, 2010).

2. Management plans have been implemented (USFWS, 2010).

3. Populations (as measured by number of adult plants) have been stable or increasing for 10 years (USFWS, 2010).

4. Permanent conservation ownership and management of at least 10 populations are assured by legally binding agreements (USFWS, 2010).

Recovery Actions:

- Implement emergency protective management of known remnant populations (USFWS, 1994).
- Survey suitable habitat for additional populations and potential reintroduction sites (USFWS, 1994).
- Protect viable populations through a range of protection tools (management agreements, acquisition, registry, cooperative agreements, etc.) (USFWS, 1994).
- Monitor existing populations (USFWS, 1994).
- Conduct research on the biology of the species and on suitable management tools for maintaining the natural ecosystem in which it occurred (USFWS, 1994).
- Implement management on protected populations (USFWS, 1994).

Conservation Measures and Best Management Practices:

- For sites with the potential to contribute toward the species' recovery (Appendix B, Tables B.1 and B.2), work with appropriate owners/managers to implement monitoring capable of producing reliable trend data at each site. Range-wide standardized monitoring protocol are generally not regarded as feasible for this species, due to the widely varying sizes of populations and the resources available to monitor them. However, site-specific protocol could be implemented such that counts or estimates provided at a given site are directly comparable from one monitoring period to the next (USFWS, 2010).
- For sites with the potential to contribute toward the species' recovery (Appendix B, Tables B.1 and B.2), characterize existing vegetation using standardized community classification methods (e.g., NatureServe's community classification systems and Schafale and Weakley (1990)). Use this information to inform restoration objectives and direct future site protection efforts toward the highest quality habitats (USFWS, 2010).
- Devise recovery criteria which balance the availability of suitable habitat with opportunities for restoration, management, and protection as dictated by landowner willingness and resource availability. These criteria should emphasize the role of prescribed fire in site restoration and management, but allow for those instances in which sites cannot be managed with fire (USFWS, 2010).

- Work with Dr. Richard Houk (Winthrop University, retired) to find successors to continue his monitoring efforts in South Carolina (USFWS, 2010).
- Clarify the role of controlled propagation, rescue and relocation, and public demonstration gardens in the species' recovery, so that sites supporting native populations in conjunction with remnants of native plant communities are prioritized for protection (above sites characterized by rescued and introduced plant material) (USFWS, 2010).

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USFWS 2010. Schweinitz's sunflower (*Helianthus schweinitzii*) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Asheville, North Carolina, Field Office, Asheville, North Carolina.

SPECIES ACCOUNT: *Helianthus verticillatus* (Whorled Sunflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/1/2014; Southeast Region (R4) (USFWS, 2015)

Physical Description

A tall, perennial, herbaceous sunflower 1-2 meters in height with flower heads about 1 cm wide (Matthews et al. 2002). Flowers from August into October (NatureServe, 2015).

Taxonomy

The U.S. Fish and Wildlife Service (Call 2009) accepts this taxon as a species in considering it a candidate for federal listing; Matthews et al. (2002) and Flora of North America Editorial Committee (2006) also treat it as a species. Two supporting studies are cited by the USFWS: (1) morphological studies and root-tip chromosome counts which showed it to be a distinct, fertile diploid (Matthews et al. 2002); and (2) comparative genetic studies with its putative parents (*H. grosserratus* and *H. angustifolius*), which showed that it does not exhibit a mixture of parental alleles at nuclear loci and does not share chloroplast DNA haplotype with either of its putative parents (Ellis et al. 2006). In contrast, the Kartesz checklists (1994 and 1999) treat this taxon as a hybrid between *Helianthus angustifolius* and *H. grosseserratus*, following earlier treatments written when it was known from only the type specimen (NatureServe, 2015).

Historical Range

The species is known from Cherokee County, Alabama; Floyd County, Georgia; and McNairy and Madison Counties, Tennessee (USFWS, 2013).

Current Range

This species occurs in remnant prairie habitats found in uplands and swales of headwater streams in the Coosa River watershed in Georgia and Alabama and in the East Fork Forked Deer and Tuscumbia Rivers' watersheds in Tennessee (USFWS, 2014).

Critical Habitat Designated

Yes; 8/26/2014.

Legal Description

On August 26, 2014, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Helianthus verticillatus* (Whorled Sunflower) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four critical habitat units (CHUs), in Indiana, Alabama, Georgia and Tennessee (79 FR 50990-51039).

Critical Habitat Designation

The critical habitat designation for *Helianthus verticillatus* includes four CHUs in Cherokee County, Alabama; Floyd County, Georgia; and Madison and McNairy Counties, Tennessee. This species critical habitat encompasses approximately 1,542.3 acres (ac) (624.2 hectares (ha)) (79 FR 50990-51039).

Unit 1: Mud Creek: Unit 1 consists of 210.6 ha (520.4 ac) of privately owned lands in Cherokee County, Alabama, located approximately 11.6 km (7.2 mi) southeast of the city limits of Cedar

Bluff. The unit begins approximately 0.06 km (0.04 mi) north of the junction of CR–164 and CR–29 and extends in a northerly direction to encompass much of the drainage area of an unnamed tributary to Mud Creek and to the northeast to encompass much of the drainage area of a second unnamed tributary to Mud Creek. The easternmost boundary of this unit is adjacent to CR–101, from approximately 1.0 km (0.6 mi) to 1.4 km (0.9 mi) north of its junction with CR–164. Silt loam and silty clay loam soils are present throughout the unit, spanning broad uplands, and terraces and flood plains of headwater streams in the Coosa River watershed (PCE 1). The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of soil disturbance due to silvicultural site preparation or timber harvest; indiscriminate herbicide use or mowing for silvicultural purposes or road right-of-way maintenance; conversion of remnant prairie habitat to agricultural or industrial forestry uses; and excessive shading or competition from native woody species or invasive, nonnative plants.

Unit 2: Coosa Valley Prairie: Unit 2 consists of 366.9 ha (906.5 ac) of privately owned lands in Floyd County, Georgia, located approximately 4.5 km (2.8 mi) northwest of the city limits of Cave Spring. This unit corresponds to the boundary of The Nature Conservancy's conservation easement on lands formerly owned by The Campbell Group and now owned by Plum Creek, a site commonly referred to as the Coosa Valley Prairie. The northern boundary of this unit follows Jefferson Road for approximately 1.4 km (0.9 mi) in a southeasterly direction, beginning approximately 1.7 km (1.0 mi) east of the Alabama-Georgia State line. From the eastern extent on Jefferson Road, the unit boundary follows an unnamed dirt road south for a distance of approximately 1.5 km (0.9 mi), where the boundary turns to the west and south before turning back to the north and again to the west, reaching the Alabama-Georgia State line. Here, the unit follows the State line in a northwest direction for approximately 0.8 km (0.5 mi) before turning east and following an unnamed dirt road in a northeasterly direction for approximately 2.7 km (1.7 mi) and reuniting with the northern boundary on Jefferson Road. Silt loam and silty clay loam soils are present throughout the unit, spanning broad uplands, depressions, and terraces and flood plains of headwater streams in the Coosa River watershed (PCE 1). Prairie openings and woodlands with low levels of canopy cover (PCE 2) are present throughout much of the unit. While Ellis and McCauley (2009, pp. 1837–1838) found very few viable achenes and low germination rates at this site, whorled sunflower has responded favorably to habitat management efforts by increasing in numbers, and there likely are now a sufficient number of compatible mates for production of viable achenes (PCE 3) at this site. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of soil disturbance due to silvicultural site preparation or timber harvest; indiscriminate herbicide use or mowing for silvicultural purposes or road right-of-way maintenance; conversion of remnant prairie habitat to agricultural or industrial forestry uses, and excessive shading or competition from native woody species or invasive, nonnative plants.

Unit 3: Prairie Branch: Unit 3 consists of 6.0 ha (14.9 ac) of privately owned land in McNairy County, Tennessee, and is located approximately 0.6 km (0.5 mi) south of the easternmost city limit of Ramer. This unit is located along Prairie Branch, a tributary to Muddy Creek, beginning approximately 0.42 km (0.26 mi) upstream of the point where it passes under Mt. Vernon Road and extending downstream for approximately 2.0 km (1.2 mi). Within this reach, the critical habitat unit forms a buffer extending 15 m (50 ft) upslope from the tops of the banks on both sides of Prairie Branch. Sandy loam soils (PCE 1) are present throughout the unit, as are small patches of vegetation containing whorled sunflower and other wet prairie species (PCE 2). The

features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of soil disturbance due to agricultural practices; indiscriminate herbicide use or mowing for road or railroad right-of-way maintenance; conversion of remnant prairie habitat to agricultural uses; and competition from invasive, nonnative plants.

Unit 4: Pinson: Unit 4 consists of 40.7 ha (100.5 ac) of privately owned land in Madison County, Tennessee, and is located approximately 4.1 km (2.5 mi) northwest of the city limits of Henderson, Tennessee. Beginning approximately 0.7 km southeast of the junction of U.S.–45 and Bear Creek Road, this unit extends approximately 0.08 km (0.05 mi) northeast of U.S.–45, crossing a railroad track, and then turns in a southeasterly direction, paralleling the track for a distance of approximately 0.5 km (0.3 mi). From this corner, the unit boundary turns southwest for a distance of approximately 0.79 km (0.49 mi), and then turns to the northwest for a distance of approximately 0.65 km (0.4 mi). From this corner, the unit boundary turns to the northeast for a distance of approximately 0.63 km (0.39 mi). Silt loam soils (PCE 1) are present throughout the unit, small patches of vegetation containing whorled sunflower and wet prairie species (PCE 2) are present, and a sufficient number of compatible mates are present for the production of a limited number of viable achenes (PCE 3) (Ellis and McCauley 2009, p. 1838). The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of soil disturbance due to agricultural practices; indiscriminate herbicide use or mowing road or railroad right-of-way maintenance; conversion of remnant prairie habitat to agricultural uses; and excessive shading or competition from native woody species or invasive, nonnative plants. Much of the land within this unit has been converted to agricultural uses, but is included because of the potential for decreasing fragmentation among the subpopulations that are present in this unit by restoring suitable vegetation within previously converted lands.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Helianthus verticillatus* critical habitat consists of three components (79 FR 50990-51039):

- (i) Silt loam, silty clay loam, or fine sandy loam soils on land forms including broad uplands, depressions, stream terraces, and floodplains within the headwaters of the Coosa River in Alabama and Georgia and the East Fork Forked Deer and Tuscumbia rivers in Tennessee.
- (ii) Sites in which forest canopy is absent, or where woody vegetation is present at sufficiently low densities to provide full or partial sunlight to whorled sunflower plants for most of the day, and which support vegetation characteristic of moist prairie communities. Invasive, nonnative plants must be absent or present in sufficiently low numbers to not inhibit growth or reproduction of whorled sunflower.
- (iii) Occupied sites in which a sufficient number of compatible mates are present for outcrossing and production of viable achenes to occur.

Special Management Considerations or Protections

The features essential to the conservation of whorled sunflower may require special management considerations or protection to reduce the following threats: (1) Soil disturbance

due to silvicultural site preparation, timber harvest, or cultivation of row crops; (2) indiscriminate herbicide use or mowing; (3) conversion of remnant prairie habitat to agricultural or industrial forestry uses; and (4) excessive shading or competition from native woody species or invasive, nonnative plants. Management activities that could ameliorate these threats include, but are not limited to: (1) Avoiding areas located in close proximity to whorled sunflower sites when planning for establishing new sites for agriculture or pulpwood and timber production; (2) ensuring that herbicide use or mowing does not occur in whorled sunflower sites during the species' growing season; (3) locating suitable habitat, determining presence or absence of whorled sunflower, and protecting or restoring as many sites or complexes of sites as possible; (4) managing, including prescribed burning, mowing, and bushhogging, to reduce canopy cover, minimize competition from native and invasive, nonnative plants, and maintain characteristic moist prairie vegetation; (5) reaching out to all landowners, including private, State, and Federal landowners, to raise awareness of the plant and its habitat; and (6) providing technical or financial assistance to landowners to help in the design and implementation of management actions that protect the plant and its habitat.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Vegetative (NatureServe, 2015); sexual (inferred from USFWS, 2014)

Breeding Season

Adult: August - October (USFWS, 2013)

Reproduction Narrative

Adult: The low number of populations in the wild may be due to poor in situ seed germination (Matthews et al. 2002). However, seed germination is high in the laboratory and the species can reproduce rapidly from rhizomes, forming a dense colony (Call 2009) (NatureServe, 2015). This species is self-incompatible (USFWS, 2014). It produces flowers from August into October (Matthews et al. 2002, pp. 17–20; Ellis and McCauley 2008, p. 1837) (USFWS, 2013).

Habitat Type

Adult: Terrestrial, wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Wet prairie, calcareous barrens, riparian (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Full to partial sunlight (USFWS, 2014)

Geographic or Habitat Restraints or Barriers

Adult: Succession (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 2013)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Habitat Narrative

Adult: A narrow habitat specialist occurring in remnant wet prairie areas and calcareous barrens, in moist, prairie-like openings in woodlands and along adjacent creeks. Soils are sandy clays which are alkaline, high in organic matter, and seasonally wet. Some associated plant species, including *Schizachyrium scoparium*, *Sorghastrum nutans*, *Andropogon gerardii*, and *Panicum virgatum*, suggest a strong prairie affinity. Other associates include *Carex cherokeensis*, *Sporobolus heterolepis*, *Physostegia virginiana*, *Silphium terebinthinaceum*, *Pycnanthemum virginianum*, *Symphytotrichum novae-angliae*, *Hypericum sphaerocarpum*, *H. angustifolius*, *Helenium autumnale*, and *Marshallia mohrii*. Most remaining wet prairies are remnants along rights-of-way where succession is artificially impeded (Call 2009) (NatureServe, 2015). The soil types are silt loams, silty clay loams, and fine sandy loams at the sites where whorled sunflower occurs. These soils share the characteristics of being strongly to extremely acidic and having low to moderate natural fertility and low to medium organic matter content (USDA 1997, pp. 73–76; USDA 1978a, pp. 24–54; USDA 1978b, p. 20; USDA 1978c, p. 44). Full or partial sunlight for most of the day is an essential feature for this species (USFWS, 2014). Initial efforts to estimate population sizes of whorled sunflower relied on counting individual stems (Allison 2002, pp. 3–8; Schotz 2001, pp. 8–10); however, due to the species' clonal growth habit, stem counts overestimate the true number of genetically distinct individuals (genets) (USFWS, 2013).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Species Trends:

Unknown (NatureServe, 2015)

Resiliency:

Low to moderate (inferred from USFWS, 2014; see current range/distribution)

Representation:

High (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from USFWS, 2014)

Number of Populations:

4 (USFWS, 2014)

Population Size:

250 - 10,000 individuals (NatureServe, 2015)

Population Narrative:

The low number of populations in the wild may be due to poor in situ seed germination (Matthews et al. 2002). However, seed germination is high in the laboratory and the species can reproduce rapidly from rhizomes, forming a dense colony (Call 2009). *H. verticillatus* has a high level of genetic diversity at the population and species level despite its rarity, which may indicate that it was more widespread in the past and perhaps became rare relatively recently (Ellis et al. 2006). Most sites recently discovered. Rarity is due to habitat loss. Its wet prairie habitat was more extensive before European settlement, fire suppression, and conversion to farmland; much of this habitat has been degraded or destroyed due to agricultural, silvicultural, and residential development (Matthews et al. 2002, Call 2009). The Georgia site has hundreds to thousands of stems (Norquist 2005, Call 2009); the number of genetic individuals is believed to be much lower than this, but is not known for certain (Call 2009). One site in Tennessee has about 70 plants (genetic individuals) with 500-1000 stems, the other site, discovered in 2006, has 36 clumps (genetic individuals) with approximately 400 stems (A. Bishop, pers. comm., 2007). One Alabama site contains an estimated 100 genetic individuals, and the second Alabama site contains an estimated 175-200 stems (representing a lower, but unknown, number of genetic individuals) (Call 2009). Five population groups are currently known extant, two in Alabama, one (with three sub-populations) in Georgia, and two in Tennessee (Norquist 2005; A. Bishop, pers. comm., 2007); in addition, there is the historical type collection from Tennessee in 1892, which has not been relocated despite searches. The estimated population size is 250 - 10,000 individuals. Population trends are unknown (NatureServe, 2015). There are four whorled sunflower populations known to be extant (USFWS, 2013).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: The threats to whorled sunflower from habitat destruction and modification are occurring throughout the entire range of the species. These threats include mechanical or chemical vegetation management associated with industrial forestry practices, maintenance of transportation and utility rights-of-way, agricultural practices, and shading and competition. While a conservation easement and suitable habitat management alleviate threats from industrial forestry that otherwise would adversely affect the Georgia population, one of the Alabama whorled sunflower subpopulations currently is threatened by industrial forestry practices. The population-level impacts from these activities are expected to continue into the future (USFWS, 2013).

Stressor: Small, isolated populations (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: The whorled sunflower is vulnerable to localized extinction because of its extremely restricted distribution and small population sizes at most known locations, which reduces the resilience of these populations to recover from acute demographic effects of threats to its

habitat. the highly fragmented distribution of populations within Tennessee, combined with their disjunct location with respect to those in Georgia and Alabama, presumably precludes gene flow among them and leaves little chance of natural recolonization of these populations in the event of localized extinctions. Small population size could be affecting reproductive fitness of the whorled sunflower. The findings of Ellis and McCauley (2008, entire) suggest that the Madison County, Tennessee, population is reproductively less fit than the Alabama population. Ellis and McCauley (2008, p. 1840) offered two possible explanations for reduced reproductive fitness of the Tennessee population, including limited mate availability due to limited diversity of self-incompatibility alleles, or more extensive inbreeding. Both could be contributing to reduced seed production and viability rates (USFWS, 2013).

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- Avoiding areas located in close proximity to whorled sunflower sites when planning for establishing new sites for agriculture or pulpwood and timber production (USFWS, 2014).
- Ensuring that herbicide use or mowing does not occur in whorled sunflower sites during the species' growing season (USFWS, 2014).
- Locating suitable habitat, determining presence or absence of whorled sunflower, and protecting or restoring as many sites or complexes of sites as possible (USFWS, 2014).
- Managing, including prescribed burning, mowing, and bush hogging, to reduce canopy cover, minimize competition from native and invasive, nonnative plants, and maintain characteristic moist prairie vegetation (USFWS, 2014).
- Reaching out to all landowners, including private, State, and Federal landowners, to raise awareness of the plant and its habitat (USFWS, 2014).
- Providing technical or financial assistance to landowners to help in the design and implementation of management actions that protect the plant and its habitat (USFWS, 2014).

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USFWS. 2015. Environmental Conservation Online System (ECOS) – Species Profile. <http://ecos.fws.gov/speciesProfile/>. Accessed April 2016

USFWS 2014. Endangered and Threatened Wildlife and Plants

Designation of Critical Habitat for *Physaria globosa* (Short's bladderpod), *Helianthus verticillatus* (whorled sunflower), and *Leavenworthia crassa* (fleshy-fruit gladeceess)

Final Rule. 79 Federal Register 165. August 26, 2014. Pages 50989 - 51039

USFWS 2013. Endangered and Threatened Wildlife and Plants

Endangered Status for *Physaria globosa* (Short's bladderpod), *Helianthus verticillatus* (whorled sunflower), and *Leavenworthia crassa* (fleshy-fruit gladeceess). 78 Federal Register 149. August 2, 2013. Pages 47109 - 47134.

U.S. Fish and Wildlife Service. 2014. Endangered and Threatened Wildlife and Plants

Designation of Critical Habitat for *Physaria globosa* (Short's bladderpod), *Helianthus verticillatus* (whorled sunflower), and *Leavenworthia crassa* (fleshy-fruit gladeceess). 79 FR 50990-51039 (August 26, 2014).

USFWS 2014a. Endangered and Threatened Wildlife and Plants

USFWS. 2013. Endangered and Threatened Wildlife and Plants

Final Rule. 79 Federal Register 165. August 26, 2014. Pages 50989 - 51039.

SPECIES ACCOUNT: *Heritiera longipetiolata* (ufa-halomtano)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/02/2015; Pacific Region (R1) (USFWS, 2016)

Physical Description

A tree (USFWS, 2015).

Taxonomy

A member of the hibiscus family (Malvaceae) (USFWS, 2015).

Historical Range

Historically, *Heritiera longipetiolata* is reported from Guam, Rota, Saipan, and Tinian (USFWS, 2015).

Current Range

It currently occurs on Guam, Saipan, Tinian, and Rota (Marian Islands) (USFWS, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available

Habitat Type

Adult: Terrestrial (USFWS, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest (USFWS, 2015)

Habitat Narrative

Adult: It occurs in the forest ecosystem (USFWS, 2015).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Resiliency:

Moderate (inferred from USFWS, 2015)

Redundancy:

Low to moderate (inferred from USFWS, 2015)

Number of Populations:

10 (USFWS, 2015)

Population Size:

~200 (USFWS, 2015)

Population Narrative:

Currently, *H. longipetiolata* is known from 10 occurrences totaling approximately 200 individuals. On Guam, *H. longipetiolata* is presently known from 4 occurrences, totaling approximately 90 individuals; on Tinian, there are between 30 and 40 individuals of *H. longipetiolata*, and possibly more in adjacent forested areas (Spaulding 2013, in litt.; Williams 2013, in litt.; Spaulding 2015, in litt.); on Saipan, *H. longipetiolata* is known from 3 occurrences, totaling at least 53 individuals, with several hundred seedlings beneath the trees (Camacho and Micronesian Environmental Services (MES) 2002, pp. 38–39); and on Rota, more recent information indicates that there is at least one known individual of *H. longipetiolata* (Cook 2010, in litt. cited in CNMI–DLNR 2015, in litt.) (USFWS, 2015).

Threats and Stressors

Stressor: Development, military training, and urbanization (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: In their 2015 Final SEIS ([http:// guambuildupeis.us/](http://guambuildupeis.us/)) (see “Historical and Ongoing Human Impacts,” above), the U.S. Department of Navy states that approximately 5,000 Marines will be relocated from Okinawa to Guam, accompanied by approximately 1,300 dependents, with a concurrent introduction of support staff and development of infrastructure, and increased use of resources such as water (Berger et al. 2005, p. 347; JGPO– NavFac, Pacific 2015, p. ES–3). The current preferred alternative sites on Guam for cantonment and live-fire training include the Naval Computer and Telecommunications Station Finegayan and Northwest Field on Andersen AFB, where this species occurs. The northern two-thirds of Tinian are leased by the U.S. Department of Defense, and the development of these lands and effects from live-fire training will directly impact this species. In November 2007, the people of Rota voted to legalize casino gambling to increase tourism, and two development projects have been proposed. Development around and within forested areas on Rota will also directly impact the forest habitat and individuals of this species (USFWS, 2015).

Stressor: Feral ungulates (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Cattle ranching is gaining in popularity, and in the future the number of cattle is expected to double from 1,500 individuals (Bagnol 2014, in litt.; NRCS 2015, in litt.). The number of cattle ranchers on Tinian has risen from 10 or 12 in 2010, to 49 ranchers by 2014 (Bagnol 2014, in litt.). As numbers of cattle and ranchers increase on Tinian, there may be a somewhat greater risk of cattle potentially escaping and becoming feral. Both feral and domestic cattle can drastically alter the landscape (Wiles et al. pp. 176–177), and depending on the location and amount of land designated as pasture land for domestic cattle, negative impacts to the forest ecosystem may be observed in the future. Several herds of Asiatic water buffalo or carabao roam southern Guam and the Naval Magazine area, and cause damage to the forest and savanna ecosystems that support this species. Observations and reports have documented that pigs and deer browse and trample this species (USFWS, 2015).

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- In 2012, the Guam Plant Extinction Prevention Program (GPEPP) was formed to address conservation concerns for a select group of native Mariana Islands plant species, including *Heritiera longipetiolata*. GPEPP is a partnership between the University of Guam (UOG), multiple Federal agencies (USFWS, DOD, and USDA), Hawaii State DLNR, and the Hawaii Plant Extinction Prevention Program (Hawaii PEPP). The goal of GPEPP is to prevent the extinction of native Mariana Islands plant species that have fewer than 200 individuals remaining in the wild on the island of Guam (GPEPP 2014, in litt.). The program's main objectives are to monitor, collect, survey, manage, and reintroduce native plant species in the Mariana Islands. They plan to work with conservation partners to protect wild populations and preserve genetic material (GPEPP 2014, in litt.) (USFWS, 2015).

References

USFWS. 2016. Environmental Conservation Online System (ECOS) – Species Profile. <http://ecos.fws.gov/ecp0/>. Accessed August 2016

USFWS 2015. Endangered and Threatened Wildlife and Plants

Endangered Status for 16 Species and Threatened Status for 7 Species in Micronesia

Final Rule. 80 Federal Register 190. October 1, 2015. Pages 59423 - 59497.

USFWS. 2015. Endangered and Threatened Wildlife and Plants

SPECIES ACCOUNT: *Hesperolinon congestum* (Marin dwarf-flax)

Species Taxonomic and Listing Information

Listing Status: Threatened; 02/03/1995; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An annual herb with linear leaves and slender stems, generally 5-15 cm tall but occasionally reaching 40 cm. Flowers (May-July) are white to rose-colored with purple anthers; they are borne in congested clusters. Anthers are purple at time of pollen release. 3 carpels and styles (NatureServe, 2015).

Taxonomy

A member of the flax family (Linaceae) (USFWS, 2011). J. K. Small (1907) established *Hesperolinon* as a distinct genus in 1907 (USFWS, 1998).

Historical Range

Its historical range has not been established, but likely included all occurrences at the time of listing, as well as extirpated occurrences on former serpentine areas in San Francisco and San Mateo Counties that are now urban development (USFWS, 2011).

Current Range

Hesperolinon congestum ranges from Marin Co. in the north to San Mateo Co. in the south, thus it spans a narrow band on serpentine soils in the S.F. Bay Area, in California. The estimated range extent is about 790 sq. mi. (NatureServe, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 1998)

Lifespan

Adult: 1 year (NatureServe, 2015)

Breeding Season

Adult: May - July (USFWS, 2011)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 1998)

Reproduction Narrative

Adult: This species is an annual (NatureServe, 2015). The species generally flowers from early May through June or July, and is sensitive to the amount and timing of rainfall (USFWS, 2011).

The species is pollinated by native insects including bee flies and pollen beetles (Robison and Morey 1992a) (USFWS, 1998).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Grasslands and chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 100 - 1,200 ft. elevation (USFWS, 1998)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: High (inferred from USFWS, 2011)

Habitat Narrative

Adult: Inhabits grasslands and chaparral on serpentine soils. The environmental specificity is very narrow; it is a narrow serpentine endemic only known from serpentine sites in parts of the S. F. Bay area (NatureServe, 2015). Serpentine soils are formed from weathered volcanic rock, with a low calcium-magnesium ratio, lack of soil nitrogen, potassium, or phosphorus, and elevated heavy metals (mineral toxicity). It is believed that *Hesperolinon congestum*'s tolerance for this soil chemistry allows it to grow where most other plant species cannot (USFWS, 2011). Known populations occur between approximately 30 and 370 meters (100 to 1,200 feet) (California Natural Diversity Data Base 1996) (USFWS, 1998).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Decline of 50-70% (NatureServe, 2015)

Species Trends:

10 - 30% decline (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015); see current range/distribution)

Redundancy:

Moderate (inferred from USFWS, 2011)

Number of Populations:

23 (USFWS, 2011)

Population Size:

10,000 - 1,000,000 individuals (NatureServe, 2015)

Adaptability:

Low (inferred from NatureServe, 2015)

Population Narrative:

Vulnerable due to its fluctuating population numbers based on rainfall and due to its frail, annual habit. The population numbers of this annual fluctuate with rainfall. There may be a few hundred at a site one year and 10's of thousands the next. One recently reported site at Lucasfilms property had 200,000 plants one year. The total estimated population size is 10,000 - 1,000,000. The long term trend for this plant is one of severe decline due to urbanization of its habitat; decline of 50-70%. This species has experienced a short term decline of 10 - 30% due to urbanization. The population numbers of this annual fluctuate with rainfall. There may be a few hundred at a site one year and 10's of thousands the next. One recently reported site at Lucasfilms property had 200,000 plants one year (NatureServe, 2015). At the present time, there are 23 extant occurrences of the species (USFWS, 2011).

Threats and Stressors

Stressor: Development (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The threat of habitat destruction continues in several forms, and varies both regionally and with specific location. Recent information concerning the Alta Robles development indicates there would be some direct impacts to *Hesperolinon congestum*, as well as likely indirect impacts due to construction at distances of 25-to-125 feet from the species and/or potential habitat (MCL 2011; MIJ 2010; Town of Tiburon 2010). These distances are far less than the 500-foot buffer recommended in our Recovery Plan for protection of this species (FWS 1998). Not only do such developments result in direct losses of the species and its habitat where the development takes place, but could result in numerous indirect effects on adjacent areas due to runoff, landslides, foot traffic, dogs, and non-native plant competition. These indirect effects may occur on both private and public lands, particularly in areas which lack permanent protections. Such indirect effects are likely to be ongoing to some extent at all of the Tiburon populations due to nearby developments. Based on information provided by the SFPUC and review of Service files, several planned actions may affect the species (E. Natesan, SFPUC, pers. comm. 2011). One such activity is the Crystal Springs/San Andreas Transmission Upgrade project, whose modest effect on *Hesperolinon congestum* will be mitigated through conservation and enhancement measures addressed in formal consultation (FWS 2010; Table 2). There is also a planned dam improvement project for Crystal Springs Reservoir which could affect *Hesperolinon congestum* or presently unoccupied serpentine area which is potential habitat over a more widespread area by allowing a higher maximum water level than at the present time. More development, even without actual direct impacts, may indirectly impact *Hesperolinon congestum* through occasional foot traffic, or local atmospheric pollutants. These effects have not yet been evaluated (USFWS, 2011).

Stressor: Ground disturbance (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Ground disturbance in serpentine areas from unmonitored casual recreational activities continues to be a threat to the species. Hiking and biking activity has been mentioned as a potential or actual threat for at least fourteen occurrences. At Middle Ridge (#8), unleashed dogs are mentioned to be the main cause of ground disturbance (often by professional dog-walkers), and hiking and bike traffic were also noted (Bittman, in litt. 2009a, 2009b; Buxton, in litt. 2010, pers. comm. 2011; LSA 2010) (USFWS, 2011).

Stressor: Succession (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Atmospheric nitrogen deposition derived from combustion sources like motor vehicles and industry in urban areas may be enriching otherwise low-nutrient serpentine soils. This may be allowing other native and nonnative plant species, such as rye grass (*Lolium* spp.) or wild oats (*Avena* spp.), to invade some serpentine areas and compete with serpentine specialist species such as *Hesperolinon congestum*. Over time, thatch and soil buildup from the invading plants can further enrich serpentine soils. Based on the estimated critical load of 4.5-5.0 kg-N/ha/year for serpentine natives such as *Hesperolinon congestum*, nitrogen is a potential threat to this species throughout its range with the exception of more rural parts of Marin County (Weiss, in litt. 2011; Fenn et al. 2010). Studies in the south bay suggest that non-natives have had an effect on other native serpentine plants at Edgewood Park (Weiss 1999), although it has not yet been demonstrated for *Hesperolinon congestum* in particular (USFWS, 2011).

Stressor: Maintenance activities (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Maintenance as a potential threat was noted at a number of locations and in various forms. Maintenance activities identified since listing included access roads, pipeline maintenance, highway maintenance, disking, herbicide spraying, and "other" maintenance. Maintenance can have a direct effect by disturbing the plants and its habitat, or indirect effects by altering the hydrology/runoff or land stability of a site (USFWS, 2011).

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Preliminary results indicate an increase in average maximum summer air temperature at Golden Gate National Recreation area, located near the Presidio (near occurrences #16 and 20), and a statewide reduction in fog frequency (Madej et al. 2010; Johnstone and Dawson 2010). *Hesperolinon congestum* abundance and flowering period is believed to be affected generally by year-to-year variations in rainfall, so it may be sensitive to climate change. However, there is

inadequate information to make accurate predictions regarding its effect on this species at this time (USFWS, 2011).

Stressor: Stochastic events (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Low plant number remains a threat to the smaller population size occurrences of *Hesperolinon congestum*. The small areas of these occurrences render them susceptible to extirpation as a result of localized stochastic events or disturbances from threats already discussed (USFWS, 2011).

Recovery

Delisting Criteria:

1. Secure and protect specified recovery areas from incompatible uses: Occupied habitat or 21 populations representing the range of the species along with adjacent unoccupied habitat and a 150-meter (500-foot) buffer (USFWS, 2011).
2. Management plan approved and implemented for recovery areas, including survival of the species as an objective; for all populations and any occupied or unoccupied habitat identified as essential to survival (USFWS, 2011).
3. Population monitoring in specified recovery areas shows stable or increasing plant numbers for a period of 20 years that include the normal precipitation cycle (or longer if suggested by the results of demographic monitoring) (USFWS, 2011).

Recovery Actions:

- Habitat protection (USFWS, 1998).
- Habitat management and restoration, including removal of invasive non-native species (USFWS, 1998).
- Surveying and monitoring (USFWS, 1998).
- Ex-situ conservation measures such as artificial rearing and seed banking (USFWS, 1998).
- Research (USFWS, 1998).
- Public participation, outreach, and education (USFWS, 1998).

Conservation Measures and Best Management Practices:

- Secure and protect all occurrences and potential (unoccupied) serpentine grassland habitat necessary for recovery of *Hesperolinon congestum* on SFPUC lands in the Crystal Springs group (as previously mentioned, our Formal Consultation applies only to a portion of the occurrences, see FWS 2011). The conservation easements, together with a comprehensive and complete management plan, should be sought to permanently protect all occurrences and potential habitat from future habitat loss due to changes in land use. The management plan should include provisions for monitoring, actions as necessary to quantify and address threats of non-native species encroachment, and means to resolve foreseeable potential conflicts created by human use or operations and maintenance activities (USFWS, 2011).

- Secure and protect to the maximum extent practicable, all occurrences and potential (unoccupied) serpentine grassland habitat necessary for recovery of *Hesperolinon congestum* at the St. Hilary's Church (#6) and Middle Ridge (#8) locations. In addition to recreational and non-native plant threats, portions of these sites are believed to be imminently threatened by potential conversion to housing developments. Avoidance of any loss is the preferred strategy. Permanent conservation easements should be sought to preclude future loss. One venue for Service participation would be during consultations pursuant to issuance of a permit from the Corps under CWA Section 404. Additionally, there need to be assurances that management, including regular monitoring and corrective action, will be timely implemented as needed to address other primary threats of non-native vegetation and human passive use. Reported adverse human impacts from recreational uses (primarily dog-walking; other uses mentioned include hiking, biking, photography, horse-back riding, photography) to this species or its habitat should be investigated, monitored, and prevented by necessary means, including restricted use/entry where other means have proven ineffective (USFWS, 2011).
- Surveys should be conducted at least once (preferably more often) in this next five years at all known locations of *Hesperolinon congestum*. In order of priority, surveys should be done for the 10 sites for which this review found no observational information at all in the last five years (#17, 5, 1, 30, 3, 21, 22, 31, 23, and 28), the non-CNDDDB site (a), and all other sites. A survey protocol should be developed, which will ideally allow detection of the peak flowering period, a reasonable estimate of population area and size, photodocumentation (of entire area, and closeups of plant forma), establishment of reproducible photo points, and a rapid assessment of the extent of visible threat factors of human-caused ground disturbance, and non-native/native species invasion (USFWS, 2011).
- Assess the effectiveness of one or more weed control measures on *Hesperolinon congestum*. This may involve comparing weed densities in areas (occurrence area and adjacent buffer) which are controlled for weeds versus those which are not, or evaluating a chronosequence before, during, and after weed control measures; or comparing different measures. For example, where grazing is used, a study might seek to establish empirical relationships between the control measure (e.g., grazing or grazer density) and weed densities, and the response by *Hesperolinon congestum* (or lack thereof) (USFWS, 2011).

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U.S. Fish and Wildlife Service. 1998. Recovery Plan for Serpentine Soil Species of the San Francisco Bay Area. Portland, Oregon. 330+ pp.

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SPECIES ACCOUNT: *Hesperomannia arborescens* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/28/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

Hesperomannia arborescens is a long-lived member of the Asteraceae (aster family). It is a small shrubby tree that usually stands 1.5 to 5 m (5 to 16 ft) tall with wide lance- or egg-shaped leaves, 10.5 to 20 cm (4.1 to 7.9 in) long, 3 to 8 cm (1.2 to 3.1 in) wide. The yellow-brown flowers are either solitary or form clusters (between two to 10) at the stem tips. The flowers are perfect, possessing both male and female reproductive parts. The dry one-seeded fruit is large, heavy and glabrous, and 1.2 to 1.4 cm (0.5 to 0.6 in). They are produced between April and June. *H. arborescens* differs from the other members of this endemic genus by having erect to ascending flower heads, thick flower head stalks, and usually hairless and relatively narrow leaves (Wagner et al. 1999).

Historical Range

Hesperomannia arborescens was historically found on the islands of Oahu, Molokai, Lanai, and Maui. On Oahu, this species was scattered throughout the Koolau Mountains from Koolauloa and Pupukea in the north to Konahuanui in the south.

Current Range

Currently, *H. arborescens* is known from at least 23 occurrences totaling 192 individuals on the islands of Oahu, Molokai, and Maui; however, it is considered extinct on Lanai. Molokai has a single known occurrence with only three individuals. Maui has four known occurrences for a total of six individuals. On Oahu, the following occurrences remain extant: Maakua (22 individuals); Kaluanui- Maakua Ridge (2); Kaipapau (6); Kaluanui (2); Halawa (3); Kapakahi Gulch (1); Niu-Waimanalo summit Ridge (1); Poamoho trail (2); lower Peahinaia trail (15); lower north Kaukonahua Gulch (1); upper north Kaukonahua Gulch (4); upper Kawaihoa trail (1) ; lower Kawaihoa trail (2) ; Kawaihoa (42); Laie-Waimea Ridge (15); north Kaukonahua Gulch (13); and south Kaukonahua Gulch (46). However, much of the habitat for this species in the Koolau Mountains has not been surveyed, and additional occurrences may be present. In the Waianae Mountains, near Palikea Gulch, there is one known occurrence with five individuals.

Occurrences of *H. arborescens* are declining, and those that remain are small, widely dispersed, and have a limited gene pool. The survival of the four remaining occurrences on Maui is questionable, as they are heavily impacted by pigs (HINHP Database 2001; Service 1998a; Wagner et al. 1999; K. Kawelo, U.S. Army, pers. comm. 2003; J. Lau, HINHP, pers. comm. 2003).

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Hesperomannia arborescens* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 16 detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Hesperomannia arborescens* under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Hesperomannia arborescens* (77 FR 57648-57862). The critical habitat designation includes 23 critical habitat units, which encompass approximately 32,935 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Hesperomannia arborescens* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Hesperomannia arborescens* includes 16 CHUs in Maui County, Hawaii with detailed unit information. There are also an unknown number of units on Lanai that contain this species (number of units is unknown because detailed unit descriptions for Lanai are not available) (81 FR 17790-18110).

Molokai—Montane Wet—Unit 1 (and) *Palmeria dolei*—Unit 40—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 40— Montane Wet This area consists of 1,545 ac (625 ha) of State land, and 1,851 ac (749 ha) of privately owned land, from the headwaters of Waialelia Stream and above Pelekunu Valley, eastward along the summit area to Mapulehu, in northcentral Molokai. These units are occupied by the plants *Bidens wiebkkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. profuga*, *Phyllostegia hispida*, and *Pteris lidgatei*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Montane Wet—Unit 1 is not known to be occupied by *Adenophorus periens*, *Cyanea procera*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Melicope reflexa*, *Phyllostegia mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwkiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 41—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 41— Montane Wet This area consists of 871 ac (353 ha) of State land, and 39 ac (16 ha) of privately owned land, from Honukaupu to Olokui (between Pelekunu and Wailau valleys), in north-central Molokai. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). Although Molokai— Montane Wet—Unit 2 is not known to be occupied by *Adenophorus periens*, *Bidens wiebkkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. procera*, *C. profuga*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Melicope reflexa*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Pteris lidgatei*, *Schiedea laui*, *Stenogyne bifida*,

or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 3 consists of 77 ac (31 ha) of State land, and 726 ac (294 ha) of privately owned land, above the east rim of Wailau Valley on eastern Molokai. This unit is occupied by the plant *Melicope reflexa*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Montane Wet—Unit 3 is not known to be occupied by *Adenophorus periens*, *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. procera*, *C. profuga*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Pteris lidgatei*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Wet Cliff—Unit 1 (and) *Palmeria dolei*—Unit 43—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 43—Wet Cliff This area consists of 1,395 ac (565 ha) of State land, and 212 ac (86 ha) of privately owned land, and encircles the plateau between Pelekunu and Wailau valleys, in north-central Molokai. These units are occupied by the plants *Brighamia rockii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea munroi*, and *Hibiscus arnottianus* ssp. *immaculatus*, and include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Wet Cliff—Unit 1 is not known to be occupied by *Cyanea grimesiana* ssp. *grimesiana*, *Hesperomannia arborescens*, *Phyllostegia hispida*, *Pteris lidgatei*, or *Stenogyne bifida*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Wet Cliff—Unit 2 (and) *Palmeria dolei*—Unit 44—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 44—Wet Cliff This area consists of 462 ac (187 ha) of State land, and 806 ac (326 ha) of privately owned land (partly within The Nature Conservancy's Pelekunu Preserve), along the rim of Pelekunu Valley from Kipapa Ridge to Mapulehu, in central Molokai. These units are occupied by the plants *Clermontia oblongifolia* ssp. *brevipes* and *Phyllostegia hispida*, and include the mixed herbland and shrubland, the moisture regime, and the subcanopy and

understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Wet Cliff—Unit 2 is not known to be occupied by *Brighamia rockii*, *Canavalia molokaiensis*, *Cyanea grimesiana* ssp. *grimesiana*, *C. munroi*, *Hesperomannia arborescens*, *Hibiscus arnottianus* ssp. *immaculatus*, *Pteris lidgatei*, or *Stenogyne bifida*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Wet Cliff—Unit 3 consists of 1,137 ac (460 ha) of State land, and 225 ac (91 ha) of privately owned land, along the rim of Wailau Valley from Mapulehu to Kahiwa Gulch, in eastern Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Molokai—Wet Cliff—Unit 3 is not known to be occupied by *Brighamia rockii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea grimesiana* ssp. *grimesiana*, *C. munroi*, *Hesperomannia arborescens*, *Hibiscus arnottianus* ssp. *immaculatus*, *Phyllostegia hispida*, *Pteris lidgatei*, or *Stenogyne bifida*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 2 (and) *Palmeria dolei*—Unit 3—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 3—Lowland Wet (and) *Newcombia cumingi*—Unit 1—Lowland Wet This area consists of 65 ac (26 ha) of State land at Moomoku, on the northwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. Although Maui—Lowland Wet—Unit 2 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendrion pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), or by the Newcomb's tree snail (*Newcombia cumingi*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 3 (and) *Palmeria dolei*—Unit 4—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 4— Lowland Wet This area consists of 1,247 ac (505 ha) of State land at Honanana Gulch on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta*, *Cyanea asplenifolia*, and *Pteris lidgatei*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 3 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwiku* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 4 (and) *Palmeria dolei*—Unit 5—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 5— Lowland Wet This area consists of 864 ac (350 ha) of State land at Kahakuloa Valley on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta* and *Cyanea asplenifolia*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 4 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwiku* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 5 (and) *Palmeria dolei*—Unit 6—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 6— Lowland Wet This area consists of 30 ac (12 ha) of State land at Iao Valley on the eastern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 5 is not known to be occupied by the plants *Alectryon macrococcus*,

Asplenium dielerectum, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 6 (and) *Palmeria dolei*—Unit 7—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 7— Lowland Wet This area consists of 136 ac (55 ha) of State land at Honokowai and Wahikuli valleys on the western slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 6 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 7 (and) *Palmeria dolei*—Unit 8—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 8— Lowland Wet This area consists of 898 ac (364 ha) of State land at Olowalu Valley, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Alectryon macrococcus*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 7 is not currently occupied by the plants *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have

determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 8 (and) *Palmeria dolei*—Unit 9—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 9— Lowland Wet This area consists of 230 ac (93 ha) of State land at upper Ukumehame Gulch, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 8 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 6 (and) *Palmeria dolei*—Unit 35—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 35— Wet Cliff This area consists of 1,858 ac (752 ha) of State land, and 253 ac (102 ha) of privately owned land, at the summit ridges of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plants *Alectryon macrococcus*, *B. conjuncta*, *Ctenitis squamigera*, *Cyrtandra munroi*, *Remya mauiensis*, and *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 6 is not known to be occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Bonamia menziesii*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyriformium*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, or *Tetramolopium capillare*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 7 (and) *Palmeria dolei*—Unit 36—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 36— Wet Cliff This area consists of 556 ac (225 ha) of State land along Honokowai ridge on the northwestern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species

identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units are occupied by the plants *Cyrtandra filipes* and *C. munroi*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 7 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 8 consists of 337 ac (137 ha) of State land along Kahakuloa ridge on the north side of west Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff—Unit 8 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat designation for *Hesperomannia arborescens* includes 23 critical habitat units, covering two ecosystem types, which encompass approximately 32,935 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7; Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve.

Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Hauula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikeekee, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet—Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet—Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu—Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 ac (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest

Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamo Ridge.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Hesperomannia arborescens* critical habitat consists of three components. Lowland wet (west Maui), Montane wet (Molokai) Wet cliff (west Maui, Molokai and Lanai) (81 FR 17790-18110):

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. Understory: Bryophytes, Ferns, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Ecosystem: Lowland Wet. Elevation: <3,000 ft (<914 m). Annual precipitation: >75 in (>190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Montane Wet. Elevation: 3,000–5,243 ft (914-1,598 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Hesperomannia arborescens* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Hesperomannia arborescens* occurs within the Lowland mesic and Lowland wet ecosystems in the Koolau Mountain caldera complex and from the Lowland mesic ecosystem in the Waianae Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (F) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas

that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and

2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic— Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; MauiWet Cliff—Units 6 and 7; and MolokaiMontane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Hesperomannia arborescens* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Currently, *H. arborescens* is known from at least 23 occurrences totaling 192 individuals on the islands of Oahu, Molokai, and Maui; however, it is considered extinct on Lanai. Molokai has a single known occurrence with only three individuals. Maui has four known occurrences for a total of six individuals. On Oahu, the following occurrences remain extant: Maakua (22 individuals); Kaluanui- Maakua Ridge (2); Kaipapau (6); Kaluanui (2); Halawa (3); Kapakahi Gulch (1); Niu-Waimanalo summit Ridge (1); Poamoho trail (2); lower Peahinaia trail (15); lower north Kaukonahua Gulch (1); upper north Kaukonahua Gulch (4); upper Kawaihoa trail (1) ; lower Kawaihoa trail (2) ; Kawainui (42); Laie-Waimea Ridge (15); north Kaukonahua Gulch (13); and south Kaukonahua Gulch (46). However, much of the habitat for this species in the Koolau Mountains has not been surveyed, and additional occurrences may be present. In the Waianae

Mountains, near Palikea Gulch, there is one known occurrence with five individuals. Occurrences of *H. arborescens* are declining, and those that remain are small, widely dispersed, and have a limited gene pool. The survival of the four remaining occurrences on Maui is questionable, as they are heavily impacted by pigs (HINHP Database 2001; Service 1998a; Wagner et al. 1999; K. Kawelo, U.S. Army, pers. comm. 2003; J. Lau, HINHP, pers. comm. 2003).

Habitat Type

Adult: Wet forest/wet shrubland

Habitat Narrative

Adult: On Oahu, *Hesperomannia arborescens* is found in association with *Acacia koa*, *Antidesma platyphyllum*, *Bobea elatior*, *Broussaisia arguta*, *Cheirodendron trigynum*, *Cibotium glaucum*, *Coprosma* spp., *Dicranopteris linearis*, *Dubautia* spp., *Hedyotis terminalis*, *Hibiscus arnottianus*, *Labordia sessilis*, *Machaerina angustifolia*, *Melicope* sp., *Metrosideros polymorpha*, *Myrsine* sp., *Nestegis sandwicensis*, *Perottetia sandwicensis*, *Pipturus albidus*, *Psychotria mariniana*, *Scaevola gaudichaudiana*, *Scaevola glabra*, *Syzygium sandwicensis*, *Tetraplasandra oahuensis*, and *Wikstroemia* spp. It typically grows on steep slopes, ridge tops, and gulches in lowland wet forests and occasionally in wet shrublands between 110 and 1,147 m (361 and 3,762 ft) in elevation (HINHP Database 2001; Service 1998a; Wagner et al. 1999). *H. arborescens* produces large, heavy, glabrous fruits between April and June and dispersal is probably low and may be why *H. arborescens* trees usually grow in close proximity to each other. Plants found in Palikea Gulch in the Waianae Mountains are morphologically different from all other known occurrences in the Koolau Mountains and on Molokai, and West Maui. Little else is known about its flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors (Service 1998a; U.S. Army 2003a; 59 FR 14482).

Dispersal/Migration***Population Information and Trends*****Resiliency:**

Fragility unknown. (NatureServe, 2015)

Representation:

Fragility unknown. (NatureServe, 2015)

Redundancy:

Fragility unknown. (NatureServe, 2015)

Number of Populations:

6 - 20 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Adaptability:

Fragility unknown. (NatureServe, 2015)

Population Narrative:

Fragility unknown. Currently 100 plants observed, estimate few hundred plants. 12 current (between 1982 and 1997) and 17 historical occurrences. (NatureServe, 2015)

Threats and Stressors

Stressor:

Exposure:

Response:

Consequence:

Narrative: The major threats to *Hesperomannia arborescens* include loss of habitat and degradation of the remaining habitat by non-native plants and animals. Non-native plants such as *Axonopus fissifolius*, *Clidemia hirta*, *Leptospermum scoparium*, *Paspalum conjugatum*, *Psidium cattleianum*, and *Tibouchina herbacea* alter the natural habitat and compete for nutrients, light, and space. Feral pigs can directly impact this species by consumption of fruits and other plant parts, or indirectly due to their rooting behavior which further degrades the habitat. Wildfires and trampling by foot traffic due to military activities also pose a threat to the remaining *H. arborescens* occurrences. There is a risk of extinction of this species due to random environmental events or reduced reproductive vigor due to its limited numbers (HINHP Database 2001; 59 FR 14482).

Recovery**Conservation Measures and Best Management Practices:**

- A State-wide management plan should be developed and implemented for the long-term conservation of all known occurrences of *Hesperomannia arborescens*. This plan should also include broader landscape actions that are needed for the recovery of this plant throughout its range. Based on the recovery plan for this species the following conservation needs have been identified. Fenced exclosures should be constructed around all known occurrences of *H. arborescens* to reduce impacts from feral ungulates. Ungulates should be controlled or removed from the vicinity of these exclosures to alleviate impact on native ecosystems. Occurrences that have only a few remaining individuals should immediately be weeded and protected (Service 1998a). Ongoing Conservation Actions: The State of Hawaii's Division of Forestry and Wildlife has attempted propagation of this species without success. They also conduct periodic invasive plant removal at the Laie occurrence. In addition, the Maui Division of Forestry and Wildlife intends to fence the four individuals in West Maui to protect them from feral pigs (Service 1998a, 2002). The Service is currently not aware of any other conservation efforts for this species.

References

USFWS 2016. Status of the Species and Critical Habitat: *Hesperomannia arborescens* (No Common Name). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016.

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

U.S. Fish and Wildlife Service. 2016. Endangered and Threatened Wildlife and Plants

Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

Final Rule . 81 FR 17790-18110 (March 30, 2016).

U.S. Fish and Wildlife Service. 2012. Endangered and Threatened Wildlife and Plants

Endangered Status for 23 Species on Oahu and Designation of Critical Habitat for 124 Species. Final Rule. 77 FR 57648-57862 (September 18, 2012)

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.”

SPECIES ACCOUNT: *Hesperomannia arbuscula* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

A shrubby tree up to about 3.3 m tall, bearing clusters of erect thistle-like flowering heads. (NatureServe, 2015)

Historical Range

See current range/distribution

Current Range

Hesperomannia arbuscula is endemic to the Waianae Mountains of Oahu and to West Maui (USFWS, 2016). Current range: Waianae Mountains of Oahu and West Maui. Historically, no additional range.

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Hesperomannia arbuscula* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 14 detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Hesperomannia arbuscula* under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Hesperomannia arbuscula* (77 FR 57648-57862). The critical habitat designation includes 8 critical habitat units, which encompass approximately 6,573 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Hesperomannia arbuscula* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Hesperomannia arbuscula* includes 14 CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Lowland Dry—Unit 5 consists of 3,615 ac (1,463 ha) of State land, and 43 ac (17 ha) of privately owned land, from Panaewa to Manawainui on the western and southern slopes of west Maui. This unit is occupied by the plants *Asplenium dielerectum*, *Bidens campylothea* ssp. *pentamera*, *Cenchrus agrimonioides*, *Gouania hillebrandii*, *Kadua coriacea*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and *Tetramolopium capillare*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy,

and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 5 is not known to be occupied by *Ctenitis squamigera*, *Cyanea obtusa*, *Hesperomannia arbuscula*, *Hibiscus brackenridgei*, *Lysimachia lydgatei*, *Neraudia sericea*, *Schiedea salicaria*, *Sesbania tomentosa*, or *T. remyi*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 6 consists of 3 ac (1 ha) of State land, and 237 ac (96 ha) of privately owned land, from Paleaahu Gulch to Puu Hona on the southern slopes of west Maui. This unit is occupied by the plants *Hibiscus brackenridgei* and *Schiedea salicaria*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 6 is not known to be occupied by *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, *Cenchrus agrimonoides*, *Ctenitis squamigera*, *Cyanea obtusa*, *Gouania hillebrandii*, *Hesperomannia arbuscula*, *Kadua coriacea*, *Lysimachia lydgatei*, *Neraudia sericea*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Spermolepis hawaiiensis*, *Tetramolopium capillare*, or *T. remyi*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 2 (and) *Palmeria dolei*—Unit 3—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 3—Lowland Wet (and) *Newcombia cumingi*—Unit 1—Lowland Wet This area consists of 65 ac (26 ha) of State land at Moomoku, on the northwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. Although Maui—Lowland Wet—Unit 2 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendrion pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), or by the Newcomb's tree snail (*Newcombia cumingi*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 3 (and) *Palmeria dolei*—Unit 4—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 4— Lowland Wet This area consists of 1,247 ac (505 ha) of State land at Honanana Gulch on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta*, *Cyanea asplenifolia*, and *Pteris lidgatei*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 3 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 4 (and) *Palmeria dolei*—Unit 5—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 5— Lowland Wet This area consists of 864 ac (350 ha) of State land at Kahakuloa Valley on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta* and *Cyanea asplenifolia*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 4 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 5 (and) *Palmeria dolei*—Unit 6—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 6— Lowland Wet This area consists of 30 ac (12 ha) of State land at Iao Valley on the eastern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—

Lowland Wet—Unit 5 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 6 (and) *Palmeria dolei*—Unit 7—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 7— Lowland Wet This area consists of 136 ac (55 ha) of State land at Honokowai and Wahikuli valleys on the western slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 6 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 7 (and) *Palmeria dolei*—Unit 8—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 8— Lowland Wet This area consists of 898 ac (364 ha) of State land at Olowalu Valley, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Alectryon macrococcus*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 7 is not currently occupied by the plants *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest

birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 8 (and) *Palmeria dolei*—Unit 9—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 9— Lowland Wet This area consists of 230 ac (93 ha) of State land at upper Ukumehame Gulch, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 8 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 5 (and) *Palmeria dolei*—Unit 29—Dry Cliff (and) *Pseudonestor xanthophrys*—Unit 29— Dry Cliff This area consists of 1,298 ac (525 ha) of State land, from Helu and across Olowalu to Ukumehame Gulch, on west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). They are occupied by the plant *Tetramolopium capillare*, and contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Dry Cliff—Unit 5 is not currently occupied by the plants *Bonamia menziesii*, *Diplazium molokaiense*, *Hesperomannia arbuscula*, *Isodendron pyriformis*, *Kadua laxiflora*, or *Neraudia sericea*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 6 consists of 279 ac (113 ha) of State land along the east wall of Ukumehame Gulch on west Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). Although Maui—Dry Cliff— Unit 6 is not currently occupied by the plants *Bonamia menziesii*, *Diplazium molokaiense*, *Hesperomannia arbuscula*, *Isodendron pyriformis*, *Kadua laxiflora*, *Neraudia sericea*, or *Tetramolopium capillare*, we have determined this area to be essential for the conservation and recovery of these dry cliff

species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 6 (and) *Palmeria dolei*—Unit 35—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 35—Wet Cliff This area consists of 1,858 ac (752 ha) of State land, and 253 ac (102 ha) of privately owned land, at the summit ridges of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plants *Alectryon macrococcus*, *B. conjuncta*, *Ctenitis squamigera*, *Cyrtandra munroi*, *Remya mauiensis*, and *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 6 is not known to be occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Bonamia menziesii*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyriformis*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, or *Tetramolopium capillare*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 7 (and) *Palmeria dolei*—Unit 36—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 36—Wet Cliff This area consists of 556 ac (225 ha) of State land along Honokowai ridge on the northwestern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units are occupied by the plants *Cyrtandra filipes* and *C. munroi*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 7 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyriformis*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 8 consists of 337 ac (137 ha) of State land along Kahakuloa ridge on the north side of west Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or

biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff— Unit 8 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendrion pyriforme*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lydgatei*, *Remya mauensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat designation for *Hesperomannia arbuscula* includes 8 critical habitat units, covering one ecosystem type, which encompasses approximately 6,573 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3; Oahu—Lowland Wet—Units 1, 2, 3, 4, 5.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Oahu—Lowland Wet—Unit 1 [541 ac (219 ha)]. This area consists of 428 ac (173 ha) of State land and 112 ac (46 ha) of City and County of Honolulu land in the lowland wet ecosystem on the windward side of the Waianae Mountains, and partially within the Mokuleia and Waianae Kai Forest Reserves. Oahu—Lowland Wet—Unit 2 [20 ac (8 ha)]. This area consists of 19 ac (8 ha) of State land in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puuhapapa. Oahu—Lowland Wet—Unit 3 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puukanehoa. Oahu—Lowland Wet—Unit 4 [27 ac (11 ha)]. This area consists of 27 ac (11 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains on State land at Puukaua. Oahu—Lowland Wet—Unit 5 [74 ac (30 ha)]. This area consists of 74 ac (30 ha) of State land in the lowland wet ecosystem, on the windward side of the Waianae Mountains at Palikea.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are a combination of physical and biological features in applicable ecosystems. The PCEs of *Hesperomannia arbuscula* critical habitat are the features of two ecosystems: Lowland mesic and Lowland wet (81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*. Subcanopy: *Chamaesyce*, *Dodonaea*, *Leptecophylla*,

Osteomeles, Psydrax, Scaevola, Wikstroemia. Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Sicyos.

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

Ecosystem: Dry Cliff. Elevation: unrestricted. Annual precipitation: <75 in (<190 cm). Substrate: >65 degree slope, rocky talus. Canopy: None. Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: Broussaisia, Cheirodendron, Leptecophylla, Metrosideros. Understory: Bryophytes, Ferns, Coprosma, Dubautia, Kadua, Peperomia.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Hesperomannia arbuscula* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Hesperomannia arbuscula* occurs within the Lowland mesic and Lowland wet ecosystems in the Waianae Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (F) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Oahu—Lowland Wet—Units 1, 2, 3, 4, 5. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. (E) Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. (F) Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

Special Management Considerations or Protections

Existing manmade features and structures, such as buildings, roads, railroads, airports, runways, other paved areas, lawns, and other urban landscaped areas, existing trails, campgrounds and their immediate surrounding landscaped area, scenic lookouts, remote helicopter landing sites, and existing fences are not included in the critical habitat designation. Federal actions limited to those areas, therefore, would not trigger a consultation under section 7 of the Act unless they may affect the species or adjacent critical habitat.

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Hesperomannia arbuscula* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes,

landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Bird pollinated (USFWS, 2016)

Lifespan

Adult: 10-20 years (USFWS, 2016)

Reproduction Narrative

Adult: Flowering and fruiting usually occurs in the spring in response to rainfall (Service 1998a). The flowers are presumably pollinated by birds, and the bristle-tipped achenes are characteristic of wind-dispersed members of the Asteraceae. However, the achenes of *H. arbuscula* are relatively large and heavy, and plants tend to grow in close colonies, suggesting that seeds are not widely dispersed (Makua Implementation Team 2003). Although the longevity of *H. arbuscula* individuals is unknown, the growth rate and size of the largest plants indicate they may live 10 to 20 years or more (Makua Implementation Team 2003). Other demographic information for *H. arbuscula* in the wild is unknown, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, seasonality of reproduction, pollination and seed dispersal, vegetative reproduction, and specific environmental requirements (USFWS, 2016).

Habitat Type

Adult: Slopes and ridges (NatureServe, 2015)

Habitat Narrative

Adult: *Hesperomannia arbuscula* in the Waianae Mountains typically grows in mesic forest on upper gulch slopes and ridge tops at elevations of 597 to 914 m (1,960 to 3,000 ft). The dominant trees at these sites are usually *Metrosideros polymorpha*, *Diospyros sandwicensis*, and *Acacia koa* (USFWS, 2016). Slopes and ridges in mesic to wet forest. (NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seed dispersal is unknown (USFWS, 2016)

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Currently, on Oahu there are 23 known total individuals in four population units located on State and private lands (Table SB 21) (U.S. Army Garrison 2005b). In 2003, there were four occurrences totaling 63 individuals on West Maui but today these population estimates are questionable (Makua Implementation Team 2003). There are no stabilization population units meeting minimum numerical criteria of this species (defined as 75 mature, reproducing individuals per population unit). Trends in reproduction indicate there are very few mature plants, which produce low numbers of seed of very low viability, and hence there is little recruitment in the wild. Thus, *H. arbuscula* on Oahu is characterized by a very low total number of individuals, and little natural regeneration and recruitment (USFWS, 2016). Fragility unknown. Currently about 50 individuals known. Estimate less than 100 plants. Three current (between 1982 and 1997) and five historical occurrences. One other occurrence seen within the last 15 years but not extant. (NatureServe, 2015)

Threats and Stressors

Stressor: Non-native vegetation (USFWS, 2016; NatureServe, 2015)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Threats include competition with non-native vegetation (NatureServe, 2015; USFWS, 2016).

Stressor: Feral pigs (USFWS, 2016; NatureServe, 2015)

Exposure:

Response:

Consequence: Loss of habitat/Loss of individuals

Narrative: Feral pigs are listed as a threat to this species (USFWS, 2016; NatureServe, 2015).

Stressor: Hikers (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat/Loss of individuals

Narrative: A hiking trail near this species habitat which threatens the species through both trampling and flower picking (USFWS, 2016).

Stressor: Small number of populations (USFWS, 1998)

Exposure:

Response:

Consequence: Extinction

Narrative: The small number of populations is also listed as a threat to this species (USFWS, 1998).

Recovery

Reclassification Criteria:

For downlisting, a total of five to seven populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1998).

Delisting Criteria:

A total of 8 to 10 populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1998).

Conservation Measures and Best Management Practices:

- Construct enclosures to protect populations against feral pigs (USFWS, 1998).
- Control competing alien plant species within enclosures (USFWS, 1998).
- Conduct research on limiting factors, especially reproductive biology and pollination (USFWS, 1998).
- Protect habitat and control threats (USFWS, 1998).
- Expand existing wild populations (USFWS, 1998).
- Conduct essential research (USFWS, 1998).
- Develop and maintain monitoring plans (USFWS, 1998).
- Reestablish wild populations within historic range (USFWS, 1998).
- Validate and revise recovery criteria (USFWS, 1998).

References

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NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

U.S. Fish and Wildlife Service. 2016. Endangered and Threatened Wildlife and Plants

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U.S. Fish and Wildlife Service. 2012. Endangered and Threatened Wildlife and Plants

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NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.”

U.S. Fish and Wildlife Service. 1998. Recovery Plan for Oahu Plants. U.S. Fish and Wildlife Service, Portland, Oregon. 207 pp., plus appendices.

SPECIES ACCOUNT: *Hesperomannia lydgatei* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/20/1991; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Hesperomannia lydgatei is a sparsely branched small tree 2 to 4 m (6.5 to 13 ft) tall with alternately arranged, lance-shaped or elliptic leaves that are 10 to 30 cm (4 to 12 in) long and 3.5 to 9 cm (1.4 to 3.5 in) wide, broader above the middle and paler beneath. The flower heads are in groups of 4 or 5 on slender stems and are clustered at the ends of branches and pendant when mature. The flower heads consist of 4 to 8 circles of overlapping bracts, the outer are purplish or brownish and the inner are silver, that surround the slender, tubular yellow florets, which are 2.3 to 2.5 cm (0.9 to 1 in) long. Flowering material was collected from July to November. Almost no mature fruits develop, and it is possible that *Hesperomannia lydgatei* is self-infertile and fails to set seed unless cross-pollinated with other individuals. The abortive fruits are crowned by a plume-like crown of light brown hairs 2 cm (0.8 in) long (Carlquist 1957, Degener 1932, Forbes 1909, Wagner et al. 1990, D. Lorence and T. Flynn, pers. obser. 1991). (USFWS, 1994)

Taxonomy

Hesperomannia is a Hawaiian endemic genus of three species of shrubs and trees and the only representative of the tribe Mutisieae in Hawai'i. (USFWS, 1994). Wagner et al. (2003) recognizes the new tribal placement of this species from Mutisieae to Vernonieae, based on ndhF sequence data as detailed in the study by Kim et al. (1998). Genetic analyses by Morden and Ching Harbin (2013) showed that four species Hawaiian *Hesperomannia* should be recognized: *H. lydgatei*, *H. oahuensis*, *H. swezeyi*, and *H. arborescens*. This changes the island distribution of some species, and eliminates *H. arbuscula*; however, there are no changes to the range or status of *H. lydgatei* on Kauai. (USFWS, 2017).

Historical Range

Historically no additional range. (NatureServe, 2015)

Current Range

Current range includes Wahiawa Mts. of Kauai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designate critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Hesperomannia lydgatei* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Hesperomannia lydgatei* includes three units totaling 4,297 acres in Kauai County, Hawaii. The units are Kauai 10—*Hesperomannia lydgatei*— a and Kauai 11—*Hesperomannia lydgatei*— b, c.

Kauai 10—*Hesperomannia lydgatei*—a: This unit is critical habitat for *Hesperomannia lydgatei* and is 646 ha (1,596 ac) on private land, containing Hulua Summit. This unit provides habitat for two populations of 250 mature, reproducing individuals of the long-lived perennial *Hesperomannia lydgatei* and is currently occupied with 296 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, stream banks and forested slopes with rich brown soil and silty clay in *Metrosideros polymorpha* or *Metrosideros polymorpha*-*Dicranopteris linearis* lowland wet forest. This unit is geographically separated from the other two units designated as critical habitat for this island-endemic species to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 11—*Hesperomannia lydgatei*—b: This unit is critical habitat for *Hesperomannia lydgatei* and is 914 ha (2,258 ac) on State (Halelea Forest Reserve) and private land. This unit contains portions of the Namolokama Mountains and Kaliko Summit. This unit provides habitat for two populations of 250 mature, reproducing individuals of the long-lived perennial *Hesperomannia lydgatei* and is currently occupied with one plant. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, stream banks and forested slopes with rich brown soil and silty clay in *Metrosideros polymorpha* or *Metrosideros polymorpha*-*Dicranopteris linearis* lowland wet forest. This unit is geographically separated from the other two units designated as critical habitat for this island-endemic species to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 11—*Hesperomannia lydgatei*—c: This unit is critical habitat for *Hesperomannia lydgatei* and is 180 ha (445 ac) on State and private land, containing Hono o Na Pali Summit. This unit provides habitat for one population of 250 mature, reproducing individuals of the long-lived perennial *Hesperomannia lydgatei* and is currently occupied with one plant. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, stream banks and forested slopes with rich brown soil and silty clay in *Metrosideros polymorpha* or *Metrosideros polymorpha*-*Dicranopteris linearis* lowland wet forest. This unit is geographically separated from the other two units designated as critical habitat for this island-endemic species to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Stream banks and forested slopes in rich brown soil and silty clay in *Metrosideros polymorpha* or *Metrosideros polymorpha*-*Dicranopteris linearis* lowland wet forest and containing one or more of the following associated native plant species: *Adenophorus periens*, *Antidesma platyphyllum*, *Broussaisia arguta*, *Cheirodendron* spp., *Cyanea* spp., *Dubautia knudsenii*, *Dubautia laxa*, *Dubautia pauciflora*, *Dubautia raillardii*, *Elaphoglossum* spp., *Freyinetia arborea*,

Hedyotis terminalis, Labordia lydgatei, Machaerina angustifolia, Peperomia spp., Pritchardia spp., Psychotria hexandra, or Syzygium sandwicensis; and

(ii) Elevations between 207 and 1,344 m (680 and 4,409 ft).

Special Management Considerations or Protections

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Lifespan

Adult: Long lived perennial tree. (USFWS, 2017).

Dependency on Other Individuals or Species

Adult: Pollination by insects such as moths or butterflies (USFWS, 1994)

Reproduction Narrative

Adult: The purple flower heads with long, tubular yellow florets of this species suggest pollination by long-tongued insects such as moths or butterflies (C. Carr, pers. comm. 1992), although field observations are required to confirm this. (USFWS, 1994)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1994)

Habitat Narrative

Adult: The habitat of Hesperomannia lydgatei in the upper Waioli Stream Valley below Namolokama Mtn. at 400 m (1,300 ft) elevation consists of lowland rain forest with Metrosideros and Dicranopteris dominant (D. Lorence, pers. obser. 1992). This is similar to the species' habitat in the Wahiawa Drainage. Hesperomannia lydgatei is currently restricted to a single large population of less than 100 individuals located in the Wahiawa/ Kanaele Bog Drainage Basin in southern Kauai at 660 to 774 meters (2,165 to 2,540 feet) elevation (Perlman 2008). (USFWS, 1994; USFWS, 2010)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: The plume-like hairs crowning the fruit strongly suggests dispersal by wind, as in many members of the aster family. (USFWS, 1994)

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Low (inferred from USFWS, 2010)

Redundancy:

Very low (inferred from USFWS, 2010)

Number of Populations:

1 (USFWS< 2010)

Population Size:

<100 (USFWS, 2010)

Population Narrative:

Hesperomannia lydgatei is currently restricted to a single large population of less than 100 individuals located in the Wahiawa/ Kanaele Bog Drainage Basin in southern Kauai at 660 to 774 meters (2,165 to 2,540 feet) elevation (Perlman 2008). (USFWS, 2010). Currently, there are individuals scattered within the Wahiawa Mountains area, and new occurrences found at Paohia drainage, Kapalaoa, and Waiahi drainage, possibly totaling as many as 100 individuals (NTBG 2010a-b, 2011a-b, 2012a-b, 2013a-i, 2014a-b, 2015a-i). One individual was observed farther north at Waioli in 2013 (NTBG 2013j). (USFWS, 2017).

Threats and Stressors

Stressor: Non-native invasive plants (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species are competing with native vegetation in much of the area. These include *Erigeron karvinskianus* (daisy fleabane), *Psidium cattleianum* (strawberry guava), *Rubus rosifolius* (thimbleberry), *Melastoma septemnerium* (melastoma), and *Clidemia hirta* (Koster's curse) (National Tropical Botanical Garden 2008). *Psidium cattleianum* (strawberry guava) may be having some of the worst effects on *Hesperomannia* through competition for light and resources. (USFWS, 2010)

Stressor: Hurricanes (USFWS, 2010)

Exposure:

Response:**Consequence:**

Narrative: Hurricanes have already taken a toll on this species, as Hurricane Iniki damaged both the Waioli and Wahiawa populations, and while the Wahiawa population seemed to bounce back, the Waioli population did not (USFWS 1994). (USFWS, 2010)

Stressor: Landslides (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: Landslides are commonly observed in the Wahiawa area (Tangalin 2008). (USFWS, 2010)

Stressor: Pigs (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: Pigs (*Sus scrofa*), which favor wet stream sides where this species occurs, dig up the ground and open it to invasive introduced plant species (Perlman 2008). (USFWS, 2010)

Stressor: Predation by insects (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: Seeds of *Hesperomannia lydgatei* are usually destroyed by insects, with larvae visible in the seed (Tangalin 2008; USFWS 1994). (USFWS, 2010)

Stressor: Black fungus (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: Leaves often have black fungus spots (National Tropical Botanical Garden 2008; Tangalin 2008). (USFWS, 2010)

Stressor: Rats (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: Rats (*Rattus* spp.) are observed in the area (Perlman 2008; USFWS 1994), but it is not known if they eat *H. lydgatei*. (USFWS, 2010)

Stressor: No pollinators (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: Lack of observed pollinators and non-viable seed are factors which probably contribute to its decline (USFWS 1994). (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to *Hesperomannia lydgatei*. However, current climate change models do not allow us to predict specifically what those effects, and their extent, would be for this species. (USFWS, 2010)

Stressor: Small population size (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: In addition to all of the other threats, species like *Hesperomannia lydgatei* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding, and disease outbreaks. (USFWS, 2010)

Recovery

Reclassification Criteria:

1. A minimum of three reproductively separate populations on the island of Kaua'i, each with at least 250 reproductive individuals (USFWS, 1994)
2. Each population must be naturally self-sustaining through the production of seeds, seedlings and mature plants, and large enough to insure long-term maintenance of genetic diversity. (USFWS, 1994)
3. The population of each species has been stabilized by removal of threats. (USFWS, 1994)

Delisting Criteria:

1. The target for delisting includes locating, or establishing if necessary, at least 2 additional wild populations, for a total of at least 5 reproductively stable populations, each with at least 250 reproductive individuals, per species. (USFWS, 1994)
2. These populations should be stable over an estimated ten year period. (USFWS, 1994)
3. All five populations should be unmanipulated and able to sustain themselves indefinitely without such human intervention as fencing and alien plant control. (USFWS, 1994)

Recovery Actions:

- Secure and manage existing populations. This task involves managing the Wahiawa Drainage and Waioli Stream Valley habitats to protect the remaining wild plants of these five species until their populations can either expand naturally or be artificially increased by outplanting. (USFWS, 1994)
- Conduct basic research essential to the conservation of the five species. Few details regarding the ecology, demographics, propagation, habitat requirements and basic life

history of these five species are known and such knowledge is essential to their conservation. (USFWS, 1994)

- Increase population numbers at existing sites. Population sizes of these five species should be increased to viable numbers in the Wahiawa Drainage, Waioli Stream Valley and Makaleha Mountains. (USFWS, 1994)
- Establish new populations. Plans must be developed for establishing new wild populations, including the selection of genetic stock. (USFWS, 1994)
- Verify the scientific validity of the recovery objectives. It is important to determine and verify the scientific validity of the recovery objective proposed herein. (USFWS, 1994)
- New recommended action in 2017 - 1: Captive propagation protocol development—Continue propagation efforts for maintenance of genetic stock. Test seeds for viability. (USFWS, 2017).
- 2017 - 2: Surveys and inventories—Continue to survey historic range of the species to determine the current status of the species. (USFWS, 2017).
- 2017 - 3: Ungulate monitoring and control—
 - o Protect all occurrences against disturbance from feral ungulates.
 - o Continue to maintain the fenced enclosure at Kanae Bog.
 - o Construct small-scale fences around remaining individuals to prevent imminent extinction. (USFWS, 2017).
- 2017 - 4: Invasive plant monitoring and control—
 - o Continue to control established ecosystem-altering nonnative invasive plant species around all populations.
 - o Continue to control invasive nonnative species that compete with the species around all populations. (USFWS, 2017).
- 2017 - 5: Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2017).
- 2017 - 6: Predator and herbivore monitoring and control—Implement effective control methods for rodents around all known populations. (USFWS, 2017).
- 2017 - 7: Predator and herbivore control research—Study *Hesperomannia lygatei* populations to determine the level of threat from invertebrate seed predation and the need for additional recovery actions. (USFWS, 2017).
- 2017 - 8: Disease control research—Determine if fungal disease is a major threat and determine control methods if necessary. (USFWS, 2017).
- 2017 - 9: Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered throughout historic range to reduce impacts from landslides and hurricanes. (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Protect the current population from pigs and invasive introduced plant species. (USFWS, 2010)
- Collect seeds from all subpopulations for genetic storage and reintroduction; plants may need pollination assistance to produce viable seed. (USFWS, 2010)
- Test seeds, when collected, for viability. (USFWS, 2010)
- Survey historical range of the species to determine the current status of the species. (USFWS, 2010)
- Research seed predation and protection methods. (USFWS, 2010)
- Determine if fungal disease is a major threat and determine control methods, if necessary. (USFWS, 2010)
- Remove pigs from the existing fenced area and surrounding areas. (USFWS, 2010)

- Propagate for reintroduction and augmentation, particularly within the existing fenced enclosure. (USFWS, 2010)
- Work with Hawaii Division of Forestry and Wildlife, The Nature Conservancy, and the landowner to continue implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2010)

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SPECIES ACCOUNT: *Hexastylis naniflora* (Dwarf-flowered heartleaf)

Species Taxonomic and Listing Information

Listing Status: Threatened; Southeast Region (R4) (USFWS, 2015); Proposed Delisting

Physical Description

A stemless perennial herb with mottled heart-shaped leaves 4-6 cm wide, supported on thin leaf-stems arising from an underground rhizome. Small dark brown or maroon-splotched flowers are borne near the rhizome tip, sometimes not rising above the leaf litter. Blooms in April and May. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Reported from Cherokee, Greenville and Spartanburg counties, South Carolina; and Cleveland, Catawba, Burke, Rutherford and Lincoln counties, North Carolina. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: This species jug-shaped flowers are usually beige to dark brown in color and appear from mid-March to early June (USFWS, 1988).

Reproduction Narrative

Adult: This species jug-shaped flowers are usually beige to dark brown in color and appear from mid-March to early June. The flowers are small and inconspicuous and are found near the base of the petioles. The fruit matures from mid-May to early July (Blomquist 1957, Gaddy 1980, 1981) (USFWS, 1988).

Habitat Type

Adult: Forest (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from NatureServe, 2015)

Site Fidelity

Adult: Moderate (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits acidic soils on moist to rather dry north-facing slopes of ravines and along bluffs and hillsides in boggy areas next to streams. Vegetation is typically oak-hickory-pine forests of the Piedmont (NatureServe, 2015). Moderate ecological integrity of the community, site fidelity and tolerance ranges are inferred based on the species habitat requirements, number of populations and relatively wide geographical representation (six counties).

Dispersal/Migration***Population Information and Trends*****Resiliency:**

Moderate (inferred from NatureServe, 2015)

Representation:

Moderate (inferred from NatureServe, 2015)

Redundancy:

Moderate (inferred from NatureServe, 2015)

Number of Populations:

21 - 80 (NatureServe, 2015)

Population Size:

1000 - 2500 individuals (NatureServe, 2015)

Population Narrative:

Two populations with at least 1000 individuals each (1981) are on registered properties. Sixty populations as of 1997. There were 24 known populations in 1989, of which 4 were protected (NatureServe, 2015). Moderate resiliency, representation and redundancy are inferred based on the number of known populations and individuals.

Threats and Stressors

Stressor: Urban development (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Urban development is listed as a threat to this species (USFWS, 2011)

Stressor: Trash disposal (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Trash disposal (as a result of urban development) is listed as a threat to this species (USFWS, 2011).

Stressor: Residential lawns (USFWS, 2011)

Exposure:**Response:****Consequence:** Loss of habitat**Narrative:** Expansion of residential lawns is listed as a threat to this species (USFWS, 2011).**Stressor:** Cattle (USFWS, 2011)**Exposure:****Response:****Consequence:** Loss of habitat/Loss of individuals**Narrative:** Cattle (mostly due to trampling) are listed as a threat to this species (USFWS, 2011).**Stressor:** Invasive exotic plants (USFWS, 2011)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** Invasive exotic plant species are rampantly spreading throughout riparian corridors and ravines across the range of this species. Invasive exotics such as English Ivy (*Hedera helix*), Chinese privet (*Ligustrum* spp.), Japanese honeysuckle (*Lonicera japonica*) and Japanese Nepal grass (*Microstegium vimineum*) are known to threaten several populations; however, the scope and magnitude of this threat has not been comprehensively assessed. This threat requires active management in order to be successfully abated. At present, the majority of protected populations are secured against habitat conversion, but lack designated managers with the technical expertise and available resources (funding and personnel) to address this threat (USFWS, 2011).**Stressor:** Road and bridge improvements (USFWS, 2011)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** Road and bridge improvement projects are listed as a threat to this species (USFWS, 2011).**Stressor:** ROW maintenance (USFWS, 2011)**Exposure:****Response:****Consequence:** Loss of habitat/Loss of individuals**Narrative:** Rights-of-way maintenance is listed as a threat to this species (USFWS, 2011).**Stressor:** Hydroelectric and drinking water reservoirs (USFWS, 2011)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** Hydroelectric and drinking water reservoir expansion and maintenance are listed as threats to this species (USFWS, 2011).**Stressor:** Fire management (USFWS, 2011)**Exposure:****Response:**

Consequence: Loss of habitat

Narrative: A final example of habitat modification bears mentioning here, although it is presently unknown whether the long-term effects to *H. naniflora* will be adverse or beneficial. One of the largest remaining populations of the species occurs at Cowpens National Battlefield in Cherokee County, South Carolina (Tables B.2 and B.3). This population has been estimated to contain over 10,000 rosettes (Rayner, 2006). NPS has begun using prescribed fire as a vegetation management tool at this site, pursuant to consultations with USFWS due to the presence of *H. naniflora* within their prescribed burn units (Bimbi, 2010; Stone, 2010; Wells, 2009; Walker et al., 2009). The scope of NPS's prescribed burning activity is increasing to encompass the majority of this *H. naniflora* population. Preliminary data suggested that burning has had no adverse effects upon growth or flowering (Walker et al., 2009). USFWS has registered concerns over the limited scope of this two-season monitoring effort and has requested a continuation of monitoring to ensure that this large population is not adversely affected by this experimental management approach (Bimbi, 2010; Wells, 2009). There is little information on the response of *H. naniflora* to fire, although anecdotal observation from a second site in Caldwell County, North Carolina suggests that the species was not appreciably harmed by a dormant season wildfire that spread through a portion of that population in the winter of 2009 (Tompkins, 2010). The continued use of prescribed burning at Cowpens National Battlefield, if accompanied by continued monitoring of the *H. naniflora* population, has the potential to significantly inform management strategies for this species (USFWS, 2011).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The North Carolina Plant Conservation and Protection Act (NC State Code Article 19B, § 106-202.12) provides limited protection from unauthorized collection and trade of plants listed under that statute. However, this statute does not protect the species or its habitat from destruction in conjunction with development projects or otherwise legal activities. Plant species are afforded even less protection in South Carolina, where they are protected only from disturbance where they occur on those properties owned by the state and specifically managed as South Carolina Heritage Preserves (SC State Code of Regulations Part 123 § 200-204). There are no other federal or state statutes that afford significant protections to *H. naniflora* (USFWS, 2011).

Stressor: Drought (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: In recent years, the southeast has experienced moderate to severe droughts that many observers have implicated in population declines and poor transplant survivorship (NC NHP, 2010; and references throughout this review). A wildfire, presumably brought on or at least exacerbated by drought conditions, burned portions of one of the largest known populations in 2009 (Foothills Landfill in Caldwell County; Golder and Associates, 2009). Accelerated climate change is expected to increase the frequency and extent of drought conditions across the southeast (Karl, et al. 2009). The extent to which these climate changes will significantly affect populations of *H. naniflora* is currently unknown (USFWS, 2011).

Recovery**Recovery Actions:**

- There is no recovery plan for this species.

Conservation Measures and Best Management Practices:

- 1. Prepare a recovery outline for the species (USFWS, 2011).
- 2. Convene a meeting of partners with significant knowledge and/or involvement (through ownership, monitoring, or management) with populations expected to play a key role in the recovery of the species. At this meeting: a. Seek confirmation of the current size and spatial extent of all populations estimated to contain more than 1,000 rosettes (e.g., all populations listed in Table B.2). If such information is lacking, prioritize and seek partner assistance for the 2011 field season, to obtain a robust estimate of current population size. b. Seek cooperation from partners for the collection of 2-3 years of baseline monitoring data capable of depicting status and trends in *H. naniflora* at each focal recovery site. These data would also establish a baseline against which post-delisting monitoring data would be compared (USFWS, 2011).
- 3. Obtain written confirmation of the type of protection afforded to all potentially protected populations, with an emphasis upon the larger populations most likely to represent self-sustaining populations of the species (e.g., Table B.2). This documentation should include: i. the full spatial extent of the known *H. naniflora* population (either fully or partially in protective ownership), ii. the boundaries of the area subject to protective ownership, iii. a description of the nature of protection afforded to the property (e.g., fee title, conservation easement, deed restriction, NCDOT owned right-of-way, or some other registry or agreement), and iv. provisions for management (including identification of responsible parties) v. landowner agreement to continue to uphold existing levels of protection and management even after the species is removed from the federal list of endangered and threatened species (USFWS, 2011).
- 4. In association with the above efforts, specifically work to address lingering uncertainties and/or increased protections at the following *H. naniflora* populations, expected to play a key role in the recovery of the species and any associated decisions to remove the species from the federal list: a. Cleveland County Landfill, Cleveland County, NC b. Cliffside Stream Station, Cleveland County and Rutherford Counties, NC c. Forest City Industrial Complex, Rutherford County, NC d. Cowpens National Battlefield, Cherokee County, SC e. Blalock Reservoir, Spartanburg County, SC f. Peters Creek, Spartanburg County, SC (USFWS, 2011).

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SPECIES ACCOUNT: *Hibiscadelphus distans* (Kauai hau kuahiwi)

Species Taxonomic and Listing Information

Listing Status: Endangered; 04/29/1986; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Hibiscadelphus distans is a shrub or small tree up to 18 feet (5.5 m) tall with smooth bark and a rounded crown. The green, heart-shaped leaves are 1.5 to 4 in (4 to 10 cm) long with numerous whitish hairs on the underside. The narrow, tubular, curved flowers are approximately 1 inch (2.5 cm) long with persistent leaf-like structures below the flowers. The flowers are greenish yellow, turning maroon with age. The seed pods are woody capsules with five sections, each containing two seeds. This species is readily grown from seeds and can be vegetatively propagated from cuttings. (USFWS, 1996)

Taxonomy

Hibiscadelphus distans was discovered on Kauai in June 1972 by L. Earl Bishop and Derral Herbst (1973) in the lower reaches of Waimea Canyon. They named it *Hibiscadelphus distans* because of its geographic isolation and morphological differences from other known species. Its morphological characters suggest that it represents the earliest evolutionarily divergent lineage for this genus (Hobdy 1984). (USFWS, 1996). In the Malvaceae family (USFWS, 2017).

Historical Range

The original population found by Bishop and Herbst in 1972 was located within the State-owned Na Pali Kona Forest Reserve, Koaie Canyon. (USFWS, 1996)

Current Range

Hibiscadelphus distans is currently found in Koaie Canyon, Kauai. (NatureServe, 2015)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual and asexual (USFWS, 1996)

Lifespan

Adult: Long lived perennial shrub (USFWS, 2017).

Dependency on Other Individuals or Species

Adult: Bird pollinators, specifically honey-eaters and honeycreepers (USFWS, 1996)

Reproduction Narrative

Adult: This species is readily grown from seeds and can be vegetatively propagated from cuttings. Trees in cultivation have begun flowering in 3 years, but the age at which trees in the

wild begin flowering is unknown. The narrow, curved flowers produce abundant nectar, indicating that they may have had an important pollination-feeding relationship with one native bird family, Meliphagidae (honey-eaters), and one subfamily, Drepanidinae (honeycreepers) (Hobdy 1984). (USFWS, 1996)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliff, forest- hardwood, forest/woodland, shrubland/chaparral (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Found in areas with full sun in summer, approximate annual rainfall of 60 in, and yearly mean temperatures ranging from 64 to 82 degrees Fahrenheit. (USFWS, 1996)

Environmental Specificity

Adult: Narrow, with several key requirements (USFWS, 1996)

Habitat Narrative

Adult: The naturally occurring *Hibiscadelphus distans* in Lower Koaje Canyon are found within a highly degraded native mesic forest that receives full sun in summer with no direct sun in winter. Exposure is 320 to 340 degrees NNW. The area receives approximately 60 in (15.2 cm) of rain annually, with yearly mean temperature ranging from 64 to 82 degrees F (18 to 28 degrees C). The substrate is basaltic bedrock overlain by dry, crumbly red-brown soil. Goats have denuded large areas causing severe erosion, and the entire area is prone to frequent rock slides. Several of the downslope plants grow in a small drainage that is dry except during heavy run-off periods. Associated species include *Aleurites moluccana*, *Artemisia kauaiensis*, *Psydrax odoratum*, *Diospyros sandwicensis*, *Lipochaeta connata*, *Myrsine* sp., *Nototrichium sandwicense*, *Pouteria sandwicensis*, *Triumfetta senitribiloba* and *Sapindus oahuensis*. *Melia azedarach*, an alien species, is now the dominant tree in the area. The ground cover is sparse and consists mainly of exotic grasses and broad-leaved herbaceous plants, including *Lantana camara*, which presents a major threat to this small population of *Hibiscadelphus distans*. Associated with the newly discovered cliffside population (upslope) are *Artemisia kauaiensis*, *Bidens sandwicensis*, *Psydrax odoratum*, *Carex meyenii*, *Dodonaea viscosa*, *Lipochaeta connata*, *Lobelia niihauensis*, and *Schiedea spergulina*. *Melinis minutifolia*, *Kalanchoe pinnata*, and *Opuntia* sp. are problem species at this location. (USFWS, 1996)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2009)

Redundancy:

Very low (inferred from USFWS, 2009)

Number of Populations:

2 (USFWS, 2009). As of 2017: one population (USFWS, 2017).

Population Size:

200-400 (20 wild) (USFWS, 2009). As of 2017: 10-20 individuals (USFWS, 2017).

Population Narrative:

Hibiscadelphus distans is critically endangered, with perhaps 20 known wild individuals in two populations. Numbers have been supplemented by propagation and outplantings, with at least 166 reintroductions from three or four population sources in 2006, and a report of over 200 outplants in four subpopulations in Piwa Valley exclosures, with signs of natural reproduction (USFWS 2008). (USFWS, 2009)

Threats and Stressors

Stressor: Browsing and erosion by feral goats (USFWS, 1996; USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The major threats to Hibiscadelphus distans include feral goat (Capra hircus) browsing within the canyon, and associated erosional hazards created by goat traffic in cliff habitat. Goats chew on the foliage and bark of Hibiscadelphus distans and eat any seedlings they can reach. They also cause landslides by dislodging rocks from ledges above the plants, damaging the trees and destroying seedlings. The surrounding vegetation has also been over browsed, causing increased erosion and danger from rock and landslides. (USFWS, 2009; USFWS, 1996)

Stressor: Competition with invasive plants (USFWS, 1996; USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The major threats to Hibiscadelphus distans include competition with invasive introduced plant species such as Lantana camara (lantana) and Melia azedarach (pride of India). Habitat disturbances have favored the introduction and spread of exotic (non-native) plants, which compete with and smother native vegetation, especially seedlings. These exotic plants include Melia azedarach, Lantana camara, Melinus minutifolia, Kalanchoe pinnata, Opuntia sp. and Myrica faya, an extremely aggressive non-native tree species that has overgrown hundreds of acres in exclosure areas (Diane Ragone, Program Coordinator, NTBG, personal observation). (USFWS, 1996; USFWS, 2009)

Stressor: Pink bollworm infestations (USFWS; 1996; USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The major threats to *Hibiscadelphus distans* include pink bollworm (*Pectinophora gossypiella*) infestation of seed capsules. The moth lays as many as 100 eggs in the calyx or flower, and the larvae feed on the seeds, destroying them. (USFWS, 1996; USFWS, 2009)

Stressor: Small population size (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The major threats to *Hibiscadelphus distans* include reduced reproductive vigor due to the small number of founder individuals (USFWS 1996; Hawaii Biodiversity and Mapping Program 2007). (USFWS, 2009)

Stressor: Recreation (USFWS, 1996)

Exposure:

Response:

Consequence:

Narrative: A hiking trail passes below the area where the plants are located, and hikers and hunters can readily reach the plants. The area has experienced incidents of unauthorized taking and vandalism (Herbst 1986). (USFWS, 1996)

Stressor: Landslides (USFWS, 1996)

Exposure:

Response:

Consequence:

Narrative: The limited range of this endangered species makes it especially vulnerable to natural disasters. Overgrazing by goats has increased erosion in this area, and heavy rains in 1989 caused an extensive landslide that destroyed the original known colony. (USFWS, 1996)

Stressor: Fire and stochastic events (USFWS, 1996)

Exposure:

Response:

Consequence:

Narrative: The remaining populations of *Hibiscadelphus distans* occur in xeric areas, which are prone to fires. High winds may knock down trees and create bridges between microhabitats, allowing fires to spread farther than would be possible in fragmented terrain. The fire danger may increase if alien plant cover increases with reduced ungulate populations. Severe hurricanes occasionally pass through the Hawaiian Islands and produce winds of a magnitude that can be extremely damaging to the vegetation. During Hurricane Iniki in 1992, winds clocked in excess of 200 mph a few miles to the north of Waimea Canyon reduced the number of outplanted individuals to approximately one-half (G. Kawakami, personal communication 1993). *Hibiscadelphus distans*, reduced to remnant populations, remains under threat from stochastic events. (USFWS, 1996)

Stressor: Genetic problems (USFWS, 1996)

Exposure:

Response:

Consequence:

Narrative: Although *Hibiscadelphus distans* was not known prior to 1972, the mesic habitat that the genus characteristically inhabited was extensive, which suggests that this species may once have been more widely distributed. If the species has gone through a bottleneck, the genetic diversity of *Hibiscadelphus distans* may already be severely reduced, possibly leaving the species prone to deleterious effects of inbreeding. (USFWS, 1996)

Stressor: Climate change loss or degradation of habitat (USFWS, 2017).

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Hibiscadelphus distans* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.879 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this species has no overlap between current and future climate envelopes, and is unlikely to tolerate expected changes in climate at its current location. This means that this species must persist within suitable microrefugia, or move to newly available climate-compatible areas to avoid extinction. (USFWS, 2017).

Recovery

Reclassification Criteria:

1. The currently occupied habitat on Kauai remains protected (under the jurisdiction of the Hawaii Division of Forestry and Wildlife) and managed to perpetuate the species (including maintenance of fencing to prevent feral ungulate damage). (USFWS, 1996)
2. At least two additional protected populations are located or established. (USFWS, 1996)
3. Each population contains at least 50 reproductive individuals. (USFWS, 1996)
- 4) Newly established populations are geographically isolated from the extant populations to ensure that all populations are not eliminated by a single small scale catastrophic event. (USFWS, 1996)
- 5) The 6 populations are maintained at the level of at least 50 reproductive individuals each for a minimum of 9 years. (USFWS, 1996)

Delisting Criteria:

1. Threats, especially feral goats, have been sufficiently reduced or eliminated to allow the six populations to reproduce unassisted. (USFWS, 1996)
2. The populations are stable or increasing and contain an adequate number of reproductive, self-regenerating adults to produce a mixture of reproductive stages (e.g. seedlings, juveniles, and adults) sufficient to ensure self-perpetuation. (USFWS, 1996)

3. There is a 10-year average of at least 250 reproductive plants in each of the six populations. (USFWS, 1996)

Recovery Actions:

- Protect and stabilize populations of *Hibiscadelphus distans*. (USFWS, 1996)
- Develop and implement plans to augment the extant populations, and create new populations, if necessary. (USFWS, 1996)
- Determine factors limiting growth and reproduction. (USFWS, 1996)
- Develop and maintain a detailed monitoring program. (USFWS, 1996)
- Verify or determine the scientific validity of the recovery objectives. (USFWS, 1996)
- 2017 Recommended actions - 1: Surveys and inventories—Conduct searches to better determine whether plants from Hipalau thought to have been extirpated by Hurricane Iniki have actually disappeared and to search for any new populations within suitable habitat. (USFWS, 2017).
- 2017 - 2: Ungulate monitoring and control—Continue to construct larger-scale fencing to allow the existing populations to expand and continue maintenance of existing fenced enclosures. Protect all occurrences against browsing and disturbances from feral ungulates. (USFWS, 2017).
- 2017 - 3: Invasive plant monitoring and control—
 - o Control established ecosystem-altering nonnative invasive plant species around all populations.
 - o Control invasive nonnative species that compete with the species around all populations. (USFWS, 2017).
- 2017 - 4: Captive propagation for genetic storage and reintroduction—Continue to collect material for complete genetic storage. (USFWS, 2017).
- 2017 - 5: Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2017).
- 2017 - 6: Predator and herbivore control research—Determine whether pink bollworm and beetles continue to infest seed capsules of *Hibiscadelphus distans* and any additional needed recovery actions. (USFWS, 2017).
- 2017 - 7: Human interaction monitoring and management—Develop and implement effective measures to reduce the impacts of hikers and trail maintenance. (USFWS, 2017).
- 2017 - 8: Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms. (USFWS, 2017).
- 2017 - 9: Fire monitoring and control—Develop and implement fire management plans for all wild and reintroduced populations. (USFWS, 2017).
- 2017 - 10: Population biology research—Summarize available biological information to determine flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, or limiting factors of *Hibiscadelphus distans*. (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Continue collecting for complete genetic storage. (USFWS, 2009)
- Construct larger-scale fencing to allow the existing populations to expand. (USFWS, 2009)
- Work with Hawaii Division of Forestry and Wildlife to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species in Koaie Canyon. (USFWS, 2009)
- Determine sites for establishing additional populations. (USFWS, 2009)

- Conduct searches to better determine whether plants from Hipalau thought to have been extirpated by Hurricane Iniki have actually disappeared and to search for any new populations within suitable habitat. (USFWS, 2009)
- Determine whether pink bollworm continues to infest seed capsules of *Hibiscadelphus distans*. (USFWS, 2009)
- Summarize available biological information to determine if anything has been learned in recent years about *Hibiscadelphus distans* flowering cycle, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, or limiting factors. (USFWS, 2009)

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SPECIES ACCOUNT: *Hibiscadelphus giffardianus* (Hau kuahiwi)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

A tree up to 7 m or more. Leaves are roundish, usually with 3 or 5 angles. Flowers are grayish green externally, and dark magenta within (NatureServe, 2015).

Taxonomy

A member of the mallow family (Malvaceae). Rock named his new genus *Hibiscadeiphus*, meaning “brother of Hibiscus” (Bryan 1971). The specific epithet, *giffardianus*, honors W.M. Giffard, who first saw the taxon in 1911 (USFWS, 1998).

Historical Range

Only one tree of *Hibiscadelphus giffardianus* has ever been known in the wild from Kipuka Puaulu in Hawaii Volcanoes National Park (USFWS 1998; 2015).

Current Range

The only known tree died in 1930 and this species is now extinct in the wild. At the time of listing, 11 reintroduced individuals were known from Kipuka Puaulu (USFWS 1996) (USFWS, 2015).

Critical Habitat Designated

Yes; 7/2/2003.

Legal Description

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Hibiscadelphus giffardianus* on the island of Hawaii.

Critical Habitat Designation

The critical habitat designation for *Hibiscadelphus giffardianus* includes one unit totaling 367 acres in Hawaii County, Hawaii.

Hawaii 26—*Hibiscadelphus giffardianus*—a [149 ha (367 ac)]: The unit contains portions of Kipuka Puaulu and Kipuka Ki, and also lies completely within the Kapapala watershed, and is completely within HVNP; provides habitat for 1 population of 100 mature, reproducing individuals of the *H. giffardianus*; and is currently occupied by 100 individuals. This unit is essential to the conservation of *H. giffardianus* because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. Although the service does not believe enough habitat currently exists to reach the recovery goal of 8 to 10 populations for this island-endemic species, we could not identify any other areas as suitable for *H. giffardianus* based upon what currently is known about this species. Only one tree has ever been known in the wild, and the species is a very narrow endemic that probably never naturally occurred in more than a single or a few populations.

Primary Constituent Elements/Physical or Biological Features

Habitat features that are essential for this species include, but are not limited to, mixed montane mesic forest.

Special Management Considerations or Protections

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for this species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Lifespan**

Adult: > 10 years (USFWS, 2015)

Reproduction Narrative

Adult: *Hibiscadelphus giffardianus* is a long-lived perennial (USFWS, 2015).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Montane mesic forest (USFWS, 1998)

Geographic or Habitat Restraints or Barriers

Adult: 3,900 - 4,300 ft. elevation (USFWS, 1998)

Habitat Narrative

Adult: Inhabits moist forest on old volcanic ash (NatureServe, 2015). This taxon grows in mixed Montane Mesic Forest at elevations between 1,200 and 1,310 meters (3,900 and 4,300 feet) (Bates 1990; HHP 1991b; HPCC 1991b1, 1991 b2) (USFWS, 1998).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends**Population Trends:**

Extinct in the wild in 1930 (USFWS, 2015; see current range/distribution)

Species Trends:

Decreasing (USFWS, 2015)

Resiliency:

Very low (inferred from USFWS, 2015)

Redundancy:

Low (inferred from USFWS, 2015)

Number of Populations:

3 (USFWS, 2015)

Population Size:

433 (USFWS, 2015)

Population Narrative:

It has been reintroduced in three sites at Hawaii Volcanoes National Park (2010). Overall, the numbers of individuals have decreased from the 440 reintroduced individuals reported in the previous 5-year review, to approximately 433 reintroduced individuals in 2014 (USFWS, 2015).

Threats and Stressors

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species (USFWS, 2015).

Stressor: Invasive plants (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Competition from invasive introduced plant species, including *Ehrharta stipoides* (meadow ricegrass), *Paspalum conjugatum* (Hilo grass), *Paspalum dilatatum* (dallis grass), *Psidium cattleianum* (strawberry guava), and *Hedychium* sp. (ginger) (USFWS, 2008).

Stressor: Fire (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Not available

Stressor: Predation (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Rats (*Rattus rattus*) strip the bark, eat seeds, and chew holes in the flowers for nectar. Japanese white-eye birds (*Zosterops japonicus*) rob nectar. *Melicope zahlbruckneri* is also threatened by two-spotted leafhoppers and slugs (USFWS, 2008).

Stressor: Stochastic events (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Species that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes and volcanic activity (USFWS, 2008).

Recovery

Reclassification Criteria:

1. A total of five to seven populations should be documented on the Big Island (USFWS, 1998).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population (for long-lived perennials) (USFWS, 1998).
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1998).

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on the Big Island (USFWS, 1998).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population (for long-lived perennials) (USFWS, 1998).
3. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1998).

Recovery Actions:

- Protect current populations and manage threats (USFWS, 1998).
- Conduct essential research (USFWS, 1998).
- Expand existing wild populations, as necessary (USFWS, 1998).
- Create new populations within historical range, as necessary (USFWS, 1998).
- Evaluate and validate recovery objectives (USFWS, 1998).

- Outplant new populations in areas of reduced threat (USFWS, 1998).
- Reduce threats from rodent predation (USFWS, 1998).
- Control insect damage (USFWS, 1998).

Conservation Measures and Best Management Practices:

- Surveys / inventories – Survey geographical and historical range for a current assessment of the species' status (USFWS, 2015).
- Captive propagation for genetic storage and reintroduction – Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. Collect genetic resources for storage at Harold L. Lyon Arboretum Seed Conservation Laboratory. This species currently has no seeds in genetic storage (USFWS, 2015).
- Ungulate monitoring and control – Maintain existing fences to protect them from the impacts of feral ungulates (USFWS, 2015).
- Invasive plant monitoring and control – Eradicate invasive introduced plants within ungulate exclosures and maintain exclosures free of invasive plants (USFWS, 2015).
- Population viability monitoring and analysis – Continue monitoring outplanted individuals (USFWS, 2015).
- Alliance and partnership development – Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2015).

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SPECIES ACCOUNT: *Hibiscadelphus hualalaiensis* (Hau kuahiwi)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

A tree 5 to 7 meters (16 to 23 feet) tall with the trunk up to 30 cm (12 inches in diameter and whitish bark. The leaf blades are heart-shaped and 10 to 15 cm (4 to 6 inches) long with a broad tip, a notched base, stellate hairs, and stalks 4 to 10 cm (1.5 to 4 inches) long. One or two flowers are borne in the axils of the leaves and have stalks 1.5 to 14 cm (0.6 to 5.5 inches) long. Five tooth like bracts are borne below each flower and the calyx is tubular or pouch-like. The overlapping petals form a curved bisymmetrical flower with longer upper petals, typical of bird-pollinated flowers. The flowers are greenish yellow on the outside and yellowish green, fading to purplish within, and 2 to 5.5 cm (0.8 to 2.2 inches) long. The fruit is woody and the seeds have a dense covering of hairs (USFWS, 1998).

Taxonomy

A member of the mallow family (USFWS, 1998). The genus is endemic to the Hawaiian islands, the species is endemic to the island of Hawaii (NatureServe, 2015).

Historical Range

Hibiscadelphus hualalaiensis was historically known from three populations, located in the Puu Waawaa region of Hualalai, on the island of Hawaii (USFWS, 1998). Last extant tree observed in 1992 at Puu Waawaa, Hawaii (NatureServe, 2015).

Current Range

Individuals have been reintroduced in South Kohala, North Kona, and in a Natural Area Reserve System on Hawaii Island (USFWS, 2015).

Critical Habitat Designated

Yes; 7/2/2003.

Legal Description

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Hibiscadelphus hualalaiensis* on the island of Hawaii (68 FR 39623 - 39722).

Critical Habitat Designation

The critical habitat designation for *Hibiscadelphus hualalaiensis* includes one unit totaling 9,832 acres in Hawaii County, Hawaii. The unit is Hawaii 10—*Hibiscadelphus hualalaiensis*—a.

Hawaii 10—*Hibiscadelphus hualalaiensis*—a [3,979 ha (9,832 ac)]: This unit contains Puu Iki and Puuwaawaa summits and is completely within the Kiholo watershed. The unit provides habitat for 8 populations, each with 100 mature, reproducing individuals of *H. hualalaiensis*, and is currently occupied by 12 individuals. This unit is essential to the conservation of *H. hualalaiensis* because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. This unit provides

enough space within the historical range of this island-endemic species for the geographic separation of the eight populations to reduce the likelihood of all recovery populations being destroyed by one naturally occurring catastrophic event. No other critical habitat has designated previously for this species. It has a limited known historical range, and there is little information available about this species.

Primary Constituent Elements/Physical or Biological Features

Habitat features that are essential for this species include, but are not limited to, dry mesic to dry *Metrosideros* forest on rocky substrate in deep soils.

Special Management Considerations or Protections

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for this species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (inferred from USFWS, 2008)

Lifespan

Adult: > 10 years (USFWS, 2015)

Breeding Season

Adult: May (USFWS, 1998)

Reproduction Narrative

Adult: It is a long-lived perennial (USFWS, 2015). All outplants flower and bear fertile fruit within three to five years (USFWS, 2008). *Hibiscadeiphus hualalaiensis* has been seen in flower in May and in fruit in June and July (C. Corn, pers. comm. 1998) (USFWS, 1998).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Dry to mesic forest (USFWS, 1998)

Geographic or Habitat Restraints or Barriers

Adult: 3,000 - 3,350 ft. elevation (USFWS, 1998)

Habitat Narrative

Adult: Inhabits dry to moist forests on old lava flows (NatureServe, 2015). This species grows in mixed dry to mesic forest remnants on lava fields, at elevations between 915 and 1,020 meters (3,000 and 3,350 feet) (Bates 1990; HHP 1993c3; HPCC 1991c, 1992a) (USFWS, 1998).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Species Trends:

Extinct in the wild since 1992 (NatureServe, 2015); slight decrease in outplanted individuals (USFWS, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

97 (USFWS, 2015)

Population Narrative:

The long term population trend is unknown. The last wild tree died in 1992 (NatureServe, 2015). Overall, the numbers of individuals have decreased from the approximately 100 outplanted individuals reported in the previous 5-year review, to approximately 97 outplanted individuals in 2015 (USFWS, 2015).

Threats and Stressors

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Hibiscadelphus hualalaiensis* is highly vulnerable to the impacts of climate

change. Furthermore, *H. hualalaiensis* was identified as a species that will have no overlapping area between current and future climate envelope (areas that contain the full range of climate conditions under which the species is known to occur) by 2100 (USFWS, 2015).

Stressor: Stochastic events (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Drought may exacerbate the effects of ungulates and has direct adverse impacts on *H. hualalaiensis* (J. Wagner, pers. comm. 2015) (USFWS, 2015). In addition to all of the other threats, species like *Hibiscadelphus hualalaiensis* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes and disease outbreaks (USFWS, 2008).

Stressor: Predation (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Several species of moths feed on the leaves, flowers, and mature capsules of *Hibiscadelphus* (Hawaii Biodiversity and Mapping Program 2005; Lorence and Wagner 1995), and the Japanese white-eye, a small naturalized bird, is a nectar robber of this genus (Lorence and Wagner 1995) (USFWS, 2008).

Recovery

Reclassification Criteria:

1. A total of five to seven populations should be documented on the Big Island (USFWS, 1998).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population (for long-lived perennials) (USFWS, 1998).
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1998).

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on the Big Island (USFWS, 1998).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population (for long-lived perennials) (USFWS, 1998).
3. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1998).

Recovery Actions:

- Protect current populations and manage threats (USFWS, 1998).
- Conduct essential research (USFWS, 1998).
- Expand existing wild populations, as necessary (USFWS, 1998).
- Create new populations within historical range, as necessary (USFWS, 1998).
- Evaluate and validate recovery objectives (USFWS, 1998).
- Reduce threats from rodent predation (USFWS, 1998).
- Outplant new populations in areas of reduced threat (USFWS, 1998).
- Protect populations from fire (USFWS, 1998).

Conservation Measures and Best Management Practices:

- Surveys / inventories – Survey geographical and historical range for a current assessment of the species' status (USFWS, 2015).
- Captive propagation for genetic storage and reintroduction -- Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change (USFWS, 2015).
- Ungulate monitoring and control – Maintain existing exclosures and monitor for potential incursions (USFWS, 2015).
- Invasive plant monitoring and control – Eradicate invasive introduced plants within ungulate exclosures and maintain exclosures free of invasive plants (USFWS, 2015).
- Population viability monitoring and analysis – Continue monitoring outplanted individuals (USFWS, 2015).
- Fire monitoring and control – Develop and implement a fire management plan at the existing exclosures (USFWS, 2015).
- Climate change adaptation strategy – Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. Develop a strategy for preventing the extinction of this species if no suitable habitat is predicted in the future (USFWS, 2015).
- Alliance and partnership development – Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2015).

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USFWS. 2008. *Hibiscadelphus hualalaiensis* (Hau kuahiwi) 5-Year Review Short Form Summary. Region 1 Pacific Islands Fish and Wildlife Office, Gina Shultz, Assistant Field Supervisor Endangered Species.

SPECIES ACCOUNT: *Hibiscadelphus woodii* (Hau kuahiwi)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Hibiscadelphus woodii, a member of the mallow family (Malvaceae), is a small branched tree 2.5 to 5 m (8.2 to 16.4 ft) tall with a rounded crown. The leaves have stalks 2.8 to 5.8 cm (1.1 to 2.3 in) long, with star shaped hairs when young, which are mostly lost as the leaf matures. Awl-shaped stipules, also covered with star-shaped hairs, are found at the base of the leaf stalk. The leaf blade is ovate, 7 to 9 cm (2.6 to 3.5 in) long, and 6.5 to 8.4 cm (2.6 to 3.3 in) wide. Star-shaped hairs are scattered along the veins of the leaves. The leaf margins are irregularly and coarsely toothed with the teeth either pointed or rounded. Flowers are borne individually on stalks 1.4 to 2.1 cm (0.6 to 0.8 in) long with star-shaped hairs. Below each flower are four to six bracts 11 to 15 mm (0.4 to 0.6 in) long and 1.8 to 4 mm (0.07 to 0.16 in) wide. The calyx is tubular, 1.3 to 1.5 cm (0.5 to 0.6 in) long, green, shallowly lobed, and moderately hairy with star-shaped hairs. The corolla is 4.5 to 4.7 cm (1.8 to 1.9 in) long, yellow with a coppery tinge when fresh, which rapidly turns purplish-maroon. The staminal column extends about 7 mm (0.3 in) beyond the lobes of the corolla. Fruits are not known from this species. (USFWS, 1998)

Taxonomy

Published in Novon 5: 183-187, 1995; Kartesz (1999) accepts. (NatureServe, 2015). In the Malvaceae family. (USFWS, 2017).

Historical Range

Hibiscadelphus woodii has been found only at the site of its discovery in Kalalau Valley on the island of Kauai within the Na Pali Coast State Park. (USFWS, 1998)

Current Range

Kalalau Rim, Kauai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Hibiscadelphus woodii* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Hibiscadelphus woodii* includes two units totaling 863 acres in Kauai County, Hawaii. The units are Kauai 11—*Hibiscadelphus woodii*—a, b.

Kauai 11—*Hibiscadelphus woodii*—a: This unit is critical habitat for *Hibiscadelphus woodii* and is 278 ha (687 ac) on State land (Hono o Na Pali NAR and Na Pali Coast State Park). This unit contains portions of Kaaalahina and Manono Ridges and Puu Ki Summit. This unit provides habitat for three populations of 100 mature, reproducing individuals of the longlived perennial

Hibiscadelphus woodii and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is important to the establishment of additional populations on Kauai in order to reach recovery goals. The habitat features contained in this unit that are essential for this species include, but are not limited to, basalt talus or cliff walls in *Metrosideros polymorpha* montane mesic forest. This unit is geographically separated from the other unit designated as critical habitat for this island-endemic species to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Although we do not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is of appropriate size and distance from the other unit to avoid their destruction by one naturally occurring catastrophic event. Kauai 11—*Hibiscadelphus woodii*—b: This unit is critical habitat for *Hibiscadelphus woodii* and is 72 ha (177 ac) on State land (Halelea Forest Reserve, Hono o Na Pali NAR, and Na Pali Coast State Park). This unit contains Kalahu Summit. This unit provides habitat for two populations of 100 mature, reproducing individuals of the long-lived perennial *Hibiscadelphus woodii* and is currently occupied with six plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, basalt talus or cliff walls in *Metrosideros polymorpha* montane mesic forest. This unit is geographically separated from the other unit designated as critical habitat for this island-endemic species to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Although we do not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is of appropriate size and distance from the other unit to avoid their destruction by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Basalt talus or cliff walls in *Metrosideros polymorpha* montane mesic forest and containing one or more of the following associated native plant species: *Artemisia australis*, *Bidens sandwicensis*, *Carex meyenii*, *Chamaesyce celastroides* var. *hanapeensis*, *Dubautia* spp., *Hedyotis* spp., *Lepidium serra*, *Lipochaeta* spp., *Lobelia niihauensis*, *Lysimachia glutinosa*, *Melicope pallida*, *Myrsine* spp., *Nototrichium* spp., *Panicum lineale*, *Poa mannii*, or *Stenogyne campanulata*; and

(ii) Elevations between 219 and 1,197 m (717 and 3,926 ft).

Special Management Considerations or Protections

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Lifespan**

Adult: Long-lived perennial. (USFWS, 2017).

Reproduction Narrative

Adult: Flowering material has been collected in March, April, and September. (USFWS, 1998)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland, cliffs (USFWS, 1998; NatureServe, 2015)

Habitat Narrative

Adult: The plants grow on cliff walls in an ohia montane mesic forest with alani, *Dubautia* sp. (naenae), *Lepidium serra* (anaunau), *Lipochaeta* sp. (nehe), *Lysimachia* sp., *Chamaesyce* sp. (akoko), manono, *Nototrichium* sp. (kului), *Myrsine* sp. (kolca), and the federally endangered species *Stenogyne campanulata*, *Lobelia niihauensis*, and *Poa mannii* (Mann's bluegrass) (USFWS 1996). (USFWS, 1998)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2012)

Redundancy:

None (inferred from USFWS, 2012)

Number of Populations:

1 (USFWS, 2012)

Population Size:

1 (USFWS, 2012). In 2012, the last known individual was revisited and confirmed to be dead (Clark 2016; PEPP 2012). (USFWS, 2017).

Population Narrative:

In 2009 and 2010, the Plant Extinction Prevention Program (2009, 2010) reported that only a single wild individual is extant on the steep, cliffy habitat in Kalalau Valley. In 2011, Ken Wood (pers. comm. 2011) confirmed that he has not visited the single individual since 2006, and that the current status of the single extant plant is unknown. (USFWS, 2012)

Threats and Stressors

Stressor: Habitat degradation by feral pigs and goats (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Habitat degradation by feral goats and pigs is a threat to *Hibiscadelphus woodii*. As early as 1778, European explorers introduced livestock, which became feral, increased in number and range, and caused significant changes to the natural environment of Hawaii. Feral pigs are currently present on Kauai and inhabit rain forests and grasslands. While rooting in the ground in search of the invertebrates and plant material they eat, feral pigs disturb and destroy vegetative cover, trample plants and seedlings, and threaten forest regeneration by damaging seeds and seedlings. They disturb soil and cause erosion, especially on slopes. Alien plant seeds are dispersed on their hooves and coats as well as through their digestive tracts, and the disturbed soil is fertilized by their feces, helping these plants to establish. Feral pigs are a major vector in the spread of many introduced plant species (Smith 1985; Stone 1985; Medeiros et al. 1986; Scott et al. 1986; Tomich 1986; Cuddihy and Stone 1990; Wagner et al. 1999). The goat, a species originally native to the Middle East and India, was successfully introduced to the Hawaiian Islands in 1792. Goats browse on introduced grasses and native plants, especially in drier and more open ecosystems. Feral goats eat native vegetation, trample roots and seedlings, cause erosion, and promote the invasion of alien plants. They are able to forage in extremely rugged terrain and have a high reproductive capacity (Clarke and Cuddihy 1980; Culliney 1988; Scott et al. 1986; Tomich 1986; van Riper and van Riper 1982). The remaining *H. woodii* individual is located on a cliff wall, and due to the steep and difficult terrain, fencing or other activities could cause erosion or landslides that may impact the plant (Wood et al. 2001). (USFWS, 2007)

Stressor: Non-native invasive plants (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: *Hibiscadelphus woodii* is threatened by alien plant species which compete with and degrade habitat of natives for space, light, water, and nutrients (Cuddihy and Stone 1990). The nonnative plant species *Erigeron karvinskianus* (daisy fleabane) is a threat to *H. woodii*, as it is a low-growing species that smothers native plants, particularly on cliffs (Service 1998). (USFWS, 2007)

Stressor: Nectar robbing (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: *Hibiscadelphus woodii* is threatened by the nectar-robbing Japanese white-eye (*Zosterops japonicus*). Nectar robbing has the potential to be highly damaging to the reproductive success of *H. woodii* (Wood et al. 2001). Nitidulidae beetles were observed in a

preserved flower specimen of *H. woodii*. It was proposed that the beetles may be responsible for the observed lack of fruit set (Wood et al. 2001). (USFWS, 2007)

Stressor: Small population size (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: In addition to all of the other threats, species like *Hibiscadelphus woodii* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes and disease outbreaks. (USFWS, 2007)

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2012)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Kauai where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Kauai where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1998)

Recovery Actions:

- The degree of damage resulting from nectar robbing by the Japanese white-eye, with emphasis on management strategies to reduce the impacts of these birds, should be assessed. (USFWS, 1998)
- Aerial hunting to reduce feral ungulates and subsequent control of alien plant species. Due to the steep terrain, fencing could potentially cause erosion or landslides that would negatively impact the plants. Aerial hunting would reduce the number of ungulates without increasing erosion. Once the numbers of feral ungulates are reduced, alien plant control should be initiated. (USFWS, 1998)
- Outplant additional plants in areas of reduced threat. Attempts should be made to establish this species in an outplanting site free from impacts of feral goats and pigs, and natural events such as rock slides. (USFWS, 1998)
- Given the degraded nature of the Kauai plant cluster's habitat, their precariously low numbers, and the severity of the threats, the highest priority actions must be aimed at protecting all extant wild individuals and populations, managing habitat to enhance survival and ensuring maintenance of adequate genetic stock ex situ. (USFWS, 1995)
- It is hoped that by eliminating current threats through management, populations of the Kauai cluster taxa will expand naturally. However, in certain special instances, wild populations of the Kauai cluster taxa may need to be augmented. (USFWS, 1995)
- Research into various aspects of the life history, habitat, pollinators, reproductive biology, symbionts, optimum requirements for growth, requirements for population viability, and control of threats to each of the Kauai cluster taxa must be carried out to better understand the requirements necessary for perpetuation of these plants. (USFWS, 1995)
- If necessary to meet recovery objectives, populations should be reestablished in areas where they are known to have occurred historically, particularly if genetically uncontaminated, cultivated materials exist which are known to have originated from the historical site. (USFWS, 1995)
- The scientific validity of the recovery objectives should be reviewed as more information becomes available. (USFWS, 1995)
- A public education program is needed to increase awareness of and support for plant recovery efforts in Hawaii. (USFWS, 1995)
- New in 2017 (in light of no wild individuals remaining) - 1: Surveys and inventories—Search for new individuals of *Hibiscadelphus woodii*. (USFWS, 2017).
- 2017 - 2: Ungulate monitoring and control—Protect all occurrences against browsing and disturbances from feral ungulates. (USFWS, 2017).
- 2017 - 3: Invasive plant monitoring and control—
 - o Control established ecosystem-altering nonnative invasive plant species around all populations.
 - o Control invasive nonnative species that compete with the species around all populations. (USFWS, 2017).
- 2017 - 4: Captive propagation for genetic storage and reintroduction—If any new individuals are found, it is imperative to redouble efforts to bring the species into cultivation or tissue culture by utilizing the skills of expert plant propagators, and by experimenting with innovative plant propagation techniques. (USFWS, 2017).
- 2017 - 5: Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2017).

- 2017 - 6: Predator and herbivore control research—
 - o Study any new *Hibiscadelphus woodii* populations to determine the level of threat from invertebrate herbivory and any additional recovery actions needed.
 - o Study any new *Hibiscadelphus woodii* populations to determine level of threat from nonnative bird nectar-robbing and any additional recovery actions needed.
 - o Control rats around any new individuals. (USFWS, 2017).
- 2017 - 7: Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms. (USFWS, 2017).
- 2017 - 8: Population biology research—Study any new individuals to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Since the extinction of *Hibiscadelphus woodii* may be imminent, with only a single known individual remaining, and with no representation of the species in ex situ culture, it is imperative to redouble efforts to bring the species into cultivation or tissue culture by utilizing the skills of expert plant propagators, and by experimenting with innovative plant propagation techniques. (USFWS, 2007)
- Aerial hunting would reduce the number of ungulates, decreasing the rate of habitat degradation. (USFWS, 2007)
- Search for new individuals of *Hibiscadelphus woodii*. (USFWS, 2007)
- Continue to collect seeds from all existing individuals and send to at least two or three different venues for propagation. (USFWS, 2012)
- Once genetic material has been propagated, reintroduce the species back into its known historical range. (USFWS, 2012)
- Monitor the condition of the single known extant individual of *Hibiscadelphus woodii*, which hasn't been visited since 2006. (USFWS, 2012)
- Control ungulates to protect the extant individual against disturbances from feral ungulates. (USFWS, 2012)
- Conduct thorough surveys of all suitable habitats where *Hibiscadelphus woodii* was historically seen. (USFWS, 2012)
- Control invasive introduced plant species around the extant population. (USFWS, 2012)
- Conduct research to develop new innovative techniques or technological advances in propagation methodology to propagate this species. (USFWS, 2012)
- Conduct research on the degree of damage resulting from nectar robbing by the Japanese white-eye, with emphasis on management strategies to reduce the impacts of these birds. (USFWS, 2012)
- Work with the Hawaii Division of Forestry and Wildlife and other land managers to continue planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2012)

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SPECIES ACCOUNT: *Hibiscus arnottianus* ssp. *immaculatus* (Koki`o ke`oke`o)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/08/1992; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Hibiscus arnottianus ssp. *immaculatus*, a member of the hibiscus family (Malvaceae), is a tree up to 3 m (10 ft) tall with alternate, oval, toothed leaves measuring 5 to 7 cm (2 to 2.8 in) long and 4 to 6.5 cm (1.6 to 2.6 in) wide. Six lance-shaped bracts (leaf-like structures), 5 to 8 mm (0.2 to 0.3 in) long, are found under each of the faintly fragrant flowers, which are arranged singly near the ends of the branches. The calyx is 2.5 to 3.0 cm (1 to 1.2 in) long and cleft into five teeth with long, narrow points. The flaring petals are white and measure 8 to 11 cm (3.1 to 4.3 in) long and 2.5 to 3.5 cm (1 to 1.4 in) wide. Anthers, on spreading filament tips 1 to 2 cm (0.4 to 0.8 in) long, are arranged along the upper third of the white staminal column, which measures 10 to 14 cm (4 to 5.5 in) in length. Capsules are enclosed by the sepals and contain 4 mm-long (0.2 in) seeds which are covered with yellowish brown hair. (USFWS, 1996)

Taxonomy

Genus primarily of tropical & subtropical regions, species endemic to Oahu & Molokai, subspecies endemic to molokai. formerly treated as separate species *H. immaculatus* by M. roe. epithet has been spelled 'immaculata' (Kartesz, 1994 checklist) and 'immaculatus' (USFWS; Kartesz spelling corrected to 'immaculatus' in 8/98 review draft). (NatureServe, 2015). In the Malvaceae family (USFWS, 2018).

Historical Range

See current range/distribution.

Current Range

Endemic to Northeast Molokai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Hibiscus arnottianus* ssp. *immaculatus* (Koki`o ke`oke`o) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes ten detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Hibiscus arnottianus* ssp. *immaculatus* includes ten CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Molokai—Coastal—Unit 1 consists of 70 ac (28 ha) of privately owned land, and 54 ac (22 ha) of federally owned land (U.S. Coast Guard) at Laau Point, from Kahaiawa to Keawakalani, along the

western coast of Molokai. This unit is occupied by the plant *Marsilea villosa*, and includes the mixed hermland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 1 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 2 consists of 263 ac (106 ha) of State land, and 710 ac (287 ha) of privately owned land, from Ilio Point to Kaa Gulch, along the northwestern coast of Molokai. This unit is occupied by the plant *Marsilea villosa* and includes the mixed hermland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 2 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 3 consists of 794 ac (321 ha) of State land, and 3 ac (1 ha) of federally owned land (Kalaupapa National Historical Park), from Kahiu Point to Wainene, along the north-central coast of Molokai. This unit is occupied by the plants *Pittosporum halophilum*, *Schenkia sebaeoides*, and *Tetramolopium rockii*, and includes the mixed hermland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 3 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Marsilea villosa*, *Peucedanum sandwicense*, or *Sesbania tomentosa*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 4 consists of 10 ac (4 ha) on Mokapu Island on the northern coast of Molokai. This area is State-owned, and is classified as a State Seabird Sanctuary. This unit is

occupied by the plants *Peucedanum sandwicense* and *Pittosporum halophilum*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 4 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Marsilea villosa*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 5 consists of 1 ac (0.5 ha) on Huelo islet on the northern coast of Molokai. This area is State-owned, and is classified as a State Seabird Sanctuary. This unit is occupied by the plants *Brighamia rockii*, *Peucedanum sandwicense*, and *Pittosporum halophilum*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 5 is not known to be occupied by *Bidens wiebkei*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Marsilea villosa*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 6 consists of 190 ac (77 ha) of State land, and 1,685 ac (682 ha) of privately owned land, from Kaholaiki Bay to Halawa Bay, on the northeastern coast of Molokai. This unit is occupied by the plants *Bidens wiebkei*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, and *Ischaemum byrone*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 6 is not known to be occupied by *Brighamia rockii*, *Hibiscus brackenridgei*, *Marsilea villosa*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 7 consists of 49 ac (20 ha) of privately owned land from Alanuihipaka Ridge to Kalanikaula, on the northeastern coast of Molokai. This unit includes the mixed herbland

and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). Although Molokai—Coastal—Unit 7 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Marsilea villosa*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Wet Cliff—Unit 1 (and) *Palmeria dolei*—Unit 43—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 43—Wet Cliff This area consists of 1,395 ac (565 ha) of State land, and 212 ac (86 ha) of privately owned land, and encircles the plateau between Pelekunu and Wailau valleys, in north-central Molokai. These units are occupied by the plants *Brighamia rockii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea munroi*, and *Hibiscus arnottianus* ssp. *immaculatus*, and include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Wet Cliff—Unit 1 is not known to be occupied by *Cyanea grimesiana* ssp. *grimesiana*, *Hesperomannia arborescens*, *Phyllostegia hispida*, *Pteris lidgatei*, or *Stenogyne bifida*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Wet Cliff—Unit 2 (and) *Palmeria dolei*—Unit 44—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 44—Wet Cliff This area consists of 462 ac (187 ha) of State land, and 806 ac (326 ha) of privately owned land (partly within The Nature Conservancy's Pelekunu Preserve), along the rim of Pelekunu Valley from Kipapa Ridge to Mapulehu, in central Molokai. These units are occupied by the plants *Clermontia oblongifolia* ssp. *brevipes* and *Phyllostegia hispida*, and include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Wet Cliff—Unit 2 is not known to be occupied by *Brighamia rockii*, *Canavalia molokaiensis*, *Cyanea grimesiana* ssp. *grimesiana*, *C. munroi*, *Hesperomannia arborescens*, *Hibiscus arnottianus* ssp. *immaculatus*, *Pteris lidgatei*, or *Stenogyne bifida*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Wet Cliff—Unit 3 consists of 1,137 ac (460 ha) of State land, and 225 ac (91 ha) of privately owned land, along the rim of Wailau Valley from Mapulehu to Kahiwa Gulch, in eastern Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Molokai—Wet Cliff—Unit 3 is not known to be occupied by *Brighamia rockii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea grimesiana* ssp. *grimesiana*, *C. munroi*, *Hesperomannia arborescens*, *Hibiscus arnottianus* ssp. *immaculatus*, *Phyllostegia hispida*, *Pteris lidgatei*, or *Stenogyne bifida*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Hibiscus arnottianus* ssp. *immaculatus* critical habitat consists of two components. Coastal (Molokai) and Wet cliff (Molokai) (81 FR 17790-18110):

Ecosystem: Coastal. Elevation: <980 ft (<300 m). Annual precipitation: <20 in (<50 cm). Substrate: Well-drained, calcareous, talus slopes; dunes; weathered clay soils; ephemeral pools; mudflats. Canopy: *Hibiscus*, *Myoporum*, *Santalum*, *Scaevola*. Subcanopy: *Gossypium*, *Sida*, *Vitex*. Understory: *Eragrostis*, *Jacquemontia*, *Lyceum*, *Nama*, *Sesuvium*, *Sporobolus*, *Vigna*.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. Understory: Bryophytes, Ferns, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which

were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookii*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*,

Bonamia menziesii, Clermontia oblongifolia ssp. brevipes, C. oblongifolia ssp. mauiensis, C. samuelii, Ctenitis squamigera, Cyanea asplenifolia, C. copelandii ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. magnicalyx, C. mannii, C. maritae, C. mceldowneyi, C. profuga, C. solanacea, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Dubautia plantaginea ssp. humilis, Geranium hanaense, G. multiflorum, Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Lifespan**

Adult: Long-lived perennial (USFWS, 2018).

Reproduction Narrative

Adult: This species was observed in flower during July 1990 (HHP 1994b). (USFWS, 1996)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Moist to wet environments (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 15 and 480 meters (USFWS, 2011)

Environmental Specificity

Adult: Low, with few key requirements (USFWS, 2011)

Habitat Narrative

Adult: Hibiscus arnottianus ssp. immaculatus typically occurs in mesic forests between 15 and 480 meters (50 and 1,600 feet) in elevation (USFWS 1992). The habitat in Wailau Valley on the ridge to Olokui where Hibiscus arnottianus subsp. immaculatus occurs is Metrosideros polymorpha (ohia) lowland mesic to wet forest. On the Anapuhi Cliffs, west of Kaaloa and Haupu Bay, the habitat where Hibiscus arnottianus subsp. immaculatus occurs is Metrosideros polymorpha – Dicranopteris linearis mesic forest. (USFWS, 2011)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Low (inferred from USFWS, 2011)

Redundancy:

Low (inferred from USFWS, 2011)

Number of Populations:

4 (USFWS, 2011). As of 2018: 3 (USFWS, 2018).

Population Size:

125 (USFWS, 2011). As of 2018: 100-200. (USFWS, 2018).

Population Narrative:

Hibiscus arnottianus subsp. *immaculatus* is endemic to East Molokai, and known only from three populations at Olokui above Waieheu, Papalaua, and Wailau. Historically, it was also known from Kalae on Molokai. In total, there are approximately 125 individuals of *Hibiscus arnottianus* subsp. *immaculatus* in four populations. (USFWS, 2011)

Threats and Stressors

Stressor: Introduced invasive species (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Threats to *Hibiscus arnottianus* subsp. *immaculatus* include introduced invasive plant species such as *Ageratina adenophora* (sticky snakeroot), *A. riparia* (spreading mist flower), *Bryophyllum pinnatum* (airplant), *Buddleia asiatica* (dogtail), *Christella dentata* (downy wood fern), *Cyrtomium falcatum* (Japanese holly fern), *Clidemia hirta* (Koster's curse), *Melinis minutiflora* (molasses grass), *Pluchea carolinensis* (sourbush), *Rubus rosifolius* (thimbleberry), and *Tibouchina herbacea* (glory bush). (USFWS, 2011)

Stressor: Habitat degradation by feral pigs and goats (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Feral pigs (*Sus scrofa*) and goats (*Capra hircus*) disturb and degrade the habitat and cause erosion and landslides, which further imperil this rare species (Perlman 2009a, b; Wood 2009 a, b). (USFWS, 2011)

Stressor: Predation by rats and slugs (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Rats (*Rattus* spp.) and slugs (unidentified species) are predators of this taxon (Perlman 2009a, b). (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to *Hibiscus arnottianus* subsp. *immaculatus*. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2011)

Stressor: Small population size (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: In addition to all of the other threats, species like *Hibiscus arnottianus* subsp. *immaculatus* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding and disease outbreaks. The extent of these natural processes on this single island endemic are exacerbated by anthropogenic threats, such as habitat loss for human development or predation by introduced species (USFWS 1992). (USFWS, 2011)

Stressor: Lack of pollinators (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Seed production seems to be problematic in this species. Whether this is due to pollination issues (lack of pollinators) or predatory insects is unclear. Prior to recent collections of cuttings at Olokui, the plants which have been propagated on Molokai were from one original founder located at Pelekunu. With the use of hand pollination, Bill Garnett has been able to produce first generation seed from these plants (W. Garnett, Wiliwili Rare Plant Nursery, pers. comm. 2009). (USFWS, 2011)

Recovery**Reclassification Criteria:**

1. A total of five to seven populations of each taxon should be documented on Molokai and at least one other island where they now occur or occurred historically. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1996)

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1996)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Molokai and at least 1 other island where they now occur or occurred historically. (USFWS, 1996)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1996)

3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1996)

Recovery Actions:

- Propagation and maintenance of genetic stock ex situ, and protection of remaining wild individuals from threats. (USFWS, 1996)
- The plan proposes the delineation of management units to conserve not only these taxa, but their habitats as well. These units should be managed to preserve as many native species (flora and fauna) as possible, through threat-control and forest-restoration programs. (USFWS, 1996)
- The next step in the recovery of these species is augmentation of small populations and re-establishment of new populations within the historical range of the species. (USFWS, 1996)
- A research program is also recommended to study the growth and reproductive viability of each taxon, determine the parameters of viable populations of each taxon, study the reproductive strategy and pollinators of each taxon, and study possible pests and diseases. (USFWS, 1996)
- Finally, the recovery criteria should be refined and revised as new information becomes available. (USFWS, 1996)
- New Recommended Action 2018 - 1: Surveys and inventories—Continue to survey for additional populations of *Hibiscus arnottianus* subsp. *immaculatus* in areas of potentially suitable habitat and at historical locations. (USFWS, 2018).
- 2018 - 2: Ungulate monitoring and control—Construct and maintain fenced exclosures and strategic fencing as appropriate to protect individuals from the negative impacts of feral ungulates. (USFWS, 2018).
- 2018 - 3: Invasive plant monitoring and control—
 - o Control established ecosystem-altering nonnative invasive plant species around all populations.
 - o Control invasive nonnative species that compete with the species around all populations. (USFWS, 2018).
- 2018 - 4: Predator and herbivore monitoring and control—
 - o Implement effective control methods for rodents at all known populations.
 - o Research and implement effective control methods for slugs. (USFWs, 2018).
- 2018 - 5: Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock and reintroduction. (USFWS, 2018).

- 2018 - 6: Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2018).
- 2018 - 7: Climate change adaptation strategy—Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. (USFWS, 2018).
- 2018 - 8: Alliance and partnership development—Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2018).

Conservation Measures and Best Management Practices:

- Continue collecting seeds and/or cuttings from all wild individuals. (USFWS, 2011)
- Propagate for genetic storage and reintroductions. (USFWS, 2011)
- Continue reintroducing individuals into protected suitable habitat within historical range. (USFWS, 2011)
- Monitor existing populations to track the status of the species and at historical sites for new recruitment. (USFWS, 2011)
- Fence all populations to provide protection from the negative impacts of feral ungulates. (USFWS, 2011)
- Control introduced invasive plant species in all known populations. (USFWS, 2011)
- Control rats in the vicinity of these populations. (USFWS, 2011)
- Develop and implement methods to control slugs and insect pests. (USFWS, 2011)
- Research pollinators and seed distributors to determine limiting factors; investigate techniques to improve natural recruitment. (USFWS, 2011)
- Work with Hawaii Division of Forestry and Wildlife, National Park Service, and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2011)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2011)

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SPECIES ACCOUNT: *Hibiscus brackenridgei* (ma`o hau hele, Native yellow hibiscus)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

Hibiscus brackenridgei ssp. *mokuleianus* is a short-lived perennial shrub of the Malvaceae (mallow family). It is a sprawling to erect shrub or small tree with lobed, heart-shaped leaves 5 to 15 cm (2 to 6 in) long. The yellow flowers, borne singly or in small clusters, have petals 3.5 to 8 cm (1.4 to 3.2 in) long. The fruits are round or oval capsules 1.1 to 2 cm (0.4 to 0.8 in) long (Wagner et al 1999). The stature, branching pattern, and morphology of leaves, stems, and flowers of *H. brackenridgei* ssp. *mokuleianus* differ in the three areas on Oahu where the species is currently known. Morphological differences among these “types” are attributable to underlying genetic differences (Makua Implementation Team 2003). The Waialua type (including plants at Kihakapu, Palikea, and Kaimuhole and Kaumoku Nui population units) represents typical *H. brackenridgei* ssp. *mokuleianus* plants, which are single-trunked trees 4 to 7 m (13 to 23 ft) tall with stems densely covered with spines. The Kealia type south of Dillingham Airfield (including the Haili to Kawaii population unit) is shorter (2 to 6 m (6.5 to 20ft) tall), branches near the ground to form a multi-trunked tree, and has moderately spiny to spineless stems. The recently discovered Makua type morphologically resembles *H. brackenridgei* ssp. *molokaiana*, which previously had been recorded only from West Molokai. The Makua type is a rambling shrub with branches that spread outward, not upwards as in the other two types, and has smaller leaves and no spines. For the purposes of the Makua Implementation Plan and this Biological Opinion, the target taxon consists of the various Oahu and Molokai occurrences of typical *H. brackenridgei* ssp. *mokuleianus* and typical *H. brackenridgei* ssp. *molokaiana*, and occurrences falling between these two morphological extremes (Makua Implementation Team 2003) (USFWS, 2016). A summer-deciduous tree up to 10 m tall. The stems and flowers bear small spines. The yellow flowers are large and showy. (NatureServe, 2015)

Historical Range

Hibiscus brackenridgei is a species endemic to the Hawaiian Islands. Historic data indicate it was known from all the main Hawaiian Islands (Wagner et al 1999). The subspecies *H. brackenridgei* ssp. *mokuleianus* historically was known from scattered locations in the Waianae Mountains of Oahu and West Molokai (Makua Implementation Team 2003) (USFWS, 2016).

Current Range

Endemic to Waianae Mts of Oahu. Wagner et al. Cite 2 populations on Kauai, but there are no records to substantiate these (NatureServe, 2015). Currently, this subspecies occurs in five naturally occurring population units (excluding inter situ, ex situ, and experimentally reintroduced sites) totaling approximately 669 individuals (Table SB 22) (U.S. Army Garrison 2006c). These population units are found on Federal, State, and private lands (68 FR 35950). In addition, several outplantings from Makua stock are located at inter situ and ex situ sites throughout Oahu (USFWS, 2016).

Critical Habitat Designated

Yes; 3/19/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Hibiscus brackenridgei* (=Native yellow hibiscus) *ma`o hau hele* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 17 detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

On September 18, 2012, the U.S. Fish and Wildlife Service (Service) designated revised critical habitat for *Hibiscus brackenridgei* on the island of Oahu.

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Hibiscus brackenridgei* on the island of Hawaii.

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Hibiscus brackenridgei* (*ma`o hau hele*, Native yellow hibiscus) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Hibiscus brackenridgei* (77 FR 57648-57862). The critical habitat designation includes 9 critical habitat units, which encompass approximately 6,359 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Hibiscus brackenridgei* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Hibiscus brackenridgei* includes 17 CHUs in Maui County, Hawaii with detailed unit information. There are also an unknown number of units on Lanai that contain this species (number of units is unknown because detailed unit descriptions for Lanai are not available) (81 FR 17790-18110).

Molokai—Coastal—Unit 1 consists of 70 ac (28 ha) of privately owned land, and 54 ac (22 ha) of federally owned land (U.S. Coast Guard) at Laau Point, from Kahaiawa to Keawakalani, along the western coast of Molokai. This unit is occupied by the plant *Marsilea villosa*, and includes the mixed hermland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 1 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrnone*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 2 consists of 263 ac (106 ha) of State land, and 710 ac (287 ha) of privately owned land, from Ilio Point to Kaa Gulch, along the northwestern coast of Molokai. This

unit is occupied by the plant *Marsilea villosa* and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 2 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 3 consists of 794 ac (321 ha) of State land, and 3 ac (1 ha) of federally owned land (Kalaupapa National Historical Park), from Kahu Point to Wainene, along the north-central coast of Molokai. This unit is occupied by the plants *Pittosporum halophilum*, *Schenkia sebaeoides*, and *Tetramolopium rockii*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 3 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Marsilea villosa*, *Peucedanum sandwicense*, or *Sesbania tomentosa*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Kahoolawe—Lowland Dry—Unit 1 consists of 1,220 ac (494 ha) of State land, north of Waihonu Gulch on west Kahoolawe. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Kahoolawe—Lowland Dry—Unit 1 is not known to be occupied by *Gouania hillebrandii*, *Hibiscus brackenridgei*, *Kanaloa kahoolawensis*, *Neraudia sericea*, *Sesbania tomentosa*, or *Vigna owahuensis*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 4 consists of 10 ac (4 ha) on Mokapu Island on the northern coast of Molokai. This area is State-owned, and is classified as a State Seabird Sanctuary. This unit is occupied by the plants *Peucedanum sandwicense* and *Pittosporum halophilum*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these

species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 4 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Marsilea villosa*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Kahoolawe—Lowland Dry—Unit 2 consists of 3,205 ac (1,297 ha) of State land from Lua o Kealialuna to Puu o Moaulaiki and Luamakika on the eastern side of Kahoolawe. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Kahoolawe—Lowland Dry—Unit 2 is not known to be occupied by *Gouania hillebrandii*, *Hibiscus brackenridgei*, *Kanaloa kahoolawensis*, *Neraudia sericea*, *Sesbania tomentosa*, or *Vigna o-wahuensis*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 5 consists of 1 ac (0.5 ha) on Huelo islet on the northern coast of Molokai. This area is State-owned, and is classified as a State Seabird Sanctuary. This unit is occupied by the plants *Brighamia rockii*, *Peucedanum sandwicense*, and *Pittosporum halophilum*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 5 is not known to be occupied by *Bidens wiebkei*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Marsilea villosa*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 6 consists of 190 ac (77 ha) of State land, and 1,685 ac (682 ha) of privately owned land, from Kaholaiki Bay to Halawa Bay, on the northeastern coast of Molokai. This unit is occupied by the plants *Bidens wiebkei*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, and *Ischaemum byrone*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 6 is not known to be occupied by *Brighamia rockii*, *Hibiscus brackenridgei*, *Marsilea villosa*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*,

or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 7 consists of 49 ac (20 ha) of privately owned land from Alanuihipaka Ridge to Kalanikaula, on the northeastern coast of Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). Although Molokai—Coastal—Unit 7 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrnei*, *Marsilea villosa*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Dry—Unit 1 consists of 24 ac (10 ha) of privately owned land, in a small gulch northwest of Mahana, in west-central Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Molokai—Lowland Dry—Unit 1 is not known to be occupied by *Bonamia menziesii*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Hibiscus brackenridgei*, *Kokia cookei*, or *Sesbania tomentosa*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Dry—Unit 2 consists of 589 ac (238 ha) of State land at Kamiloloa on the southern slopes of Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Molokai—Lowland Dry—Unit 2 is not known to be occupied by *Bonamia menziesii*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Hibiscus brackenridgei*, *Kokia cookei*, or *Sesbania tomentosa*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 1 consists of 11,465 ac (4,640 ha) of State land, 2,069 ac (837 ha) of federally owned land, and 3 ac (1 ha) of privately owned land, from Kanaio to Kahualau Gulch on the southern slopes of east Maui. This unit is occupied by the plants *Bonamia menziesii*, *Cenchrus agrimonoides*, *Flueggea neowawraea*, *Melicope adscendens*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and includes the mixed herbland and shrubland, the moisture

regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 1 is not known to be occupied by *Alectryon macrococcus*, *Bidens micrantha* ssp. *kalealaha*, *Canavalia pubescens*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Sesbania tomentosa*, *Solanum incompletum*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 2 consists of 1,851 ac (749 ha) of State land at Keokea on the southern slopes of east Maui. This unit is occupied by the plants *Bonamia menziesii*, *Canavalia pubescens*, and *Hibiscus brackenridgei*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 2 is not known to be occupied by *Alectryon macrococcus*, *Bidens micrantha* ssp. *kalealaha*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 3 consists of 188 ac (76 ha) of privately owned land, at Keauhou on the southern slopes of east Maui. This unit is occupied by the plant *Canavalia pubescens*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 3 is not known to be occupied by *Bidens micrantha* ssp. *kalealaha*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 4 consists of 1,266 ac (512 ha) of State land (including the Department of Land and Natural Resources) at Ahihi-Kinau Natural Area Reserve on the southern slopes of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Maui—Lowland Dry—Unit 4 is not currently occupied by *Bidens micrantha* ssp. *kalealaha*, *Bonamia menziesii*, *Canavalia pubescens*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 5 consists of 3,615 ac (1,463 ha) of State land, and 43 ac (17 ha) of privately owned land, from Panaewa to Manawainui on the western and southern slopes of west Maui. This unit is occupied by the plants *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, *Cenchrus agrimonioides*, *Gouania hillebrandii*, *Kadua coriacea*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and *Tetramolopium capillare*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 5 is not known to be occupied by *Ctenitis squamigera*, *Cyanea obtusa*, *Hesperomannia arbuscula*, *Hibiscus brackenridgei*, *Lysimachia lydgatei*, *Neraudia sericea*, *Schiedea salicaria*, *Sesbania tomentosa*, or *T. remyi*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 6 consists of 3 ac (1 ha) of State land, and 237 ac (96 ha) of privately owned land, from Paleaahu Gulch to Puu Hona on the southern slopes of west Maui. This unit is occupied by the plants *Hibiscus brackenridgei* and *Schiedea salicaria*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 6 is not known to be occupied by *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, *Cenchrus agrimonioides*, *Ctenitis squamigera*, *Cyanea obtusa*, *Gouania hillebrandii*, *Hesperomannia arbuscula*, *Kadua coriacea*, *Lysimachia lydgatei*, *Neraudia sericea*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Spermolepis hawaiiensis*, *Tetramolopium capillare*, or *T. remyi*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due

to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat designation includes nine units totaling 6,359 acres on Oahu. The units are Oahu—Lowland Dry—Unit 1, 2, 8, 9, 10, 11, Oahu— Lowland Mesic—Unit 1, 2, 3.

Oahu—Lowland Dry—Unit 1 consists of 49 ac (20 ha) of State land and 53 ac (22 ha) of privately owned land in the Waianae Mountains, extending from Haili Gulch to Kawaipahai. This unit is occupied by *Hibiscus brackenridgei* and includes the dry forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland dry ecosystem. This unit also contains unoccupied habitat that is essential to the conservation of the species by providing the PCEs necessary for the expansion of the existing wild populations. Oahu—Lowland Dry—Unit 2 consists of 29 ac (12 ha) in the lowland dry ecosystem in the Waianae Mountains, on Federal land within Kaena Point State Park. Although this unit is not known to be occupied by *Hibiscus brackenridgei*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Dry—Unit 8 consists of 96 ac (40 ha) of privately owned land and 3 ac (1 ha) of State land as part of the old railroad right-of-way in the lowland dry ecosystem, at the Kalaeloa Barber's Point Harbor area. Although this unit is not known to be occupied by *Hibiscus brackenridgei*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Dry—Unit 9 consists of 17 ac (7 ha) of City and County land, 3 ac (1 ha) of privately owned land, 1 ac (0.5 ha) of State land, and 16 ac (6 ha) of Federal (Pearl Harbor NWR) land in the lowland dry ecosystem at Kalaeloa. Although this unit is not known to be occupied by *Hibiscus brackenridgei*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Dry—Unit 10 consists of 43 ac (17 ha) of State land (DHHL) in the lowland dry ecosystem at Kalaeloa. Although this unit is not known to be occupied by *Hibiscus brackenridgei*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Dry—Unit 11 includes the dry forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland dry ecosystem. Although this unit is not known to be occupied by *Hibiscus brackenridgei*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable

habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Mesic—Unit 1 consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). This unit is occupied by *Hibiscus brackenridgei* and includes the mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem. This unit also contains unoccupied habitat that is essential to the conservation of the species by providing the PCEs necessary for the expansion of the existing wild populations. Oahu—Lowland Mesic—Unit 2 consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Although this unit is not known to be occupied by *Hibiscus brackenridgei*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Mesic—Unit 3 consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. Although this unit is not known to be occupied by *Hibiscus brackenridgei*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

The critical habitat designation for *Hibiscus brackenridgei* includes one unit totaling 485 acres in Hawaii County, Hawaii. The unit is Hawaii 10—*Hibiscus brackenridgei*—a.

Hawaii 10—*Hibiscus brackenridgei*—a [196 ha (485 ac)]: This unit contains Puu Huluhulu and lies completely within the Kiholo watershed. The unit provides habitat for 1 population of 300 mature, reproducing individuals of *H. brackenridgei* and is currently occupied by 5 individuals. This unit is essential to the conservation of *H. brackenridgei* because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. This unit provides the easternmost critical habitat within the species' historical range. The unit is geographically separated from other critical habitat for this multi-island species in order to reduce the likelihood of all recovery populations being destroyed by one naturally occurring catastrophic event.

The critical habitat designation for *Hibiscus brackenridgei* includes 9 critical habitat units, covering two ecosystem types, which encompass approximately 6,359 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Dry—Units 1, 2, 8, 9, 10, 11; Oahu—Lowland Mesic—Units 1, 2, 3.

Oahu—Lowland Dry—Unit 1 [102 ac (41 ha)]; This area consists of 49 ac (20 ha) of State land and 53 ac (22 ha) of privately owned land in the Waianae Mountains, extending from Haili Gulch to Kawaipahai. Oahu—Lowland Dry—Unit 2 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland dry ecosystem in the Waianae Mountains, on Federal land within Kaena Point State Park. Oahu—Lowland Dry—Unit 8 [99 ac (40 ha)]. Oahu—This area consists of 96 ac (40 ha) of privately owned land and 3 ac (1 ha) of State land as part of the old railroad right-of-way in the lowland dry ecosystem, at the Kalaeloa Barber's Point Harbor area. Oahu—Lowland Dry—Unit 9 [37 ac (15 ha)]. This area consists of 17 ac (7 ha) of City and County land, 3 ac (1 ha) of privately owned land, 1 ac (0.5 ha) of State land, and 16 ac (6 ha) of Federal (Pearl Harbor NWR) land in the lowland dry ecosystem at Kalaeloa. Oahu—Lowland Dry—Unit 10 [43 ac (17 ha)]. This area consists of 43 ac (17 ha) of State land (DHHL) in the lowland dry ecosystem at Kalaeloa. Oahu—Lowland Dry—Unit 11 [166 ac (67 ha)]. This area consists of 166 ac (67 ha) of federal land (U.S. Navy) in the lowland dry ecosystem at Kalaeloa.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Hibiscus brackenridgei* critical habitat consists of two components. Coastal (Lanai and Molokai) and Lowland dry (east Maui, west Maui, Lanai, Molokai and Kahoolawe (81 FR 17790-18110):

Ecosystem: Coastal. Elevation: <980 ft (<300 m). Annual precipitation: <20 in (<50 cm). Substrate: Well-drained, calcareous, talus slopes; dunes; weathered clay soils; ephemeral pools; mudflats. Canopy: *Hibiscus*, *Myoporum*, *Santalum*, *Scaevola*. Subcanopy: *Gossypium*, *Sida*, *Vitex*. Understory: *Eragrostis*, *Jacquemontia*, *Lyceum*, *Nama*, *Sesuvium*, *Sporobolus*, *Vigna*.

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*. Subcanopy: *Chamaesyce*, *Dodonaea*, *Leptecophylla*, *Osteomeles*, *Psydrax*, *Scaevola*, *Wikstroemia*. Understory: *Alyxia*, *Artemisia*, *Bidens*, *Chenopodium*, *Nephrolepis*, *Peperomia*, *Sicyos*.

(i) In units Oahu—Lowland Dry—Unit 1, Oahu—Lowland Dry—Unit 2, Oahu—Lowland Dry—Unit 8, Oahu—Lowland Dry—Unit 9, Oahu—Lowland Dry—Unit 10, and Oahu—Lowland Dry—Unit 11, the physical and biological features of critical habitat for *Hibiscus brackenridgei* var. *mokuleianus* and *Hibiscus brackenridgei* var. *molokaiana* are: (A) Elevation: Less than 3,300 ft (1,000 m). (B) Annual precipitation: Less than 50 in (130 cm). (C) Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. (D) Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*,

Sapindus. (E) Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. (F) Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Plumbago, Sicyos, Sida, Waltheria.

(ii) In units Oahu—Lowland Mesic— Unit 1, Oahu—Lowland Mesic—Unit 2, and Oahu—Lowland Mesic—Unit 3, the physical and biological features of critical habitat for *Hibiscus brackenridgei* var. *mokuleianus* and *Hibiscus brackenridgei* var. *molokaiana* are: (A) Elevation: Less than 3,300 ft (1,000 m). (B) Annual precipitation: 50 to 75 in (130 to 190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (F) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Habitat features that are essential for this species include, but are not limited to, Acacia koa lowland mesic forest.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Hibiscus brackenridgei* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Hibiscus brackenridgei* occurs within the Lowland dry and Lowland mesic ecosystems in the Waianae Mountain caldera complex:

Oahu—Lowland Dry—Units 1, 2, 8, 9, 10, 11. (A) Elevation: <3,300 ft (<1,000 m). (B) Annual Precipitation: <50 in (<130 cm). (C) Substrate: Weathered silty loams to stony clay, rocky ledges, little weathered lava. (D) Canopy: Diospyros, Myoporum, Pleomele, Santalum, Sapindes. (E) Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. (F) Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Plumbago, Sicyos, Sida, Waltheria.

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (F) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia*

var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to

reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

All critical habitat, except in the coastal ecosystem on Oahu, requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs and goats). Feral ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required during nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat posed by fire to Oahu—Lowland Dry—Unit 1, 2, 8, 9, 10, 11 and Oahu—Lowland Mesic—Unit 2, 3. Oahu—Lowland Dry—Unit 1 and Oahu—Lowland Mesic—Unit 1, 2, 3 may require special management to reduce the threat of landslides, rockfalls, and flooding.

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for these species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Hibiscus brackenridgei* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (USFWS, 2016)

Breeding Season

Adult: Flowering occurs from December through June (USFWS, 2016).

Reproduction Narrative

Adult: Wild plants of all types lose their leaves at the beginning of the summer dry season, usually by June, and remain dormant until new growth appears with the wet season, usually by October. The three Oahu types vary in growth rates and age at which cultivated plants begin to flower. Most of the cultivated Makua stock flowers at younger than 6 months; cultivated stock of the other types begin to flower at ages ranging from 6 months to 4 years. Flowering occurs from December through June. Flowers open in the afternoon and early evening and remain open until early the next morning, and are pollinated by sphinx or hawk moths. Mature seed capsules are present from February through June, and seeds of cultivated plants may remain viable in garden soil for up to 15 years. In the wild, seedlings are often found at locations where no mature plants have been seen for many years. The longevity of *H. brackenridgei* ssp. *mokuleianus* plants in the wild is undocumented, but it is considered a short-lived species because wild populations appear to undergo large fluctuations in numbers (Makua Implementation Team 2003). Other demographic information for *H. brackenridgei* ssp. *mokuleianus* in the wild is unknown, including longevity, number of seeds produced, survivorship to sexual maturity, pollination and seed dispersal, vegetative reproduction, and specific environmental requirements (USFWS, 2016).

Habitat Type

Adult: Dry forests and shrublands (NatureServe, 2015)

Habitat Narrative

Adult: Dry forests and shrublands on moderate to steep gulch slopes and on cliff ledges (NatureServe, 2015). *Hibiscus brackenridgei* ssp. *mokuleianus* on Oahu occurs on slopes, cliffs, and arid ledges in lowland dry forest and shrubland at elevations of 24 to 490 m (79 to 1,607 ft) (68 FR 35950). The Waialua type occurs in dry gulches, gulch bottoms, and lower to middle gulch slopes in mixed and native dry forest, and the Kealia type occurs on open ledges and bluffs in mixed native and alien grasses, shrubs, and trees (Makua Implementation Team 2003). The Makua type occurs in sites similar to the West Molokai site, on rocky slopes in areas that are

drier and more open than any of the other Oahu sites, and in vegetation consisting of mixed native and alien shrubs and grasses (USFWS, 2016).

Dispersal/Migration

Population Information and Trends

Population Trends:

Increasing (USFWS, 2016)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Fragility unknown. Current estimate is less than 300 plants. 2 current (between 1982 and 1997) and 6 historical occurrences. (NatureServe, 2015). Since listing, demographic data indicate major improvement in the status of *Hibiscus brackenridgei* ssp. *mokuleianus*. Total numbers within in situ population units have increased from 62 in 2003 to 669 in 2006, and about seven percent of the current known individuals are mature plants. Germination and survival of seedlings have increased primarily due to management actions to reduce ungulate damage and weed competition. Nonetheless, there are no population units for this taxon meeting minimum numeric criteria for stabilization (defined as 50 mature, reproducing individuals per population unit for short-lived perennials). Inter situ sites have been outplanted on Oahu at Kaiser High School, Kaala Learning Center, and Waimea Botanical Garden; ex situ sites have been outplanted at Koko Crater Botanical Garden and Leeward Community College; and experimental reintroductions have been outplanted at Kaluakauila Management Unit on Makua. All plants within the Makua action area, including experimental reintroductions and those in the Makua population unit, are located in high risk fire zones for training-related wildfire. Thus, *H. brackenridgei* ssp. *mokuleianus* is characterized by five population units not reaching minimum stabilization criterion, at low numbers that are at risk of fire, ungulates, and competition from invasive weeds (USFWS, 2016).

Threats and Stressors

Stressor: Fire (NatureServe, 2015; USFWS, 1999)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Threats include fire (NatureServe, 2015; USFWS, 1999)

Stressor: Non-native plants (NatureServe, 2015; USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Threats include competition with alien plants (NatureServe, 2015; USFWS, 1999)

Stressor: Reduced reproductive vigor (USFWS, 1999)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Random naturally occurring events causing extinction and/or reduced reproductive vigor due to the small number of populations is a threat to this species (USFWS, 1999).

Stressor: Road construction (USFWS, 1999)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Road construction is listed as a threat to this species (USFWS, 1999).

Recovery

Reclassification Criteria:

For downlisting, a total of five to seven populations of each taxon should be documented on islands where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure with the following minimum numbers of mature individuals per population: 100 for long-lived perennials, 300 for short-lived perennials, and 500 for the annual taxa. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered.

Delisting Criteria:

For delisting, a total of 8 to 10 populations of each taxon should be documented on islands where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with the following minimum numbers of mature individuals per population: 100 for long-lived perennials, 300 for short-lived perennials, and 500 for the annual taxa. Each population should persist at this level for a minimum of five consecutive years.

Conservation Measures and Best Management Practices:

- Protect habitat and control threats (USFWS, 1999).
- Expand existing wild populations (USFWS, 1999).
- Conduct essential research (USFWS, 1999).
- Develop and maintain monitoring plans (USFWS, 1999).
- Reestablish wild populations within historic range (USFWS, 1999).
- Validate and revise recovery criteria (USFWS, 1999).

References

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

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SPECIES ACCOUNT: *Hibiscus clayi* (Clay's hibiscus)

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/25/1994; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Hibiscus clayi, a member of the mallow family (Malvaceae), is a shrub or tree 4 to 8 m (13 to 26 ft) tall with stems bearing sparse hairs at the branch tips. The oval or elliptical leaves are usually 3 to 7 cm (1 to 3 in) long and 15 to 35 mm (0.6 to 1.4 in) wide and have a hairless upper surface and slightly hairy lower surface. The leaf margins are entire or toothed toward the apex. The flowers are borne singly near the ends of the branches. The flaring petals are dark red, 45 to 60 mm (1.8 to 2.4 in) long, and 10 to 18 mm (0.4 to 0.7 in) wide. The green tubular or urn shaped calyx is usually 15 to 25 mm (0.6 to 1 in) long with five or six shorter bracts beneath. The fruits are pale brown capsules 12 to 14 mm (0.5 to 0.6 in) long, containing about 10 oval, brownish black seeds about 4 mm (0.16 in) long. (USFWS, 1995)

Taxonomy

In the currently accepted treatment of the Hawaiian members of the family, David M. Bates (1990) considers *H. newhousei* to be a synonym of *H. clayi*. (USFWS, 1995). In the Malvaceae family. (USFWS, 2017).

Historical Range

See current range/distribution.

Current Range

Hibiscus clayi was known historically from scattered locations on the island of Kauai, including the Kokee region on the western side of the island, Moaloaa Valley to the north, Nounou Mountain in Wailua to the east, and as far south as Haiku (USFWS 1994). Newly discovered in the Molooa Forest Reserve (FR) in 2011. (USFWS, 2017).

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designate critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Hibiscus clayi* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Hibiscus clayi* includes six units totaling 1,987 acres in Kauai County, Hawaii. The units are Kauai 4—*Hibiscus clayi*—a, b, c, d, e and Kauai 5—*Hibiscus clayi*—f.

Kauai 4—*Hibiscus clayi*—a: This unit is critical habitat for *Hibiscus clayi* and is 4 ha (9 ac) on private land near Puu Eu. This unit, in combination with unit 4—*Hibiscus clayi*—d, provides habitat for one population of 100 mature, reproducing individuals of the long-lived perennial *Hibiscus clayi* and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is essential to the establishment of additional populations on

Kauai in order to reach recovery goals. The habitat features contained in this unit that are essential for this species include, but are not limited to, slopes in *Acacia koa* or *Diospyros* spp.-*Pisonia* spp.-*Metrosideros polymorpha* lowland dry or mesic forest. This unit is geographically separated from other critical habitat for this island-endemic species to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Although we do not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is of an appropriate distance from the other units to avoid their destruction by one naturally occurring catastrophic event. Kauai 4—*Hibiscus clayi*—b: This unit is critical habitat for *Hibiscus clayi* and is 85 ha (210 ac) on private land on the northeast side of Makaleha Mountain. This unit, in combination with 4—*Hibiscus clayi*—e, provides habitat for one population of 100 mature, reproducing individuals of the long-lived perennial *Hibiscus clayi* and is currently unoccupied. This unit is important to the conservation of the taxon because it supports habitat that is important to the establishment of additional populations on Kauai in order to reach recovery goals. The habitat features contained in this unit that are essential for this species include, but are not limited to, slopes in *Acacia koa* or *Diospyros* spp.-*Pisonia* spp.-*Metrosideros polymorpha* lowland dry or mesic forest. This unit is geographically separated from other critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Although we do not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is of an appropriate distance from the other units so that each potential recovery population on Kauai within the unit is geographically separated enough to avoid their destruction by one naturally occurring catastrophic event. Kauai 4—*Hibiscus clayi*—c: This unit is critical habitat for *Hibiscus clayi* and is 590 ha (1,455 ac) on State (Kealia and Moloaa Forest Reserves) and private land. This unit contains Leleiwī and Puu Awa Summits. This unit provides habitat for three populations of 100 mature, reproducing individuals of the long-lived perennial *Hibiscus clayi* and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is important to the establishment of additional populations on Kauai in order to reach recovery goals. The habitat features contained in this unit that are essential for this species include, but are not limited to, slopes in *Acacia koa* or *Diospyros* spp.-*Pisonia* spp.-*Metrosideros polymorpha* lowland dry or mesic forest. Although we do not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is of an appropriate distance from the other units to avoid their destruction by one naturally occurring catastrophic event. Kauai 4—*Hibiscus clayi*—d: This unit is critical habitat for *Hibiscus clayi* and is 48 ha (119 ac) on private land. This unit contains Leleiwī and a portion of the northwest side of Makaleha Mountain. This unit, in combination with unit 4—*Hibiscus clayi*—a, provides habitat for one population of 100 mature, reproducing individuals of the long-lived perennial *Hibiscus clayi* and is currently unoccupied. This unit is important to the conservation of the taxon because it supports habitat that is important to the establishment of additional populations on Kauai in order to reach recovery goals. The habitat features contained in this unit that are essential for this species include, but are not limited to, slopes in *Acacia koa* or *Diospyros* spp.-*Pisonia* spp.-*Metrosideros polymorpha* lowland dry or mesic forest. This unit is geographically separated from other critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Although we do not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is of an appropriate distance from other units to avoid their destruction by one naturally occurring catastrophic event. Kauai 4—*Hibiscus clayi*—e: This unit is critical habitat for *Hibiscus clayi* and is 19 ha (47 ac) on State land (Kealia Forest Reserve) at the headwaters of Makaleha Stream. This unit, in combination with unit 4—

Hibiscus clayi—b, provides habitat for one population of 100 mature, reproducing individuals of the longlived perennial *Hibiscus clayi* and is currently unoccupied. This unit is important to the conservation of the taxon because it supports habitat that is important to the establishment of additional populations on Kauai in order to reach recovery goals. The habitat features contained in this unit that are essential for this species include, but are not limited to, slopes in *Acacia koa* or *Diospyros* spp.-*Pisonia* spp.-*Metrosideros polymorpha* lowland dry or mesic forest. This unit is geographically separated from other critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Although we do not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is of an appropriate distance from other units to avoid their destruction by one naturally occurring catastrophic event.

Kauai 5—*Hibiscus clayi*—f: This unit is critical habitat for *Hibiscus clayi* and is 60 ha (148 ac) on State land (Nonou Forest Reserve), containing portions of the Nonou Mountains. This unit provides habitat for one population of 100 mature, reproducing individuals of the longlived perennial *Hibiscus clayi* and is currently occupied with four plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, slopes in *Acacia koa* or *Diospyros* spp.- *Pisonia* spp.-*Metrosideros polymorpha* lowland dry or mesic forest. This unit is geographically separated from the other five units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Although we do not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is of an appropriate distance from the other units to avoid their destruction by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

- (i) Slopes in *Acacia koa* or *Diospyros* spp.-*Pisonia* spp.-*Metrosideros polymorpha* lowland dry or mesic forest and containing one or more of the following associated native plant species: *Artemisia australis*, *Bidens* spp., *Cyanea hardyi*, *Gahnia* spp., *Hedyotis acuminata*, *Munroidendron racemosum*, *Pandanus tectorius*, *Panicum tenuifolium*, *Pleomele aurea*, *Pipturus* spp., *Psychotria* spp., or *Psychdrax odorata*; and
- (ii) Elevations between 121 and 765 m (396 and 2,509 ft).

Special Management Considerations or Protections

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild,

outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Lifespan**

Adult: Long-lived perennial. (USFWS, 2017).

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 230 to 350 meters (750 to 1,150 feet); prefers semi-open canopy (USFWS, 1995; USFWS, 2008)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1995; USFWS, 2008)

Habitat Narrative

Adult: This lowland dry forest species generally grows on slopes at an elevation of 230 to 350 meters (750 to 1,150 feet). The vegetation of Nounou Mountain is a relictual *Acacia koa* mesic forest dominated by the invasive introduced tree *Psidium cattleianum* (strawberry guava). The remaining individuals grow on a steep north-east facing slope, under a dry semi-open canopy (Wood 2002; Tangalin 2006; Perlman 2006). Associated taxa include *Syzygium curnini* (Java plum), *koa*, *kukui*, and *ti* (USFWS 1994a). (USFWS, 1995; USFWS, 2008)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2008)

Redundancy:

Very low (inferred from USFWS, 2008)

Number of Populations:

1 (USFWS, 2008). As of 2017: 4 (USFWS, 2017).

Population Size:

20 (5 wild) (USFWS, 2008). As of 2017: 80 - 93 individuals (USFWS, 2017).

Population Narrative:

There are currently five remaining wild trees in the Nounou Mountains as well as approximately 15 outplanted nursery trees (National Tropical Botanical Garden 2006). (USFWS, 2008). As of 2017, 50 individuals have been reintroduced. (USFWS, 2017).

Threats and Stressors

Stressor: Invasive plants (USFWS, 1995)

Exposure:

Response:

Consequence:

Narrative: The major current threat is competition with alien plant taxa. Strawberry guava is the greatest threat, but common guava, Hilo grass, basketgrass, Java plum, kukui, lantana, ti, and Schinus terebinthifolius (Christmas berry) are also present. The area of the Nounou Mountain population has been planted with Araucaria columnaris (columnar araucaria), which is reproducing and may prevent regeneration of native plants. (USFWS, 1995)

Stressor: Human disturbance (USFWS, 1995)

Exposure:

Response:

Consequence:

Narrative: The close proximity of most of the plants to a hiking trail makes them prone to human disturbance. (USFWS, 1995)

Stressor: Pigs (USFWS, 1995)

Exposure:

Response:

Consequence:

Narrative: Pigs pose a potential threat to the species. (USFWS, 1995)

Stressor: Small population size (USFWS, 1995)

Exposure:

Response:

Consequence:

Narrative: The small total number of existing individuals poses a threat of stochastic extinction and/or reduced reproductive vigor (USFWS 1994a). (USFWS, 1995)

Stressor: Predation by rats and mites (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Rats eat the seeds, and hibiscus mites have been observed on the plants (Wood 2002). (USFWS, 2008)

Stressor: Vandalism (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: There is some evidence of vandalism, in that machete and saw marks were observed on the trunks of plants in January 2000 (Wood 2002). (USFWS, 2008)

Stressor: Ungulate degradation of habitat (USFWS, 2017).

Exposure:

Response:

Consequence:

Narrative: —In addition to habitat degradation by feral pigs, habitat degradation leading to increased erosion and landslides by feral goats is also a threat to *Hibiscus clayi* at the Molokaa FR occurrences (NTBG 2011b-d). (USFWS, 2017).

Stressor: Climate change loss or degradation of habitat (USFWS, 2017).

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Hibiscus clayi* is extremely vulnerable to the impacts of climate change with a vulnerability score of 0.91 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). (USFWS, 2017).

Stressor: Fire destruction or degradation of habitat (USFWS, 2017).

Exposure:

Response:

Consequence:

Narrative: —Fire is noted as a threat to the Molokaa FR occurrences of *Hibiscus clayi* (NTBG 2011b-d). Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community. Fire can destroy dormant seeds as well as individual plants. Successive fires burn farther and farther into native habitat and alter microclimate conditions to further alter habitat conditions to favor nonnative plants. Nonnative plants convert native plant communities to nonnative dominated plant communities (D'Antonio and Vitousek 1992; Tunison et al. 2002). Increasing episodes of drought, expansion of invasive grass cover, and temperature increases have led to an increase in the number of wildfires on Kauai (Trauernicht et al. 2015). (USFWS, 2017).

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Kauai and at least one other island where they now occur or occurred historically. (USFWS, 1995)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1995)
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1995)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Kauai and at least one other island where they now occur or occurred historically. (USFWS, 1995)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1995)
3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1995)

Recovery Actions:

- In order to prevent this taxon from going extinct, propagation efforts and the maintenance of adequate genetic stock ex situ should be undertaken immediately, as well as the protection of remaining wild individuals from mule deer or black tailed deer, feral goats, and feral pigs. (USFWS, 1995)
- A research program is also recommended to study the growth and reproductive viability of each taxon, determine the parameters of viable populations of each taxon, study the reproductive strategy and pollinators of each taxon, study possible pests and diseases, and use the results of such research to improve management practices. (USFWS, 1995)
- A program of augmentation of very small populations and reestablishment of new populations within the historical range of the species is also needed. (USFWS, 1995)
- A public education program is also needed to increase public awareness and support for plant recovery efforts. (USFWS, 1995)
- Finally, the recovery objectives should be refined and revised as new information becomes available. (USFWS, 1995)
- New recommended actions for 2017 - 1: Surveys and inventories—Continue to survey for populations in known historical range and suitable habitat. (USFWS, 2017).
- 2017 - 2: Ungulate monitoring and control—Continue to construct and maintain fenced enclosures to protect individuals from the negative impacts of feral ungulates. Protect all occurrences against browsing and disturbances from feral ungulates to prevent imminent extinction. (USFWS, 2017).

- 2017 - 3: Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative species that compete with the species around all populations. (USFWS, 2017).
- 2017 - 4: Captive propagation for genetic storage and reintroduction—Continue to collect seeds and cuttings for storage and propagation. (USFWS, 2017).
- 2017 - 5: Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2017).
- 2017 - 6: Predator and herbivore control research— o Control rats at all populations. o Investigate control methods for Hibiscus mites and determine the need for additional recovery actions. (USFWS, 2017).
- 2017 - 7: Human interaction monitoring and management—Develop and implement measures to reduce the threat of collecting. Inform trail maintenance personnel regarding the locations of rare and endangered species. (USFWS, 2017).
- 2017 - 8: Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms. (USFWS, 2017).
- 2017 - 9: Population biology research—Summarize available biological information to determine information gained regarding flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, or limiting factors of Hibiscus clayi. (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Collect seed from the sole representative of a now extinct population from Haupū, Kauai, and the remaining individuals in the Nounou population, continue propagation, and cross the resultant offspring with individuals from the Nounou lineage to expand the genetic base of the species. (USFWS, 2008)
- Fence individual plants for short-term protection from ungulates. (USFWS, 2008)
- Control introduced invasive plant species around remaining plants. (USFWS, 2008)
- Survey for populations in known historical sites and suitable habitat. (USFWS, 2008)
- Augment the wild population as plants become available in nurseries. (USFWS, 2008)
- Reintroduce individuals into suitable habitat within historical range that is being managed for the known threats to this species. (USFWS, 2008)

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SPECIES ACCOUNT: *Hibiscus dasycalyx* (Neches River rose-mallow)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/11/2013; Southwest Region (R2)

Physical Description

The rose-mallow is a nonwoody perennial in the Malvaceae (mallow) family that grows 1.9-7.5 feet (ft.) (0.6-2.3 meters (m)) tall. Leaves are alternate, simple, generally t-shaped, and deeply three-lobed with petioles 1.1-1.8 inches (in) (3-5 centimeters (cm)) long. The species generally produces a single creamy white (rarely pink) flower at the base of the leaf stalk along the uppermost branches or stems. Plants are single to multi-stemmed. Each branch or stem can have numerous leaves, with the total number of flowers per plant numbering in the hundreds. Flowering is rain dependent, spanning a few weeks in June and July. Seeds are set in August (T. Philipps, pers. comm. 2016a). Large, numerous stamens are monadelphous, forming a tube that is united with the base of the petals. Potential pollinators may include, but are not limited to: the American bumble bee (*Bombus pensylvanicus*), Hibiscus bee (*Ptilothrix bombiformis*), moths, and the scentless plant bug (*Niesthrea louisianica*) (Klips 1995, Warnock 1995, Warriner 2011). (USFWS, 2018)

Taxonomy

In the Malvaceae (mallow) family (USFWS, 2013)

Historical Range

The natural range is within Trinity, Houston, Harrison, and Cherokee Counties, Texas (USFWS, 2013a)

Current Range

Known from Trinity, Houston, Harrison, Cherokee, and Nacogdoches Counties in east Texas, in the Neches, Sabine, and Angelina River basins and the Mud and Tantabogue Creek basins (USFWS, 2013a).

Critical Habitat Designated

Yes; 10/11/2013.

Legal Description

On September 11, 2013, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective October 11, 2013) for *Hibiscus dasycalyx* (Neches River rose-mallow) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes eleven critical habitat units (CHUs), in Cherokee, Harrison, Houston, Nacogdoches, and Trinity Counties, Texas (78 FR 56072-56120).

Critical Habitat Designation

The critical habitat designation for *Hibiscus dasycalyx* includes eleven CHUs in Cherokee, Harrison, Houston, Nacogdoches, and Trinity Counties, Texas. This species critical habitat encompasses approximately 166.5 acres (ac) (67 hectares (ha)). Brief descriptions are provided below; maps depicting these areas are included in the Final Rule (USFWS, 2013).

Unit 1: SH 94 ROW: Unit 1 consists of 3.4 ac (1.4 ha) on both the 94 ROW and on private land in Trinity County.

Unit 2: Harrison County: Unit 2 is found at a location between 0.2–0.4 mi (0.3–0.6 km) north of Farm to Market Road 2625 in Harrison County.

Unit 3: Lovelady: Unit 3 in Houston County, found northwest of Farm to Market 230, extends 0.3 mi (0.5 km) north and contains 6.3 ac (2.5 ha) of private land.

Unit 4: SH 204 ROW: Unit 4 in Cherokee County contains 8.7 ac (3.5 ha) of occupied habitat along SH 204 ROW and within the Mud Creek basin.

Unit 5: Davy Crockett NF, Compartment 55: Unit 5 is the only unit that contains a natural population of the Neches River rose-mallow on Federal lands within the Davy Crockett NF.

Unit 6: Davy Crockett NF, Compartment 11: Unit 6 includes 7.3 ac (3.0 ha) of occupied habitat on Compartment 11 on Federal land in the Davy Crockett NF within Houston County.

Unit 7: Davy Crockett NF, Compartment 20: Unit 7 includes 3.4 ac (1.4 ha) of Federal land in Compartment 20 of the Davy Crockett NF, Houston County.

Unit 8: Davy Crockett NF, Compartment 16: Unit 8 encompasses 32.8 ac (13.3 ha) of occupied Federal habitat in the Davy Crockett NF, Houston County.

Unit 9: Champion: The Champion site, Trinity County, is located on private land approximately 0.7 mi (1.1 km) south-southeast of the Houston County line, about 0.8 mi (1.2 km) north of the confluence of White Rock Creek and Cedar Creek (TXNDD 2012a, p. 55).

Unit 10: Mill Creek Gardens: Unit 10 is an introduced site at Mill Creek Gardens, Nacogdoches County. Stephen F. Austin State University Mass Arboretum purchased the land and created the gardens in 1995 as part of a conservation agreement.

Unit 11: Camp Olympia: Unit 11 is located on private property in Trinity County. The unit contains 0.2 ac (0.1 ha) of palustrine wetland habitat north of Lake Livingston.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Hibiscus dasycalyx* critical habitat consists of two components (78 FR 56072-56120):

- (i) Hydric alluvial soils and the potential for flowing water when found in depressional sloughs, oxbows, terraces, side channels, or sand bars; and
- (ii) Native woody or associated herbaceous vegetation, largely with an open canopy providing partial to full sun exposure with few to no nonnative species.

Special Management Considerations or Protections

Threats to those features that define the primary constituent elements for the Neches River rose-mallow include: (1) Alteration of naturalized flow regimes through projects that require channelization; (2) water diversions or hydrologic change to streams and rivers; (3) encroachment from native woody riparian species and nonnative species; (4) detrimental roadside management practices including inappropriate frequency and timing of mowing during the species' blooming period; (5) herbivory and, (6) trampling from hog and cattle; and (7) drought. Special management considerations or protection are required within critical habitat areas to address these threats. Special management activities that could ameliorate these threats include, but are not limited to: • Construction of cattle exclusion fencing to remedy herbivory at Lovelady to maintain plant survival and suitable habitat; • Restoration of the cattle stock pond back to a natural flatwoods pond at Lovelady to restore the sites hydrology; • Coordination with TXDOT to establish and continue effective management along ROWs for control of native woody species and nonnatives (including, but not limited to mowing, brush-hogging, or other hand-clearing techniques) and completion of these techniques only during the appropriate life stages of the Neches River rose-mallow to maintain open habitat; • Coordination with the Angelina and Neches River Authority and consultation with the U.S. Army Corps of Engineers on the proposed construction of Lake Columbia Reservoir in Cherokee County to maintain hydrology at the downstream Neches River rose-mallow site; • Consultation between the Service and the U.S. Army Corps of Engineers for any filling or draining of Federal jurisdictional wetlands to ensure maintenance of hydrology; and • Clearing or burning on the Davy Crockett NF for control of Chinese tallow and to maintain an adequate level of openness in habitat. (USFWS, 2013)

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Insect (USFWS, 2013a)

Lifespan

Adult: Unknown (USFWS, 2013a)

Breeding Season

Adult: Flowering occurs between June and August, sometimes into late October (USFWS, 2013a)

Key Resources Needed for Breeding

Adult: Insects for pollination (USFWS, 2013a)

Reproduction Narrative

Adult: This perennial species dies back to the ground every year and resprouts from the base; however, the plant still maintains aboveground stems. Longevity of the species is unknown, but it may be long-lived. Cross-pollination occurs within populations, and the species has high reproductive potential (fecundity). Flowering occurs between June and August, sometimes into late October; the blooming period may only last 1 day. The species produced an average of 50 fruits per plant, but seed viability and survivorship are not known. Potential pollinators of the Neches River rose-mallow may include, but are not limited to, the common bumblebee (*Bombus*

pensylvanicus), Hibiscus bee (*Ptilothrix bombiformis*), moths, and the scentless plant bug *Niesthrea louisianica* (USFWS, 2013a).

Habitat Type

Adult: Wetlands (USFWS, 2013a)

Habitat Vegetation or Surface Water Classification

Adult: Seasonally or regularly inundated sloughs, oxbows, terraces, sand bars, and bottomlands (USFWS, 2013a)

Environmental Specificity

Adult: Narrow. Specialist or community with key requirements common (NatureServe, 2015)

Habitat Narrative

Adult: The Neches River rose-mallow is endemic to relatively open habitat of the Pineywoods (or Timber belt) of east Texas, within Cherokee, Houston, Harrison, and Trinity Counties, and has been introduced into Nacogdoches and Houston Counties. It is known from seasonally or regularly inundated sloughs, oxbows, terraces, sand bars, and bottomlands, with hydric alluvial soils (loamy to clayey). An open canopy is typical, but plants also grow in partial sun. Sites are both perennial and intermittent wetlands with water levels between sites varying due to their proximity to water, amount of rainfall, and floodwaters. Intermittent wetlands are inundated during the winter months but become dry during the summer months (USFWS, 2013a).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Neches River rose-mallow seeds are likely to be dispersed by flowing water. Research has not been done to identify methods of seed dispersal upstream; however, avian species may facilitate this process (USFWS, 2013a).

Population Information and Trends**Number of Populations:**

11 (8 natural; 3 introduced) (USFWS, 2018)

Population Size:

Approximately 2200 - 2500 individuals (NatureServe, 2015)

Minimum Viable Population Size:

At least 10 viable populations of the rose-mallow, each containing an average of about 1,400 individuals (USFWS, 2018)

Population Narrative:

When the species was listed in 2013, 11 populations were determined to be occupied by the rose-mallow. Of those 11 populations, 3 sites have not been verified in over 20 years and 3 included introductions on the Davy Crockett National Forest. In addition to these natural populations, the Service is also aware of 8 reintroductions, introductions, or display gardens, some of which were coordinated through the Service. (USFWS, 2018)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013a)

Exposure:

Response:

Consequence:

Narrative: A primary threat to the Neches River rose- mallow is the ongoing encroachment of nonnative and native woody species into its generally open, intermittent or perennial wetlands. Altered hydrology (including beaver dams) can have huge impacts on habitat since this species is water-dependent. Right-of-way populations are vulnerable to bridge and road expansion, new road construction, and upgrade projects, which could impact the sites' hydrology, soil stability, wetland and riparian vegetation, and water quality. Conversion of wetlands to silvicultural uses and associated herbicide use to remove unwanted vegetation is a threat. Habitat damage from trampling by feral hogs and cattle is also a threat, as is drought periods possible related to climate change (USFWS, 2013a).

Stressor: Predation (USFWS, 2013a)

Exposure:

Response:

Consequence:

Narrative: Mammalian herbivory has affected the majority of sites; however, grazing pressures are largely attributed to the lack of other available food resources during periods of drought. Neches River rose-mallow recovers quickly from herbivory incidents and can produce secondary growth, minimizing the overall negative effects of mammalian herbivory. This type of herbivory is not considered to be a threat to the species. Insect herbivory was also observed on several of the sites and was not rangewide, but, with anticipated climate change shifts in temperature and the likelihood that insect populations will increase, the Services conclude that insect predation is a minor stressor that will likely continue into the future, but it is not a threat to the species (USFWS, 2013a).

Recovery**Reclassification Criteria:**

Not applicable.

Delisting Criteria:

A Recovery Plan has not been developed.

Recovery Actions:

- A Recovery Plan has not been developed. The following present the summary statement of recovery needs presented in the 2018 Recovery Outline. (USFWS, 2018)
- - Survey sites that have not been visited in over 20-30 years and determine if they contain the physical and biological features of habitat. - Engage landowners to conduct conservation and stewardship on their property. - Using current niche models to identify other areas of potential habitat for rose-mallow and plan to conduct surveys at those sites. Niche models can also be used in future scenarios where climate change might alter the species current range (i.e. range expansion). - Consider introductions and reintroductions that would further

the representation and resiliency of the rose-mallow across its range, but that are also in-line with the species' propagation and reintroduction plan. - Communicate with partners, academics, nurseries, and plant communities about proper introduction procedures and encourage collaboration with the Service. - Continue to monitor existing populations for threats. - Conduct key biological studies to better understand the species reproductive needs (i.e. longevity, seed dispersal, age structure). This information can inform the recovery targets and needs in a recovery plan. - Develop a species Recovery Plan in FY2020. (USFWS, 2018)

Conservation Measures and Best Management Practices:

- Not available.

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SPECIES ACCOUNT: *Hibiscus waimeae* ssp. *hannerae* (Koki`o ke`oke`o)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Hibiscus waimeae ssp. *hannerae* is a gray-barked tree, 6 to 10 m (20 to 33 ft) tall, with star-shaped hairs densely covering its leaf and flower stalks and branchlets. The circular to broadly egg-shaped leaves are usually 5 to 18 cm (2 to 7 in) long and 3 to 13 cm (1.2 to 5 in) wide. The strongly fragrant flowers are borne singly near the ends of the branches on flower stalks 2 to 3 cm (0.8 to 1.2 in) long. The calyx is tubular, normally 3 to 4.5 cm (1.2 to 1.8 in) long, with lobes 8 to 15 mm (0.2 to 0.6 in) long. The flaring petals are white when the flower opens in the morning, but fade to pinkish in the afternoon. The petals, usually 4 to 6 cm (1.6 to 2.4 in) long, are basally attached to the staminal column to form a tube about 1.5 cm (0.6 in) long. The exerted staminal column is up to 15 cm (6 in) long and reddish to crimson at the tip. The filaments arise in the upper half of the staminal column and spread up to 2.5 cm (1 in) long. The fruit is a cartilaginous, egg-shaped capsule 1.8 to 2.5 cm (0.7 to 1 in) long and hairless. (USFWS, 1998)

Taxonomy

A member of the mallow family (Malvaceae). Two subspecies are recognized, both occurring on Kauai: ssp. *hannerae* and ssp. *waimeae*. (USFWS, 1998)

Historical Range

Historically known from northern Kauai (USFWS, 1998).

Current Range

Currently known from two populations on northern Kauai (USFWS, 1998).

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designate critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Hibiscus waimeae* ssp. *hannerae* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Hibiscus waimeae* ssp. *hannerae* includes one unit totaling 2,765 acres in Kauai County, Hawaii. The unit is Kauai 11—*Hibiscus waimeae* ssp. *hannerae*—a.

Kauai 11—*Hibiscus waimeae* ssp. *hannerae*—a: This unit is critical habitat for *Hibiscus waimeae* ssp. *hannerae* and is 1,120 ha (2,769 ac) on State (Halelea Forest Reserve, Hono o Na Pali NAR, Haena and Na Pali Coast State Parks) and private land. This unit contains Limahuli Falls and Kulanaililia, Maunapuluo, and Pali Elele Summits. This unit provides habitat for eight populations of 100 mature, reproducing individuals of the long-lived perennial *Hibiscus waimeae* ssp. *hannerae* and is currently occupied with 25 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is

important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, *Metrosideros polymorpha*-*Dicranopteris linearis* or *Pisonia* spp.-*Charpentiera elliptica* lowland wet or mesic forest.

Primary Constituent Elements/Physical or Biological Features

Within this unit, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

- (i) *Metrosideros polymorpha*-*Dicranopteris linearis* or *Pisonia* spp.- *Charpentiera elliptica* lowland wet or mesic forest and containing one or more of the following associated native plant species: *Antidesma* spp., *Bidens* spp., *Bobea* spp., *Cibotium* spp., *Cyanea* spp., *Cyrtandra* spp., *Perrottetia sandwicensis*, *Pipturus* spp., *Psychotria* spp., *Sadleria* spp., or *Syzygium sandwicensis*; and
- (ii) Elevations between 174 and 1,155 m (570 and 3,787 ft).

Special Management Considerations or Protections

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Moist to wet environments (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 190 and 560 meters (USFWS, 1998)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1998)

Habitat Narrative

Adult: In Limahuli Valley, *Hibiscus waimeae* ssp. *hannerae* is growing in an ohia-uluhe lowland wet forest between 190 and 560 meters (620 and 1,850 feet) elevation. At this location, associated species include ahakea, amau, haha, haiwale, and *Syzygium* sp. The Hanakapiai Valley population is growing in *Pisonia* sp. (papala kepau) - *Charpentiera elliptica* (papala) lowland mesic forest with ahakea, hame, kopiko, mamaki, and the alien species *Aleurites moluccana* (kukui), between 220 and 370 meters (720 and 1,200 feet) (USFWS, 1998). Recent surveys have updated reported ecosystem conditions for *Hibiscus waimeae* subsp. *hannerae*. The species seems to be an essentially riparian tree found almost exclusively along streams at all locations except in the hanging valley to the west of the falls in upper Limahuli where it is wet, but not riparian (USFWS, 2010).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2010)

Redundancy:

Very low (inferred from USFWS, 2010)

Number of Populations:

3 (USFWS, 2010)

Population Size:

80-85 (USFWS, 2010)

Additional Population-level Information:

Surveys conducted since completion of the last 5-year review for this species located new populations of *Hibiscus waimeae* ssp. *hannerae* in the Koaie-Waimea Canyon area (NTBG 2016a, p-q, 2017a). Currently, there are four known populations totaling approximately 100 individuals. Because of this, PEPP upgraded the species' conservation status to "POP," meaning that, although there are more than 50 individuals in the wild, numbers are declining (PEPP 2015). (USFWS 2017).

Population Narrative:

There are approximately 80 and 85 individuals currently reported from three areas: Limahuli Valley, Hanakapiai, and Pohakuao. (USFWS, 2010). Surveys conducted since the last 5-year review in 2010 have revealed new populations of *Hibiscus waimeae* ssp. *hannerae* at Hanakapiai (10 individuals), Pohakuao (seven individuals), lower Limahuli Valley (32 to 42 individuals), and

from Koaie to Waimea Canyon (between Hipalau and Kawaiiki) (at least 10 individuals) (NTBG 2015a-g, 2016a-r; PEPP 2015). This brings the current number of populations to four (the Koaie occurrences are in three subpopulations) totaling about 100 individuals. (USFWS 2017)

Threats and Stressors

Stressor: Non-native plants (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Threats to *Hibiscus waimeae* subsp. *hannerae* are invasive introduced plant species which include *Ageratina riparia* (spreading mist flower), *Aleurites moluccana*, *Blechnum appendiculatum* (NCN), *Bryophyllum pinnatum* (airplant), *Buddleia asiatica* (dogtail), *Clidemia hirta* (Koster's curse), *Clusia rosea* (autograph tree), *Coffea arabica* (Arabian coffee), *Erigeron karvinskianus* (daisy fleabane), *Lantana camara* (lantana), *Oplismenus hirtellus* (basketgrass), *Pluchea* spp. (sourbush), *Psidium cattleianum* (strawberry guava), *Psidium guajava* (common guava), *Rubus rosifolius* (thimbleberry), *Schefflera actinophylla* (octopus tree), and *Sphaeropteris cooperi* (Australian tree fern) (National Tropical Botanical Garden 2008a; Perlman 2008; Tangalin 2008). (USFWS, 2010)

Stressor: Habitat degradation by pigs and goats (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Pigs (*Sus scrofa*) and goats (*Capra hircus*) are degrading the habitats where *Hibiscus waimeae* subsp. *hannerae* grows (Perlman 2008). (USFWS, 2010)

Stressor: Predation by insects and rats (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Insect damage to the capsules has been reported. White grubs of unidentified caterpillars, along with holes and frass (insect excrement), were noted in the seeds and capsules. Many green fruits were seen with damage, seeds seen with aborted embryos, and the few full sized fruits were filled with insect frass. Very few seeds were observed in good condition without holes, including immature fruits (National Tropical Botanical Garden 2008a; Tangalin 2008). Rats (*Rattus* spp.) are also noted as a problem (Perlman 2008). (USFWS, 2010)

Stressor: Lack of pollinators (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Lack of pollinators, and loss of pollen production are cited as limiting factors to reproduction by one botanist (Perlman 2008). Only a few immature individuals have been observed (M. DeMotta, pers. comm. 2008). Most seed is destroyed by insects, however most cultivated plants are grown from seed, as cuttings are very difficult to start (Tangalin 2008). (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to *Hibiscus waimeae* subsp. *hannerae*. However, current climate change models do not allow us to predict specifically what those effects, and their extent, would be for this species. (USFWS, 2010)

Stressor: Stochastic events (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: One hurricane or other stochastic environmental events impacting that small corner of northern Kauai where this species is found could reduce or eliminate the entire species, as was the case with Hurricane Iniki. (USFWS, 2010)

Stressor: Small population size (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: In addition to all of the other threats, species like *Hibiscus waimeae* subsp. *hannerae* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding, and disease outbreaks. (USFWS, 2010)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Kauai where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Kauai where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)

3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1998)

Recovery Actions:

- Construct enclosures around two remaining populations along the stream in Limahuli Valley and the back of Hanakapiai Valley. (USFWS, 1998)
- Begin attempts to outplant in protected areas in order to increase reproductive vigor. 84+ pp. (USFWS, 1998)
- Given the degraded nature of the Kauai plant cluster's habitat, their precariously low numbers, and the severity of the threats, the highest priority actions must be aimed at protecting all extant wild individuals and populations, managing habitat to enhance survival and ensuring maintenance of adequate genetic stock ex situ. (USFWS, 1995)
- It is hoped that by eliminating current threats through management, populations of the Kauai cluster taxa will expand naturally. However, in certain special instances, wild populations of the Kauai cluster taxa may need to be augmented. (USFWS, 1995)
- Research into various aspects of the life history, habitat, pollinators, reproductive biology, symbionts, optimum requirements for growth, requirements for population viability, and control of threats to each of the Kauai cluster taxa must be carried out to better understand the requirements necessary for perpetuation of these plants. (USFWS, 1995)
- If necessary to meet recovery objectives, populations should be reestablished in areas where they are known to have occurred historically, particularly if genetically uncontaminated, cultivated materials exist which are known to have originated from the historical site. (USFWS, 1995)
- The scientific validity of the recovery objectives should be reviewed as more information becomes available. (USFWS, 1995)
- A public education program is needed to increase awareness of and support for plant recovery efforts in Hawaii. (USFWS, 1995)
- Captive propagation for genetic storage and reintroduction—Propagation has been largely from seeds and cuttings (NTBG 2017b). There are at least 10 individuals planted at NTBG's Lawai and Limahuli gardens as living collections (NTBG 2015h-o, 2016m). The NTBG seed bank has 18 different collections of seeds, many representing individual wild plants, and the nursery is currently propagating plants from several different collections and individual wild plants (NTBG 2017b). (USFWS 2017)
- To prevent extinction, which is the first step in recovering the species, the taxon must be managed to control threats (e.g., fenced) and have 50 individuals from each of three populations represented in an ex situ (at other than the plant's natural location, such as a nursery or seed bank) collection. In addition, a minimum of three populations should be documented on Kauai where they now occur or occurred historically and each of these populations must be naturally reproducing (i.e., viable seeds, seedlings, or saplings), with a minimum of 25 mature individuals per population. (USFWS 2017)
- Surveys and inventories—Continue to survey for populations in known historical range and suitable habitat (USFWS 2017).
- Ungulate monitoring and control (USFWS 2017)
- Invasive plant monitoring and control (USFWS 2017)
- Predator and herbivore control research (USFWS 2017)

Conservation Measures and Best Management Practices:

- Collect material for genetic storage and propagation for reintroduction. (USFWS, 2010)
- Resurvey Hanakapiai for an accurate count of individuals. (USFWS, 2010)
- Identify appropriate areas for protection of this species. (USFWS, 2010)
- Fence to prevent further degradation of habitat by feral pigs and goats. (USFWS, 2010)
- Once enclosed, manage areas to remove invasive introduced plant species. (USFWS, 2010)
- Propagate from representatives of all populations for augmentation and reintroduction. (USFWS, 2010)
- Increase genetic diversity of species' offspring by reintroducing from a mixture of genetic stocks into protected areas in situ, as well as ex situ, in order to increase reproductive vigor and genetic diversity. (USFWS, 2010)
- Manage the wild and any reintroduced populations to prevent insect predation, and, if necessary, hand pollinate, in order to produce viable seed. (USFWS, 2010)
- Work with Hawaii Division of Forestry and Wildlife and Hawaii State Parks to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2010)

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SPECIES ACCOUNT: *Hoffmannseggia tenella* (Slender rush-pea)

Species Taxonomic and Listing Information

Commonly-used Acronym: SRP

Listing Status: Endangered; 12/02/1985; Southwest Region (Region 2)

Physical Description

Hoffmannseggia tenella is a perennial legume (Fabaceae: pea family) with spreading stems 8-15 cm long terminating in 3-5 flowered, eglandular inflorescences and having a long woody taproot. Leaves are bipinnately compound with petioles to 13 cm long; leaflets are oblong, 2-4 mm in length, and 1-2 mm broad in 5 or 6 pairs on each of 3-7 pinnae. Flowers are orange and approximately 5 mm long with 10 stamens. Filaments have retrorse hairs. The legumes are 12-15 mm long, 4-6 mm broad and contain 2-4 seeds. Flowering usually occurs from early March to June, sporadically thereafter depending on rainfall (USFWS, 1985b; Mahler, 1982). (USFWS, 1988)

Taxonomy

Slender rush-pea is in the class Magnoliopsida, order Fabales, and family Fabaceae (Poole 1988). There are currently no other scientific or common names for this species (Poole 1988). Although the final rule (FR) listed SRP as belonging to the pea family, Fabaceae, it was later listed under the family Leguminosae. These two family names are used interchangeably. Family Fabaceae is the more widely accepted classification for legumes like the SRP. In addition, the International Union for Conservation of Nature and Natural Resources (IUCN) clarified the correct spelling of the genus as *Hoffmannseggia*, not *Hoffmanseggia* (USFWS 1985). (USFWS, 2008)

Historical Range

Historically known from Nueces and Kleberg Counties, Texas.

Current Range

In Texas, extending from Robstown, Nueces County, on the most northeastern extent of the range to east-central Kleberg County, then west to a point near Kingsville, and north to the vicinity of the Nueces/Jim Wells County line, encompassing approximately 221,000 acres. (USFWS, 2008)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 2008)

Breeding Season

Adult: March to June (USFWS, 2008)

Reproduction Narrative

Adult: The SRP has monoclinal flowers, bearing both male and female reproductive parts in the same flower (Poole 1988). The species appears to be reproductively active during the spring and summer months, however this activity can be prolonged into the fall in a sporadic fashion in response to rainfall events, even if the prevailing climatic conditions are dry (Mahler 1982a, Bush 1990). Fruiting dates are documented from February through July (USFWS 1988) and seed/fruit dispersal dates from March through June (Mahler 1982a). (USFWS, 2008)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Grassland/herbaceous (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Prefers sparsely vegetated areas (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Patches (USFWS, 2008)

Environmental Specificity

Adult: Low (inferred from USFWS, 2008)

Habitat Narrative

Adult: Slender rush-pea occurs in the eco-region known as the Gulf Prairies and Marshes biotic zone (Correll and Johnston 1970). All documented SRP sites occur in patches of short-grass native prairies adjacent to intermittent or permanently flowing creeks, with the exception of the two most southeastern Kleberg County populations described by Jones in 1964 as being in a "pasture opening on clay loam" and on a "clayey roadside" (TNDD 2007). This species is found in sparsely vegetated openings within bluestem-sacahuista grasslands on heavy clay soils of the South Texas Coastal Plain. The SRP occurs in areas of Victoria Clays which are calcareous, crumbly, clay soils that are self-mulching and greatly cultivated for crops. This species is a perennial legume that occurs in patches of native short- and mid-grass prairie adjacent to watercourses, such as permanent and intermittent creeks. This species is a member of the lower seral stages of succession, perhaps even a pioneer species" or an invader species of highly disturbed soils where it persists until crowded out by other species. (USFWS, 2008; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Number of Populations:

8 (USFWS, 2018)

Population Size:

>10,000 (NatureServe, 2015)

Population Narrative:

As a result of work funded through a 2008-2010 Preventing Extinction cooperative agreement and other monitoring efforts, 8 populations were found to be extant (Table 5), although four of these (Hwy 77, St. James Cemetery, Bishop City Park, and a private residence in Bishop) are less than 2.5 km (1.6 miles) apart from the others and probably function as a single metapopulation. Three of the eight (Sablatuna County Park, Bishop City Park, and a private residence between St. James Cemetery and Bishop City Park) are new discoveries, and the Petronilla site has been temporarily recovered through suppression of the nonnative grass Kleberg bluestem with grass-specific herbicide. Although the King Ranch training area (KRTA) sites have not been visited since 1993, the populations (probably subpopulations of another metapopulation) are likely extant since we have no knowledge that habitat has been disturbed to the point that it is not suitable for rush-pea. (USFWS, 2018)

Threats and Stressors

Stressor: Habitat alteration (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Historically, conversion of native prairie to row crops and improved pasture was probably the largest factor contributing to losses of SRP populations and habitat (Poole 1988). The range of SRP has likely been considerably contracted by these types of land conversion activities in Nueces and Kleberg counties. Slender rush-pea populations were probably reduced in size or eliminated altogether as habitat was converted to cropland or deliberately planted to monoculture pastures of non-native grasses. Increased cover by woody species may also have impacted some SRP habitat (USFWS 1988). (USFWS, 2008)

Stressor: Non-native plants (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: More recently, threats to the integrity of the remaining habitat have increased as non-native pasture grasses, including Kleberg bluestem, King Ranch bluestem, Coastal Bermudagrass, and other introduced grasses have continued to spread throughout this region (Mahler 1982a, Poole 1988, Kuvlesky et al. 2002). These grasses are opportunistic species, either producing copious amounts of seed that can be spread both deliberately and/or inadvertently, or spreading rapidly by vegetative means. Seeding of highway and pipeline ROWs and highways to reduce erosion has helped to increase the distribution of some of these non-native grasses into the native prairie remnants that constitute natural habitat for SRP, as seen at the Petronilla Creek and Highway 77 ROW sites (Poole 1988). The condition of short-grass prairie habitat within the

unplowed rangeland in Kleberg County is not known. Prescribed winter burns and cattle grazing are the primary land management known to occur in this area. Non-native, pasture grasses, predominantly Kleberg bluestem, King Ranch bluestem (*Bothriochloa ischaemum*), and Coastal Bermudagrass (*Cynodon dactylon*), have encroached and altered the composition of the native vegetation community at the three accessible SRP population sites at Petronilla Creek/Highway 70, Highway 77 ROW, and St. James Cemetery (Mahler 1982a, Poole 1988, D. Price pers. comm. 2006). These non-native grasses tend to produce dense monocultures with few short-grass native species able to persist (Mahler 1982a). Woody species, including honey mesquite (*Prosopis glandulosa*), huisache, retama, and others have also become more prevalent in the remnant prairie fragments where SRP persists (Mahler 1982a, USFWS 1988, Ruth 2000). Kleberg bluestem, native to India, China, North Africa, and Egypt, is considered highly competitive, with long creeping rhizomes and continual seed production throughout the year under favorable conditions. Drought tolerance has enabled people to use this grass as a stabilizer on roadsides and pipeline ROWs, and seeds are highly mobile by several means of transport (Drawe 2004). The shallow, fibrous roots of many grass species such as Kleberg bluestem allow quicker absorption of moisture and nutrients than is capable by tap-rooted species, such as SRP, which must wait for deeper moisture penetration (D'Antonio and Mahall 1991). In addition to subsurface competition, fast growing non-native grasses can spread quickly and potentially out-compete SRP for both space and sunlight (Pressly 1998). Greenhouse shade cloth studies using SRP plants grown at the Kika de la Garza PMC demonstrated significant differences in petiole heights and lengths between non-shaded (controls) versus shaded treatments and also differences in the growth pattern (Pressly 2002). Non-shaded plants grew in a prostrate manner while the petioles of the shaded plants grew upwards (Pressly 2002). However, this greenhouse study did not show significant mortality of SRP at 30%, 40%, or 50% shading (Pressly 2002). (USFWS, 2008)

Stressor: Disturbances from construction and maintenance (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Localized disturbances causing losses of individual SRP plants have been attributed to highway construction projects as well as ROW maintenance procedures, maintenance of gas pipelines, and excavation of burial plots (Poole 1988). Survey reports indicated some damage to SRP individuals at St. James Cemetery caused by mowing with blades set low to the ground. Other observations at the cemetery reported on damage associated with equipment tracking through the population, and from piling of cleared brush on top of SRP. Consequently, TPWD recommended mowing at a height of no less than 6 inches (approximately 15 cm), which has been incorporated into cemetery groundskeeping procedures (Perez 1992). Also, a management agreement between TxDOT and TPWD included recommendations to continue established mowing practices on the Highway 77 ROW with a full-width mowing 4 times a year and a strip mowed every 6 weeks between May through December. (USFWS, 2008)

Stressor: Grazing (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: This was not known as a threat at the time of listing. Poole (1986) did observe that 4 SRP plants at the Petronilla/Hwy 70 population "looked as though rabbits had been biting them."

However, no other evidence, anecdotal or otherwise, exists regarding the effects of grazing or browsing on this species. Data on abundance and distribution of cottontails (*Sylvilagus floridanus*) and jackrabbits (*Lepus californicus*) in Nueces and Kleberg counties is lacking; however, it is possible that rabbit populations may have become more concentrated in the remnant strips of habitat in Nueces County. Plants may be susceptible to insect vectors and/or grazing effects, but no research has been conducted to document such effects. No new information regarding the predation or disease of SRP has been found. (USFWS, 2008)

Recovery

Reclassification Criteria:

Downlisting Criteria 1: To downlist rush-pea, 15 populations should have an estimated 1,500 mature individual plants per population. Downlisting may be possible if each of these populations is stable or increasing over the next 35 years. The extant populations (eight total), as well as any that may be restored, augmented, or created, should be maintained with at least five natural populations located in the drainage systems (Petronila, Oso, Chilipitin Creek-San Fernando, Alazan Bay-Baffin Bay Creek basins) where the species is known to naturally occur to ensure genetic representation. (USFWS, 2018)

Downlisting Criteria 2: Each rush-pea site should be managed for and support high quality shortgrass prairie habitat. High quality shortgrass prairie habitat has these characteristics: 1) occurs in unplowed, relatively undisturbed soils; 2) has a high diversity and high vegetative cover of native grasses and forbs; 3) has a low vegetative cover of introduced grasses; and, 4) has a low vegetative cover of woody species (i.e. native brush). High quality shortgrass prairie habitat should contain species commonly associated with rush-pea (see Table 7 of 2018 Recovery Plan). Prolific and aggressive nonnative grasses should not constitute more than small patches within each high quality shortgrass prairie site and invasive grasses and woody species should not be spreading throughout the site or inhibiting growth and reproduction of rush-pea. Each rush-pea site should be managed and monitored appropriately to ensure the maintenance and restoration of high quality shortgrass prairie habitat conditions and to minimize and control threats over a period of 35 years. (USFWS, 2018)

Delisting Criteria:

Delisting Criteria 1: A minimum of 20 populations are necessary for delisting and should have at least 1,500 mature individual plants per population. Delisting may be possible if each of these populations remains stable or increasing over a period of 60 years. All existing populations, including those that have been restored, created, or reintroduced, are protected and a minimum of five natural populations are extant within each drainage system (Petronila, Oso, Chilipitin Creek-San Fernando, Alazan Bay-Baffin Bay Creek basins). (USFWS, 2018)

Delisting Criteria 2: Populations will be protected long-term (protection in perpetuity being optimum) through fee title acquisition, conservation easements, or conservation or management agreements. Species-specific, USFWS-approved annual monitoring and management plans will guide these efforts. Each population site should have high quality shortgrass prairie habitat (see Downlisting Criteria 1 for a description). (USFWS, 2018)

Recovery Actions:

- 1. Habitat protection and management of all known population sites of Slender rush-pea in the United States. - Establish positive working relationships with landowners and land managers of all known sites. Maintain contact with all landowners or land managers each year. Educate landowners about the extreme rarity and significance of both the ecosystem and species on their property. Encourage the long-term stewardship of the shortgrass prairie at these sites through technical assistance to landowners; also potentially through long-term leases, conservation easements, and conservation agreements. - Cooperate with landowners and land managers to develop and implement management plans that address landowner and species goals. With willing landowners, determine short- and long-term land use goals and their effects on Slender rush-pea. With all cooperating landowners, develop and implement management plans that are beneficial to the species as well as acceptable to landowners and land managers. Develop a monitoring program that is reviewed by the USFWS and other interested parties, with voluntary landowner assistance, to evaluate the effects of management practices on the species and ensure consistent and reliable monitoring of plant populations and management. - Enforce applicable laws and regulations. Work with regulatory agencies (DOD– NASK, TXDOT, TPWD, USDANRCS, and through internal USFWS coordination) to ensure that existing regulations are used to provide adequate protection of current habitat. (USFWS, 2018)
- 2. Monitor Slender rush-pea on an annual basis. - Use the approved monitoring plans to annually monitor rush-pea, its habitat, management actions, and threats at extant sites. - Monitor species and biotic communities and assess ecological integrity and conservation status of historic sites. (USFWS, 2018)
- 3. Initiate studies to gather biological information needed for effective management and recovery of rush-pea. - Determine specific habitat requirements (specifically limiting factors). Study soils and underlying geology. Determine the plant community structure for Slender rush-pea. Study community dynamics/ecology. - Study population dynamics. Analyze the demographic structure of all populations. Characterize phenology and assess the most vulnerable stages of life cycle. Determine the primary means of reproduction in the wild. Study pollination biology and determine effective pollination requirements and effective pollinators. Study seed production and dispersal. Study seedling recruitment. Study population genetics to determine the genetic diversity within and among populations. (USFWS, 2018)
- 4. Survey for additional populations of rush-pea. As more information about the habitat and biology of the species becomes available, determining areas capable of supporting the species may be more predictable. Models, maps, and other tools will be developed showing the vegetative and edaphic characteristics of occupied sites. This information will help to determine where coastal shortgrass prairie habitats currently might remain intact and/or where the species could be located. These potential areas are a high priority to survey and engage in stewardship efforts. These surveys should be performed to locate existing and new populations and for use as potential reintroduction sites in Texas. (USFWS, 2018) (USFWS, 2018)
- 5. Cooperatively work with landowners and land managers to restore additional shortgrass prairie sites located in one or more of the drainage areas from which rush-pea is known to co-occur. (USFWS, 2018) (USFWS, 2018)
- 6. Establish seed or propagule banks and ex-situ (botanical garden, refugium, research institute, etc.) populations for the species. These banks and ex-situ populations will be

established using approved reintroduction plans for Slender rush-pea (see Recovery Action 7 below). (USFWS, 2018)

- 7. Conduct a reintroduction program on public and private lands where there are willing partners. Evaluate and document the success of different cultivation techniques, site preparation, and other management techniques based on research, and assess any additional information necessary to attempt reintroduction. Reintroduced populations for Slender rush-pea should not be considered successful until they are established, reproductively active, self-perpetuating, and demonstrated to be demographically and genetically viable. (USFWS, 2018)
- 8. Develop an education and outreach program. Develop any necessary educational or outreach materials. Provide educational and outreach materials to landowners and land managers. Provide educational and outreach materials to interested parties including agencies, engineering and consulting firms, developers, utilities, county road associations, and others.
- 9. Conduct Population Viability Analyses (PVA) and update the existing MVPs for the species based on current biological and ecological information. Investigate Slender rush-pea' population genetics to ensure long-term persistence. Develop traditional MVP estimates for Slender rush-pea. Reassess the MVP size when new information is made available. (USFWS, 2018)
- 10. Review and track recovery. Maintain the STXPRT to help review the status of Slender rush-pea and assess the effectiveness of the management plans and other recovery tasks. Revise the Recovery Plan as appropriate. Develop a post-delisting monitoring plan when appropriate. (USFWS, 2018)

Conservation Measures and Best Management Practices:

- Continued loss and degradation of habitat due to invasion by non-native, fast-spreading grasses is the most pressing threat to the continued existence of SRP populations at sites in Nueces County. There is an immediate need to implement and experiment with management actions involving mowing treatments, selective applications of herbicides, hand removal, and potentially even prescribed burning to control exotics at the cemetery and the Highway 77 ROW sites. Monitoring of SRP response will be needed to document effectiveness of various management techniques. Effective methodologies should be incorporated into management plans for both populations. Annual monitoring should be carried out to determine if populations are stable, increasing, or declining. The Service and/or TPWD should establish a cooperative agreement with the cemetery owner to assist the landowner in implementing the management plan. Based on the results of SRP's response to various management treatments, TxDOT should consider changes to their management of the Highway 77 ROW, including changes to mowing schedules. (USFWS, 2008)
- A systematic approach to surveying for new populations is needed, particularly in Kleberg County where the natural habitat is potentially in better condition. If additional populations are located in rangeland settings, the effects of prescribed burns on SRP should be analyzed. (USFWS, 2008)
- A reintroduction plan should be established for the SRP to allow experimental plantings into natural habitat, particularly at the former population sites on the western side of the Highway 77 ROW and at the Petronilla Creek/Highway 70 ROW. The SRP has proven to be easily germinated from untreated seed and prospects seem good for propagating the species. A thorough genetics analysis of SRP is needed to develop a sound reintroduction plan. (USFWS, 2008)
- Knowledge regarding species' habitat requirements, population biology, and population ecology needs to be gathered and analyzed in order to develop down-listing and delisting recovery criteria.

Additional research needs include determination of habitat requirements, demographic trends, population biology, reproductive biology, and pollinators. (USFWS, 2008)

- The recovery plan for SRP needs to be revised to incorporate all new information on biology, ecology, and management recommendations. Objective and measurable recovery criteria that relate directly to the 5 listing factors should be developed. (USFWS, 2008)

References

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USFWS. 2008. Slender Rush-pea (*Hoffmannseggia tenella*)

USFWS. 2018. Texas Coastal Bend Shortgrass Prairie Multi-Species Recovery Plan: Including Slender Rush-Pea (*Hoffmannseggia tenella*) and South Texas Ambrosia (*Ambrosia cheiranthifolia*). U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 130 pp. August 23, 2018.

SPECIES ACCOUNT: *Holocarpha macradenia* (Santa Cruz tarplant)

Species Taxonomic and Listing Information

Listing Status: Threatened; 03/20/2000; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An annual herb with stiffly spreading stems that are bristly and glandular. Inflorescence dense with heads in the upper axils; flowers yellow; phyllaries gland-tipped (NatureServe, 2015).

Taxonomy

A member of the aster family (Asteraceae). *Holocarpha macradenia* is one of only four species of the genus *Holocarpha*, all geographically restricted to California (USFWS, 2014).

Historical Range

Historically, habitat for *Holocarpha macradenia* occurred on grasslands and prairies found on coastal terraces in elevations below 330 feet (100 m), from Monterey County, north to Contra Costa and Marin Counties (USFWS, 2014).

Current Range

Holocarpha macradenia occurs in coastal grasslands and prairies in Contra Costa, Santa Cruz, and Monterey Counties, California (Service 2000) (USFWS, 2014).

Critical Habitat Designated

Yes; 10/16/2002.

Legal Description

On October 16, 2002, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Holocarpha macradenia* (Santa Cruz tarplant) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes eleven critical habitat units (CHUs), in California (67 FR 63968-64007).

Critical Habitat Designation

The critical habitat designation for *Holocarpha macradenia* includes eleven CHUs in Contra Costa, Santa Cruz, and Monterey Counties, California. This species critical habitat encompasses approximately 2,902 acres (ac) (1,175 hectares (ha)) (67 FR 63968-64007).

Unit A: Mezue: Unit A consists of grassland habitat on sloping alluvial deposits from old marine terraces within Wildcat Regional Park in Contra Costa County. This entire unit of approximately 50 ha (130 ac) is on lands managed by the EBRPD. Management activities at this site include controlled grazing, removal of invasive artichoke thistle, and annual population monitoring (EBRPD 1992, 2001). Of the 22 sites that were used as sites to introduce *Holocarpha macradenia* seed in the East Bay region between 1982 and 1986, this population has been the only one that has consistently supported a large population of *H. macradenia*. In the year 2000, this population supported over 17,000 individuals (CDFG 2000). Although this population is an introduced population, this unit is essential to the survival and conservation of the species because this population represents the genetic variability in the northernmost portion of the plant's range and is important for the expansion of the existing population. In recognition of the conservation

value of this population, the Service is contributing funding toward nonnative species removal at this site (Service 2002).

Unit B: Graham Hill: Unit B consists of grasslands on a relatively flat coastal terrace prairie on the west side of Graham Hill Road, approximately 1 mile north of the City of Santa Cruz in Santa Cruz County. This entire unit of approximately 12 ha (30 ac) is on privately owned lands. The unit includes a 7-ha (17-ac) area that has been set aside through a conservation easement to the County of Santa Cruz for conservation of coastal prairie habitat and *Holocarpha macradenia* as mitigation for an adjacent development that comprises 52 residences and associated amenities. The population has been fenced and nonnative species have been removed; however, efforts to enhance the population, as called for in a management plan (Environmental Science Associates 1996), have not yet been initiated. In 1994, this population numbered 12,000 individuals; by 1998, 675 individuals were counted; and in 2001, approximately 550 individuals were counted (V. Haley, consultant, Felton, California, pers. comm., 2001). This unit is important because it currently supports a population of *H. macradenia* and because it represents the western limit of the cluster of populations that are found on the northern end of Monterey Bay. This unit, along with the Fairway Unit, occurs at the highest elevation of the native populations (122 m (400 ft)) and consequently the farthest away from the influence of the coastal climate. Preserving the genetic variability within the species that has allowed it to adapt to these different environmental conditions is essential for the long-term survival and conservation of the species.

Unit C: De Laveaga: Unit C consists of grasslands on a relatively flat coastal terrace prairie within De Laveaga Park just north of the City of Santa Cruz in Santa Cruz County. This entire unit of approximately 2 ha (5 ac) is on State lands managed by the CANG and supported by Federal funds from the National Guard Bureau. The CANG does not anticipate undertaking any new military activities on this parcel beyond its current use as an assembly point for monthly drills and as storage for equipment. In 2001, a maintenance crew from the adjacent city-owned golf course spread wood chips from a felled tree over half the population. The CANG has initiated management actions to restore and enhance habitat for *H. macradenia*, including removal of the wood chips and chunks of eucalyptus logs. In addition, the CANG has initiated development of an INRMP (CANG 2002); if the final plan meets the criteria outlined earlier in our response to comment number eight, the critical habitat designation may be removed from this unit in the future. This unit is essential because it currently supports a population of *H. macradenia* and because it is one of only seven populations in the cluster of populations that are found on the northern end of Monterey Bay. Despite its small size, this unit is essential because it is located between the Graham Hill, Arana Gulch, and Rodeo Gulch Units, and is important for maintaining connectivity between these other units.

Unit D: Arana Gulch: Unit D consists of grasslands on a relatively flat coastal terrace prairie within an open space preserve just north of Woods Lagoon in the City of Santa Cruz. This entire unit of approximately 26 ha (65 ac) is on lands owned and managed by the City of Santa Cruz. It is bounded on the west, east, and north sides by existing development and on the south side by the Santa Cruz Harbor. Huge population fluctuations have occurred on this site, ranging from 100,000 individuals in the late 1980s when the site was being grazed by cattle, to no plants in 1995 (K. Lyons, in litt., 2001). The City entered into a Memorandum of Understanding with the CDFG in 1997 to manage *Holocarpha macradenia*, which includes utilizing a variety of management techniques to enhance the population. As of 1998, individuals numbered approximately 12,820; in 2000, they numbered 234; and in 2002 they numbered approximately 10,000 (K. Lyons, in litt.,

2001; Seals 2002). This unit is essential because it currently supports a population of *H. macradenia* and because it is one of only seven populations in the cluster of populations that are found on the northern end of Monterey Bay. This unit and the Twin Lakes Unit occur at the lowest elevation of the native populations in the northern Monterey Bay area (12 to 18 m (40 to 60 ft)) and are consequently the closest to the influence of the coastal climate. Moreover, these two units are within one-half mile of each other and therefore could retain connectivity between them. It is also essential for the recovery of the species because current management by the City of Santa Cruz has allowed this site to support the third largest standing native population of tarplant. It therefore contributes significantly to the seed bank reserve for the species and is large enough to support management activities that may be necessary to maintain the population at this site.

Unit E: Twin Lakes: Unit E consists of grasslands on relatively flat coastal terrace prairie just north of Schwan Lagoon within the City of Santa Cruz. This entire unit of approximately 11 ha (26 ac) is on lands owned by the CDPR within Twin Lakes State Park. It is bounded on the west, north, and east sides by existing development, and on the south side by Schwan Lagoon. Since 1997, CDPR has been actively managing *Holocarpha macradenia* habitat by removing invasive, nonnative species and attempting various methods of enhancing the population (Service 2000). CDPR has also funded research on *H. macradenia* seed bank dynamics (Bainbridge 1999). This population has ranged in size from 120 individuals in 1986 to 21 individuals in 2002 (Hyland 2002). This unit is essential because it currently supports a population of *H. macradenia* and because it is one of only seven populations in the cluster of populations that are found on the northern end of Monterey Bay. As with the Arana Gulch Unit, it occurs at the lowest elevation of the native populations in the northern Monterey Bay area (12 to 18 m (40 to 60 ft)) and consequently the closest to the influence of the coastal climate. Moreover, the two units are within one-half mile of each other and therefore could retain connectivity between them.

Unit F: Rodeo Gulch: Unit F consists of sloping alluvial deposits and adjacent relatively flat coastal terrace prairie that straddles the Arana Gulch and Rodeo Gulch drainages north of the community of Soquel in Santa Cruz County. It is bounded on the north, east, and south sides by existing development; the western side is bounded by lands that have not been developed. This entire unit of approximately 11 ha (26 ac) is on privately owned lands. This unit includes a parcel that has recently been proposed for a housing development known as Santa Cruz Gardens Subdivision Unit 12 (Denise Duffy and Associates 2001). This parcel was previously set aside in a "temporary open space easement" as mitigation for destroying a portion of the *H. macradenia* population by an earlier phase of the development in 1986 (Service 2000). The current development proposal calls for setting aside approximately 23 ha (56 ac) for conservation and recreation purposes, and includes much of the habitat that supports *H. macradenia*. Salvage of soil and an *H. macradenia* seed bank is being proposed for another portion of the project site that will be impacted by development (Lyons 1999). This population numbered approximately 60 individuals in 1993; none have been observed since then (CNDDDB 2001). However, a seed bank likely persists at this site. This unit is essential because of the likely presence of an *H. macradenia* seed bank and because it is one of only seven populations in the cluster of populations that are found on the northern end of Monterey Bay. In addition to the seed bank for this population, this unit supports grassland habitat that provides for future expansion of the population. Also, it is within one-half mile of the Soquel Unit, and therefore could retain connectivity between the units.

Unit G: Soquel: Unit G consists of grasslands on sloping alluvial deposits and adjacent relatively flat coastal terrace prairie that straddles the Rodeo Gulch and Soquel Creek drainages north of the community of Soquel in Santa Cruz County. It is bounded on the north, east, and south sides by existing development; the western side is bounded by lands that have not been developed. Approximately 22 ha (55 ac) of this 40-ha (100-ac) unit is within Anna Jean Cummings Regional Park (also known as O'Neill Ranch), which is managed by the County of Santa Cruz. The remaining portion is privately owned. On the park lands, the population has been fenced, and portions of the habitat for the plant are being mowed and raked in accordance with a management plan (Ecosystems West 1999; Joe Rigney, consultant, pers. comm., 2001). The County of Santa Cruz approved a housing development for the privately owned parcel (previously known as Tan, but now called Seacrest) in 1997. The development included an approximately 4-ha (10-ac) parcel to be set aside for conservation and a plan to manage the habitat for *Holocarpha macradenia*. Although part of the same population, the CNDDDB has maintained two separate entries (O'Neill and Tan) to reflect the two land ownerships. The total number of individuals in the combined population has never been larger than 200 individuals, with the private parcel supporting only a portion of those (CNDDDB 2001). To date, management activities have not resulted in enhancing the population of the species on either parcel. This unit is essential because it has recently supported a population of *H. macradenia* and the seed bank is still present, and because it is one of only seven populations in the cluster of populations that are found on the northern end of Monterey Bay. In addition to the seed bank for this population, this unit supports grassland habitat that provides for future expansion of the population. Also, it is within one-half mile of the Rodeo Gulch Unit, and therefore could retain connectivity between the units. Moreover, the acreage in Anna Jean Cummings Park represents one of the best remaining fragments of habitat on which to attempt recovery activities for *H. macradenia*, as it has been subject to fewer impacts than other sites.

Unit H: Porter Gulch: Unit H consists of grasslands on gently sloping alluvial deposits derived from a coastal terrace that straddles the Bates Creek and Porter Gulch drainages north of the community of Soquel in Santa Cruz County. It is bounded on all sides by undeveloped lands. This entire unit of approximately 14 ha (35 ac) is on privately owned lands. The population of *Holocarpha macradenia* at this site includes an approximately 12-ha (30-ac) parcel that was proposed for a lot split. A management plan for the species was developed as part of the proposed split (Greening Associates 1995); however, the management plan for *H. macradenia* has not been fully implemented. This unit also includes adjacent coastal prairie habitat, of which approximately 4 ha (9 ac) was deeded in 2001 to the Land Trust of Santa Cruz County for preservation. In 1993, the population of *H. macradenia* numbered approximately 1,500 individuals (CNDDDB 2001). The population numbered only several hundred individuals in 2001 when the site was observed to support a large cover of rattlesnake grass that likely competed with *H. macradenia* (C. Rutherford, Service, pers. obs., 2001). This unit is essential because it currently supports a population of *H. macradenia*, and because it is one of only seven populations in the cluster of populations that are found on the northern end of Monterey Bay. Also, along with the Graham Hill Unit, this one occurs at the highest elevation of the native populations (122 m (400 ft)) and consequently the farthest away from the influence of the coastal climate. Preserving the genetic variability within the species that has allowed it to adapt to these slightly different environmental conditions is essential for the long-term survival and conservation of the species.

Unit I: Watsonville: Unit I consists of grasslands on alluvial fans and marine terraces west of the City of Watsonville in Santa Cruz County; during the remapping for the final rule we removed most of the lowlying drainages that interdigitate with the grasslands. The northern and eastern boundaries reach toward the Corralitos Creek drainage except where it runs up against existing development. The southeastern and southern boundary is formed by the Pajaro River drainage. The western boundary is formed by the Harkins Slough drainage and then generally follows Buena Vista Drive north until it intersects with the northern perimeter of the Watsonville Airport (Airport). This unit excludes paved areas of the Airport, but includes the unpaved portions surrounding the runways. This approximately 488-ha (1,205-ac) unit is partly owned by the City of Watsonville (the Airport and High School) (approximately 125 ha (309 ac)); a small portion is under easement to CalTrans (approximately 8 ha (19 ac)); a portion is designated as a Reserve by the CDFG (approximately 15 ha (37 ac)); and the remaining portion is privately owned (approximately 340 ha (840 ac)). This unit overlaps in part with an area that is targeted for regional conservation planning by the CDFG. Through its Conceptual Area Protection Plan process, CDFG, along with other Federal, State, and local agencies and organizations, are identifying opportunities to preserve sensitive species and habitats, including the Harkins Slough and Watsonville Slough wetlands and adjacent habitats (J. DeWald, in litt., 2001). This unit is essential because it currently supports multiple populations of *H. macradenia* including the populations known from the Airport, Harkins Slough, Apple Hill, and Bay Breeze (see Background for additional population information). This unit also supports grassland habitat that is important for the expansion of existing populations and for maintaining connectivity between the populations. It is also one of only three areas that support populations of *H. macradenia* that are found in the central Monterey Bay area and in the southern end of the range of the species. Preserving any genetic variability within the species that has allowed it to adapt to these slightly different environmental conditions is essential for the long-term survival and conservation of the species. Just prior to publication of this final rule, we were informed that construction of the Millennium High School had been initiated. Therefore, with this unit description, we are removing the 32 acres that are being converted to building, paved surfaces, and playing fields because these areas will no longer support the primary constituent elements. Note, however, that the 32 acres have not been removed from the map depicting this unit; nor have they been subtracted from the unit total and overall total number of acres being designated as critical habitat for the species.

Unit J: Casserly: Unit J consists of open patches of grassland interspersed with golf course greens, cattle pastures, croplands, and orchards. This entire unit of approximately 450 ha (1,110 ac) consists of privately owned lands. It is the unit for which the least amount of information is available, particularly with respect to existing land uses. The Spring Hills population of *Holocarpa macradenia* occurs within this unit. The population numbered approximately 4,000 individuals in 1990 (CNDDB 2001); the population was observed in 1995 and 2001, though not counted. The population was fragmented by development of the Spring Hills Golf Course, and now consists of five separate occurrences. This unit is essential because it currently supports multiple occurrences of *H. macradenia* that are found in the Monterey Bay area, including the five populations known from the Spring Hills Golf Course. This unit also supports grassland habitat that is important for the expansion of existing populations, and for maintaining connectivity between these populations. It is one of only three areas that support populations of *H. macradenia* that are found in the central Monterey Bay area and in the southern end of the range of the species as well as the most inland distribution of the species. Preserving genetic

variability within the species that has allowed it to adapt to these slightly different environmental conditions is essential for the long-term survival and conservation of the species.

Unit K: Elkhorn: Unit K consists of sloping terrain on the edges of a coastal terrace, just south of the Pajaro River in northern Monterey County. The population of *Holocarpha macradenia* that is found here is unusual in that it occurs on a canyon bottom; it is also the only population that occurs primarily on the Santa Ynez soil series. This unit of approximately 70 ha (170 ac) is privately owned by the Elkhorn Slough Foundation (Foundation). The CDFG holds a conservation easement on an approximately 16-ha (40-ac) parcel that overlaps in part with this unit; the Foundation is managing the parcel for its biological values. Multiple Federal, State, and local government and private agencies have recently developed a conservation plan for the Elkhorn Slough watershed; this critical habitat unit is within the 18,210-ha (45,000-ac) area on which the conservation plan focuses (Scharffenberger 1999). In 1993, the population at this site comprised approximately 3,200 individuals (CNDDDB 2001). *Salix* spp. (willow) planting that has been undertaken as part of a riparian enhancement project may increase shading on an adjacent population of *H. macradenia*, leading to a reduction in the size of that population (Holl, in litt., 2002). This unit is essential because it currently supports a population of *H. macradenia* and because it is one of only three areas that support populations of *H. macradenia* that are found on the central Monterey Bay area and in the southern end of the range of the species. Also, this is the only population that occurs primarily on the Santa Ynez soil series. Preserving any genetic variability within the species that has allowed it to adapt to these slightly different environmental conditions is essential for the long-term survival and conservation of the species. In addition to the current population, this unit comprises grassland habitat that is important for the expansion of the population.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Holocarpha macradenia* critical habitat consists of three components (67 FR 63968-64007):

(i) Soils associated with coastal terrace prairies, including the Watsonville, Tierra, Elkhorn, Santa Inez, and Pinto series.

(ii) Plant communities that support associated species, including native grasses such as *Nassella* sp. (needlegrass) and *Danthonia californica* (California oatgrass); native herbaceous species such as members of the genus *Hemizonia* (other tarplants), *Perideridia gairdneri* (Gairdner's yampah), *Plagiobothrys diffusus* (San Francisco popcorn flower), and *Trifolium buckwestiorum* (Santa Cruz clover); and

(iii) Physical processes, particularly soils and hydrologic processes, that maintain the soil structure and hydrology that produce the seasonally saturated soils characteristic of *Holocarpha macradenia* habitat.

Special Management Considerations or Protections

Much of what is known about the specific physical and biological requirements of *Holocarpha macradenia* is described in the Background section of this final rule. Additional information about appropriate management techniques is being generated by ongoing management efforts and research on life history. As discussed in the Background section, several agencies such as the

CDFG, California Department of Parks and Recreation (CDPR), CalTrans, County of Santa Cruz, City of Santa Cruz, and EBRPD are undertaking efforts to learn how to better enhance habitat for *H. macradenia*. Some of these efforts are being carried out with the cooperation of researchers from UC Santa Cruz and Berkeley's Jepson Herbarium. Preliminary management and seed bank studies show that habitat manipulation such as burning, mowing, grazing, and scraping can increase standing numbers of plants and may be necessary to enhance and maintain populations of *H. macradenia*. Active management is often necessary to preserve habitat that is essential for the long-term conservation of *H. macradenia*. Special management considerations or protections may be needed to maintain the primary constituent elements for *Holocarpha macradenia* within the units being designated as critical habitat. In some cases, protection of existing habitat and current ecological processes may be sufficient to ensure that populations of *H. macradenia* are maintained, and have the ability to reproduce and disperse into surrounding habitat at those sites. In other cases, however, active management may be needed to maintain the primary constituent elements for *H. macradenia*. We have outlined below the most likely special management or protection that *H. macradenia* may require. (1) The native soils on which *Holocarpha macradenia* is found should be maintained to optimize conditions for the species. Physical properties of the soil, such as its chemical composition, salinity, texture, and drainage capabilities would best be maintained by limiting or restricting deep tilling and the use of herbicides, fertilizers, or other soil amendments. (2) The hydrologic regime of the area surrounding *Holocarpha macradenia* habitat should be maintained to provide for the seasonally moist soils that the species favors. Increasing or decreasing surface and subsurface water flow to these areas through habitat alteration that either artificially adds water (e.g., through irrigation) or reduces water (e.g., through diversions associated with construction projects) could decrease the suitability of these areas to support *H. macradenia*. (3) The grassland communities should be maintained to ensure that the habitat needs of pollinators and dispersal agents are maintained. The use of pesticides should be limited or restricted so that viable populations of pollinators are present to facilitate reproduction of *Holocarpha macradenia*. Fragmentation of habitat through construction of roads and certain types of fencing should be sufficiently limited to allow seed dispersal agents to move *H. macradenia* seed throughout the unit. (4) The grassland communities need to be maintained to facilitate germination and the establishment of seedlings, because this is a critical bottleneck in the life cycle of the species (Bainbridge, in litt., 2002b). In particular, this portion of the species' life cycle requires a reduced litter layer and canopy height of surrounding vegetation. This can be achieved through either mowing or livestock grazing. A discussion of more detailed prescriptions is beyond the scope of this rule, as the optimal regime will vary from site to site, depending on a number of variables. However, research efforts that are currently underway will assist in developing more site-specific recommendations. (5) In the grassland communities where *Holocarpha macradenia* occurs, invasive, nonnative species such as French broom, eucalyptus, acacia, Harding grass, bromes, artichoke thistle, and bristly ox-tongue and other species need to be actively managed to reduce competition and maintain the open habitat that *H. macradenia* needs. (6) Certain areas where *Holocarpha macradenia* occurs may need to be fenced to protect them from accidental or intentional trampling by humans and livestock, and to facilitate management of the habitat through intentional grazing or other means.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual: cross-pollination (USFWS, 2014)

Lifespan

Adult: 1 year (USFWS, 2014)

Breeding Season

Adult: July - October (USFWS, 2014)

Key Resources Needed for Breeding

Adult: Insect pollinators, soil seed bank (USFWS, 2014)

Reproduction Narrative

Adult: This is an annual plant. Flowering from July to October, the inflorescences comprise yellow ray and disc flowers. Native bees, flies, wasps, and winged beetles have been observed pollinating *H. macradenia* (Barber 2002). Plants produce 1 to 60 inflorescences with two types of flowers that produce two types of achenes (seeds) with different morphologies and requirements for germination. Results of studies indicate that disk seeds produced by *Holocarpha macradenia* germinate within a year of production while ray seeds form persistent seed banks. *Holocarpha macradenia* is self-incompatible, meaning that individuals will not produce viable seeds without cross pollinating with other individuals (Baldwin, in litt. 2001) (USFWS, 2014).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Coastal prairies and grasslands (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Periodic fire (USFWS, 2014)

Geographic or Habitat Restraints or Barriers

Adult: 10 - 220 m elevation (NatureServe, 2015)

Environmental Specificity

Adult: Moderate (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits coastal prairies and grasslands, often with clay or sandy-clay soils, at 10 - 220 m elevation. Most frequent associates are non-native grasses and non-native French broom (*Genista monpessulana*). The environmental specificity is moderate (generalist or community with some key requirements scarce) (NatureServe, 2015). Soils associated with coastal terrace prairies include the Watsonville, Tierra, Elkhorn, Santa Inez, and Pinto series. Physical processes, particularly soils and hydrologic processes that maintain the soil structure and hydrology that produce the seasonally saturated soils characteristic of *H. macradenia* habitat, are necessary features for the conservation of the species. Historically, coastal prairie species such as *Holocarpha macradenia* may have evolved under light grazing pressure and an intense fire regime used by California Native American groups (Heady et al. 1988). Grazing likely improves

habitat quality for *H. macradenia* by removing plant biomass cover, reducing aboveground competition during the growing season, and reducing thatch accumulations that inhibit tarplant germination. Additionally, trampling by grazers can open, roughen, and compact surface layers of soil (USFWS, 2014).

Dispersal/Migration

Dispersal

Adult: Low; possibly high if dispersed by animals (USFWS, 2014)

Dispersal/Migration Narrative

Adult: Most seeds remain on the plant until the first significant rain (0.6-1.2 inches (15–30 millimeters (mm)) in late autumn (Service 2002, Holl and Hayes 2006). Neither type of seed appears to have a structural means for dispersal, and most fall within 17.7 inches (45 cm) of the plant (Holl and Hayes 2006) though it is possible that some ray seeds may be dispersed over long distances by animals (Satterthwaite et al. 2007) (USFWS, 2014).

Population Information and Trends

Population Trends:

Decline of 50-70% (NatureServe, 2015)

Species Trends:

10 - 30% decline (NatureServe, 2015)

Resiliency:

Low to moderate (inferred from USFWS, 2014; see current range/distribution)

Redundancy:

Moderate (inferred from USFWS, 2014)

Number of Populations:

14 native, 4 - 8 experimental (USFWS, 2014)

Population Size:

Uncertain, possibly ~25,000 (NatureServe, 2015)

Adaptability:

High (inferred from NatureServe, 2015)

Population Narrative:

The plant is not terribly vulnerable intrinsically; it is a robust composite that can colonize open areas. Long term trend has been one of substantial decline; 50-70%. The short term trend has been one of steady decline (10 - 30%) due to development. It is difficult to trust some of the population data CNDDDB has received. For example, one form stated there were "millions" of plants, which seems doubtful. More solid estimates sent to the CNDDDB tend to be from the early 1990's and therefore constitute old information. These add up to about 25,000 plants

(NatureServe, 2015). *Holocarpha macradenia* occurs in 14 native and 4 to 8 experimentally seeded populations (USFWS, 2014).

Threats and Stressors

Stressor: Development (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: In Santa Cruz County, coastal prairie habitat was converted to ranching and agricultural lands in the late 1800s and early 1900s; subsequently, this habitat was favored for the expansion of urban centers, especially around the cities of Santa Cruz and Watsonville. California coastal prairies have been affected by humans to the extent that their recovery is extremely slow or even unlikely, and will require human intervention (Stromberg and Griffin 1996; Hamilton et al. 2002, as cited in Buisson et al. 2006). The Apple Hill population is located on a small Caltrans right-of-way. The population was once comprised of three colonies, two of which were extirpated by the construction of a housing development on adjacent private property. The remaining colony occurs on a strip of land between the housing development and Highway 152. The Arana Gulch population and its designated critical habitat will be subject to additional habitat alteration and destruction with the construction of a bike path proposed by the City of Santa Cruz. A portion of the habitat associated with the Watsonville Airport may be subject to additional alteration; a proposed development project would permanently impact approximately 2 acres (0.8 ha) of *Holocarpha macradenia* critical habitat within the Watsonville critical habitat area (Unit I) (Olberding Environmental 2009). The Winkle population of *Holocarpha macradenia*, also referred to as the Santa Cruz Gardens population, was partially destroyed by development in 1986 (Arnold and Lyons 2009). Further development has been proposed within a 58.6-acre (23.7-ha) project site that includes the Winkle population (USFWS, 2014).

Stressor: Nonnative plants (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Overgrowth of nonnative invasive species is a principal ongoing threat for *Holocarpha macradenia* populations. Even with management, most populations are in decline due to *H. macradenia*'s inability to compete with the overgrowth of nonnative vegetation. Invasive species that have been identified as threats to *H. macradenia* populations include but are not limited to: *Genista monspessulana* (French broom), *Foeniculum vulgare* (fennel), *Eucalyptus* spp. (*eucalyptus*); *Acacia decurrens*, *A. melanoxylon* (acacia); artichoke thistle; *Rubus discolor* (Himalayan blackberry); *Phalaris aquatica* (harding grass); *Festuca arundinacea* (tall fescue); *Cardaria draba* (hoary cress); *Carduus pycnocephala* (Italian thistle); *Picris echioides* (bristly ox-tongue); *Trifolium angustifolium* (narrow-leafed clover); *Convolvulus arvensis* (field bindweed); and *Conium maculatum* (poison hemlock) (Service 2000, Watsonville Wetlands Watch 2009) (USFWS, 2014).

Stressor: Herbivory (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: A study by Maze (2009) indicated that invertebrate herbivory on *Holocarpha macradenia* significantly affected the survivability of *H. macradenia* seedlings. Most of the herbivory observed in the study was caused by the nonnative grey garden slug (*Deroceras reticulatum*). Although results of this study indicate that herbivory could potentially be a problem for *H. macradenia*, or possibly exacerbate other threats to *H. macradenia* populations, herbivory does not appear to be a significant threat at this time (USFWS, 2014).

Stressor: Low reproductive success (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: The eight populations of *Holocarpha macradenia* in Contra Costa County are the result of 22 experimental seedlings performed from 1982 to 1986, within Wildcat Canyon Regional Park on East Bay Municipal Utility District land. The 22 experimental seedlings have been managed with invasive plant removal and a grazing regime, yet have resulted in only 8 lasting populations, with only one of these populations (Mezue) showing substantial numbers and an increasing trend over time. Additionally, of the 8 remaining populations, data show that only about half of these have had persistent numbers of aboveground plants over the past 10 years (Legard, unpubl. data 2010). Although some seeding attempts have been somewhat successful, it appears that the management, timing, location of plantings, and techniques greatly influence the results of the persistence of *Holocarpha macradenia*, and long term viability in these cases remains unclear (USFWS, 2014).

Stressor: Environmental stochasticity (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Much of the coastal prairie habitat that supports *Holocarpha macradenia* has been altered, fragmented, or destroyed, so that most of the remaining habitat is of small acreage and supports only very small populations. Because *H. macradenia* is not capable of self-fertilization, individuals cannot produce viable seeds without cross pollinating with other individuals. Small populations may have a more difficult time attracting pollinators and therefore may experience lower seed production rates, leading to reduced species viability and possible extirpation over time (Service 2000, Satterthwaite 2007). With only 14 naturally occurring populations in a limited portion of its historic range, environmental stochasticity remains a threat to *H. macradenia*, and is currently a greater threat than it was at the time of listing (USFWS, 2014).

Stressor: Climate change (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Impacts to *H. macradenia* under predicted future climate change are unclear. The potential impacts of climate change on the flora of California were discussed by Loarie et al. (2008). Based on modeling, they predicted that species' distributions will shift in response to climate change and that species will "move" to higher elevations and northward, depending on the ability of each species to do so (USFWS, 2014).

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- Coordinate a meeting with CDFW and the Elkhorn Slough Foundation, including species experts and managers of *Holocarpha macradenia* populations, to collaborate on current status of the species, successful management and census techniques, and to continue efforts toward management of the species and conservation of habitat (USFWS, 2014).
- Work with the appropriate governing agencies or landowners to continue and/or improve management for *Holocarpha macradenia* populations, and initiate programs for populations that do not currently undergo a management regime. Possibilities may include but are not limited to: At Fairway Drive, working with the County of Santa Cruz and the Homeowners Association toward more active long-term management and restoration of habitat and populations; working with the Spring Hills Golf Course to investigate possibilities to restore and manage habitat and populations on their property; at O'Neill/Tan, working with the County of Santa Cruz and private landowners toward more active long-term management and restoration of habitat and populations; at Atkinson Lane, working with PG&E toward the possibility of long-term management and restoration of habitat and populations; at Apple Hill, working with Caltrans to better manage and restore habitat and populations; and at Arana Gulch, working with the City of Santa Cruz toward more vigorous long-term management and restoration of habitat and populations (USFWS, 2014).
- Investigate opportunities for conservation of lands that support suitable habitat for the species and for future outplanting (USFWS, 2014).
- Evaluate suitable habitat for future outplanting, and investigate seeding and transplanting techniques that will lead to large, self-sustained populations (USFWS, 2014).
- Based on research already conducted by Satterthwaite et al. (2007), Bainbridge (2003, 2007), and the California Department of Parks and Recreation (Hyland, unpubl. data 2002, 2004, 2007, 2009), undertake additional research to investigate seed bank dynamics, particularly how to maintain optimal balance between aboveground populations and the seed bank (USFWS, 2014).
- Conduct research to investigate mowing, raking, grazing, and other techniques that are beneficial to *Holocarpha macradenia* and develop best management strategies, particularly for management of thatch and nonnative species, utilizing these techniques (USFWS, 2014).
- Investigate the impacts of climate change on *Holocarpha macradenia* (USFWS, 2014).

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SPECIES ACCOUNT: *Hudsonia montana* (Mountain golden heather)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/19/1980; Southeast Region (R4)

Physical Description

A low, spreading shrub, not over 3-4 dm tall, with evergreen, needle-like leaves. Bright yellow flowers bloom in June and July. (NatureServe, 2015) Stems--Numerous, decumbent-based, often rooting at lower nodes, producing abundant spur shoots, the side branches arching upward, the whole plant forming low open clumps 8-15 cm high, occasionally forming patches 8-10 dm across, most often in clumps 15-20 cm, the old shoot growth with bark a dark reddish-brown, with numerous irregular narrow cracks revealing paler inner bark, the newer shoots with epidermis more reddish, the newest growth pale reddish-brown or tan, pilose. Leaves--Alternate, ascending and overlapping in tight spirals from base to tip of shoots and spur shoots, linear, mostly 3-8 mm long, sometimes curved, greenish, firm, somewhat thickened, toward the base above somewhat concave, toward the apex thicker, the tips with a conic callus, the surfaces at first pilose, later nearly smooth. Flowers are few to several, solitary from the tips of shoots and spur shoots, on slender, erect or ascending, pilose-tomentose peduncles mostly 5-10 mm long. Flowers are bisexual, regular; calyx turbinate, mm long, the 5 sepals unequal, fused at base to a cup, the 2 longest lobes linear-subulate, the others lance-ovate, acuminate, the outer surface pilose-tomentose; petals 5, distinct, pale yellow, spreading, twice as long as the sepals; stamens distinct, smooth, up to 25, ca. 3 mm long, the anthers broadly ellipsoidal, ca. 0.3 mm long. Ovary superior, 3-carpellate, pilose. Fruits are capsule ovoid, ca. 3 mm long, pilose to base, splitting into 3 firm valves, 1 with the persistent elongate style; seeds few, usually 2-3, asymmetrically oblong-ellipsoidal or ovoid, ca. 1 mm long, the surface covered low, papillose, gray-white bumps. (USFWS, 1983)

Taxonomy

Mountain golden heather was described by Nuttall (1818) in 1816 as *Hudsonia montana*. In 1972, Skag and Nickerson proposed that it be treated as a subspecies of *Hudsonia ericoides* (*Hudsonia ericoides* ssp. *montana*). This treatment was followed by the Smithsonian Institution in their 1975 report to the Congress and by subsequent Federal Register publications. Various authors however, have continued to recognize the taxon as a distinct species and morphological, cytological, and population studies confirm the distinctness of *Hudsonia montana* from *Hudsonia ericoides* (Morse, 1979). (USFWS, 1983)

Historical Range

See current range/distribution.

Current Range

Very narrow endemic, known from only two adjacent North Carolina counties; east rim of Linville Gorge, within 8 km. of Table Rock Mountain, and 2 pops. about 20 miles distant from Linville Gorge. (NatureServe, 2015)

Critical Habitat Designated

Yes; 11/19/1980.

Legal Description

On October 20, 1980, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective November 19, 1980) for *Hudsonia montana* (Mountain golden heather) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in North Carolina (USFWS, 1980).

Critical Habitat Designation

The critical habitat designation for *Hudsonia montana* includes one CHU in Burke County, North Carolina. This species critical habitat encompasses approximately 1,085 acres (ac) (438 hectares (ha)). A description is provided below; a map depicting the critical habitat area is available in the Final Rule (USFWS, 1980).

North Carolina: Burke County; the area bounded by the following: on the west by the 2200' contour; on the east by the Linville Gorge Wilderness Boundary north from the intersection of the 2200' contour and the Shortoff Mountain Trail to where it intersects the 3400' contour at "The chimneys"-then following the 3400' contour north until it reintersects the Wilderness Boundary-then following the Wilderness Boundary again northward until it intersects the 3200' contour extending west from its intersection with the Wilderness Boundary until it begins to turn south-at this point the Boundary extends due east until it intersects the 2200' contour.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Hudsonia montana* critical habitat are not defined (45 FR 69360-69393).

Special Management Considerations or Protections

Any activity which would result in increased trampling or disturbance. of the fragile areas where *Hudsonia montana* occurs would adversely modify the Critical Habitat. The long-term solution for best protecting *Hudsonia montana* may be to greatly reduce the human traffic in the immediate areas where this plant occurs. In this respect, Critical Habitat designation may affect Federal activities as this may require prohibiting the development of new trails in areas where the plant occurs, relocating old trails, or other steps by the Forest Service. (USFWS, 1980)

Life History**Food/Nutrient Resources****Breeding Season**

Adult: The plant flowers in late May, on warmer, sunnier sites. Each bud produces one flower, which lasts for approximately eight hours—from early morning to late afternoon. All flower parts are persistent except the petals, which wither and shed as the evening approaches, unless the closing sepals trap them. The peak bloom is reached the first full week of June, with only scattered flowers appearing through June. Rarely will a flower be seen in July (USFWS, 1983).

Reproduction Narrative

Adult: According to Pharr (in prep.), the vegetative phenophase of mountain golden heather begins in May when the small, dull-green leaves appear in tufts. One season's vegetative growth ranges from 1 cm on a small plant to 11 cm on a healthy mature plant. Flowering stems produce

little vegetative growth. In October the leaves begin to yellow then brown. Dead brown leaves persist, appressed and scale like, on the other branches. The plant flowers in late May, on warmer, sunnier sites. Each bud produces one flower, which lasts for approximately eight hours—from early morning to late afternoon. All flower parts are persistent except the petals, which wither and shed as the evening approaches, unless the closing sepals trap them. The peak bloom is reached the first full week of June, with only scattered flowers appearing through June. Rarely will a flower be seen in July. Similar in structure to other *Hudsonia* species, the flowers are self-compatible and may self-pollinate in the late afternoon as the flower closes, forcing the anthers to loose their pollen against the pistil. The plants have a well-formed pollen suggesting sexual rather than asexual reproduction. Pharr further stated that the fruiting phenophase occurs from late June through July. Morse, according to Pharr, has germinated a few seeds collected in July 1979. Pharr also noted that by early August few capsules remain intact and unopened. Seedlings have been found at some sites. (Morse, 1979; Pharr, in prep) (USFWS, 1983).

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Shallow soils that form over quartzite or mica gneiss rock ledges. Usually in the sparsely vegetated ecotone between bare rock and heath bald (NatureServe, 2015). Species is a specialist that inhabits a very narrow range (NatureServe, 2015). This habitat specificity infers that the species requires high ecological integrity of the community and site fidelity and has low tolerance range.

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Stable (USFWS, 2012)

Number of Populations:

1 - 20 (NatureServe, 2015)

Population Size:

1000 - 10,000 individuals (NatureServe, 2015)

Population Narrative:

Species suffers from recreational use of habitat; brittle stems break under foot, and plants have been scorched by campfires. Difficult to determine because of its growth habit (spreading); adjacent clumps may have originated by clonal spread from a single individual. Reproduction by seed known in the wild. Known from a few nearby populations in one small area, plus two other populations in an adjacent county (NatureServe, 2015). The low number of populations and specific habitat requirements infers low resiliency, representation and redundancy of the species. USFWS (2012) notes that the 5 known populations are relatively stable.

Threats and Stressors

Stressor: Fire suppression (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Fire suppression is a primary threat to this species, because it facilitates competition from other woody vegetation and suppresses seedling recruitment (e.g., Frost et al., 1995) (USFWS, 2012).

Stressor: Recreational activities (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of individual plants

Narrative: Trampling from recreational users is listed as a threat to this species. Paradoxically, recreational impacts (from campers) serve to slow further vegetation succession and occasionally expose mineral soils in these fire suppressed areas, thereby resulting in impacts to established plants while simultaneously facilitating seedling recruitment (Frost, pers. Comm., 2007) (USFWS, 2012).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2012).

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The North Carolina Plant Conservation and Protection Act (NC State Code Article 19B, 106-202.12) provides limited protection from unauthorized collection and trade of plants listed under that statute. However, this statute does not protect the species or its habitat from destruction in conjunction with development projects or otherwise legal activities. There are no federal or state statutes that afforded significant protections to *H. montana*. Therefore, inadequacy of existing regulatory mechanisms continues to threaten this species (USFWS, 2012).

Recovery

Delisting Criteria:

1. The five known populations are maintained as current levels or above and are self-sustaining (USFWS, 2012).
2. Species biology and site dynamics are sufficiently understood to assure effective long-term management strategy (USFWS, 2012).

3. Species biology and site dynamics are sufficiently understood to assure effective long-term management strategy (USFWS, 2012).

4. The species and its habitat are protected from present and foreseeable human-related and natural threats that may interfere with the survival of any of the populations (USFWS, 2012).

Recovery Actions:

- The known populations have been relatively stable over time, though only through active land management (USFWS, 2012).
- Although we have learned a large amount of information about the species' biology and site dynamics so far, there are still many unknowns (e.g. water requirements and shade management) (USFWS, 2012).
- More time and management work is required prior to deciding if the policies are effective (USFWS, 2012).
- *Hudsonia montana* and its habitat are not protected from human-related activities and natural threats. The USFS is unable to perform controlled burns within the habitat that is home to the largest populations of the species due to the proximity of housing developments. The destruction of habitat due to recreation has not been completely eliminated even when trails and camping sites are closed to the public. The possible effects of climate change on this species are currently unknown, so it is not clear if protection can be provided to *H. montana* if climate change were to become a threat in the future (USFWS, 2012).

Conservation Measures and Best Management Practices:

- Monitor effects from the 2012 prescribed burn on Woods Mountain (USFWS, 2012).
- Begin a physical removal of duff layer on Woods Mountain and restore *H. montana* for future introduction into restored area (USFWS, 2012).
- Prepare and finalize individual fire-use and prescribed burns plans for each of the individual populations of the species (USFWS, 2012).
- Resume prescribed burns in Linville Gorge, with emphasis upon those populations with the longest lapse in burning (USFWS, 2012).
- Repeat census of all known populations (USFWS, 2012).
- Perform research to examine *H. montana* water requirements and shade tolerance (USFWS, 2012).
- Establish a system of interagency cross-checks to ensure that necessary actions are completed each year until restoration efforts are complete and required management is reduced to routine management (USFWS, 2012).
- Obtain low altitude, high resolution aerial (or satellite) imagery sufficient for delineation of currently occupied and restorable habitat. Use this imagery set to set measurable goals for future habitat restoration efforts (USFWS, 2012).
- Digitize photos from long-term photo monitoring project, or a subset of these, with the intent of examining changes in spatial extent (and seedling recruitment) under varying management regimes (e.g. burning) and threat abatement strategies (e.g. closures) (USFWS, 2012).
- Revise recovery criteria and/or the species recovery plan (USFWS, 2012).
- Work with the USFS to continue censusing populations every five years. Work with the USFS and support efforts to complete an EA for control of exotic, invasive species across all Wilderness areas, including the LGW. Work with and support the USFS, Wild South, and other CFLRP partners, to continue exotic, invasive species inventory and management projects at the LOW. Work with and

support the USFS, Wild South, and other CFLRP partners to quantify visitor use and identify visitor use patterns to prioritize management that would help minimize recreational impacts at the LGW. Coordinate with the USFS and an appropriate botanical garden to collect and bank seeds. Highest priority sites should be those with only one EO, adjacent to a trail, and no prior seed collection (Table Rock and Chimney Gap). Work with the USFS and support efforts to complete an EA for prescribed burning in occupied mountain golden heather habitat or all fire-adapted habitats within the LGW. (USFWS, 2019)

- Attempt to reintroduce the species to the southern end of Table Rock using seeds collected from elsewhere within the Table Rock population, or other sites within Linville forge. (USFWS, 2012)

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SPECIES ACCOUNT: *Hymenoxys herbacea* (Lakeside daisy)

Species Taxonomic and Listing Information

Listing Status: Threatened; 06/23/1988; Great Lakes-Big Rivers Region (R3) (USFWS, 2015)

Physical Description

The Lakeside daisy is a perennial herb with flowering stalks, 5-25 cm tall, arising from basal tufts of leaves. When the plants are not in bloom, the small tufts of leaves are easily overlooked, but in bloom (late April-June, or July in Canada) the plants are extremely showy, with populations simultaneously producing masses of large (3-4 cm in diameter) yellow flower heads. (NatureServe, 2015)

Taxonomy

The species was listed as *Hymenoxys acaulis* var. *glabra* (USFWS, 1988) and is treated that way in most floras. Based upon the work of Cusick (1991), who noted chromosomal, reproductive, and physical differences between the Lakeside daisy and the original nominate species, the Fish and Wildlife Service recognized the Lakeside daisy as a separate species, *Hymenoxys herbacea*. More recent treatment is *Tetranneuris herbacea* (USFWS, 2016).

Historical Range

At the time of listing, the Lakeside daisy was known from only one fragmented population in the U.S., in Ottawa County, Ohio and from two regions in Ontario, Canada. It was presumed extirpated in Will and Tazewell, County Illinois (USFWS, 2016).

Current Range

Currently, the Lakeside daisy is known from sites in Ohio, Illinois, Michigan, and Ontario. It is extant on the Marblehead Peninsula of Ottawa Co., Ohio and in Ontario, Canada on Manitoulin Island and the Bruce Peninsula. The largest populations are in Ontario. Additionally, three introduced populations that are likely not functioning as an ecological community, have been transplanted into appropriate habitat in Erie County, Ohio and in DuPage and Cook County, Illinois. Sites presumed extirpated in Will and Tazewell County, Illinois are now identified as restored populations. The population in Michigan occurs in Brevort Township, Mackinac County (USFWS, 2016).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Obligate outcrosser (self-incompatible), but also reproduces clonally. (NatureServe, 2015)

Lifespan

Adult: Unknown, possibly decades (USFWS, 1990)

Breeding Season

Adult: Flowers late April to early June (USFWS, 1990)

Reproduction Narrative

Adult: The Lakeside daisy is a perennial that flowers from late April to early June. Although locally variable, an average of 75% of the adult plant population in any given area is in flower during this time. Under optimal greenhouse conditions, plants grown from seed can achieve reproductive size within seven months; in natural populations it may take two to three years (DeMauro 1990). Buds are visible by early spring at the rosette center. Flowers are visited by bumble bees (Dr. R. Betz, pers. obs.), small carpenter and halictid bees (R. Panzer, Northeastern Illinois University, pers. obs.), and the pearl crescent butterfly (USFWS, 2016). It is possible that pollination is also achieved by wind. Outcrossing is necessary for seed production because Lakeside daisy exhibits sporophytic incompatibility within a clone (DeMauro 1988a). In natural populations, seed production averages 49 seeds per inflorescence (DeMauro 1988a). The number of inflorescences/plant is positively correlated with plant size and although highly variable, the two are positively correlated (DeMauro 1988a). Achenes develop quickly and are wind-dispersed three to four weeks following fertilization. In natural populations, spring and fall seed germination have been observed (DeMauro pers. obs.). Under optimal artificial storage conditions, seeds can remain viable for at least three years (DeMauro unpub. data); in natural populations, it is not known how long seeds remain viable or if there is a seed bank. Although the longevity of clonal colonies is not known, plants can grow up to one meter in diameter; under field conditions it may take on the order of decades to achieve this size. (USFWS, 1990)

Habitat Type

Adult: Alvar habitat (flat limestone or dolostone bedrock with thin to no soil, few to no trees, and subject to seasonal drought) and modified alvar habitat where original habitat has been modified or removed by quarrying activities and is in the form of gravel (USFWS, 2016).

Habitat Vegetation or Surface Water Classification

Adult: Limestone or dolomite outcrops (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Thin soils over limestone or dolomite outcrops or soils (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (inferred from USFWS, 1990)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Site Fidelity

Adult: High (USFWS, 1990)

Habitat Narrative

Adult: The Lakeside daisy requires full sun and occurs on limestone or dolomite outcrops, on thin soils over dolomite or limestone, and on dry limestone prairie soils. It may also occur in openings of forests. It is almost exclusively found on such soils or on bare rocks. Typically, the

plains are sandy or gravelly with rocks up to one inch in size or larger. An active quarry with the open, gravelly, limestone habitat has one of the best populations of the daisy. (USFWS, 1990)

Dispersal/Migration**Motility/Mobility**

Adult: Limited (inferred from USFWS, 1990)

Dispersal

Adult: Low (inferred from USFWS, 1990)

Dispersal/Migration Narrative

Adult: Achenes develop quickly and are wind-dispersed three to four weeks following fertilization, typically in early to mid-June. It is not known how far seeds disperse, however the greatest numbers of seedlings appear within one-half meter of adult plants (DeMauro pers. obs.). (USFWS, 1990)

Population Information and Trends**Population Trends:**

Stable to declining (USFWS, 2016)

Species Trends:

Stable to declining (USFWS, 2016)

Resiliency:

Low (inferred from NatureServe, 2015)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

6 - 20 (NatureServe, 2015)

Population Size:

200 - 1,000,000 individuals (USFWS, 2016)

Minimum Viable Population Size:

Minimum of 5,000 individuals is necessary to maintain the balance between mutation and genetic drift; fewer than 50 individuals will result in loss of self-incompatibility alleles (USFWS, 2016)

Adaptability:

Low (NatureServe, 2015)

Population Narrative:

The species is locally abundant in good stands. There are extensive, probably millions of clumps, but the number of clonal colonies is unknown and probably far fewer. Overall, the population size is difficult to determine. Naturally occurring populations are known from two sites on Marblehead Peninsula in Ottawa County, Ohio (Lafarge Quarry and Lakeside Daisy State Nature Preserve) and Manitoulin Island and Bruce Peninsula in Ontario, Canada where 24 extant or more localities are known (Ontario CDC, 3/94). The size of the population within the Lafarge Quarry is estimated to be 10.05 million (5.78 juvenile plants and 4.27 adult plants) individuals as of 2015 but 3 million of the adult plants occur in an area planned for imminent mining in the next 3-5 years. The size of the population on the Lakeside Daisy State Nature Preserve is estimated to be 1.4-1.7 million. An introduced population occurs on Kelleys Island in Erie County, Ohio in 1989 that contained over 18,800 adult plants in 2014 and is increasing. Populations in Illinois were presumed extirpated from Will and Tazewell Counties but they have been identified as restored populations although continue to decline with the population in Will County containing less than 200 plants. Introduced populations also exist in DuPage and Cook Counties, Illinois with varying numbers from 64 to over 400 individuals surveyed in recent years. A population was discovered at a single Michigan site in Brevort Township, Mackinac County and is located on lands managed by Hiawath National Forest and the Michigan Nature Association with less than 200 plants. An additional reserve population was established by the Michigan Nature Association and planted in 2010. These populations occur on a variety of private and federally-owned lands with different levels of protection (USFWS, 2016).

Threats and Stressors

Stressor: Habitat destruction (USFWS, 2010; 2016)

Exposure:

Response:

Consequence:

Narrative: The limestone or dolomite outcrops on which the daisy occurs are subject to commercial quarrying. Cottage and industrial development may eliminate habitat, while trampling and soil compaction can result from grazing or recreational activities and may impair habitat (NatureServe, 2015). Quarry operations have increased in recent years and have impacted a significant amount of occupied habitat and no additional habitat has been protected nor can alvar habitat be created. A survey conducted in 2015 shows that occupied habitat within the quarry has declined from 400-450 acres to approximately 92.552 acres mostly due to quarry activity. ATV use can destroy plants or habitat, or lead to the introduction of invasive species. Road and powerline right-of-way maintenance including herbicide spraying and snow plowing, may also adversely impact habitat. (USFWS, 2010; 2016)

Stressor: Succession (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The species requires an open, sunny habitat. Successional growth around forest openings and at the edges may eliminate the open requirement. In some cases, past maintenance of rights-of-way has kept habitat open and needs to continue without herbicide spraying to benefit the species. (USFWS, 2010)

Stressor: Inadequacy of existing regulations (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Although laws and regulations exist to protect the Lakeside daisy on most public sites, enforcement is lacking and destruction is still occurring. On private land, the Lakeside daisy is not afforded protection, and some populations are being seriously impacted by quarrying activities. (USFWS, 2010)

Stressor: Self-incompatibility (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The self-incompatibility of the Lakeside daisy requires outcrossing between individuals with different self-incompatibility genes. Populations within larger regions, such as those on Marblehead Peninsula and Manitoulin Island, are likely in contact with many individuals that each has a different self-incompatibility gene. However, small populations tend to lose self-incompatibility genes, increasing the probability of nearby plants sharing the same gene, and therefore reducing the potential to effectively outcross. It is theorized that this may have been a leading factor in the natural disappearance of one of the last Lakeside daisy populations in Illinois (DeMauro 1982). (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Climate change may be a serious threat for a rare, endemic plant species like the Lakeside daisy. The habitat for the Lakeside daisy currently spans a narrow range of habitat types, including dry, limestone prairies and alvar communities, which are globally rare. According to regional precipitation and temperature models, increased temperatures and increased rainfall may alter the habitat for the Lakeside daisy in such a way that the plant cannot adapt or invasive plants may encroach (Union of Concerned Scientists 2009). It is not known how the Lakeside daisy will be impacted by temperature or precipitation increases, but lowered lake levels caused by increased temperature will further alter the climate (Easterling and Karl 2000). (USFWS, 2010)

Recovery

Delisting Criteria:

- 1) 475 acres of essential habitat containing the population center at the Marblehead Quarry, Ottawa County, Ohio are acquired and managed. (USFWS, 1990)
- 2) 465 acres of additional essential habitat at the Marblehead Quarry is protected through easements, restrictive covenants or leases. (USFWS, 1990)
- 3) The variety is restored to a minimum of one large, stable population in each of two geographically distinct, protected sites of suitable size within the variety's historic range in Illinois. (USFWS, 1990)

4) Restored populations are maintained for fifteen consecutive years, with monitoring to continue for an additional ten years. (USFWS, 1990)

Recovery Actions:

- Provide adequate habitat protection for the only large, naturally-occurring population in the United States, i.e. Marblehead Peninsula, through the purchase or establishment of conservation easements of suitable modified alvar habitat from Lafarge. (USFWS, 2016)
- Coordinate monitoring among all three states where this species currently occurs so that information is consistent and meaningful. (USFWS, 2016)
- Provide necessary management at all protected sites, including removing non-native invasive species and woody encroachment, deterring herbivory, limiting ATV access, and reducing competition. (USFWS, 2016)
- Continue to augment introduced Lakeside daisy populations on suitable sites within the species' historical range. (USFWS, 2016)
- Revise recovery criteria to include new data prior to next 5-year review. (USFWS, 2016)
- Continue to monitor populations of Lakeside daisy, both natural and introduced, for reproductive output, recruitment, individual plant growth, and survival. (USFWS, 2016)
- Cooperatively work with Lafarge Quarry to collect seed and transplant individuals from the areas of the quarry that are at greatest threat of being quarried and have the highest genetic and habitat diversity. (USFWS, 2016)
- Cooperatively work with the ODNR Division of Mineral Resources Management to amend the Lafarge Quarry mining permit so that undisturbed areas can be recolonized by Lakeside daisy, instead of being planted with other species and creating significant competition. (USFWS, 2016)
- Increase gene pools and population numbers in restored population sites by seeding and transplanting individuals from various locations within natural populations. (USFWS, 2016)
- Improve awareness to the public about the harm of collecting federally listed plant species and the importance of protecting and maintaining unique ecosystems, such as alvars, for recovery of plant species. (USFWS, 2016)
- Botanical and geological surveys should be performed throughout Ohio, Indiana, Illinois, Michigan, and Wisconsin to assess the potential for suitable habitat of Lakeside daisy introduction. (USFWS, 2016)
- Further research into the origin of the Michigan populations to guide future recovery actions. (USFWS, 2016)

Conservation Measures and Best Management Practices:

- Revise recovery criteria to include new data prior to next 5-year review. (USFWS, 2010)
- Provide adequate habitat protection for the only large, naturally-occurring population in the United States, i.e. Marblehead Peninsula, through the purchase or establishment of conservation easements of abandoned quarry property. (USFWS, 2010)
- Cooperatively work with Lafarge Quarry to protect areas of the quarry that are least likely to be quarried and have the highest genetic and habitat diversity. (USFWS, 2010)
- Determine the presence or absence of seed banks and the duration of seed viability. (USFWS, 2010)
- Establish Lakeside daisy populations on suitable sites within the species historical range. (USFWS, 2010)

- Botanical and geological surveys should be performed throughout Ohio, Indiana, Illinois, Michigan, and Wisconsin to assess the potential for suitable habitat of Lakeside daisy introduction. (USFWS, 2010)
- Continue to monitor populations of Lakeside daisy, both natural and introduced, for reproductive output, recruitment, individual plant growth, and survival. (USFWS, 2010)
- Increase gene pools and population numbers in restored population sites by seeding and transplanting individuals from various locations within natural populations. (USFWS, 2010)
- Provide necessary management at all protected sites, including removing non-native invasive species and woody encroachment, deterring herbivory, limiting ATV access and prescribed burning (in Illinois only). (USFWS, 2010)
- Conduct genetic research using highly polymorphic genetic loci to determine the genetic distance of natural populations and determine the viability of small, introduced populations. (USFWS, 2010)
- Inform the public about the harm of collecting federally listed plant species and the importance of unique ecosystems. (USFWS, 2010)

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SPECIES ACCOUNT: *Hymenoxys texana* (Texas prairie dawn-flower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/13/1986; Southwest Region (Region 2) (USFWS, 2016)

Physical Description

An annual plant 3.5—18 cm (1.4—7.1 in.) high with several divergent branches arising from a rosette of basal leaves. Basal leaves 1—16 mm (.04—59 in.) wide, up to 4 cm (1.6 in.) long, widest toward the tip, margins with short teeth or lobes from mid—blade to tip. Stem leaves few, linear. Flower heads usually few, small. Bracts of flower heads in two series 5—6 mm (.16—.20 in.) long. Ray flowers minute and concealed by the bracts. Disk flowers yellow, 3—4 mm (.12—.16 in.) long. Fruits about 2 mm (.08 in.) long with 5 apical scales 1—2 mm (.04—.08 in.) long (USFWS, 1989).

Taxonomy

Coulter and Rose (1891) described these plants as a new species and placed them in the genus *Actinella*. Greene (1898) separated the *Actinella* taxa with free phyllaries into the genus *Tetranuris* and placed those with united outer phyllaries into the genus *Picradenia*. Thus, *Hymenoxys texana* became *Picradenia texana* (Coulter & Rose) Greene. Cockrell (1904) recognized *Tetranuris* as a distinct genus but could not separate the North American *Picradenia* species from the genus *Hymenoxys* of South America. He, therefore, united *Picradenia* with *Hymenoxys* and transferred *Hymenoxys texana* into its present genus. The only specimens available to these early workers were the Thunberg collections of 1889 and 1890. *Hymenoxys texana* was not collected again until 1981 when James Kessler discovered a few small populations north of Cypress in Harris County (Mahler 1982 and 1983). The relationship of *Hymenoxys texana* to four annual temperate South American species of *Hymenoxys* has yet to be thoroughly investigated. Three of these South American taxa lack ray flowers and perhaps one or more of them is the near relative of *Hymenoxys texana*, which has minute rays. A taxonomic treatment of the South American taxa is available (Parker 1962), and Sanderson (1973) reported the basic chromosome number of $n = 15$ for all four South American species. The North American *Hymenoxys* most similar to *Hymenoxys texana* is the annual species, *Hymenoxys odorata*, but the prominent long ray flowers and the deeply pinnately divided leaves of *Hymenoxys odorata* easily distinguish it from *Hymenoxys texana*. (USFWS, 1989)

Historical Range

Up until about 1992, *H. texana* was known only from the northwest portion of Houston with only one population located in Fort Bend County (Barker Reservoir), with subsequent populations located in Addicks Reservoir in Harris County (USFWS, 2015).

Current Range

This species is now confirmed in five counties in Texas: Fort Bend, Gregg, Harris, Trinity, and Waller. (USFWS, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources**Lifespan**

Adult: 1 year (USFWS, 2015)

Breeding Season

Adult: March to April (USFWS, 2015)

Reproduction Narrative

Adult: *H. texana* is an annual plant that flowers from early March through mid to late April and produces yellow, cone-shaped seed heads. (USFWS, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Grassland/herbaceous, barrens, pimple mounds (USFWS, 2015; NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found in poorly drained, sparsely vegetated areas (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Patches (USFWS, 2015)

Environmental Specificity

Adult: Moderate, with some key requirements (USFWS, 2015)

Habitat Narrative

Adult: *H. texana* is found in small, conspicuous, sparsely vegetated areas of fine, sandy, and compact soils. These bare spots are often located on the lower sloping portions of pimple mounds (USFWS 1990). Pimple mounds are low, roughly circular or elliptical domes or shield-like mounds, often with flat tops, composed of unstratified sandy loam soils coarser than, and distinct from, the surrounding less coarse, often clayey soil. Pimple mounds range from 1 to 30 m in diameter, and attain heights from about 10 cm to over 2 m (Johnson and Horwath Burnham 2012). *H. texana* thrives in disturbed, open areas with barren slicks made up of a select few soils, and where specific hydrological requirements can be met. Common soil series associated with *H. texana* consist of primarily Gessner Complex (Ge) and Katy Find Sandy Loam (Ka or Kf). Soils are slightly saline, sticky when wet and powdery when dry. Sometimes associated with other Texas Gulf Coastal Plain endemics such as Texas windmill-grass (*Chloris texensis*) and Houston machaeranthera (*Machaeranthera aurea*). A recent description of *H. texana* describes the species as found in localized patches ranging from 2 to 3 m in size or as large as 100 square meters usually associated with Gessner and Katy fine sandy loam soils which sometimes are located at the base of pimple mounds (Smeins 2014). (USFWS, 2015; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Number of Populations:

~40 - 50 populations; exact number unclear (USFWS, 2015)

Population Size:

~50,000 in one location surveyed in 2012; population unknown at other sites (USFWS, 2015)

Population Narrative:

While there are 63 known occurrences of *H. texana* in the TxNDD (TPWD 2014) this can not be interpreted to mean that 63 distinct populations exist. Although nearly 50 populations are known for this species, almost all are threatened by development from the expanding city of Houston. Some sites have been destroyed within a year of their discovery. In 2012, a Gregg county landowner first identified *H. texana* on 187 ac (75.7 ha) where surveys found the largest *H. texana* population with estimates greater than 50,000 individuals. (USFWS, 2015)

Threats and Stressors

Stressor: Habitat loss and alteration (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Habitat conversion, fragmentation, and degradation continue to be a threat. Expanding urbanization, paved roadways, feral hogs, alteration of watershed drainages, development of natural resources, and agricultural development contribute to the continued loss of suitable habitat. Heavy grazing and in some cases illegal grazing practices can be detrimental to *H. texana* and may even prevent the species from recruiting. Although efforts to restore, create, and effectively manage habitat for the *H. texana* are currently underway, suitable habitat continues to be degraded or lost within this species range. Considerable increases in overstory vegetation are visible in aerial photography over a majority of the current species' range. This increase in canopy cover results in significant declines in some *H. texana* populations (e.g. Addicks and Barker Reservoirs) where thousands of individual plants once thrived at numerous sites. Due to limited habitat management at Addicks and Barker Reservoir, there is a significant decline in the number of suitable sites with *H. texana* present at this location and as a result, individual plant numbers have declined as well. Management practices such as mowing (with certain restrictions) do not seem to harm *H. texana*, and in some instances, promote its existence. However, deep soil disturbances such as plowing and feral hog wallowing can be detrimental to its existence. Many of the current sites are not adequately fenced and are subjected to feral hog and cattle grazing. Managed grazing and installing fence panels aimed at excluding feral hogs will greatly benefit *H. texana* (USFWS, 2015).

Stressor: Drought (USFWS, 2015)

Exposure:**Response:****Consequence:**

Narrative: The distribution of *H. texana* appears to be naturally restricted as a result of the specific habitat and soil requirements. However, persistent drought conditions can cause the plant to remain dormant and produce smaller, less robust plants with fewer seed heads. The drought of 2011 was especially hard on *H. texana* as evidenced by the reduced number of mature plants. Cool and wet winter weather seems to be conducive to early spring growth and maturation. (USFWS, 2015)

Stressor: Competition (USFWS, 2015)

Exposure:**Response:****Consequence:**

Narrative: Competition from woody vegetation, such as Chinese tallow *Triadica sebifera* (an invasive exotic), yaupon *Ilex vomitoria* (native), and other native trees and grasses (at the ground and canopy layers), remains a large threat to the species. In areas where there is no on-the-ground management, the potential for loss is great as the woody vegetation continues to encroach creating a canopy cover that essentially allows other species to outcompete *H. texana*. The USFWS continues to work with other state and local partners to develop management guidelines to enhancing *H. texana* habitat. (USFWS, 2015)

Stressor: Climate change (USFWS, 2015)

Exposure:**Response:****Consequence:**

Narrative: Our analyses under the Act include consideration of ongoing and projected changes in climate. The terms “climate” and “climate change” are defined by the Intergovernmental Panel on Climate Change (IPCC). “Climate” refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2012). The term “climate change” thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2012). Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative and they may change over time, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables (e.g., habitat fragmentation). Winter and spring field observations indicate in years where drought conditions are prevalent, *H. texana* plants tend to respond with fewer, less robust individuals, and fewer seed heads. Conversely, in years where rainfall exceeds normal levels and plants may be inundated for extended periods of time, *H. texana* respond with fewer and less robust plants with yellowish leaves. Therefore, while it appears reasonable to assume that *H. texana* may be affected by the intense climate swings forecasted, and climate change should be considered a threat, the Service lacks sufficient certainty to know how climate change specifically will affect this plant. (USFWS, 2015)

Recovery

Reclassification Criteria:

Hymenoxys texana can be downlisted to threatened when: (USFWS, 1989).

(1) at least 50 separate populations, each occupying at least 1 hectare (2.47 acres) of suitable habitat, are discovered or established (USFWS, 1989)

(2) when at least 50 populations are protected from land use practices or land use changes that could destroy the populations (USFWS, 1989)

Delisting Criteria:

Hymenoxys texana can be removed from the threatened and endangered species list when management practices are developed and implemented which ensure the numbers of plants at protected populations remain stable. (USFWS, 1989)

Recovery Actions:

- Protect *Hymenoxys texana* and its habitat from existing and future threats. Contact private landowners and Federal agency personnel. Work with the landowners and agency personnel to implement management practices that will protect the species. Establish protected sites on both private and public lands. Develop and implement a long range management plan. Enforce applicable Federal and State laws and regulations. Monitor populations. Alter management plans, if necessary, to reflect improvement or deterioration of populations (USFWS, 1989).
- Gather information on the natural history of *Hymenoxys texana* for use in management. Determine habitat requirements, including edaphic factors, dependence on natural phenomena and cultural practices, local microclimate, and air and water quality. Determine associated species, vegetation types, and community structure. Record associated vegetation, frequency, density, and dominance. Determine frequently associated species. Determine if the bare soil at *Hymenoxys texana* sites represents an edaphic climax. Study population biology, including demography, phenology, reproductive biology (types of reproduction, pollination biology, seed dispersal and biology, seeding biology). Study community ecology, beneficial and neutral effects of other species, and negative effects of other species (USFWS, 1989).
- Update management plans as new data accumulates (USFWS, 1989).
- Search for new sites and populations (USFWS, 1989).
- Establish a botanical garden population and, if needed, attempt to establish populations in suitable natural habitat. Develop and refine propagation techniques. Establish a self-sustaining botanical garden population. Search for suitable reintroduction sites (USFWS, 1989).
- Develop public awareness, an appreciation, and support for the preservation and study of *Hymenoxys texana* (USFWS, 1989).
- The USFWS recommends the following actions be taken for the conservation of *H. texana*: - Reevaluate the 1990 Recovery Plan to reflect new species information including associated species lists, species range, survey methodologies, and soil findings in partnership with local land managers, botanists, and federal and state resource agency staff. - Develop protocol to delineate and define "populations" for downlisting or delisting this species. - Develop a central database to house all pertinent site population information. - Continue to monitor and survey known populations while searching for additional populations. - Update

- associated species list as necessary. - Implement section 6-funded projects, USFWS Partners for Fish and Wildlife program projects, and cooperative agreements with state and federal agencies. - Continue to search for additional populations. - Acquire new landowner conservation agreements with interested parties when appropriate. - Continue to support conservation and recovery awareness efforts through public and landowner outreach. - Redefine the range of *H. texana* through strategic GIS mapping efforts. *H. texana* is now more broadly distributed than originally thought, soil characteristics may be different at various locations, and associated species may vary at the different locations across the range. - Standardize surveying and monitoring protocols to provide consistent population data. If a new site is found, include soils analysis, associated species, genetic analysis, hydrological conditions, location, identify any threats, and note any pollinators present. - Yearly survey and monitoring data should be deposited with the TxNDD to facilitate accurate and up-to-date species specific information. (USFWS, 2015)
- Research Needs for the continued existence of *H. texana* - Assess and quantify predator threats (terrestrial mammals and/or insects). - Soil analysis at each identified site. - Analyze and quantify the role of pollinators at *H. texana* sites. - Complete a thorough habitat range assessment using GIS analysis due to the increased range spanning five counties. - Conduct further research regarding alternative propagation techniques. - Complete additional studies to optimize frozen storage techniques for *H. texana*. - Identify propagation and relocation strategies for successful plug and seed transplant to suitable sites within the species range. - Identify the mechanism and/or agents of dispersal, dispersal patterns, and the effects of disturbance on dispersal. - Include genetic analysis for all sites to determine any genetic variability within sites. (USFWS, 2015)

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SPECIES ACCOUNT: *Hypericum cumulicola* (Highlands scrub hypericum)

Species Taxonomic and Listing Information

Listing Status: Endangered; 2/20/1987; Southeast Region (R4)

Physical Description

Hypericum cumulicola is a small, short-lived perennial herb reaching 20 to 70 cm in height. It is branched from the base and has a woody, fibrous root system. The stems are shorter and more numerous in winter and spring before reproductive stalks are differentiated. Usually there are three stems, but there can be as many as 17 stems on a healthy plant (Quintana-Ascencio and Morales-Hernández in press). During the reproductive season, all stems of mature individuals bear flowers and fruits. The leaves of *H. cumulicola* are opposite, simple, entire, and needle-like. Flowers are small, bisexual, and arranged in cymes. The calyx consists of five distinct sepals, while the corolla consists of five bright yellow petals shaped like the blades of a propeller. There are approximately 27 anthers. The gynoecium has three, sometimes four locules, and the ovary is superior with approximately 22 ovules aligned around the walls of the ovary (parietally). The style has three, sometimes four, white lobes. Fruits are small capsules, red when immature and dark purple at the time of dehiscence. Mature seeds are small and dark brown. This species, as other *Hypericum*, may contain hypericin, a promising compound with protective effect in the control of viral diseases in animals (Duke 1989) (USFWS, 1999)

Taxonomy

Hypericum is a predominantly temperate genus, and a member of the family Hypericaceae. This family is closely related to the Clusiaceae (Guttiferae), and some authorities include both groups together (Cronquist 1988). In central Florida, *H. cumulicola* is morphologically distinct from other species in its genus (Ward and Godfrey 1978). In 1924, Small first named the plant *Sanidophyllum cumulicola*. Later, Adams (1962) reassigned the species to the genus *Hypericum*, renaming it *Hypericum cumulicola*. *Hypericum cumulicola*'s closest relative in Florida is *H. gentianoides*, which is very similar morphologically, but branches repeatedly above the base versus only at the base for *H. cumulicola* (Archbold Biological Station, personal communication 1998). (USFWS, 1999)

Historical Range

See current range.

Current Range

Lake Wales Ridge in Polk and Highlands counties in Florida, from just north of Sunray, Polk County (FWS 1996) to the south end of the Lake Wales Ridge near Archbold Biological Station in Highlands County. (USFWS, 1999)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources**Reproduction Narrative**

Adult: Because Highlands scrub hypericum has many-flowered stems, a single large plant can have as many as 1,600 reproductive structures (fruits, flowers, or buds) by the end of the reproductive season (Quintana-Ascencio and Morales Hernández 1997). Flowers are exposed one at a time or in small numbers (up to eight per branch) each day. The new flowers open early in the morning and the petals curl up by noon depending on the weather. This species is self-compatible, but the flowers must be visited by pollinators to set seed (ABS 2003). The mature purple capsules remain attached to the stem after releasing seeds. Seeds do not show any obvious primary dispersal mechanism and probably are dispersed passively by gravity. “Native solitary bees (*Dialictus* spp. and *Augochloropsis* spp.) appear to be the primary pollinators. Other visitors include *Geron* sp., *Copestilius nigrum*, and *Bombus* sp. Pollinator visitation occurs at similar rates regardless of flower or plant density” (ABS 2003, citing Boyle and Menges 2001; M. Evans, personal communication in Quintana-Ascencio et al. 1998). Most flowering and fruiting occurs between June and September, coinciding with the rainy season and daily thunderstorms typical of the region. Stems dry at the end of the reproductive season and new ones sprout from the base in late winter and early spring. Germination occurs from November through June, but most seedlings germinate between December and February. Plants reach maturity in as little as a year. Highlands scrub hypericum inhabits Florida scrub vegetation on upland areas with excessively drained white sand soil (Judd 1980a). It is almost exclusively found in rosemary balds – patches of bare sand surrounding Florida rosemary within scrub vegetation. It shares these bare patches with a number of other small scrub endemic herbs, grasses, and even a few small shrubs (Christman and Judd 1990). Rosemary balds have a fire frequency from 10 to 100 years (Myers 1990) while the surrounding scrubs have higher fire return intervals. Occasionally, Highlands scrub hypericum occurs in openings in well-drained scrubby flatwoods or with turkey oak on yellow sand soil (P. Quintana-Ascencio, ABS, personal communication, 1995). Where found, it is locally common and can occur in large groups of several thousand individuals (Judd 1980a).

Habitat Type

Adult: Scrub

Habitat Narrative

Adult: Highlands scrub hypericum is one of a suite of herbs (and a few grasses) that inhabit sunny, sandy gaps between the shrubs that dominate scrub vegetation. Many of these gap-inhabiting species are endemic to the LWR. The gap size requirements of Highlands scrub hypericum appear to be intermediate between those of two other co-occurring rosemary scrub plants: snakeroot, which is restricted to large openings (Menges and Kimmich 1996); and wireweed, which is found in large and small gaps between shrubs (Hawkes and Menges 1995). Highlands scrub populations have a high degree of genetic differentiation among populations (Menges et al. 2001).

Dispersal/Migration**Population Information and Trends****Population Narrative:**

Most populations of Highlands scrub hypericum are relatively small. The median size for 34 populations was 539 individuals, and most populations were smaller than 1,000 plants (Menges et al. 1998). A population viability model (Quintana-Ascencio et al. 2003) concluded that “fire kills above-ground individuals, but seeds in the soil survive fire and form long-lived seed banks. Fire suppression and alteration of fire regimes constitute a threat for this species because of its dependence on fire to release local populations from competitive exclusion” (ABS 2003). “After fire in Florida rosemary scrub, *Hypericum cumulicola* [Highlands scrub hypericum] had higher fecundity, survival, establishment, and population growth rates than in unburned populations” (Quintana-Ascencio et al. 2003). This may be due to a number of mechanisms, including killing back of shrubs, removal of lichens, destruction of allelopathic agents that affect seed germination, and the creation of open gaps that may have higher levels of soil water (Quintana-Ascencio et al. 2003). The seed germination rate for this species is extremely low except at recently-burned sites (Quintana-Ascencio et al. 2003). The most critical life-history stage influencing Highlands scrub hypericum’s population growth rate and fitness is seed survival in the soil seed bank. The next-most-important life-history stage is seedling recruitment (Quintana-Ascencio et al. 2003). Massive recruitment of plants in favorable patches and in favorable years allows Highlands scrub hypericum populations to “increase rapidly and/or replenish the soil seed bank. Similar population explosions are documented in other short-lived perennials (Picó et al. 2002) and annual plants with a seed bank (Kalisz and McPeck 1992), which are able to cope with high or unpredictable environmental variation” (Quintana-Ascencio et al. 2003). The survival of Highlands scrub hypericum populations in fire-dependent habitats thus depends on the seed bank, while seedling recruitment is highly variable and depends on environmental cues (Picó et al. 2003). A population viability assessment model (Quintana-Ascencio et al. 2003) strongly also affirms that fire is essential for Highlands scrub hypericum to persist over the long term. Even the largest populations may be imperiled by fire intervals greater than 50 years. Smaller populations are more vulnerable to lack of fire. These authors consider fire suppression and alteration of fire regimes to constitute threats to this species “because of its dependence on fire to release local populations from competitive exclusion” (Quintana-Ascencio et al. 2003; Quintana-Ascencio and Morales Hernández 1997; Quintana-Ascencio and Menges 2000). In planning fire regimes for scrub, it is important to take into consideration the needs of multiple plant and animal species. Management that alternates short and long fire intervals may allow species to coexist, while invariant fire return intervals may harm some species (Quintana-Ascencio et al. 2003). Researchers at ABS have developed spatially explicit disturbance-demographic models of Highlands scrub hypericum. “This spatially explicit, individual-based model improves the precision of prior matrix projections that did not include Florida rosemary or spatial structure. It allows prediction of ranges of Florida rosemary densities that will allow scrub hypericum populations to persist under various fire regimes.” The model’s predictions agreed with “observed differences in scrub hypericum disappearance among gaps with contrasting rosemary densities but similar times-since-fire,” so this modeling approach is likely to prove useful in predicting the effects of fires and other disturbances, including mechanical treatments of overgrown scrub, such as roller-chopping (Quintana-Ascencio et al. 2004). Early inventories of LWR endemic plants found this species at few sites – only 69 of 254 scrub sites surveyed by Christman (1988) (ABS 2003). This severely restricted range, combined with continuing habitat loss, led to its listing. Highlands scrub hypericum is locally abundant, with populations larger than a thousand plants and presumably large seed banks in the soil at ABS, the properties of the LWRWEA (including Lake Placid, Holmes Avenue, Lake Apthorpe, and Carter Creek), Lake June-in-Winter Scrub State Park, TNC’s Saddle Blanket Lakes Preserve, and the Arbuckle tract of LWR State Forest. On these lands, Highlands scrub hypericum has

benefited from fire-oriented land management practices and insights provided by the intensive demographic research program at ABS.

Threats and Stressors

Stressor: Habitat destruction or modification

Exposure:

Response:

Consequence:

Narrative: This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 million persons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

Stressor: Lack of adequate fire management

Exposure:

Response:

Consequence:

Narrative: Fire is necessary to maintain the scrub habitats upon which this species depends. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time (Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species. (USFWS, 2019)

Stressor: Limited geographic range

Exposure:

Response:

Consequence:

Narrative: This species occurs within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have

become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

Recovery

Reclassification Criteria:

1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to ensure 20 to 90 percent probability of persistence for 100 years (USFWS, 1999)
2. When these populations, within the historic range of *H. cumulicola* are adequately protected from further habitat loss, degradation, fragmentation, and fire suppression (USFWS, 1999)
3. When these sites are managed to maintain the rosemary phase of sandpine scrub to support *H. cumulicola* (USFWS, 1999)
4. When monitoring programs demonstrate that populations of *H. cumulicola* on these sites support sufficient population sizes (USFWS, 1999)
5. When those populations are stable and distributed throughout the historic range (USFWS, 1999)
6. When *H. cumulicola* are sexually or vegetatively reproducing at sufficient rates to maintain the population (USFWS, 1999)

Delisting Criteria:

1. At least 20 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)
2. Populations (as defined in criterion 1) in rosemary scrub habitats are distributed across the known range of the species. (USFWS, 2019)
3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

Recovery Actions:

- Determine current distribution of *H. cumulicola*. This species has been relatively well-surveyed and a distribution has been ascertained. Additional surveys will confirm the species' distribution and locate new sites. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties has been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Conduct research on life history characteristics of *H. cumulicola*. Continue the study of basic biology and ecology of this species. To effectively recover this species more specific biological information is needed. (USFWS, 1999)
- Monitor existing populations of *H. cumulicola*. (USFWS, 1999)
- Provide public information about *H. cumulicola*. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private land owners be appropriately informed about this species. Care is needed, though, to avoid revealing specific locality information about where *H. cumulicola* is found. (USFWS, 1999)
- Develop delisting criteria. Once reclassification is achieved, research and monitoring results may provide data necessary to develop delisting criteria. (USFWS, 1999)
- Habitat-Level Recovery Actions: Prevent degradation of existing habitat. Restore areas to suitable habitat. Continue habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

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SPECIES ACCOUNT: *Ilex cookii* (Cook's holly)

Species Taxonomic and Listing Information

Listing Status: Endangered; 6/19/1987; Southeast Region (R4) (USFWS, 2015)

Physical Description

An evergreen shrub or small tree reaching 8 feet (2.5 meters) in height. The leaves are alternate, simple, thin but leathery, glabrous, and entire. They are from 3/4 to 1 3/4 inches (2 to 4 centimeters) long and 3/8 to 7/8 inches (1 to 2.2 centimeters) wide and reach an abrupt point at the apex. The upper surface is dark shiny green and the lower a pale green with microscopic black dots. *Ilex cookii* is dioecious, male and female flowers are borne on different plants. Female flowers are minute (1/16 inch or 2 millimeters long) and white. Fruits are a drupe approximately 3/16 inch (5 millimeters) in diameter. Male flowers have not been observed (USFWS, 1990).

Taxonomy

Belongs to the family Aquifoliaceae (USFWS, 1990).

Historical Range

Endemic to the dwarf forests of the central mountains of Puerto Rico (USFWS, 1990).

Current Range

It is currently known from only seven herbarium collections, all from Cerro Punta and Monte Jayuya (USFWS, 2013).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 1990)

Key Resources Needed for Breeding

Adult: Unknown (USFWS, 1990)

Reproduction Narrative

Adult: *Ilex cookii* is dioecious, producing minute male and female flowers on separate plants. Pollination is probably effected by insects or wind, although the pollination biology of this species has not been studied (USFWS, 1990).

Habitat Type

Adult: Terrestrial (USFWS, 2013)

Habitat Vegetation or Surface Water Classification

Adult: Lower montane wet forest (USFWS, 2013)

Geographic or Habitat Restraints or Barriers

Adult: Occurs > 2,700 ft. elevation (USFWS, 2013)

Habitat Narrative

Adult: The species appear to be restricted to the dwarf (elfin) forest vegetation in the central mountains (elevations greater than 2700 feet or 830 meters) of Puerto Rico. It occurs wholly within the lower montane wet forest life zone (USFWS, 2013). The clay soils are deep, well-drained, very strongly acid, and overlay a thick layer of highly weathered rock. A deep humus layer is present on the forest floor. Tree roots often form a tight superficial mat (Gierbolini 1973) (USFWS, 1990).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Unknown (USFWS, 2013)

Species Trends:

Unknown (USFWS, 2013)

Resiliency:

Very low (inferred from USFWS, 2013)

Redundancy:

Low (inferred from USFWS, 2013)

Number of Populations:

5 (USFWS, 2013)

Population Size:

35 (USFWS, 2013)

Population Narrative:

The species status is unknown; the species has not been sighted since 1970 and is only known from 7 very poor herbarium collections. Although specific surveys for the plant have not been conducted, Cook's holly is believed to still occur on two mountain peaks in central Puerto Rico: Cerro Punta and Monte Jayuya in the municipalities of Ponce and Jayuya at the highest elevation points (greater than 2,700 feet [830 meters]) (USFWS, 2019a). Only a few individuals have been documented, 1 adult and 4 seedlings at Cerro Punta and 30 seedlings at Monte Jayuya; there are no recent survey or population estimates currently available for this species (USFWS, 2019b).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Although the known populations are located within the Toro Negro Commonwealth Forest, these areas are subjected to development or expansion of telecommunication infrastructure. Permits to build new communication facilities or expand currently existing ones within or near Commonwealth forest are prevalent (PRDNER 2004). Destruction or modification of this kind of habitat may be irreversible. Therefore, the microhabitat conditions necessary for the recovery of the species may be lost if habitat is modified for the construction of further communication facilities. Mr. José R. Román (2012, pers. comm.), former forest manager of the Toro Negro Commonwealth Forest, states that the telecommunication companies and the Puerto Rico Energy and Power Authority (PREPA) conduct maintenance activities such as trimming and clearing the vegetation without coordination with the forest manager, affecting the forest vegetation and Cook's holly habitat. Un-coordinated vegetation clearing activities and the lack of knowledge of this species may result in accidental damage or extirpation of individuals (O. Monsegur 2012, pers. comm.). Human induced fire is a current threat for the species at Cerro Punta and Monte Jayuya. Areas potentially used by the species in Cerro Punta and Monte Jayuya have been affected by human induced fires (Monsegur-Rivera, 2012 pers. obs.) (USFWS, 2013). Hurricane Maria caused habitat destruction across the Island in 2017 and surveys for other listed species in the same area known to this species showed natural and anthropogenic impacts to habitat (USFWS, 2019).

Stressor: Invasive species (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Invasive native plants such as the fern *Gleichenella pectinata* may invade and alter diverse native dwarf forest communities, often resulting in plant monocultures that support few wildlife species (Monsegur-Rivera 2012, pers. obs.) *Gleichenella pectinata* colonize disturbed areas faster than other native plants, thereby excluding the native plants. *Gleichenella pectinata* may grow as an invasive by forming dense mats and it seems to be fire tolerant and form mats of dry material that serve as fuel for human induced fires. The fern is currently found occupying areas disturbed by fire, landslides and road construction. If the fern continues to spread and colonizes Cook's holly habitat, it could alter the fire regime, microclimate, and nutrient cycling of the habitat that the species depend. Furthermore, the native vine-like fern *Hypolepis repens* was observed on the area colonizing forest gaps probably created by previous hurricanes. It was also noted that this species was growing over other federally listed species (*Cyathea dryopteroides*) (Monsegur-Rivera 2012, pers. obs.) (USFWS, 2013).

Stressor: Collection (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: The species is recognized by its rarity and restricted range making it more attractive to collectors and scientists. Although Commonwealth Law No. 241 regulates collection of listed plant species (see Factor D evaluation below), permits to collect listed plant species for scientific

or educational purposes could be issued by the PRDNER. Currently, few botanists are searching for the species, and the species has not been found. Because little is known about Cook's holly (i.e. abundance, distribution, habitat requirement and phenology), any collection of seedlings, saplings, flowers, fruits, or parts of the individual without appropriated evaluation of its effect on the species could adversely affect the status of the population (USFWS, 2013).

Stressor: Limited distribution and small population size (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: One of the most important factors affecting the continued existence of the Cook's holly is its limited distribution. In the Caribbean, native plant species, particularly endemics with limited distribution, may be vulnerable to natural or anthropogenic events such as hurricanes, landslides and genetic variation. The Cook's holly is more susceptible to natural disturbances such as hurricanes or landslides, because it is confined to geographically small areas (USFWS 1991). Moreover, the low number of individuals per population may represent another limiting factor as small populations may be composed entirely of male or female individuals, thus limiting the potential of breeding. Given the extremely limited geographic distribution and elevation range of Cook's holly, it is highly likely that its genetic variability is extremely low. This would result in a loss of alleles by random genetic drift, which would limit the species' ability to respond to changes in the environment (Monsegur-Rivera 2012, pers. comm.)

Stressor: Climate change (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Changes in climate can have a variety of direct and indirect impacts on species, and can exacerbate the effects of other threats. Rather than assessing "climate change" as a single threat in and of itself, we examine the potential consequences to species and their habitats that arise from changes in environmental conditions associated with various aspects of climate change. Vulnerability to climate change impacts is a function of sensitivity to those changes, exposure to those changes, and adaptive capacity (IPCC 2007; Glick et al. 2011). The effects of climate change may increase the intensity of hurricanes and landslides. In addition, climate change may alter (modify) the surrounding vegetation around the individuals of Cook's holly. Changes that may occur are changes in soil disturbance and the microclimate of the area caused by the increase in hurricanes and landslides, where lower elevation vegetation may dominate the limited area where Cook's holly could occur. Cook's holly is reported to exist in the highest peak mountains in Puerto Rico and if lower vegetation becomes dominant this species would not be able to survive (USFWS, 2013).

Recovery

Reclassification Criteria:

At least two new populations capable of self-perpetuation have been established within protected units of the Commonwealth Forest (Monte Guilarte or Toro Negro) or on Federal land within the Caribbean National Forest (USFWS, 2013).

Delisting Criteria:

Threat reduction and management activities have been implemented to a degree that the species will remain viable into the foreseeable future (USFWS, 2019b).

The existing six (6) populations of elfin tree fern within protected areas (Commonwealth Forests) show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (USFWS, 2019b).

Establish two (2) additional populations within protected areas that show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (USFWS, 2019b).

Recovery Actions:

- Pursue surveys for Cook's holly within historical collection areas and include non-traditional sites that harbor suitable habitat for the species (USFWS, 2019a).
- Protect current habitat (USFWS, 1990).
- Conduct research on the life history of these species, evaluate methods of propagation and to look for reintroduction sites (USFWS, 1990).
- Propagate and produce seedlings for enhancement of existing populations and the establishment of new populations (USFWS, 1990).
- Monitor all known populations, and develop a long-term management and monitoring protocol of natural and established populations to reduce site-specific threats for Cook's holly and its habitat (USFWS, 2019b).

Conservation Measures and Best Management Practices:

- Field surveys on Cook's holly should be conducted, within the historical sites for this plant and in non-traditional sites with suitable habitat to determine the existence of this species (USFWS, 2013).
- Field studies on Ilex species in Puerto Rico and the Antilles should be conducted (USFWS, 2013).
- Specimens should be compared with the type material and other herbarium specimens, including the ones not seen by González-Gutiérrez (2007), to confirm the identity and if Cook's holly constitutes a valid species. This should include molecular (DNA) studies to clarify the relationships within the genus (USFWS, 2013).
- Studies should be conducted of the species' phenology and reproductive biology (USFWS, 2013).
- Studies should be conducted to determine the patterns of genetic variation, in order to develop a plan to preserve the species' germplasm (USFWS, 2013).
- Propagation and reintroduction should be conducted in order to strengthen the existing population. We must take into consideration if the species continues to be viable, existing threats to the species, and if we find ways to propagate without seeds (USFWS, 2013).
- The population should be monitored on a regular basis, and additional survey visits should be made after hurricanes, landslides, or other major disturbances (USFWS, 2013).
- As new information becomes available and when individuals are documented, the recovery plan should be revisited and possibly revised to establish measurable criteria, including how many individuals constitute a self-sustainable population and how many populations would be needed to delist the species (USFWS, 2013).

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USFWS 2013. Cook's Holly (*Ilex cookii*) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Southeast Region. Caribbean Ecological Services Field Office, Boquerón, Puerto Rico.

SPECIES ACCOUNT: *Ilex sintenisii* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 4/22/1992

Physical Description

A shrub or small tree reaching 4.5 m in height and 7.6 cm in diameter. The alternate leaves are glabrous, obovate to elliptic, and coriaceous, measuring 1 to 2.5 cm long and 0.6 to 1.9 cm wide (Little et al. 1974). The leaf apex is notched, with edges turned under, and with the midrib slightly sunken. The bark is gray and smooth, usually covered with mosses and liverworts. This is a dioecious species, with white axillary flowers, growing solitary or in small groups, with pedicels of 0.6 to 1.0 cm long. Female and male flowers bear a 4-5 lobed calyx and corolla, with elliptic white petals slightly united at the base. Female flowers contain 4-5 alternate, nonfunctional stamens, and a four-celled ovary; the male flowers bear larger stamens and a small nonfunctional pistil. The fruit is a drupe, which is green when immature (Little et al. 1974) (USFWS, 1993).

Historical Range

See current range/distribution.

Current Range

Specimens originally collected in the upper elevations of the Luquillo Mountains, Puerto Rico. (USFWS, 1993). *Ilex sintenisii* is known only from the dwarf forest type on higher elevations (over 600 meters (1,968 ft) in elevation) at EYNF. It is distributed between two peaks: Pico El Yunque and Pico del Este and along their access roads, where a total of 465 individuals have been reported at three sites (USFWS 2015). However, the species' prime habitat lies in inaccessible areas that have not been surveyed. (USFWS, 2019).

Critical Habitat Designated

Yes;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Unknown (USFWS, 2015)

Reproduction Narrative

Adult: Little is known about the reproductive biology of this species. During May of 1991, individuals of *Ilex sintenisii* were producing flowers and fruits (Garcia and Laboy 1991). According to Little et al. (1974), this species flowers throughout the year (USFWS, 1993).

Habitat Type

Adult: Dwarf forest (USFWS, 1993)

Habitat Vegetation or Surface Water Classification

Adult: Dwarf forest (USFWS, 1993)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1993)

Site Fidelity

Adult: High (inferred from USFWS, 1993)

Habitat Narrative

Adult: The Luquillo Mountains region is of volcanic origin and of a rough topography, with cliffs and rock exposures at high elevations. Six major rivers are born in the mountains and waterfalls are numerous. Nineteen soils belonging to four soil associations have been identified within the Caribbean National Forest (Silander et al. 1986), of which the Los Guineos-Guayabota-Rock land association constitutes the most extensive one (USDA 1977). This association contains acidic, shallow to deep, well drained to poorly drained steep soils. The Caribbean National Forest holds four vegetation types: tabonuco forest, palo colorado forest, palma de sierra forest, and dwarf or elfin forest. All the known localities of *Callicarpa ampla* and *Styrax portoricensis*, and some localities of *Ternstroemia luquillensis* and *Ternstroemia subsessilis* occur within the palo colorado vegetation type. Some localities of *Ternstroemia luquillensis* and *Ternstroemia subsessilis*, and all the localities of *Ilex sintenisii* occur in the dwarf forest vegetation type (USFWS, 1993). High ecological integrity and site fidelity as well as low tolerance ranges are inferred based on species specific habitat needs and low number of populations.

Dispersal/Migration**Motility/Mobility**

Adult: Low (Inferred from USFWS, 1993)

Dispersal

Adult: Low (Inferred from USFWS, 1993)

Dependency on Other Individuals or Species for Dispersal

Adult: Low/Slow (inferred from USFWS, 1993)

Population Information and Trends**Population Trends:**

Unknown (USFWS, 2015)

Species Trends:

Unknown (USFWS, 2015)

Resiliency:

Low (inferred from USFWS, 2015)

Representation:

Low (inferred from USFWS, 2015)

Redundancy:

Low (inferred from USFWS, 2015)

Number of Populations:

23 subpopulations (USFWS, 2015)

Population Size:

~465 total individuals (USFWS, 2015)

Population Narrative:

Ilex sintenisii: When the recovery plan was approved, the number of individuals of this species was known to be between 150 to 200 individuals distributed within El Yunque National Forest: Pico El Yunque and Pico del Este. During the surveys in 2011, a total of 23 subpopulations were identified containing approximately 465 individuals, the majority within the area of Pico El Yunque and Pico del Este (Table 3). Most of the localities are associated with remnants of dwarf forest vegetation along Pico del Este and its access road, and Pico El Yunque and its access road. The dwarf forest is found above 600 m in elevation. This forest type is frequently enveloped by clouds, and its trees, are short, small, dense, and floristically impoverished compared to forests in lower elevations (Weaver 1995). It is probable that the populations reported in the Recovery Plan overlap with the populations surveyed as part of the 2011 surveys (Anastacio Gómez, USFS, 2012, pers. comm.). Furthermore, it is probable that the number of populations and individuals were underestimated as the prime habitat for the species lies within an inaccessible area that is difficult to survey (Omar Monsegur, USFWS, 2011, pers. obs.). Despite the lack of long-term monitoring, the current surveys indicate that *I. sintenisii* is more common and widespread within its habitat at El Yunque (USFWS, 2015).

Threats and Stressors

Stressor: Forest management (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat/Loss of individuals

Narrative: At the time of listing, forest management practices such as the establishment and maintenance of plantations, selective cutting, trails and roads construction and maintenance, and shelter construction may have affected these trees. Furthermore, the proposed reconstruction and reopening of Road PR 191 was considered as a direct threat to some populations of these species. The destruction of the dwarf or elfin forests for the construction and/or expansion of communication facilities by the U.S. Navy and private entities were also considered a threat. Based on the available information, the core of the known populations of *I. sintenisii*, *S. portoricensis*, *C. ampla*, *T. subsessilis*, and *T. luquillensis* occur within the boundaries of El Yunque National Forest. Since the time of listing the USFWS has not documented any case of an individual of an endangered species being affected by forest management practices (management of plantations, trail maintenance or road construction). Moreover, the plans to reopen Road PR 191 have been abandoned due to the potential for further landslides that may compromise the project. Nonetheless, the USFS consults with the Service under Section 7 of the ESA when proposing actions within the forest to ensure that possible adverse effects to listed species are avoided or minimized before any such project is implemented. In addition, the USFS conduct environmental reviews documents under NEPA for all actions in the forest. These

consultation mechanisms are effective tools to minimize possible effects of management activities on species and their habitats. Based on the above, we consider the present or threatened destruction, modification, or curtailment of the species habitat or range as low in magnitude and not imminent threat to these species (USFWS, 2015).

Stressor: Overutilization (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Despite the fact that plant collection in El Yunque National Forest is prohibited, when the five species were listed, collection was considered a threat due to the ornamental potential of these species. However, there is no evidence indicating that the species has been affected by these factors. Based on the above, we believe that overutilization for commercial, scientific or educational purposes is no longer a threat to these species (USFWS, 2015).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat/Loss of individuals

Narrative: Since the currently known populations of these species are mostly restricted to El Yunque National Forest, and there are appropriate Commonwealth and Federal laws and regulations protecting these five species, we believe that the inadequacy of existing regulatory mechanisms should no longer be considered a threat to them. However, historical collections indicate that suitable habitat may extend to private properties adjacent to El Yunque. In fact, some of the known populations that occur within El Yunque National Forest are located just along the boundaries of the forest. Thus, it is important to note that enforcement on private lands continues to be a challenge as accidental damage or extirpation of individuals has occurred with other federally listed species due to lack of knowledge of the species by private land owners and law enforcement officers (USFWS, 2015).

Stressor: Hurricanes (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat/Loss of individuals

Narrative: Due to the low number of populations and individuals, hurricanes were identified as a threat to *I. sintenisii*, *S. portoricensis*, *C. ampla*, *T. subsessilis* and *T. luquillensis* in the final rule. As endemic to the Caribbean, these tree species should be well adapted to tropical storms disturbance. However, the low number of populations and individuals pose a threat to the species by making them more susceptible to stochastic events such as hurricanes. In fact, it is not clear to what extent populations of these species may have been affected by Hurricane Hugo (which devastated El Yunque National Forest in 1989) or Hurricane Georges (in 1998). The heavy rains associated with tropical storms and hurricanes in the mountains of Puerto Rico often lead to landslides. Despite the low number of populations and individuals, the USFWS considers hurricanes, landslides and climate change as a moderate and non-imminent threat to these species (USFWS, 2015).

Stressor: Landslides (USFWS, 2015)

Exposure:

Response:**Consequence:** Loss of habitat/Loss of individuals

Narrative: Natural landslides are common as part of the forest dynamics of El Yunque and it is expected that the frequency of this disturbance increases as a result of severe extreme rain events or droughts. Given the steep slopes on which most of these species grow, massive landslides may extirpate entire populations. The USFWS is aware that an area of road PR 191 that formerly connected the municipalities of Río Grande and Naguabo, and that run across the forest has historically been affected by landslides. This area was the site of some populations that were not located by the interagency group in 2011. Due to the severity of landslides, it was determined that it was not logistically and economically feasible to repair this road. Based on the 2011 surveys, *I. sintenisii* seems to be the only species that is not imminently threatened by hurricanes and landslides. The prime habitat for *I. sintenisii* is associated with dwarf forest vegetation. Due to the low agricultural value and inaccessibility of this habitat, this vegetation was not cleared during the peak of the deforestation of the island, and thus some of the highest parts of El Yunque remain as pristine forest. This explains the relative abundance of the species along the summits of Pico El Yunque and Pico del Este. Despite the low number of populations and individuals, the USFWS considers hurricanes, landslides and climate change as a moderate and non-imminent threat to these species (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)**Exposure:****Response:****Consequence:** Loss of habitat/Loss of individuals

Narrative: This species may be further threatened by climate change, which is predicted to increase the frequency and strength of tropical storms and can cause severe droughts (Hopkinson et al. 2008). Vulnerability to climate change impacts is a function of sensitivity to those changes (e.g., changes rain regime and moisture availability), exposure to those changes, and adaptive capacity (Glick et al. 2011). Despite the relative abundance and apparently stability of the populations of *I. sintenisii*, its habitat is considered rare in Puerto Rico. These areas (dwarf forest vegetation) are ecological islands that harbor unique vegetation and environmental conditions. Shifts of vegetation communities are expected as temperatures and moisture regimes are altered by climate change. Under this scenario populations of *I. sintenisii* as well as *S. portoricensis*, *C. ampla*, *T. subsessilis*, and *T. luquillensis* may be displaced or outcompeted by native or exotic species with wider environmental plasticity. Despite the low number of populations and individuals, the USFWS considers hurricanes, landslides and climate change as a moderate and non-imminent threat to these species (USFWS, 2015).

Stressor: Genetic variation (USFWS, 2015)**Exposure:****Response:****Consequence:** Loss of viability

Narrative: Along with a decreasing population size, negative impacts of habitat fragmentation may result in erosion of genetic variation through the loss of alleles by random genetic drift (Honnay and Jacquemyn 2007) and may also limit the ability of a species to respond to a changing environment (Booy et al. 2000). Given the extremely small population size and lack of connectivity between populations of *S. portoricensis*, *C. ampla*, *T. subsessilis* and *T. luquillensis* in Puerto Rico, it is highly likely that their genetic variability is extremely low. Based on the above, we consider the lack of genetic variation a high and imminent threat to *S. portoricensis*, *C. ampla*,

T. subsessilis and *T. luquillensis*. Overall, we consider hurricanes, landslides, climate change and genetic variation as threats to *S. portoricensis*, *C. ampla*, *T. subsessilis* and *T. luquillensis*. Due to the small number of populations, the USFWS considers the above mentioned threats as high in magnitude and imminent for those species. In the case of *I. sintenisii*, the species is at least stable and probably improving, thus we consider the above mentioned threats as low and non-imminent (USFWS, 2015).

Recovery

Reclassification Criteria:

An agreement between the Fish and Wildlife Service and the USDA Forest Service concerning the protection of *Callicarpa ampla*, *Ilex sintenisii*, *Styrax portoricensis*, *Ternstroemia luquillensis*, and *Ternstroemia subsessilis* within the Caribbean. National Forest property has been prepared and implemented (USFWS, 1993).

An agreement between the Fish and Wildlife Service and the Department of Natural and Environmental Resources (DNER) concerning the protection of the three species in Commonwealth forests has been prepared and implemented, if the species is found within DNER properties (USFWS, 1993).

New populations (the number of which should be determined following the appropriate studies) capable of self perpetuation have been established within protected areas (USFWS, 1993).

Delisting Criteria:

1. Existing natural populations exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (addresses Factors E). (USFWS, 2019).
2. Establish or discover four (4) additional populations within the current range at EYNF that exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (addresses Factors A and E). (USFWS, 2019).
3. Establish or discover two (2) new populations outside the current range but within the historical range (e.g., Carite, Guilarte or Toro Negro Commonwealth Forests) that exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (addresses Factors A and E). (USFWS, 2019).
4. Threats have been addressed and/or managed to the extent that the species will remain viable into the foreseeable future (addresses Factor A and E). (USFWS, 2019).

Recovery Actions:

- Criterion 1 has been partially met. There is no formal agreement between the USFS and the USFWS for the implementation of a management plan to protect these five species. However, the El Yunque National Forest is managed by the USFS for conservation, and has an approved "Revised Land and Resource Management Plan" (1997), which is currently under revision. Moreover, Federal agencies are mandated to carry out programs for the conservation of endangered species under Section 7 of the Endangered Species Act (ESA) to ensure that any action authorized, funded or carried out by a Federal agency is not likely to jeopardize the continued existence of a federally listed species. Thus, the USFS continually

consults with the USFWS to avoid and minimize impacts to listed species and their habitat at El Yunque National Forest. In addition, on July 26, 2005, the U.S. Congress enacted the Caribbean National Forest Act to designate approximately 10,000 acres of land in the El Yunque National Forest as wilderness and as a component of the National Wilderness Preservation System in accordance with the Wilderness Act (16 U.S.C. 1131 et seq.). This Act prohibits certain activities (e.g., timber harvest) within wilderness designated areas, although it does not preclude the installation and maintenance of facilities (e.g., data collection and remote transmission facilities) essential to the scientific and conservation purposes of the Forest Service. Therefore, the majority of the habitat upon which these species depend upon is essentially protected (USFWS, 2015).

- Criterion 2 has been partially met. Although there is no specific agreement between USFWS and the PRDNER concerning the protection of these three species in Commonwealth forests, there is an agreement between the two agencies under Section 6 of the Endangered Species Act, in which the PRDNER carries out conservation activities for the benefit of threatened and endangered species. Furthermore, these five species are listed by the PRDNER as endangered, and thus are protected by regulations of the Commonwealth of Puerto Rico (See factor D.). Therefore, special consideration is taken when considering actions within areas that harbor suitable habitat for these species (USFWS, 2015).
- Criterion 3 has been initiated. The Puerto Rico Conservation Trust (PRCT) is successfully propagating *Styrax portoricensis*. The USFWS has utilized some of this material and begun planting this species (approximately 50 individuals) at El Yunque National Forest. In addition, the PRDNER began planting *Styrax portoricensis* (approximately 5 individuals) in the Carite Commonwealth Forest. Furthermore, the USFS has propagated *Callicarpa ampla* by air layering (cloning by promoting rooting of branches using hormones), and has planted about three individuals at El Portal in El Yunque National Forest. However, little information is available about the reproductive biology and the ecology of these species. Further research and monitoring of reintroduced individuals is required to determine the success of these actions. There is no information about the propagation of any of the remaining three species (*Ilex sintenisii*, *Ternstroemia luquillensis* and *Ternstroemia subsessilis*) (USFWS, 2015).
- New in 2019: 1. Establish long-term conservation mechanisms (e.g., land conservation easements and conservation agreements) for private lands outside/bordering EYNF since these lands share similar vegetation and habitat characteristics. This new action should be included within Recovery Task 11. (USFWS, 2019).
- 2019 - 2. A protocol for the propagation and reintroduction of all five species should be developed in collaboration with partners (e.g., University of Puerto Rico, KEW, Fairchild Tropical Botanic Garden, PRDNER, Para La Naturaleza and Natural Resources Conservation Service). The protocol should address the feasibility of seed banking these species, and if deemed necessary, seed material should be stored at the Millennium Seed Bank (KEW) and USDA National Laboratory for Genetic Resources Preservation in Ft. Collins. This new action should be included within Recovery Task 33. (USFWS, 2019).
- 2019 - 3. Studies in the species' population genetics should be conducted to determined patterns of genetic diversity across the species natural distribution, and to provide baseline information for sound management of these species. This new action should be included within Recovery Task 3. (USFWS, 2019).

Conservation Measures and Best Management Practices:

- 1. The USFS should establish a long term monitoring program for the populations of listed plants at El Yunque National Forest to determine population trends for these species. The guidelines for these monitoring should be included as part of the El Yunque National Forest Management Plan (USFWS, 2015).
- 2. Develop a comprehensive survey and assessment of the population of *I. sintenisii*. This survey must be standardized to ensure that the habitat (dwarf forest) is efficiently surveyed (USFWS, 2015).
- 3. Molecular studies should be conducted to determine the relationships within the genus *Ilex* in Puerto Rico (USFWS, 2015).
- 4. The USFS, PRDNER and the USFWS should develop an intensive survey program to inventory areas within and outside El Yunque National Forest with potential habitat for these species. This program should include training to field biologists to allow personnel to recognize listed species in the field (USFWS, 2015).
- 5. The populations that are actively producing seeds need to be identified and monitored to collect seed material for recovery purposes. A protocol to collect seed should be developed and implemented to avoid altering the natural recruitment of the species (USFWS, 2015).
- 6. Enhancement of natural populations should be considered a priority, particularly for *S. portoricensis*, *C. ampla*, *T. subsessilis* and *T. luquillensis*. The development of adequate propagation techniques is essential for the recovery of these species (USFWS, 2015).
- 7. Studies should be conducted to determine the patterns of genetic variation within and among populations, in order to develop a plan to preserve the species genetic variability (USFWS, 2015).
- 8. The recovery plan should be revised to establish measurable delisting criteria, including how many individuals constitute a self-sustainable population and how many populations would be needed to delist the species (USFWS, 2015).

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5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Southeast Region, Caribbean Ecological Services Field Office, Boquerón, Puerto Rico.

SPECIES ACCOUNT: *Iliamna corei* (Peter's Mountain mallow)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/12/1986; Northeast Region (R5) (USFWS, 2015)

Physical Description

Iliamna corei is an erect, ascending, perennial herb growing from a woody rhizome producing densely pubescent pale-green branches up to 1 m in height. The maple-like leaves are simple, with 5-7 palmate lobes, margins serrate to dentate, bases truncate to cordate, and stellate-pubescent on both surfaces. The size of the leaves decreases gradually towards the tips of the branches. The pink flowers are solitary or clustered in the axils of the upper leaves. There are 5 radially symmetrical, separate petals 2.5-3 cm long and 5 sepals fused 1/4 to 1/2 their length into a bell-shaped, hairy calyx. Stamens are numerous, their bases fused into a tube surrounding the pistil. The flower appears generally similar to the cultivated hibiscus, or rose-of-Sharon. Fruits are lobed capsules with mature carpels 8-10 mm long, densely hairy, containing 2-3 seeds in each carpel. (USFWS, 1990)

Taxonomy

Considered a distinct species known only from a single site in the Virginia mountains. Bodo Slotta & Porter (2006) studied the genetic variation in North American *Iliamna* and analyses determined that *I. corei* is distinct. Additional research in the late 1980s also support that this taxon should be separated from *I. remota* on the basis of genetic analyses. Kartesz considers these differences minor, and includes these Virginia plants, along with *Iliamna remota*, in his circumscription of the nominate variety of *Iliamna rivularis*. Included in *Iliamna rivularis* var. *rivularis* by Kartesz, 1994 checklist and 1999 floristic synthesis; by others considered distinct from *I. rivularis*, but included in *Iliamna remota*. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Only site known is Giles County in Ridge and Valley Province of Virginia. (NatureServe, 2015)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual (vegetative) and sexual (outcrossing) (NatureServe, 2015)

Dependency on Other Individuals or Species

Adult: Pollinated by bees (USFWS, 1990)

Breeding Season

Adult: Late June to early August (USFWS, 1990)

Key Resources Needed for Breeding

Adult: Seed scarification is required for germination (Bodo Slotta & Porter 2006) (NatureServe, 2015)

Reproduction Narrative

Adult: *Iliamna* is rhizomatous. Seed scarification is required for germination (Bodo Slotta & Porter 2006). *I. corei* flowers from late June to early August. It is believed to be pollinated primarily by sweat bees of the genus *Halictus*, which are abundant in the area. (USFWS, 1990; NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest - Mixed, Forest/Woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Sunny, open areas (USFWS, 1990)

Geographic or Habitat Restraints or Barriers

Adult: Mature *Iliamna corei* plants appear to prefer open sites without much competing vegetation (USFWS, 1990)

Dependency on Other Individuals or Species for Habitat

Adult: The dominant trees growing in association with *I. corei* include *Quercus rubra*, *Q. prinus*, *Carya* spp., *Robinia pseudo-acacia*, *Pinus virginiana*, *Betula lenta*, and *Celtis occidentalis*. The shrub layer is primarily composed of *Berberis canadensis*, *Crataegus* spp., and *Rhus typhina*. The more common herbs, forbs, and vines include *Verbesina occidentalis*, *Tradescantia ohiensis*, *Polymnia canadensis*, *Aquilegia canadensis*, *Chenopodium standleyanum*, *Rosa carolina*, *Dioscorea villosa*, *Clematis viorna*, and *Parthenocissus quinquefolius*. The only plants that appear to be directly competing with the *Iliamna* are *Polymnia* and *Berberis*. (USFWS, 1990)

Habitat Narrative

Adult: *Iliamna corei* occurs in the shallow soil of the Clinch sandstone outcrops on the northwest-facing slope of Peters Mountain (elevation 1000 m), near the ridge line of a mixed deciduous-evergreen forest. Regarding the species' edaphic requirements, soil tests from the sites of two different *Iliamna* clones show pH ranging from 5.3 to 5.6. Quantities of macro- and micronutrients from the two sites (in parts per million) include: phosphorus (32 and 53), potassium (157 and 58), calcium (120), and magnesium (101 and 65). Soils underlying the *Iliamna* population are very dark and appear to be highly organic in composition. The dominant trees growing in association with *I. corei* include *Quercus rubra*, *Q. prinus*, *Carya* spp., *Robinia pseudo-acacia*, *Pinus virginiana*, *Betula lenta*, and *Celtis occidentalis*. The shrub layer is primarily composed of *Berberis canadensis*, *Crataegus* spp., and *Rhus typhina*. The more common herbs, forbs, and vines include *Verbesina occidentalis*, *Tradescantia ohiensis*, *Polymnia canadensis*, *Aquilegia canadensis*, *Chenopodium standleyanum*, *Rosa carolina*, *Dioscorea villosa*, *Clematis*

viorna, and Parthenocissus quinquefolius. The only plants that appear to be directly competing with the Iliamna are Polymnia and Berberis. (USFWS, 1990)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Declining (USFWS, 2008)

Species Trends:

Declining (USFWS, 2008)

Resiliency:

Low (inferred from USFWS, 1990)

Representation:

High (NatureServe, 2015)

Redundancy:

Low (inferred from USFWS, 1990)

Number of Populations:

1 (NatureServe, 2015)

Population Size:

1 - 250 individuals (NatureServe, 2015)

Additional Population-level Information:

Monitoring reports from The Nature Conservancy indicated that since the 2008 status review, the Peter's Mountain Mallow numbers have fluctuated, but the overall population trend appears to be stable (USFWS 2019).

Population Narrative:

Peters Mountain mallow (*Iliamna corei*), a member of the family Malvaceae, is known from only a single site on Peters Mountain, near The Narrows of the New River, in Giles County, Virginia. The occurrence is very tolerant to on-site activities. (NatureServe, 2015)

Threats and Stressors

Stressor: Encroachment of vegetation (USFWS, 1990)

Exposure:

Response:

Consequence:

Narrative: The encroachment of competing vegetation, resulting in a reduction of direct sunlight reaching the plants, appears to be contributing to the decline in the size and reproductive vigor of the population. Historical references indicate that *Iliamna corei* was previously exposed to a great deal more direct sunlight than is the case today (U.S. Fish and Wildlife Service, 1986). In recent years forest canopy on Peters Mountain has grown considerably, probably in association with fire suppression management. Construction of a hiking trail and a powerline near the mallow site in the early 1970s appears to have promoted the invasion of weedy competitors, primarily *Polymnia canadensis*. (USFWS, 1990)

Stressor: Lack of recruitment (USFWS, 1990)

Exposure:

Response:

Consequence:

Narrative: A major concern in regard to recovery of *Iliamna corei* has been lack of recruitment. Although a viable seedbank exists in the soil, no seedlings are being produced because the seeds are not germinating. Recent experimental evidence indicates that germination is readily stimulated by heat (Baskin and Baskin, 1990) and light fire (C. Baskin and J. Baskin, pers. comm.). (USFWS, 1990)

Stressor: Low sexual fecundity (USFWS, 1990)

Exposure:

Response:

Consequence:

Narrative: In addition to the lack of seed germination at the natural population site, the remaining *I. corei* clones have been exhibiting extremely low sexual fecundity. From 1986-1988, only 14 mature capsules were produced, despite profuse flowering. Many buds aborted before flowering, and the majority of buds that did produce flowers disarticulated from the plant after anthesis. The record drought years of 1987 and 1988 may have contributed to reproductive failure; however, the plants were watered regularly during the drought periods of those years. Seed production data from most of the years previous to 1986 are unavailable, but Strausbaugh and Core indicated that, in 1932, the plants were producing an "abundant supply of seeds." Herbarium specimens collected by Massey in 1934 and 1939 (at VPI&SU) also have mature capsules containing many seeds (J. Randall, pers. comm.). The mystery of seed production in the natural population has been largely solved and the problem ameliorated by recent work at VPI&SU, as described below. (USFWS, 1990)

Stressor: Small population size (USFWS, 1990)

Exposure:

Response:

Consequence:

Narrative: Because so few plants comprise the natural population, removal of individual stems, whether by humans or other animals, constitutes a threat to the species' survival. In October 1987, a feral goat browsed all of the *Iliamna* stems to within 30 cm of the ground. In 1987 and 1988, a total of 16 stems were cut, apparently for collection. (USFWS, 1990)

Stressor: Herbivory (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Herbivory by deer and other animals is a continuing threat, mitigated by placement of small wire cages around individual and small groups of PMM. Replacement and enlargement of these enclosures to accommodate plant growth requires continuing annual effort throughout the field season (Edward and SanJule 2007). (USFWS, 2008)

Stressor: Fire suppression (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Suppression of natural fires necessitates an on-going commitment to prescribed burning. (USFWS, 2008)

Recovery**Reclassification Criteria:**

1. The natural population has reached carrying capacity and has been self-maintaining or expanding into new areas for at least 5 years. (USFWS, 1990)
2. Life history, ecology, and population biology are understood sufficiently to manage effectively. (USFWS, 1990)
3. There exists an established and continuing management program. (USFWS, 1990)
4. The tract of land on which it occurs is permanently protected. (USFWS, 1990)
5. Plants representing a variety of genotypes are propagated at a minimum of two plant breeding facilities. (USFWS, 1990)

Delisting Criteria:

1. The natural population has reached carrying capacity and has been self-maintaining or expanding into new areas for at least 5 years. (USFWS, 1990)
2. Life history, ecology, and population biology are understood sufficiently to manage effectively. (USFWS, 1990)
3. There exists an established and continuing management program. (USFWS, 1990)
4. The tract of land on which it occurs is permanently protected. (USFWS, 1990)
5. Plants representing a variety of genotypes are propagated at a minimum of two plant breeding facilities. (USFWS, 1990)
6. Studies indicate that it is appropriate to establish new populations. (USFWS, 1990)
7. Five additional populations have been located or established. (USFWS, 1990)

8. These new populations are protected and stable or expanding for at least 5 years. (USFWS, 1990)

Recovery Actions:

- Monitor known population and manage as necessary. (USFWS, 1990)
- Study life history, ecological, and population parameters. (USFWS, 1990)
- Maintain representative individuals at two plant breeding facilities. (USFWS, 1990)
- Outplant individuals within historic range. (USFWS, 1990)
- Acquire full title to the population site. (USFWS, 1990)
- Research to better understand site requirements and germination and care for seedlings so new populations can be established (USFWS 2019).
- Research the seasonality and intensity of fire needed to stimulate germination of seeds in the seed bank. This would help to better manage existing population and plan burns in new areas (USFWS 2019).

Conservation Measures and Best Management Practices:

- Conduct and assess effects of landscape burn in 2009. Burn implementation is already scheduled and funded. (USFWS, 2008)
- Continue ex situ seed increase efforts and assure long-term seed storage. (USFWS, 2008)
- Update reclassification criteria 1 and 5 to clarify target population size and composition (whole plants and seed production) in the wild and requirements for ex situ conservation. Updated criteria, consistent with the scope and intent of the corresponding criteria in the 1990 recovery plan, should reflect current information about PMM biology. (USFWS, 2008)
- Based on results of initial landscape scale burn, evaluate future burning requirements and associated funding needs. (USFWS, 2008)
- Develop long-term agreements for continuing management of PMM population(s) at the Narrows Preserve. (USFWS, 2008)
- Reconsider need for and desirability of establishing additional PMM populations outside the species' known historic range. Evaluate feasibility of alternative strategies to provide for long-term security and delisting of PMM. If necessary, revise delisting criteria and recovery plan accordingly. (USFWS, 2008)

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SPECIES ACCOUNT: *Ipomopsis polyantha* (Pagosa skyrocket)

Species Taxonomic and Listing Information

Listing Status: Endangered; 08/26/2011; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

Ipomopsis polyantha is an herbaceous biennial 12 to 24 inches tall, branched from near the base above the basal rosette of leaves. Deeply divided leaves with linear segments are scattered up the stem. Flower clusters are along the stem in the axils of the leaves as well as at the top of the stem. The white flowers are 0.4 in long, with short corolla tubes 0.18 to 0.26 in (0.45 to 0.65 cm) long, and flaring corolla lobes flecked with purple dots, often very dense (Anderson 1988). The stamens extend noticeably beyond the flower tube, and the pollen is blue (Grant 1956), changing to yellow as it matures (Collins 1995). (USFWS, 2011)

Taxonomy

Ipomopsis polyantha was originally described by Rydberg (1904) as *Gilia polyantha*. Grant (1956) moved the species into the genus *Ipomopsis*. Two varieties, *G. polyantha* var. *brachysiphon* and *G. polyantha* var. *whitingii*, were recognized by Kearney and Peebles (1943). Currently available information indicates that *I. polyantha* is a distinct species (Porter and Johnson 2000; Porter et al. 2003 in Anderson 2004). (USFWS, 2011)

Historical Range

The historical range of *Ipomopsis polyantha* is unknown, but likely included a much broader area than the currently occupied habitat. (USFWS, 2011)

Current Range

The two known occurrences of *Ipomopsis polyantha* are in Archuleta County, Colorado within about 13 miles (mi) (21 kilometers (km)) of each other, and collectively occupy about 388.4 acres (ac) (157.1 hectares (ha)) of habitat within a range that includes about 6.5 square mi (16.8 square km). (USFWS, 2011)

Critical Habitat Designated

Yes; 8/13/2012.

Legal Description

On August 13, 2012, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Ipomopsis polyantha* (Pagosa skyrocket) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four critical habitat units (CHUs), in Colorado (77 FR 48356-48415).

Critical Habitat Designation

The critical habitat designation for *Ipomopsis polyantha* includes four CHUs in Archuleta County, Colorado. This species critical habitat encompasses approximately 9,641 acres (ac) (3,902 hectares (ha)) (77 FR 48356-48415).

Unit 1, the Dyke Unit, consists of 1,475 ac (597 ha) of Federal and private lands. The Unit is located at the junction of U.S. Hwy 160 and Cat Creek Road (County Road 700) near the historic

town of Dyke in Archuleta County, Colorado. Ninety-seven percent of this Unit is on private lands; of these private lands, 1 percent is within highway ROWs. Three percent is on Federal land managed by the BLM, through the Pagosa Springs Field Office of the San Juan Public Lands Center. This Unit is currently occupied. This Unit currently has all the physical and biological features essential to the conservation of the species including a collection of all three communities (barren shales, open montane grassland (primarily Arizona fescue) understory at the edges of open Ponderosa pine, or clearings within the Ponderosa pine and Rocky Mountain juniper and Utah juniper and oak communities), pockets of shale with little to no competition from other species, suitable elevational ranges from 6,720 to 7,285 ft (2,048 to 2,220 m), Mancos shale soils, suitable climate, pollinators and habitat for these pollinators, and areas where the correct disturbance regime is present. Lands within this Unit are largely agricultural although some housing is present within the Unit. A large hunting ranch also falls within this Unit. While these lands currently have the physical and biological features essential to the conservation of *Ipomopsis polyantha*, because of a lack of cohesive management and protections, special management will be required to maintain these features in this Unit. Threats to *Ipomopsis polyantha* in this Unit include highway maintenance and disturbance (several hundred plants have been documented along Highway 160 (CNHP 2012b, p. 5)), grazing, agricultural use, *Bromus inermis* encroachment, potential development, and a new road that was constructed through the *I. polyantha* population.

Unit 2, the O'Neal Hill Botanical Unit consists of 564 ac (228 ha) of USFS land managed by the San Juan National Forest. The Unit is north of Pagosa Springs, roughly 13 mi (21 km) north along Piedra Road. Roughly 49 percent of this Unit (279 ac (113 ha)) falls within the O'Neal Hill Special Botanical Area that was designated to protect another Mancos shale endemic, *Lesquerella pruinosa* (Pagosa bladderpod). Because *L. pruinosa* is sometimes found growing with *Ipomopsis polyantha*, we believe the site has high potential for introduction of *I. polyantha*. This Unit is not currently occupied. We reduced this Unit from our proposed critical habitat designation in our notice of availability (77 FR 18161) so that the thick pasture grass and riparian areas in the bottomlands that do not contain many of the PCEs for *I. polyantha* would no longer be included (Holtrop 2011, p. 1). This Unit currently has all the physical and biological features essential to the conservation of the species, including a collection of all three plant communities, pockets of shale with little to no competition from other species, suitable elevational ranges from 7,640 to 8,360 ft (2,330 to 2,550 m), Mancos shale soils, suitable climate, habitat for pollinators (although we do not know if *Ipomopsis polyantha* pollinators are found here), and areas where the correct disturbance regime is present. Because of the presence of these features, we believe this may make a good introduction area for *I. polyantha* in the future and is needed to ensure conservation of the species. Threats to *Ipomopsis polyantha* in this Unit include road maintenance and disturbance, low levels of recreation, including hunting, deer and elk use, and a utility corridor and related maintenance (Brinton 2011, p. 1). *Ipomopsis polyantha* is known from only two populations, both with few or no protections (little resilience). For adequate resiliency and protection we believe it is necessary for survival and recovery that additional populations with further protections be established. Because this area receives low levels of use and because it is already partially protected through the special botanical area, the area would make an ideal site for future introductions of *I. polyantha*. Therefore, we have identified this Unit as critical habitat for *I. polyantha*.

Unit 3, the Pagosa Springs Unit, is the largest of the four *Ipomopsis polyantha* CHUs and consists of 6,456 ac (2,613 ha) of municipal, State, and private lands. The Unit is located at the junction

of Highways 160 and 84, south along Highway 84, west along County Road 19, and east along Mill Creek Road. Ownership of the land in Unit 3 is divided as follows: 86.1 percent is under private ownership, 9.2 percent is owned by the Town of Pagosa Springs, 1.7 percent is owned and operated by the Colorado State Land Board (SLB), 0.7 percent falls within the Colorado Department of Transportation (CDOT) ROWs, 0.4 percent is found on CDOW lands, 0.2 percent is located on Archuleta County ROWs, and 1.4 percent is located on a parcel newly acquired by Archuleta County. This Unit is currently occupied and contains the majority of *I. polyantha* individuals. This Unit currently has all the physical and biological features essential to the conservation of the species, including a collection of all three plant communities, pockets of shale with little to no competition from other species, suitable elevational ranges from 6,960 to 7,724 ft (2,120 to 2,350 m), Mancos shale soils, suitable climate, pollinators and habitat for these pollinators, and areas where the correct disturbance regime is present. Lands within this Unit fall into a wide array of land management scenarios, including agricultural use, junkyards, urban areas, small residential lots, and large 30- to 40-ac (12- to 16-ha) residential parcels. While these lands currently have the physical and biological features essential to the conservation of *Ipomopsis polyantha*, because of a lack of cohesive management and protections, special management will be required to maintain these features in this Unit. Since 86 percent of this Unit is under private ownership and there is no land under Federal ownership, the primary threat to the species in this Unit is agricultural or urban development. Other threats include highway ROW disturbances, *Bromus inermis* and other nonnative invasive species, excessive livestock grazing, and mowing.

Unit 4, Eight Mile Mesa, consists of 1,146 ac (464 ha) of USFS lands that are managed by the Pagosa Springs Field Office of the San Juan National Forest. This Unit is located roughly 6.5 mi (10.5 km) south of the intersections of Highways 160 and 84 in Pagosa Springs, Colorado, and on the western side of Highway 84. This Unit is not currently occupied. We reduced this Unit from our proposed critical habitat designation in our notice of availability (77 FR 18161) so that isolated patches, separated from the rest of the Unit by roads, would no longer be included (Holtrop 2011, p. 1). This Unit currently has all the physical and biological features essential to the conservation of the species including a collection of all three plant communities, pockets of shale with little to no competition from other species, suitable elevational ranges from 7,320 to 7,858 ft (2,230 to 2,395 m), Mancos shale soils, suitable climate, habitat for pollinators, and areas where the correct disturbance regime is present. Because there are so few Mancos shale sites on Federal lands, and because this site has an array of habitat types, it provides the best potential area for introduction of *Ipomopsis polyantha* in the future. Threats to *Ipomopsis polyantha* in this Unit include a road running through the site, recreational use, horseback riding, dispersed camping and hunting, and firewood gathering. The road is a threat because it generates fugitive dust and pollutants, provides a source for nonnative invasive plants, causes habitat fragmentation, increases edge effects and drying, and may limit pollinator movement, among other reasons. The Unit has some dense Ponderosa pine stands, and several small wildfires, which are actively suppressed, occur every year. Benefiting the designation, there is a vacant grazing allotment at this Unit, and noxious weeds are being actively controlled (Brinton 2011, p. 1). *Ipomopsis polyantha* is known from only two populations, both with few or no protections (little resilience). For adequate resiliency and protection we believe it is necessary for survival and recovery that additional populations with further protections be established. Therefore, we have identified this Unit and one other unoccupied area as critical habitat for *I. polyantha*.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Ipomopsis polyantha* critical habitat consists of five components (77 FR 48356-48415):

(i) Mancos shale soils.

(ii) Elevation and climate. Elevations from 6,400 to 8,100 ft (1,950 to 2,475 m) and current climatic conditions similar to those that historically occurred around Pagosa Springs, Colorado. Climatic conditions include suitable precipitation; cold, dry springs; and winter snow.

(iii) Plant community. (A) Suitable native plant communities (as described in paragraph (2)(iii)(B) of this entry) with small (less than 100 ft² (10 m²)) or larger (several hectares or acres) barren areas with less than 20 percent plant cover in the actual barren areas. (B) Appropriate native plant communities, preferably with plant communities reflective of historical community composition, or altered habitats which still contain components of native plant communities. These plant communities include: (1) Barren shales; (2) Open montane grassland (primarily Arizona fescue) understory at the edges of open Ponderosa pine; or (3) Clearings within the ponderosa pine/Rocky Mountain juniper and Utah juniper/oak communities.

(iv) Habitat for pollinators. (A) Pollinator ground and twig nesting areas. Nesting and foraging habitats suitable for a wide array of pollinators and their life-history and nesting requirements. A mosaic of native plant communities and habitat types generally would provide for this diversity. (B) Connectivity between areas allowing pollinators to move from one site to the next within each plant population. (C) Availability of other floral resources, such as other flowering plant species that provide nectar and pollen for pollinators. Grass species do not provide resources for pollinators. (D) A 3,280-ft (1,000-m) area beyond occupied habitat to conserve the pollinators essential for plant reproduction.

(v) Appropriate disturbance regime. (A) Appropriate disturbance levels--Light to moderate, or intermittent or discontinuous disturbances. (B) Naturally maintained disturbances through soil erosion or human-maintained disturbances that can include light grazing, occasional ground clearing, and other disturbances that are not severe or continual.

Special Management Considerations or Protections

The features essential to the conservation of this species (plant community and competitive ability, elevation, soils, climate, reproduction, and disturbance regime) may require special management considerations or protection to reduce threats. *Ipomopsis polyantha*'s highly restricted soil requirements and geographic range make it particularly susceptible to extinction at any time from commercial, municipal, and residential development; associated road and utility improvements and maintenance; heavy livestock use; inadequacy of existing regulatory mechanisms; fragmented habitat; and prolonged drought (76 FR 45054). Over 86 percent of the species' occupied habitat is on private land with no limits on development (Service 2011c, p. 2). Special management considerations or protections are required within critical habitat areas to address these threats. Management activities that could ameliorate these threats include (but are not limited to): Introducing new *Ipomopsis polyantha* populations; establishing permanent conservation easements or acquiring land to protect the species on private lands; developing

zoning regulations that could serve to protect the species; establishing conservation agreements on private and Federal lands to identify and reduce threats to the species and its features; eliminating the use of smooth brome and other competitive species in areas occupied by the species; promoting and encouraging habitat restoration; developing other regulatory mechanisms to further protect the species; placing roads and utility lines away from the species; minimizing heavy use of habitat by livestock; and minimizing habitat fragmentation. These management activities would protect the PCEs for the species by preventing the loss of habitat and individuals, maintaining or restoring plant communities and natural levels of competition, protecting the plant's reproduction by protecting its pollinators, and managing for appropriate levels of disturbance.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Presumably sexual and outcrossing (inferred from USFWS, 2011)

Lifespan

Adult: Biennial (two years) (USFWS, 2011)

Dependency on Other Individuals or Species

Adult: Bees as pollinators (USFWS, 2011)

Breeding Season

Adult: Spring and summer (inferred from USFWS, 2011)

Reproduction Narrative

Adult: *Ipomopsis polyantha* sets far less fruit when self-pollinated and the male and female reproductive parts are separated both spatially and temporally (Collins, 1995). Therefore, we conclude that pollinators are necessary for the long-term successful reproduction and conservation of the plant. Over 30 different insects have been collected visiting *I. polyantha* flowers (Collins, 1995). The primary pollinators are all bee species; these include the nonnative honeybee *Apis mellifera* (honeybees) and native bees that nest in the ground or twigs (Collins, 1995). (USFWS, 2012) Mature seeds germinate to form rosettes that produce flowering stalks during the next growing season, or they may persist as rosettes for a year or more until conditions are right for flowering. Plants produce abundant fruits and seeds, but have no known mechanism for long-distance dispersal (Collins 1995, pp. 111-112). After seeds are mature, the plants dry up and die. We do not know how long the seeds remain viable. (USFWS, 2011)

Habitat Type

Adult: Rocky, clay (shale) soils (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: *Pinus ponderosa* forests with montane grassland understory (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Seeds germinate much faster in Mancos Shale soil (USFWS, 2011)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Site Fidelity

Adult: High (USFWS, 2011)

Habitat Narrative

Adult: In Colorado, *Ipomopsis polyantha* occurs on rocky clay soils of the Mancos Shale in the southern San Juan Mountains, typically on road shoulders where the soil has been disturbed. Highest densities are under *Pinus ponderosa* forests with montane grassland understory (Anderson 2004, Anderson 1988). Elevation is 2073-2195 m. (NatureServe, 2015)

Dispersal/Migration**Dispersal**

Adult: Low (USFWS, 2011)

Dispersal/Migration Narrative

Adult: Plants have no known mechanism for long-distance dispersal (Collins, 1995). Pollinator-mediated pollen dispersal is typically limited to the foraging distances of pollinators, and no bee species is expected to travel more than 1 mi to forage (Tepedino, 2009). (USFWS, 2011)

Population Information and Trends**Population Trends:**

Fluctuating (USFWS, 2011)

Species Trends:

Stable (inferred from USFWS, 2011)

Resiliency:

Moderate (inferred from USFWS, 2011)

Representation:

Low (USFWS, 2011)

Redundancy:

Low (inferred from USFWS, 2011)

Population Growth Rate:

Potentially high (USFWS, 2011)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

Estimated at 162,220 (USFWS, 2011)

Adaptability:

Very limited (USFWS, 2011)

Population Narrative:

This species' long term trend is unknown. The species is capable of significant reproduction, but only in its specialized clay shale habitats, which are very limited and subject to development. It has been known to demonstrate significant increases following fire. (USFWS, 2011)

Threats and Stressors

Stressor: Development (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Ipomopsis polyantha is threatened with destruction of plants and habitat due to commercial, residential, municipal, and agricultural property development, and associated new utility installations and access roads. We have documented recent losses of habitat and individuals within the Pagosa Springs and Dyke occurrences of the species. The species is highly vulnerable to ground disturbance during development because seedlings and rosettes are destroyed and transplanting is not known to be successful. (USFWS, 2011)

Stressor: Highway rights-of-way (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Development of several planned bike trails along highway rights-of-way would eliminate portions of current occurrences located along the highways where the trails would be located. The distribution of Ipomopsis polyantha within highway ROWs makes this species susceptible to threats associated with highway activities and maintenance. Exotic grasses planted by CDOT along roadsides dominate the ROW between pavement and ditch, limiting most I. polyantha plants to the ROW bank between ditch and fence. This limitation to the species' habitat along roadsides is significant because so little habitat exists elsewhere for the species. (USFWS, 2011)

Stressor: Livestock herbivory and disturbance (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: This species is threatened by destruction of flowering plants, rosettes, and seeds due to concentrated livestock disturbance and some herbivory. Observations of the "fence line effect"--healthy plants outside the fence and impacted plants inside the fence--at several locations on private land used for cattle and horse grazing indicate that Ipomopsis polyantha does not tolerate intensive livestock grazing (Anderson, 2004). Such observations from seven locations (pastures) in 2009 found few or no plants in the three heavily grazed pastures and numerous plants in the adjacent pastures with light or no grazing (Glennie and Mayo, 2010). We do not know whether the destruction of the plants was a result of herbivory or trampling. I. polyantha is not found in heavily grazed pastures, but occurrences have been observed in lightly

grazed horse pastures and abandoned pastures (CNAP, 2007). Plants could possibly recolonize a pasture if livestock numbers were reduced sufficiently and the seed bank was still viable, or if there was a seed source nearby, but few plants persist in areas of continual grazing (Collins, 1995). (USFWS, 2011)

Stressor: Inadequate regulatory mechanisms (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: No State regulations protect rare plant species in Colorado. There are no known town or county regulations that provide for protection or conservation of *I. polyantha* or its habitat. Road maintenance crews voluntarily refrain from mowing or broadcast spraying ROWs within the range of *Ipomopsis polyantha*; however, there is no law, regulation, or policy requiring them to do so. Potential new annexations into the Town of Pagosa Springs will change zoning from residential and agricultural parcels to commercial and small lot residential, with anticipated adverse impacts to *I. polyantha*. Decisions regarding annexations are currently being made to encourage growth that will boost the local economy, but provisions for avoidance or minimization of disturbance to habitat for the plants are not included in these decisions or plans. (USFWS, 2011)

Stressor: Specific physiological requirements for germination and growth (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: *Ipomopsis polyantha* is limited to the 6.5 square miles of Pagosa-Winifred soils derived from Mancos Shale. The species has specific physiological requirements for germination and growth that may prevent its spread to other locations (Anderson, 2004). In greenhouse trials, seeds will germinate and grow on other soils, but they grow much faster on Mancos Shale soils (Collins, 1995). Faster growth may give *I. polyantha* a competitive advantage on relatively barren Mancos shale that it lacks on other soils, where its smaller seedlings have more competition from other plants for nutrients and water. (USFWS, 2011)

Stressor: Drought (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: *I. polyantha* is very sensitive to the timing and amount of moisture due to its biennial life history. The species could experience a reduction in its reproductive output as a result of drought or general drying that may result from climate change. The limited geographic range of the Mancos Shale substrate that underlies the entire *Ipomopsis polyantha* habitat likely limits the ability of the species to adapt by shifting occurrences in response to climatic conditions. (USFWS, 2011)

Stressor: Lack of proven methods for propagation and reintroduction (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: In two different situations where plants were removed from utility work, the removed and transplanted individuals (in suitable habitat) survived initially and even produced a very few flowering plants. However, no surviving rosettes were found by the third year. Unless effective transplanting methods are developed, populations cannot be successfully moved out of the way of any development and thus is highly vulnerable to development. (USFWS, 2011)

Recovery

Reclassification Criteria:

None specified

Delisting Criteria:

None specified

Recovery Actions:

- No Recovery Plan

Conservation Measures and Best Management Practices:

- None specified

References

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

U. S. Fish and Wildlife Service. 2011. Endangered and Threatened Wildlife and Plants

Determination of Endangered Status for *Ipomopsis polyantha* (Pagosa Skyrocket) and Threatened Status for *Penstemon debilis* (Parachute Beardtongue) and *Phacelia submutica* (DeBeque Phacelia). Final rule. 76 Federal Register 144, July 27, 2011. Pages 45054-45075.

U.S. Fish and Wildlife Service. 2012. Endangered and Threatened Wildlife and Plants

Designation of Critical Habitat for *Ipomopsis polyantha* (Pagosa skyrocket), *Penstemon debilis* (Parachute beardtongue), and *Phacelia submutica* (DeBeque phacelia). Final Rule. 77 FR 48356-48415 (August 13, 2012).

U. S. Fish and Wildlife Service. 2012. Endangered and Threatened Wildlife and Plants

Designation of Critical Habitat for *Ipomopsis polyantha* (Pagosa skyrocket), *Penstemon debilis* (Parachute beardtongue), and *Phacelia submutica* (DeBeque phacelia)

Final Rule. 77 Federal Register 156. August 13, 2012. Pages 48367-48418.

SPECIES ACCOUNT: *Ipomopsis sancti-spiritus* (Holy Ghost ipomopsis)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/23/1994; Southwest Region (Region 2) (USFWS, 2016)

Physical Description

A herbaceous biennial or short-lived perennial that can remain as a low rosette of leaves for several years before it flowers and dies. The mature plant has one or a few erect stems 3 - 8 decimeters (dm) (12 - 32 inches (in)) tall. The basal and stem leaves are pinnately divided with sharp points terminating each division. The flowers are pink, tubular, and terminate in five spreading lobes. The stamens and the short style of the ovary are deep inside the flower tube (USFWS, 2002).

Taxonomy

In the phlox family (Polemoniaceae) and a member of the *Ipomopsis aggregata* complex of species and subspecies (USFWS, 2002).

Historical Range

See Current Range.

Current Range

Endemic to a single canyon in the Sangre de Cristo Mountains, New Mexico (USFWS, 2002)

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Insects (EPA, 2016)

Key Resources Needed for Breeding

Adult: Insects for pollination (EPA, 2016)

Reproduction Narrative

Adult: Maschinski (1996) found that *Ipomopsis sancti-spiritus* needs pollinators for either self- or outcross-fertilization and that fertilization is required to produce fruits (USFWS 2002).

Habitat Type

Adult: Terrestrial (USFWS, 2002)

Habitat Vegetation or Surface Water Classification

Adult: Roadsides and small woodland clearings beneath Ponderosa pine on steep, south- or southwest-facing slopes (NatureServe, 2015).

Geographic or Habitat Restraints or Barriers

Adult: Elevation from 2,350 - 2,500 m (USFWS, 2002)

Habitat Narrative

Adult: Holy Ghost ipomopsis grows in Holy Ghost Canyon on relatively dry, steep, west to southwest-facing slopes on about the lower one third of the canyon side (excluding the creek riparian margin). The geologic substrate is partly weathered Terrero Limestone. Appears to grow best in bare mineral soils with its highest densities on disturbed sites such as road cuts. The occupied habitat in Holy Ghost Canyon ranges in elevation from 2,350 - 2,500 m (USFWS, 2002). Grows in roadsides and small woodland clearings beneath Ponderosa pine on steep, south- or southwest-facing slopes (NatureServe, 2015).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Potentially dispersed by insects, birds, and mammals (EPA, 2016).

Population Information and Trends**Population Trends:**

Not available.

Species Trends:

Not available.

Resiliency:

Low (inferred from NatureServe, 2015)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

50 - 2500 individuals (NatureServe, 2015)

Population Narrative:

Monitoring data has captured large fluctuations in the Holy Ghost ipomopsis population, ranging from a high of 2,047 in 1996 to a low of 240 in 2001. Plot monitoring between 2003 and 2008 has shown that the average number of individuals per year is 703, divided into an average of 183 flowering plants and 520 rosettes per year, with flowering individuals comprising 26% of the total number of individuals (Sivinski and Tonne 2007, 2008)(USFWS, 2008).

Threats and Stressors

Stressor: Limited distribution (USFWS, 2002)

Exposure:

Response:

Consequence:

Narrative: Holy Ghost ipomopsis is found in a single population of approximately 2,500 plants in one canyon on the Pecos Santa Fe National Forest. The population is vulnerable to stochastic events such as wildfire and disease. A related threat is the apparently limited reproductive success of Holy Ghost ipomopsis, leading to a possible deficit of compatible alleles for pollination or inbreeding depression. In controlled pollination studies, only 13% of the flowers of a sample of 10 plants successfully set fruit (Maschinski and Sivinski, unpublished data 2002). In comparison, the more common species *Ipomopsis arizonica* has an average of 76% of flowers successfully set fruit (USFWS, 2002).

Stressor: Heavy recreational use (USFWS, 2002)

Exposure:

Response:

Consequence:

Narrative: There are approximately 36 summer cabins and a USFS campground within Holy Ghost Canyon. A nearby trout stream is used by anglers resulting in intense recreational use during the months the plant is flowering. Impacts to Holy Ghost ipomopsis from recreation are mostly from residents and campers who walk the forest road and occasionally pick native wildflowers. Holy Ghost ipomopsis is pleasingly showy and sometimes taken. When the flowering stem is broken off, some plants will produce new stems from the lateral buds. This response has been studied in other species of *Ipomopsis*. For *I. aggregate*, Paige (1992a) found fruit and seed production equal between plants with stems removed late in the flowering season and undamaged plants. For *I. arizonica*, Maschinski (1989) found fruit and seed production lower for plants with late season stem removal than for undamaged plants. No studies of this compensating growth response have been done for Holy Ghost ipomopsis; however, Maschinski (Arboretum at Flagstaff, pers. comm. 2002) has noted that plants with broken stems in August produced no fruit for the season (USFWS, 2002).

Stressor: Inadequate protection by regulatory mechanisms (USFWS, 2002)

Exposure:

Response:

Consequence:

Narrative: Prior to listing, no Federal law protected the Holy ghost ipomopsis and no USFS management plan had been developed for the species. Now listed as Federally endangered, the Act prohibits the malicious damage, destruction, or removal and reduction to possession of plants occurring on Federal lands. However, because of the heavy recreational use within the plant's range and its attractive flower, it continues to be vulnerable to unauthorized picking. A comprehensive USFS management plan is needed to assure the population's continuing viability (USFWS, 2002).

Stressor: Management activities (USFWS, 2002)

Exposure:

Response:

Consequence:

Narrative: Dependence on human disturbance to create habitat puts Holy Ghost ipomopsis directly in the path of future ground-disturbing activities, including road widening, use of heavy equipment, competition from non-native plants, and control of spruce budworm (USFWS, 2002).

Stressor: Exclusion of fire and timber harvest (USFWS, 2002)

Exposure:

Response:

Consequence:

Narrative: Extended fire suppression produces dense thickets and suppresses the herbaceous understory (Moir and Dieterich 1988). This trend is obvious in Holy Ghost Canyon where fire has been excluded for at least 80 years. The forest openings required by Holy Ghost ipomopsis are rare and the species has become confined almost entirely to road cuts and other habitat created through human disturbance. As these disturbance sites are recolonized by trees and shrubs, Holy Ghost ipomopsis numbers decline. Because frequent prescribed fire is incompatible with the present use of the area, this species is now dependent on recurrent soil disturbance associated with Forest Road 122 and the residential home sites in Holy Ghost Canyon. These activities may be insufficient to create or maintain enough habitat to perpetuate a viable population of Holy Ghost Ipomopsis. Timber harvest or significant forest thinning could potentially simulate the effects of natural fire and create Ipomopsis habitat. The principal land uses in the canyon are now summer homes and recreation. Timber harvest, which conflicts with these uses, has been eliminated from the canyon for several decades (USFWS, 2002).

Recovery

Reclassification Criteria:

1. Maintenance of the current population in Holy Ghost Canyon at an average of 2,000 plants per year (USFWS, 2002).
2. Establishment of four additional populations in the upper Pecos Basin, and (3) implementation of a management plan to assure the continued survival of the species (USFWS, 2002).
3. Implementation of a management plan to assure the continued survival of the species (USFWS, 2002).

Delisting Criteria:

Not defined (USFWS, 2002)

Recovery Actions:

- Protect the Holy Ghost ipomopsis population and habitat from existing threats (USFWS, 2002).
- Complete studies to determine the habitat and biological requirements of Holy Ghost ipomopsis (USFWS, 2002).
- Maintain plants in cultivation at a botanical garden and establish a seed bank (USFWS, 2002).
- Survey potentially suitable habitats (USFWS, 2002).
- Develop and implement a plan to establish more populations (USFWS, 2002).

- Encourage public awareness and support for the preservation of Holy Ghost ipomopsis (USFWS, 2002).
- Use the results of monitoring and research studies to determine if populations can sustain themselves and to establish criteria for removing the species from the list of threatened and endangered species (USFWS, 2002).
- Develop a post-recovery monitoring plan (USFWS, 2002).

Conservation Measures and Best Management Practices:

- Commence interagency discussions about management issues regarding the following management needs: archeological surveys, authorized by the USFS, in occupied and potential Holy Ghost ipomopsis habitat that could provide the opportunity for disturbance experiments at a small scale and for WUI project implementation at a large scale; design and implementation of disturbance and forest thinning experiments; augmentation of the Holy Ghost Canyon population with seed and greenhouse-grown material; development of experimental plots to study control of invasive grasses; fire management and road maintenance concerns; spruce budworm control using BT; and, development of a USFS species-specific management plan for the Holy Ghost ipomopsis and/or a USFS area-specific management plan for Holy Ghost Canyon (USFWS, 2008).
- Revisit the 1991 population estimate of 1,250 to 2,500 individuals to see if those numbers and the ratio used to estimate the number of flowering adults and rosettes accurately reflect current numbers of Holy Ghost ipomopsis individuals (USFWS, 2008).
- Conduct a census of the Holy Ghost Canyon population and map all portions of the population including peripheral colonies. Map all monitoring transects and estimate the portion of the total population represented by monitoring data (USFWS, 2008).
- Continue propagation of Holy Ghost ipomopsis for replanting within Holy Ghost Canyon provided that there are projects and clearances in place for their use (USFWS, 2008).
- Establish a botanical garden population and a seed bank for restoration efforts (USFWS, 2008).
- Establish a Botanical Reserve Area in Holy Ghost Canyon to protect the only naturally occurring population of Holy Ghost ipomopsis (USFWS, 2008).
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SPECIES ACCOUNT: *Isodendrion hosakae* (Aupaka)

Species Taxonomic and Listing Information

Listing Status: Endangered; 01/14/1991; Pacific Region (R1) (USFWS, 2016)

Physical Description

Isodendrion hosakae is in the Violaceae, or violet family. It is a branched, upright, short-lived evergreen shrub. Plants range from 8 to 82 centimeters (3 to 32 inches) tall. Flowers and fruits occur on woody stems. Leaves are leathery and lance-shaped, measuring 3 to 7 centimeters (1.2 to 2.8 inches) long and 0.6 to 2.0 centimeters (0.2 to 0.8 in) wide. Stipules are persistent and conspicuously cover stem ends. Flowers are bilaterally symmetrical, yellowish-green to white, and up to 18 millimeters (0.7 inches) long. The fruit is a red-tinged, green elliptical capsule measuring 12 to 16 millimeters (4.7 to 6.3 inches) long, and contains obovoid seeds. *Isodendrion hosakae* is most similar to *I. pyriformis* differing in leaf shape and size of lower flower petal (U.S. Army 2003a).

Historical Range

See current range/distribution

Current Range

Isodendrion hosakae is limited in distribution to the South Kohala District on the island of Hawaii. The potential historical distribution of the taxon is not known, since it was only described some 50 years ago. The species is found on three cinder cones in the Waikoloa area to include Puu Papapa, Puu Nohonaohae, and an unnamed cone east-northeast of Nohonaohae (see Figure 40 in the Transformation Biological Assessment). The presence of this species was confirmed in 2002 on Nohonaohae cinder cone and Puu Papapa (U.S. Army 2003a). The Service considers the existing individuals to be in one meta-population with several sub-populations.

Critical Habitat Designated

Yes; 7/2/2003.

Legal Description

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Isodendrion hosakae* on the island of Hawaii (68 FR 39623 - 39722).

Critical Habitat Designation

The critical habitat designation for *Isodendrion hosakae* includes six units totaling 482 acres in Hawaii County, Hawaii. The units are Hawaii 4—*Isodendrion hosakae*—a, b, c, d, e, f. Hawaii 4—*Isodendrion hosakae*—f, currently is occupied. This unit is essential to the conservation of *I. hosakae* because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The five unoccupied units are essential to the conservation of the species because they support habitat that is necessary for the establishment of additional populations in order to reach recovery goals. Each unit is geographically separated from other critical habitat for this island-endemic species in order to reduce the likelihood of all recovery populations being destroyed by one naturally occurring catastrophic event. Within the six units, habitat is provided on the island

of Hawaii for a total of six populations of *I. hosakae*, each with 300 mature, reproducing individuals.

Hawaii 4—*Isodendron hosakae*—a [49 ha (121 ac)]: This unit contains most of Puu Pa cinder cone and lies in the Pohakuloa watershed in the southwest and in the Waikoloa/Waiulaula watershed in the northeast. Hawaii 4—*Isodendron hosakae*—b [35 ha (87 ac)]: This unit contains most of the Holoholoku cinder cone and lies completely within the Pohakuloa watershed. Hawaii 4—*Isodendron hosakae*—c [49 ha (121 ac)]: This unit contains most of the Puu Makahalau cinder cone and lies completely within the Waipunahoe watershed. Hawaii 4—*Isodendron hosakae*—d [49 ha (121 ac)]: This unit contains most of the Puu Io and Puu Kekuakahea cinder cones and lies completely in the Waipunahoe watershed. Hawaii 4—*Isodendron hosakae*—e [11 ha (26 ac)]: This unit contains most of the Heihei cinder cone and lies completely within the Pohakuloa watershed. Hawaii 4—*Isodendron hosakae*—f [51 ha (127 ac)]: This unit contains upper portions of an unnamed cinder cone in the Pohakuloa watershed. The unit is currently occupied by 8 individuals of *I. hosakae*.

Primary Constituent Elements/Physical or Biological Features

Habitat features that are essential for this species include, but are not limited to, cinder cones with montane dry shrubland.

Special Management Considerations or Protections

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for this species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Habitat Type

Adult: Cinder cones

Habitat Narrative

Adult: *Isodendron hosakae* occurs in areas that have been converted to pasture lands for many decades. The species is typically found on steep cinder cones, inaccessible to cattle and feral herbivore grazers but it was likely to have been more widely distributed before ungulates were

introduced to Hawaii. The species occurs in dry montane shrublands dominated by *Dodonaea viscosa*, *Sophora chrysophylla*, *Wikstroemia* sp, and *Santalum* sp. Plants are often found within the crown of other native shrubs, suggesting a beneficial association. Currently, much of the habitat is now dominated by non-native grass species (e.g., *Pennisetum setaceum*). *Isodendron hosakae* has been observed at elevations from 900 to 1,030 meters (2,953 to 3,379 feet) (U.S. Army 2003a).

Dispersal/Migration

Population Information and Trends

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Additional Population-level Information:

Isodendron hosakae had been known exclusively from three cinder cones in South Kohala (USFWS 1994). Plants now currently only occupy 1 cinder cone, Pu'u Pāpapa, where 57 mature individuals, 44 immature individuals, and 49 seedlings are known, in the Ke'āmuku Maneuver Area of Pōhakuloa Training Area (PTA) (PTA 2019). A total of 85 wild plants are represented by seeds in a seed bank at the PTA. Future outplanting efforts include assuring genetic representation of at least 50 wild plants at each of 4 outplanting sites within the PTA (PTA 2017). (USFWS 2019)

Population Narrative:

Seed production appears nominal. Currently about 320 plants observed, estimate less than 1000 plants. 3 current and no historical occurrences. (NatureServe, 2015)

Threats and Stressors

Stressor:

Exposure:

Response:

Consequence:

Narrative: The major threat to *Isodendron hosakae* is browsing by cattle due to the species' presence on pasture land. Other threats include fire; browsing pressure from ungulates; competition with non-native plant species; and due to the very limited distribution of this species, a single natural or human-caused environmental disturbance could be catastrophic. At the occurrence with the largest number of individuals, severe damage from cattle was noted during a botanical survey conducted in 1988. Plants were broken, and only 25 to 50 plants out of more than 300 previously surveyed in 1980 and 1982, remained. The cinder cones and the species on them are particularly vulnerable to fire. For example, in 1999, fire consumed 95 percent of the Nohonaohae cinder cone vegetation and the occurrence of eight individuals of *I. hosakae* was reduced to a single plant. *Isodendron hosakae* is also threatened by competition for light, space and nutrients from non-native plant species including *Pennisetum setaceum*, *Salsola kali*, and *Senecio madagascariensis* (U.S. Army 2003a).

Stressor:**Exposure:****Response:****Consequence:**

Narrative: All wild individuals are fenced and fences are maintained and they are considered protected from feral ungulates. All future outplanting sites will occur in fenced, suitable habitat in the Ke'āmuku Maneuver Area. Other documented threats, such as invasive plants, fire, and military activities are being mitigated by the Natural Resources Program for the PTA (PTA 2107, USFWS 2012). An approximately 5-acre (2-hectare) habitat restoration project was initiated in July of 2018 and is ongoing at Pu'u Pāpapa, currently focused on the removal of the invasive *Pennisetum setaceum*, and anticipated to include outplanting of native plant species known from the area (PTA 2019). Climate change has also been identified as a threat, but has yet to be addressed for this species (USFWS 2012). Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai'i using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under predicted climate change. This assessment concluded that *I. hosakae* is highly vulnerable to the impacts of climate change, with a score of 0.827 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). This species was determined to have no overlap between current and future climate envelopes, and is unlikely to easily tolerate expected changes in climate. This limitation means that *I. hosakae* must either endure in suitable microrefugia within its current climate envelope, or move to newly available climate-compatible areas to avoid extinction. Therefore, additional management actions are needed to conserve this taxon into the future (USFWS 2019).

Recovery**Reclassification Criteria:**

There are 5 to 10 populations in suitable, protected habitat with 500 mature individuals per population (USFWS 2019).

All major threats are controlled around the target populations (USFWS 2019).

Populations are represented in an ex situ collection as defined in the Center for Plant Conservation guidelines (Guerrant et al. 2004) that is secure and well managed (USFWS 2019).

All target populations have been stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions may continue to be necessary. (USFWS 2019)

Delisting Criteria:

All of the downlisting criteria have been met (USFWS 2019).

All target populations have been stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but an ongoing need for ecosystem-wide management actions may remain if long-term agreements are in place to continue management (USFWS 2019).

Conservation Measures and Best Management Practices:

- The following important conservation actions are needed: control threats from cattle and maintenance of ungulate-proof fences around each occurrence of *Isodendron hosakae*; establishment of fire breaks and development of a fire response and suppression plan for Keamuku Parcel; establishment of a germ plasm reserve; control of *Pennisetum setaceum* and other non-native plants species; restoration of native habitat; and outplanting to enhance remaining wild occurrences and establishment of new occurrences within its historic range (Service 1994). In addition, a State-wide management plan that identifies areas and landscapes for the long-term conservation of all known occurrences of *I. hosakae* is needed. As part of this management plan, landowners and managers should delineate management units to conserve this species and other native species through threat control and habitat restoration.

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SPECIES ACCOUNT: *Isodendrion laurifolium* (Aupaka)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

A shrub 10-20 dm tall. The flowers are purple and are borne singly along the stems (NatureServe, 2015).

Taxonomy

A member of the violet family (Violaceae). Other published names considered synonymous with *Isodendrion laurifolium* are *I. forbesii*, *I. lydgatei*, *I. subsessilifolium*, and *I. waianaeense* (Wagner et al. 1990) (USFWS, 1999).

Historical Range

It was historically known from scattered locations on Kauai and the Koolau and Waianae Mountains on Oahu (USFWS, 2009).

Current Range

Currently occurs on Oahu and Kauai (NatureServe, 2015).

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Isodendrion laurifolium* (Aupaka) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Isodendrion laurifolium* (77 FR 57648-57862). The critical habitat designation includes 15 critical habitat units, which encompass approximately 9,271 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Isodendrion laurifolium* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Isodendrion laurifolium* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Isodendrion laurifolium* includes 15 critical habitat units, covering two ecosystem types, which encompass approximately 9,271 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7; Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and

277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac (105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

The critical habitat designation for *Isodendron laurifolium* includes two units totaling 1,979 acres in Kauai County, Hawaii. The units are Kauai 11—*Isodendron laurifolium*— a, b.

Kauai 11—*Isodendron laurifolium*—a: This unit is critical habitat for *Isodendron laurifolium* and is 401 ha (991 ac) on State land (Kuia NAR). This unit contains portions of Mahanaloa Valley and Milolii Ridge. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial *Isodendron laurifolium* and is currently occupied with

between 86 and 96 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. It provides habitat for the westernmost range of the species that is unique to Kauai. The habitat features contained in this unit that are essential for this species include, but are not limited to, diverse mesic forest dominated by *Metrosideros polymorpha*, *Acacia koa* or *Diospyros* spp. This unit provides for two populations within this multi-island species' historical range on Kauai that are some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event. Kauai 11—*Isodendron laurifolium*—b: This unit is critical habitat for *Isodendron laurifolium* and is 400 ha (988 ac) on State land (Alakai Wilderness Preserve) containing portions of Kawaiiki Valley. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial *Isodendron laurifolium* and is currently occupied with between six and eight plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. It provides habitat for the westernmost range of the species that is unique to Kauai. The habitat features contained in this unit that are essential for this species include, but are not limited to, diverse mesic forest dominated by *Metrosideros polymorpha*, *Acacia koa* or *Diospyros* spp. This unit provides for two populations within this multi-island species' historical range on Kauai that are some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Isodendron laurifolium* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Isodendron laurifolium* occurs within the Lowland mesic and Dry cliff ecosystems in the Waianae Mountain caldera complex and was known historically (last observed > 20 yrs ago) from the Lowland mesic ecosystem in the Koolau Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: *Antidesma*, *Chamaesyce*, *Diospyros*, *Dodonaea*. (F) Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Schiedea*.

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Diverse mesic forest dominated by *Metrosideros polymorpha*, *Acacia koa* or *Diospyros* spp. and containing one or more of the following associated native plant species: *Alphitonia ponderosa*, *Antidesma* spp., *Claoxylon sandwicense*, *Dodonaea viscosa*, *Dubautia* spp.,

Elaeocarpus bifidus, Euphorbia haeleeleana, Hedyotis terminalis, Kokia kauaiensis, Melicope anisata, Melicope barbigera, Melicope ovata, Melicope peduncularis, Myrsine lanaiensis, Nestegis sandwicensis, Pisonia spp., Pittosporum glabrum, Pleomele aurea, Pouteria sandwicensis, Psydrax odorata, Streblus pendulinus, or Xylosma hawaiiense; and

(ii) Elevations between 397 and 1,164 m (1,303 and 3,817 ft).

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Isodendron laurifolium* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Lifespan

Adult: < 10 years (USFWS, 2013)

Breeding Season

Adult: February - December (USFWS, 2009)

Reproduction Narrative

Adult: It is a short-lived perennial (fewer than ten years) (USFWS, 2013). Specimen vouchers at Bernice P. Bishop Museum (C. Imada, Bernice P. Bishop Museum, pers. comm. 2008), the herbarium database at the National Tropical Botanical Garden (2008), and data from Hawaii Biodiversity and Mapping Program (2007) reveal the following phenological patterns: on Kauai, flowering specimens were noted from February through April, July through September, and November to December; fruiting specimens were noted in February, March, May, July through September, and November to December. On Oahu, flowering was noted from February to March, May to June, August, and October; fruiting was noted in February and May (USFWS, 2009).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Ohia, koa-ohia or ohia-lama mesic or wet forest (USFWS, 1999)

Geographic or Habitat Restraints or Barriers

Adult: 1,620 - 2,700 ft. elevation (USFWS, 1999)

Habitat Narrative

Adult: Inhabits moist forests, or rarely wet forests. On gulch slopes (NatureServe, 2015). Environmental requirements and limiting factors are unknown. *Isodendron laurifolium* is usually found at elevations between 490 and 820 meters (1,620 and 2,700 feet) in diverse mesic forest, or rarely wet forest, dominated by ohia or koa-ohia, or ohia-lama with hame, maua, *Hedyotis terminalis*(manono), *Pisonia* sp. (papala kepau), and *Pouteria* sp. (alan) (USFWS 1996a; S. Perlman, personal communication 1999) (USFWS, 1999).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Decrease in population number; increase in population size (USFWS, 2013)

Resiliency:

Low (inferred from NatureServe, 2015; see current range/distribution)

Redundancy:

Moderate (inferred from USFWS, 2013)

Number of Populations:

16 (USFWS, 2013)

Population Size:

219 (USFWS, 2013)

Additional Population-level Information:

Isodendron laurifolium has been found on Kauai at Makaha (ca 70 individuals), Paaiki (one individual), Poopooiki (one individual), Kawaiula (nine individuals), Kalalau (one individual), Kuia drainage (nine individuals), Nualolo (one individual), and on Waialae Trail (ca 50 individuals) (NTBG 2013a, 2014a-f, 2015a-e, 2016a-d). In 2015, Wood et al. reported 9 “subpopulations” (considered “populations” by USFWS) on Kauai totaling 130 individuals (Wood et al. 2015). This is a decline from the last five year review. On Oahu, *I. laurifolium* is reported from the Waianae Mountains at Makaha (58 individuals), Waianae Kai (12 individuals), and Pahole (12 individuals) (PEPP 2017). Currently, there are nine populations on Kauai, and three on Oahu. These populations total about 212 individuals, with the majority of individuals on Kauai. (USFWS 2017)

Population Narrative:

The numbers on Kauai remain around 150 individuals in 13 or fewer populations; three populations of *Isodendron laurifolium* are located on Oahu. Populations of *Isodendron laurifolium* appear to have fluctuated since the last five-year review, with fewer populations but an increase from 164 to 219 individuals (USFWS, 2013).

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The species is threatened by habitat degradation from feral goats (*Capra hircus*), feral pigs (*Sus scrofa*), black-tailed or mule deer (*Odocoileus hemionus*); competition with introduced invasive plant species such as: *Psidium cattleianum* (strawberry guava), *Rubus rosifolius* (thimbleberry), *Lantana camara* (lantana), *Grevillea robusta* (silky oak), *Kalanchoe pinnata* (air plant) and *Erigeron karvinskianus* (daisy fleabane); and potentially from military activities (Factor E) (USFWS 1996, 1999, 2003a, b, 2007; K. Wood, pers. comm. 2008) (USFWS, 2009).

Stressor: Climate change (USFWS 2017)

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Isodendron laurifolium* is extremely vulnerable to the impacts of climate change with a vulnerability score of 0.843 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon

into the future. Seed storage and propagation efforts are ongoing, with individuals outplanted in managed areas. (USFWS 2017)

Recovery

Reclassification Criteria:

1. A total of five to seven populations should be documented on islands where it now occurs or occurred historically (USFWS, 1999).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 1999).
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1999).

Delisting Criteria:

1. A total of 8 to 10 populations should be documented on islands where it now occurs or occurred historically (USFWS, 1999).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 1999).
3. Each population should persist at this level for a minimum of five consecutive years (USFWS, 1999).

Recovery Actions:

- Protect habitat and control threats (USFWS, 1999).
- Expand existing wild populations (USFWS, 1999).
- Conduct essential research (USFWS, 1999).
- Develop and maintain monitoring plans (USFWS, 1999).
- Reestablish wild populations within the historic range (USFWS, 1999).
- Validate and revise recovery criteria (USFWS, 1999).
- Construct exclosures to protect populations against feral and wild ungulates (USFWS, 1999).
- Control competing alien plant species (USFWS, 1999).
- Maintain adequate genetic stock (USFWS, 1999).
- Enhance wild populations and establish new populations (USFWS, 1999).
- Captive propagation for genetic storage and reintroduction—Seed collection and plant propagation for Oahu populations is ongoing and almost complete with over 2,000 seeds in storage from 51 founders. PEPP also has 19 plants from nine different collections growing at the Pahole Rare Plant Facility (Lyon Arboretum 2017). There are three seed collections that have been made over the last few years from plants on Kauai (NTBG 2017). (USFWS 2017)
- Reintroduction and translocation—There is an outplanting on Oahu of approximately 40 individuals (PEPP 2017). On Kauai, there are about 25 individuals in three separate exclosures (HBMP 2010; PEPP 2012, 2013, 2014). (USFWS 2017)

- Fire monitoring and control—On Oahu, the Waianae Mountains Watershed Partnership is controlling nonnative plant species and growing a native plant fuel break in Waianae Kai to reduce the risk of wildfires. (USFWS 2017)
- Predator and herbivore monitoring and control—On Oahu, the Oahu Army Natural Resources Program (OANRP) is controlling ungulates and rats within fenced exclosures at Makaha (U.S. Army 2016). (USFWS 2017)
- Surveys and inventories—Survey geographical and historic range for a thorough current assessment of the species (USFWS 2017).
- Invasive plant monitoring and control (USFWS 2017) o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative species that compete with the species around all populations.
- Population biology research—Study *Isodendron laurifolium* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS 2017).
- Genetic research—Assess genetic variability within extant populations (USFWS 2017).

Conservation Measures and Best Management Practices:

- Captive propagation for genetic storage and reintroduction: Collect cuttings or seed from tagged individuals, recording maternal source. Continue to collect seeds from all existing populations (USFWS, 2013).
- Reintroduction / translocation: Determine which sites are least invaded by invasive introduced plant species and which appear to have the highest likelihood of maintaining new reintroductions. Continue to reintroduce the species back into its known historical range (USFWS, 2013).
- Ungulate exclosures: Construct ungulate-proof fenced exclosures around each population and monitor the fences for any signs of breaching. Protect all populations against disturbances from feral ungulates (USFWS, 2013).
- Ecosystem-altering invasive plant species control – Control invasive introduced plant species around all populations (USFWS, 2013).
- Predator / herbivore control - Implement effective control methods for rodents (USFWS, 2013).
- Surveys / inventories - Survey geographical and historical range for a thorough current assessment of the species status (USFWS, 2013).
- Threats research: Develop and implement effective measures to reduce the impact of landslides and flooding and military activities. Assess the modeled effects of climate change on this species, and use results to determine future landscape needed for the recovery of the species (USFWS, 2013).
- Fire protection - Develop and implement fire management plans for all wild and reintroduced populations (USFWS, 2013).
- Alliance and partnership development - Initiate planning and contribute to implementation of ecosystem-level management and restoration to benefit this species (USFWS, 2013).
- Genetics research - Assess genetic variability within extant populations (USFWS, 2013).
- Population biology research - Study *Isodendron laurifolium* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2013).

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SPECIES ACCOUNT: *Isodendron longifolium* (Aupaka)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

An erect, few-branched, lanky shrub, 6-20 dm tall, with purple flowers borne singly along the branches (NatureServe, 2015).

Taxonomy

A member of the violet family (Violaceae). *Isodendron christensenii* and *Isodendron maculatum* (St. John 1952, 1978b) are considered synonymous with *Isodendron longifolium* (Wagner et al. 1990) (USFWS, 1999).

Historical Range

Historically *Isodendron longifolium* was known from scattered locations on Kauai and the Waianae Mountains on Oahu (Lorence and Flynn 1991, 1993; USFWS 1996a; Hawaii and Pacific Plants Recovery Coordinating Committee, in litt. 1996) (USFWS, 1999).

Current Range

Since 2003, seven populations were observed on Kauai and no individuals were observed on Oahu (USFWS, 2011).

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Isodendron longifolium* (Aupaka) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Isodendron longifolium* (77 FR 57648-57862). The critical habitat designation includes 23 critical habitat units, which encompass approximately 33,624 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Isodendron longifolium* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Isodendron longifolium* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Isodendron longifolium* includes 23 critical habitat units, covering two ecosystem types, which encompass approximately 33,624 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7; Oahu—Lowland Wet—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

Oahu—Lowland Wet—Unit 1 [541 ac (219 ha)]. This area consists of 428 ac (173 ha) of State land and 112 ac (46 ha) of City and County of Honolulu land in the lowland wet ecosystem on the windward side of the Waianae Mountains, and partially within the Mokuleia and Waianae Kai Forest Reserves. Oahu—Lowland Wet—Unit 2 [20 ac (8 ha)]. This area consists of 19 ac (8 ha) of State land in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puuhapapa. Oahu—Lowland Wet—Unit 3 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puukanehoa. Oahu—Lowland Wet—Unit 4 [27 ac (11 ha)]. This area consists of 27 ac (11 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains on State land at Puukaua. Oahu—Lowland Wet—Unit 5 [74 ac (30 ha)]. This area consists of 74 ac (30 ha) of State land in the lowland wet ecosystem, on the windward side of the Waianae Mountains at Palikea. Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Hauula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikēkee, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau

Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet—Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet—Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu—Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamoa Ridge.

The critical habitat designation for *Isodendron longifolium* includes five units totaling 3,488 acres in Kauai County, Hawaii. The units are Kauai 7—*Isodendron longifolium*—a, Kauai 10—*Isodendron longifolium*—b, and Kauai 11—*Isodendron longifolium*—c, d, e.

Kauai 7—*Isodendron longifolium*—a: This unit is critical habitat for *Isodendron longifolium* and is 338 ha (833 ac) on private land. This unit contains Hokulei Peak, Haupu and Naluakeina Summits, and Queen Victoria's Profile. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Isodendron longifolium* and is currently occupied with two plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. It provides habitat for the westernmost range of the species. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep slopes, gulches, or stream banks and flats in undisturbed areas, in mesic or wet *Metrosideros polymorpha*-*Acacia koa* forests. This unit provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Kauai 10—*Isodendron longifolium*—b: This unit is critical habitat for *Isodendron longifolium* and is 142 ha (350 ac) on private land containing Hulua Summit. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Isodendron longifolium* and is currently occupied with between 83 and 103 plants. This unit is essential to the

conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. It provides habitat for the westernmost range of the species. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep slopes, gulches, or stream banks and flats in undisturbed areas, in mesic or wet *Metrosideros polymorpha*-*Acacia koa* forests. This unit provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Kauai 11—*Isodendron longifolium*—c: This unit is critical habitat for *Isodendron longifolium* and is 59 ha (145 ac) on State land (Kokee and Na Pali Coast State Parks), containing Kainamanu Summit. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Isodendron longifolium* and is currently occupied with 20 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. It provides habitat for the westernmost range of the species. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep slopes, gulches, or stream banks and flats in undisturbed areas, in mesic or wet *Metrosideros polymorpha*-*Acacia koa* forests. This unit provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event. Kauai 11—*Isodendron longifolium*—d: This unit is critical habitat for *Isodendron longifolium* and is 494 ha (1,219 ac) on State land (Halelea Forest Reserve). This unit contains Kaliko and Puu Manu Summit. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Isodendron longifolium* and is currently occupied with between 80 and 90 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. It provides habitat for the westernmost range of the species. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep slopes, gulches, or stream banks and flats in undisturbed areas, in mesic or wet *Metrosideros polymorpha*-*Acacia koa* forests. This unit provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event. Kauai 11—*Isodendron longifolium*—e: This unit is critical habitat for *Isodendron longifolium* and is 381 ha (941 ac) on State (Halelea Forest Reserve, Hono o Na Pali NAR, and Na Pali Coast State Park) and private land. This unit contains Pohahea Summit. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial *Isodendron longifolium* and is currently occupied with 424 plants. This unit is essential to the conservation of the taxon because it supports extant colonies of this species and includes habitat that is important for the expansion of the present populations, which are currently considered nonviable. It provides habitat for the westernmost range of the species. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep slopes and some flats in certain undisturbed areas, gulches, or stream banks in mesic or wet *Metrosideros polymorpha*-*Acacia koa* forests. This unit provides for two populations within this multi-island species' historical range on Kauai that are some distance

away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Isodendron longifolium* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Isodendron longifolium* occurs within the lowland mesic and Lowland wet ecosystems in the Waianae Mountain caldera complex and the Koolau Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (E) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Oahu—Lowland Wet—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (E) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Steep slopes, gulches, or streambanks and flats in undisturbed areas, in mesic or wet *Metrosideros polymorpha*-*Acacia koa* forests and containing one or more of the following native species: *Antidesma* spp., *Bidens* spp., *Bobea brevipes*, *Cheirodendron* spp., *Cibotium* spp., *Cyanea hardyi*, *Cyrtandra* spp., *Dicranopteris linearis*, *Diospyros* spp., *Eugenia reinwardtiana*, *Hedyotis* spp., *Ilex anomala*, *Melicope* spp., *Nestegis sandwicensis*, *Peperomia* spp., *Perrottetia sandwicensis*, *Pipturus* spp., *Pittosporum* spp., *Pritchardia* spp., *Psychotria* spp., *Psydrax odorata*, or *Syzygium sandwicensis*; and

(ii) Elevations between 127 and 1,295 m (418 and 4,246 ft).

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Isodendron longifolium* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations,

intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Lifespan

Adult: < 10 years (USFWS, 2011)

Breeding Season

Adult: Unknown (USFWS, 1999)

Key Resources Needed for Breeding

Adult: Unknown (USFWS, 1999)

Reproduction Narrative

Adult: It is a short-lived perennial (fewer than 10 years) (USFWS, 2011). Reproductive cycles, longevity, specific environmental requirements, and limiting factors are unknown (USFWS, 1999).

Habitat Type

Adult: Terrestrial (NatureServe, 2015); riparian (USFWS, 1999)

Habitat Vegetation or Surface Water Classification

Adult: Mixed mesic forest, wet ohia forest (USFWS, 1999)

Geographic or Habitat Restraints or Barriers

Adult: 1,350 - 2,500 ft. elevation (USFWS, 1999)

Habitat Narrative

Adult: Usually in moist forests; less frequently in wet forests. On gulch slopes and in gulch bottoms (NatureServe, 2015). *Isodendrion longifolium* is found on steep slopes, gulches, and stream banks in mixed mesic or wet ohia forest, usually at elevations between 410 and 760 meters (1,350 and 2,500 feet) (USFWS, 1999).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Resiliency:

Very low (inferred from USFWS, 2011; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2011)

Number of Populations:

7 (USFWS, 2011)

Population Size:

103+ (USFWS, 2011)

Additional Population-level Information:

A total of 7 populations have been observed on Kaua'i since 2009: 1) Hanakāpi'ai (2 individuals in 2012), 2) Honopū (60 individuals in 2013; PEPP 2014), 3) 'Ili'ili'ula (about 50 individuals in 2013), 4) Mānoa Stream/Limahuli (1 individual; PEPP 2014), 5) Mount Kahili (3 individuals in 2016), 6) Nu'alolo (13 individuals in 2012), and 7) Wai'ahi in the northern headwaters and north of Kapalaoa (estimated 200 individuals; NTBG 2013d-f). Two other populations, located near Mt. Hā'ūpu and in Wainiha, had been observed in 2005 and 2009, respectively, but not since then. This species has not been observed since 2001 in these 5 locations: Pōhakuao, Waioli Valley, Kalalau Valley, Kawai'ula Valley, and the Wahiawa Stream area. Walsh (2015) reported an estimate of 11 extant "subpopulations" (considered "populations" by the Service) totaling 350 individuals from Kaua'i, with the majority of plants in 1 large population of 200 individuals at Wai'ahi (consisting of at least 2 sites within this population). This estimate includes some populations that were last observed prior to 2009. On O'ahu there are two populations totaling four individuals in the Wai'anae Mountains; three plants in Ka'awa Gulch and one in Palikea Gulch. There are no other known plants in the Ko'olau Mountains (OANRP 2016; PEPP 2017). Prior to 2003, the maximum total population estimate for this species was 2,000 plants. A decline in population size has been observed at all locations that have been revisited and for which population estimates have been revised. There is a current maximum total population size of 354, and a minimum total population size (of populations visited within the last 7 years) of 333 individuals. On O'ahu the decline has been most severe, with only 6 percent of the known plants remaining (4 of 65 individuals). Since 2009, 7 populations have been observed on Kaua'i,

and 2 on O'ahu. These populations total 333 to 354 individuals, with the majority of individuals on Kaua'i, and around 200 plants estimated to be in the largest single population at Wai'ahi. Despite the recent discovery of the large Wai'ahi population, which represents an increase in the total number of known plants since the previous 5-year review, the species continues to be in overall decline. Population size has decreased in all populations that have been revisited, and the estimated total number of individuals has decreased by over 80 percent compared to estimates prior to 2003. (USFWS 2019)

Population Narrative:

The total census for *I. longifolium* statewide is seven populations containing at least 103 individuals (USFWS, 2011).

Threats and Stressors

Stressor: Habitat destruction and degradation (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Habitat degradation or destruction by feral goats (*Capra hircus*) and pigs (*Sus scrofa*) and invasive introduced plant species (USFWS, 2011).

Stressor: Predation (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Goats, pigs, and rats (*Rattus* spp.) eat the fruit, and slugs (unidentified species) presumably also eat the foliage of *Isodendron longifolium* (Hawaii Biodiversity and Mapping Program 2009; National Tropical Botanical Garden 2010b; Wood 2009b) (USFWS, 2011).

Stressor: Stochastic events (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Fire is considered a threat to *Isodendron longifolium* on Kauai (Hawaii Biodiversity and Mapping Program 2009; Perlman 2009; Wood 2009b). On Oahu, the Palikea Gulch occurrence is also potentially threatened by fire (USFWS 2003b). On Oahu, there is also the risk of extinction from naturally occurring events due to the small number of occurrences and individuals (USFWS 2003b) (USFWS, 2011).

Stressor: Climate change (USFWS 2019)

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai'i using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Isodendron longifolium* is vulnerable to the impacts of climate change with a vulnerability score

of 0.49 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). (USFWS 2019)

Stressor: Hurricanes (USFWS 2019)

Exposure:

Response:

Consequence:

Narrative: While the effects of hurricanes do not pose a new threat, they were not specifically discussed in the last 5-year review. In November 1982, Hurricane 'Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Ni'ihau, Kaua'i, and O'ahu (Businger 1998). In September 1992, Hurricane 'Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kaua'i. Although specific effects on *Isodendron longifolium* populations are not known to have been quantified, many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of extirpating a localized population in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, models project an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by the year 2100 (Murakami et al. 2013). (USFWS 2019)

Stressor:

Exposure:

Response:

Consequence:

Narrative: Further, two of the extant populations are impacted by the presence of a new threat, black-tailed deer. Growth and stability of the newly discovered Wai'ahi population is limited by rats eating fruit and plants, slugs eating seedlings, and weeds restricting population areas and competing for resources. No populations on Kaua'i are protected from ungulates. A landscape-based assessment of climate change vulnerability for native plants of Hawai'i using high resolution climate change projections was completed by Fortini et al. (2013) and their analysis showed that *Isodendron longifolium* is vulnerable to the effects of climate change. Seed storage and propagation efforts are ongoing. The O'ahu plants are well represented in captive propagation, but only 10 individuals from Kaua'i are represented. (USFWS 2019)

Recovery

Reclassification Criteria:

1. A total of five to seven populations should be documented on islands where it now occurs or occurred historically (USFWS, 1999).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 1999).

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1999).

Delisting Criteria:

1. A total of 8 to 10 populations should be documented on islands where it now occurs or occurred historically (USFWS, 1999).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 1999).
3. Each population should persist at this level for a minimum of five consecutive years (USFWS, 1999).

Recovery Actions:

- Protect habitat and control threats (USFWS, 1999).
- Expand existing wild populations (USFWS, 1999).
- Conduct essential research (USFWS, 1999).
- Develop and maintain monitoring plans (USFWS, 1999).
- Reestablish wild populations within the historic range (USFWS, 1999).
- Validate and revise recovery criteria (USFWS, 1999).
- Construct exclosures to protect populations against feral and wild ungulates (USFWS, 1999).
- Control competing alien plant species (USFWS, 1999).
- Maintain adequate genetic stock (USFWS, 1999).
- Enhance wild populations and establish new populations (USFWS, 1999).
- Protect endangered plants from fire (USFWS, 1999).
- Captive propagation for genetic storage and reintroduction—Seed collection and propagation is ongoing at Lyon Arboretum and at The National Tropical Botanical Garden (NTBG). There are nine plants from three collections at the Pahole Rare Plant Facility. There are two founders represented at the Lyon Micropropagation Lab (both are founders that are also at the Pahole Facility). There are four founders from one other population on O‘ahu (Ka‘awa) represented at the Lyon Seed Conservation Lab. There are a few dozen plants at the NTBG nursery from three different collection events on Kaua‘i (Waiahi (eight individuals represented), Mt. Kāhili (one individual represented), and Hanakāpi‘ai (one individual represented)) (PEPP 2016; Lyon Arboretum 2017; NTBG 2017). (USFWS 2019)
- Surveys and inventories—Survey for populations of *Isodendron longifolium* in areas of potentially suitable habitat. (USFWS 2019)
- Invasive plant monitoring and control (USFWS 2019):
 - o Control established ecosystem-altering nonnative invasive plant species around all populations.
 - o Control invasive nonnative species that compete with the species around all populations.
- Reintroduction and translocation—Reintroduce individuals into suitable habitat within historical range that is being managed for known threats to this species (USFWS 2019).
- Predator and herbivore control research—Determine and implement effective control measures for slugs (USFWS 2019).
- Predator and herbivore monitoring and control—Implement effective control methods for rodents (USFWS 2019).

Conservation Measures and Best Management Practices:

- Construct large-scale fences around all naturally occurring and reintroduced individuals to control feral ungulates (USFWS, 2011).
- Control invasive introduced plant species around known populations (USFWS, 2011).
- Collect material for genetic storage and propagation for reintroduction (USFWS, 2011).
- Coordinate fire protection on State Natural Area Reserves, such as Mt. Kaala, where one of three Oahu populations occurs (USFWS, 2011).
- Control rats in the vicinity of these populations (USFWS, 2011).
- Develop and implement methods to control slugs (USFWS, 2011).
- Assess the current status of historic populations, reproductive trends, and threats to the species to determine if downlisting is warranted (USFWS, 2011).
- Work with Hawaii Division of Forestry and Wildlife and Hawaii State Parks to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2011).
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2011).

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SPECIES ACCOUNT: *Isodendrion pyriforme* (Kula wahine noho)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/04/1994; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Isodendrion pyriforme A. Gray is a small, branched shrub 2.6-6.6 ft (0.8-2 m) tall (Wagner et al. 1990). Elliptic to lance-shaped leaf blades are 1-2.6 in (2.5-6.5 cm) long and 0.3-1.3 in (0.8-3.2 cm) wide. The papery-textured blade is moderately hairy beneath (at least on the veins) and stalked. The stalk (petiole) is 0.2-0.4 in (0.5-1 cm) long and is subtended by oval, hairy, bract-like structures (stipules) 0.1-0.2 in (2.8-5 mm) long. Fragrant, bilaterally symmetrical flowers are solitary. The flower stalk (pedicel) is 0.07-0.2 in (1.5-4 mm) long, white hairy, and subtended by two bracts 0.08-0.1 in (2-3 mm) long. Bracts arise at the tip of the main flower stalk (peduncle) 0.08-0.2 in (2-6 mm) long. The five sepals are lance-shaped 0.1-0.2 in (3.5-5 mm) long, membranous-edged and fringed with white hairs. Five green-yellow petals are somewhat unequal, 0.4-0.6 in (10-15 mm) long and lobed, 0.2 in (5 mm), the upper being the shortest and the lower the longest. The fruit is a 3-lobed, oval capsule, 0.5 in (12 mm) long, which splits to release olive-colored seeds 0.1 in (3-3.2 mm) long and 0.08 in (1.8-2.2 mm) in diameter. (USFWS, 1996)

Taxonomy

First described by Asa Gray (1852) after its collection on Oahu during the United States Exploring Expedition of 1841. St. John (1952), in his monograph, divided the genus into five species: *I. hawaiiense* St. John, *I. hittebrandii* St. John, *I. tanaianse* St. John, *I. motakajense* St. John, and *I. remyi* St. John. The current treatment (Wagner et al. 1990) recognizes *I. pyriforme* as the correct name and considers the other names as synonyms. Gray chose the specific epithet, *pyriforme*, because the shape of the leaf resembles a pear (*pyrus*) (USFWS, 1996).

Historical Range

See Current Range.

Current Range

Known from Niihau, Oahu, Molokai, Maui, Lanai and Hawaii (USFWS, 1996).

Critical Habitat Designated

Yes; 3/19/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Isodendrion pyriforme* (Kula wahine noho) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 13 detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

On September 18, 2012, the U.S. Fish and Wildlife Service (Service) designated revised critical habitat for *Isodendrion pyriforme* on Oahu.

On September 20, 2018, the U.S. Fish and Wildlife Service designated final critical habitat for *Isodendrion pyriforme* on the island of Hawaii.

Critical Habitat Designation

The critical habitat designation for *Isodendron pyrifolium* includes 13 CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Molokai—Lowland Mesic—Unit 1 (and) *Palmeria dolei*—Unit 37—Lowland Mesic (and) *Pseudonestor xanthophrys*—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Ctenitis squamigera*, *Cyanea dunbariae*, *C. mannii*, *C. profuga*, *Cyperus fauriei*, *Cyrtandra filipes*, *Gouania hillebrandii*, *Labordia triflora*, *Neraudia sericea*, *Santalum haleakalae* var. *lanaiense*, *Schiedea lydgatei*, *S. sarmentosa*, *Silene alexandri*, *S. lanceolata*, *Spermolepis hawaiiensis*, and *Zanthoxylum hawaiiense*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Mesic—Unit 1 is not known to be occupied by *Asplenium dielerectum*, *Bonamia menziesii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea procera*, *C. solanacea*, *Diplazium molokaiense*, *Festuca molokaiensis*, *Flueggea neowawraea*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Melicope mucronulata*, *M. munroi*, *M. reflexa*, *Phyllostegia haliakalae*, *P. mannii*, *P. pilosa*, *Sesbania tomentosa*, *Stenogyne bifida*, or *Vigna o-wahuensis*, or the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 2 (and) *Palmeria dolei*—Unit 3—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 3— Lowland Wet (and) *Newcombia cumingi*—Unit 1—Lowland Wet This area consists of 65 ac (26 ha) of State land at Moomoku, on the northwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. Although Maui—Lowland Wet—Unit 2 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), or by the Newcomb's tree snail (*Newcombia cumingi*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 3 (and) *Palmeria dolei*—Unit 4—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 4— Lowland Wet This area consists of 1,247 ac (505 ha) of State land at Honanana Gulch on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta*, *Cyanea asplenifolia*, and *Pteris lidgatei*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 3 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 4 (and) *Palmeria dolei*—Unit 5—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 5— Lowland Wet This area consists of 864 ac (350 ha) of State land at Kahakuloa Valley on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta* and *Cyanea asplenifolia*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 4 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 5 (and) *Palmeria dolei*—Unit 6—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 6— Lowland Wet This area consists of 30 ac (12 ha) of State land at Iao Valley on the eastern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 5 is not known to be occupied by the plants *Alectryon macrococcus*,

Asplenium dielerectum, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 6 (and) *Palmeria dolei*—Unit 7—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 7— Lowland Wet This area consists of 136 ac (55 ha) of State land at Honokowai and Wahikuli valleys on the western slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 6 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 7 (and) *Palmeria dolei*—Unit 8—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 8— Lowland Wet This area consists of 898 ac (364 ha) of State land at Olowalu Valley, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Alectryon macrococcus*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 7 is not currently occupied by the plants *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have

determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 8 (and) *Palmeria dolei*—Unit 9—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 9— Lowland Wet This area consists of 230 ac (93 ha) of State land at upper Ukumehame Gulch, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 8 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformum*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 5 (and) *Palmeria dolei*—Unit 29—Dry Cliff (and) *Pseudonestor xanthophrys*—Unit 29— Dry Cliff This area consists of 1,298 ac (525 ha) of State land, from Helu and across Olowalu to Ukumehame Gulch, on west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). They are occupied by the plant *Tetramolopium capillare*, and contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Dry Cliff—Unit 5 is not currently occupied by the plants *Bonamia menziesii*, *Diplazium molokaiense*, *Hesperomannia arbuscula*, *Isodendron pyriformum*, *Kadua laxiflora*, or *Neraudia sericea*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 6 consists of 279 ac (113 ha) of State land along the east wall of Ukumehame Gulch on west Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). Although Maui—Dry Cliff— Unit 6 is not currently occupied by the plants *Bonamia menziesii*, *Diplazium molokaiense*, *Hesperomannia arbuscula*, *Isodendron pyriformum*, *Kadua laxiflora*, *Neraudia sericea*, or *Tetramolopium capillare*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations

within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 6 (and) *Palmeria dolei*—Unit 35—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 35—Wet Cliff This area consists of 1,858 ac (752 ha) of State land, and 253 ac (102 ha) of privately owned land, at the summit ridges of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plants *Alectryon macrococcus*, *B. conjuncta*, *Ctenitis squamigera*, *Cyrtandra munroi*, *Remya mauiensis*, and *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 6 is not known to be occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Bonamia menziesii*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, or *Tetramolopium capillare*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 7 (and) *Palmeria dolei*—Unit 36—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 36—Wet Cliff This area consists of 556 ac (225 ha) of State land along Honokowai ridge on the northwestern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units are occupied by the plants *Cyrtandra filipes* and *C. munroi*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 7 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 8 consists of 337 ac (137 ha) of State land along Kahakuloa ridge on the north side of west Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff—Unit 8 is

not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat designation for *Isodendron pyrifolium* includes 14 units totaling 1,924 acres on Oahu. The units are Oahu—Lowland Dry—Unit 1, 2, 8, 9, 10, 11; Oahu— Dry Cliff—Unit 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Lowland Dry—Unit 1 consists of 49 ac (20 ha) of State land and 53 ac (22 ha) of privately owned land in the Waianae Mountains, extending from Haili Gulch to Kawaipahai. Although this unit is not known to be occupied by *Isodendron pyrifolium*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Dry—Unit 2 consists of 29 ac (12 ha) in the lowland dry ecosystem in the Waianae Mountains, on Federal land within Kaena Point State Park. Although this unit is not known to be occupied by *Isodendron pyrifolium*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Dry—Unit 8 consists of 96 ac (40 ha) of privately owned land and 3 ac (1 ha) of State land as part of the old railroad right-of-way in the lowland dry ecosystem, at the Kalaeloa Barber's Point Harbor area. Although this unit is not known to be occupied by *Isodendron pyrifolium*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Dry—Unit 9 consists of 17 ac (7 ha) of City and County land, 3 ac (1 ha) of privately owned land, 1 ac (0.5 ha) of State land, and 16 ac (6 ha) of Federal (Pearl Harbor NWR) land in the lowland dry ecosystem at Kalaeloa. Although this unit is not known to be occupied by *Isodendron pyrifolium*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Dry—Unit 10 is not known to be occupied by another plant being listed as endangered in this rule, *Bidens amplexans*. However, we have determined this area to be essential for the conservation and recovery of this lowland dry species, because it provides the PCEs necessary for the

reestablishment of wild populations within the historical ranges of the species. Although this unit is not known to be occupied by *Isodendron pyrifolium*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Dry—Unit 11 is not known to be occupied by another plant being listed as endangered in this rule, *Bidens amplexans*. However, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Although this unit is not known to be occupied by *Isodendron pyrifolium*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 1 consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. This unit is on State land within the Pahole Natural Area Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. Although this unit is not known to be occupied by *Isodendron pyrifolium*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Dry Cliff—Unit 2 consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. This unit is almost entirely within the Makua Keaau Forest Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. Although this unit is not known to be occupied by *Isodendron pyrifolium*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Dry Cliff—Unit 3 consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. This unit is partially within the Waianae Kai Forest Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. Although this unit is not known to be occupied by *Isodendron pyrifolium*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Dry Cliff—Unit 4 consists of 24 ac (10 ha) of State land in the dry cliff

ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. This unit is partially within the Waianae Kai Forest Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. Although this unit is not known to be occupied by *Isodendron pyrifolium*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 6 consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. Although this unit is not known to be occupied by *Isodendron pyrifolium*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 7a consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. Although this unit is not known to be occupied by *Isodendron pyrifolium*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 7b consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. Although this unit is not known to be occupied by *Isodendron pyrifolium*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 8 consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve. A small portion of this area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. Although this unit is not known to be occupied by *Isodendron pyrifolium*, the

Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Isodendron pyriformis* critical habitat consists of four components. Lowland mesic (Molokai), Lowland wet (west Maui), Dry cliff (west Maui) and Wet cliff (west Maui) (81 FR 17790-18110):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Dry Cliff. Elevation: unrestricted. Annual precipitation: <75 in (<190 cm). Substrate: >65 degree slope, rocky talus. Canopy: None. Subcanopy: *Antidesma*, *Chamaesyce*, *Diospyros*, *Dodonaea*. Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Schiedea*.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. Understory: *Bryophytes*, *Ferns*, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

(i) In units Oahu—Lowland Dry—Unit 1, Oahu—Lowland Dry—Unit 2, Oahu—Lowland Dry—Unit 8, Oahu—Lowland Dry—Unit 9, Oahu—Lowland Dry—Unit 10, and Oahu—Lowland Dry—Unit 11, the physical and biological features of critical habitat are: (A) Elevation: Less than 3,300 ft (1,000 m). (B) Annual precipitation: Less than 50 in (130 cm). (C) Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. (D) Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*, *Sapindus*. (E) Subcanopy: *Chamaesyce*, *Dodonaea*, *Leptecophylla*, *Osteomeles*, *Psydrax*, *Scaevola*, *Wikstroemia*. (F) Understory: *Alyxia*, *Artemisia*, *Bidens*, *Chenopodium*, *Nephrolepis*, *Peperomia*, *Sicyos*.

(ii) In units Oahu—Dry Cliff—Unit 1, Oahu—Dry Cliff—Unit 2, Oahu—Dry Cliff—Unit 3, Oahu—Dry Cliff—Unit 4, Oahu—Dry Cliff—Unit 6, Oahu—Dry Cliff—Unit 7a, Oahu—Dry Cliff—Unit 7b, and Oahu—Dry Cliff—Unit 8, the physical and biological features of critical habitat are: (A) Elevation: Unrestricted. (B) Annual precipitation: Less than 75 in (190 cm). (C) Substrate: Greater than 65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: *Antidesma*, *Chamaesyce*, *Diospyros*, *Dodonaea*. (F) Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Schiedea*.

PCEs: 1. Lowland dry ecosystem. 2. Elevation <1000 meters. 3. Annual precipitation <130 cm. 4. Substrate: Weathered silty loams to stony clay, rocky ledges, little weathered lava. 5. Supporting one or more of these associated native plant genera (a) Canopy (*Diospyros*, *Erythrina*, *Metrosideros*, *Myoporum*, *Pleomele*, *Santalum*, *Sapindus*) (b) Subcanopy (*Chamaesyce*, *Dodonaea*, *Osteomeles*, *Psydrax*, *Scaevola*, *Wikstroemia*) (c) Understory (*Alyxia*, *Artemisia*, *Bidens*, *Capparis*, *Chenopodium*, *Nephrolepis*, *Peperomia*, *Sicyos*.) (USFWS, 2018).

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendrion pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat

containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

All critical habitat, except in the coastal ecosystem on Oahu, requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs and goats). Feral ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required during nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat posed by fire to Oahu—Lowland Dry—

Unit 1, 2, 8, 9, 10, 11 and Oahu—Dry Cliff—Unit 2, 3, 4, 6, 7 8. Oahu—Lowland Dry—Unit 1 and Oahu—Dry Cliff—Unit 1, 2, 3, 4, 6, 7, 8 may require special management to reduce the threat of landslides, rockfalls, and flooding.

For *Bidens micrantha* ssp. *ctenophylla*, *Isodendron pyrifolium*, and *Mezoneuron kavaense*, we have determined that the features essential to their conservation are those required for the successful functioning of the lowland dry ecosystem in which they occur (see Table 2, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation (USFWS, 2018).

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: During periods of drought, this species will drop all but the newest leaves. After sufficient rains, the plants produce flowers with seeds ripening 1 to 2 months later (C. Corn, pers. comm., 1996). (USFWS, 1996)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Shrubland/chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at low elevations (USFWS, 1996)

Environmental Specificity

Adult: Low, with few key requirements (USFWS, 1996)

Habitat Narrative

Adult: *Isodendron pyrifolium* is found in dry to mesic forests at low elevations. This species was formerly associated predominantly with taxa such as *Canthium odoratum* (alahe'e), *Sida fallax* (ilima), *Santalum* (sandalwood, 'iliahi), *Myoporum sandwicense* (naio), *Sophora chrysophylla* (mamane), and *Waltheria indica* L. ('uhaloa) (Paul Weissich, Weissich and Associates, pers. comm., 1992, 1995). (USFWS, 1996)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Resiliency:

Very low (inferred from USFWS, 2015)

Redundancy:

Very low (inferred from USFWS, 2015)

Number of Populations:

5 (1 wild) (USFWS, 2015)

Population Size:

95 (5 wild, 85 outplanted) (USFWS, 2015)

Population Narrative:

Recently (1991) rediscovered near the Kailua-Kona dump by Ken Nagata. Currently, there are five wild individuals of *Isodendron pyrifolium* known in North Kona (J. Wagner, pers. comm. 2015). There are four outplanted populations containing 90 individuals (J. Wagner, in litt. 2015). (USFWS, 2015; NatureServe, 2015)

Threats and Stressors

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Climate change destruction or degradation of habitat – Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Isodendron pyrifolium* is highly vulnerable to the impacts of climate change. Furthermore, *I. pyrifolium* was identified as a species that will have no overlapping area between current and future climate envelope (areas that contain the full range of climate conditions under which the species is known to occur) by 2100. Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2015)

Stressor: Predation by giant African land snail and red spider mites (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: The giant African land snail (*Achatina fulica*) is reported to girdle outplantings which eventually kills the plants (J. Wagner, in litt. 2015). In addition, red spider mites (*Tetranychus urticae*) are a threat to this species and may lead to the death of young plants if not controlled. (USFWS, 2015)

Stressor: Non-native invasive plants (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: The major threats identified for *Isodendron pyrifolium* include habitat degradation by introduced invasive plants species like *Pennisetum setaceum* and *Leucaena leucocephala*, susceptibility to fire, stochastic extinction, and residential development (USFWS 1994; Perlman 2006). The invasive introduced plant *Pennisetum setaceum* (fountain grass) forms dense clumps and competes for space; increases fuel loading for fires, and competes very efficiently for surface moisture (Tummons 2006c, D'Antonio and Vitousek 1992). (USFWS, 2008)

Stressor: Small population size (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Species like *Isodendron pyrifolium* that are currently restricted to small portions of a single island, and limited to a few populations and individuals, are inherently more vulnerable to extinction than widespread species because of the higher risks posed by genetic bottlenecks, random demographic fluctuations and localized catastrophes such as housing development. (USFWS, 2008)

Stressor: Predation by rats (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Rats eat seeds and unknown insects eat leaves of *Isodendron pyrifolium* (Perlman 2006). (USFWS, 2008)

Stressor: Drought (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Other threats affecting the plants are drought (Perlman 2006; Tummons 2006c and d). (USFWS, 2008)

Stressor: Fire (USFWS, 1996)

Exposure:

Response:

Consequence:

Narrative: Drying stands of invasive species and other weedy species greatly increase the fire load and fire potential. (USFWS, 1996)

Recovery**Reclassification Criteria:**

1. A total of five to seven populations of each taxon should be documented on the Big Island and at least one other island where it now occurs or occurred historically, if it is not endemic to the Big Island. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived

perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1996)

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1996)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on the Big Island and at least 1 other island where they now occur or occurred historically, if it is not endemic to the Big Island. (USFWS, 1996)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 individuals per population for short-lived perennials. (USFWS, 1996)

3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1996)

Recovery Actions:

- In order to prevent possible extinction of this species, propagation and maintenance of ex situ genetic stock is necessary. (USFWS, 1996)
- It is imperative that plans to fence and protect the remaining wild population be carried out. (USFWS, 1996)
- Control of fountain grass and koa haole should be undertaken in the habitat of the wild population. (USFWS, 1996)
- Propagation and outplanting of ex situ stock will be needed in order to establish a sufficient number of populations and plants for recovery. (USFWS, 1996)
- Efforts should be made to re-establish the species on Oahu and Maui within its known historical range in order to ensure against random extinction. (USFWS, 1996)

Conservation Measures and Best Management Practices:

- Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. (USFWS, 2015)
- Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change. (USFWS, 2015)
- Augment current natural populations to increase numbers of individuals. (USFWS, 2015)
- Maintain existing exclosures and monitor for potential incursions. (USFWS, 2015)
- Continue control and maintenance of invasive plants within fenced exclosures. (USFWS, 2015)
- Control rodents within the vicinity of all known *Isodendron pyriformis* populations. (USFWS, 2015)
- Develop and implement a fire management plan at the existing exclosure. Continue maintaining firebreaks around the wild and outplanted populations. (USFWS, 2015)
- Continue monitoring wild and outplanted individuals for a thorough current assessment of the species' status. (USFWS, 2015)
- Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. Develop a strategy for preventing the extinction of this species if no suitable habitat is predicted in the future. (USFWS, 2015)

- Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2015)

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SPECIES ACCOUNT: *Ivesia kingii* var. *eremica* (Ash Meadows ivesia)

Species Taxonomic and Listing Information

Listing Status: Threatened; 05/20/1985; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial herb that forms a tuft of narrowly divided, grayish leaves. Flowering stems are about 9 cm long and bear white flowers from August to October. Some botanists question whether this taxon is distinctive enough to be maintained as a discrete variety of the species *I. kingii*. (The species as a whole is extremely variable and somewhat rare.) (NatureServe, 2015).

Taxonomy

A member of the Rosaceae family (USFWS, 1990). Kartesz (1994 checklist and 1999 floristic synthesis) does not recognize varieties in this species; however, USFWS recognizes var. *eremica* as distinct from the typical var. *kingii*. As Kartesz notes (in letter to Larry Morse, 25Nov99), he reviewed all of the available Nevada collections and concluded that "this [var. *eremica*] is nothing more than an extremely variable expression of *Ivesia kingii*"; he also notes that various individuals, including Barbara Ertter, had listed characters considered useful in separating the two taxa, she (Ertter) has more recently indicated (in a personal communication with Kartesz) that researchers in the Netherlands "also maintain it as nothing more than a taxonomic synonym of *Ivesia kingii*." However, Ertter (in a personal communication to Jim Morefield) as of 06 Apr 99 still considered this a valid taxon at the varietal level (NatureServe, 2015).

Historical Range

Endemic of Ash Meadows, south Nye County, Nevada. Type found in Coville and Funston, Nye County, Nevada in 1891 (NatureServe, 2015).

Current Range

Small, local populations are scattered throughout Ash Meadows in Nevada (USFWS, 1990).

Critical Habitat Designated

Yes; 5/20/1985.

Legal Description

On May 20, 1985, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Ivesia kingii* var. *eremica* (Ash Meadows ivesia) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Nevada (50 FR 20777-20794).

Critical Habitat Designation

The critical habitat designation for *Ivesia kingii* var. *eremica* includes one CHU in Nye County, Nevada (50 FR 20777-20794).

Nevada, Nye County, Ash Meadows.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Ivesia kingii* var. *eremica* critical habitat consists of one component (50 FR 20777-20794):

Known primary constituent elements include saline seep areas of light colored clay uplands.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from sews, 1990)

Lifespan

Adult: 2+ years (inferred from USFWS, 1990)

Breeding Season

Adult: Summer - fall (USFWS, 1990)

Reproduction Narrative

Adult: Plants are perennial. It produces flowers during the late summer and autumn (Mozingo and Williams 1980) (USFWS, 1990).

Habitat Type

Adult: Wetland, terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Saltbrush scrub near springs (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 657 - 690 m elevation (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Solitary clumps (USFWS, 1990)

Environmental Specificity

Adult: Very narrow (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Inhabits moist alkaline areas in openings of saltbrush scrub near springs. It is dependent on springs. Dust from erosion may smother plants. Found at elevations of 657 - 690 m. It is narrowly confined to a single spring-fed desert wetland area with extremely saline soils (NatureServe, 2015). It occupies highly alkaline, barren soils that remain moistened by water spreading outward from surface flow discharged by springs. Plants occur as solitary clumps (USFWS, 1990).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Very low (inferred from USFWS, 1990; see current range/distribution)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

9 (NatureServe, 2015)

Adaptability:

Low (inferred from NatureServe, 2015)

Population Narrative:

A Nevada endemic, narrowly confined to a single spring-fed desert wetland area with extremely saline soils. Only nine occurrences are known, and the habitat is very threatened by development. Agricultural development and the associated large-scale draw-down of the region's water resources have already destroyed large portions of the local native flora. There were nine occurrences in Nevada as of 11 Sept 97 (NatureServe, 2015).

Threats and Stressors

Stressor: Past habitat destruction and modification (USFWS, 1985)

Exposure:

Response:

Consequence:

Narrative: The presence of water in Ash Meadows has long attracted human activity and provided a refuge for man's survival in an arid desert. The magnitude of man's impact on the local environment has increased over time and resulted in the decline of local endemic species. Large-scale disturbance began in the early 1960's when approximately 2,000 acres of upper Carson Slough was mined for peat. This removed approximately six feet of substrate and eliminated one of the largest marshes in southern Nevada. Endemic plant populations were reduced or eliminated when lands were cleared for crops and pasture, roads were constructed, and when impoundments were constructed then filled (Sanchez 1981). Impoundments now inundate several hundred acres of habitats believed to support the Ash Meadows ivesia. Many roads were built through areas now designated as critical habitat for plant species. Approximately 65 miles of gravel and unimproved roads now exist within the essential habitat, directly affecting Ash Meadows ivesia. All of the endemic species were additionally affected by

secondary impacts of these roads, which largely resulted from increased vehicular access to sensitive areas. Because of all past activities, small populations of species endemic to Ash Meadows presently occupy a small portion of their historic habitat (USFWS, 1990).

Stressor: Introduced species (USFWS, 1990)

Exposure:

Response:

Consequence:

Narrative: Introduced species, including salt cedar (*Tamarix*), mosquitofish, sailfin mollies (*Poecelia lativinna*), wild horses, bullfrogs, and crayfish further reduced endemic plant and animal populations by displacement through competition for food and space, and/or predation (Miller 1948, Beatley 1977 a, b; Reveal 1978 a, b, c; Soltz and Naiman 1978, Schoenherr 1981, Knight and Clemmer 1987). Roads facilitated introduction of non-native species (particularly aquatic species), and the detrimental influence of trampling caused by water-oriented recreation. Introduced species are now widespread throughout the area, and trampling has reduced populations of endemic mollusks and plant populations adjacent to springs. Large herds of wild horses altered spring morphology and impacted endemic plant and snail populations (Hershler and Sada 1987, Landye 1973, Mozingo and Williams 1980) (USFWS, 1990).

Recovery

Reclassification Criteria:

Not available

Delisting Criteria:

1. The species is present in all locales it historically occupied within Ash Meadows (USFWS, 1990).
2. The species has reached self-sustaining populations (as measured by frequency values for plants on critical habitat) (USFWS, 1990).
3. The essential habitat is free of threats from all non-native animals, exotic plants, and detrimental human disturbances (USFWS, 1990).
4. Springs have returned to historic discharge rates and water flow is reestablished into historic channels (USFWS, 1990).
5. Native plant and aquatic communities have been reestablished to historic structure and composition within all essential habitat (USFWS, 1990).

Recovery Actions:

- Secure habitat and water sources for the Ash Meadows ecosystem (USFWS, 1990).
- Conduct research on the biology of the species (USFWS, 1990).
- Conduct management activities within essential habitat (USFWS, 1990).
- Reestablish populations/monitor new and existing populations (USFWS, 1990).
- Determine/verify recovery objectives (USFWS, 1990).

Conservation Measures and Best Management Practices:

- Approval of the Ash Meadows Habitat Management Plan by the Bureau initiated a number of more recent conservation programs on public domain lands (USBLM 1980). Barbed wire fencing was installed to prevent wild horses' entrance to approximately 425 acres surrounding Big and Jackrabbit Springs, and emergent vegetation has been periodically removed from School Springs. Wild horses were captured during August 1985 to eliminate trampling of springs, stream banks, and rare plants (USFWS, 1990).
- The States of Nevada and California and the Service have been actively involved in recognizing the declining status of species endemic to Ash Meadows. These agencies variously list a number of local species as either threatened or endangered. Numerous botanists affiliated with various universities and native plant societies throughout the nation have surveyed the area's vegetation and documented rare plant distribution. Although much work has been conducted, much of it has been directed toward preventing further loss of populations and habitat and not toward habitat or population enhancement. The purchase of much of the area by The Nature Conservancy and subsequent purchase of these lands by the Service to establish the Ash Meadows Refuge has been the single largest step toward providing security for these species (USFWS, 1990).

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U.S. Fish and Wildlife Service. 1985. Determination of Threatened Status With Critical Habitat for six plants and One Insect In Ash Meadows, Nevada and California and Endangered Status With Critical Habitat for One Plant In Ash Meadows, Nevada and California. Final rule. 50 FR 20777-20794 (May 20, 1985).

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A."

SPECIES ACCOUNT: *Ivesia webberi* (Webber Ivesia)

Species Taxonomic and Listing Information

Listing Status: Threatened; 07/03/2014; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial, tap-rooted low spreading herb to 2.5 dm across, hairy throughout; overall color greenish-gray foliage with dark red stems and bright-yellow clusters of flowers, the whole plant becoming reddish-tinged late in the season. Leaves 3-7 cm long, mostly basal, with 4-8 pairs of leaflets crowded toward tips; leaflets 3-10 mm long, each further divided into 2-5 narrow segments. Flower clusters at stem tips, about 15-50 mm across, with 5-15 flowers each; each flower about 10 mm across on a stalk 1-8 mm long, petals 5, bright yellow, 2-3 mm long, much smaller than the green sepals; stamens 5 (NatureServe, 2015).

Taxonomy

A member of the Rose family (Rosaceae) (USFWS, 2014).

Historical Range

Known from Upper Long Valley on the California-Nevada border, and elsewhere in Nevada from both north and southwest of Reno, Washoe County, and from the western slope of the Pine Nut Mountains, Douglas County (NatureServe, 2015)

Current Range

Ivesia webberi is currently known to occupy a total of approximately 165 acres (66.8 hectares) within five counties in California and Nevada along the transition zone between the eastern edge of the northern Sierra Nevada and the northwestern edge of the Great Basin (Service 2014, p. 8) (USFWS, 2014).

Critical Habitat Designated

Yes; 6/3/2014.

Legal Description

On June 3, 2014, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Eriogonum cadium* (Umtanum Desert buckwheat) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 16 critical habitat units (CHUs), in California and Nevada (79 FR 32126-32155).

Critical Habitat Designation

The critical habitat designation for *Eriogonum cadium* includes 16 CHUs in Plumas, Lassen, and Sierra Counties in northeastern California, and in Washoe and Douglas Counties in northwestern Nevada. This species critical habitat encompasses approximately 2,170 acres (ac) (879 hectares (ha)) (79 FR 32126-32155).

Unit 1: Sierra Valley: Unit 1 consists of 274 ac (111 ha) of Federal, State, and private lands. This unit is located near the junction of State Highway 49 and County Highway A24 in Plumas County, California. Nineteen percent of this unit is on Federal lands managed by the BLM, 16 percent is on California State land, and 65 percent is on private lands. This unit is currently occupied and is

the most western occupied unit within the range of *Ivesia webberi*. The Sierra Valley Unit is important to the recovery of *I. webberi* because it supports 44.8 ac (18.1 ha), or nearly one-third (27.2 percent), of all habitat (165 ac (66.8 ha)) that is occupied by *I. webberi* across the species' range. Threats to *I. webberi* in this unit include nonnative, invasive species; wildfire; OHV use; roads; livestock grazing; and any other forms of vegetation or ground-disturbing activities. While these lands currently have the physical and biological features essential to the conservation of *I. webberi*, because of a lack of cohesive management and protections, special management will be required to maintain these features in this unit. These threats should be addressed as detailed above in the "Special Management Considerations or Protection" section.

Unit 2: Constantia: Unit 2 consists of 155 ac (63 ha) of Federal land. This unit is located east of U.S. Highway 395, southeast of the historic town of Constantia, in Lassen County, California. One hundred percent of this unit is on Federal lands managed by the BLM. This unit is currently occupied and is the most northern occupied unit within the range of *Ivesia webberi*. The Constantia Unit is important to the recovery of *I. webberi* primarily because it represents one of relatively few locations within the Great Basin where the species is known to exist. Given the increasing prevalence of both site-specific and landscape-scale threats operating throughout this region and specifically within areas occupied by *I. webberi* (Service 2014, entire), this location and most others where the species occurs confer redundancy within the species' distribution, thereby buffering the species against the risk of extirpation likely to result from these threats or other less-predicable stochastic events. Not a lot is known about the current condition of *I. webberi* and its habitat at this site; however, wildfire and any other forms of vegetation or ground-disturbing activities are threats to *I. webberi* in this unit. While these lands currently have the physical and biological features essential to the conservation of *I. webberi*, because of a lack of cohesive management and protections, special management will be required to maintain these features in this unit. These threats should be addressed as detailed above in the "Special Management Considerations or Protection" section.

Unit 3: East of Hallelujah Junction: Wildlife Area (HJWA)–Evans Canyon Unit 3 consists of 122 ac (49 ha) of Federal and State lands. This unit is located east of U.S. Highway 395 on the border of HJWA in Lassen County, California. Eighty-two percent of this unit is on California State land managed as the HJWA, and 18 percent is on Federal land managed by the BLM. This unit is currently occupied and is approximately 1.6 mi (2.6 km) away from Unit 4, which may allow for social pollinator dispersal between these two units. Additionally, this is the only place where *Ivesia webberi* is found as a co-dominant in an *Artemisia tridentata* Nutt. (big sagebrush) community instead of an *Artemisia arbuscula* (low sagebrush) community. The perennial bunchgrass and forb components of the *Artemisia tridentata* community found within this unit are the same as those occurring in locations where *A. arbuscula* is co-dominant with *I. webberi*. The East of HJWA–Evans Canyon Unit is important to the recovery of *I. webberi* primarily because it represents one of relatively few locations within the Great Basin where the species is known to exist. Given the increasing prevalence of both sitespecific and landscape-scale threats operating throughout this region and specifically within areas occupied by *I. webberi* (Service 2014, entire), this location and most others where the species occurs confer redundancy within the species' distribution, thereby buffering the species against the risk of extirpation likely to result from these threats or other less-predicable stochastic events. Wildfire and any other forms of vegetation or grounddisturbing activities are threats to *I. webberi* in this unit. While these lands currently have the physical and biological features essential to the conservation of *I. webberi*, because of a lack of cohesive management and protections, special management will be required

to maintain these features in this unit. These threats should be addressed as detailed above in the “Special Management Considerations or Protection” section.

Unit 4: Hallelujah Junction Wildlife Area (HJWA): Unit 4 consists of 69 ac (28 ha) of State lands. This unit is located west of U.S. Highway 395 within HJWA in Sierra County, California. One hundred percent of this unit is on California State land managed as the HJWA. It is currently occupied and is approximately 1.6 mi (2.6 km) away from Unit 3, which may allow for social pollinator dispersal between these two units. The HJWA Unit is important to the recovery of *I. webberi* primarily because it represents one of relatively few locations within the Great Basin where the species is known to exist. Given the increasing prevalence of both site-specific and landscape-scale threats operating throughout this region and specifically within areas occupied by *I. webberi* (Service 2014, entire), this location and most others where the species occurs confer redundancy within the species’ distribution, thereby buffering the species against the risk of extirpation likely to result from these threats or other less-predictable stochastic events. Wildfire and any other forms of vegetation or grounddisturbing activities are threats to *I. webberi* in this unit. While these lands currently have the physical and biological features essential to the conservation of *I. webberi*, because of a lack of cohesive management and protections, special management will be required to maintain these features in this unit. These threats should be addressed as detailed above in the “Special Management Considerations or Protection” section.

Unit 5: Subunit 5a—Dog Valley Meadow and Subunit 5b—Upper Dog Valley Subunit 5a—Dog Valley Meadow Subunit 5a consists of 386 ac (156 ha) of Federal lands. This subunit is located east of Long Valley Road in Dog Valley in Sierra County, California. One hundred percent of this subunit is on Federal lands managed by the Forest Service. It is currently occupied and is 0.5 mi (0.8 km) away from Subunit 5b, which may allow for social pollinator dispersal between these two subunits. The Dog Valley Meadow Subunit is important to the recovery of *Ivesia webberi* because it supports 71.58 ac (28.97 ha), or nearly half (43.5 percent), of all habitat (165 ac (66.8 ha)) that is occupied by *I. webberi* across the species’ range and 100,000 plants, or approximately 2 to 10 percent (i.e., dependent on which population estimate range is used for the calculation) of individuals known to exist across the species’ range (Service 2014, pp. 15–16). Threats to *I. webberi* in this subunit include nonnative, invasive plant species; wildfire; OHV and other recreational use; and any other forms of vegetation or grounddisturbing activities. Additionally, this subunit historically was grazed, but the grazing allotment currently is vacant (Service 2014, p. 16). While these lands currently have the physical and biological features essential to the conservation of *I. webberi*, because of a lack of cohesive management and protections, special management will be required to maintain these features in this subunit. These threats should be addressed as detailed above in the “Special Management Considerations or Protection” section. Subunit 5b—Upper Dog Valley Subunit 5b consists of 29 ac (12 ha) of Federal and private lands. This subunit is located west of Long Valley Road and south of the Dog Valley campground in Dog Valley in Sierra County, California. Forty-one percent of this subunit is on Federal lands managed by the Forest Service, and 59 percent is on private lands. It is currently occupied and is 0.5 mi (0.8 km) away from Subunit 5a, which may allow for social pollinator dispersal between these two subunits. The Upper Dog Valley Subunit is important to the recovery of *I. webberi* primarily because it represents one of relatively few locations within the Great Basin where the species is known to exist. Given the increasing prevalence of both sitespecific and landscape-scale threats operating throughout this region and specifically within areas occupied by *I. webberi* (Service 2014, entire), this location and most others where the species occurs confer redundancy within

the species' distribution, thereby buffering the species against the risk of extirpation likely to result from these threats or other less-predicable stochastic events. Threats to *I. webberi* in this subunit include nonnative, invasive plant species; wildfire; OHV use; and any other forms of vegetation or ground-disturbing activities. Additionally, this subunit historically was grazed, but the grazing allotment is currently vacant (Service 2014, p. 16). While these lands currently have the physical and biological features essential to the conservation of *I. webberi*, because of a lack of cohesive management and protections, special management will be required to maintain these features in this subunit. These threats should be addressed as detailed above in the "Special Management Considerations or Protection" section.

Unit 6: White Lake Overlook: Unit 6 consists of 109 ac (44 ha) of Federal and private lands. This unit is located north of Long Valley Road in Sierra County, California. Ninety percent of this unit is on Federal lands managed by the Forest Service and 10 percent is on private lands. This unit is currently occupied and is 1 mi (1.6 km) or less away from Units 7 and 9, which may allow for social pollinator dispersal between these units. The White Lake Overlook Unit is important to the recovery of *Ivesia webberi* because it supports 13.56 ac (5.49 ha), or 8.2 percent, of all habitat (165 ac (66.8 ha)) that is occupied by *I. webberi* across the species' range. Threats to *I. webberi* in this unit include wildfire and any other forms of vegetation or ground-disturbing activities. While these lands currently have the physical and biological features essential to the conservation of *I. webberi*, because of a lack of cohesive management and protections, special management will be required to maintain these features in this unit. These threats should be addressed as detailed above in the "Special Management Considerations or Protection" section.

Unit 7: Subunit 7a—Mules Ear Flat and Subunit 7b—Three Pine Flat and Jeffrey Pine Saddle:
Subunit 7a—Mules Ear Flat Subunit 7a consists of 65 ac (27 ha) of Federal and private lands. This subunit is located west of the CaliforniaNevada border and southeast of Long Valley Road in Sierra County, California. Forty-eight percent of this subunit is on Federal land managed by the Forest Service, and 52 percent is on private lands. This subunit is currently occupied and is 1 mi (1.6 km) or less away from Units 6 and 9, which may allow for social pollinator dispersal between these units. The Mules Ear Flat Subunit is important to the recovery of *I. webberi* primarily because it represents one of relatively few locations within the Great Basin where the species is known to exist. Given the increasing prevalence of both sitespecific and landscape-scale threats operating throughout this region and specifically within areas occupied by *I. webberi* (Service 2014, entire), this location and most others where the species occurs confer redundancy within the species' distribution, thereby buffering the species against the risk of extirpation likely to result from these threats or other less-predicable stochastic events. Threats to *I. webberi* in this subunit include nonnative, invasive plant species; wildfire; OHV use; roads; and any other forms of vegetation or ground-disturbing activities. Additionally, this subunit historically was grazed, but the grazing allotment currently is vacant (Service 2014, p. 17). While these lands currently have the physical and biological features essential to the conservation of *I. webberi*, because of a lack of cohesive management and protections, special management will be required to maintain these features in this subunit. These threats should be addressed as detailed above in the "Special Management Considerations or Protection" section.
Subunit 7b—Three Pine Flat and Jeffrey Pine Saddle Subunit 7b consists of 68 ac (27 ha) of Federal and private lands. This subunit is located east of the CaliforniaNevada border in Washoe County, Nevada. Four percent of this subunit is on Federal lands managed by the Forest Service, and 96 percent is on private lands. It is currently occupied and is 1 mi (1.6 km) or less away from Units 6, 8, and 9, which may allow for social pollinator dispersal between these units. The Three Pine Flat and Jeffery Pine Saddle

Subunit is important to the recovery of *I. webberi* primarily because it represents one of relatively few locations within the Great Basin where the species is known to exist. Given the increasing prevalence of both sitespecific and landscape-scale threats operating throughout this region and specifically within areas occupied by *I. webberi* (Service 2014, entire), this location and most others where the species occurs confer redundancy within the species' distribution, thereby buffering the species against the risk of extirpation likely to result from these threats or other less-predicable stochastic events. Threats to *I. webberi* in this subunit include nonnative, invasive plant species; wildfire; OHV use; roads; and any other forms of vegetation or ground-disturbing activities. Additionally, this subunit historically was grazed, but the grazing allotment currently is vacant (Service 2014, p. 17). While these lands currently have the physical and biological features essential to the conservation of *I. webberi*, because of a lack of cohesive management and protections, special management will be required to maintain these features in this subunit. These threats should be addressed as detailed above in the "Special Management Considerations or Protection" section.

Unit 8: Ivesia Flat: Unit 8 consists of 62 ac (25 ha) of Federal land. This unit is located south of U.S. Highway 395 in Washoe County, NV. One hundred percent of this unit is on Federal land managed by the Forest Service. It is currently occupied and is 1 mi (1.6 km) away from Subunit 7b, which may allow for social pollinator dispersal between these two units. The Ivesia Flat Unit is important to the recovery of *Ivesia webberi* because it supports 100,000 plants (Service 2014, p. 17), or approximately between 2 and 10 percent (i.e., dependent on which population estimate range is used for the calculation) of individuals known to exist across the species' range. Threats to *I. webberi* in this unit include nonnative, invasive plant species; wildfire; OHV use; roads; and any other forms of vegetation or ground-disturbing activities. Additionally, this unit historically was grazed, but the grazing allotment currently is vacant (Service 2014, pp. 17–18). While these lands currently have the physical and biological features essential to the conservation of *I. webberi*, because of a lack of cohesive management and protections, special management will be required to maintain these features in this unit. These threats should be addressed as detailed above in the "Special Management Considerations or Protection" section.

Unit 9: Stateline Road 1: Unit 9 consists of 193 ac (78 ha) of Federal and private lands. This unit is located along the California-Nevada border in Sierra County, California, and Washoe County, Nevada. Ninety-six percent of this unit is on Federal land managed by the Forest Service, and 4 percent is on private lands. It is currently occupied and is 1 mi (1.6 km) or less away from Units 6, 7, and 10, which may allow for social pollinator dispersal between these units. The Stateline Road 1 Unit is important to the recovery of *I. webberi* primarily because it represents one of relatively few locations within the Great Basin where the species is known to exist. Given the increasing prevalence of both sitespecific and landscape-scale threats operating throughout this region and specifically within areas occupied by *I. webberi* (Service 2014, entire), this location and most others where the species occurs confer redundancy within the species' distribution, thereby buffering the species against the risk of extirpation likely to result from these threats or other less-predicable stochastic events. Threats to *I. webberi* in this unit include nonnative, invasive plant species; wildfire; development; and any other forms of vegetation or ground-disturbing activities. Additionally, this unit historically was grazed, but the grazing allotment currently is vacant (Service 2014, p. 18). While these lands currently have the physical and biological features essential to the conservation of *I. webberi*, because of a lack of cohesive management and protections, special management will be required to maintain these features in this unit. These

threats should be addressed as detailed above in the “Special Management Considerations or Protection” section.

Unit 10: Stateline Road 2: Unit 10 consists of 66 ac (27 ha) of Federal land. This unit is located along the California–Nevada border in Sierra County, California, and Washoe County, Nevada. One hundred percent of this unit is on Federal land managed by the Forest Service. It is currently occupied and is less than 1 mi (1.6 km) away from Unit 9, which may allow for social pollinator dispersal between these units. The Stateline Road 2 Unit is important to the recovery of *I. webberi* primarily because it represents one of relatively few locations within the Great Basin where the species is known to exist. Given the increasing prevalence of both site-specific and landscape-scale threats operating throughout this region and specifically within areas occupied by *I. webberi* (Service 2014, entire), this location and most others where the species occurs confer redundancy within the species’ distribution, thereby buffering the species against the risk of extirpation likely to result from these threats or other less-predicable stochastic events. Threats to *I. webberi* in this unit include nonnative, invasive plant species; wildfire; development; and any other forms of vegetation or ground-disturbing activities. Additionally, this unit historically was grazed, but the grazing allotment currently is vacant (Service 2014, p. 18). While these lands currently have the physical and biological features essential to the conservation of *I. webberi*, because of a lack of cohesive management and protections, special management will be required to maintain these features in this unit. These threats should be addressed as detailed above in the “Special Management Considerations or Protection” section.

Unit 11: Hungry Valley: Unit 11 consists of 56 ac (23 ha) of Federal land. This unit is located west of Eagle Canyon Drive in Washoe County, Nevada. One hundred percent of this unit is on Federal land managed by the BLM. It is currently occupied and is the eastern most occupied unit within the range of *Ivesia webberi*. The Hungry Valley Unit is important to the recovery of *I. webberi* primarily because it represents one of relatively few locations within the Great Basin where the species is known to exist. Given the increasing prevalence of both sitespecific and landscape-scale threats operating throughout this region and specifically within areas occupied by *I. webberi* (Service 2014, entire), this location and most others where the species occurs confer redundancy within the species’ distribution, thereby buffering the species against the risk of extirpation likely to result from these threats or other less-predicable stochastic events. Threats to *I. webberi* in this unit include nonnative, invasive plant species; wildfire; OHV use and other recreational use; roads; livestock grazing; and any other forms of vegetation or ground-disturbing activities. While these lands currently have the physical and biological features essential to the conservation of *I. webberi*, because of a lack of cohesive management and protections, special management will be required to maintain these features in this unit. These threats should be addressed as detailed above in the “Special Management Considerations or Protection” section.

Unit 12: Black Springs: Unit 12 consists of 163 ac (66 ha) of Federal and private lands. This unit is located northwest of North Virginia Street and south of U.S. Highway 395 in Washoe County, Nevada. Eighty-two percent of this unit is on Federal land managed by the Forest Service, and 18 percent is on private lands. It is currently occupied and is approximately 1 mi (1.6 km) away from Unit 13, which may allow for social pollinator dispersal between these units. The Black Springs Unit is important to the recovery of *I. webberi* primarily because it represents one of relatively few locations within the Great Basin where the species is known to exist. Given the increasing prevalence of both site-specific and landscape-scale threats operating throughout this region and specifically within areas occupied by *I. webberi* (Service 2014, entire), this location and most

others where the species occurs confer redundancy within the species' distribution, thereby buffering the species against the risk of extirpation likely to result from these threats or other less-predicable stochastic events. Threats to *I. webberi* in this unit include nonnative, invasive plant species; wildfire; OHV use; roads; and any other forms of vegetation or ground-disturbing activities. Additionally, this unit historically was grazed, but the grazing allotment currently is vacant (Service 2014, p. 19). While these lands currently have the physical and biological features essential to the conservation of *I. webberi*, because of a lack of cohesive management and protections, special management will be required to maintain these features in this unit. These threats should be addressed as detailed above in the "Special Management Considerations or Protection" section.

Unit 13: Raleigh Heights: Unit 13 consists of 253 ac (103 ha) of Federal and private lands. This unit is located northwest of North Virginia Street and south of U.S. Highway 395 in Washoe County, Nevada. Ninety-one percent of this unit is on Federal land managed by the Forest Service, and 9 percent is on private lands. It is currently occupied and is approximately 1 mi (1.6 km) away from Unit 12, which may allow for social pollinator dispersal between these units. The Raleigh Heights Unit is important to the recovery of *Ivesia webberi* because it supports between 100,000 to 4,000,000 plants (Service 2014, p. 19), or approximately 10 to 79.5 percent (i.e., dependent on which population estimate range is used for the calculation) of individuals known to exist across the species' range. Threats to *I. webberi* in this unit include nonnative, invasive plant species; wildfire; OHV use; roads; and any other forms of vegetation or ground-disturbing activities. While these lands currently have the physical and biological features essential to the conservation of *I. webberi*, because of a lack of cohesive management and protections, special management will be required to maintain these features in this unit. These threats should be addressed as detailed above in the "Special Management Considerations or Protection" section.

Unit 14: Dutch Louie Flat: Unit 14 consists of 54 ac (22 ha) of Federal and private lands. This unit is located southwest of South McCarran Boulevard in Washoe County, Nevada. Twenty-four percent of this unit is on Federal lands managed by the Forest Service, and 76 percent is on private lands. It is currently occupied and is approximately 0.5 mi (0.8 km) away from Unit 15, which may allow for social pollinator dispersal between these units. The Dutch Louie Flat Unit is important to the recovery of *Ivesia webberi* because it supports between 600,000 to 693,795 plants (Service 2014, pp. 19–20), or approximately 14 to 61 percent (i.e., dependent on which population estimate range is used for the calculation) of individuals known to exist across the species' range. Threats to *I. webberi* in this unit include nonnative, invasive plant species; wildfire; OHV and other recreational use; roads; development; and any other forms of vegetation or ground-disturbing activities. While these lands currently have the physical and biological features essential to the conservation of *I. webberi*, because of a lack of cohesive management and protections, special management will be required to maintain these features in this unit. These threats should be addressed as detailed above in the "Special Management Considerations or Protection" section.

Unit 15: The Pines Powerline: Unit 15 consists of 32 ac (13 ha) of private lands. This unit is located southwest of South McCarran Boulevard in Washoe County, Nevada. One hundred percent of this unit is on private lands. It is currently occupied and is approximately 0.5 mi (0.8 km) away from Unit 14, which may allow for social pollinator dispersal between these two units. The Pines Powerline Unit is important to the recovery of *I. webberi* primarily because it represents one of relatively few locations within the Great Basin where the species is known to

exist. Given the increasing prevalence of both site-specific and landscape-scale threats operating throughout this region and specifically within areas occupied by *I. webberi* (Service 2014, entire), this location and most others where the species occurs confer redundancy within the species' distribution, thereby buffering the species against the risk of extirpation likely to result from these threats or other less-predicable stochastic events. Threats to *I. webberi* in this unit include nonnative, invasive plant species; wildfire; OHV and other recreational use; roads; development; and any other forms of vegetation or ground-disturbing activities. While these lands currently have the physical and biological features essential to the conservation of *I. webberi*, because of a lack of cohesive management and protections, special management will be required to maintain these features in this unit. These threats should be addressed as detailed above in the "Special Management Considerations or Protection" section.

Unit 16: Dante Mine Road: Unit 16 consists of 14 ac (6 ha) of Federal and private lands. This unit is located east of U.S. Highway 395 in Douglas County, Nevada. Seventy-three percent of this unit is on Federal land managed by the BLM, and 27 percent is on private lands. It is currently occupied and is the southernmost unit within the range of *Ivesia webberi*. The Dante Mine Road Unit is important to the recovery of *I. webberi* primarily because it represents one of relatively few locations within the Great Basin where the species is known to exist. Given the increasing prevalence of both site-specific and landscape-scale threats operating throughout this region and specifically within areas occupied by *I. webberi* (Service 2014, entire), this location and most others where the species occurs confer redundancy within the species' distribution, thereby buffering the species against the risk of extirpation likely to result from these threats or other less-predicable stochastic events. Threats to *I. webberi* in this unit include nonnative, invasive plant species; wildfire; roads; development; and any other forms of vegetation or ground-disturbing activities. While these lands currently have the physical and biological features essential to the conservation of *I. webberi*, because of a lack of cohesive management and protections, special management will be required to maintain these features in this unit. These threats should be addressed as detailed above in the "Special Management Considerations or Protection" section.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Eriogonum codium* critical habitat consists of four components (79 FR 32126-32155):

(i) Plant community. (A) Open to sparsely vegetated areas composed of generally short-statured associated plant species. (B) Presence of appropriate associated species that can include (but are not limited to): *Antennaria dimorpha*, *Artemisia arbuscula*, *Balsamorhiza hookeri*, *Elymus elymoides*, *Erigeron bloomeri*, *Lewisia rediviva*, *Poa secunda*, and *Viola beckwithii*. (C) An intact assemblage of appropriate associated species to attract the floral visitors that may be acting as pollinators of *Ivesia webberi*.

(ii) Topography. Flats, benches, or terraces that are generally above or adjacent to large valleys. Occupied sites vary from slightly concave to slightly convex or gently sloped (0–15°) and occur on all aspects.

(iii) Elevation. Elevations between 4,475 and 6,237 feet (1,364 and 1,901 meters).

(iv) Suitable soils and hydrology. (A) Vernal moist soils with an argillic horizon that shrink and swell upon drying and wetting; these soil conditions are characteristic of known *Ivesia webberi* populations and are likely important in the maintenance of the seedbank and population recruitment. (B) Suitable soils that can include (but are not limited to): Reno—a fine, smectitic, mesic Abruptic Xeric Argidurid; Xman—a clayey, smectitic, mesic, shallow Xeric Haplargids; Aldi—a clayey, smectitic, frigid Lithic Ultic Argixerolls; and Barshaad—a fine, smectitic, mesic Aridic Palexeroll.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. All areas designated as critical habitat contain features that will require some level of management to address the current and future threats. In all units, special management will be required to ensure that the habitat is able to provide for the growth and reproduction of the species. A detailed discussion of threats to *Ivesia webberi* and its habitat can be found in the *Ivesia webberi* Species Report (Service 2014, pp. 22–32). The features essential to the conservation of *I. webberi* (plant community and competitive ability, and suitable topography, elevation, soils, and hydrology required for the persistence of adults as well as successful reproduction of such individuals and the formation of a seedbank) may require special management considerations or protection to reduce threats. The current range of *I. webberi* is subject to human-caused modifications from the introduction and spread of nonnative invasive species including *Bromus tectorum*, *Poa bulbosa*, and *Taeniatherum caputmedusae*; modified wildfire regime; increased access and fragmentation of habitat by new roads and OHVs; agricultural, residential, and commercial development; and soil and seedbank disturbance by livestock (Service 2014, pp. 22–32). Special management considerations or protection are required within critical habitat areas to address these threats. Management activities that could ameliorate these threats include (but are not limited to): Treatment of nonnative, invasive plant species; minimization of OHV access and placement of new roads away from the species and its habitat; regulations or agreements to minimize the effects of development in areas where the species resides; minimization of livestock use or other disturbances that disturb the soil or seeds; and minimization of habitat fragmentation. Where the species occurs on private lands, protection and management could be enhanced by various forms of land acquisition from willing sellers, ranging from the purchase of conservation easements to fee title acquisition. These activities would protect the primary constituent elements for the species by preventing the loss of habitats and individuals, protecting the habitat and soils from undesirable patterns or levels of disturbance, and facilitating the management for desirable conditions, including disturbance regimes.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Unknown; probably sexual: cross-pollination (NatureServe, 2015)

Lifespan

Adult: 2+ years (USFWS, 2014)

Key Resources Needed for Breeding

Adult: Presumably insect pollinators (USFWS, 2013)

Reproduction Narrative

Adult: No studies of reproduction or dispersal are known for *Ivesia webberi*. Insect-mediated out-crossing is the most likely reproductive mode. No asexual or vegetative reproduction is apparent in this species (NatureServe, 2015). This is a perennial plant (USFWS, 2014). Pollinators specific to *Ivesia webberi* have not been identified. However, most *Ivesia* species reproduce from seed with insect-mediated pollination occurring between flowers of the same or different plants (Witham 2000, p. 20) (USFWS, 2013).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Flat, bench, terrace (USFWS, 2013); shrubland/chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Dense vegetation (NatureServe, 2015); 4,475 - 6,237 ft. elevation (USFWS, 2013)

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Inhabits shallow shrink-swell clay soils with a gravelly surface layer over volcanic, generally andesitic bedrock, usually codominating with *Artemisia arbuscula* and *Elymus elymoides* in association with *Antennaria dimorpha*, *Balsamorhiza hookeri*, *Erigeron bloomeri*, *Lewisia rediviva*, *Viola beckwithii*, etc. *Ivesia webberi* has been found only in relatively open plant associations where competition for light and moisture with other species is low. It is absent from adjacent, otherwise appropriate habitat where deeper soils and taller, denser vegetation has developed. It can tolerate some moderate disturbance as it has been observed in some mildly disturbed sites; however long-term survival depends upon the continued availability of undisturbed mid-elevation benches or saddles with shallow, very rocky pavement-like soils derived from andesite or similar volcanic material. The environmental specificity is narrow; the vast majority of apparently suitable habitat has proven to be unoccupied by the species, suggesting that more cryptic habitat factors may also be involved (NatureServe, 2015). Known populations of *Ivesia webberi* occur between 4,475 and 6,237 feet (ft.) (1,364 and 1,901 meters (m)) in elevation (Steele and Roe 1996, unpubl. survey; Witham 2000, p.16; Howle and Henault 2009, unpubl. survey). It occurs in flats, benches, or terraces that are generally above or adjacent to large valleys, on slightly concave, convex, and gently sloped (0–15°) landscapes, in soils with an argillic horizon (USFWS, 2013).

Dispersal/Migration

Dispersal

Adult: Low (NatureServe, 2015)

Dispersal/Migration Narrative

Adult: Seed dispersal for this species is probably low to none. The seeds are relatively large and probably become lodged in crevices in the rocky pavement-like soils very soon after being shed by the parent plant (NatureServe, 2015).

Population Information and Trends**Population Trends:**

Decline of 30-50% (NatureServe, 2015)

Species Trends:

10 - 30% decline (NatureServe, 2015)

Resiliency:

Very low (inferred from NatureServe, 2015)

Redundancy:

Moderate (inferred from NatureServe, 2015)

Number of Populations:

14 (NatureServe, 2015)

Population Size:

~ 4,855,200 (NatureServe, 2015); unknown (USFWS, 2014)

Population Narrative:

This species has experienced a long-term decline of 30-50%. The number of occurrences with good viability has declined recently (10 - 30%) due to encroachment of residential development and invasive plant species. The population estimated to be at least 4,855,200 individuals. These plants occur densely on very limited acreage. May 2005 records from California indicate 112,500 plants there. Currently known from 6 extant populations in Washoe and Douglas Counties, Nevada, and 8 extant populations in Lassen, Plumas and Sierra Counties, California. This brings the total extant sites to about 14 (NatureServe, 2015). Reliable estimation of population sizes or trends in *I. webberi* is complicated because past population estimates have usually been obtained by different observers employing a variety of methodologies and varying levels of survey effort (Service 2014, p. 12) (USFWS, 2014).

Threats and Stressors

Stressor: Nonnative plants and altered fire regime (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: The primary threat to *I. webberi* is the combined and synergistic effect from the encroachment of nonnative, invasive plant species into the *I. webberi* plant community and the

modified fire regime resulting from this encroachment (Service 2014, pp. 23– 26). Nonnative, invasive plant species, such as *Bromus tectorum* (cheatgrass), *Poa bulbosa* (bulbous bluegrass), and *Taeniatherum caput-medusae* (medusahead), have become established and are part of the associated plant community at 12 of the 16 extant populations of *I. webberi*. Nonnative, invasive plant species negatively affect *I. webberi* through competition, displacement, and degradation of the quality and composition of the *Artemisia arbuscula*—perennial bunchgrass—forb community in which *I. webberi* occurs. In addition to these effects, these nonnative, invasive plant species, once established, contribute fuels that increase the frequency and likelihood of wildfire in *I. webberi* habitat (USFWS, 2014).

Stressor: Roads and off-highway vehicles (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: OHV impacts to *I. webberi* populations have increased during the past 20 years as population growth and associated development have increased (Bergstrom 2009, p. 22), especially in the Reno urban area where 6 of the 16 populations occur. Eleven of 16 extant *I. webberi* populations are adjacent to or intersected by dirt roads and have been impacted to some degree by road development and OHV use (Service 2014, pp. 26–27). Roads cause habitat loss and degradation, and when vehicles drive off existing roads and trails, they can crush plants, compact soils, and provide a means for nonnative, invasive plant species to invade otherwise remote, intact habitats (USFWS, 2014).

Stressor: Development (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Development, which results in direct mortality and in habitat loss, degradation, and fragmentation, has resulted in the extirpation of one *Ivesia webberi* population and the loss of a portion of another population (Service 2014, p. 27). Residential or commercial development is ongoing or planned at each of the four Nevada populations located on private lands. In addition, construction of a 120-kV overhead transmission line may impact two *I. webberi* populations located on Forest Service lands (Service 2014, pp. 27–28) (USFWS, 2014).

Stressor: Grazing (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Livestock grazing has the potential to result in negative effects to *I. webberi* due to trampling and substrate disturbance, but this situation is dependent on factors such as stocking rate and season of use. Two *I. webberi* populations occur in areas that are currently grazed by cattle, and another seven populations occur within vacant grazing allotments that could be reopened to grazing to alleviate grazing pressures on nearby allotments (Service 2014, p. 30) (USFWS, 2014).

Stressor: Climate change (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Climate change is likely to affect *Ivesia webberi*, although it is difficult to project specific effects. In the Great Basin, temperatures have risen 0.9 to 2.7 degrees Fahrenheit (°F) (0.5 to 1.5 degrees Celsius (°C)) in the last 100 years and are projected to warm another 3.8 to 10.3 °F (2.1 to 5.7 °C) over the rest of the century (Service 2014, p. 31). Under current climate change projections, it is anticipated that future climatic conditions will favor the further spread of nonnative, invasive plants and increase the frequency, spatial extent, and severity of wildfires (Service 2014, p. 31). Alteration of temperature and precipitation patterns as a result of climate change also may result in decreased survivorship of *I. webberi* by causing physiological stress, altering phenology, and reducing reproduction or seedling establishment (USFWS, 2014).

Recovery**Reclassification Criteria:**

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- Not available

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SPECIES ACCOUNT: *Jacquemontia reclinata* (Beach jacquemontia)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015)

Physical Description

Beach jacquemontia is a perennial vine which has a main stem with numerous laterals spreading out from a stout rootstock (Robertson, 1971). These reclining, partly twining or ascending, slender stems are woody at the base and may twine over other plants (Robertson, 1971; Austin, 1979). The older leaves and stems of this species can be glabrous, but the pubescence makes younger leaves and stems appear whitish (Austin, 1979). The leaves are entire, alternate, estipulate, spirally arranged, and almost always petiolate, reaching one to three cm in length and 0.5 to 2.5 cm in breadth (Small, 1905; Robertson, 1971; Austin, 1979). The flowers of this species are white to light pink and the sepals are persistent. The inflorescences can be axillary cymose or solitary with branches 8-40 millimeters (mm) long, usually not exceeding the leaves (Robertson, 1971; Austin, 1979). The fruit is a light brown capsule about four to five mm long (Small, 1905; Robertson, 1971). Additional physical descriptions of beach jacquemontia can be found in Small (1905) and Robertson (1971).

Taxonomy

Though *J. havanensis* is closely related, beach jacquemontia's main distinction is its ciliolate (marginal fringe of hairs) sepals and rather succulent leaves (Robertson, 1971). This ciliolate on the outer sepals and fleshy leaves also distinguishes this species from *J. curtissii*, which has hairless sepals and narrow leaves that are not fleshy (Austin, 1979). There are about 100 species of the genus *Jacquemontia*, most of which are found in tropical and subtropical America (Robertson, 1971). Beach jacquemontia is the only species found along the beaches of southeastern Florida (Austin, 1979). Beach jacquemontia was first described from specimens collected in 1903 at northern Miami Beach (Small, 1905). The original treatment of this taxon as a distinct species was upheld by Robertson (1971) during a review of the genus *Jacquemontia*. Three other species are found in Florida: *J. curtissii* inhabits pinelands on the mainland, while *J. jamaicensis* and *J. pentantha* occur in the Florida Keys (Small, 1933). Although Small (1933) considered beach jacquemontia's range to extend into the West Indies, Austin (1979) considered it endemic to the east coast of Florida.

Historical Range

Found historically in Martin Co. FL (NatureServe, 2015)

Current Range

Palm Beach, Broward, and Dade Cos., FL; reintroduction projects initiated. (NatureServe, 2015). Beach jacquemontia is a member of the morning glory family (Convolvulaceae) that is restricted to the southeastern coast of Florida. Much of the primary habitat of this species, beach coastal strand and maritime hammock, has been destroyed or altered for residential and commercial construction. Fewer than 1,000 individual plants exist. They are found in small, widely separated populations in Miami-Dade, Broward, and Palm Beach counties, where habitat loss and modification place this species at a high risk of extinction. Habitat conservation and management and reintroduction efforts are needed to make sure of the survival of this species. The information presented here is from the Multi-species Recovery Plan for South Florida

(Service, 1999), which represents a revision of the existing recovery plan for the beach jacquemontia (Service, 1995).

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Breeding Season**

Adult: flowers from November to May

Reproduction Narrative

Adult: Beach jacquemontia flowers from November to May, but may vegetatively propagate at any time. The incidence or importance of vegetative propagation is not known at this time. At some sites, beach jacquemontia sets fruit and disperses seed prolifically (Robertson, 1971); however, few seedlings or young plants are ever found near adult plants. Microhabitat conditions and locations relative to adult plants probably play a major role in providing suitable germination sites (Austin, personal communication, 1997; Kernan, personal communication, 1997). For example, at Crandon Park, naturally sown seeds had extremely low germination rates (unmeasurable) compared to seeds taken from this site and germinated under greenhouse conditions (70%). Findings from these investigations indicated that germination rates were highest in more organic soils in the shade, but that the seed viability was short-lived once sowed.

Habitat Type

Adult: Coastal dunes/shrubby hammocks

Habitat Narrative

Adult: Pine rocklands and the crest and lee side of coastal dunes. (Based on Ward 1979, Wunderlin 1982.) (NatureServe, 2015). At Crandon Park, Dade County, beach jacquemontia exists on dune faces at the edge of shrubby hammocks. At Hugh Taylor Birch State Recreation Area [SRA], Broward County, beach jacquemontia is located in coastal scrub with little canopy cover and exposed sandy substrate. There, it receives protection from direct ocean winds and sea spray (Lippincott, 1990). Seedling and young beach jacquemontia grow best when shaded. Under natural conditions, young plants are typically found growing in the shade of adjacent shrubs and trees. When mature, beach jacquemontia spread laterals from the rootstock into adjacent exposed sites (Kernan, personal communication, 1997).

Dispersal/Migration***Population Information and Trends*****Number of Populations:**

Nine

Population Size:

~700

Population Narrative:

The barrier islands within the range of beach jacquemontia are entirely urbanized except for a few small parks and private estates. Johnson et al. (1993) inventoried all tracts of native coastal vegetation in southeast Florida that were four or more hectares in size. They found only 24 tracts of that description in the known range of beach jacquemontia, five of them entirely or mostly in private ownership. These tracts comprised about 87 hectare [ha] of beach strand vegetation in public ownership, 10.5 ha in private ownership, and 26.7 ha of maritime hammock in public ownership. In 1991, less than 1,000 individual plants of beach jacquemontia were known to occur on 12 sites (Austin 1991). Eleven of these sites were in public parks or recreation areas operated by State, county, or local governments in Palm Beach (eight sites), Broward (one site), and Dade (two sites) counties. The only known privately owned site, in Broward County, had just one plant (Johnson et al., 1993; Austin, 1991). A 1995 survey for beach jacquemontia located 450 to 600 plants at ten sites in Dade and Palm Beach counties (Kernan, personal communication, 1995). More than half of these plants were located at two sites: Red Reef Park in Palm Beach County and Crandon Park in Dade County. The remaining plants were scattered in populations of fewer than 50 individuals in Broward, Dade, and Palm Beach counties. As of 1996, beach jacquemontia was known from only nine sites in Dade and Palm Beach counties (Garview, personal communication, 1997; Davis, personal communication, 1997). Eight of these sites contained natural populations, while one site was established from restoration efforts. Several previously known sites have been lost over the past several years, including re-established populations at Coral Cove Park and Gemini Gardens (private), and Juno Beach Park, Nasa (private). There may be an additional historic site in Palm Beach County added if future surveys confirm the presence of beach jacquemontia. Since 1996, surveys have revealed that more beach jacquemontia colonies in Palm Beach County have been lost. Colonies are now known to exist at Carlin Park, Loggerhead Park, Red Reef Park, Red Reef Golf Course, South Beach Park, and South Inlet Park. Gemini Gardens, Atlantic Dunes Park and Spanish River Park were not included in those surveys (Davis, personal communication, 1998). Information from specific localities of beach jacquemontia suggests that the species is relatively secure at some sites but susceptible at others. For example, it was collected at South Coral Cove Park, Jupiter Island, Palm Beach County, in 1962, but was not found there in 1990 (Johnson et al., 1993). The disappearance from this site is due to beach erosion and shading from Australian pines (Johnson et al., 1993). Several specimens identified as beach jacquemontia from the Jupiter Lighthouse on the mainland opposite the southern tip of Jupiter Island have been subsequently identified as *J. curtissi* (Davis, personal communication, 1998). Land clearing for residential development has eliminated beach jacquemontia from other sites in this area (Austin, 1979). Although apparently suitable habitat exists at Blowing Rocks Preserve and Hobe Sound NWR on Jupiter Island, beach jacquemontia has not been found there (Johnson et al., 1993). Surveys conducted in 2003-2004 estimate the total population to be 700 individuals on nine sites (Maschinski et al., 2004). This number is down slightly from the 2003 estimate of 760 individuals on nine of ten existing sites surveyed. The populations at Carlin Park and Loggerhead Park in Palm Beach County experienced a greater than 50% population reduction observed in the fall of 2003, probably due in part to canopy closure caused by encroachment of hardwoods. Two plants were discovered at Lake Worth Inlet in Palm Beach County in 2001, but only one remained in January 2004. Outplanted populations remained steady. At Red Reef Park in Palm Beach County, 15 of 18 outplanted individuals were surviving in January 2004, the same number observed during the 2003 visit. At Bill Baggs State Park in Miami-Dade County, seven of 93

plants remained of the outplanted population in February 2004, with one plant lost since the survey conducted in the previous year.

Threats and Stressors

Stressor: Loss and degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Loss of habitat to urbanization and beach erosion led to the listing of beach jacquemontia as endangered on November 24, 1993 (Service, 1993). The vast majority of beach coastal strand and maritime hammock vegetation, the primary habitat of this species, has been destroyed by residential and commercial construction. Habitat within public lands has also been destroyed or degraded due to construction of parking lots, pedestrian routes, picnic areas, and other modifications for recreational uses. Additional habitat has been lost to beach erosion at some sites (Johnson et al. 1993, Davis, personal communication, 1997).

Stressor: Fragile demographics

Exposure:

Response:

Consequence:

Narrative: The limited geographic distribution, fragmentation of remaining habitat, small sizes of beach jacquemontia populations, and possibility of stochastic natural events make it doubtful that many of the existing populations will persist for 100 years.

Recovery

Conservation Measures and Best Management Practices:

- To ensure the survival of this plant, the remaining populations of beach jacquemontia on public lands will require active management and a program of propagation, germplasm conservation, and augmentation. Basic demographic, pollination, seed dispersal, seed germination and seed establishment information is needed to recover this endangered species. Successful management will require new surveys for sites that contain beach jacquemontia, complete knowledge of where it existed historically, and surveys for sites within its historic range that would be suitable for re-establishment. In addition, threats to existing and proposed sites posed by commercial and residential development and invasion of exotic species need to be addressed. Because additional protection of beachfront property through fee title acquisition or easement is unlikely due to real estate costs, beach jacquemontia will be best protected and recovered through re-establishment efforts. Greenhouse propagated plants were successfully re-established to three sites in Crandon Park in 1989; however, two plants used in the Coral Cove Beach Dune Restoration Project in 1994 did not survive (Davis, personal communication, 1994). Although this attempt was unsuccessful, we believe the recovery of this species can be partially accomplished through re-establishment as part of dune restoration projects. Dade County is planning to re-establish about 60 beach jacquemontia plants at Bill Baggs Cape Florida SRA, Key Biscayne, Dade County (Carter, personal communication, 1997). It is important to remember that beach jacquemontia should only be re-established in areas within its historic range. Restoration efforts should also consider using other plants that occur naturally with beach jacquemontia, so that more of a representative vegetative complex is re-created. Some of the existing beach jacquemontia sites and many other potentially suitable

recipient sites for beach *jacquemontia* translocation will require removal and control of exotic vegetation as part of the restoration process. It seems that this species does best in sparsely vegetated habitats, and that one of the factors responsible for its decline is the lack of sparsely vegetated areas that are typical of overwashed dunes (Davis, personal communication, 1998). At Crandon Park, herbicides are being used on a few plots where beach *jacquemontia* is suppressed by St. Augustine grass, and the plants do not seem to be adversely affected. Fire may also play an important role in habitat maintenance for beach *jacquemontia* as demonstrated by the short-term response to a recent burn on Bear Cut Preserve on Key Biscayne, Dade County (Kernan, personal communication, 1996). The long-term effects of burning will need to be analyzed over the next several years. Mowing or bush-hogging could also be used where fire cannot be safely used, or in areas where the plants currently exist as a result of mowing.

References

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NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

USFWS. 2015. Environmental Conservation Online System (ECOS) – Species Profile. <http://ecos.fws.gov/ecp0/>. Accessed April 2016.

SPECIES ACCOUNT: *Juglans (=Nogal) jamaicensis* (West Indian Walnut (=Nogal))

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 1/13/1997

Physical Description

A large distinctive tree with fissured bark which may reach up to 25 meters (82 feet) in height. Twigs, buds, and leaf axes have minute rusty hairs. The leaves are alternate (growing at alternating intervals on either side of the stem) and compound (having two or more leaflets born on single stalk) and consist of from 16 to 20 mostly paired, nearly stalk-less-leaflets (small leaf or segment of a compound leaf). Leaflets are from 5.5 to 9.0 centimeters (2.2 to 3.5 inches) long and 2.2 to 4.0 centimeters (0.9 to 1.6 inches) wide, thin and nearly hairless, except on the veins beneath. Leaflets are lanceolate (narrow and tapering at each end), finely toothed, long-pointed and rounded, and unequal at the base. Nogal is monoecious; male and female flowers are borne in different clusters or catkins on the same tree. Staminate or male flowers are numerous and in drooping catkins, 8.8 to 11.0 centimeters (3.5 to 4.3 inches) long, that are borne on the twigs of the previous year. Pistillate or female flowers are several along an axis, 4.4 to 8.8 centimeters (1.7 to 3.5 inches) long, borne at the ends of the shoots of the season. Individual male flowers are composed of a 6-lobed calyx (outer protective covering of a flower) and many stamens (pollen producing reproductive organ of a flower). Female flowers are about 0.5 centimeters (0.2 inches) long, composed of a 4-toothed scale opening at one side and 4 sepals (one of the segments forming the calyx). The fruit, a drupe, is a walnut which is composed of a blackish husk, a brown rough-ridged hard shell from 1.6 to 2.75 centimeters (0.6 to 1.1 inches) wide and one large, oily, edible seed (Little et al. 1974, Proctor 1992) (USFWS, 1999).

Taxonomy

The name *Juglans jamaicensis* C. DC. has been used for plants from Cuba, Hispaniola, and Puerto Rico. Adams (1972) stated that the single report of the species from Jamaica was probably an error. Schaarschmidt (2002) recognized two varieties: var. *insularis* (Griseb.) H.Schaarschmidt from western Cuba, and var. *jamaicensis* from central and eastern Cuba, Hispaniola, and Puerto Rico. Schaarschmidt (2002) stated that the Puerto Rican population may be a third subspecies of *J. jamaicensis*. However, there is no formal change in the nomenclature of the species (USFWS, 2019).

Historical Range

See current range/distribution.

Current Range

Known from Cuba, Hispaniola, and Puerto Rico, but little information is currently available on its status in the first two countries (Liogier and Martorell 1982). The Center for Plant Conservation (1992) described it as "not common" and Proctor (1992) stated it was becoming increasingly rare on these two islands (USFWS, 1999).

Critical Habitat Designated

Yes;

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Lack of natural recruitment represents one of the major threats to the Nogal. The known population is predominantly composed of old individuals as sapling stages are missing (Omar A. Monsegur, Service, pers. obs., 2011). Without natural recruitment or successful augmentation from captive propagated individuals, these populations are likely to become extirpated as older individuals of Nogal die. In the case of future (not yet planned) efforts to enhance the natural populations by planting seedlings and saplings, it remains unknown if the planted individuals will develop as mature plants capable of reproduction. Flowering or fruit production of individuals planted in the wild has not been reported to date. Therefore, we consider the lack of natural recruitment a high and imminent threat to the species (USFWS, 2013).

Habitat Type

Adult: Forest (USFWS, 1999)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 1999)

Environmental Specificity

Adult: Narrow/specialist (USFWS, 1999)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1999)

Site Fidelity

Adult: High (inferred from USFWS, 1999)

Habitat Narrative

Adult: Nogal or the West Indian walnut is found on lands adjacent to the Monte Guilarte Commonwealth Forest in the central mountains of Puerto Rico. The mountains are upper Cretaceous, volcanic in origin. Soils are derived from these fine-grained igneous (volcanic) rocks and are high in permeable clay and low in silt and sand. Red or purplish in color, the well-drained soils have a very acidic subsoil (layer of soil beneath the surface soil). The most widely distributed soil is the Los Guineos series (Department of Natural Resources 1976). The area of the known population falls within the subtropical lower montane wet forest life zone (Ewel and Whitmore 1973). Four vegetation associations have been described in the Monte Guilarte Commonwealth Forests. Upper slopes are covered by sierra palm (*Prestoea montana*) forest interspersed with forest dominated by caimitillo (*Micropholis garcinifolia*) and granadillo (*Buchenavia capitata*). High peaks and exposed ridges are characterized by a dwarf or elfin forest which is dominated by evergreen, gnarled, small leaved species. Lower slopes and valleys were originally planted in coffee under shade trees (e.g., *Inga* sp., *Citrus* sp.) (USFWS, 1999). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred by the specific habitat requirements of this species and the low number of known populations (USFWS, 2013). Francis and Alemañy (1994) described the habitat of *J. jamaicensis*

throughout its range. The most important recent development for the species is the acquisition of the land where the Adjuntas population occurs and the incorporation of that land into the Guilarte Commonwealth Forest (Rubén Padrón, pers. comm., 2011). In Puerto Rico, Nogal occurs within the subtropical wet forest and lower montane wet forest life zones (Ewel and Whitmore 1973). Rainfall in both of these life zones, which differ in elevation, ranges from approximately 2,000 to 4,000 mm (ca. 80-160 in.) per year. These Holdridge life zones occupy areas that were extensively deforested for agriculture, especially during the nineteenth century. Areas in which agricultural activities have been abandoned and regeneration of natural vegetation has occurred may provide possible sites for the establishment of new populations of Nogal (USFWS, 2019).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Many fruits were seen on the ground, but most appeared too old and no longer viable. The absence of pericarp and the presence of fruits under rocks suggest animal dispersal, perhaps by rodents. In fact, predation of Nogal fruits by rats (*Rattus rattus*) and weevils has been reported (Ovidio González, DNER, pers. comm. 2011) (USFWS, 2013).

Population Information and Trends

Resiliency:

Low (inferred from USFWS, 2013)

Representation:

Low (inferred from USFWS, 2013)

Redundancy:

Low (inferred from USFWS, 2013)

Number of Populations:

One (USFWS, 2013)

Population Size:

~31 individuals (USFWS, 2013)

Population Narrative:

Acevedo (1984) stated that the population of Nogal in Adjuntas, Puerto Rico, consisted of about twenty individuals, ranging from 8 to 20 meters (m) in height. Proctor (1992) stated that “at last count, only 14 trees of this species were known to survive in the wild”. The population visited by Service and UPRM staff on March 10, 2011 consisted of 19 adult trees, two juveniles and eight seedlings. The trees ranged from 7 to 20 m in height (mean = 12.0 m, s.d. = 4.28), and 6.0 to 85.2 centimeters (cm) in dbh (mean = 31.5 cm, s.d. = 19.80). One had two trunks and another was branched near the base. About two of the trees were partly or largely dead, and two others were found dead. No trees were observed with flowers or fruits. Many fruits were seen on the ground, but most appeared too old and no longer viable. The absence of pericarp and the presence of fruits under rocks suggest animal dispersal, perhaps by rodents. In fact, predation of Nogal fruits by rats (*Rattus rattus*) and weevils has been reported (Ovidio González, DNER, pers. comm. 2011) (USFWS, 2013). Low resiliency, representation and redundancy are inferred based

on this species single known population and low number of individuals (USFWS, 2013). The Plan specifies that the Service will consider delisting *Juglans jamaicensis* when: 1. protection of the known populations has been achieved (through means which may include acquisition and landowner agreements), and 2. new populations (the numbers of which should be determined following the appropriate studies) capable of self perpetuation have been established within protected areas, such as the Monte Guilarte or Toro Negro Commonwealth Forests. The Plan specifies that these are minimum requirements and could be expanded upon if the regenerative or propagative potential of natural and ex situ populations proves to be insufficient. Alternatively, if new populations of the species are discovered, it may be preferable to place greater emphasis on protection, rather than propagation, in order to achieve a minimum number of plants necessary for recovery. Criterion 1 has partially been met. The known population at the base of La Silla de Calderón has been acquired and incorporated into the Guilarte Commonwealth Forest. However, there is the potential that the known population forms part of a larger population that extends to private properties and has not been surveyed. If landowner agreement can be obtained, those private properties should be surveyed for the presence of the species to determine if the area should be targeted for potential acquisition and/or protection. Criterion 2 has not been met. Attempts to establish new populations have been conducted at “Bosque del Pueblo” in Adjuntas and other adjacent areas, including the Guilarte Commonwealth Forest. However, there is no data about the status of these individuals or the establishment of any self-sustainable population of this species in Puerto Rico (USFWS, 2019). Acevedo (1984) stated that the population of Nogal in Adjuntas, Puerto Rico, consisted of about twenty individuals, ranging from 8 to 20 meters (m) in height. Proctor (1992) stated that “at last count, only 14 trees of this species were known to survive in the wild”. The population visited by Service and UPRM staff on March 10, 2011 consisted of 19 adult trees, two juveniles and eight seedlings. The trees ranged from 7 to 20 m in height (mean = 12.0 m, s.d. = 4.28), and 6.0 to 85.2 centimeters (cm) in dbh (mean = 31.5 cm, s.d. = 19.80). One had two trunks and another was branched near the base. About two of the trees were partly or largely dead, and two others were found dead. No trees were observed with flowers or fruits. Many fruits were seen on the ground, but most appeared too old and no longer viable. The absence of pericarp and the presence of fruits under rocks suggest animal dispersal, perhaps by rodents. In fact, predation of Nogal fruits by rats (*Rattus rattus*) and weevils has been reported (Ovidio González, DNER, pers. comm. 2011). In 2009, over 50 individuals of the species were planted in the Guilarte Forest as a reintroduction (DNER 2011) (see additional discussion under C.1.f). However, it is too soon to determine whether or not this will become a viable, self-sustaining population (USFWS, 2019). Studies of genetic variation have not been conducted, but based on the very small number of individuals, limited genetic variability is expected. Reintroduction of plants from the Dominican Republic, where the species is more abundant, would likely alter the pattern of genetic variation in Puerto Rico (cf. Francis and Alemañy 1994) (USFWS, 2019). Spatial distribution: *Juglans jamaicensis* occurs in all of the Greater Antilles except Jamaica, even though its name suggests otherwise (a misunderstanding by the botanist describing it originally; Proctor 1992). This species was considered increasingly rare in Cuba, Hispaniola, and Puerto Rico. In fact, it was virtually extinct in the wild in Puerto Rico at the time of Proctor’s 1992 report. Nogal was first collected in Puerto Rico around 1865 by Agustín Stahl from an area between Peñuelas and Adjuntas at an elevation of approximately 2,297 ft (700 m). The species was subsequently collected by the German botanist Paul Sintenis in 1886 from Saltillo near Adjuntas and again in 1887 from Santa Rosa near Utuado. Bartolomé Barcelá made an additional collection in 1915 from an area near Adjuntas. Nogal became so scarce that it was considered possibly extinct until the early 1970s. The species was not reported again until 1974, when it

was rediscovered at an elevation of 3,120 ft (950 m) west of Cerro La Silla de Calderón, an area located near the southwest corner of the municipality of Adjuntas. A survey of these trees was conducted in 1992 by the U.S. Forest Service. A total of 14 individuals were documented, the largest of which was more than 66 ft (20 m) in height. Plant specimens deposited in herbaria can be mapped using the information provided in their labels. UPRM staff used the point-circle method (Chapman and Wieczorek 2006) that assigns coordinates for the location of the collection as well as an estimate of their uncertainty (in meters), based on the locality descriptions obtained from the specimen labels of such localities, to allow the creation of an accurate species distribution map. Specimens with location uncertainties less than 300 m (Figure 1) have been collected from montane forests at elevations between 2,950 and 3,281 ft. (900 and 1000 m). Such accurate locations, within the Adjuntas municipality, include Ultisols of the Maricao clay, Los Guineos clay and Los Guineos-Maricao soil associations, and Inceptisols of the Mucara silty clay soil association, all on slopes of 20-60% inclination. The other eight specimen localities, with inaccurate locality descriptions (inaccuracies from 2,000 to 15,620 m), were collected within the municipalities of Utuado and Adjuntas (Appendix 1). *Juglans jamaiensis* may have been more widespread in Puerto Rico historically, but much of the forested areas in the central mountain region were cut for the planting of sun coffee, although most of the recently documented trees today survive in former sun coffee plantations. The species, possibly never a common one, may also have been cut for the use of its valuable wood (USFWS, 2019). Addendum 1. In December 2017, Dr. Eugenio Santiago, affiliate professor of the University of Puerto Rico, Río Piedras Campus, visited Cerro La Silla de Calderon in the municipality of Adjuntas to assess the only known natural population of nogal in Puerto Rico (Santiago 2018, pers. comm.). During his assessment, from the 20 individuals of nogal previously estimated from this location (USFWS 2013), Dr. Santiago only found 3 adult individuals that were in good conditions and that suffered minimal damage from Hurricane María (Table 1)(Santiago 2018, pers. comm.). Dr. Santiago estimated a 40% to 50% reduction on canopy cover after the hurricane on that area. However, he reported seeing around 20 seedlings in great conditions and developing leafs (Santiago 2018, pers. comm.). Thus, he believes that canopy openness caused by Hurricane María promoted breeding and germination at the site, resulting in those seedlings, (Santiago 2018, pers. comm.). In addition, he reported a possible fourth adult individual in the proximity of the original locality, but he was not certain about the identification of that individual as a nogal (Table 1) (Santiago 2019, pers. comm.). No herbivory nor diseases were observed on adults or seedlings (Santiago 2019, pers. comm.). As for the reintroduction efforts, the current status of the 50 nogal individuals planted at the Guilarte Commonwealth Forest in 2009 is unknown (Cintron, PRDNER, 2019, pers. comm.) (Table 1). In December 2013, an additional 10 individuals were planted also at the Guilarte Commonwealth Forest near the trail known as “Vereda Interpretativa”, but by December 2014 all trees had died (Cintron, PRDNER, 2019, pers. comm.) (Table 1). Causes of death of these individuals include heavy drought, excess of canopy cover caused by growth of Palma de Sierra (*Prestoea montana*), and fallen organic debris on planted nogal individuals (Cintron, PRDNER, 2019, pers. comm.) (USFWS, 2019).

Threats and Stressors

Stressor: Land clearing (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Most known individuals are located on public lands within the Guilarte Commonwealth Forest. The property that harbors the known population at the base of La Silla de Calderón has been acquired and incorporated into the Guilarte Forest. Thus, the individuals located within these lands are protected. However, there is the potential that this known population forms part of a larger population that extends to other adjacent private properties that have not been surveyed. Therefore, habitat modification as a result of land clearing of mature secondary forest currently present within the known range of the species for agricultural purposes, urban development and construction of infrastructure may pose a threat to this species because these forest lands may harbor undetected individuals or populations of Nogal that are not protected. Based on the above information, we consider habitat destruction or modification as a low and non-imminent threat to the species (USFWS, 2013).

Stressor: Disease (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: UPRM staff observations of partly or completely dead trees suggest that disease may be a current threat to the species. However, because of limited information available, we consider this threat low and non-imminent (USFWS, 2013).

Stressor: Predation (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of viability/reproduction

Narrative: Seed predation by rats and weevils has been reported under nursery conditions (Ovidio González, PRDNER, pers. comm. 2011). Thus, predation of seeds in the wild may occur. Due to the very small number of live trees currently known to exist, disease and predation should be considered as a possible threat to this species in Puerto Rico. However, because of limited information available, we consider this threat low and non-imminent (USFWS, 2013).

Stressor: Hurricanes and Landslides (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Hurricanes frequently affect the islands of the Caribbean. As a species endemic to the Greater Antilles, Nogal should be well adapted to tropical storms, but the damage observed on trees in the Adjuntas population might suggest otherwise. In addition, the very heavy rains associated with tropical storms and hurricanes in the mountains of Puerto Rico often lead to landslides. Given the steep slopes on which most known Nogal trees grow, a massive landslide would not only take out the trees and their young offspring, but their seed bank and substrate as well. Nogal may be further threatened by climate change, which is predicted to increase the frequency and strength of tropical storms and can cause severe droughts (Hopkinson et al. 2008.). Due to the extremely low number of adult individuals and the problems regarding the natural recruitment of the species, severe hurricanes and associated landslides pose a threat to the species. However, the frequency of severe hurricanes is low so the Service considers severe tropical storms as a low and non-imminent threat to the species (USFWS, 2013).

Stressor: Genetic Variation (USFWS, 2013)

Exposure:**Response:**

Consequence: Loss of genetic variability

Narrative: Along with a decreasing population size, negative impacts of habitat fragmentation may result in erosion of genetic variation through the loss of alleles by random genetic drift (Honnay and Jacquemyn 2007) and may also limit the ability of a species to respond to a changing environment (Booy et al. 2000). Given the extremely small population size of Nogal in Puerto Rico, it is highly likely that its genetic variability is extremely low (Duane Kolterman, UPRM, pers. comm., 2011). In order to safeguard the remaining genetic diversity, the origin and survival of reintroduced individuals needs to be monitored as well as their development into mature individuals. Consequently, the protection and monitoring of known adult individuals should be considered as a high priority for the conservation of the species. Based on the above, we consider the lack of genetic variation a high and imminent threat to the species (USFWS, 2013).

Stressor: Lack of natural recruitment (USFWS, 2013)

Exposure:**Response:**

Consequence: No young trees/aging population

Narrative: Lack of natural recruitment represents one of the major threats to the Nogal. The known population is predominantly composed of old individuals as sapling stages are missing (Omar A. Monsegur, Service, pers. obs., 2011). Without natural recruitment or successful augmentation from captive propagated individuals, these populations are likely to become extirpated as older individuals of Nogal die. In the case of future (not yet planned) efforts to enhance the natural populations by planting seedlings and saplings, it remains unknown if the planted individuals will develop as mature plants capable of reproduction. Flowering or fruit production of individuals planted in the wild has not been reported to date. Therefore, we consider the lack of natural recruitment a high and imminent threat to the species (USFWS, 2013).

Stressor: Unknown pollination biology for this species including presumption of wind-pollination (USFWS, 2019).

Exposure:**Response:****Consequence:**

Narrative: The pollination biology of the species remains unknown, but it is presumed that Nogal, like other members of its genus and family, is wind-pollinated. At least in order to allow outcrossing, this strategy requires adequate abundance of individuals and population density, adequate exposure to wind, and windy conditions during the flowering season. According to Duane Kolterman (UPRM, pers. comm., 2011) this is an uncommon strategy in tropical forests, and may represent a limitation for the species (USFWS, 2019).

Stressor: Apparent lack of a natural fruit and seed dispersal agent (USFWS, 2019).

Exposure:**Response:****Consequence:**

Narrative: Of even greater concern is the apparent lack of a natural fruit and seed dispersal agent. The fruits are apparently dispersed primarily by gravity and secondarily by animals

(probably introduced rats). However, the Nogal's distribution suggests that some native animal(s) must have assisted in its dispersal in the remote past. The fruits (large and heavy, mesocarp hard rather than fleshy, endocarp hard and bony) do not seem well adapted for dispersal by bats, and there have not been any native terrestrial mammals in Puerto Rico for hundreds of years or longer. Temperate species of *Juglans* are mammal-dispersed. For example, in the northeastern United States, *J. nigra* (the Black walnut) is dispersed by native squirrels (Duane Kolterman, UPRM, pers. comm., 2011). The absence of a disperser may well represent a serious limitation for the species. It would be interesting to inquire as to the dispersal agents that may have been observed on other Greater Antillean islands (Hispaniola and Cuba) (USFWS, 2019).

Stressor: Present or threatened destruction, modification or curtailment of its habitat or range (USFWS, 2019).

Exposure:

Response:

Consequence:

Narrative: Most known individuals are located on public lands within the Guilarte Commonwealth Forest. The property that harbors the known population at the base of La Silla de Calderón has been acquired and incorporated into the Guilarte Forest. Thus, the individuals located within these lands are protected. However, there is the potential that this known population forms part of a larger population that extends to other adjacent private properties that have not been surveyed. Therefore, habitat modification as a result of land clearing of mature secondary forest currently present within the known range of the species for agricultural purposes, urban development and construction of infrastructure may pose a threat to this species because these forest lands may harbor undetected individuals or populations of Nogal that are not protected. Based on the above information, we consider habitat destruction or modification as a low and nonimminent threat to the species (USFWS, 2019).

Stressor: Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2019).

Exposure:

Response:

Consequence:

Narrative: In 1974, Little et al. believed that *J. jamaicensis* might be extinct in Puerto Rico. They stated that "the walnut trees, which probably were uncommon or rare, might have been cut for the prized wood." Overcollection of the edible nuts could also reduce the species' reproductive ability. However, at present, the very small number of trees and the fact that the known population lies within a protected area does not lend itself to commercial harvesting. There is no evidence that the species has been affected by overutilization for scientific or educational purposes. Based on the above, we believe that overutilization is no longer a threat to the species (USFWS, 2019).

Stressor: Disease or predation (USFWS, 2019).

Exposure:

Response:

Consequence:

Narrative: UPRM staff observations of partly or completely dead trees suggest that disease may be a current threat to the species. In addition, seed predation by rats and weevils has been reported under nursery conditions (Ovidio González, PRDNER, pers. comm. 2011). Thus,

predation of seeds in the wild may occur. Due to the very small number of live trees currently known to exist, disease and predation should be considered as a possible threat to this species in Puerto Rico. However, because of limited information available, we consider this threat low and non-imminent (USFWS, 2019).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2019).

Exposure:

Response:

Consequence:

Narrative: The Commonwealth of Puerto Rico approved Law No. 241 in 1999, known as “Nueva Ley de Vida Silvestre de Puerto Rico” (New Wildlife Law of Puerto Rico). The purpose of this law is to protect, conserve, and enhance both native and migratory wildlife species, declare as the property of Puerto Rico all wildlife species within its jurisdiction, regulate permits, hunting activities, and exotic species, among others. Law No. 241 includes plants as part of the wildlife species. In 2004, the Puerto Rico Department of Natural and Environmental Resources (PRDNER) approved the “Reglamento para Regir el Manejo de las Especies Vulnerables y en Peligro de Extinción en el Estado Libre Asociado de Puerto Rico” (Regulation 6766 to regulate the management of threatened and endangered species in Puerto Rico). Nogal has been included in the list of protected species and designated as endangered under Regulation 6766. Under Article 2.06, this regulation prohibits collecting, cutting, removing, among other activities, listed plant individuals within the jurisdiction of Puerto Rico. Based on the presence of Commonwealth laws and regulations protecting Nogal, we believe that the inadequacy of existing regulatory mechanisms should no longer be considered a threat to this species. However, it is important to note that enforcement on private lands continues to be a challenge as accidental damage or extirpation of 10 individuals of endangered plants has occurred due to lack of knowledge of the species by private land owners. This is highlighted because Nogal is difficult to identify unless it is in fruit or the person (private land owner, law enforcement officers or biologists) has expertise on the species (USFWS, 2019).

Stressor: Other natural or manmade factors affecting its continued existence: Hurricanes and Landslides (USFWS, 2019).

Exposure:

Response:

Consequence:

Narrative: Hurricanes and Landslides. Hurricanes frequently affect the islands of the Caribbean. As a species endemic to the Greater Antilles, Nogal should be well adapted to tropical storms, but the damage observed on trees in the Adjuntas population might suggest otherwise. In addition, the very heavy rains associated with tropical storms and hurricanes in the mountains of Puerto Rico often lead to landslides. Given the steep slopes on which most known Nogal trees grow, a massive landslide would not only take out the trees and their young offspring, but their seed bank and substrate as well. Nogal may be further threatened by climate change, which is predicted to increase the frequency and strength of tropical storms and can cause severe droughts (Hopkinson et al. 2008.). Due to the extremely low number of adult individuals and the problems regarding the natural recruitment of the species, severe hurricanes and associated landslides pose a threat to the species. However, the frequency of severe hurricanes is low so the Service considers severe tropical storms as a low and non-imminent threat to the species (USFWS, 2019).

Stressor: Other natural or manmade factors affecting its continued existence: Nonnative Species (USFWS, 2019).

Exposure:

Response:

Consequence:

Narrative: Nonnative Species. Introduced rats (*Rattus* spp.) are apparently serving as secondary dispersers for Nogal, but they are also reported to be seed predators. It is unlikely that rats are as efficient as the (hypothetical) original dispersers were, but they are well known to be efficient seed predators (Duane Kolterman, UPRM, pers. comm., 2011). The Service considers nonnative species a low and non-imminent threat to Nogal as no evidence exists to link rat seed predation to the low recruitment of the species (see Factor C) (USFWS, 2019).

Stressor: Other natural or manmade factors affecting its continued existence: Genetic Variation (USFWS, 2019).

Exposure:

Response:

Consequence:

Narrative: Genetic Variation. Along with a decreasing population size, negative impacts of habitat fragmentation may result in erosion of genetic variation through the loss of alleles by random genetic drift (Honnay and Jacquemyn 2007) and may also limit the ability of a species to respond to a changing environment (Booy et al. 2000). Given the extremely small population size of Nogal in Puerto Rico, it is highly likely that its genetic variability is extremely low (Duane Kolterman, UPRM, pers. comm., 2011). In order to safeguard the remaining genetic diversity, the origin and survival of reintroduced individuals needs to be monitored as well as their development into mature individuals. Consequently, the protection and monitoring of known adult individuals should be considered as a high priority for the conservation of the species. Based on the above, we consider the lack of genetic variation a high and imminent threat to the species (USFWS, 2019).

Stressor: Other natural or manmade factors affecting its continued existence: Lack of Natural Recruitment (USFWS, 2019).

Exposure:

Response:

Consequence:

Narrative: Lack of Natural Recruitment. Lack of natural recruitment represents one of the major threats to the Nogal. The known population is predominantly composed of old individuals as sapling stages are missing (Omar A. Monsegur, Service, pers. obs., 2011). Without natural recruitment or successful augmentation from captive propagated individuals, these populations are likely to become extirpated as older individuals of Nogal die. In the case of future (not yet planned) efforts to enhance the natural populations by planting seedlings and saplings, it remains unknown if the planted individuals will develop as mature plants capable of reproduction. Flowering or fruit production of individuals planted in the wild has not been reported to date. Therefore, we consider the lack of natural recruitment a high and imminent threat to the species (USFWS, 2019).

Stressor: The species continues to be threatened by same factors identified in the 2013 5-year status review for the species (USFWS, 2019).

Exposure:

Response:**Consequence:**

Narrative: Addendum 1. Threat Factor Analysis: The information gathered during this review indicates that from the only known population of nogal, located in the Guilarte Commonwealth Forest, only three (possibly four) adult nogal individuals are left. However, no cause for the disappearance of the rest of the individuals of this population has been identified. In fact, minimal damage to the population from Hurricane María was documented. Nevertheless, impacts of wind forces from the hurricane resulted on an estimated reduction of 40% to 50% of canopy cover on the suitable habitat for the species. From our review, the species continues to be threatened by same factors identified in the 2013 5-year status review for the species. However, a comprehensive assessment of this population should be conducted to determine if there are additional trees, and if observed seedlings were successfully recruited into the population (USFWS, 2019).

Stressor: Due to undetected presence on private lands, habitat modification (i.e. vegetation clearance for road reconstruction and agriculture or residential projects) continues to be a threat to the species (USFWS, 2019).

Exposure:**Response:****Consequence:**

Narrative: Addendum 1. Threat Factor Analysis: Since undetected individuals or population of nogal may be present in private lands adjacent to the Silla de Calderón area, habitat modification (i.e. vegetation clearance for road reconstruction and agriculture or residential projects) continues to be a threat to the species. However, these effects may be ameliorated by regulatory mechanisms currently in place in Puerto Rico to protect listed species and their habitats (e.g., Commonwealth Law No. 241-1999 and Regulation 6766) (See Five Factor Analysis Section above) (USFWS, 2019).

Recovery**Delisting Criteria:**

1. Protection of the known populations has been achieved (through means which may include acquisition and landowner agreements) (USFWS, 2013).
2. New populations (the numbers of which should be determined following the appropriate studies) capable of self perpetuation have been established within protected areas, such as the Monte Guilarte or Toro Negro Commonwealth Forests (USFWS, 2013).

Recovery Actions:

- Criterion 1 has partially been met. The known population at the base of La Silla de Calderón has been acquired and incorporated into the Guilarte Commonwealth Forest. However, there is the potential that the known population forms part of a larger population that extends to private properties and has not been surveyed. If landowner agreement can be obtained, those private properties should be surveyed for the presence of the species to determine if the area should be targeted for potential acquisition and/or protection (USFWS, 2013).
- Criterion 2 has not been met. Attempts to establish new populations have been conducted at “Bosque del Pueblo” in Adjuntas and other adjacent areas, including the Guilarte

Commonwealth Forest. However, there is no data about the status of these individuals or the establishment of any self-sustainable population of this species in Puerto Rico (USFWS, 2013).

- The known population should be monitored to collect seed material for propagation purposes. A protocol to collect seed should be created and implemented to avoid altering the natural recruitment of the species and maintain genetic diversity. Seed material from Puerto Rico should be sent to botanical gardens (Kew, Fairchild, etc.) to ensure that the species is propagated and its genetic identity is safeguarded (USFWS, 2019).
- Propagation and reintroduction efforts must continue. It is essential that the seed sources be as diverse as possible, and that record-keeping be both meticulous and as redundant as necessary to ensure that no data are lost (USFWS, 2019).
- All existing known trees should be monitored on a yearly basis; additional visits should be made after hurricanes, landslides, or other major disturbances to determine their effects on the population (USFWS, 2019).
- Monitoring should also consider the presence of possible pests affecting the establishment of seedling and saplings (USFWS, 2019).
- Studies should be conducted to determine the patterns of genetic variation of the species in order to develop a plan to preserve the species germplasm. This should include a comparison with trees from Hispaniola and Cuba (var. *jamaicensis*) (USFWS, 2019).
- Enhancement of the genetic diversity of *J. jamaicensis* with germplasm from outside Puerto Rico should be considered (USFWS, 2019).
- The Adjuntas Substation of the UPR-Mayagüez Agricultural Experiment Station (EEA) should be considered for the propagation of the species as well as for the establishment of an experimental population. The EEA-Adjuntas offers plenty of land, appropriate ecological conditions, adequate security, and resident personnel trained in plant propagation and maintenance (USFWS, 2019).
- The recovery plan should be revised to establish measurable criteria, including how many individuals constitute a self-sustainable population and how many populations would be needed to delist the species (USFWS, 2019).

Conservation Measures and Best Management Practices:

- 1. The known population should be monitored to collect seed material for propagation purposes. A protocol to collect seed should be created and implemented to avoid altering the natural recruitment of the species and maintain genetic diversity. Seed material from Puerto Rico should be sent to botanical gardens (Kew, Fairchild, etc.) to ensure that the species is propagated and its genetic identity is safeguarded (USFWS, 2013).
- 2. Propagation and reintroduction efforts must continue. It is essential that the seed sources be as diverse as possible, and that record-keeping be both meticulous and as redundant as necessary to ensure that no data are lost (USFWS, 2013).
- 3. All existing known trees should be monitored on a yearly basis; additional visits should be made after hurricanes, landslides, or other major disturbances to determine their effects on the population (USFWS, 2013).
- 4. Monitoring should also consider the presence of possible pests affecting the establishment of seedling and saplings (USFWS, 2013).
- 5. Studies should be conducted to determine the patterns of genetic variation of the species in order to develop a plan to preserve the species germplasm. This should include a comparison with trees from Hispaniola and Cuba (var. *jamaicensis*) (USFWS, 2013).

- 6. Enhancement of the genetic diversity of *J. jamaicensis* with germplasm from outside Puerto Rico should be considered (USFWS, 21013).
- 7. The Adjuntas Substation of the UPR-Mayagüez Agricultural Experiment Station (EEA) should be considered for the propagation of the species as well as for the establishment of an experimental population. The EEA-Adjuntas offers plenty of land, appropriate ecological conditions, adequate security, and resident personnel trained in plant propagation and maintenance (USFWS, 2013).
- 8. The recovery plan should be revised to establish measurable criteria, including how many individuals constitute a self-sustainable population and how many populations would be needed to delist the species (USFWS, 2013).

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SPECIES ACCOUNT: *Justicia cooleyi* (Cooley's water-willow)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 7/27/1989

Physical Description

An erect, perennial, rhizomatous herb growing to 5 dm tall. Stems are quadrangular, covered with hairs. Leaves are opposite, up to 7 cm long. Flowers are axillary or terminal. Corolla is about 10 mm long, deep reddish-purple, with a tube 5 mm long and with 2 prominent lips. (Based on Ward 1979.) (NatureServe, 2015)

Taxonomy

Distinct species. (NatureServe, 2015)

Historical Range

See Current

Current Range

Hernando, Lake, and Sumter counties, Fla. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Kral (1983), relying on sparse data, suggested a flowering season of August-December, or November-March. Specimen label data indicate flowering beginning by mid-August, flowering in mid-September, and flowering in February (Wunderlin et al. 1980) (USFWS, 1994). USFWS (2010) notes that the flowering period is from October-December.

Habitat Type

Adult: Hardwood hammocks/hardwood & Pine Forests (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Fine sandy loams or silty clay loams of shady, moist, deciduous hammocks underlain by limestone, along small gullies or meandering streams, low rises in swamp woodlands, and hammocks (Ward 1979). MESIC HARDWOOD HAMMOCKS AND HARDWOOD-PINE FORESTS AND ALONG ADJACENT ROADSIDES, USUALLY IN DENSE TO LIGHT SHADE. SOILS RANGE FROM MOIST

TO SEASONALLY WET AND ARE TYPICALLY UNDERLAIN BY LIMESTONE (NatureServe, 2015). High ecological integrity of the community, site fidelity and low tolerance ranges are inferred based on the specific habitat requirements of this species and the low number of known populations.

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Decreasing (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

6 - 20 (NatureServe, 2015)

Population Size:

1000 - 2500 individuals (NatureServe, 2015)

Population Narrative:

The short-term population trend is a 10-30% decline. TWO POPULATIONS ON CHINSEGUT HILL HAVE CA. 200 PLANTS EACH. CA. 1500 PLANTS KNOWN FROM USDA PLANT MATERIALS CENTER. SEVERAL HUNDRED PLANTS KNOWN FROM ROADSIDES. 15 EORS CONFIRMED WITHIN THE LAST DECADE (1990-2000), 14 SITES IN HERNANDO AND 1 SITE IN SUMTER COUNTIES (NatureServe, 2015). Low resiliency, representation and redundancy are inferred based on the low number of known populations and individuals.

Threats and Stressors

Stressor: Invasive plants (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Competition and shading by invasive plants is listed as a threat to this species (USFWS, 2010).

Stressor: Agricultural development (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Agricultural development is listed as a threat to this species (USFWS, 2010).

Stressor: Residential development (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Residential development is listed as a threat to this species (USFWS, 2010).

Stressor: Predation (USFWS, 2010)

Exposure:

Response:

Consequence: Population decline

Narrative: Deer herds have been documented browsing heavily on *J. cooleyi* at the Headquarters Tract in the Withlacoochee State Forest (FDOF 2001). This predation has resulted in reducing the size and density of this plant at this site. More information is needed to determine if the threat of vertebrate predation on this species has increased beyond what has naturally occurred and is causing a decline in the populations (USFWS, 2010).

Stressor: Disease (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of individuals/Decreased health of populations

Narrative: A fungal or bacterial disease has been found and is affecting the plants at the USDA Plant Materials Center (USFWS 1994, Landry 1995). There have been no attempts to identify the pathogen to determine the best treatment for this species (USFWS, 2010).

Stressor: Inadequacy of existing regulations (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: *Justicia cooleyi* is listed as endangered by the State of Florida on the Regulated Plant Index (Florida Department of Agriculture and Consumer Services Rule 5B-40). This law regulates the taking, transport, and sale of listed plants. It does not prohibit private property owners from destroying populations of listed plants on their property nor require landowners to manage habitats to maintain populations. Existing Federal and State regulations prohibit the removal or destruction of listed plant species on public lands. However, such regulations afford no protection to listed plants on private lands. The ESA only protects populations from disturbances on Federal lands or when a 'Federal nexus' is involved for other lands, meaning any action that is authorized (e.g. permitted), funded or carried out by a Federal agency. In addition, State regulations are less stringent than Federal regulations toward land management practices that may adversely affect populations of listed plants on private land. *J. cooleyi* is located on State conservation lands and USDA lands in Hernando County. *J. cooleyi* is also found along roadways and private lands at several sites in Hernando and Sumter Counties. In the absence of protections provided under the Act, we believe existing State regulatory mechanisms described above are inadequate to protect this species (USFWS, 2010).

Stressor: Mining (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Loss of habitat due to limestone mining is expected to be a continuing threat to this species (USFWS, 2010).

Stressor: Right-of-way maintenance

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Right-of-way maintenance (mowing and herbicide use) is listed as a threat to this species if it takes place at the wrong time of year (USFWS, 2010)

Recovery

Delisting Criteria:

To develop objective, measurable criteria, we need to better understand the distributions of this plant. Delisting of this species should become feasible as habitat is protected and new populations are (re)established. Plausible criteria for recovery for Cooley's water-willow recovery would require at least 15 viable and self-sustaining populations, totaling at least 4 10,000 individuals. Population viability at recovery levels must be demonstrated for 10 consecutive years (USFWS, 2010).

Conservation Measures and Best Management Practices:

- 1. Revise the current recovery plan to include updated objective and measurable recovery criteria for reclassifying this species to threatened status and delisting that are related to reducing the threats identified in the recovery plan, as well as updated information on the species distribution and biology (USFWS, 2010).
- 2. Support further research on: a. Effects of mowing and predator control on this species. b. Life history needs. c. Microhabitat requirements of this species. d. Identification and treatment of the pathogen causing the fungal or bacterial disease. e. Genetics of this species. f. Transplant experiments, long-term seed viability trials, and optimizing germination protocols (USFWS, 2010).
- 3. Continue working with public land managers to increase management efforts to benefit *J. cooleyi* on their lands (USFWS, 2010).
- 4. Conduct surveys at known sites of occurrence and expand surveys to other suitable areas in Hernando and Sumter Counties to provide distribution information needed to determine where plants currently exist and to prioritize recovery actions such as reintroductions at suitable sites (USFWS, 2010).
- 5. Determine effective methods to control invasive species in areas where *J. cooleyi* occurs. Follow up with monitoring of herbicide treatment effects on this species (USFWS, 2010).

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SPECIES ACCOUNT: *Kadua (=Hedyotis) cookiana* (Awiiwi)

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/25/1994; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Hedyotis cookiana, a member of the coffee family (Rubiaceae), is a small shrub with many branches 10 to 20 cm long. The papery-textured leaves are long and narrow, 4 to 8 cm long and about 0.5 to 1.2 cm wide, and fused at the base to form a sheath around the stem. The bisexual or female flowers are arranged in clusters of threes on flower stalks about 8 to 15 mm long, with the central flower on the longest stalk. Beneath the flower clusters are sharp-pointed bracts (modified leaves). The fleshy white corolla is trumpet-shaped and about 8 to 9 mm long, with lobes about 2 mm long. Fruits are top-shaped or spherical capsules about 3.0 to 3.5 mm long and 3.5 to 4 mm wide that open at maturity to release wedge-shaped reddish brown seeds. (USFWS, 1995)

Taxonomy

Genus occurs throughout tropics and subtropics. Species endemic to hawaiian islands. (NatureServe, 2015); In 2015, the Service published a technical correction for this and other plant and wildlife species, recognizing the taxonomic change from *Hedyotis cookiana* to *Kadua cookiana* (80 FR 35860, June 23, 2015). The taxonomic change does not affect the range or endangered status of this species. (USFWS, 2018)

Historical Range

Historically, *Hedyotis cookiana* was known from only three collections: Kealakekua on the island of Hawaii, Halawa and Kalawao on Molokai, and at the foot of the Koolau Mountains on Oahu (Fosberg 1943, HHP 1994, Hillebrand 1888). (USFWS, 1995)

Current Range

Current range is Kauai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Kadua (=Hedyotis) cookiana* on the island of kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Kadua (=Hedyotis) cookiana* includes one unit totaling 1,905 acres in Kauai County, Hawaii. The unit is Kauai 11—*Hedyotis cookiana*—a.

Kauai 11—*Hedyotis cookiana*—a [771 ha (1,905 ac)]: This unit is critical habitat for *Hedyotis cookiana* and is 772 ha (1,907 ac) on State land (Hono o Na Pali NAR and Na Pali Coast State Park). This unit contains Kanakau Summit. This unit provides habitat for seven populations of 300 mature, reproducing individuals of the short-lived perennial *Hedyotis cookiana* and is currently

occupied with between 60 and 80 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, streambeds or steep cliffs close to water sources in relict *Metrosideros polymorpha* low mesic and low wet forest communities. Although the Service does not believe that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is of appropriate size so that each potential recovery population on Kauai within the unit is geographically separated enough to avoid their destruction by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Within this unit, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Streambeds or steep cliffs close to water sources in relict *Metrosideros polymorpha* lowland mesic and lowland wet forest communities containing one or more of the following associated native plant species: *Boehmeria grandis*, *Chamaesyce celastroides* var. *hanapeensis*, *Hibiscus kokio* ssp. *saintjohnianus*, *Machaerina angustifolia*, *Nototrichium sandwicense*, *Pipturus kauaiensis*, *Pleomele aurea*, *Pouteria sandwicensis*, *Psydrax odorata*, or *Rauvolfia sandwicensis*; and

(ii) Elevations between 120 and 553 m (392 and 1,814 ft).

Special Management Considerations or Protections

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial and palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Riparian, forest- hardwood, forest/woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Wet environments (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 170 and 370 meters (USFWS, 1995)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1995)

Habitat Narrative

Adult: Habitat requirements for *Kadua cookiana* are areas around cool, clean flowing water such as streams, springs, and especially perennial waterfalls (Wood 2008). This species is believed to have formerly been much more widespread on several of the main Hawaiian Islands at elevations between 170 and 370 meters (560 and 1,200 feet) (USEWS 1994a). It grows with *Artemisia australis* (ahinahina), *Bidens forbesii* (kookoolau), *Carex meyenii* (no common name [NCN]), *Chamaesyce celastroides* var. *hanapepensis* (akoko), *Christella cyatheoides* (kikawaio), *Kadua elatior* (awiwi), and *Machaerina angustifolia* (uki), in an area dominated by alien vegetation. Other native associated plants include *Eragrostis variabilis* (kawelu), *Selaginella arbuscula* (Iepelepe a moa), *Lipochaeta connata* var. *acris* (nehe), and *Metrosideros polymorpha* (ohia) (National Tropical Botanical Garden 2009a; Wood 2008). (USFWS, 1995; USFWS, 2010)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2010)

Redundancy:

Very low (inferred from USFWS, 2010)

Number of Populations:

2 (USFWS, 2010; USFWS, 2018)

Population Size:

<200 wild individuals (USFWS, 2018)

Population Narrative:

Recent observations show that its distribution is restricted to Hanakoa and Waiahuakua Valleys on the Na Pali coast of Kauai. Ken Wood of the National Tropical Botanical Garden estimates there are approximately 100 to 122 individuals remaining in the wild. (USFWS, 2010); In 2011, the 5-year review reported two populations on Kaua'i totaling 100 to 120 individuals. Currently,

the two populations are in the same areas, with about 150 individuals at Waiahuakua and about 50 or fewer individuals at Hanakoa (Williams 2018, in litt.). This species has not been observed on O'ahu, Moloka'i, or Hawai'i since the 1800s and is likely extirpated from these islands. (USFWS, 2018)

Threats and Stressors

Stressor: Feral animals (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: In Waiahuakua, threats to this species are feral animals including pigs (*Sus scrofa*) and goats (*Capra hircus*). (USFWS, 2010)

Stressor: Invasive plants (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: In Waiahuakua, dominant invasive introduced plant species include *Adiantum raddianum* (NCN), *Ageratina riparia* (Hamakua pamakani, spreading mist flower), *Ageratum conyzoides* (maile hohono), *Blechnum appendiculatum* (NCN), *Clidemia hirta* (Koster's curse), *Elephantopus mollis* (elephant's-foot), *Erigeron karvinskianus* (daisy fleabane), *Lantana camara* (lantana), *Melinis minutiflora* (molasses grass), *Oplismenus hirtellus* (basketgrass, honohono), *Pluchea carolinensis* (sourbush, marsh fleabane), *Psidium guajava* (guava), *Setaria parviflora* (yellow foxtail), and *Syzygium cumini* (java plum) (Wood 2008). Waterfall vegetation is dominated by invasive introduced plant species. The general area below the falls has a 14 meter (46 foot) overstory of *Aleurites moluccana* (30 to 50 percent cover) and *Mangifera indica* (mango) (5 to 30 percent cover). The understory includes *Psidium guajava*, *Zingiber zerumbet* (awapuhi), *Oplismenus hirtellus* (honohono), *Christella dentata* (pai i iha), and *Coffea arabica* (Arabian coffee). Along with scattered non-native trees, shrubs and ferns including *Ageratina riparia* (spreading mist flower), *Blechnum appendiculatum* (NCN), *Kalanchoe pinnata* (airplant), *Clidemia hirta* (Koster's curse), *Cyperus meyerianus* (NCN), *Elephantopus mollis* (elephant's-foot), *Melinis minutiflora* (molasses grass), *Pluchea carolinensis* (sourbush), *Sacciolepis indica* (Glenwood grass), *Setaria palmifolia* (yellow foxtail), *Syzygium cumini* (java plum), and *Syzygium malaccense* (mountain apple) (National Tropical Botanical Garden 2008a). (USFWS, 2010)

Stressor: Natural disasters (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: In Waiahuakua and Hanakoa Valley, threats to this species are feral animals include hurricanes, landslides, and floods. (USFWS, 2010)

Stressor: Climate change loss or degradation of habitat (USFWS, 2010; USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai'i using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Kadua cookiana* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.869 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future, such as locating key microsites that overlap with current and future climate envelopes for outplanting efforts. (USFWS, 2017)

Stressor: Stochastic events and small population size (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: In addition to all of the other threats, species like *Kadua cookiana* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding, and disease outbreaks. The effects of these processes on this single-island endemic are exacerbated by anthropogenic threats, such as habitat loss for human development or predation by introduced species (USFWS 1995). (USFWS, 2010)

Stressor: Lack of adequate hunting regulations (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Both populations of *Kadua cookiana* occur within a State hunting area. Ungulate destruction and degradation of habitat, and predation by ungulates, are noted as threats to this species. One population is also within the Na Pali Coast State Wilderness Area, but there is no documented ungulate control and no fencing to prevent ungulate ingress (Division of State Parks 2018, in litt.). In addition, public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations are at risk (DLNR 2010). (USFWS, 2018)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Kauai and at least one other island where they now occur or occurred historically. (USFWS, 1995)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1995)
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1995)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Kauai and at least one other island where they now occur or occurred historically. (USFWS, 1995)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1995)
3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1995)

Recovery Actions:

- In order to prevent this taxon from going extinct, propagation efforts and the maintenance of adequate genetic stock ex situ should be undertaken immediately. (USFWS, 1995)
- Protection of remaining wild individuals from feral goats, feral pigs and competition from alien weeds is imperative. (USFWS, 1995)
- Population viability and monitoring—Continue to survey known localities and suitable habitat areas on Kaua'i to determine the current status of all populations of *Kadua cookiana*. (USFWS, 2018)
- Ungulate monitoring and control—Construct and maintain exclusion fences, or strategic fencing as appropriate, to protect *K. cookiana* from the impacts of feral ungulates. (USFWS, 2018)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. (USFWS, 2018)
- Captive propagation for genetic storage and reintroduction—Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. Evaluate genetic resources currently in storage to determine the need to place additional material into long-term storage due to this species' vulnerability to climate change. Research potential problems resulting from lack of pollen viability. (USFWS, 2018)
- Reintroduction and translocation—Augment current populations and reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2018)
- Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use this information to determine future landscape needed for the recovery of the species. (USFWS, 2018)
- Alliance and partnership development—Work with Hawai'i Division of Forestry and Wildlife and Hawai'i State Parks to initiate planning and contribute to implement of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2018)

Conservation Measures and Best Management Practices:

- Continue collecting material for genetic storage and propagation for reintroduction. (USFWS, 2010)
- Work with Hawaii Division of Forestry and Wildlife and Hawaii State Parks to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2010)

- Control invasive introduced plant species around wild plants. (USFWS, 2010)
- Construct large-scale fences around all naturally occurring and reintroduced individuals to eliminate negative impacts from feral ungulates. (USFWS, 2010)
- Assessment of genetic variability within extant population. (USFWS, 2010)
- Collect fruit from any outplanted individuals that set seed to add to the genetic diversity of the ex situ material. (USFWS, 2010)
- Reintroduce individuals into protected suitable habitat within historical range. (USFWS, 2010)
- Update the listed entity on 50 CFR 17 to match the currently recognized taxonomy. (USFWS, 2010)
- Investigate techniques to improve natural recruitment. (USFWS, 2010)

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SPECIES ACCOUNT: *Kadua (=Hedyotis) coriacea* (Kio`ele)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/15/1992; Pacific Region (R1) (USFWS, 2016)

Physical Description

Kadua coriacea is in the Rubiaceae, or coffee family. It is a small, many-branched, erect shrub, with leathery leaves that are more or less oval-shaped. The leaves are hairless above, hairless or downy below, and 3 to 8 centimeters (1.2 to 3.2 inches) long with sheath-like petioles. Stipules are reduced and attached to the petiole base. Flowers are clustered, trumpet-shaped, cream colored, and fleshy. Fruits are cup or top-shaped, containing dark-brown, irregularly angled seeds. *Kadua coriacea* is distinguished from other species in the genus by its small flowers with triangular leaf-like appendages (calyx lobes) that do not enlarge when the fruit develops. The fruits are longer than wide and flower buds are square in cross-section (U.S. Army 2003a).

Taxonomy

In 2012, USFWS revised the taxonomic status for this species when it revised critical habitat on Oahu, with no change in range or distribution (USFWS 2012a). This species is now listed as *Kadua coriacea* (formerly *Hedyotis coriacea*) and addressed as such for the remainder of this review. (USFWS, 2015)

Historical Range

Historically, *Kadua coriacea* was found on Oahu, Maui, and Hawaii Island (Wagner et al. 1999). (USFWS, 2015)

Current Range

It is presently known from the islands of Maui and Hawaii. At least one plant is currently known on the island of Maui (West Maui Natural Area Reserve). On the island of Hawaii, plants are known from the Kipuka Kalawamauna Endangered Plants Habitat, along Charlie Circle, and near Kipuka Alala (U.S. Army 2003a).

Critical Habitat Designated

Yes; 5/14/2003.

Legal Description

On May 14, 2003 (Revised March 30, 2016), the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Kadua coriacea* (Kio`ele (=Hedyotis)) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

On September 18, 2012, the U.S. Fish and Wildlife Service (Service), designated revised critical habitat for *Kadua* (=Hedyotis) *coriacea* on the island of Oahu, Hawaii.

Critical Habitat Designation

The critical habitat designation for *Kadua coriacea* includes two CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Lowland Dry—Unit 5 consists of 3,615 ac (1,463 ha) of State land, and 43 ac (17 ha) of privately owned land, from Panaewa to Manawainui on the western and southern slopes of west Maui. This unit is occupied by the plants *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, *Cenchrus agrimonioides*, *Gouania hillebrandii*, *Kadua coriacea*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and *Tetramolopium capillare*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 5 is not known to be occupied by *Ctenitis squamigera*, *Cyanea obtusa*, *Hesperomannia arbuscula*, *Hibiscus brackenridgei*, *Lysimachia lydgatei*, *Neraudia sericea*, *Schiedea salicaria*, *Sesbania tomentosa*, or *T. remyi*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 6 consists of 3 ac (1 ha) of State land, and 237 ac (96 ha) of privately owned land, from Paleaahu Gulch to Puu Hona on the southern slopes of west Maui. This unit is occupied by the plants *Hibiscus brackenridgei* and *Schiedea salicaria*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 6 is not known to be occupied by *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, *Cenchrus agrimonioides*, *Ctenitis squamigera*, *Cyanea obtusa*, *Gouania hillebrandii*, *Hesperomannia arbuscula*, *Kadua coriacea*, *Lysimachia lydgatei*, *Neraudia sericea*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Spermolepis hawaiiensis*, *Tetramolopium capillare*, or *T. remyi*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat designation for *Kadua* (=Hedyotis) *coriacea* includes 7 units totaling 7,823 acres on Oahu. The units are Oahu—Lowland Mesic—Unit 1, 2, 3, 4, 5, 6, 7.

Oahu—Lowland Mesic—Unit 1 consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Although this unit is not known to be occupied by *Kadua* (=Hedyotis) *coriacea*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland

Mesic—Unit 2 consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Although this unit is not known to be occupied by *Kadua* (=Hedyotis) coriacea, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Mesic—Unit 3 consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Although this unit is not known to be occupied by *Kadua* (=Hedyotis) coriacea, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Mesic—Unit 4 consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. This unit includes the lowland mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem. Although this unit is not known to be occupied by *Kadua* (=Hedyotis) coriacea, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Mesic—Unit 5 consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. This unit includes the mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem. Although this unit is not known to be occupied by *Kadua* (=Hedyotis) coriacea, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Mesic—Unit 6 consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Although this unit is not known to be occupied by *Kadua* (=Hedyotis) coriacea, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Mesic—Unit 7 consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge. Although this unit

is not known to be occupied by *Kadua* (=Hedyotis) *coriacea*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Kadua coriacea* critical habitat consists of one component. Lowland dry (west Maui) (81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*. Subcanopy: *Chamaesyce*, *Dodonaea*, *Leptecophylla*, *Osteomeles*, *Psydrax*, *Scaevola*, *Wikstroemia*. Understory: *Alyxia*, *Artemisia*, *Bidens*, *Chenopodium*, *Nephrolepis*, *Peperomia*, *Sicyos*.

Within these units, the physical and biological features of critical habitat are:

- (i) Elevation: Less than 3,300 ft (1,000 m).
- (ii) Annual precipitation: 50 to 75 in (130 to 190 cm).
- (iii) Substrate: Shallow soils, little to no herbaceous layer.
- (iv) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*.
- (v) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*.
- (vi) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp.

lepidotum, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat

conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

All critical habitat, except in the coastal ecosystem on Oahu, requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs and goats). Feral ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required during nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat posed by fire to Oahu—Lowland Mesic—Unit 2, 3, 7. Oahu—Lowland Mesic—Unit 1, 2, 3, 4, 5, 6, 7 may require special management to reduce the threat of landslides, rockfalls, and flooding.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Life history information is unknown, including flowering cycles, pollination vectors, seed dispersal agents, longevity, and environmental requirements. Immature and mature fruits have been observed in August, flowers in September, vegetative growth in December, and immature fruits and flowers in January 1999 (U.S. Army 2003a).

Habitat Type

Adult: Mesic shrublands or forests

Habitat Narrative

Adult: *Kadua coriacea* is found on steep, rocky, slopes in dry Dodonaea Shrublands and forests on the island of Maui. On the island of Hawaii, the species occurs on pahoehoe lava flows in Sparse *Metrosideros* Treelands and Open *Metrosideros* Treelands with sparse to dense shrub understories. It is found at elevations from 1,500 to 1,700 meters (4,921 to 5,577 feet) at PTA. Associated species include *Metrosideros polymorpha*, *Leptecophylla tameiameia*, *Alyxia*

oliviformis, Bidens menziesii, Gouania hillebrandii, Sida fallax, Melanthera lamarum, Myoporum sandwicense, and Schiedea menziesii.

Dispersal/Migration

Population Information and Trends

Number of Populations:

5 (1 wild, 4 reintroduced; USFWS, 2015)

Population Size:

167 wild individuals, ~448 outplanted (USFWS, 2015)

Population Narrative:

At the time of the previous 5-year review, the wild population at PTA contained nine populations with 149 mature and 6 immature individuals (USFWS 2008). In 2009, there were 160 mature and 7 immature wild individuals at PTA (U.S. Army Garrison Pohakuloa [U.S. Army] 2010). In 2010, the population remained stable with 167 wild individuals of *Kadua coriacea* at PTA (162 mature and 5 immature), with two immature individuals advancing to the mature life stage (U.S. Army 2010). The 167 wild individuals are located within seven Areas of Species Recovery (ASR) managed by the U.S. Army (U.S. Army 2014). There are four reintroduction sites outside of PTA containing approximately 448 individuals of *Kadua coriacea* (U.S. Army 2015). Overall, the numbers of individuals have increased from the 156 wild individuals reported in the previous 5-year review to approximately 167 wild individuals in 2015. There are four reintroduction populations containing approximately 448 individuals. (USFWS, 2015)

Threats and Stressors

Stressor: Climate change destruction or degradation of habitat (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *K. coriacea* is moderately vulnerable to the impacts of climate change. Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2015)

Stressor: Stochastic events – Drought mortality or reduced viability (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Drought may exacerbate the effects of ungulates and has direct adverse impacts on *K. coriacea* (U.S. Army 2014). (USFWS, 2015)

Recovery

Recovery Actions:

- Surveys / inventories – Survey geographical and historical range for a current assessment of the species' status. (USFWS, 2015)
- Captive propagation for genetic storage and reintroduction Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. Expand locations of genetic resources for storage. Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change. (USFWS, 2015)
- Ungulate monitoring and control – Maintain existing fences and continue removing ungulates from remaining fenced units to protect them from the impacts of feral ungulates. (USFWS, 2015)
- Population viability monitoring and analysis – Continue monitoring wild and reintroduced individuals. (USFWS, 2015)
- Invasive plant monitoring and control – Eradicate invasive introduced plants within ungulate exclosures and maintain exclosures free of invasive plants. (USFWS, 2015)
- Alliance and partnership development – Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2015)
- Climate change adaptation strategy – Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. (USFWS, 2015)

Conservation Measures and Best Management Practices:

- The following important conservation actions are needed: 1) additional populations of *Kadua coriacea* should be established across the species' range to increase the number of individuals; 2) existing populations of *K. coriacea* should be protected by constructing ungulate exclosures; 3) control non-native plants species; and 4) monitor plants and habitat. Research should be conducted on pollinators, reproductive biology, and other possible limiting factors that affect this species including specific research to determine if this species is susceptible to direct or indirect damage by ants (Service 1997). In addition, a State-wide management plan that identifies areas and landscapes for the long-term conservation of all known occurrences of *K. coriacea* is needed. As part of this management plan, landowners and managers should delineate management units to conserve this species and other native species through threat control and habitat restoration.

References

USFWS 2016. Status of the Species and Critical Habitat: *Kadua* (=Hedyotis) *coriacea* (Kio'ele). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FSTF from Chris Mullens 9/30/2016.

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

USFWS. 2015. 5-year Review, Short Form Summary, *Kadua coriacea* (=Hedyotis *coriacea*) (kio'ele). PIFWO, Honolulu, Hawaii.

U.S. Fish and Wildlife Service. 2016. Endangered and Threatened Wildlife and Plants

Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

Final Rule . 81 FR 17790-18110 (March 30, 2016).

U.S. Fish and Wildlife Service. 2003. Endangered and Threatened Wildlife and Plants

Designation of Critical Habitat for 60 Plant Species from the Islands of Maui and Kahoolawe, HI

Final Rule. 68 FR 25934-26165 (May 14, 2003).

U.S. Fish and Wildlife Service. 2012. Endangered and Threatened Wildlife and Plants

Endangered Status for 23 Species on Oahu and Designation of Critical Habitat for 124 Species. Final rule. 77 FR 57647 - 57862 (September 18, 2012).

SPECIES ACCOUNT: *Kadua* (=Hedyotis) *degeneri* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

Hedyotis degeneri var. degeneri (aka Kadua degeneri) is a short-lived perennial shrub in the Rubiaceae (coffee) family. The long stems sprawl on the ground or are supported by surrounding vegetation. The stems bear short leafy shoots in the leaf axils, and older stems have peeling, corky layers of bark. The oppositely arranged leaves are 1 to 3 cm (0.4 to 1.2 in) long. Inflorescences at the branch tips contain 1 to 10 greenish flowers. Some flowers are perfect (with both male and female reproductive parts) and others possess only female reproductive parts. The round seed capsules split open across the top when mature (Wagner et al 1999; Makua Implementation Team 2003) (USFWS, 2016). A prostrate, branched shrub. Flowers in terminal clusters of up to 10 flowers. (NatureServe, 2015)

Historical Range

Hedyotis degeneri var. degeneri is endemic to the northern Waianae Mountains of Oahu. Records indicate this taxon historically was known from Mt. Kaala in the northern Waianae Mountains, and was found primarily on the windward side of the range. Hedyotis degeneri var. degeneri in the Kahanahaiki area of Makua are the only ones recorded on the leeward side of the Waianae Mountains (USFWS, 2016).

Current Range

Endemic to Waianae Mountains, Oahu.

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Kadua (=Hedyotis) degeneri under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for Kadua (=Hedyotis) degeneri (77 FR 57648-57862). The critical habitat designation includes 11 critical habitat units, which encompass approximately 7,332 acres on the Island of Oahu, Hawaii.

The critical habitat designation for Kadua (=Hedyotis) degeneri includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for Kadua (=Hedyotis) degeneri includes 11 critical habitat units, covering two ecosystem types, which encompass approximately 7,332 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3; Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac (105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Kadua (=Hedyotis) degeneri* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Kadua (=Hedyotis) degeneri* occurs within the Lowland mesic and Dry cliff ecosystems in the Waianae Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None.

(E) Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. (E) Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for Kadua (=Hedyotis) degeneri to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Insect pollinated (USFWS, 2016)

Lifespan

Adult: ~10 years (USFWS, 2015)

Reproduction Narrative

Adult: Flowering and fruiting has been recorded at various times of the year. The flowers are likely to be insect-pollinated, but dispersal agents for the fruits are unknown. The longevity of H. degeneri var. degeneri individuals is unknown, but it is probably similar to that of other small shrubs that live less than 10 years (Makua Implementation Team 2003). Other demographic information for H. degeneri var. degeneri in the wild is unknown, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, seasonality of reproduction, pollination and seed dispersal, vegetative reproduction, and specific environmental requirements (USFWS, 2016).

Habitat Type

Adult: Shrubland/forest (NatureServe, 2015; USFWS, 2016)

Habitat Narrative

Adult: Moist shrublands and forests. On shrubby cliffs or exposed shrubby ridges, or in the forest understory on gulch slopes. (NatureServe, 2015). Hedyotis degeneri var. degeneri typically grows on upper gulch slopes and on ridge tops between elevations of 570 and 720 m (1,870 to 2,360 ft). It usually occurs in the understory of mesic forests dominated by Diospyros sandwicensis and/or Metrosideros species. Hedyotis degeneri var. degeneri also occurs where scrubby forests of the upper gulch slopes grade into shrubland on ridge crests (USFWS, 2016).

Dispersal/Migration***Population Information and Trends***

Population Trends:

Unknown

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Fragility unknown. Currently fewer than 100 plants known. 2 current (between 1982 and 1997) and 2 historical occurrences. (NatureServe, 2015). It is estimated only one occurrence of six individuals of *H. degeneri* var. *degeneri* was known when the species was listed in 1991 (56 FR 55770). All except one of the known *H. degeneri* var. *degeneri* population units were discovered in the last eight years, so population trends are not yet evident (Makua Implementation Team 2003). More individuals were discovered in 2003, when there were five occurrences totaling 131-146 individuals. Since 2003 additional individuals have been discovered. Currently, there are 322 known individuals in two population units located on Federal, State, and private lands (Table SB 19) (U.S. Army Garrison 2005b). Two of these population units exceed minimum numerical criteria for stabilization population units (defined as 100 mature, reproducing individuals per population unit) (USFWS, 2016).

Threats and Stressors

Stressor: Non-native ungulates (USFWS, 2016; NatureServe, 2015)

Exposure:

Response:

Consequence: Loss of individuals/loss of habitat

Narrative: Major threats include destruction by feral pigs (NatureServe, 2015; USFWS, 2016)) and other non-native ungulates (USFWS, 2016).

Stressor: Non-native plants (USFWS, 2016; NatureServe, 2015)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Major threats include alien plant species (Christmasberry, molasses grass, and strawberry guava) (NatureServe, 2015; USFWS, 2016).

Stressor: Small number of individuals (NatureServe, 2015)

Exposure:

Response:

Consequence: Extinction

Narrative: A major threat to this species is the small number of extant individuals. (NatureServe, 2015)

Recovery

Reclassification Criteria:

For downlisting, a total of five to seven populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1998).

Delisting Criteria:

A total of 8 to 10 populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1998).

Conservation Measures and Best Management Practices:

- Protect habitat and control threats (USFWS, 1998).
- Expand existing wild populations (USFWS, 1998).
- Conduct essential research (USFWS, 1998).
- Develop and maintain monitoring plans (USFWS, 1998).
- Reestablish wild populations within historic range (USFWS, 1998).
- Validate and revise recovery criteria (USFWS, 1998).

References

USFWS. 2016. Status of the Species and Critical Habitat: *Hedyotis degeneri* var. *degeneri* (aka *Kadua degeneri*) (No Common Name). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

U.S. Fish and Wildlife Service. 2012. Endangered and Threatened Wildlife and Plants

Endangered Status for 23 Species on Oahu and Designation of Critical Habitat for 124 Species. Final Rule. 77 FR 57648-57862 (September 18, 2012)

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A."

U.S. Fish and Wildlife Service. 1998. Recovery Plan for Oahu Plants. U.S. Fish and Wildlife Service, Portland, Oregon. 207 pp., plus appendices.

SPECIES ACCOUNT: *Kadua (=Hedyotis) fluviatilis* (kampua'a)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2017)

Physical Description

Kadua fluviatilis is a scandent shrub, foetid when bruised; with cylindrical, but slightly flattened, stems, 1 to 8 feet (ft) (0.3 to 2.5 meters (m)) long, glabrous, and with short lateral branches. Leaves are widely spaced, papery, elliptic-oblongate to elliptic-lanceolate, 3.2 to 6.8 inches (in) (8 to 17 centimeters (cm)) long, and 1.2 to 2 in (3 to 5 cm) wide. Flowers are perfect and pistillate, borne in reduced axillary, cymose inflorescences. Calyx lobes are deltate to narrowly ovate, 0.5 to 0.7 in (1.2 to 1.8 cm) long, 0.1 to 0.2 in (0.3 to 0.6 cm) wide, with several small sac-like glands between corolla lobe sinuses. The corolla is white, fleshy and waxy, with a tube 0.9 to 1.2 in (2.2 to 3.0 cm) long. Capsules are woody, strongly quadrangular or winged, 0.3 to 0.5 in (0.8 to 1.3 cm) long, and 0.4 to 0.5 in (0.9 to 1.3 cm) in diameter. Seeds are translucent reddish brown, wedge-shaped, and minutely reticulate (Wagner et al. 1999a, pp. 1,142-1,144).

Taxonomy

Kingdom: Plantae; Phylum: Anthophyta; Class: Dicotyledoneae; Order: Rubiales; Family: Rubiaceae (Madder family). First described as *Kadua fluviatilis* by Forbes (1912, p. 6), this species was moved to the genus *Hedyotis* by Fosberg (1943, p. 90), and was recognized as a distinct taxon in Wagner et al. (1999a). Terrell et al. (2005, pp. 832, 833) placed *Hedyotis fluviatilis* in synonymy with *Kadua fluviatilis*, the earlier, validly published name. There are only minor floral characteristics separating *K. fluviatilis* from *K. acuminata* and further taxonomic studies are needed (Wagner et al. 1999a, p. 1,144).

Historical Range

Historically, *Kadua fluviatilis* was found on the island of Kauai in the Haupu Mountains; and on the island of Oahu in the northern Koolau Mountains ranging from Kaluanui gulch to Kipapa gulch (HBMP 2008).

Current Range

Currently, this species is known on Kauai from the northern Na Pali Coast and Halelea Forest Reserve, and in the southern Haupu Mountains. On Oahu, *Kadua fluviatilis* is found in the northern Koolau Mountains, on both the windward and leeward sides, ranging from Koloa gulch to Helemano Stream (HBMP 2008).

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Habitat Type**

Adult: Moist to wet forests on gulch slopes and along streambanks. When growing on streambanks, the plants are often close to the normal water level and inundated during flooding (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Palustrine Habitat: Riparian; Terrestrial Habitats: Forest-Hardwood, Forest/Woodland (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow to moderate (NatureServe, 2015)

Habitat Narrative

Adult: On Kauai, *Kadua fluviatilis* is found in mixed native shrubland and wet *Metrosideros* (ohia) lowland forest with the associated native species *Bidens* spp. (kookoolau), *Boehmeria grandis* (akolea), *Dicranopteris linearis* (uluhe), *Diplazium sandwichianum* (hoio), *Hibiscus waimeae* ssp. *hannerae* (kokio keokeo), *Isodendron longifolium* (aupaka), *Lobelia niihauensis* (no common name (NCN)), *Machaerina angustifolia* (uki), *Perrottetia sandwicensis* (olomea), *Pipturus albidus* (waimea), at elevations between 750 and 2,231 ft (229 and 680 m) (Hawaii Biodiversity and Mapping Program (HBMP) 2008); and in open shrubland with sparse tree cover of *Antidesma platyphyllum* var. *hillebrandii* (hame), *Bobea brevipes* (ahakea), *Cheirodendron fauriei* (olapa), *Cibotium glauca* (hapuu), *D. linearis*, *Kadua affinis* (manono), *Melicope feddei* (alani), *Metrosideros polymorpha* (ohia), *Sadleria pallida* (amau), *Tetraplasandra* spp. (ohe), and *Xylosma hawaiiense* (maua) (Wood, in litt. 1998). On Oahu, *K. fluviatilis* occurs in wet *Metrosideros* forest on rocky streambanks with the associated native species *D. linearis*, *Melicope clusiifolia* (kukaemoa), *Pritchardia martii* (loulou), *Psychotria* spp. (kopiko), *Rhynchospora sclerioides* (kuolohia), *Scaevola chamissoniana* (naupaka kuahiwi), *Syzygium sandwicensis* (ohia ha), and ferns, at elevations between 820 and 1,990 ft (250 and 607 m) (HBMP 2008). (USFWS, 2014).

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Decreasing (USFWS, 2016)

Species Trends:

Decline (USFWS, 2014)

Resiliency:

Low (inferred from USFWS, 2016)

Redundancy:

Low (inferred from USFWS, 2016)

Number of Populations:

11 on the islands of Oahu (7) and Kauai (4) (USFWS, 2014) Oahu: 1; Kauai: 2 (USFWS, 2016)

Population Size:

400-900 individuals (USFWS, 2014) Oahu: 20 - 25; Kauai: 500 (USFWS, 2016)

Population Narrative:

This species is known from 11 populations totaling between 400 and 900 individuals on the islands of Oahu and Kauai (HBMP 2008; Wood 2005, p. 7, National Tropical Botanical Garden (NTBG) 2009). On Kauai, the populations occur at Hoolulu-Hanakapiai (several individuals), Hanakapiai Falls (20 to 30 individuals), Waioli Valley (25 individuals), and Haupu (400 to 500 individuals) (NTBG 2009; Perlman, in litt. 2010). On Oahu, the populations occur at Kaluanui Stream (50 individuals), Maakua and Koloa gulches (50 to 100 individuals, and 8 individuals), Kaipapau Valley (200 to 450 individuals), Kawaiiki Stream (50 to 200 individuals), Opaepa Stream (10 to 40 individuals) (HBMP 2008; U.S. Army 2006). The 50 individuals at Helemano Stream could not be relocated in 2011 (PEPP, in litt. 2012, p. 113). We are unaware of additional surveys conducted since 2011. (USFWS, 2014) Currently, during surveys on Oahu in 2013, only 20 to 25 individuals were observed in one occurrence (Wood 2005b, in litt., NTBG 2009, in litt.; HBMP 2010; Ching Harbin 2015, in litt.). On Kauai, *K. fluviatilis* is known from two occurrences totaling approximately 500 individuals (HBMP 2010). Numbers of occurrences and individuals are decreasing on Oahu and Kauai, from 16 occurrences to 3, and from over 1,000 individuals to about 500 individuals (HBMP 2010; OTFM 2014, in litt.) (USFWS, 2016).

Threats and Stressors

Stressor: Feral pigs and goats (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: This species is highly threatened by feral pigs and goats that degrade and destroy habitat (HBMP 2008). Evidence of the activities of feral pigs has been reported at the Hanakapiai Falls and Haupu populations of *Kadua fluviatilis* on Kauai, and at all of the Oahu populations (Wood, in litt. 1998; HBMP 2008). Feral goats have been observed at the Hanakapiai Falls population on Kauai (HBMP 2008). Predation by feral pigs and goats is a likely threat to *Kadua fluviatilis* as evidence of the activities of feral pigs has been reported at almost all the known populations, and activities of feral goats has been reported at the Hanakapiai Falls population on Kauai (USFWS, 2014).

Stressor: Nonnative plants

Exposure:

Response:

Consequence:

Narrative: Nonnative plant species highly threaten *Kadua fluviatilis* as they degrade habitat and outcompete native species (HBMP 2008; Wood, in litt. 1998). In particular, nonnative pest plant species degrade habitat by modifying availability of light, altering soil-water regimes, modifying nutrient cycling, or altering fire characteristics of native plant communities (Smith 1985, pp. 227-230; Cuddihy and Stone 1990, p. 74; Vitousek et al. 1997, pp. 6-10).

Stressor: Landslides (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: *Kadua fluviatilis* is negatively affected by landslides on Kauai (HBMP 2010) (USFWS, 2016).

Stressor: Climate change (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013, p. 78) found that, as environmental conditions are altered by climate change, *K. fluviatilis* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions (USFWS, 2016).

Recovery**Recovery Actions:**

- Survey for populations of *Kadua fluviatilis* in areas of potentially suitable habitat (USFWS, 2014).
- Conduct further taxonomic study.
- Control feral pigs and goats by removing these species from areas where *K. fluviatilis* populations exist.
- Prevent reinvasion of feral pigs and goats through the use of exclosures.
- Control nonnative plants through physical, mechanical, and biological control methods, as well as herbicides when necessary.
- Conduct research into potential biocontrol species.

Conservation Measures and Best Management Practices:

- Control feral pigs and goats by removing these species from areas where *K. fluviatilis* populations exist (USFWS, 2014).
- Prevent reinvasion of feral pigs and goats through the use of exclosures.
- Control nonnative plants through physical, mechanical, and biological control methods, as well as herbicides when necessary.

References

USFWS. 2014. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for *Kadua fluviatilis* (kampua`a), Pacific Region, 16 p.

USFWS. 2017. Environmental Conservation Online System (ECOS) – Species Profile. <http://ecos.fws.gov/ecp0/>. Accessed March 2017.

USFWS 2014. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for *Kadua fluviatilis* (kampua`a), Pacific Region, 16 p.

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

USFWS. 2016. Endangered and Threatened Wildlife and Plants

Endangered Status for 49 Species From the Hawaiian Islands. Final rule. 81 FR 67786 - 67860
(September 30, 2016).

SPECIES ACCOUNT: *Kadua (=Hedyotis) parvula* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

Hedyotis parvula (aka *Kadua parvula*) is a short-lived perennial shrub in the Rubiaceae (coffee) family. It is an erect to sprawling perennial shrub with branches 10 to 30 cm (4 to 12 in) long and oppositely arranged leaves 1 to 4 cm (0.4 to 1.6 in) long. Inflorescences are borne at the branch tips. The four-lobed flowers are white and may have purplish pink tips, and are 5 to 6 mm (about 0.2 in) long. The flowers are either perfect (with both male and female reproductive parts) or possess only female reproductive parts. The round seed capsules are 3.3 to 4.0 mm (0.1 to 0.2 in) long, split open across the top upon maturity, and contain small dull brown seeds (Wagner et al 1999; Makua Implementation Team 2003) (USFWS, 2016). A heavily branched shrub that grows either upright or sprawling with leathery leaves that are uniform in shape, and with clusters of tubular white flowers. (NatureServe, 2015)

Historical Range

See Current Range/Distribution information.

Current Range

Hedyotis parvula is endemic to the Waianae Mountains of Oahu and has been documented from Makaleha to Nanakuli valleys. Only two occurrences of *H. parvula* were known when the species was listed in 1991 (56 FR 55770). Most of the population units were recently discovered in the last 20 years. One occurrence on Ohikilolo Ridge indicates a major decline from 100 plants when discovered in 1993 to fewer than 20 plants in 2000 (Makua Implementation Team 2003). Overall, the Ohikilolo population unit appears to be increasing in numbers since the early 1990s. Currently, there are 418 known total individuals in two population units located on Federal and State lands (Table SB 20) (U.S. Army Garrison 2005b). Both population units exceed minimum numerical criteria for stabilization population units (defined as 50 mature, reproducing individuals per population unit) (USFWS, 2016). Endemic to Waianae Mountains of Oahu (NatureServe, 2015).

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Kadua (=Hedyotis) parvula* under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Kadua (=Hedyotis) parvula* (77 FR 57648-57862).

The critical habitat designation includes 11 critical habitat units, which encompass approximately 7,332 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Kadua (=Hedyotis) parvula* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs

necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Kadua* (=Hedyotis) *parvula* includes 11 critical habitat units, covering two ecosystem types, which encompass approximately 7,332 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3; Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac (105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Kadua* (=Hedyotis) *parvula* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Kadua* (=Hedyotis) *parvula* occurs within the lowland mesic and dry cliff ecosystems in the Waianae Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (F) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. (F) Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Kadua* (=Hedyotis) *parvula* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (moths) (USFWS, 2016)

Lifespan

Adult: <10 years (USFWS, 2016)

Breeding Season

Adult: Flowering and fruiting have been recorded year round (USFWS, 2016).

Reproduction Narrative

Adult: Flowering and fruiting has been recorded throughout the year. The flowers of *H. parvula* are relatively large and prominently displayed above the plant's foliage, suggesting pollination by night-flying moths; dispersal agents for the fruits are unknown. The longevity of *H. parvula* individuals is unknown, but it is probably similar to that of other small shrubs that live less than 10 years (Makua Implementation Team 2003). Other demographic information for *H. parvula* in the wild is unknown, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, seasonality of reproduction, pollination and seed dispersal, vegetative reproduction, and specific environmental requirements (USFWS, 2016). Distyly occurs in genus. Most in this genus have minute black seeds in woody cocci which are wind dispersed.; SEXUAL; ABIOTIC; Wind; (NatureServe, 2015)

Habitat Type

Adult: Cliffs and ledges (NatureServe, 2015)

Habitat Narrative

Adult: Hedyotis parvula typically grows on cliff faces or on exposed rocky ridges. The vegetation in these areas is mesic, low-growing, and sparse, and includes native herbs, grasses, sedges, and shrubs. Plants tend to grow on steep cliffs where ungulates and weeds are not a threat (USFWS, 2016). Moist cliffs and ledges with native shrubs, grasses, and sedges. (NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Seed dispersal is unknown (USFWS, 2016).

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Fragility unknown. Rediscovered in 1993, currently about 105+ plants known. Four current (between 1982 and 1997) and five historical occurrences. (NatureServe, 2015). One occurrence on Ohikilolo Ridge indicates a major decline from 100 plants when discovered in 1993 to fewer than 20 plants in 2000 (Makua Implementation Team 2003). Overall, the Ohikilolo population unit appears to be increasing in numbers since the early 1990s. Currently, there are 418 known total individuals in two population units located on Federal and State lands (Table SB 20) (U.S. Army Garrison 2005b). Both population units exceed minimum numerical criteria for stabilization population units (defined as 50 mature, reproducing individuals per population unit) (USFWS, 2016).

Threats and Stressors

Stressor: Botanists (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: Threats include overzealous botanists (NatureServe, 2015).

Stressor: Erosion (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: Threats include erosion (NatureServe, 2015).

Stressor: Feral animals (NatureServe, 2015; USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Threats include habitat degradation by feral goats (NatureServe, 2015; USFWS, 2016).

Stressor: Alien plants (NatureServe, 2015; USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Threats include competition from alien plants (NatureServe, 2015; USFWS, 2016).

Stressor: Small population size (NatureServe, 2015; USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Threats include small population size (NatureServe, 2015; USFWS, 2016).

Stressor: Military activities (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Military activities are listed as a threat to this species (USFWS, 2016).

Stressor: Fire (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Military-related wildfire in the action area, arson or careless fires have recently approached the Halona population unit outside the action area (USFWS, 2016).

Recovery

Reclassification Criteria:

For downlisting, a total of five to seven populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1998).

Delisting Criteria:

A total of 8 to 10 populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300

mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1998).

Conservation Measures and Best Management Practices:

- Protect habitat and control threats (USFWS, 1998).
- Expand existing wild populations (USFWS, 1998).
- Conduct essential research (USFWS, 1998).
- Develop and maintain monitoring plans (USFWS, 1998).
- Reestablish wild populations within historic range (USFWS, 1998).
- Validate and revise recovery criteria (USFWS, 1998).
- Construct enclosures or other strategic fencing to protect populations against feral ungulates (USFWS, 1998).
- Control competing alien plant species within enclosures (USFWS, 1998).
- Provide protection from fire (USFWS, 1998).

References

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USFWS. 2016. Status of the Species and Critical Habitat: *Hedyotis parvula* (aka *Kadua parvula*) (No Common Name). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016.

U.S. Fish and Wildlife Service. 1998. Recovery Plan for Oahu Plants. U.S. Fish and Wildlife Service, Portland, Oregon. 207 pp., plus appendices.

SPECIES ACCOUNT: *Kadua* (=Hedyotis) *st. johnii* (Na Pali beach hedyotis)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/30/1991; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Hedyotis St. -johnii is a succulent perennial herb of the coffee family (Rubiaceae) with slightly woody, trailing, quadrangular stems up to 30 cm (1 foot) long. The fleshy leaves are clustered toward the base of the stem and are broadly ovate to broadly elliptic, 5.5 to 15 cm (2 to 6 in) long and about 3.5 to 7.5 cm (2 in) wide. Clusters of flowers are borne on 7 to 15 cm (3 to 6 in) long flowering stems. The leafy, broadly ovate calyx lobes are about 3 to 4 mm (0.1 in) long and wide, enlarging in fruit to about 8 to 11 mm (0.4 in) long and wide. The green petals are fused into a tube about 5 to 8 mm (0.2 in) long and wide. The fruit consists of kidney-shaped capsules with dark brown to blackish angular seeds. Hedyotis st. -johnii is distinguished from related species by its succulence, basally clustered fleshy leaves, shorter floral tube, and large leafy calyx lobes when in fruit (Wagner et al. 1990). (USFWS, 1995)

Taxonomy

Terrell et al. (2005) found seed and fruit characters of the Hawaiian species were distinct from Asian and Pacific species of Hedyotis subgenus Hedyotis and from North American specimens of tribe Hedyotideae. In light of these morphological changes, the oldest available genus name, Kadua, was resurrected and applied to all Hawaiian species. In 2015(b), the Service published a technical correction for this and other plant and wildlife species, recognizing the taxonomic change from Hedyotis st.-johnii to Kadua st.-johnii (80 FR 35860, June 23, 2015). The taxonomic change does not affect the range or endangered status of this species. In addition, the common name given for H. st.-johnii in the List of Endangered and Threatened Plants, Na Pali beach hedyotis, was not historically used prior to listing of the species. Because Wagner et al. (1999) did not identify an independently accepted common name for this species; we revised the List of Endangered and Threatened Plants to indicate that no common name exists. We refer to this species as Kadua st.-johnii throughout the remainder of this document. (USFWS, 2017)

Historical Range

Endemic to the island of Kauai (USFWS, 2017)

Current Range

Endemic to the island of Kauai. Currently along the Na Pali Coast of Kauai (USFWS, 2017)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for Kadua (=Hedyotis) st. johnii on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Kadua* (=Hedyotis) *st. johnii* includes one unit totaling 589 acres in Kauai County, Hawaii. The unit is Kauai 11—Hedyotis *st.-johnii*—a.

Kauai 11—Hedyotis *st.-johnii*—a: This unit is critical habitat for Hedyotis *st.-johnii* and is 238 ha (589 ac) on State land (Hono o Na Pali NAR, Na Pali Coast State Park, and Puu Ka Pele Forest Reserve) Makaha point to Waiahuakua Valley. This unit provides habitat for seven populations of 300 mature, reproducing individuals of the short-lived perennial Hedyotis *st.-johnii* and is currently occupied with between 227 and 292 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, crevices of north-facing, near-vertical coastal cliff faces within the spray zone in sparse dry coastal shrubland.

Primary Constituent Elements/Physical or Biological Features

Within this unit, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

- (i) Crevices of north-facing, nearvertical coastal cliff faces within the spray zone in sparse dry coastal shrubland and containing one or more of the following native plant species: *Artemisia australis*, *Bidens* spp., *Capparis sandwichiana*, *Chamaesyce celastroides*, *Eragrostis variabilis*, *Heteropogon contortus*, *Lipochaeta connata*, *Lycium sandwicense*, *Myoporum sandwicense*, *Nototrichium sandwicense*, or *Schiedea apokremnos*; and
- (ii) Elevations between 0 and 187 m (0 and 613 ft).

Special Management Considerations or Protections

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Observation from herbarium vouchers at the Bernice P. Bishop Museum and National Tropical Botanical Garden suggest that plants were flowering in January, March, April, May, and December; fruiting specimens were from February, March, May, July, August, and October (National Tropical Botanical Garden 2008; K. Wood, National Tropical Botanical Garden, pers. comm. 2008; C. Imada, Bernice P. Bishop Museum, pers. comm. 2008). (USFWS, 2009)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Bare rock/talus/scree, cliff (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations below 75 meters (USFWS, 1995)

Environmental Specificity

Adult: Narrow, with several key requirements (USFWS, 1995)

Habitat Narrative

Adult: Hedyotis st. -johnii grows in the crevices of north-facing, near-vertical coastal cliff faces within the spray zone (below 75 meters (250 feet)). The associated vegetation is sparse dry coastal shrubland and includes species such as the native Arternisia australiis (ahinahina) and akoko, and the alien Pluchea symphytifolia (sourbush) (USFWS 1991a). (USFWS, 1995)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2009)

Redundancy:

Low (inferred from USFWS, 2009)

Population Growth Rate:

Slowly decreased (USFWS, 2009)

Number of Populations:

5 (USFWS, 2017)

Population Size:

47 wild individuals (USFWS, 2017)

Population Narrative:

As of February 2004, the species had declined to three populations containing 30 individuals in Milolii, Kalalau, and Nualolo (Perlman 2006). In 2004, an additional collection was recorded from Awaawapuhi (National Tropical Botanical Garden 2008) growing from coastal cliffs just

northeast of the river mouth which may be a new locality. Two individuals were noted at this new locality (National Tropical Botanical Garden 2008). Numbers and populations have decreased since the species was listed in 1991 to now, with fewer than 50 plants remaining (Perlman 2006; National Tropical Botanical Garden 2008; USFWS 2008; K. Wood, pers. comm., June 2008). (USFWS, 2009); Currently, there are only 47 total individuals, with only 38 mature individuals remaining in five sites along 10 km (6.2 mi) of the Na Pali Coast of Kauai (PEPP 2017; Wood et al. 2015). (USFWS, 2017)

Threats and Stressors

Stressor: Predation and habitat degradation by cattle and goats (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The main threats to *Kadua st.-johnii* are predation and habitat degradation by feral goats (*Capra hircus*), and trampling and grazing by feral cattle (*Bos taurus*). As a result of past goat activity, this species is now almost entirely restricted to sites inaccessible to goats. (USFWS, 2009)

Stressor: Invasive plants (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Competition from introduced invasive plant species such as *Pluchea carolinensis* (sourbrush), *Lantana camara* (lantana), *Erigeron karvinskianus* (daisy fleabane), *Leucaena leucocephala* (haole koa) and *Ageratina conyzoides* (billygoat weed), and *Chamaesyce hirta* (hairy spurge) is also a major threat to this species (Factor E) (USFWS 1991, 1995, 2003; Wood et al. 2001; K. Wood, pers. comm. 2008). (USFWS, 2009)

Stressor: Small population size and stochastic events (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: In addition to the threats listed above, species like *Kadua st.-johnii* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, fire, droughts flooding and disease outbreaks (USFWS 1995; Wood et al. 2001; K. Wood, pers. comm. 2008). (USFWS, 2009)

Stressor: Climate change loss or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate

change. The assessment by Fortini et al. (2013) concluded that *Kadua st.-johnii* is extremely vulnerable to the impacts of climate change, with a vulnerability score of 0.978 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this species has no overlap between current and future climate envelopes, and is unlikely to tolerate expected changes in climate at its current location. This means that this species must persist within suitable microrefugia, or move to newly available climate-compatible areas to avoid extinction. Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2017)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Kauai and at least one other island where they now occur or occurred historically. (USFWS, 1995)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1995)
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1995)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Kauai and at least one other island where they now occur or occurred historically. (USFWS, 1995)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1995)
3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1995)

Recovery Actions:

- Given the degraded nature of the Kauai plant cluster's habitat, their precariously low numbers, and the severity of the threats, the highest priority actions must be aimed at protecting all extant wild individuals and populations, managing habitat to enhance survival and ensuring maintenance of adequate genetic stock ex situ. A monitoring program to track the status of the populations, and to assess the effectiveness of threat management, will also be essential. (USFWS, 1995)
- It is hoped that by eliminating current threats through management, populations of the Kauai cluster taxa will expand naturally. However, in certain special instances, wild populations of the Kauai cluster taxa may need to be augmented. This should be done conservatively and only after careful consideration of all factors involved, particularly the threat of introducing detrimental organisms into the wild populations. Augmentation efforts should always be well-documented as to lineage and methods. (USFWS, 1995)

- Research into various aspects of the life history, habitat, pollinators, reproductive biology, symbionts, optimum requirements for growth, requirements for population viability, and control of threats to each of the Kauai cluster taxa must be carried out to better understand the requirements necessary for perpetuation of these plants. Such additional knowledge would allow more appropriate management and assessment techniques to be developed, and is needed in order to determine meaningful parameters for definition of specific recovery criteria for each taxon. (USFWS, 1995)
- If necessary to meet recovery objectives, populations should be reestablished in areas where they are known to have occurred historically, particularly if genetically uncontaminated, cultivated materials exist which are known to have originated from the historical site. The goal of reintroduction of these taxa is to permanently reestablish viable populations of these taxa in stable and secure conditions. (USFWS, 1995)
- The scientific validity of the recovery objectives should be reviewed as more information becomes available. (USFWS, 1995)
- A public education program is needed to increase awareness of and support for plant recovery efforts in Hawaii. (USFWS, 1995)
- Surveys and inventories—Survey geographical and historic range for a thorough current assessment of the species. (USFWS, 2017)
- Ungulate monitoring and control—Protect all occurrences against browsing, trampling, and disturbances from feral ungulates. Fence areas where this species grows to provide protection against the negative impacts of ungulates. Continue to construct small-scale fences around remaining wild individuals to prevent imminent extinction (USFWS, 2017)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. Control invasive nonnative species that compete with the species around all populations. (USFWS, 2017)
- Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. (USFWS, 2017)
- Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2017)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and drought. (USFWS, 2017)

Conservation Measures and Best Management Practices:

- Continue collection of genetic resources for storage, future propagation and reintroducing into protected suitable habitat within historical range. (USFWS, 2009)
- Construct enclosure fences to protect individuals from the adverse impacts of feral pigs, and eradicate introduced invasive plant species within the enclosures. (USFWS, 2009)
- Enhance current natural populations to increase numbers of individuals. (USFWS, 2009)
- Survey geographical and historical range for a thorough current assessment of the species. (USFWS, 2009)
- Initiate planning and contribute to implementation of ecosystem level restoration and management to benefit this species. (USFWS, 2009)
- Assess genetic variability within extant and ex situ populations. (USFWS, 2009)
- Study *Kadua st.-johnii* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. (USFWS, 2009)

- Update the listed entity on 50 CFR 17 to match the currently recognized taxonomy. (USFWS, 2009)

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SPECIES ACCOUNT: *Kadua cordata ssp. remyi* (=Hedyotis schlechtendahliana var. remyi) (Kopa)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/03/1999; Pacific Region (R1) (USFWS, 2016)

Physical Description

A usually few-branched subshrub with glossy leaves. Flowers are cream-colored (NatureServe, 2015).

Taxonomy

A member of the coffee family (Rubiaceae) (USFWS, 2002). The 2012 supplement to the Manual of the Flowering Plants of Hawaii (Wagner et al. 2012) accepts the change from the genus Hedyotis to the currently accepted Kadua, and recognizes Hedyotis schlechtendahliana var. remyi as Kadua cordata ssp. remyi. In 2012, USFWS proposed to revise the taxonomic status for this species when it proposed to revise critical habitat designations on Maui, Lanai, Kahoolawe, and Molokai (USFWS 2012). The proposed change will recognize Hedyotis schlechtendahliana var. remyi with the new name of Kadua cordata ssp. remyi. (USFWS, 2014).

Historical Range

It is endemic to the island of Lanai (USFWS 2002; USFWS, 2014). Historically (prior to 1970), Hedyotis schlechtendahliana var. remyi was known from five locations on the northwestern portion of Lanaihale on the island of Lanai (Hawaii Natural Heritage Program Database 2001; Wagner et al. 1999; U.S. Fish and Wildlife Service 1999b, 2002a) (USFWS, 2002).

Current Range

It currently occurs on Lanai (NatureServe, 2015).

Critical Habitat Designated

Yes; 1/9/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Hedyotis schlechtendahliana var. remyi (Kopa) (aka Kadua cordata ssp. remyi) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes no detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for Hedyotis schlechtendahliana var. remyi includes an unknown number of CHUs in Maui County, Hawaii. This species is known from the island of Lanai and there is no detailed critical habitat information available for this island (81 FR 17790-18110).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Hedyotis schlechtendahliana var. remyi critical

habitat consists of two components. Lowland mesic (Lanai) and Lowland wet (Lanai) (81 FR 17790-18110):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire,

drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Lifespan

Adult: < 10 years (USFWS, 2014)

Key Resources Needed for Breeding

Adult: Unknown (USFWS, 2002)

Reproduction Narrative

Adult: It is a short-lived perennial (fewer than 10 years) (USFWS, 2014). Pollination vectors, seed dispersal agents, longevity of plants and seeds, specific environmental requirements, and other limiting factors are unknown for *Hedyotis schlechtendahlana* var. *remyi* (U.S. Fish and Wildlife Service 2002a) (USFWS, 2002).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Mesic to wet forest (NatureServe, 2015); mesic shrubland (USFWS, 2002)

Geographic or Habitat Restraints or Barriers

Adult: 2,400 - 3,000 ft. elevation (USFWS, 2002)

Habitat Narrative

Adult: Inhabits mesic to wet forest, sometimes on windswept ridges (NatureServe, 2015). *Hedyotis schlechtendahlana* var. *remyi* typically grows on or near ridge crests in mesic windswept shrubland at elevations between 730 and 900 meters (2,400 to 3,000 feet) (USFWS, 2002).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Very low (inferred from NatureServe, 2015; see current range/distribution)

Redundancy:

Very low (inferred from USFWS, 2014)

Number of Populations:

1 (USFWS, 2018)

Population Size:

1 (USFWS, 2018)

Population Narrative:

Overall *H. schlechtendahliana* var. *remyi* has increased from no individual reported in the last 5-year review to two individuals (PEPP 2011). This increase in numbers resulted from concentrated surveys near current and historical locations (USFWS, 2014).; In the last 5-year review for *Kadua cordata* subsp. *remyi* in 2014, there were only two individuals. Currently, one individual, a seedling at Hulopo'e, remains (PEPP 2016, 2018; Oppenheimer 2018, in litt.). (USFWS, 2018)

Threats and Stressors

Stressor: Climate change loss or degradation of habitat (USFWS, 2014; USFWS, 2018))

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this subspecies. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai'i using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) was conducted at the species level and concluded that *Kadua cordata* is vulnerable to the impacts of climate change, with a vulnerability score of 0.287 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Based on the range of subspecies *remyi*, it is uncertain if the vulnerability would increase if the analysis was completed separately for this taxon. (USFWS, 2018)

Stressor: Stochastic events (USFWS, 2014 and 2002)

Exposure:

Response:

Consequence:

Narrative: Drought is a threat to this species (PEPP 2009, 2012) (USFWS, 2014). Random environmental events or reduced reproductive vigor due to the small number of remaining individuals and populations is a threat to this species (USFWS, 2002).

Stressor: Herbivory (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: An unknown invertebrate was reported as a threat to this species (PEPP 2010, 2012) (USFWS, 2014).

Stressor: Axis deer (USFWS, 2002)

Exposure:

Response:

Consequence:

Narrative: Habitat degradation and destruction is occurring from axis deer (USFWS, 2002).

Stressor: Nonnative plants (USFWS, 2002)

Exposure:

Response:

Consequence:

Narrative: This species is threatened by competition with alien plant taxa such as *Psidium cattleianum* (strawberry guava), *Morella faya* (fire tree), *Leptospermum scoparium* (New Zealand tea), and *Schinus terebinthifolius* (Christmasberry) (USFWS, 2002).

Stressor: Collection (USFWS, 2002)

Exposure:

Response:

Consequence:

Narrative: A potential threat includes unrestricted collecting or excessive visits by individuals interested in seeing rare plants (Hawaii Natural Heritage Program Database 2001; U.S. Fish and Wildlife Service 1999b, 2002a) (USFWS, 2002).

Recovery**Reclassification Criteria:**

1. A total of five to seven populations should be documented on islands where it now occurs or occurred historically (USFWS, 2002).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 2002).
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 2002).

Delisting Criteria:

1. A total of 8 to 10 populations should be documented on islands where it now occurs or occurred historically (USFWS, 2002).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 2002).
3. Each population should persist at this level for a minimum of five consecutive years (USFWS, 2002).

Recovery Actions:

- Protect habitat and control threats (USFWS, 2002).
- Expand existing wild populations (USFWS, 2002).
- Conduct essential research (USFWS, 2002).
- Develop and maintain monitoring plans (USFWS, 2002).
- Reestablish wild populations within the historic range (USFWS, 2002).
- Validate and revise recovery criteria (USFWS, 2002).
- Construct exclosures to protect populations against axis deer (USFWS, 2002).
- Maintain adequate genetic stock (USFWS, 2002).
- Control competing alien plant species (USFWS, 2002).

- Enhance wild populations and establish new populations (USFWS, 2002).
- Surveys and inventories—Continue to survey for additional populations of *Kadua cordata* subsp. *remyi* in areas of potentially suitable habitat and at historic locations. (USFWS, 2018)
- Ungulate monitoring and control—Maintain fencing and remove ungulates from fenced area to prevent browsing by axis deer. (USFWS, 2018)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. Control invasive nonnative species that compete with the species around all populations. (USFWS, 2018)
- Fire monitoring and control—Develop and implement a fire management plan for all populations. (USFWS, 2018)
- Predator and herbivore monitoring and control—Identify unknown invertebrate damaging wild plants and determine control method if necessary. (USFWS, 2018)
- Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock and reintroduction. (USFWS, 2018)
- Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2018)
- Population viability monitoring and analysis—Continue to monitor wild and reintroduced individuals. (USFWS, 2018)
- Climate change adaptation strategy—Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. (USFWS, 2018)
- Alliance and partnership development—Continue to contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2018)

Conservation Measures and Best Management Practices:

- Surveys / inventories – Continue surveying geographical and historical range for a current assessment of the species' status (USFWS, 2014).
- Ungulate monitoring and control – Maintain fencing to exclude browsing by deer (USFWS, 2014).
- Captive propagation for genetic storage and reintroduction – Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range (USFWS, 2014).
- Reintroduction / translocation – Continue to augment current natural populations to increase numbers of individuals (USFWS, 2014).
- Fire monitoring and control – Develop and implement a fire management plan for all populations (USFWS, 2014).
- Invasive plant monitoring and control – Continue control of invasive introduced plant species within enclosures (USFWS, 2014).
- Population viability monitoring and analysis – Continue to monitor wild and outplanted populations (USFWS, 2014).
- Threats – predator / herbivore control research – Identify unknown invertebrate damaging remaining wild individuals (USFWS, 2014).
- Alliance and partnership development – Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2014).

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SPECIES ACCOUNT: *Kadua haupuensis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2017)

Physical Description

A shrub, 3 to 5 ft. (1 to 1.5 m) tall, with erect, brittle stems and glabrous branchlets with minutely hairy nodes. Older branches are brown with longitudinally fissured bark. Leaves are oblong to lanceolate or lanceolate-ovate and glabrous or sparsely hairy, 1 to 5 in (3 to 12 cm) long and 0.4 to 1 in (1 to 3cm) wide, with conspicuous reticulate veins. Petioles are narrowly winged. Flowers are white or greenish-white with a purple tint. Fruit capsules produce numerous brown or blackish seeds (Lorence et al. 2010, pp. 137–144) (USFWS, 2015).

Taxonomy

A member of the coffee family (Rubiaceae). *Kadua haupuensis* is recognized as a distinct taxon by Lorence et al. (2010, pp. 137–144) (USFWS, 2015).

Historical Range

Known from the Mount Haupu region of Kauai, Hawaiian Islands (NatureServe, 2015). *Kadua haupuensis* was discovered in 2007, just below and along cliffs in an isolated area on the north face of Mt. Haupu, on southern Kauai (USFWS, 2015).

Current Range

Currently, there are no known extant individuals of *K. haupuensis* in the wild (USFWS, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination, self-pollination (inferred from USFWS, 2015)

Reproduction Narrative

Adult: This species is subdioecious (male and female flowers on separate plants, with sporadic hermaphroditic flowers) (USFWS, 2015).

Habitat Type

Adult: Terrestrial (USFWS, 2014)

Habitat Vegetation or Surface Water Classification

Adult: Lowland mesic forest (USFWS, 2014)

Geographic or Habitat Restraints or Barriers

Adult: 984 - 1,640 ft. elevation (USFWS, 2014)

Habitat Narrative

Adult: *Kadua haupuensis* occurs just below and along the cliffline in an isolated area on the northern face of Mt. Haupu, on southern Kauai between 300 and 500 m (984 and 1640 ft.) elevation, in the lowland mesic ecosystem (Lorence et al. 2010, pp. 137-144) (USFWS, 2014).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Species Trends:

No wild individuals currently known (USFWS, 2015); 7 individuals observed in 2010 (USFWS, 2014)

Number of Populations:

0 (USFWS, 2015)

Population Size:

0 wild, 11 propagated (USFWS, 2015)

Population Narrative:

There are no wild individuals currently known, however, there are 11 individuals of this species propagated from collections from the wild plants (USFWS, 2015). Originally in 2010, there were 7 individuals of *Kadua haupuensis*; however, subsequent attempts to relocate this species have been unsuccessful (USFWS, 2014).

Threats and Stressors

Stressor: Feral pigs (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Feral pigs modify and destroy the habitat of *Kadua haupuensis* on Kauai (Lorence et al. 2010, p. 140). Feral pigs are extremely destructive and have both direct and indirect impacts on native plant communities. While rooting in the earth in search of invertebrates and plant material, pigs directly impact native plants by disturbing and destroying vegetative cover, and by trampling plants and seedlings (USFWS, 2015).

Stressor: Predation (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Three species of introduced rats occur in the Hawaiian Islands. Predation of fruits and seeds by rats is a potential threat (USFWS, 2015).

Stressor: Small population size/stochastic events (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: The small number of remaining individuals in propagation, and no known remaining wild individuals, may limit this species' ability to adapt to environmental change. Low numbers and small occurrences of these plants result in greater vulnerability to stochastic events and can result in reduced levels of genetic variability leading to diminished capacity to adapt to environmental changes. Landslides are an additional threat to this species at its last known occurrence; one landslide could lead to extirpation of the species by direct destruction (USFWS, 2015).

Stressor: Nonnative plants (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Nonnative plants such as *Caesalpinia decapetala* (wait-a-bit) and *Passiflora laurifolia* (yellow granadilla), and various grasses that modify and destroy native habitat and outcompete native plants are found at the last known location of *K. haupuensis* (USFWS, 2015).

Stressor: Climate change (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to the ecosystem that supports this species. Fortini et al. (2013, pp. 1134) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013, p. 95) concluded that *Kadua haupuensis* is vulnerable to the impacts of climate change (USFWS, 2014).

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- Mature fruits with seeds were collected upon initial discovery of this species. Currently, *K. haupuensis* is being cultivated at the National Tropical Botanical Gardens on Kauai and is expected

to be outplanted in the future for the purpose of reestablishing an extant population (Lorence et al. 2010, pp. 137-144) (USFWS, 2014).

- Continue to survey for populations of *Kadua haupuensis* in areas of potentially suitable habitat (USFWS, 2014).
- Continue propagation efforts for maintenance of genetic stock (USFWS, 2014).
- Reintroduce individuals into suitable habitat within historic range that is being managed for additional known threats (e.g., nonnative animals and plants) to this species (USFWS, 2014).

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Endangered Status for 49 Species From the Hawaiian Islands

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SPECIES ACCOUNT: *Kadua laxiflora* (= *Hedyotis mannii*) (Pilo)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/08/1992; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Hedyotis mannii, a member of the coffee family (Rubiaceae), is a perennial plant with smooth, usually erect stems 30 to 60 cm (1 to 2 ft) long, which are woody at the base and four-angled or winged. The leaves are opposite, thin in texture, elliptic to sometimes lance-shaped, and are usually 8 to 18 cm (3 to 7 in) long and 2.5 to 6.5 cm (1 to 2.6 in) wide. Stipules (leaf-like appendages), which are attached to the slightly winged leaf stalks where they join and clasp the stem, are triangular, 5 to 14 mm (0.2 to 0.6 in) long, and have a point usually 4 to 11 mm (0.2 to 0.4 in) long. Flowers are arranged in loose clusters up to 30 cm (1 ft) long at the ends of the stems and are either bisexual or female. The green hypanthium is top-shaped, about 1 to 1.5 mm (0.05 in) long, with sepals 1.5 to 3 mm (0.06 to 0.1 in) long and 1 to 2 mm (0.04 to 0.08 in) wide at the top. The greenish-white, fleshy petals are fused into a trumpet shaped tube 5 to 14 mm (0.2 to 0.6 in) long. Capsules are top-shaped and measure 2 to 3 mm (0.08 to 0.1 in) long and about 3 to 4 mm (0.1 in) in diameter. (USFWS, 1996)

Taxonomy

Genus occurs throughout tropics & subtropics, species endemic to Hawaiian islands. Similar to *H. schlehtendahlia* but distinguished by strongly angled stem and a few other characters. Recognized as *Kadua laxiflora* by Terrell et al. 2005. (NatureServe, 2015); In 2015, the Service published a technical correction for this and other plant and wildlife species, recognizing the taxonomic change from *Hedyotis mannii* to *Kadua laxiflora* (80 FR 35860, June 23, 2015). The taxonomic change does not affect the range or endangered status of this species. (USFWS, 2018)

Historical Range

Historical occurrences on Lānaʻi and Molokaʻi (USFWS, 2018)

Current Range

Current range includes west Maui (USFWS, 2018)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Hedyotis mannii* (Pilo) aka *Kadua laxiflora* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 14 detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Hedyotis mannii* includes 14 CHUs in Maui County, Hawaii with detailed unit information. There are also an unknown number of units on Lanai that contain this species (number of units is unknown because detailed unit descriptions for Lanai are not available) (81 FR 17790-18110).

Molokai—Lowland Mesic—Unit 1 (and) *Palmeria dolei*—Unit 37—Lowland Mesic (and) *Pseudonestor xanthophrys*—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Ctenitis squamigera*, *Cyanea dunbariae*, *C. mannii*, *C. profuga*, *Cyperus fauriei*, *Cyrtandra filipes*, *Gouania hillebrandii*, *Labordia triflora*, *Neraudia sericea*, *Santalum haleakalae* var. *lanaiense*, *Schiedea lydgatei*, *S. sarmentosa*, *Silene alexandri*, *S. lanceolata*, *Spermolepis hawaiiensis*, and *Zanthoxylum hawaiiense*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Mesic—Unit 1 is not known to be occupied by *Asplenium dielirectum*, *Bonamia menziesii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea procera*, *C. solanacea*, *Diplazium molokaiense*, *Festuca molokaiensis*, *Flueggea neowawraea*, *Isodendron pyriformum*, *Kadua laxiflora*, *Melicope mucronulata*, *M. munroi*, *M. reflexa*, *Phyllostegia haliakalae*, *P. mannii*, *P. pilosa*, *Sesbania tomentosa*, *Stenogyne bifida*, or *Vigna o-wahuensis*, or the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Mesic—Unit 1 (and) *Palmeria dolei*—Unit 42—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 42— Montane Mesic This area consists of 257 ac (104 ha) of State land, and 559 ac (226 ha) of privately owned land from Kamiloloa to Makolelau in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Bidens wiebkei*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Montane Mesic—Unit 1 is not known to be occupied by *Asplenium dielirectum*, *Cyanea dunbariae*, *C. mannii*, *C. procera*, *C. solanacea*, *Cyperus fauriei*, *Kadua laxiflora*, *Melicope mucronulata*, *Neraudia sericea*, *Plantago princeps*, or *Stenogyne bifida*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 2 (and) *Palmeria dolei*—Unit 3—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 3— Lowland Wet (and) *Newcombia cumingi*—Unit 1—Lowland Wet This area consists of 65 ac (26 ha) of State land at Moomoku, on the northwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the

lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. Although Maui—Lowland Wet—Unit 2 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), or by the Newcomb's tree snail (*Newcombia cumingi*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 3 (and) *Palmeria dolei*—Unit 4—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 4— Lowland Wet This area consists of 1,247 ac (505 ha) of State land at Honanana Gulch on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta*, *Cyanea asplenifolia*, and *Pteris lidgatei*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 3 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 4 (and) *Palmeria dolei*—Unit 5—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 5— Lowland Wet This area consists of 864 ac (350 ha) of State land at Kahakuloa Valley on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta* and *Cyanea asplenifolia*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 4 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia*

mannii, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwiku* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 5 (and) *Palmeria dolei*—Unit 6—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 6— Lowland Wet This area consists of 30 ac (12 ha) of State land at Iao Valley on the eastern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 5 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielarectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwiku* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 6 (and) *Palmeria dolei*—Unit 7—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 7— Lowland Wet This area consists of 136 ac (55 ha) of State land at Honokowai and Wahikuli valleys on the western slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 6 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielarectum*, *Bidens conjuncta*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwiku* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 7 (and) *Palmeria dolei*—Unit 8—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 8— Lowland Wet This area consists of 898 ac (364 ha) of State land at Olowalu Valley, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Alectryon macrococcus*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 7 is not currently occupied by the plants *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 8 (and) *Palmeria dolei*—Unit 9—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 9— Lowland Wet This area consists of 230 ac (93 ha) of State land at upper Ukumehame Gulch, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 8 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 5 (and) *Palmeria dolei*—Unit 29—Dry Cliff (and) *Pseudonestor xanthophrys*—Unit 29— Dry Cliff This area consists of 1,298 ac (525 ha) of State land, from Helu and across Olowalu to Ukumehame Gulch, on west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). They are occupied by the plant *Tetramolopium capillare*, and contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Dry Cliff—Unit 5 is not currently occupied by the plants *Bonamia menziesii*, *Diplazium molokaiense*, *Hesperomannia arbuscula*, *Isodendron*

pyrifolium, *Kadua laxiflora*, or *Neraudia sericea*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 6 consists of 279 ac (113 ha) of State land along the east wall of Ukumehame Gulch on west Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). Although Maui—Dry Cliff—Unit 6 is not currently occupied by the plants *Bonamia menziesii*, *Diplazium molokaiense*, *Hesperomannia arbuscula*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Neraudia sericea*, or *Tetramolopium capillare*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 6 (and) *Palmeria dolei*—Unit 35—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 35—Wet Cliff This area consists of 1,858 ac (752 ha) of State land, and 253 ac (102 ha) of privately owned land, at the summit ridges of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plants *Alectryon macrococcus*, *B. conjuncta*, *Ctenitis squamigera*, *Cyrtandra munroi*, *Remya mauiensis*, and *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 6 is not known to be occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Bonamia menziesii*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, or *Tetramolopium capillare*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 7 (and) *Palmeria dolei*—Unit 36—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 36—Wet Cliff This area consists of 556 ac (225 ha) of State land along Honokowai ridge on the northwestern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units are occupied by the plants *Cyrtandra filipes* and *C. munroi*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 7 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B.*

conjuncta, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyriforme*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lydgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 8 consists of 337 ac (137 ha) of State land along Kahakuloa ridge on the north side of west Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff—Unit 8 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylothea* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyriforme*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lydgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Hedyotis mannii* critical habitat consists of six components. Lowland mesic (Lanai and Molokai), Lowland wet (west Maui and Lanai), Montane wet (Lanai), Montane mesic (Molokai), Dry cliff (west Maui) and Wet cliff (west Maui and Lanai) (81 FR 17790-18110):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: *Ferns*, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: *Acacia*, *Ilex*, *Metrosideros*, *Myrsine*, *Nestegis*, *Nothoecstrum*, *Pisonia*, *Pittosporum*, *Psychotria*, *Sophora*, *Zanthoxylum*. Subcanopy: *Alyxia*, *Charpentiera*, *Coprosma*, *Dodonaea*, *Kadua*, *Labordia*, *Leptecophylla*, *Phyllostegia*, *Vaccinium*. Understory: Ferns, *Carex*, *Peperomia*.

Ecosystem: Dry Cliff. Elevation: unrestricted. Annual precipitation: <75 in (<190 cm). Substrate: >65 degree slope, rocky talus. Canopy: None. Subcanopy: *Antidesma*, *Chamaesyce*, *Diospyros*, *Dodonaea*. Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Schiedea*.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. Understory: Bryophytes, Ferns, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the

conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkii*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 150 and 1,050 meters (USFWS, 1996)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1996)

Habitat Narrative

Adult: Hedyotis mannii typically grows on dark, narrow, rocky gulch walls in mesic and perhaps wet forests at 150 to 1,050 meters (490 to 3,450 feet) in elevation (USFWS 1992). Associated plant species include mamaki, Cibotium (hapuu), Cyanea (haha), and Psychotria (kopiko) (USFWS 1992). On Lanai, the habitat at Hauola Gulch is Metrosideros polymorpha – Dicranopteris linearis wet riparian and mesic forest. On West Maui at the back of Kauaula Valley, the habitat is seeping wet vertical basalt cliffs. (USFWS, 1996; USFWS, 2011)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2011)

Redundancy:

Very low (inferred from USFWS, 2011)

Number of Populations:

2 (USFWS, 2011; USFWS, 2017)

Population Size:

wild individuals: 0 (Moloka'i), 0 (Lana'i), ~30 (Maui); ~40 outplanted (USFWS, 2018)

Population Narrative:

Currently, there are three individuals in two populations on Lanai and six individuals in a single population on Maui. (USFWS, 2011); In 2011, the 5-year review reported two populations on Lānaʻi totaling three individuals and six individuals on west Maui. Plants on Molokaʻi were extirpated. Currently, there are two populations totaling 33 individuals at ʻĪao Valley and Honokōhau on west Maui, and no wild individuals are known on Lānaʻi or Molokaʻi (Oppenheimer 2018, in litt.; PEPP 2010, 2011, 2012, 2016, 2017a).

Threats and Stressors

Stressor: Invasive plants (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plants such as *Buddleia asiatica* (dogtail), *Lantana camara* (lantana), and *Melinis minutiflora* (molasses grass) threaten *Hedyotis mannii* (Perlman 2009). On Lanai, introduced invasive plant species include *Morella faya* (fire tree), *Pluchea carolinensis* (sourbush), *Psidium cattleianum* (strawberry guava), *Rubus rosifolius* (thimbleberry), and *Tibouchina herbacea* (glorybush) (Perlman 2009; Wood 2009). In Maui, invasive introduced plants include *Ageratina adenophora* (sticky snakeroot), *Buddleia asiatica*, *Clidemia hirta* (Koster's curse), *Erigeron karvinskianus* (daisy fleabane), *Rubus rosifolius*, and *Tibouchina herbacea*, as well as damage from landslides (Wood 2009). (USFWS, 2011)

Stressor: Floods (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Threats that modify habitat include floods. (USFWS, 2011)

Stressor: Animals (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Threats that modify habitat include feral pigs (*Sus scrofa*), goats (*Capra hircus*), feral axis deer (*Axis axis*) and mouflon sheep (*Ovis musimon*). (USFWS, 2011)

Stressor: Predation by rats and insects (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Rats (*Rattus* spp.) and slugs (various species) are herbivores of *Kadua laxiflora* (Perlman 2009). Certain unidentified insects apparently are seed predators, and have destroyed the seeds before they could be collected. No method has yet been developed to protect the flowers or fruits to prevent insect predation (H. Oppenheimer, pers. comm. 2009). (USFWS, 2011)

Stressor: Climate change loss or degradation of habitat (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai'i using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Kadua laxiflora* is vulnerable to the impacts of climate change, with a vulnerability score of 0.395 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions may be needed to conserve this taxon into the future. (USFWS, 2018)

Stressor: Small population size (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: In addition to all of the other threats, species like *Kadua laxiflora* that are endemic to very small portions of a few islands are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding, and disease outbreaks. The extent of these natural processes on this taxon with very low numbers is exacerbated by anthropogenic threats, such as habitat loss for human development or predation by introduced species (USFWS 1996). (USFWS, 2011)

Recovery**Reclassification Criteria:**

1. A total of five to seven populations of each taxon should be documented on Molokai and at least one other island where they now occur or occurred historically. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1996)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1996)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Molokai and at least 1 other island where they now occur or occurred historically. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1996)
3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1996)

Recovery Actions:

- Given the altered nature of the Molokai Recovery Plan taxa's habitat, their low numbers, and the severity of the threats acting upon them, the highest priority recovery actions must be aimed at protecting those individuals and populations that currently exist, and managing their habitat to control the threats affecting their survival. Surveys should begin immediately for taxa that have not been observed for several years. If the species cannot be found, they may be considered for delisting due to extinction. A monitoring program is essential to track the status of the populations of all of the taxa covered in this plan, and to assess the effectiveness of threat management. (USFWS, 1996)
- The Molokai cluster taxa may expand naturally following the elimination of current threats through management. However, in certain instances, wild populations may need to be augmented in order to reach down/delisting criteria. Suitable sites for population augmentation should be selected after careful evaluation of the threat of introducing detrimental organisms into the wild populations. Augmentation efforts should always be well-documented as to lineage and methods. (USFWS, 1996)
- Research into various aspects of the life history, habitat, pollinators, reproductive biology, symbionts, optimum requirements for growth, requirements for population viability, and control of threats for each of the Molokai Recovery Plan taxa is needed in order to better understand the requirements necessary for perpetuation of these plants. Additional knowledge would allow more appropriate management and assessment techniques to be developed, and is needed in order to determine meaningful parameters for definition of specific recovery criteria for each taxon. (USFWS, 1996)
- All populations of the Molokai Recovery Plan taxa should be monitored to ensure that current information is available for each. A detailed monitoring plan should be designed and implemented for each taxon. Permanent plots should be set up for each population, and individuals mapped by size class, in order to establish baseline information regarding population size, local distribution patterns and threats. As new populations are discovered or established, they should be added to the monitoring program. Individual plants may also be carefully tagged as appropriate for monitoring purposes. Data collection should include quantities and locations of all extant plants as well as any other relevant observations regarding phenology, habitat or threats. Plots should be set up to allow point-and/or line-intercept monitoring methods as appropriate for each situation. Information such as changes in numbers of plants by size class, changes in vigor of individual plants, and changes or disturbances to the environment should be noted as appropriate and that data recorded. (USFWS, 1996)
- If necessary to meet recovery objectives, populations should be reestablished in areas where they are known or believed to have occurred historically, particularly if genetically uncontaminated, cultivated materials exist that are known to have originated from the historical site. The goal of reintroduction is to permanently re-establish viable populations of these taxa in stable and secure conditions. (USFWS, 1996)
- The scientific validity of the recovery criteria should be reviewed and revised as appropriate as more information becomes available. (USFWS, 1996)
- Population viability and monitoring—Continue to survey known localities and suitable habitat areas on Lānaʻi and west Maui to determine the current status of all populations of *Kadua laxiflora*. Search historical habitat on Molokaʻi for occurrences of this species. (USFWS, 2018)

- Ungulate monitoring and control—Continue to construct and maintain exclusion fences, or strategic fencing as appropriate, to protect *K. laxiflora* from the impacts of feral ungulates. (USFWS, 2018)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. (USFWS, 2018)
- Fire destruction or degradation of habitat—Develop and implement fire prevention management plan for Lānaʻi. (USFWS, 2018)
- Captive propagation for genetic storage and reintroduction—Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. Evaluate genetic resources currently in storage to determine the need to place additional material into long-term storage due to this species' vulnerability to climate change. (USFWS, 2018)
- Reintroduction and translocation—Augment current populations and reintroduce individuals into suitable habitat within historical range that is managed for known threats to this species. (USFWS, 2018)
- Rodent predation or herbivory—Implement effective methods to control rats at known populations. (USFWS, 2018)
- Invertebrate predation or herbivory—Identify insects that are seed predators and determine need for control methods. (USFWS, 2018)

Conservation Measures and Best Management Practices:

- Survey areas where *Kadua laxiflora* has been reported to determine the current status of the species. (USFWS, 2011)
- Monitor known populations and collect any available seed for genetic storage and reintroduction. (USFWS, 2011)
- Fence existing populations to protect them from negative impacts of ungulates. (USFWS, 2011)
- Control invasive introduced species around known populations. (USFWS, 2011)
- Develop and implement methods to control rats and slugs. (USFWS, 2011)
- Propagate to augment the existing populations. (USFWS, 2011)
- Establish additional populations within protected suitable habitat. (USFWS, 2011)
- Update the listed entity on 50 CFR 17 to match the currently recognized taxonomy. (USFWS, 2011)
- Work with Hawaii Division of Forestry and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2011)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2011)

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

Final Rule . 81 FR 17790-18110 (March 30, 2016).

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SPECIES ACCOUNT: *Kanaloa kahoolawensis* (Kohe malama malama o kanaloa)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/03/1999; Pacific Region (R1) (USFWS, 2016)

Physical Description

A densely branched shrub 0.75-1 m tall. Compound leaves are clustered near twig tips. Pompom-like flower clusters are white (NatureServe, 2015).

Taxonomy

A member of the legume family (Fabaceae). *Kanaloa kahoolawensis* was unknown to science until its discovery by Steve Perlman and Ken Wood in 1992 on a steep, rocky spire on the coast of Kahoolawe. David Lorence and Wood have determined that this plant represents a new genus, and have named the species *Kanaloa kahoolawensis* (Lorence and Wood 1994) (USFWS, 2002).

Historical Range

Discovered in 1992 on the southern coast of Kahoolawe (USFWS, 2002).

Current Range

There is one natural occurrence on Kahoolawe and captive individuals on Kauai and Maui (USFWS, 2014).

Critical Habitat Designated

Yes; 5/14/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Kanaloa kahoolawensis* (Kohe malama malama o kanaloa) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes five detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Kanaloa kahoolawensis* includes five CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Kahoolawe—Coastal—Unit 1 consists of 1,516 ac (613 ha) of State land from Kaneloa to Lae o Kaule, including Aleale, along the southern and eastern coast of Kahoolawe. It is occupied by the plant *Kanaloa kahoolawensis* and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Kahoolawe—Coastal—Unit 1 is not known to be occupied by the plants *Sesbania tomentosa* or *Vigna owahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species

because it provides the physical or biological features necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Kahoolawe—Coastal—Unit 2 consists of 12 ac (5 ha) of State land on Puukoa, an islet off the southern coast of Kahoolawe. It is occupied by the plant *Sesbania tomentosa* and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Kahoolawe—Coastal—Unit 2 is not known to be occupied by *Kanaloa kahoolawensis* or *Vigna o-wahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Kahoolawe—Coastal—Unit 3 consists of 189 ac (76 ha) of State land from Laepaki to Honokanaia along the western coast of Kahoolawe. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). Although Kahoolawe—Coastal—Unit 3 is not known to be occupied by *Kanaloa kahoolawensis*, *Sesbania tomentosa*, or *Vigna o-wahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Kahoolawe—Lowland Dry—Unit 1 consists of 1,220 ac (494 ha) of State land, north of Waihonu Gulch on west Kahoolawe. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Kahoolawe—Lowland Dry—Unit 1 is not known to be occupied by *Gouania hillebrandii*, *Hibiscus brackenridgei*, *Kanaloa kahoolawensis*, *Neraudia sericea*, *Sesbania tomentosa*, or *Vigna owahuensis*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Kahoolawe—Lowland Dry—Unit 2 consists of 3,205 ac (1,297 ha) of State land from Lua o Kealialuna to Puu o Moaulaiki and Luamakika on the eastern side of Kahoolawe. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Kahoolawe—Lowland Dry—Unit 2 is not known to be occupied by *Gouania hillebrandii*, *Hibiscus brackenridgei*, *Kanaloa kahoolawensis*, *Neraudia sericea*, *Sesbania tomentosa*, or *Vigna o-wahuensis*, we have determined this area to be essential

for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Kanaloa kahoolawensis* critical habitat consists of two components. Coastal (Kahoolawe) and Lowland dry (Kahoolawe) (81 FR 17790-18110):

Ecosystem: Coastal. Elevation: <980 ft (<300 m). Annual precipitation: <20 in (<50 cm). Substrate: Well-drained, calcareous, talus slopes; dunes; weathered clay soils; ephemeral pools; mudflats. Canopy: Hibiscus, Myoporum, Santalum, Scaevola. Subcanopy: Gossypium, Sida, Vitex. Understory: Eragrostis, Jacquemontia, Lyceum, Nama, Sesuvium, Sporobolus, Vigna.

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: Diospyros, Myoporum, Pleomele, Santalum. Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Sicyos.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and

6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkii*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*,

Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Lifespan**

Adult: < 10 years (USFWS, 2014)

Breeding Season

Adult: Unknown (USFWS, 2002)

Key Resources Needed for Breeding

Adult: Unknown (USFWS, 2002)

Reproduction Narrative

Adult: It is a short-lived perennial (fewer than 10 years) (USFWS, 2014). Flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown (U.S. Fish and Wildlife Service 1999b, 2002b) (USFWS, 2002).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Mixed coastal shrubland (USFWS, 2002)

Geographic or Habitat Restraints or Barriers

Adult: 150 - 200 ft. elevation (USFWS, 2002)

Habitat Narrative

Adult: Found on dry rocky slopes with sparse native shrubland (NatureServe, 2015). The only known habitat is steep rocky talus slopes in mixed coastal shrubland at elevations between 45 to 60 meters (150 to 200 feet) (USFWS, 2002).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Stable (USFWS, 2014)

Resiliency:

Very low (inferred from USFWS, 2014; see current range/distribution)

Redundancy:

Very low (inferred from USFWS, 2014)

Number of Populations:

1 (USFWS, 2014)

Population Size:

Wild: 1; captive: 4 (USFWS, 2014)

Population Narrative:

Overall, the number of wild individuals for *Kanaloa kahoolawensis* remained stable with only a single wild individual currently known and as stated in the previous 5-year review (USFWS 2008). There are four individuals in captive propagation on Kauai and Maui (USFWS, 2014).

Threats and Stressors

Stressor: Climate change (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Kanaloa kahoolawensis* is highly vulnerable to the impacts of climate change and is noted as the ten most vulnerable plant species to climate change (USFWS, 2014).

Stressor: Disease and predation (USFWS, 2014 and 2002)

Exposure:

Response:

Consequence:

Narrative: The Olinda Rare Plant Facility reported downy mildew as a threat to the single individual in captive propagation (USFWS 2010). Powdery mildew was also reported as a threat to *K. kahoolawensis* at Maui Nui Botanical Gardens (2012). Olinda Rare Plant Facility reported spider mites as a threat to the single individual in captive propagation (USFWS 2010) (USFWS, 2014). Rats are a potential threat to *K. kahoolawensis* because the species has seeds similar in appearance and presentation to the seeds of the federally endangered *Caesalpinia kavaensis* (uhiuhi), which are eaten by rats (USFWS, 2002).

Stressor: Habitat degradation (USFWS, 2002)

Exposure:

Response:

Consequence:

Narrative: The major threats to *Kanaloa kahoolawensis* are landslides and the alien plant species *Emilia fosbergii* (pualele), *Chloris barbata* (swollen finger grass), and *Nicotiana glauca* (tree tobacco). Goats played a major role in the destruction of vegetation on Kahoolawe before they were removed, and *K. kahoolawensis* probably survived only because the rocky stack is almost completely separated from the island and inaccessible to goats. Trampling and habitat degradation by introduced cats and native seabirds are also potential threats (USFWS, 2002).

Stressor: Stochastic events (USFWS, 2002)

Exposure:

Response:

Consequence:

Narrative: Random environmental events and/or reduced reproductive vigor are also a threat to this species because only one individual is known (USFWS, 2002).

Stressor: Collection (USFWS, 2002)

Exposure:

Response:

Consequence:

Narrative: Potential threats include unrestricted collecting or excessive visits by individuals interested in seeing rare plants (P. Higashino, personal communication 2000; Cuddihy and Stone 1990; Lorence and Wood 1994; U.S. Fish and Wildlife Service 1999b, 2002b) (USFWS, 2002).

Recovery

Reclassification Criteria:

1. A total of five to seven populations should be documented on islands where it now occurs or occurred historically (USFWS, 2002).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 2002).
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 2002).

Delisting Criteria:

1. A total of 8 to 10 populations should be documented on islands where it now occurs or occurred historically (USFWS, 2002).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 2002).
3. Each population should persist at this level for a minimum of five consecutive years (USFWS, 2002).

Recovery Actions:

- Protect habitat and control threats (USFWS, 2002).

- Expand existing wild populations (USFWS, 2002).
- Conduct essential research (USFWS, 2002).
- Develop and maintain monitoring plans.
- Reestablish wild populations within historic range.
- Validate and revise recovery criteria.
- Construct exclosures to protect the single remaining wild population against feral ungulates (USFWS, 2002).
- Maintain adequate genetic stock (USFWS, 2002).
- Control competing alien plant species (USFWS, 2002).
- Enhance wild populations and establish new populations (USFWS, 2002).

Conservation Measures and Best Management Practices:

- Surveys / inventories – Survey geographical and historical range for a current assessment of the species' status (USFWS, 2014).
- Captive propagation genetic storage and reintroduction: Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change (USFWS, 2014).
- Invasive plant monitoring and control – Eradicate invasive introduced plant species within the vicinity of the last known wild individual (USFWS, 2014).
- Predator / herbivore monitoring and control – Continue controlling rodents within the vicinity of the last known wild individual and at captive propagation facilities to enable seed production (USFWS, 2014).
- Population viability monitoring and analysis – Continue monitoring wild and captive propagated individuals (USFWS, 2014).
- Disease monitoring and control – Continue controlling powdery mildew outbreaks at captive propagation facilities (USFWS, 2014).
- Climate change adaptation strategy – Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change (USFWS, 2014).
- Alliance and partnership development – Continue initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2014).

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SPECIES ACCOUNT: *Keysseria (=Lagenifera) erici* (Mt. Waialeale Island daisy)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (R1) (USFWS, 2016)

Physical Description

Keysseria erici is a short, rhizomatous perennial herb in the sunflower family (Asteraceae). Scapes (leafless or bractless flower stalks) are tinged purple, 3 to 15 centimeters (cm) (1.2 to 6 inches (in)) long, hirtellous (pubescent with minute and somewhat rigid hairs) and villous (covered with soft, shaggy unmated) hairs. Leaves form an oblong basal rosette, 0.8 to 1.3 centimeters (cm) (0.3 to 0.5 in) long, 0.2 to 0.45 cm (0.08 to 0.2 in) wide, and with golden or purplish hairs. Flower heads are solitary, 6 to 10 millimeters (mm) (0.2 to 0.4 in) in diameter, with rays white or sometimes tinged purple, entire or deeply and asymmetrically lobed, with globose glands. Corollas are yellow, lobed, 1.8 to 2.7 mm (0.07 to 0.1 in) long, with globose glands. Achenes (a dry one-seeded indehiscent fruit) are somewhat compressed, with a conspicuous cartilaginous ring at maturity, 1.2 to 1.7 mm (0.05 to 0.07 in) long, and with globose glands near the apex (Mill 1999). (USFWS, 2017)

Taxonomy

Forbes originally placed this entity in the genus *Lagenifera*, which was upheld by Mill (1999). However, Wagner and Herbst (2003), the most recently accepted Hawaiian plant taxonomy, upheld Nesom's (2001) understanding of the differences between *Lagenifera* and *Keysseria* and recognize the taxon as a species of *Keysseria*. Wood (2006) expressed some doubt regarding the taxonomic distinctness of *K. erici* and *K. helenae*. According to Mill (1999) hybrids between these two species may occur in the Waialeale summit area of Kauai or these plants may represent extremes of one variable species. Further taxonomic study is needed (Mill 1999; Wood 2006). (USFWS, 2017)

Historical Range

Little is known of the historical occurrences of *K. erici*. The type was collected by Forbes (1918, p. 306) from the "Alakai swamp, Waimea drainage basin" on Kauai (USFWS, 2010).

Current Range

Currently, populations occur at Namolokama, Hanakapiai-Wainiha ridge, In-between Bog, and at the Kilohana bogs (including Rain Gauge Bog, T Bog, and Platanthera Bog) (Kauai) (HBMP 2007) (USFWS, 2010).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Keysseria (=Lagenifera) erici* (Alakai Swamp Island-daisy) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Keysseria* (=Lagenifera) *erici* includes three CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Montane Wet—Section 1: Montane Wet—Section 1 consists of 13,055 ac (5,257 ha) in the montane wet ecosystem, extending across the Alakai Plateau from Hanakoa to Mount Waialeale, on State (12,628 ac, 5,110 ha) and privately owned (427 ac, 173 ha) land in the Na Pali Coast State Park, the Alakai Wilderness Preserve, the Na PaliKona and Halelea forest reserves, and Hono o Na Pali NAR (Figure 4). It is occupied by the plants *Astelia waialealae*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *K. helenae*, *Labordia helleri*, *L. pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, and *Platydesma rostrata*; by the akekee and akikiki; and by the picture-wing fly. This section also contains unoccupied habitat that is essential to the conservation of these 18 species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the montane wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and the species-specific PCEs including (1) bogs (identified as PCEs for *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*) (2) bog hummocks (identified as PCEs for *Astelia waialealae* and *Lysimachia daphnoides*); (3) arthropod prey (identified as PCEs for the akekee and the akikiki); and (4) larval-stage host plants, *Cheirodendron* and *Tetraplasandra* sp., (identified as a PCE for the picture-wing fly). Although Montane Wet—Section 1 is not known to be occupied by the plants *Dubautia kalalauensis*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, those portions of the section that overlies previously designated critical habitat fall within two existing Critical Habitat Units of 50 CFR 17.99(a)(1): Unit 10, Map 35a; and Unit 11, Map 64a. The previously undesignated land comprises Unit 23, Map 217f; and Unit 24, Map 217g. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 4—Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 4—Montane Wet).

Kauai—Montane Wet—Section 2: Montane Wet—Section 2 consists of 790 ac (320 ha) in the montane wet ecosystem, extending from Kahuamaa Flat south to the edge of Waimea Canyon, on State-owned land in Kokee State Park (Figure 4, above). The entire section is within previously designated critical habitat, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Dubautia kalalauensis*, *Labordia helleri*, *Melicope puberula*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*, and by the akekee. This section includes montane wet forest, potentially some small-scale boggy areas, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and arthropod prey (identified as a species-specific PCE for the akekee). Although Montane Wet—Section 2 is not known to be occupied by the plants *Astelia waialeale*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialeale*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *Myrsine mezii*, and *Phyllostegia renovans*; by the akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be

essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. This area also supports the arthropod prey identified as a PCE for the akikiki, and the larval-stage host plants (*Cheirodendron* and *Tetraplasandra* spp.) identified as a PCE for the picturewing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within previously designated Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 5—Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 5—Montane Wet).

Kauai—Montane Wet—Section 3: Montane Wet—Section 3 consists of 413 ac (167 ha) in the montane wet ecosystem, encompasses the summit of Namolokama, on State (156 ac, 63 ha) and privately owned (257 ac, 104 ha) land in the Halelea Forest Reserve (Figure 4, above). It is entirely within previously designated critical habitat, and is occupied by the plants *Keysseria erici* and *Labordia pumila*. This section includes the montane wet forest, the moisture regime, and the canopy, subcanopy, and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and bogs (identified as a species-specific PCE for *K. erici*). Although Montane Wet—Section 3 is not known to be occupied by the plants *Astelia waialeale*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia kalalauensis*, *D. waialeale*, *Geranium kauaiense*, *Keysseria helenae*, *Labordia helleri*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*; by the akekee and akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. It also supports the arthropod prey identified as a PCE for the akekee and akikiki, and the larval-stage host plants (*Cheirodendron* and *Tetraplasandra* spp.) identified as a PCE for the picture-wing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 6—Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 6—Montane Wet).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Keysseria* (=Lagenifera) *erici* critical habitat consists of one component (Montane wet). Specific PCEs include: Bogs (75 FR 18960-19165):

Ecosystem: Montane Wet. Elevation: 3,000–5,243 ft (914-1,598 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations

or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to

further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available

Habitat Type

Adult: Wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Montane bog (NatureServe, 2015); *Metrosideros* mixed bog, montane wet ecosystem (USFWS, 2010b)

Dependencies on Specific Environmental Elements

Adult: Montane wet ecosystem (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: 4,000 - 5,120 ft elevation (USFWS, 2010)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Habitat Narrative

Adult: Montane bogs in wet forests, in the cloud zone. The environmental specificity is very narrow; it only occurs in the Alakai swamp region in bogs (Russell 2004) (NatureServe, 2015). It occurs in *Metrosideros* mixed bogs in the montane wet ecosystem, at elevations between 4,000 and 5,120 ft (1,219 and 1,561 m) (Mill 1999, pp. 329–330; HBMP 2007; TNCH 2007) (USFWS, 2010).; *Keyseria erici* occurs in *Metrosideros polymorpha* (ohia) mixed bogs in the montane wet ecosystem between 1,219 and 1,561 meters (4,000 and 5,120 feet) elevation (TNCH 2007) with associated native plant species including *Carex* spp. (NCN), *Cheirodendron dominii* (olapa), *Deschampsia nubigena* (hairgrass), *Dichanthelium* spp. (NCN), *Dicranopteris linearis* (uluhe), *Dubautia* spp. (naenae), *Labordia pumila* (kamakahala), *Leptecophylla tameiameia* (pukiawe), *Lobelia villosa* (NCN), *Machaerina angustifolia* (uki), *Metrosideros* spp., *Plantago pachyphylla* (laukahi kuahiwi), *Rhynchospora* spp. (kuolohia), *Vaccinium* spp. (ohelo), *Viola* spp. (violet) (HBMP 2010). (USFWS, 2017)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Species Trends:

< 30% decline (NatureServe, 2015)

Resiliency:

Very low (inferred from USFWS, 2010; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2010)

Number of Populations:

3 - 4 (USFWS, 2017)

Population Size:

~1500 wild individuals (USFWS, 2017)

Population Narrative:

The long term population trend is unknown. While the species has always been restricted to the bogs of the Alakai, it may have occurred in more bogs in the area in the past and the number of individuals has declined (Russell 2002); decline of < 30% (NatureServe, 2015). There are 3 - 4 populations totaling several thousand individuals (USFWS, 2010).; Little is known of the historical distribution of *Keysseria erici*. The type was collected by Forbes (1918) from the "Alakai swamp, Waimea drainage basin" on Kauai. While the species has probably always been restricted in range, it may have occurred in more bogs in the area in the past. At the time of listing, this species was found in three to four populations totaling several thousand individuals at Namolokama, Hanakapiai-Wainiha Ridge, In-Between Bog, and the Kilohana Bogs (including Rain Gauge Bog, T Bog, and Platanthera Bog) (HBMP 2010). Due to frequent inclement weather at the summit, biannual monitoring by USFWS and DOW staff is sometimes precluded. In most recent years of monitoring, the populations and numbers of individuals have had little fluctuation (Brueggemann 2002). Current estimates are of 30 individuals at Kawaikini, over 300 individuals at Waialeale, and possibly greater than 1,000 individuals in the Waialeale summit area (NTBG 2015; PEPP 2015; Wood 2006). The individuals at Namolokama have not been observed since 1988 (HBMP 2010). In addition, if *K. erici* and *K. helenae* are determined not to be distinct species, then the number of individuals may total as high as over 3,000 for the combined total (Wood 2006). (USFWS, 2017)

Threats and Stressors

Stressor: Ungulate degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Feral pigs (*Sus scrofa*) and goats (*Capra hircus*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil (Loope 1998; van Riper and van Riper 1982). Feral pigs and goats and evidence of their activities have been observed at all occurrences of *Keysseria erici* (HBMP 2010; NTBG 2015; PEPP 2015; Wood 2006). (USFWS, 2017)

Stressor: Established ecosystem-altering invasive plant modification and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community (Cuddihy and Stone 1990). Habitat modification and destruction by invasive introduced plants negatively affects *Keysseria erici* at all locations. The nonnative plants with the greatest impacts include *Axonopus fissifolius* (narrow-leaved carpetgrass), *Andropogon virginicus* (broomsedge), *Erechtites valerianifolia* (fireweed), *Erigeron karvinskianus* (daisy fleabane), *Juncus planifolius* (bog rush), *Rubus argutus* (prickly Florida blackberry), *R. rosifolius* (thimbleberry), *Sacciolepis indica* (glenwood grass), and *Setaria parviflora* (yellow foxtail) (HBMP 2010; NTBG 2015; Wood 2006). (USFWS, 2017)

Stressor: Hurricanes—Loss and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013). (USFWS, 2017)

Stressor: Climate change loss or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible

responses necessary for persistence under climate change. This assessment concluded that *Keysseria erici* is highly vulnerable to the impacts of climate change with a vulnerability score of 0.819 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2017)

Stressor: Ungulate predation or herbivory (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Herbivory by feral pigs and goats is reported to be a threat to *Keysseria erici* (HBMP 2010; NTBG 2015; PEPP 2015 Wood 2006). (USFWS, 2017)

Stressor: Rodent predation or herbivory (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Herbivory by rats is noted to be a threat to *Keysseria erici* (NTBG 2015). Rats eat virtually every part of plants and at every stage: fleshy fruits, seeds, flowers, stems, leaves, shoot, seedlings, and roots (Russell 1980; Cuddihy and Stone 1990). The effects on plants range from reduced vigor and decreased reproduction to mortality of individuals and complete lack of recruitment. (USFWS, 2017)

Stressor: Lack of adequate hunting regulations (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: The Waialeale summit bog and North Bog populations are provided some protection by a fenced enclosure; however, individuals near North Bog and at Kawaikini are not fenced. Hunting areas surround all occurrences. Public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations are at risk (DLNR 2010). (USFWS, 2017)

Stressor: Lack of adequate biosecurity legislation (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Introduction of invasive nonnative plant species to the State of Hawaii and destruction of habitat and competition by nonnative plants are threats to *Keysseria erici*. Pest species have caused the extinction of native species, the destruction of native forests, and the spread of disease. The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, is authorized to prevent the introduction or dissemination of animal and plant pests on all ships, aircraft, and their cargo and baggage arriving in the U.S. and its territories; however, pest species continue to enter the State. In addition, Federal import regulations do not address many species that could be pests in Hawaii (CGAPS 2009; Ikuma et al. 2002). (USFWS, 2017)

Stressor: Invasive species—Established invasive plant species competition (USFWS, 2017)

Exposure:**Response:****Consequence:**

Narrative: The nonnative plants noted to compete with *Keysseria erici* for water, light, and nutrients include *Axonopus fissifolius*, *Erechtites valerianifolia*, *Juncus planifolius*, *Paspalum urvillei* (vasey grass), and *Sacciolepis indica* (HBMP 2010; Wood 2006). (USFWS, 2017)

Recovery**Reclassification Criteria:**

To meet the interim stage of recovery of *Keysseria erici*, 600 mature individuals are needed in each of three populations and all major threats must be controlled around the populations designated for recovery at this stage. There should also be demonstrated regeneration of seedlings and documented replacement regeneration within each of the target populations. The populations must be adequately represented in an ex situ collection as defined in the Center for Plant Conservation's guidelines (Guerrant et al. 2004). Adequate monitoring must be in place and conducted to assess individual plant survival, population trends, trends of major limiting factors, and response of major limiting factors to management. (USFWS, 2017)

In addition to achieving 5 to 10 populations with 1,000 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats. (USFWSI, 2017)

Delisting Criteria:

In addition to achieving 5 to 10 populations with 1,000 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis. (USFWS, 2017)

Recovery Actions:

- Surveys and inventories—Continue to survey for other populations of *Keysseria erici* in areas of potentially suitable habitat. (USFWS, 2017)

- Ungulate monitoring and control—Protect all occurrences against browsing and disturbances from feral ungulates. Continue to construct and maintain fenced exclosures around all populations. (USFWS, 2017)
- Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species around all populations. Continue to control invasive nonnative plant species around all populations that compete with the species. (USFWS, 2017)
- Predator and herbivore monitoring and control—Implement effective control methods for rodents. (USFWS, 2017)
- Captive propagation for genetic storage and reintroduction—Begin propagation efforts for maintenance of genetic stock. (USFWS, 2017)
- Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2017)
- Population biology research—Study *Keysseria erici* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2017)
- Genetic research—Conduct research on the distribution and genetic relationship of *Keysseria erici* with *K. helenae*. Conduct research on the taxonomic and hybridization issues of the species. (USFWS, 2017)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms. (USFWS, 2017)
- Based on the recovery criteria above, consider development of a recovery plan. (USFWS, 2017)

Conservation Measures and Best Management Practices:

- USFWS and the Hawaii Division of Forestry and Wildlife have fenced 9 montane bogs in the Alakai Plateau, totaling approximately 40 hectares (100 acres). These fenced bogs contain some scattered individuals of *K. erici* (USFWS, 2010a).

References

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Determination of Endangered Status for 48 Species on Kauai and Designation of Critical Habitat. Final rule. 75 FR 18960 - 19165 (April 13, 2010).

USFWS. 2017. *Keysseria erici* (No common name), 5-year review, summary and evaluation. PIFWO, Honolulu, Hawaii.

U.S. Fish and Wildlife Service. 2010. Endangered and Threatened Wildlife and Plants

Determination of Endangered Status for 48 Species on Kauai and Designation of Critical Habitat

Final Rule . 75 FR 18960-19165 (April 13, 2010).

SPECIES ACCOUNT: *Keysseria (=Lagenifera) helenae* (Alakai Swamp Island daisy)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (R1) (USFWS, 2016)

Physical Description

Rhizomatous perennial herbs, usually branched at base. Leaves in a basal rosette or distributed 3 - 12 cm along the ascending stem. Heads are solitary, rays are white or sometimes tinged purple (NatureServe, 2015).

Taxonomy

A member of the sunflower family (Asteraceae) (USFWS, 2010).

Historical Range

Little is known of the historical occurrences of *K. helenae*. The type was collected from the “swamp near Kaholuamano” by Forbes (1918, p. 306) (USFWS, 2010).

Current Range

Currently, this species is found at Kauluwehi Bog in the Alakai Wilderness Preserve, at Waialeale, and on Kahili-Kawaikini Ridge (Kauai) (USFWS, 2010).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Keysseria (=Lagenifera) helenae* (Mt. Waialeale Island-daisy) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Keysseria (=Lagenifera) helenae* includes three CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Montane Wet—Section 1: Montane Wet—Section 1 consists of 13,055 ac (5,257 ha) in the montane wet ecosystem, extending across the Alakai Plateau from Hanakoa to Mount Waialeale, on State (12,628 ac, 5,110 ha) and privately owned (427 ac, 173 ha) land in the Na Pali Coast State Park, the Alakai Wilderness Preserve, the Na PaliKona and Halelea forest reserves, and Hono o Na Pali NAR (Figure 4). It is occupied by the plants *Astelia waialealae*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *K. helenae*, *Labordia helleri*, *L. pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, and *Platydesma rostrata*; by the akekee and akikiki; and by the picture-wing fly. This section also contains unoccupied habitat that is essential to the conservation of these 18 species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the

montane wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and the species-specific PCEs including (1) bogs (identified as PCEs for *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*) (2) bog hummocks (identified as PCEs for *Astelia waialealae* and *Lysimachia daphnoides*); (3) arthropod prey (identified as PCEs for the akekee and the akikiki); and (4) larval-stage host plants, *Cheirodendron* and *Tetraplasandra* sp., (identified as a PCE for the picture-wing fly). Although Montane Wet–Section 1 is not known to be occupied by the plants *Dubautia kalalauensis*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, those portions of the section that overlie previously designated critical habitat fall within two existing Critical Habitat Units of 50 CFR 17.99(a)(1): Unit 10, Map 35a; and Unit 11, Map 64a. The previously undesignated land comprises Unit 23, Map 217f; and Unit 24, Map 217g. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 4–Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 4–Montane Wet).

Kauai—Montane Wet—Section 2: Montane Wet–Section 2 consists of 790 ac (320 ha) in the montane wet ecosystem, extending from Kahuamaa Flat south to the edge of Waimea Canyon, on State-owned land in Kokee State Park (Figure 4, above). The entire section is within previously designated critical habitat, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Dubautia kalalauensis*, *Labordia helleri*, *Melicope puberula*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*, and by the akekee. This section includes montane wet forest, potentially some small-scale boggy areas, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and arthropod prey (identified as a species-specific PCE for the akekee). Although Montane Wet–Section 2 is not known to be occupied by the plants *Astelia waialeale*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialeale*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *Myrsine mezii*, and *Phyllostegia renovans*; by the akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. This area also supports the arthropod prey identified as a PCE for the akikiki, and the larval-stage host plants (*Cheirodendron* and *Tetraplasandra* spp.) identified as a PCE for the picturewing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within previously designated Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 5–Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 5–Montane Wet).

Kauai—Montane Wet—Section 3: Montane Wet–Section 3 consists of 413 ac (167 ha) in the montane wet ecosystem, encompasses the summit of Namolokama, on State (156 ac, 63 ha) and privately owned (257 ac, 104 ha) land in the Halelea Forest Reserve (Figure 4, above). It is entirely within previously designated critical habitat, and is occupied by the plants *Keysseria erici* and *Labordia pumila*. This section includes the montane wet forest, the moisture regime, and the

canopy, subcanopy, and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and bogs (identified as a species-specific PCE for *K. erici*). Although Montane Wet–Section 3 is not known to be occupied by the plants *Astelia waialeale*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia kalalauensis*, *D. waialeale*, *Geranium kauaiense*, *Keysseria helenae*, *Labordia helleri*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*; by the akekee and akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. It also supports the arthropod prey identified as a PCE for the akekee and akikiki, and the larval-stage host plants (*Cheirodendron* and *Tetraplasandra* spp.) identified as a PCE for the picture-wing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 6–Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 6–Montane Wet).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Keysseria* (=Lagenifera) *helenae* critical habitat consists of one component (Montane wet). Specific PCEs include: Bogs (75 FR 18960-19165):

Ecosystem: Montane Wet. Elevation: 3,000–5,243 ft (914-1,598 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within

each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available

Habitat Type

Adult: Wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Montane bog (NatureServe, 2015); Metrosideros polymorpha or mixed sedge and grass bogs (USFWS, 2010)

Dependencies on Specific Environmental Elements

Adult: Montane wet ecosystem (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: 3,900 - 5,120 ft. elevation (USFWS, 2010)

Environmental Specificity

Adult: Narrow (Natureserve, 2015)

Habitat Narrative

Adult: Montane bogs in wet forests, in the cloud zone. The environmental specificity is narrow; it only occurs in bogs in the Alakai swamp area (Russell 2004) (NatureServe, 2015). It is found in Metrosideros polymorpha or mixed sedge and grass bogs at elevations between 3,900 and 5,120 ft (1,189 and 1,561 m) in the montane wet ecosystem (Mill 1999, p. 330; HBMP 2007; TNCH 2007) (USFWS, 2010).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Species Trends:

Stable (NatureServe, 2015)

Resiliency:

Very low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Population Size:

~11,000 (USFWS, 2017))

Population Narrative:

The long term population trend is unknown. There are approximately 300 individuals known. The U.S. Fish and Wildlife monitored this species from 2001 to 2004 and the numbers fluctuated

very little (Russell 2004). There are four extant (observed 1994-2007) occurrences on the island of Kauai (HBMP 2007) (NatureServe, 2015). At the time of listing, this species was found at Kauluwehi Bog in the Alakai Wilderness Preserve, at Waialeale, and on Kahili-Kawaikini Ridge, totaling approximately 300 individuals (HBMP 2010; Wood 2003, in litt.). In more recent surveys, about 100 to possibly as many as 1,000 individuals were found at Sincock Bog and USGS Bog, occasional individuals below and along the ridges in the Kawaikini summit area, and an estimated 5,000 to as many as 10,000 individuals west of Waialeale summit (NTBG 2011, 2012a-b, 2013a-c, 2014a-b, 2015a-b). While the species has probably always been restricted in range, it may have occurred in more bogs in the area in the past. Due to often inclement weather at the summit, biannual monitoring by USFWS and DOFAW staff is sometimes precluded. In most recent years of monitoring, the populations and numbers of individuals have had little fluctuation. If *K. erici* and *K. helenae* are determined not to be distinct species, then the number of individuals may total in the thousands for the combined taxon (Wood 2006) (USFWS, 2017)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from non-native plants, pigs, hurricanes, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species.

Stressor: Predation and herbivory (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species present an immediate and significant threat to *Keysseria helenae* throughout its range due to documented browsing and trampling by pigs, goats, and deer (USFWS, 2010).

Stressor: Ungulate degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Feral pigs (*Sus scrofa*) and goats (*Capra hircus*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil (Loope 1998; van Riper and van Riper 1982). Feral pigs and goats

and evidence of their activities have been observed at all occurrences of *Keysseria helenae* (HBMP 2010; NTBG 2011, 2013a-b, 2014a, 2015a-b; Wood 2006) (USFWS, 2017).

Stressor: Established ecosystem-altering invasive plant modification and degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community (Cuddihy and Stone 1990).

Habitat modification and destruction by invasive introduced plants negatively affects *Keysseria helenae* at all locations. The nonnative plants with the greatest impacts include *Axonopus fissifolius* (narrow-leaved carpetgrass), *Andropogon virginicus* (broomsedge), *Blechnum appendiculatum* (NCN), *Clidemia hirta* (Koster's curse), *Cyperus meyenianus* (NCN), *Erechtites valerianifolia* (fireweed), *Erigeron karvinskianus* (daisy fleabane), *Juncus planifolius* (bog rush), *Melastoma septemnerium* (NCN), *Paspalum conjugatum* (Hilo grass), *Psidium cattleianum* (strawberry guava), *Rhodomyrtus tomentosa* (downy myrtle), *Rubus argutus* (prickly Florida blackberry), *R. rosifolius* (thimbleberry), *Sacciolepis indica* (glenwood grass), *Setaria parviflora* (yellow foxtail) and *Sphaeropteris cooperi* (Australian tree fern) (HBMP 2010; NTBG 2012a-c, 2013b, 2014a-b, 2015a-b; Wood 2006) (USFWS, 2017).

Stressor: Hurricanes—Loss and degradation of habitat

Exposure:

Response:

Consequence:

Narrative: In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013) (USFWS, 2017).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Keysseria helenae* is highly vulnerable to the impacts of climate change with a vulnerability

score of 0.926 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this species has no overlap between current and future climate envelopes, and is unlikely to tolerate expected changes in climate at its current location. This means that this species must persist within suitable microrefugia, or move to newly available climate-compatible areas to avoid extinction. Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Stressor: Ungulate predation or herbivory

Exposure:

Response:

Consequence:

Narrative: Herbivory by feral pigs and goats is reported to be a threat to *Keysseria helenae* because evidence of their activities in the only known locations of this species has been reported (HBMP 2010; NTBG 2011, 2013a-b, 2014a, 2015a-b; Wood 2006) (USFWS, 2017).

Stressor: Rodent predation or herbivory

Exposure:

Response:

Consequence:

Narrative: Herbivory by rats is noted to be a threat to *Keysseria helenae* (NTBG 2012c, 2013a-b, 2014a-b, 2015a-b). Rats eat virtually every part of plants and at every stage: fleshy fruits, seeds, flowers, stems, leaves, shoot, seedlings, and roots (Russell 1980; Cuddihy and Stone 1990). The effects on plants range from reduced vigor and decreased reproduction to mortality of individuals and complete lack of recruitment (USFWS, 2017).

Recovery

Reclassification Criteria:

In addition to achieving 5 to 10 populations with 1,000 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats (USFWS, 2017).

Delisting Criteria:

In addition to achieving 5 to 10 populations with 1,000 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVA for individual species based on current management and monitoring data collected at regular intervals determined by demographic

parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis (USFWS, 2017).

Recovery Actions:

- Current Management Actions: • PEPP has begun monitoring the occurrence at USGS Bog (PEPP 2015). • Ungulate monitoring and control—USFWS, working in cooperation with DOFAW, has fenced two of the three bogs in which *Keysseria helenae* occurs. These actions provide protection to a population of *K. helenae* at Waialeale, and a portion of the population at Kauluwehi Bog; however, the species as a whole is still impacted by these threats and will require long-term monitoring and management to maintain threat free areas (Bruegmann 2002). • Invasive plant monitoring and control—USFWS, working in cooperation with DOFAW, has conducted intermittent biannual weeding (Bruegmann et al. 2015, in litt.). • Fifty-seven seeds were collected from Sincock Bog 4 in 2015 from approximately three plants and sent to Lyon Arboretum for viability testing. None of the seeds germinated (Lyon Arboretum 2017) (USFWS, 2017).
- RECOMMENDATIONS FOR FUTURE ACTIONS • Surveys and inventories—Continue to survey for other populations of *Keysseria helenae* in areas of potentially suitable habitat. • Ungulate monitoring and control—Protect all occurrences against browsing and disturbances from feral ungulates. Continue to construct and maintain fenced exclosures around all populations. • Invasive plant monitoring and control o Continue to control established ecosystem-altering nonnative invasive plant species around all populations. o Continue to control invasive nonnative plant species around all populations that compete with the species. • Predator and herbivore monitoring and control—Implement effective control methods for rodents. • Captive propagation for genetic storage and reintroduction—Begin propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. 16 • Population biology research—Study *Keysseria helenae* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats • Genetic research—Conduct research on the distribution and genetic relationship of *Keysseria erici* with *K. helenae*. Conduct research on the taxonomic and hybridization issues of the species. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms. • Based on the recovery criteria above, consider development of a recovery plan (USFWS, 2017).

Conservation Measures and Best Management Practices:

- USFWS and the Hawaii Division of Forestry and Wildlife have fenced 9 montane bogs in the Alakai Plateau, totaling approximately 40 hectares (100 acres). These fenced bogs contain some scattered individuals of *K. helenae* (USFWS, 2010a).

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SPECIES ACCOUNT: *Kokia cookei* (Cooke's koki`o)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/29/1979; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Kokia cookei is a small deciduous tree. The only wild individual of this century was about 3 m (10 ft) in height (Rock 1919). The height has been described as “12-15 ft high” (3.7-4.6 m) (Hillebrand 1888), “probably 3.5-4.5 m” (11.5-15 ft) (Degener 1934), and “perhaps 3-5 in” (9.8-16.4 ft) (Bates 1990). The leaves are simple, five- to seven-lobed with an entire margin, 5-13 cm (1-5.2 in) wide and clustered at branch ends. The large flowers occur singly in leaf axils near branch ends. Flowers are subtended by three sometimes persistent bracts that are 1.5 cm (0.6 in) long. Flowers are showy with twisted and recurved orange-red petals clustered together around a staminal column about 6.5 cm (2.6 in) long. The fruit is a five-lobed, dry, dehiscent (splitting open when ripe) capsule, globose and up to 3 cm (1.2 in) in diameter, producing seeds 10-13 mm (0.4-0.5 in) long, covered with a short dense pubescence. (USFWS, 1998)

Taxonomy

In the mallow family (Malvaceae). Additional Hawaiian names for the genus include koki'o and hau hele'ula. English common names for *Kokia cookei* are Molokai red cotton, Cooke kokio, and Hawaiian tree cotton; synonyms include *Gossypium diynarioides* Hillebrand and *Kokia drynarioides* (Seemann) Degener (USFWS, 1998).

Historical Range

Historically known from western Molokai. (USFWS, 1998).

Current Range

Species is extirpated from its natural range. There are several individuals in cultivation in managed collections on Molokai (USFWS, 2014).

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Kokia cookei* (Cooke's koki`o) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Kokia cookei* includes two CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Molokai—Lowland Dry—Unit 1 consists of 24 ac (10 ha) of privately owned land, in a small gulch northwest of Mahana, in west-central Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although

Molokai—Lowland Dry—Unit 1 is not known to be occupied by *Bonamia menziesii*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Hibiscus brackenridgei*, *Kokia cookei*, or *Sesbania tomentosa*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Dry—Unit 2 consists of 589 ac (238 ha) of State land at Kamiloloa on the southern slopes of Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Molokai—Lowland Dry—Unit 2 is not known to be occupied by *Bonamia menziesii*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Hibiscus brackenridgei*, *Kokia cookei*, or *Sesbania tomentosa*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Kokia cookei* critical habitat consists of one component. Lowland dry (Molokai) (81 FR 17790-18110):

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*,

Schiedea jacobii, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkii*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*,

Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Lifespan**

Adult: >39 years (USFWS, 1998)

Other Reproductive Information

Adult: Regarding pollination, unpublished research by Robert Hobdy and Drs. Herbert and Irene Baker demonstrated that Kokia drynarioides and Kokia kauaiensis are adapted to facilitate flower visitation and pollination by nectar-feeding birds. Flowering Kokia cookei trees may have been important food sources for native nectar-feeding honeyeater (Melphagidae) and honeycreeper (Fringillidae: Drepanidinae) birds. Honeybees (Apis mellifera) do visit the flowers of Kokia cookei (R. Nakagawa and W. Morton, personal communication 1995). (USFWS, 1998)

Reproduction Narrative

Adult: Single, isolated trees of Kokia cookei can produce viable seeds. Regarding pollination, unpublished research by Robert Hobdy and Drs. Herbert and Irene Baker demonstrated that Kokia drynarioides and Kokia kauaiensis are adapted to facilitate flower visitation and pollination by nectar-feeding birds. Flowering Kokia cookei trees may have been important food sources for native nectar-feeding honeyeater (Melphagidae) and honeycreeper (Fringillidae: Drepanidinae) birds. Honeybees (Apis mellifera) do visit the flowers of Kokia cookei (R. Nakagawa and W. Morton, personal communication 1995). Kokia cookei can be a fairly long-lived tree. One of the original seedlings produced from the last wild tree lived for over 39 years (1915 to sometime after 1954). (USFWS, 1998)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Annual rainfall of 50-63 cm (20-25 in), mostly falling in a few winter storms (USFWS, 1998)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 300 and 600 meters (USFWS, 1998)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1998)

Habitat Narrative

Adult: The only historic habitat of *Kokia cookei* is dryland forest on the western (leeward) end of Molokai near Mahana, northeast of Puu Nana at approximately 200 m (660 ft) elevation. The former habitat of *Kokia cookei* appears most similar to modern dryland forest at Kanepuu, Lanai, and leeward Haleakala, Maui, at 300-600 m (1,000-2,000 ft) elevation. In a recent classification of Hawaiian vegetation types (Gagne and Cuddihy 1990), the habitat of *Kokia cookei* appears closest to the Olopua/Lama (*Nestegis/Diospyros*) forest type known currently only from Kanepuu, Lanai. Associated native taxa are *Nestegis sandwicensis* (olopua, pua), *Nototrichium sandwicense* (kului), *Xylosma hawaiiense* (maua), *Diospyros sandwicensis* (lama), *Nesoluma polynesicum* (keahi), and *Bonamia menziesii*, an endangered liana endemic to Hawaii. Soil of the habitat of *Kokia cookei* on Molokai is a mollisol soil (Armstrong 1983). These are relatively young soils with good drainage that are generally rich in plant nutrients (Armstrong 1983). Rainfall of this leeward area is strongly seasonal with most of the approximately 50-63 cm (20-25 in) of annual precipitation falling in a few winter storms generally followed by arid summers (Armstrong 1983, Wagner et al. 1990). (USFWS, 1998)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Short-term trends suggest declines of greater than 30%. (NatureServe, 2015)

Resiliency:

None (inferred from USFWS, 2014)

Redundancy:

None (inferred from USFWS, 2014)

Number of Populations:

1 (0 wild) (USFWS, 2014; USFWS, 2018)

Population Size:

~10 (0 wild) (USFWS, 2018)

Population Narrative:

Short-term population trends suggest declines of greater than 30%. There are 8 plants in cultivation. In 2012, two individuals were outplanted on Molokai in a living gardens collection (Plant Extinction Prevention Program [PEPP] 2012). (USFWS, 2014; NatureServe, 2015). New Status Information: • In 2014, the 5-year review reported individuals in captive propagation at Waimea Arboretum, Lyon Arboretum, Amy Greenwell Ethnobotanical Garden, Leeward Community College, Ho'olawa Farms, and Maui Nui Botanical Garden. In 2012, two individuals had been outplanted on Moloka'i in a living garden (inter situ) collection. Currently, there are still no known wild individuals. There are 10 propagated individuals outplanted on east Maui,

and one individual remains in the inter situ collection on Moloka'i (PEPP 2017a, b) (USFWS, 2018).

Threats and Stressors

Stressor: Habitat conversion (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Dryland forests of the Hawaiian Islands have been greatly reduced and fragmented as a result of agricultural practices, the actions of introduced ungulates, invasion by non-native plant species, and increased fire frequency (Gagne and Cuddihy 1990; Cuddihy and Stone 1990). (USFWS, 1998)

Stressor: Effects of introduced grazing mammals (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: *Kokia cookei* was directly impacted by browsing, bark stripping, and soil trampling by domestic and feral cattle, goats, and sheep (Rock 1913). In the early 1900s, Mahana, the only locality where *Kokia cookei* was known from the wild, was a central site for a sheep ranch run by Molokai Ranch. In 1908, the ranch had 17,000 sheep; by 1920, the ranch discontinued raising sheep (Pukui et al. 1974). Referring to *Kokia cookei*, Rock (1913) noted: "Several trees occurred on the west end of Molokai, at Mahana, all having now died, owing to ravages of cattle, sheep and goats, which eat off the bark and leaves." (USFWS, 1998)

Stressor: Climate change (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Climate change destruction or degradation of habitat – Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) did not include *Kokia cookei*. (USFWS, 2014)

Stressor: Slugs (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: In 2012, slugs (unidentified species) were reported as a threat to *K. cookei* (PEPP 2012). (USFWS, 2014)

Stressor: Rats (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Rats (*Rattus* spp.) were reported as a threat to *K. cookei* (PEPP 2012). (USFWS, 2014)

Stressor: Loss of pollinators (USFWS, 1998)

Exposure:

Response:

Consequence:

Narrative: Prior to the arrival of Polynesians around 400 A.D., nectar-feeding passerine birds were apparently common in lowland dryland forest areas of the Hawaiian Islands (James and Olson 1991). After the arrival of Polynesians, and followed by Europeans in the late 1700s, native nectar-feeding birds were extirpated from dryland forests. *Kokia cookei* is apparently adapted to bird pollination. The loss of native nectar-feeding birds may have contributed to the decline of this species. (USFWS, 1998)

Stressor: Seed predation (USFWS, 1998)

Exposure:

Response:

Consequence:

Narrative: No specific mention of seed predation by insect larvae has been noted on *Kokia cookei*. However, Hillebrand (1888) noted of the related *Kokia lanceolata*, “The ripe seeds are mostly spoiled by worms, for in consequence of the imperfect dehiscence of the capsule they are retained an undue length of time.” Seed predation by insects occurs in the wild in the related species *Kokia kauaiensis* (KenWood, National Tropical Botanical Garden, personal communication 1995). Though including no specific mention for the genus *Kokia*, Swezey (1954) noted two species of moths (Lepidoptera: Tortricidae) as seed predators of other native Hawaiian species of Malvaceae. (USFWS, 1998)

Stressor: Small population size (USFWS, 1998)

Exposure:

Response:

Consequence:

Narrative: The low number of individuals and populations of *Kokia cookei* is the result of catastrophic habitat conversion and a recent history of failed propagation efforts. (USFWS, 1998)

Stressor: Lack of naturally rooted plants (USFWS, 1998)

Exposure:

Response:

Consequence:

Narrative: A fire in 1978 at the Cooke’s Kauluwai residence killed the last naturally rooted *Kokia cookei* plant. All *Kokia cookei* are now plants grafted onto rootstocks of related species. This technique, though successful in allowing for the continuing survival of the species, may have resulted in plants of reduced vigor and longevity compared to naturally rooted plants derived from seeds. (USFWS, 1998)

Stressor: Lack of viable seed production (USFWS, 1998)

Exposure:

Response:

Consequence:

Narrative: The primary threat to the continuing survival of this species is the lack of viable seed production, which may be due to genetic problems associated with severe inbreeding and loss of genetic variability (USFWS 1979). All living plants of *Kokia cookei* are clones and genetic copies of a single individual. The lack of viable seeds may also be related to poor vigor of grafted plants of the species. The plant used in cloning had produced viable seeds (Woolliams and Gerum 1992). (USFWS, 1998)

Recovery

Reclassification Criteria:

1. Five field populations (3 on Molokai, 1 on Lanai, 1 on Maui), each with 80-100 mature individuals are secure, and managed in perpetuity. (USFWS, 1998)
2. Natural regeneration from viable seeds is occurring at all of the five outplanting sites for at least 3 consecutive years. (USFWS, 1998)
3. Five consecutive years of monitoring shows that the populations have a stable age structure. (USFWS, 1998)
- 4) All threats to these field populations are mitigated or eliminated. (USFWS, 1998)

Delisting Criteria:

1. Three additional field populations (1 on Molokai, 1 on Lanai, 1 on Maui), each with 80-100 mature individuals are secure, and managed in perpetuity. (USFWS, 1998)
- 2) Natural regeneration from viable seeds is occurring at all eight outplanting sites for at least 5 consecutive years. (USFWS, 1998)
3. Five consecutive years of monitoring shows that the populations have a stable age structure. (USFWS, 1998)
4. All threats to these populations are reduced to the point that *Kokia cookei* can successfully reproduce without assistance from humans with a 10-year average of 80-100 reproductive plants in each of the populations. (USFWS, 1998)

Recovery Actions:

- Increase number of grafted plants to at least 100 individuals. (USFWS, 1998)
- Continue research and development of cloning propagation methods such as grafting, air layering, and tissue culture. (USFWS, 1998)
- Continue research and propagation efforts on plants that produce viable seeds. (USFWS, 1998)
- Establish and maintain 8 field populations, each with at least 80-100 mature plants, on the islands of Molokai (4 populations), Lanai (2 populations), and Maui (2 populations). (USFWS, 1998)
- Validate recovery criteria. (USFWS, 1998)
- New Management Actions: • Surveys and monitoring—The Plant Extinction Prevention Program (PEPP) comanages reintroductions of *Kokia cookei* (PEPP 2013, 2014, 2015, 2016,

- 2017a). • Captive propagation for genetic storage and reintroduction— o Currently, the 2017 PEPP Statewide ex situ report indicates that seven of the eight founders from grafted material are represented in collections on east Maui, and two founders are represented in a reintroduction (seven individuals) on Molokaʻi (PEPP 2017b). o The Lyon Arboretum Micropropagation Laboratory reports 39 containers of propagules representing at least five individuals from plants at Fleming Arboretum on east Maui (Lyon Arboretum 2017). o The National Tropical Botanical Garden (NTBG) reports one seed from self-pollinated individual from the living collections (NTBG 2013, 2014, 2015, 2017). o Maui Nui Botanical Garden (MNBG) reported one grafted scion from material stored at Lyon Arboretum representing one wild individual in 2013, but they currently do not have any material (MNBG 2013, 2018). o The Olinda Rare Plant Facility (ORPF) reports one potted plant propagated from an individual at Fleming Arboretum, and five potted plants from plants from an inter situ collection on Molokaʻi (ORPF 2018). o The Pahole Rare Plant Facility (PRPF) on Oʻahu reports one plant in storage since 2013 (PRPF 2013, 2018). o Waimea Valley Arboretum reports seven plants representing one individual (Waimea Valley Arboretum 2017). o Fleming Arboretum reports five individuals (one mature, four seedlings) grown from a plant propagated at Waimea Arboretum, and two grafted individuals from material at ORPF (Fleming Arboretum 2018). o PEPP monitors inter situ and ex situ plants on east Maui and Molokaʻi (PEPP 2014, 2015, 2016, 2017a). Currently, PEPP reports that there are 10 individuals on east Maui at Fleming Arboretum and eight inter situ individuals on Molokaʻi (PEPP 2014, 2015, 2016, 2017a). • Stochastic events—Build resiliency and redundancy— With focused propagation efforts inter situ plants on Molokaʻi are producing viable seeds. Efforts will continue with the east Maui reintroductions and will hopefully produce similar results (PEPP 2016) (USFWS, 2018).
- Recommendations for Future Actions: We are not aware of any new threats or significant new information regarding the species' biological status since the last 5-year review in 2014. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2018. • Population viability and monitoring—Continue monitoring outplanted individuals. • Ungulate monitoring and control—Continue to construct and maintain exclusion fences to protect *K. cookei* from the impacts of feral ungulates. • Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. • Fire destruction or degradation of habitat—Develop and implement fire prevention management plans for reintroduction areas on east Maui and Molokaʻi. • Captive propagation for genetic storage and reintroduction— o Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. o Continue to increase numbers of grafted individuals. o Continue pollination trials to produce viable seeds. • Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historical range that is being managed for known threats to this species. • Rodent predation or herbivory—Implement effective methods to control rats at known populations. • Invertebrate predation or herbivory—Implement effective methods to control slugs at known populations. • Alliance and partnership development—Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2018).

Conservation Measures and Best Management Practices:

- Research and develop better propagation methods to produce viable seeds in cultivation. (USFWS, 2014)

- Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. (USFWS, 2014)
- Continue to increase numbers of grafted individuals. (USFWS, 2014)
- Propagate individuals of *K. cookei* in captive propagation to produce viable seeds. (USFWS, 2014)
- Continue reintroducing into protected suitable habitat within historical range to increase numbers of individuals. (USFWS, 2014)
- Fence remaining populations to protect them from the impacts of feral ungulates. (USFWS, 2014)
- Control invasive introduced plant species in the vicinity of all known *K. cookei* populations. (USFWS, 2014)
- Control slugs and rodents within the vicinity of all known *K. cookei* populations. (USFWS, 2014)
- Continue monitoring outplanted and captive propagated individuals. (USFWS, 2014)
- Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2014)

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SPECIES ACCOUNT: *Kokia drynarioides* (Koki`o)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/04/1984; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Kokia drynarioides is a small tree from 4 to 10 m (13 to 35 ft) tall and with a trunk up to 20 cm (8 in) in diameter. The star-shaped leaves are large (7 to 28 cm long or 2.75 to 11 in) with 7 to 9 palmate lobes, and are pale, glossy green, often with distinct red veins. The large and showy flowers are borne singly in leaf axils. Three large bracts below the flower are persistent. The petals are red, 10 to 15 cm (4 to 6 in) long and up to 8 cm (3.1 in) wide. The flowers are similar to *Hibiscus* flowers in that the stamens fuse to form a column around the style. The petals are somewhat twisted in the bud and the spiral pattern remains in the open flower. The fruit is a 5-lobed dry capsule about 2.5 cm (1 in) long. (Lamoureux 1981). (USFWS, 1994)

Taxonomy

Genus endemic to Hawaiian Islands; in the Malvaceae or mallow family. Synonyms listed by Wagner et al. (1990) are *Gossypium drynarioides*, *Hibiscus drynarioides* and *Kokia rockii*. (USFWS, 1994)

Historical Range

See Current Range.

Current Range

Currently known from the North Kona District of western Hawaii Island. (NatureServe, 2015)

Critical Habitat Designated

Yes; 12/4/1984.

Legal Description

On December 4, 1984, the U.S. Fish and Wildlife Service designated critical habitat for *Kokia drynarioides*. This rule implements the protection provided by the Endangered Species Act of 1973, as amended, for *Kokia drynarioides* and its critical habitat (49 FR 47397 - 47401).

Critical Habitat Designation

The critical habitat designation includes three areas totaling 2,600 acres in the North Kona District, Hawaii County, Hawaii.

1. Ka'upulehu Ahupua'a area, bounded as follows: from a point of origin at Universal Transverse Mercator (UTM) coordinate 925880 near or on the west boundary of the Ka'upulehu 1800 - 1801 lava flow (approximately at intersection of said west boundary and 2600 ft. elevation contour); thence west southwesterly approximately 864 ft. to UTM coordinate 909899 (near the 1400 ft. elevation contour); thence east northeasterly approximately 378 ft. to UTM coordinate 913900 (also near the 1400 ft. elevation contour); then south southeasterly approximately 720 ft. to UTM coordinate 916891; thence east northeasterly approximately 320 ft. to UTM coordinate 920892 (near the said west boundary of the 1800 - 1801 lava flow); thence south southeasterly

approximately 1140 ft. to the point of origin. Included in this area is Ka'upulehu Forest Reserve, Section B.

2. Ka'upulehu Ahupua'a and Pu'uwa'awa'a Ahupua'a boundary area, identified as follows: an unnamed kipuka (discontinuity) in 1800 - 1801 lava that straddles the boundary between Ka'upulehu and Pu'uwa'awa'a Ahupua'a and also crosses Mamalahoa Highway between 2400 and 1000 feet of elevation. Excluded is a small tonuge of the said kipuka that extends south of UTM coordinate 941885 at approximately 2400 ft. of elevation and above. UTM coordinate 931924 marks the low elevation end of the said kipuka.

3. Pu'uwa'awa'a Ahupua'a area, identified as follows: Halepi'ula 3, Waimea Paddock of Pu'uwa'awa'a Ranch, which lies south of (upslope) and abuts Mamalahoa Highway just east of the boundary between Ka'upulehu and Pu'uwa'awa'a Ahupua'a. East boundary of the 1800 - 1801 Ka'upulehu lava flow is the west boundary of the paddock. The paddock corners are near UTM coordinates 948901 (NW), 985909 (NE) 973886 (SE), and 971879 (SW).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements of critical habitat are:

appropriate soil type, climate, protection from grazing damage, protection from aggressive exotic weeds, and presence of suitable pollinators.

Special Management Considerations or Protections

Any activity that would significantly disturb the soil, topography, or other physical and biological components of the area in which *Kokia drynarioides* occurs could adversely modify its critical habitat. Existing and proposed land uses in the immediate locality of the population and in its surroundings must be carefully examined if such modifications are to be prevented. This might require exclosures to insure the establishment of seedlings and survival of existing trees and the removal of some lands from grazing. The State of Hawaii is currently considering Natural Area Reserve status for a portion of the Pu'uwa'awa'a Ranchlands.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Self-fertilization is possible (USFWS, 1994)

Breeding Season

Adult: Year-round (USFWS, 1994)

Reproduction Narrative

Adult: The reproductive biology of wild plants is completely unknown. Individual, isolated trees do produce viable seed, so self-fertilization is possible with this species. There is some evidence of vegetative reproduction, as three damaged individuals re-sprouted when the trunks were cut. A comment by Young and Popenoe (1916) indicates that a cultivated seedling of *Kokia cookei* began flowering at about age 4 years. Herbarium collections show that *Kokia drynarioides* may flower at any time of the year. (USFWS, 1994)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Rainfall between 75 and 100 cm (30-40 in) a year, with no pronounced wet and dry seasons; temperature varies between 14 and 18 degrees Celsius (USFWS, 1994)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 460 and 900 meters (1,500 to 3,000 feet) (USFWS, 1994)

Environmental Specificity

Adult: Narrow, with several key requirements (USFWS, 1994)

Habitat Narrative

Adult: *Kokia drynarioides* has historically grown between 460 meters (1500 feet) and 900 meters (3000 feet) elevation. The general slope is 50 to 100. The substrate is mostly rough a'ā lava covered by a thin and discontinuous layer of organic soil (Sato et al. 1973, Lamoureux 1981). The steep slope and rugged volcanic features of the landscape impede passage on the ground. The rainfall in this area is about 75 to 100 centimeters (30 to 40 inches) a year, with no pronounced wet and dry seasons (Blumenstock and Price 1961). Air temperature also fluctuates little during the year, with mean monthly temperatures varying between 14 and 18 degrees Celsius (58 and 64 degrees Fahrenheit) (Lamoureux 1982). The moderate rainfall and high insolation in combination with the shallow, excessively drained, soil provides a dry habitat where moisture is probably frequently limiting. The Kaupulehu and Puuwaawaa habitat of *Kokia drynarioides* is Lama/Kauila Forest (*Diospyros/Columbrina oppositifolia*), a subtype of the Lowland Dry Forest (Gagne and Cuddihy 1990). The canopy of this open forest is 5 to 6 meters (16.4 - 19.7 feet) high and is made up of a diversity of native tree species with native shrubs below, and includes several other rare plant species. (USFWS, 1994)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Stable (USFWS, 2015)

Resiliency:

Very low (inferred from USFWS, 2015)

Redundancy:

Very low (inferred from USFWS, 2015)

Population Growth Rate:

Stable (USFWS, 2015)

Number of Populations:

2 (USFWS, 2015)

Population Size:

2-8 wild individuals (USFWS, 2015)

Population Narrative:

In 2013, there were two populations containing 2 to 5 mature individuals, 3 immature individuals, and 21 seedlings of *Kokia drynarioides* (PEPP 2014). Research is ongoing as to whether the individuals currently found at Puu Waawaa are wild (natural) or outplanted (PEPP 2014). Overall, the numbers of individuals have remained stable from the two wild individuals reported in the previous 5-year review to approximately 2 to 8 wild individuals in 2015 (PEPP 2014). (USFWS, 2015)

Threats and Stressors

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Climate change destruction or degradation of habitat – Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Kokia drynarioides* is highly vulnerable to the impacts of climate change. Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2015)

Stressor: Grazing and browsing by ungulates (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Rock (1913), Degener (1946) and others recognized that the rapid disappearance from North Kona of *Caesalpinia kavaensis* and *Kokia drynarioides* was mostly due to forest destruction and community disintegration as a result of cattle ranching in the dry forest. Nearly all of the habitat on the island of Hawaii is or has until recently been managed for commercial cattle production. Seedlings and saplings of both species are highly palatable to cattle. Feral goats and sheep also live in this habitat. (USFWS, 1994)

Stressor: Fountain grass invasion and enhanced fire danger (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Today the most devastating factor within the dry forest habitat of these two species on the island of Hawaii is the invasion by fountain grass that has occurred during this century, resulting in its complete domination of the groundcover in the dry forest habitat of North Kona. Fountain grass has two major negative impacts on the community: the promotion of fire and usurpation of native plant habitat. Fountain grass is a fire-adapted bunch grass that enhances fuel-loading and promotes fire (Tunison in press). Unlike most other alien grasses, fountain grass can invade barren lava flows that were not formerly subject to wildfire. Major fires burned through Puuwaawaa Ranch in 1986 and 1988. Trees of both species, as well as other native dry forest species, were completely eliminated from the burned areas in these fires. Wildfire also burned a major portion of the boundary kipuka section of the *Kokia drynarioides* critical habitat in May, 1993, killing an estimated 80% of the *Kokia drynarioides* and *Caesalpinia kavaensis* found there (L. Mehrhoff, personal communication 1993). (USFWS, 1994)

Stressor: Non-native plants (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Many other alien plants are naturalized in the North Kona habitat. Two that are widespread and disruptive are lantana (*Lantana camara*) and silk oak (*Grevillea robusta*). Two cultivated plants that have become established locally on the cinder cone of Puuwaawaa itself are the custard apple (*Annona cherimola*) and *Pittosporum viridiflorum* (Takeuchi 1990). (USFWS, 1994)

Stressor: Lack of genetic diversity (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Since the numbers of individuals of both of these two species are very low, it is possible that each species' viability may be reduced due to problems with in-breeding and the depleted gene pool. At this time, it appears that both species produce viable seeds that grow normally when protected. If *Kokia drynarioides* are grown in botanical gardens near other *Kokia* species from other islands, it is possible that cross-pollination leading to hybridization may take place. Such mixing of the gene pools should be avoided by keeping careful records of provenance. (USFWS, 1994)

Stressor: Predation by rats, mice, game birds, and invertebrates (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Predation of seeds of both species by introduced rats, mice and unspecified game birds and invertebrates is well known. Rats eat the seeds of both species while they are still on the tree (Lamoureux 1981, 1982). The large, hard, bean-like seeds of *Caesalpinia kavaensis* have been found in rat burrows (Lamoureux 1982) as have the seed coats of *Kokia drynarioides* (Derral Herbst, U.S. Fish and Wildlife Service, personal communication 1992). The importance of seed predation has not been scientifically assessed. (USFWS, 1994)

Stressor: Volcanic eruptions (USFWS, 1994)

Exposure:

Response:**Consequence:**

Narrative: The North Kona populations of these two species occur in a relatively restricted area on the side of a dormant volcano that last erupted about 1800 AD. A future eruption could threaten these wild populations. (USFWS, 1994)

Stressor: Drought (USFWS, 1994)

Exposure:**Response:****Consequence:**

Narrative: The North Kona area has experienced drought conditions for several years, and if these two species reproduce only in widely spaced times of favorable climactic conditions, the prolonged drought could be a factor in their recent decline. It is also possible that the drought conditions have exacerbated the insect infestation problems because dry vegetation is more susceptible to such invasion (C. Corn, personal communication 1993). (USFWS, 1994)

Recovery**Reclassification Criteria:**

1. It is observed and documented that the major threats are greatly reduced. (USFWS, 1994)
2. It is observed and documented that following the removal of threats, new trees are being recruited by natural regeneration at a rate adequate to replace individuals lost from the population and preserve long term genetic diversity. (USFWS, 1994)
3. Recovery proceeds for the time, approximately 13 years, needed to provide demographic data to be used in population viability analysis (PVA) to estimate minimum population numbers and densities for effective reproduction. (USFWS, 1994)
4. A thorough review of the environmental dynamics and human activities within the dry forest habitat is conducted to determine the minimum habitat area needed to give a high probability of survival of the species over the next 200 years. (USFWS, 1994)
5. Current habitat has been secured in perpetuity. (USFWS, 1994)
6. Any management practices necessary to maintain the protected habitats have been implemented. (USFWS, 1994)
7. The habitat is populated with the numbers and densities of these two species indicated by the results of research and the PVA (minimum of 100 naturally reproducing individuals in each of 3 populations of each species in North Kona and a minimum of 100 naturally reproducing *Caesalpinia kavaensis*, in each of three populations, on each of Oahu, Lanai, Kauai and Maui). (USFWS, 1994)

Delisting Criteria:

Not available.

Recovery Actions:

- Current habitat of *Caesalpinia kavaensis* and *Kokia drynarioides* should be protected through cooperative agreements with landowners, and threats to current populations should be controlled. (USFWS, 1994)
- Implementing the management plan will require further research to identify and characterize the environmental threats that are preventing natural regeneration of these two species and to develop management techniques. (USFWS, 1994)
- The increase in numbers of these two species should be enhanced by special care and treatment of seeds and seedlings within the management sites. Recruitment from seeds collected on the site or from nearby trees should be promoted by management techniques developed through research. Techniques might include barriers to discourage seed predation, drip irrigation systems, placement of seeds in select microhabitats, and shelters or other features to reduce evapotranspiration. (USFWS, 1994)
- In order to reach the delisting goals of 3 populations of each species on Hawaii island and 3 populations of *Caesalpinia kavaensis* on Oahu, Lanai, Kauai and Maui, new populations of *Caesalpinia kavaensis* will have to be established on Lanai, Kauai and Maui within the historical range of the species. (USFWS, 1994)
- An important role for research is to verify the scientific validity of the stated recovery objectives in this plan. (USFWS, 1994)

Conservation Measures and Best Management Practices:

- Survey geographical and historical range for a current assessment of the species' status. (USFWS, 2015)
- Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. (USFWS, 2015)
- Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change. (USFWS, 2015)
- Maintain existing exclosures and monitor for potential incursions. (USFWS, 2015)
- Eradicate invasive introduced plants within ungulate exclosures and maintain exclosures free of invasive plants. (USFWS, 2015)
- Continue monitoring wild and reintroduced individuals. (USFWS, 2015)
- Develop and implement a fire management plan at the existing exclosures. (USFWS, 2015)
- Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. (USFWS, 2015)
- Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2015)

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SPECIES ACCOUNT: *Kokia kauaiensis* (Koki`o)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

A tree, 5-10 m tall, with shallowly lobed leaves and large, ornamental, brick-red flowers. (NatureServe, 2015)

Taxonomy

The species was originally described as a subspecies, *Kokia rockii* var. *kauaiensis*, in 1919, but was later elevated to a full species. (USFWS, 1996)

Historical Range

Two individuals in Hipalau Valley have not been reported since 1993 (Perlman 2008), and one individual noted in Pohakuao has not been seen since 1999. (USFWS, 2010)

Current Range

Kokia kauaiensis is known from northwestern Kauai in Paaiki Valley; Mahanaloa-Kuia Valley junction, the western side of Kalalau Valley, and Pohakuao Valley, both within Na Pali Coast State Park; and Koaie Stream branch of Waimea Canyon, where some plants may be within the boundary of the Alakai Wilderness Preserve. (USFWS, 1996)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Kokia kauaiensis* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Kokia kauaiensis* includes four units totaling 2,417 acres in Kauai County, Hawaii. The units are Kauai 11—*Kokia kauaiensis*—a, b, c, d.

Kauai 11—*Kokia kauaiensis*—a: This unit is critical habitat for *Kokia kauaiensis* and is 155 ha (384 ac) on State land (Alakai Wilderness Preserve). This unit contains portions of Kawaiiki and Kipalau Valleys. This unit provides habitat for three populations of 100 mature, reproducing individuals of the long-lived perennial *Kokia kauaiensis* and is currently occupied with 70 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, diverse mesic forest. This unit is geographically separated from the other three units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Kokia kauaiensis*—b: This unit is critical habitat for *Kokia kauaiensis* and is 30 ha (74 ac) on State land (Na Pali Coast State Park) within Pohakuau Valley.

This unit provides habitat for one population of 100 mature, reproducing individuals of the long-lived perennial *Kokia kauaiensis* and is currently occupied with two plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, diverse mesic forest. This unit is geographically separated from the other three units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 11—*Kokia kauaiensis*—c: This unit is critical habitat for *Kokia kauaiensis* and is 666 ha (1,648 ac) on State land (Kuia NAR). This unit contains portions of Milolii Ridge, Kuia and Mahanaloa Valleys. This unit provides habitat for two populations of 100 mature, reproducing individuals of the long-lived perennial *Kokia kauaiensis* and is currently occupied with between 78 and 83 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, diverse mesic forest. This unit is geographically separated from the other three units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 11—*Kokia kauaiensis*—d: This unit is critical habitat for *Kokia kauaiensis* and is 127 ha (313 ac) on State land (Na Pali Coast State Park) within Kalalau Valley. This unit provides habitat for two populations of 100 mature, reproducing individuals of the long-lived perennial *Kokia kauaiensis* and is currently occupied with 16 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, diverse mesic forest. This unit is geographically separated from the other three units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

- (i) Diverse mesic forest containing one or more of the following associated native plant species: *Acacia koa*, *Alyxia oliviformis*, *Antidesma* spp., *Bobea* spp., *Chamaesyce celastroides*, *Claoxylon sandwicense*, *Dicranopteris linearis*, *Diellia pallida*, *Diospyros hillebrandii*, *Diospyros sandwicensis*, *Dodonaea viscosa*, *Flueggea neowawraea*, *Hedyotis* spp., *Hibiscus* spp., *Isodendron laurifolium*, *Lipochaeta fauriei*, *Melicope* spp., *Metrosideros polymorpha*, *Nestegis sandwicensis*, *Nototrichium* spp., *Pisonia* spp., *Pleomele aurea*, *Pouteria sandwicensis*, *Psydrax odorata*, *Pteralyxia kauaiensis*, *Rauvolfia sandwicensis*, *Santalum freycinetianum* var. *pyrularium*, *Streblus pendulinus*, *Syzygium sandwicensis*, *Tetraplasandra* spp., or *Xylosma* spp.; and
- (ii) Elevations between 300 and 1,049 m (984 and 3,441 ft).

Special Management Considerations or Protections

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic

material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Unknown (USFWS, 1998)

Lifespan

Adult: More than 10 years (USFWS, 1998)

Reproduction Narrative

Adult: No life history information for this species is currently available. However, it is considered a "long-lived perennial" (i.e., more than 10 years). (USFWS, 1998)

Habitat Type

Adult: Gulch slopes and bottoms. (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Mesic hardwood forests (NatureServe, 2015)

Habitat Narrative

Adult: *Kokia kauaiensis* typically grows in diverse mesic forest at elevations between 1,960 and 2,600 feet. Associated species include ahakea, koa, kukui, *Diospyros sandwicensis* (lama), manono, hala pepe, papala, *Nestegis sandwicensis* (olopua), and ohia (USFWS 1996). (USFWS, 1998)

Dispersal/Migration**Dispersal**

Adult: Unknown

Dispersal/Migration Narrative

Adult: No life history information for this species is currently available. (USFWS, 1998)

Population Information and Trends**Population Trends:**

Declining (USFWS, 2010)

Species Trends:

Declining (USFWS, 2017)

Resiliency:

Low (inferred from USFWS, 2010)

Representation:

Low (inferred from USFWS, 2010)

Redundancy:

Low (inferred from USFWS, 2010)

Number of Populations:

4 (USFWS, 2017)

Population Size:

28 (USFWS, 2017)

Adaptability:

Low (inferred from USFWS, 2010)

Population Narrative:

Overall, current populations and numbers of individuals have declined to an estimated 45 to 50 individuals in five populations. Fossil evidence suggests that this now rare and geographically restricted species was widespread a millennium ago. The species exhibits high survival and rapid growth of outplanted individuals at Makauwahi Cave (D. Burney, National Tropical Botanical Garden, pers. comm. 2008; Burney et al. 2001). (USFWS, 2010). New Status Information: • The number of individuals of *Kokia kauaiensis* has declined since the time of the last 5- year review in 2010. At that time, there were five occurrences totaling between 45 and 50 individuals. Currently, 15 trees remain in Kuia out of the 23 observed in 2004. Eight individuals remain out of the 38 observed in Paaiki in 2000. Two individuals of the six observed in 2005 remain at Kahuamaa Flat. Two individuals are also at Mahanaloa, and one is at Lonomea. All individuals have died at Pohakuao, Koaie, and Kawaiiki (PEPP 2017). The cause of this rapid decline is unknown (USFWS, 2017).

Threats and Stressors

Stressor: Invasive, alien plants (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: A major threat affecting the regeneration and survival of *Kokia kauaiensis* is competition and habitat degradation by a multitude of invasive introduced plant species, ranging from ferns, grasses and herbs, to shrubs and small trees. (USFWS, 2010)

Stressor: Habitat degradation (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Threats include substrate loss, due to habitat degradation by feral goats (*Capra hircus*), pigs (*Sus scrofa*), and mule deer (*Odocoileus hemionus*).

Stressor: Seed predation (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Seed predation by rats (*Rattus* sp.) and insects, including mites (species unknown), leaf hopper (species unknown), and coffee twig borer (*Xylosandrus compactus*) have all been observed on *K. kauaiensis*. (USFWS, 2010)

Stressor: Natural events (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Fire, hurricanes, landslides, and falling rocks are all potential threats. (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to *K. kauaiensis*. However, current climate change models do not allow us to predict specifically what those effects, and their extent, would be for this species. (USFWS, 2010)

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: —Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Kokia kauaiensis* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.758 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Stressor: Stochastic events—Reduced viability due to low numbers

Exposure:

Response:

Consequence:

Narrative: Populations of *Kokia kauaiensis* are declining. Small, isolated populations often exhibit reduced levels of genetic variability, which diminishes the species' capacity to adapt and respond to environmental changes, thereby lessening the probability of long-term persistence (Barrett and Kohn 1991; Newman and Pilon 1997). The problems associated with small population size and vulnerability to random demographic fluctuations or natural catastrophes are further magnified by synergistic interactions with other threats, such as anthropogenic impacts like

habitat loss from human development or predation by nonnative species. Very small plant populations may experience reduced reproductive vigor due to ineffective pollination or inbreeding depression (USFWS, 2017).

Recovery

Reclassification Criteria:

A total of five to seven populations should be documented on Kauai. (USFWS, 1995)

Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials. (USFWS, 1995)

Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1995)

Delisting Criteria:

A total of eight to ten populations should be documented on Kauai. (USFWS, 1995)

Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials. (USFWS, 1995)

Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1995)

Recovery Actions:

- Remove alien plants inside completed enclosures. (USFWS, 1998)
- Expand current populations. (USFWS, 1995)
- Conduct research essential to conservation of the species. (USFWS, 1995)
- Establish new populations as needed to reach recovery objectives. (USFWS, 1995)
- Validate and revise recovery objectives. (USFWS, 1995)
- Devise and implement a public education program. (USFWS, 1995)
- New Management Actions:
 - Captive propagation for genetic storage and reintroduction—Over 300 seeds were collected from Kawaiiki, Paaiki, Koaie, and Kalalau (east and west) populations (NTBG 2017). There are dozens of plants in the NTBG gardens, mostly from Kalalau, and there are a few dozen seedlings in the NTBG nursery from individuals from Kuai (NTBG 2017). Three founders from three different populations are represented at the Lyon Arboretum Seed Bank (Lyon Arboretum 2017).
 - Reintroduction and Translocation—Individuals have been outplanted into managed exclosures at Iapa ridge, Mahanaloa, Nualolo, Piwa, and Limahuli. Currently, there are 101 individuals outplanted (PEPP 2017).
 - Predator and herbivore monitoring and control—PEPP is monitoring all known populations and conducting some rat control (PEPP 2011, 2012, 2013, 2014, 2015).
 - Population biology research—PEPP assisted researchers from the University of Florida in making collections of *Kokia kauaiensis* for leaf miner studies (PEPP 2015) (USFWS, 2017).
- Recommendations for Future Actions: A decline in individuals is a new threat with no known cause. The following recommendations for future actions are reiterated for the 5-year

review for 2017. • Surveys and inventories—Continue to survey geographical and historic range for a thorough current assessment of the species. • Ungulate monitoring and control—Control feral ungulates within fenced exclosures. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative species that compete with the species around all populations. • Captive propagation for genetic storage and reintroduction—Continue to collect seeds for storage and for propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Population viability monitoring and analysis—Monitor growth and survival rates for both wild and reintroduced individuals. • Population biology research—Study *Kokia kauaiensis* populations to determine cause of decline. Determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides, fire, and low numbers (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Continue to collect seeds for full genetic storage and for use in reintroduction efforts. (USFWS, 2010)
- Survey Koaie and Kawaiiki area for additional individuals. (USFWS, 2010)
- Develop a standard monitoring protocol, using tagging and GIS coordinates, to determine reintroduction needs for the species. (USFWS, 2010)
- Monitor growth and survival rates for both wild and reintroduced individuals. (USFWS, 2010)
- Work with Hawaii Division of Forestry and Wildlife and Hawaii State Parks to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2010)

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SPECIES ACCOUNT: *Korthalsella degeneri* (Hulumoa)

Species Taxonomic and Listing Information

Listing Status: Endangered; 9/18/2012; Pacific Region (R1) (USFWS, 2016)

Physical Description

A perennial subshrub with stems that are woody at the base, which is parasitic on the native trees *Sapindus oahuensis* (kaulu) and *Nestegis sandwicensis* (olopua) (USFWS, 2012).

Taxonomy

In the mistletoe family (Viscaceae) (USFWS, 2012).

Historical Range

Recorded in 1938 from Makua Valley on Oahu, but little else is known of its historical range (USFWS, 2012).

Current Range

On Oahu, is known from Makaha Valley. In addition, individuals of this species may also occur in Makua Valley and at Kahanahaikiis (USFWS, 2012).

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On September 18, 2012, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Korthalsella degeneri* (Hulumoa) under the Endangered Species Act of 1973, as amended (Act) (77 FR 57648-57862). The critical habitat designation includes 8 critical habitat units, which encompass approximately 1,449 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Korthalsella degeneri* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Korthalsella degeneri* includes 8 critical habitat units, covering one ecosystem type, which encompasses approximately 1,449 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley.
Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo.
Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge.
Oahu—Dry Cliff—Unit 4 [24 ac

(10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac(105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Korthalsella degeneri* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Korthalsella degeneri* occurs within the indicated ecosystem in the Waianae Mountain caldera complex:

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: *Antidesma*, *Chamaesyce*, *Diospyros*, *Dodonaea*. (E) Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Schiedea*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Korthalsella degeneri* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Pollination potentially abiotic and by insect (EPA, 2016).

Habitat Type

Adult: Terrestrial (USFWS, 2012)

Habitat Vegetation or Surface Water Classification

Adult: Forest in dry cliff ecosystem (USFWS, 2012)

Dependencies on Specific Environmental Elements

Adult: Parasitic on the native trees *Sapindus oahuensis* (kaulu) and *Nestegis sandwicensis* (olopua) (USFWS, 2012).

Geographic or Habitat Restraints or Barriers

Adult: Elevations between 1,100 and 1,500 ft (USFWS, 2012).

Environmental Specificity

Adult: Parasitic to two species of native trees (USFWS, 2012).

Habitat Narrative

Adult: This species occurs in diverse forest in the dry cliff ecosystem at elevations between 1,100 and 1,500 ft (335 and 460 m) in the Waianae Mountains. It is parasitic on the native trees *Sapindus oahuensis* (kaulu) and *Nestegis sandwicensis* (olopua) (USFWS, 2012).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Potential dispersal mechanisms are abiotic and biotic (EPA, 2016).

Population Information and Trends**Population Trends:**

Decline of >10% (NatureServe, 2015)

Species Trends:

Unknown (NatureServe, 2015)

Resiliency:

Medium (inferred from NatureServe, 2015)

Representation:

Medium (inferred from NatureServe, 2015)

Redundancy:

Medium (inferred from NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

250 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Prior to human arrival on Oahu, native mesic forests were widespread and abundant and it is assumed that this species was relatively abundant within this habitat type (USFWS 2003). Long-term decline of >10%. One occurrence is estimated to have between 900 and 1000 individuals (J. Lau, in litt. 2000 cited by USFWS 2011). Two occurrences (J. Lau, in litt. 2000; U.S. Army 2006 cited by USFWS 2011). (NatureServe, 2015). Confirmation of the identification of these

individuals is difficult because another related species, *Korthalsella platycaula*, is also found in Makua Valley (USFWS, 2012).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative plants, animals (pigs and goats), fire, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Fire can destroy dormant seeds as well as the plants themselves, even in steep or inaccessible areas. Successive fires that burn farther and farther into native habitat destroy native plants, and remove habitat for native species by altering microclimate conditions favorable to alien plants. The projected effects of climate change will likely exacerbate the effects of the other threats to the species (USFWS, 2012).

Stressor: Predation and herbivory (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs and goats) is considered an ongoing threat to *Korthalsella degeneri* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2012).

Stressor: Loss of host plants and trampling by humans (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: *Korthalsella degeneri* faces the threat of loss of host plants. *Korthalsella degeneri* is an obligate parasite on two native host plants, *Sapindus oahuensis* and *Nestegis sandwicensis*, which occur in the dry cliff ecosystem of the Waianae Mountains of Oahu. Introduced ungulates are a threat to the host plants, because of trampling and topsoil disruption, leading to erosion and the establishment and spread of nonnative plants (USFWS, 2012).

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor:

Exposure:
Response:
Consequence:
Narrative:

Stressor:
Exposure:
Response:
Consequence:
Narrative:

Stressor:
Exposure:
Response:
Consequence:
Narrative:

Recovery

Reclassification Criteria:
Not available.

Delisting Criteria:
Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

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SPECIES ACCOUNT: *Labordia cyrtandrae* (Kamakahala)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

Labordia cyrtandrae is a short-lived perennial in the Loganiaceae (logania family). This species is a shrub, 0.7 to 2 m (2.3 to 6.6 ft) tall, with ovate to broadly elliptic leaves, 12 to 30 cm (4.7 to 11.8 in) long and 4 to 14 cm (1.6 to 5.5 in) wide. The pale greenish-yellow flowers form compound panicle cymes of eight to 80. The fruit is 3.2 to 3.5 cm (1.3 to 1.4 in) long, and are some of the largest in the genus. *Labordia* is an endemic Hawaiian genus of 12 species that are known to hybridize. However, no hybrids involving *L. cyrtandrae* have been documented even though this species overlaps in range with numerous other taxa in the genus. The New York Botanical Garden has attempted to hybridize this species with other members of the genus without success. *L. cyrtandrae* is distinguished from others in the genus by its fleshy, hairy, cylindrical stem which flattens upon drying, the shape and length of the floral bracts, and the length of the corolla tube and lobes (Wagner et al. 1999).

Historical Range

Historically, *Labordia cyrtandrae* was known from both the Waianae and Koolau Mountains of Oahu. In the Koolau Mountains, this species extended from Kawailoa trail to Waialae Iki, almost the entire length of the mountain range.

Current Range

Currently, there are 19 known *L. cyrtandrae* individuals remaining in six occurrences: Kaalaea (2 individuals), east Makalaea (4), north Mohiakea (1), north Haleauau (3), south Haleauau (3), and Mount Kaala (6). However, there is a great deal of under-surveyed potential habitat for this taxon on the upper slopes of Mt. Kaala. Occurrences of this plant are declining, and those that remain are small and widely dispersed, which puts the species at risk of extinction from naturally occurring events and/or lack of reproductive vigor (Service 1998a; U.S. Army 2003a; K. Kawelo, U.S. Army, pers. comm. 2003; J. Lau, HINHP, pers. comm. 2003).

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Labordia cyrtandrae* (Kamakahala) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Labordia cyrtandrae* (77 FR 57648-57862). The critical habitat designation includes 32 critical habitat units, which encompass approximately 39,247 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Labordia cyrtandrae* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Labordia cyrtandrae* includes 32 critical habitat units, covering four ecosystem types, which encompass approximately 39,247 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7; Oahu—Lowland Wet—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; Oahu—Montane Wet—Unit 1; Oahu—Wet Cliff—Units 1, 2, 3, 4, 5, 6, 7, 8

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

Oahu—Lowland Wet—Unit 1 [541 ac (219 ha)]. This area consists of 428 ac (173 ha) of State land and 112 ac (46 ha) of City and County of Honolulu land in the lowland wet ecosystem on the windward side of the Waianae Mountains, and partially within the Mokuleia and Waianae Kai Forest Reserves. Oahu—Lowland Wet—Unit 2 [20 ac (8 ha)]. This area consists of 19 ac (8 ha) of State land in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puuhapapa. Oahu—Lowland Wet—Unit 3 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puukanehoa. Oahu—Lowland Wet—Unit 4 [27 ac (11 ha)]. This area consists of 27 ac (11 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains on State land at Puukaua. Oahu—Lowland Wet—Unit 5 [74 ac (30 ha)]. This area consists of 74 ac (30 ha) of State land in the lowland wet ecosystem, on the windward side of the Waianae Mountains at Palikea. Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Waialele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Hauula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in

the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikēkee, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet—Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet—Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu—Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamo Ridge.

Oahu—Montane Wet—Unit 1 [370 ac (150 ha)]. This area consists of 18 ac (7 ha) of City and County of Honolulu land, 352 ac (142 ha) of State land, and less than 1 ac (less than one ha) of privately-owned land in the montane wet ecosystem at the summit of the Waianae Mountains at Kaala, and partially within the Mokuleia Forest Reserve and the Kaala Natural Area Reserve.

Oahu—Wet Cliff—Unit 1 [235 ac (95 ha)]. This area consists of 167 ac (68 ha) of State land, 68 ac (28 ha) of City and County of Honolulu land, and less than 1 ac (less than 1 ha) of privately owned land in the wet cliff ecosystem in the Waianae Mountains, near the summit of Kaala, and partially within the Mokuleia and Waianae Kai FRs and the Kaala Natural Area Reserve. Oahu—Wet Cliff—Unit 2 [3 ac (1 ha)]. This area consists of 3 ac (1 ha) of State land in the wet cliff ecosystem in the Waianae Mountains at Puuhapapa, within a small area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Oahu—Wet Cliff—Unit 3 [16 ac (6 ha)]. This area consists of 16 ac (6 ha) in the wet cliff ecosystem on State land in the Waianae Mountains at Puukanehoa, partially within an area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Oahu—Wet Cliff—Unit 4 [23 ac (9 ha)]. This area consists of 23 ac (9 ha) in the wet

cliff ecosystem on State land in the Waianae Mountains at Puukaua, partially overlapping an area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and recently acquired by the State. Oahu—Wet Cliff—Unit 5 [31 ac (13 ha)]. This area consists of 31 ac (13 ha) of State land in the wet cliff ecosystem in the Waianae Mountains, at Palikea and north of Palikea. Oahu—Wet Cliff—Unit 6 [151 ac (61 ha)]. This area consists of 151 ac (61 ha) in the wet cliff ecosystem on State land on the windward side of the Koolau Mountains in Kaipapau Gulch, entirely within the Kaipapau Forest Reserve. Oahu—Wet Cliff—Unit 7 [144 ac (58 ha)]. This area consists of 144 ac (58 ha) in the wet cliff ecosystem in State land on the windward side of the Koolau Mountains in Hauula Gulch, entirely within the Hauula Forest Reserve. Oahu—Wet Cliff—Unit 8 [4,649 ac (1,881 ha)]. This area consists of 1,479 ac (598 ha) of State land, 1,281 ac (519 ha) of City and County of Honolulu land, 5 ac (2 ha) of Federal land, and 1,884 ac (762 ha) of privately owned land, in the wet cliff ecosystem along the summit of the Koolau Mountains, overlapping portions of Sacred Falls State Park, the Waiahole FR (Waiahole and Iolekaa sections), the Kaneohe and Honolulu Watershed FRs, and the Nuana Pali State Wayside.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Labordia cyrtandrae* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Labordia cyrtandrae* occurs within the Lowland mesic, Lowland wet, Montane wet and Wet cliff ecosystems in the Waianae Mountain caldera complex and the Lowland mesic, Lowland wet and Wet cliff ecosystems in the Koolau Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Oahu—Lowland Wet—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (F) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Oahu—Montane Wet—Unit 1. (A) Elevation: 3,300–6,600 ft (1,000-2,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Well-developed soils, montane bogs. (D) Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. (E) Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. (F) Understory: *Ferns*, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Oahu—Wet Cliff—Units 1, 2, 3, 4, 5, 6, 7, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: >65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. (F) Understory: *Bryophytes*, *Ferns*, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Labordia cyrtandrae* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: *Labordia cyrtandrae* mostly flowers from May through June. Fruit appear from July through August, but this species is sporadically fertile year-round. The flowers are functionally unisexual with male and female flowers on separate plants. Little else is known about its flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors (Service 1998a).

Habitat Type

Adult: Mesic to wet forests and shrublands

Habitat Narrative

Adult: *Labordia cyrtandrae* typically grows in shady gulches, slopes, and glens in mesic to wet forests and shrublands dominated by *Metrosideros polymorpha*, *Diplopterygium pinnatum*, and/or *Acacia koa*. It is found between 212 and 1,233 m (695 and 4,044 ft) elevation. Associated native plant species include *Antidesma* sp., *Artemisia australis*, *Bidens torta*, *Boehmeria grandis*, *Broussaisia arguta*, *Chamaesyce* sp., *Coprosma* sp., *Cyrtandra* sp., *Dicranopteris linearis*, *Diplazium sandwichianum*, *Dubautia plantaginea*, *Lysimachia hillebrandii*, *Peperomia membranacea*, *Perrottetia sandwicensis*, *Phyllostegia* sp., *Pipturus albidus*, *Pouteria sandwicensis*, *Psychotria* sp., or *Rumex* sp. (HINHP Database 2001; Service 1998a).

Dispersal/Migration

Population Information and Trends

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Fragility unknown. Currently about 8-9 plants observed. 3 current (between 1982 and 1997) and 13 historical occurrences. (NatureServe, 2015)

Threats and Stressors

Stressor:**Exposure:****Response:****Consequence:**

Narrative: The major threats to *Labordia cyrtandrae* include loss of habitat and degradation of the remaining habitat by non-native plants and animals. The non-native plants threaten *L. cyrtandrae* by altering its habitat and competing with it for nutrients, light, and space. These non-native plants include *Axonopus fissifolius*, *Clidemia hirta*, *Juncus planifolius*, *Psidium cattleianum*, *Rubus argutus*, *Setaria parviflora*, and *Schinus terebinthifolius*. Feral pigs can impact *L. cyrtandrae* by consuming fruits and other plant parts, or by rooting soil which degrades the habitat. Rats also threaten this species by consuming fruits and other plant parts. The small number of individuals of *L. cyrtandrae* and the loss of its normal pollinators may result in decreased genetic variability within and among occurrences over successive generations and could potentially lead to inbreeding depression. The small number of remaining individuals also makes this species vulnerable to extinction from random environmental events. Some individuals are threatened by fire from military activities (HINHP Database 2001; Service 1998a).

Recovery**Conservation Measures and Best Management Practices:**

- A State-wide management plan should be developed and implemented for the long-term conservation of all known occurrences of *Labordia cyrtandrae*. This plan should also include broader landscape actions that are needed for the recovery of this plant throughout its range. The recovery plan for this species identifies important conservation needs for *L. cyrtandrae*. Where feasible, exclosures should be constructed around the remaining occurrences of this plant to reduce impacts from feral pigs. Subsequent control or removal of pigs from these areas and the broader landscape will alleviate their impact on native ecosystems. If fencing is not logistically feasible, other methods of ungulate control are recommended. In this case, removal and control of pigs over a larger landscape is essential to the conservation of *L. cyrtandrae*. Non-native plants should be removed or controlled in the vicinities of all known occurrences. A coordinated fire protection plan for endangered plant species on Federal land needs to be developed and implemented. Occurrences of *L. cyrtandrae* are also seriously threatened by rat predation. Removal and control of rats using approved rodenticides should be emphasized during fruiting season and, when approved, should include aerial dispersal of rodenticides over the broader landscape. To prevent extinction of *L. cyrtandrae*, ex situ propagation should be initiated with material from all known occurrences. To date, ex situ propagation has not been successful. More research must be conducted to determine a successful method of ex situ propagation (Service 1998a).

References

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SPECIES ACCOUNT: *Labordia helleri* (Kamakahala)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (R1) (USFWS, 2016)

Physical Description

A shrub 2 - 4.5 m tall, sometimes climbing. Cymes are pendulous or erect, with 3 - 9 flowers. Corollas are white or pale greenish yellow (NatureServe, 2015).

Taxonomy

A member of the logania family (Loganiaceae) (Wagner et al. 1999, pp. 856–857) (USFWS, 2010b). The genus is widespread in tropics and subtropics, rarely temperate species endemic to Kauai. It is closely related to *L. tinifolia* differs in having longer corolla lobes and in fruit characteristics (NatureServe, 2015).

Historical Range

Historically, *L. helleri* was wide-ranging on Kauai. Collections were made as far south as the Haupu Mountains, through central Kauai to the northwestern coast (HBMP 2007) (USFWS, 2010b).

Current Range

The largest population extends from the Na Pali Kona Forest Reserve into Kuia Natural Area Reserve (NAR). Other populations occur at upper Mahanaloa, Limahuli, Waioli, Kaunuohua ridge, Kohua ridge, Koaie stream, Kawaiiki, southeast Puu Kolo, and Puu Kolo-Kahuamoa (Kauai) (USFWS, 2010b).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Labordia helleri* (Kamakahala) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 17 critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Labordia helleri* includes 17 CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Lowland Mesic—Section 1: Lowland Mesic—Section 1 consists of 2,006 ac (812 ha) in the lowland mesic ecosystem, including mesic forest extending from Awaawapuhi Trail south to Makaha Ridge, in the Na Pali Kona Forest Reserve and the Kuia NAR (Figure 1-A). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plants *Doryopteris angelica*, *Labordia helleri*, *Platydesma rostrata* and *Psychotria hobbdi*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that

is essential to the conservation of these four species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic—Section 1 is not known to be occupied by the species *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Dubautia kenwoodii*, *Pittosporum napaliense*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 2: Lowland Mesic—Section 2 consists of 379 ac (154 ha) in the lowland mesic ecosystem, including mesic forest extending from Keanapuka to Kahuamaa Flat along the rim and cliffs of the Kalalau Valley, in the Na Pali Coast State Park (Figure 1-A, above). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plants *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Pittosporum napaliense*, and *Psychotria hobdyi*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these six species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic—Section 2 is not known to be occupied by the species *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Platydesma rostrata*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 3: Lowland Mesic—Section 3 consists of 124 ac (50 ha) in the lowland mesic ecosystem, including mesic forest extending from Manono Ridge, Pohakuao Valley, to Kanakuu, within the Na Pali Coast State Park (Figure 1- A, above). The entire section is Stateowned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plants *Canavalia napaliensis*, *Chamaesyce eleanoriae*, and *Charpentiera densiflora*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these three species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic—Section 3 is not known to be occupied by the species *Chamaesyce remyi* var. *remyi*, *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Pittosporum napaliense*, *Platydesma rostrata*, *Psychotria hobdyi*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 4: Lowland Mesic—Section 4 consists of 81 ac (33 ha) in the lowland mesic ecosystem, including mesic forest at the head of the Hanakapiai Valley, in the Na Pali Coast State Park (Figure 1-A, above). The entire section is Stateowned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plant *Charpentiera densiflora* and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. Although Lowland Mesic—Section 4 is not known to be occupied by the species *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *Chamaesyce remyi* var. *remyi*, *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Pittosporum napaliense*, *Platydesma rostrata*, *Psychotria hobdyi*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 5: Lowland Mesic—Section 5 consists of 37 ac (15 ha) in the lowland mesic ecosystem, including mesic forest on the slopes of Mt. Haupu, on privately owned land (Figure 1-B). The entire section is within previously designated critical habitat, and falls within Critical Habitat Unit 7 of 50 CFR 17.99(a)(1), Map 23a. This section is occupied by the plants *Chamaesyce remyi* var. *remyi* and *Tetraplasandra bisattenuata*, and includes mesic forest and shrubland, the moisture regime, and subcanopy and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these two species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic—Section 5 is not known to be occupied by the species *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *Charpentiera densiflora*, *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Pittosporum napaliense*, *Platydesma rostrata*, and *Psychotria hobdyi*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 1: Lowland Wet—Section 1 consists of 1,164 ac (471 ha) in the lowland wet ecosystem (117 ac (47.4 ha) on State land; 1,047 ac (424 ha) on private land), including wet forest extending from Kulanalilia into Limahuli Valley to Honoonapali, in the Halelea Forest Reserve (Figure 2-A). The section includes 1,099 ac (445 ha) of State and privately owned land within previously designated critical habitat and 65 ac (26 ha) of newly designated critical habitat on private land. The area that falls within designated critical habitat lies within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and newly designated Critical Habitat Unit 20, Map 217c. This section is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Labordia helleri*, and *Phyllostegia renovans*. This section also contains unoccupied habitat that is essential to the conservation of these four species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory

plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 1 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Melicope paniculata*, *M. puberula*, *Platydesma rostrata*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 2: Lowland Wet—Section 2 consists of 172 ac (70 ha) in the lowland wet ecosystem, including wet forest extending from Alealau to Pohakea, within the Hono o Na Pali NAR and the Na Pali Coast State Park (Figure 2-A, above). The entire section is Stateowned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plant *Melicope puberula*. This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 2 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope paniculata*, *Phyllostegia renovans*, *Platydesma rostrata*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 3: Lowland Wet—Section 3 consists of 756 ac (306 ha) in the lowland wet ecosystem, including wet forest in upper Wainiha Valley, on privately owned land in the Halelea Forest Reserve (Figure 2-B). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyrtandra oenobarba*, *Melicope puberula*, *Phyllostegia renovans*, and *Stenogyne kealiae*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 3 is not known to be occupied by the species *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope paniculata*, *Platydesma rostrata*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 4: Lowland Wet—Section 4 consists of 591 ac (239 ha) in the lowland wet ecosystem, including wet forest at the head of Lumahai Valley, on State (10 ac, 4.1 ha) and privately owned (581 ac, 235 ha) land in the Halelea Forest Reserve (Figure 2-B, above). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyrtandra oenobarba*, *Melicope paniculata*, *Phyllostegia renovans*, and *Platydesma rostrata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 4 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope puberula*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population numbers of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 5: Lowland Wet—Section 5 consists of 1,541 ac (624 ha) in the lowland wet ecosystem, including wet forest extending from the headwaters of the Wailua River at “Blue Hole” south to Iole, on State (442 ac, 179 ha) and privately owned (1,099 ac, 445 ha) land in the Lihue-Koloa Forest Reserve (Figure 2-C). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36a, and is occupied by the plants *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Melicope paniculata*, *Phyllostegia renovans*, and *Platydesma rostrata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 5 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Labordia helleri*, *Melicope puberula*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 6: Lowland Wet—Section 6 consists of 789 ac (319 ha) in the lowland wet ecosystem, including wet forest extending from Kapalaoa to Kanaele Bog and Lauahihaihai in the Wahiawa Mountains, on State (134 ac, 54 ha) and privately owned (655 ac, 265 ha) land in the Lihue-Koloa Forest Reserve (Figure 2-D). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36a, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Platydesma rostrata*, and *Tetraplasandra bisattenuata*. This section also contains unoccupied habitat that is essential to the conservation of these five

species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 6 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Labordia helleri*, *Melicope paniculata*, *M. puberula*, *Phyllostegia renovans*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Montane Mesic—Section 1: Montane Mesic—Section 1 consists of 2,423 ac (980 ha) in the montane mesic ecosystem, including the area above Honopu Valley to Mahanaloa Valley, on State owned land in Kokee State Park, the Na Pali-Kona Forest Reserve, and Kuia NAR (Figure 3-A). The entire section is within previously designated critical habitat for the plant species, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70c, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Labordia helleri*, *Myrsine knudsenii*, *Platydesma rostrata*, *Psychotria grandiflora*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*. This section is also occupied by the akekee and the picture-wing fly; maps of critical habitat for these species can be found at 50 CFR 17.95(b) for the akekee and akikiki (Unit 1—Montane Mesic), and at 50 CFR 17.95(i) for the picture-wing fly (Unit 1—Montane Mesic). This section also contains unoccupied habitat that is essential to the conservation of these nine species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the montane mesic forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane mesic ecosystem (Table 3), as well as species-specific PCEs for the akekee and akikiki (arthropod prey) and picture-wing fly (the larval-stage host plants, *Cheirodendron* sp. and *Tetraplasandra* sp.). Although Montane Mesic—Section 1 is not known to be occupied by the species *Diellia mannii*, *Myrsine mezii*, and the akikiki, we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Montane Mesic—Section 2: Montane Mesic—Section 2 consists of 376 ac (152 ha) in the montane mesic ecosystem and includes a portion of the area surrounding a tributary of Nawaimaka Stream east to Kumuwela Ridge (Figure 3-A, above). The entire section is State-owned within Kokee State Park, and includes 8 ac (3 ha) of newly designated critical habitat. This section is occupied by *Diellia mannii* and the picture-wing fly *Drosophila sharpi*, and includes the montane mesic forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane mesic ecosystem (Table 3), as well as the larval-stage host plants (*Cheirodendron* sp. and *Tetraplasandra* sp.) associated with the picture-wing fly. This section also contains unoccupied habitat that is essential to the conservation of these two species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Montane Mesic—Section 2 is not known to be occupied by the plants *Chamaesyce remyi* var. *remyi*, *Labordia helleri*, *Myrsine knudsenii*, *Myrsine mezii*,

Platydesma rostrata, *Psychotria grandiflora*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*, or by the birds the akekee and akikiki, we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range, as well as species-specific PCEs for the akekee and akikiki (arthropod prey). Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, that portion of the section that overlies previously designated critical habitat falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70c. The previously undesignated land comprises Critical Habitat Unit 21 of 50 CFR 17.99(a)(1), Map 217d. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 2—Montane Mesic), and for the picture-wing fly at 50 CFR 17.95(i) (Unit 2—Montane Mesic).

Kauai—Montane Mesic—Section 3: Montane Mesic—Section 3 consists of 139 ac (56 ha) in the montane mesic ecosystem, including the upper portion of the Nawaimaka Valley up to Kapukapaia Ridge, on State-owned land in the Na Pali-Kona Forest Reserve (Figure 3-B). This section is not in previously designated critical habitat and includes the only montane mesic forest occupied by the plant *Myrsine mezii*, and the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. Although Montane Mesic—Section 3 is not known to be occupied by the plants *Chamaesyce remyi* var. *remyi*, *Labordia helleri*, *Myrsine knudsenii*, *Myrsine mezii*, *Platydesma rostrata*, *Psychotria grandiflora*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*; by the birds the akekee and akikiki; or by the picturewing fly *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. It also provides for the species-specific PCEs for the akekee and akikiki (arthropod prey) and the larval-stage host plants (*Cheirodendron* sp. and *Tetraplasandra* sp.) associated with *D. sharpi*. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, this section comprises Critical Habitat Unit 22 of 50 CFR 17.99(a)(1), Map 217e. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 3—Montane Mesic), and for the picturewing fly at 50 CFR 17.95(i) (Unit 3—Montane Mesic).

Kauai—Montane Wet—Section 1: Montane Wet—Section 1 consists of 13,055 ac (5,257 ha) in the montane wet ecosystem, extending across the Alakai Plateau from Hanakoa to Mount Waialeale, on State (12,628 ac, 5,110 ha) and privately owned (427 ac, 173 ha) land in the Na Pali Coast State Park, the Alakai Wilderness Preserve, the Na Pali-Kona and Halelea forest reserves, and Hono o Na Pali NAR (Figure 4). It is occupied by the plants *Astelia waialealae*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *K. helenae*, *Labordia helleri*, *L. pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, and *Platydesma rostrata*; by the akekee and akikiki; and by the picture-wing fly. This section also contains unoccupied habitat that is essential to the conservation of these 18 species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the montane wet forest, the moisture regime, and canopy, subcanopy, and understory plant species

identified as PCEs in the montane wet ecosystem (Table 3), and the species-specific PCEs including (1) bogs (identified as PCEs for *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*) (2) bog hummocks (identified as PCEs for *Astelia waialealae* and *Lysimachia daphnoides*); (3) arthropod prey (identified as PCEs for the akekee and the akikiki); and (4) larval-stage host plants, *Cheirodendron* and *Tetraplasandra* sp., (identified as a PCE for the picture-wing fly). Although Montane Wet–Section 1 is not known to be occupied by the plants *Dubautia kalalauensis*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, those portions of the section that overlies previously designated critical habitat fall within two existing Critical Habitat Units of 50 CFR 17.99(a)(1): Unit 10, Map 35a; and Unit 11, Map 64a. The previously undesignated land comprises Unit 23, Map 217f; and Unit 24, Map 217g. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 4–Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 4–Montane Wet).

Kauai—Montane Wet—Section 2: Montane Wet–Section 2 consists of 790 ac (320 ha) in the montane wet ecosystem, extending from Kahuamaa Flat south to the edge of Waimea Canyon, on State-owned land in Kokee State Park (Figure 4, above). The entire section is within previously designated critical habitat, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Dubautia kalalauensis*, *Labordia helleri*, *Melicope puberula*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*, and by the akekee. This section includes montane wet forest, potentially some small-scale boggy areas, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and arthropod prey (identified as a species-specific PCE for the akekee). Although Montane Wet–Section 2 is not known to be occupied by the plants *Astelia waialeale*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialeale*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *Myrsine mezii*, and *Phyllostegia renovans*; by the akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. This area also supports the arthropod prey identified as a PCE for the akikiki, and the larval-stage host plants (*Cheirodendron* and *Tetraplasandra* spp.) identified as a PCE for the picturewing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within previously designated Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 5–Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 5–Montane Wet).

Kauai—Montane Wet—Section 3: Montane Wet–Section 3 consists of 413 ac (167 ha) in the montane wet ecosystem, encompasses the summit of Namolokama, on State (156 ac, 63 ha) and privately owned (257 ac, 104 ha) land in the Halelea Forest Reserve (Figure 4, above). It is entirely within previously designated critical habitat, and is occupied by the plants *Keysseria erici* and *Labordia pumila*. This section includes the montane wet forest, the moisture regime, and the canopy, subcanopy, and understory plant species identified as PCEs in the montane wet

ecosystem (Table 3), and bogs (identified as a species-specific PCE for *K. erici*). Although Montane Wet–Section 3 is not known to be occupied by the plants *Astelia waialeale*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia kalalauensis*, *D. waialeale*, *Geranium kauaiense*, *Keysseria helenae*, *Labordia helleri*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*; by the akekee and akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. It also supports the arthropod prey identified as a PCE for the akekee and akikiki, and the larval-stage host plants (*Cheirodendron* and *Tetraplasandra* spp.) identified as a PCE for the picture-wing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 6–Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 6–Montane Wet).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Labordia helleri* critical habitat consists of four components (Lowland mesic, Lowland wet, Montane mesic, Montane wet) (75 FR 18960-19165):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<914 m). Annual precipitation: 50–75 in (127–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Ecosystem: Lowland Wet. Elevation: <3,000 ft (<914 m). Annual precipitation: >75 in (>190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Montane Wet. Elevation: 3,000–5,243 ft (914–1,598 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Ecosystem: Montane Mesic. Elevation: 3,300–5,243 ft (914–1,598 m). Annual precipitation: 50–75 in (127–190 cm). Substrate: weathered aa lava, rocky mucks, thin silty loams, deep volcanic ash soils. Canopy: *Acacia*, *Metrosideros*, *Psychotria*, *Tetraplasandra*, *Zanthoxylum*. Subcanopy: *Cheirodendron*, *Coprosma*, *Kadua*, *Ilex*, *Myoporum*, *Myrsine*. Understory: *Bidens*, *Dryopteris*, *Leptecophylla*, *Poa*, *Scaevola*, *Sophora*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations

or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to

further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from NatureServe, 2015)

Reproduction Narrative

Adult: *Labordia* species are functionally dioecious (Motley and Carr 1998), potentially making reproduction more difficult in very small occurrences (NatureServe, 2015).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: *Metrosideros-Acacia-Dicranopteris* mesic to wet forest (USFWS, 2010b)

Geographic or Habitat Restraints or Barriers

Adult: 1,200 - 3,900 ft. elevation (USFWS, 2010b)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits moist forests in gulches or on ridges. The environmental specificity is unknown (NatureServe, 2015). It occurs in *Metrosideros-Acacia-Dicranopteris* mesic to wet forest, at elevations between 1,200 and 3,900 ft. (366 and 1,189 m), in the lowland mesic, lowland wet, montane mesic, and montane wet ecosystems (HBMP 2007; TNCH 2007) (USFWS, 2010b).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Resiliency:

Very low (inferred from NatureServe, 2015)

Redundancy:

Low to moderate (inferred from USFWS, 2010a)

Number of Populations:

17 (USFWS, 2017)

Population Size:

30 - 1200 (USFWS, 2017)

Population Narrative:

The long term population trend is unknown. Total estimated AOO is 36 sq. km (NatureServe, 2015). There are ten populations totaling 350 - 550 individuals (USFWS, 2010a). Herbarium specimens document occurrences from 2010 through 2017 at Honopu, Awaawapuhi and Nualolo, Mahanaloa to Milolii, Kohua, Kawaiiki, Nawaimaka, Kumuwela, Koaie, and Kapalaoa (NTBG 2010a-d, 2011a-f, 2012a-i, 2013a-d, 2015ag, 2016a-q, 2017). Numbers of individuals at these nine locations are estimated to total from 300 to possibly over 1,000 or more. The occurrences at Kumuwela and the Kalalau rim to Milolii ridge are the largest. Currently, Flynn (2016) reports eight "subpopulations" (considered "populations" by USFWS) totaling 100 individuals, with the largest population consisting of 50 individuals (USFWS, 2017).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from non-native plants, pigs, goats, deer, hurricanes, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species.

Stressor: Predation and herbivory (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species present an immediate and significant threat to *Labordia helleri* throughout its range due to documented browsing and trampling by pigs, goats, and deer, and documented mechanical damage by rats (USFWS, 2010).

Stressor:**Exposure:****Response:****Consequence:****Narrative:**

Stressor: Ungulate degradation of habitat

Exposure:**Response:****Consequence:**

Narrative: Feral pigs (*Sus scrofa*), goats (*Capra hircus*), and black-tailed deer (*Odocoileus hemionus*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil (Loope 1998; van Riper and van Riper 1982). Feral pigs goats, and blacktailed deer, and evidence of their activities, have been observed at Kalalau to Milolii, Kawaiiki, Honopu, Mahanaloa, Koaie, Makaha, Kohua, Kumuwela, Kapalaoa, Nawaimaka (HBMP 2010; NTBG 2010a-d, 2011af, 2012a-i, 2013a-b, d, 2015c-g, 2016a-n, q, 2017; PEPP 2011, 2014) (USFWS, 2017).

Stressor: Established ecosystem-altering invasive plant modification and degradation of habitat

Exposure:**Response:****Consequence:**

Narrative: Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community (Cuddihy and Stone 1990). Habitat modification and destruction by invasive introduced plants negatively affects *Labordia helleri* at all locations. The nonnative plants with the greatest impacts include *Clidemia hirta* (Koster's curse), *Erigeron karvinskianus* (daisy fleabane), *Hedychium gardnerianum* (kahili ginger), *Lantana camara* (lantana), *Morella faya* (firetree), *Passiflora tarminiana* (banana poka), *Psidium cattleianum* (strawberry guava), *Rubus argutus* (prickly Florida blackberry), *R. rosifolius* (thimbleberry) and *Sphaeropteris cooperi* (Australian tree fern) (HBMP 2010; NTBG 2010a, 2011b-f, 2012a-i, 2013d, 2015c-g, 2016a-n, q) (USFWS, 2017).

Stressor: Landslides and flooding loss or degradation of habitat

Exposure:**Response:****Consequence:**

Narrative: Floods, including tree falls and erosion associated with them, can have a significant effect on small populations. Landslides and erosion due to natural weathering destabilize substrates, damage and destroy individual plants, and alter hydrological patterns (Stearns 1985). Landslides have been reported to be a threat to populations of *Labordia helleri* at Waioli, Kapalaoa, and Honopu (HBMP 2010; NTBG 2010b-c; PEPP 2014) (USFWS, 2017).

Stressor: Hurricanes—Loss and degradation of habitat

Exposure:**Response:****Consequence:**

Narrative: —In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013) *USFWS, 2017).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Labordia helleri* is vulnerable to the impacts of climate change with a vulnerability score of 0.535 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery

Reclassification Criteria:

In addition to achieving 5 to 10 populations with 1,000 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats (USFWS, 2017).

Delisting Criteria:

In addition to achieving 5 to 10 populations with 1,000 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional

information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis (USFWS, 2017).

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys (USFWS, 2010a).
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units (USFWS, 2010a).
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys (USFWS, 2010a).
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range (USFWS, 2010a).
- Conduct research on control methods for introduced slugs and avian malaria (USFWS, 2010a).
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction (USFWS, 2010a).
- Identify threats and prioritize which ones to address first for the two birds (USFWS, 2010a).
- Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program (USFWS, 2010a).
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security (USFWS, 2010a).
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems (USFWS, 2010a).
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations (USFWS, 2010a).
- Current Management Actions: • Population viability monitoring—PEPP has begun monitoring some individuals at Awaawapuhi and Honopu (PEPP 2011, 2014). • Ungulate monitoring and control—In 2009, NTBG completed portions of an ungulate (pig and goat) exclusion fence around the perimeter of Limahuli Valley on Wainiha and Hanakapiai Ridge. In addition, monitoring for feral ungulate breaches within the fenced areas of Limahuli Preserve is ongoing (NTBG 2008). • Invasive plant monitoring and control—Invasive plant

control is ongoing within Limahuli Preserve (NTBG 2008). • A couple hundred seeds have been collected and stored at NTBG seed bank from five populations. Seeds were also propagated but only one plant had been planted in the gardens, from the Waimea location (NTBG 2013e, 2014, 2015h). Seeds were collected by PEPP in 2011 and sent to the DOFAW propagation facility (USFWS, 2017).

- **RECOMMENDATIONS FOR FUTURE ACTIONS** • Surveys and inventories—Continue to survey for other populations of *Labordia helleri* in areas of potentially suitable habitat. • Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect individuals of *Labordia helleri*. Control feral ungulates within fenced exclosures. • Invasive plant monitoring and control—
 - o Control established ecosystem-altering nonnative invasive plant species around all populations.
 - o Control invasive nonnative plant species around all populations that compete with the species.
- Predator and herbivore monitoring and control—Implement effective control methods for rodents. • Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms. • Population biology research—Study *Labordia helleri* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. • Based on the recovery criteria above, consider development of a recovery plan (USFWS, 2017).

Conservation Measures and Best Management Practices:

- This species is currently in controlled propagation for genetic storage and/or reintroduction efforts (USFWS, 2010a).

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SPECIES ACCOUNT: *Labordia lorenciana* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2016)

Physical Description

A small tree. Individuals are 10 to 13 ft. (3 to 4 m) tall. The bark is grayish brown and mottled white or dark brown. Leaves are opposite, chartaceous (papery), and hairy. Flowers, functionally unisexual, are green, forming unbranched cymes. Fruit mature to brown capsules 1 to 1.5 in (25 to 37 mm) with ellipsoid 0.08 to 0.12 in (2 to 3 mm) seeds (Wood et al. 2007, pp. 195–197) (USFWS, 2015).

Taxonomy

A member of the Logania family (Loganiaceae) (USFWS, 2015).

Historical Range

Known only from the Kawai`iki Valley, Kauai (NatureServe, 2015).

Current Range

Kawaiiki Valley, Kauai. Additional surveys for *L. lorenciana* have not been successful; however, experts believe this species may occur in other areas (Wood et al. 2007, p. 198) (USFWS, 2015).

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available

Habitat Type

Adult: Terrestrial (USFWS, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Montane mesic forest (USFWS, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at 3,800 ft. elevation (USFWS, 2015)

Habitat Narrative

Adult: This species occurs on the island of Kauai at 3,800 ft. (1,160 m), in forest in the montane mesic ecosystem (Wood et al. 2007, pp. 197–198) (USFWS, 2015). Occurs on a north-facing slope in association with montane mixed mesic forest and is restricted to the lower drainage banks (Wood et al. 2007). The slope is moderate with a substrate composed of brown granular soil with basalt talus and abundant leaf litter (Wood et al. 2007) (NatureServe, 2015).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Very low (inferred from USFWS, 2015)

Redundancy:

Very low (inferred from USFWS, 2015)

Number of Populations:

1 (USFWS, 2015)

Population Size:

4 (USFWS, 2015)

Population Narrative:

Currently, there are four known individuals in Kawaiiki Valley (USFWS, 2015).

Threats and Stressors

Stressor: Nonnative mammals (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Feral pigs and goats modify and destroy the habitat of *Labordia lorenciana* (Wood et al. 2007, p. 198). In Hawaii, pigs dig up forest ground cover consisting of delicate and rare species of orchids, ferns, mints, lobeliads, and other taxa, including their roots, tubers, and rhizomes (Stone and Anderson 1988, p. 137). Goats can be highly destructive to native vegetation and contribute to erosion by: (1) Eating young trees and young shoots of plants before they become established; (2) creating trails that damage native vegetative cover; (3) destabilizing substrate and creating gullies that convey water; and (4) dislodging stones from ledges that results in rockfalls and landslides that damage or destroy native vegetation below (Cuddihy and Stone 1990, pp. 63–64) (USFWS, 2015).

Stressor: Nonnative plants (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Competition with nonnative plant species, including *Lantana camara*, *Passiflora tarminiana* (banana poka), *Psidium cattleianum* (strawberry guava), and *Rubus argutus*, is a

threat to *L. lorenciana*, as these nonnative plants have the ability to spread rapidly and cover large areas in the forest understory, and can outcompete native plants (Smith 1985, pp. 180–250; Vitousek et al. 1987 in Cuddihy and Stone 1990, p. 74; Wood et al. 2007, p. 198) (USFWS, 2015).

Stressor: Small population size/stochastic events (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Randomly occurring natural events, such as landslides, flash floods, fallen tree limbs, and fire, are a likely threat to *L. lorenciana* where it occurs on Kauai (Wood et al. 2007, p. 198). This species may experience reduced reproductive vigor as there is no in situ seedling recruitment and a very small number of individuals remain (Wood et al. 2007, p. 198) (USFWS, 2015).

Stressor: Predation (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Predation of seeds by rats is a likely threat to this species (Wood et al. 2007, p. 198). Herbivory by nonnative slugs is reported to adversely impact this species (USFWS, 2015).

Stressor: Climate change (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to the ecosystem that supports this species. Fortini et al. (2013, pp. 1-134) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013, p. 79) concluded that *Labordia lorenciana* is highly vulnerable to the impacts of climate change (USFWS, 2014).

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- The National Tropical Botanical Gardens on Kauai has several propagated individuals (Wood et al. 2007, pp. 195-199). Current efforts are directed toward creating a reproductively successful ex situ

stock (Wood et al. 2007, pp. 195-199), which if successful, will likely be outplanted in suitable habitat (USFWS, 2014).

- Continue to survey for populations of *Labordia lorenciana* in areas of potentially suitable habitat (USFWS, 2014).
- Continue propagation efforts for maintenance of genetic stock (USFWS, 2014).
- Reintroduce individuals into suitable habitat within historic range that is being managed for additional known threats (e.g., nonnative animals and plants) to this species (USFWS, 2014).

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SPECIES ACCOUNT: *Labordia lydgatei* (Kamakahala)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/20/1991; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Labordia lydgatei is a much-branched shrub or small tree 2 to 3 m (6.5 to 10 ft) tall with sparsely hairy, square stems. The opposite leaves are elliptic, often wider toward the tip, 5 to 10 cm (2 to 4 in) long, and 2 to 7 cm (0.8 to 2.8 in) wide, smooth above and with fine hairs on the lower surface. Intra-petiole stipules are present. The inflorescences are produced at the ends of the stems and comprise 6 to 21 small, slender, tubular pale yellow flowers about 0.7 cm (0.3 in) long. Flower buds were collected in May and mature flowers in July. Green fruits were collected in October. The fruit is a small ovoid capsule with a short, blunt beak. At maturity it splits into two valves to expose the seed mass (Forbes 1916, Sherff 1939, Wagner et al. 1990). (USFWS, 1994)

Taxonomy

Labordia is a Hawaiian endemic genus of 15 woody species related to *Geniostoma* (Sherff 1939, Wagner et al. 1990). The Hawaiian vernacular name for members of this genus is kamakahala. (USFWS, 1994). A member of the logania family (Loganiaceae) (USFWS, 2003).

Historical Range

Historically known from the Wahiawa drainage, Waioli Stream Valley, and Makaleha Mountains on Kauai (USFWS, 2003).

Current Range

Currently known at Pali Elele, Waioli Valley, Lelewi, Lumahai Valley, and Kapalaoa on Kauai (USFWS, 2003).

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Labordia lydgatei* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Labordia lydgatei* includes five units totaling 5,307 acres in Kauai County, Hawaii. The units are Kauai 4—*Labordia lydgatei*—a, Kauai 10—*Labordia lydgatei*—b, and Kauai 11— *Labordia lydgatei*—c, d, e.

Kauai 4—*Labordia lydgatei*—a: This unit is critical habitat for *Labordia lydgatei* and is 587 ha (1,455 ac) on State (Kealia and Moloaa Forest Reserves) and private land. This unit contains Kekoiki, Lelewi, Namahana, and Puu Awa Summits. This unit provides habitat for one population of 250 mature, reproducing individuals of the short-lived perennial *Labordia lydgatei* and is currently occupied with one plant. This unit is essential to the conservation of the taxon because

it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, stream banks in *Metrosideros polymorpha-Dicranopteris linearis* forest. This unit is geographically separated from the other four units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 10—*Labordia lydgatei*—b: This unit is critical habitat for *Labordia lydgatei* and is 1,035 ha (2,558 ac) on State (Lihue-Koloa Forest Reserve) and private land. This unit contains Hulua, Iole, Kahile, and Pilikea Summits. This unit provides habitat for two populations of 250 mature, reproducing individuals of the shortlived perennial *Labordia lydgatei* and is currently occupied with five plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, stream banks in *Metrosideros polymorpha-Dicranopteris linearis* forest. This unit is geographically separated from the other four units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 11—*Labordia lydgatei*—c: This unit is critical habitat for *Labordia lydgatei* and is 325 ha (804 ac) on private land within Lumahai Valley. This unit provides habitat for one population of 250 mature, reproducing individuals of the short-lived perennial *Labordia lydgatei* and is currently occupied with seven plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, stream banks in *Metrosideros polymorpha-Dicranopteris linearis* forest. This unit is geographically separated from the other four units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Labordia lydgatei*—d: This unit is critical habitat for *Labordia lydgatei* and is 82 ha (204 ac) on State land (Halelea Forest Reserve). This unit contains portions of Waioli Valley and Waiopa Summit. This unit provides habitat for one population of 250 mature, reproducing individuals of the short-lived perennial *Labordia lydgatei* and is currently occupied with two plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, stream banks in *Metrosideros polymorpha-Dicranopteris linearis* forest. This unit is geographically separated from the other four units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Labordia lydgatei*—e: This unit is critical habitat for *Labordia lydgatei* and is 119 ha (291 ac) on State (Halelea Forest Reserve, Hono o Na Pali NAR, and Na Pali Coast State Park) and private land. This unit contains Hono O Na Pali and Pali Elele Summits. This unit provides habitat for one population of 300 mature, reproducing individuals of the shortlived perennial *Labordia lydgatei* and is currently occupied with two plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is

currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, stream banks in *Metrosideros polymorpha*-*Dicranopteris linearis* forest. This unit is geographically separated from the other four units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

- (i) Streambanks in *Metrosideros polymorpha*-*Dicranopteris linearis* lowland wet forest containing one or more of the following associated native plant species: *Antidesma platyphyllum* var. *hillebrandii*, *Cyanea* spp., *Cyrtandra* spp., *Dubautia knudsenii*, *Hedyotis terminalis*, *Ilex anomala*, *Labordia hirtella*, *Psychotria* spp., or *Syzygium sandwicensis*; and
- (ii) Elevations between 182 and 1,148 m (597 and 3,737 ft).

Special Management Considerations or Protections

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Breeding Season

Adult: April to October (USFWS, 2009)

Reproduction Narrative

Adult: Motley and Carr (1998) examined flowers of 13 of the 16 Hawaiian endemic species of *Labordia* to confirm that they are functionally dioecious (containing both male and female parts but only one of those parts is fertile). Observation from herbarium vouchers at Bernice P. Bishop Museum (C. Imada, Bernice P. Bishop Museum, pers. comm. 2008), National Tropical Botanical Garden (2008a), and database records from the Hawaii Biodiversity and Mapping Program (2007) noted flowering in all months between April and October; fruiting specimens were noted from March and May through September. (USFWS, 2009)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015); streambanks (USFWS, 2003)

Geographic or Habitat Restraints or Barriers

Adult: Elevations between 597 and 3,427 ft (USFWS, 2003)

Environmental Specificity

Adult: Low, with few key requirements (USFWS, 1994)

Habitat Narrative

Adult: The habitat of *Hesperomannia lydgatei* and *Labordia lydgatei* in the upper Waioli Stream Valley below Namolokama Mtn. at 400 m (1,300 ft) elevation consists of lowland rain forest with *Metrosideros* and *Dicranopteris* dominant (D. Lorence, pers. obser. 1992). This is similar to the species' habitat in the Wahiawa Drainage and the *L. lydgatei* habitat in the Makaleha Mountains. (USFWS, 1994) . Associated native plant species include *Antidesma platyphyllum* var. *hillebrandii* (hame), *Cyanea* spp., *Cyrtandra* spp., *Dubautia knudsenii*, *Hedyotis terminalis*, *Ilex anomala*, *Labordia hirtella* (kamakahala), *Psychotria* spp., or *Syzygium sandwicensis* (USFWS, 2003).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2009)

Redundancy:

Very low (inferred from USFWS, 2009)

Number of Populations:

5 (USFWS, 2009)

Population Size:

29 (USFWS, 2009)

Population Narrative:

In the 2003 rule designating critical habitat, six populations were reported containing 37 individuals located on State (Lihue-Koloa and Halelea Forest Reserves) and privately owned lands at Pali Elele, Waioli Valley, Lelewi, Lumahai Valley, and Kapalaoa. As of 2005, numbers were similar, with five populations containing 29 individuals (USFWS 2008). (USFWS, 2009). New Status Information: • The number of individuals of *Labordia lydgatei* has increased since the time of the last 5- year review in 2009, likely resulting from more intensive surveys in suitable habitat. In 2009, there were five occurrences totaling 29 individuals. Currently, there

are four locations of occurrences. In upper Limahuli from upper Hanakapiai to the Wainiha side there are at least 50 individuals (NTBG 2010a, c, 2011a, c, 2012a-e, i, k-l, 2013b-g, 2014c, e, g). In Wahiawa to Hanapepe and the slopes of Kapalaoa there are seven individuals reported from two locations (2010b, d-f, 2011b, 2012n-o, 2013a). At Iole there is one individual reported, and at Waiahi there is one individual reported (NTBG 2010e, 2012m). These four areas total at least 58 individuals. There were six individuals reported at Makaleha in 2010, but their current status is unknown (PEPP 2010). There are no current reports of individuals last seen in the 1990s at Leleiwi, Waioli, or Iliiliula (HBMP 2010) (USFWS, 2017).

Threats and Stressors

Stressor: Invasive plants (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The major threats to *Labordia lydgatei* include competition from invasive introduced plants species such as *Clidemia hirta* (Koster's curse) and *Rubus rosifolius* (thimbleberry). (USFWS, 2009)

Stressor: Habitat degradation by ungulates (USFWS, 1994; USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Habitat degradation by feral pigs (*Sus scrofa*) and goats (*Capra hircus*) are a major threat. At present feral animals appear to pose a significant threat to the Makaleha area (K. Wood, pers. comm. 1993) and slight to moderate feral pig damage was noted in four areas in the Wahiawa Drainage, and in the Waioli Stream Valley (D. Lorence and T. Flynn, pers. obser. 1991). Rooting was primarily confined to moist, shady valley bottoms along streams. (USFWS, 1994; USFWS, 2009)

Stressor: Seed predation by rats (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Other threats include potential seed predation by rats (*Rattus* spp.). (USFWS, 2009)

Stressor: Landslides (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Although most slopes in these areas are not excessively steep and are usually clothed with vegetation, there is evidence of past landslides in the area, especially after Hurricane Iniki (D. Lorence, pers. obser. 1991-1992). Landslides clearly pose a threat to populations of these species growing on relatively steep slopes or in valley bottoms. (USFWS, 1994)

Stressor: Lack of pollinators (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Two of the species, *Cyanea undulata* and *Labordia lydgatei*, have fruits obviously adapted for bird dispersal. Passage of these seeds through a bird's gut may be necessary to insure their germination, and pollination may be inhibited by a lack of bird or native insect pollinators. (USFWS, 1994)

Stressor: Hurricanes (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: In September 11, 1992 Hurricane Iniki passed directly over Kaua'i with winds gusting up to 175 miles per hour. Considerable damage was inflicted on the native forests in many parts of the island (S. Perlman & K. Wood, pers. comm. 1992). A small part of the Wahiawa Drainage was surveyed on October 7, 1992, to assess hurricane damage to populations of the five endangered species known to occur there (D. Lorence, pers. obser. 1992). Damage to the vegetation varied from slight to severe depending on exposure to the winds, and several landslides had occurred. In this very limited survey at least one or several individuals of each endangered species had been severely damaged or destroyed by winds that uprooted the plants or snapped the main stem, falling trees or branches, or landslides. In the Waioli Stream Valley, two of three *Hesperomania lydgatei* individuals were destroyed by the storm. (USFWS, 1994)

Stressor: Small population size (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: In addition to all of the other threats, species such as *Labordia lydgatei* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding and disease outbreaks. (USFWS, 2009)

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Labordia lydgatei* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.668 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this species has no overlap between current and future climate envelopes, and is unlikely to tolerate expected changes in climate at its current location. This means that this species must persist within suitable microrefugia, or move to newly available climate-compatible areas to avoid extinction. Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery**Reclassification Criteria:**

1. A total of at least three populations of *Cyanea undulata* should be documented, each with at least 250 reproductive individuals. (USFWS, 1994)
2. Each of these populations must be naturally reproducing, stable, or increasing in number, by removal of threats, with adequate percentages of adults, juveniles, and seedlings necessary for long-term maintenance of population numbers and genetic diversity. (USFWS, 1994)
3. The full genetic diversity of each population is backed up as living and stored material at one or more nurseries or botanical gardens. (USFWS, 1994)

Delisting Criteria:

1. The target includes locating or establishing, if necessary, at least two additional wild populations for a total of at least five reproductively stable populations, each with at least 250 reproductive individuals. (USFWS, 1994)
2. These populations should be stable over an estimated ten year period. If new populations are established, they should have optimum genetic composition and be within the historical range of the species. (USFWS, 1994)
3. All five populations should be unmanipulated and able to sustain themselves indefinitely without human intervention (including fencing and introduced invasive plant species control) (USFWS 1994). (USFWS, 1994)

Recovery Actions:

- Secure and manage existing populations. Preservation of the existing habitat at the Wahiawa Drainage, Waioli Stream Valley and Makaleha Mountains is essential to stabilize known populations and prevent the decline of these species, as all the known genetic diversity for the five species occurs here. (USFWS, 1994)
- Conduct basic research essential to the conservation of the five species. Few details regarding the ecology, demographics, propagation, habitat requirements and basic life history of these five species are known and such knowledge is essential to their conservation. (USFWS, 1994)
- Increase population numbers at existing sites. Population sizes of these five species should be increased to viable numbers in the Wahiawa Drainage, Waioli Stream Valley and Makaleha Mountains. Existing populations may be augmented by enhancement of in situ reproduction and by planting viable seeds, cuttings, or air layers in situ, either directly in the ground or in pots containing soil from nearby. (USFWS, 1994)
- Establish new populations. Plans must be developed for establishing new wild populations, including the selection of genetic stock. Ideally, additional populations of each species should be sought on Kaua'i. If these cannot be located or do not exist, and new populations must be established, then a protocol must be formulated for establishing new populations. (USFWS, 1994)
- Verify the scientific validity of the recovery objectives. It is important to determine and verify the scientific validity of the recovery objective proposed herein. (USFWS, 1994)

- **New Management Actions:**
 - Invasive plant monitoring and control—PEPP is monitoring effects of feral ungulates and invasive nonnative plants at several populations of *Labordia lydgatei* (PEPP 2010, 2011, 2012, 2013).
 - Predator and herbivore monitoring and control—PEPP is monitoring several populations and implementing insect control (PEPP 2013).
 - Captive propagation for genetic storage and reintroduction—In 2014 and 2015, 100s of seeds from the larger Limahuli population were collected by individual and placed in storage. There is one founder represented at the Lyon Arboretum Micropropagation Lab. There are 17 collections at the NTBG seed bank representing 11 different founders for short term storage (Lyon Arboretum 2017; NTBG 2017) (USFWS, 2017).
- **Recommendations for Future Actions:** The following recommendations for future actions are reiterated for the 5-year review for 2017.
 - Surveys and inventories—Continue to survey geographical and historic range for a thorough current assessment of the species.
 - Ungulate monitoring and control—Construct enclosure fences to protect individuals from the activities of feral ungulates. Protect all occurrences against disturbances from feral ungulates to prevent imminent extinction.
 - Invasive plant monitoring and control—
 - o Control established ecosystem-altering nonnative invasive plant species around all populations.
 - o Control invasive nonnative species that compete with the species around all populations.
 - Predator and herbivore monitoring and control—
 - o Control rats at all populations.
 - o Investigate impact of insect predation on seeds and determine the need for additional recovery actions.
 - Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock.
 - Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.
 - Genetic research—Assess genetic variability within extant and ex situ individuals.
 - Population biology research—Study *Labordia lydgatei* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats.
 - Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Construct enclosure fences to protect individuals from the activities of feral pigs, and eradicate introduced invasive plant species within the enclosures. (USFWS, 2009)
- Continue collection of genetic resources for storage, future propagation, and reintroduction into protected suitable habitat within historical range. (USFWS, 2009)
- Enhance current natural populations to increase numbers of individuals. (USFWS, 2009)
- Work with the Kauai Watershed Alliance to continue and expand ecosystem-level management of the Wahiawa Bog area and to initiate planning and contribute to implementation of ecosystem level restoration and management to benefit this species in the Makaleha area. (USFWS, 2009)
- Survey geographical and historical range for a thorough current assessment of the status of the species. (USFWS, 2009)
- Assess genetic variability within extant and ex situ individuals. (USFWS, 2009)
- Study *Labordia lydgatei* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. (USFWS, 2009)

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SPECIES ACCOUNT: *Labordia pumila* (Kamakahala)

Species Taxonomic and Listing Information

Listing Status: Endangered; 5/13/2010; Pacific Region (R1) (USFWS, 2016)

Physical Description

A sparingly branched shrub. Cymes are sessile, with up to 15 flowers. Corollas are orange (NatureServe, 2015).

Taxonomy

A member of the logania family (Loganiaceae) (USFWS, 2010b). This genus is endemic to Hawaiian Islands (NatureServe, 2015).

Historical Range

Little is known of the historical locations of *L. pumila* on Kauai. The type specimen was collected by Wawra (1869, 1870) at the summit of Waialeale (USFWS, 2010b).

Current Range

It occurs on the Alakai plateau, at the summit of Waialeale, along the Wainiha rim, and at Namolakama (Kauai) (USFWS, 2010b).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Labordia pumila* (Kamakahala) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Labordia pumila* includes three CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Montane Wet—Section 1: Montane Wet—Section 1 consists of 13,055 ac (5,257 ha) in the montane wet ecosystem, extending across the Alakai Plateau from Hanakoa to Mount Waialeale, on State (12,628 ac, 5,110 ha) and privately owned (427 ac, 173 ha) land in the Na Pali Coast State Park, the Alakai Wilderness Preserve, the Na PaliKona and Halelea forest reserves, and Hono o Na Pali NAR (Figure 4). It is occupied by the plants *Astelia waialealae*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *K. helenae*, *Labordia helleri*, *L. pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, and *Platydesma rostrata*; by the akekee and akikiki; and by the picture-wing fly. This section also contains unoccupied habitat that is essential to the conservation of these 18 species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the montane wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and the species-specific PCEs

including (1) bogs (identified as PCEs for *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*) (2) bog hummocks (identified as PCEs for *Astelia waialealae* and *Lysimachia daphnoides*); (3) arthropod prey (identified as PCEs for the akekee and the akikiki); and (4) larval-stage host plants, *Cheirodendron* and *Tetraplasandra* sp., (identified as a PCE for the picture-wing fly). Although Montane Wet—Section 1 is not known to be occupied by the plants *Dubautia kalalauensis*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, those portions of the section that overlie previously designated critical habitat fall within two existing Critical Habitat Units of 50 CFR 17.99(a)(1): Unit 10, Map 35a; and Unit 11, Map 64a. The previously undesignated land comprises Unit 23, Map 217f; and Unit 24, Map 217g. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 4—Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 4—Montane Wet).

Kauai—Montane Wet—Section 2: Montane Wet—Section 2 consists of 790 ac (320 ha) in the montane wet ecosystem, extending from Kahuamaa Flat south to the edge of Waimea Canyon, on State-owned land in Kokee State Park (Figure 4, above). The entire section is within previously designated critical habitat, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Dubautia kalalauensis*, *Labordia helleri*, *Melicope puberula*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*, and by the akekee. This section includes montane wet forest, potentially some small-scale boggy areas, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and arthropod prey (identified as a species-specific PCE for the akekee). Although Montane Wet—Section 2 is not known to be occupied by the plants *Astelia waialeale*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialeale*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *Myrsine mezii*, and *Phyllostegia renovans*; by the akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. This area also supports the arthropod prey identified as a PCE for the akikiki, and the larval-stage host plants (*Cheirodendron* and *Tetraplasandra* spp.) identified as a PCE for the picturewing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within previously designated Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 5—Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 5—Montane Wet).

Kauai—Montane Wet—Section 3: Montane Wet—Section 3 consists of 413 ac (167 ha) in the montane wet ecosystem, encompasses the summit of Namolokama, on State (156 ac, 63 ha) and privately owned (257 ac, 104 ha) land in the Halelea Forest Reserve (Figure 4, above). It is entirely within previously designated critical habitat, and is occupied by the plants *Keysseria erici* and *Labordia pumila*. This section includes the montane wet forest, the moisture regime, and the canopy, subcanopy, and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and bogs (identified as a species-specific PCE for *K. erici*). Although Montane

Wet—Section 3 is not known to be occupied by the plants *Astelia waialeale*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia kalalauensis*, *D. waialeale*, *Geranium kauaiense*, *Keysseria helenae*, *Labordia helleri*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*; by the akekee and akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. It also supports the arthropod prey identified as a PCE for the akekee and akikiki, and the larval-stage host plants (*Cheirodendron* and *Tetraplasandra* spp.) identified as a PCE for the picture-wing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 6—Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 6—Montane Wet).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Labordia pumila* critical habitat consists of one component (Montane wet). Species-specific PCEs include: Bogs (75 FR 18960-19165):

Ecosystem: Montane Wet. Elevation: 3,000–5,243 ft (914-1,598 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: *Ferns*, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat

caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual: cross-pollination (inferred from NatureServe, 2015)

Reproduction Narrative

Adult: Labordia species are functionally dioecious (Motley and Carr 1998), potentially making reproduction more difficult in very small occurrences (NatureServe, 2015).

Habitat Type

Adult: Terrestrial, wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Metrosideros polymorpha mixed sedge and grass bogs (USFWS, 2010b); wet forest and shrubland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 3,478 - 5,100 ft. elevation (USFWS, 2010b)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits wet forests and shrublands, and montane bogs. The environmental specificity is unknown (NatureServe, 2015). It occurs in the montane wet ecosystem at elevations between 3,478 and 5,100 ft. (1,060 to 1,555 m) in Metrosideros polymorpha mixed sedge and grass bogs (Wagner et al. 1999, p. 860; HBMP 2007; TNCH 2007) (USFWS, 2010b).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Species Trends:

Stable (NatureServe, 2015)

Resiliency:

Very low (inferred from USFWS, 2010b; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2010a)

Number of Populations:

4 (USFWS, 2017)

Population Size:

~500 (USFWS, 2017)

Population Narrative:

The long term population trend is unknown. Apparently, plant numbers fluctuated very little between 2001 and 2004 (Marie Bruegmann, pers. comm. to USFWS 2004) (NatureServe, 2015). There are three populations totaling 500 individuals (USFWS, 2010a). *Labordia pumila* persists in the Waialeale and Kilohana bogs, and in 2013 individuals were found at Kawaikini. Currently, these populations remain the same, with a new population of at least two individuals found further east at Kawaikini (NTBG 2013b, 2015) (USFWS, 2017)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from non-native plants, pigs, hurricanes, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species.

Stressor: Predation and herbivory (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species present an immediate and significant threat to *Labordia pumila* throughout its range due to documented browsing and trampling by pigs, goats, and deer (USFWS, 2010).

Stressor: Ungulate degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Feral pigs (*Sus scrofa*) and goats (*Capra hircus*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil (Loope 1998; van Riper and van Riper 1982). Feral pigs and goats and evidence of their activities have been observed at Waialeale, Wainiha, and Kawaikini (HBMP 2010; NTBG 2011, 2013b, 2014, 2015) (USFWS, 2017).

Stressor: Established ecosystem-altering invasive plant modification and degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community (Cuddihy and Stone 1990). Habitat modification and destruction by invasive introduced plants negatively affects *Labordia pumila* at all locations. The nonnative plants with the greatest impacts include *Andropogon glomeratus* (bushy beardgrass), *Andropogon virginicus* (broomsedge), *Axonopus fissifolius* (narrow-leaved carpetgrass), *Blechnum appendiculatum* (NCN), *Buddleja asiatica* (dog tail), *Clidemia hirta* (Koster's curse), *Cyperus meyenianus* (NCN), *Erigeron karvinskianus* (daisy fleabane), *Hedychium gardnerianum* (kahili ginger), *Juncus planifolius* (rush), *Melastoma septemnerium* (NCN), *Paspalum conjugatum* (Hilo grass), *P. urvillei* (vasey grass), *Psidium cattleianum* (strawberry guava), *Rhodomyrtus tomentosa* (downy myrtle), *Rubus argutus* (prickly Florida blackberry), *R. rosifolius* (thimbleberry), *Sacciolepis indica* (glenwood grass), and *Sphaeropteris cooperi* (Australian tree fern) (HBMP 2010; NTBG 2013b, 2014, 2015) (USFWS, 2017).

Stressor: Landslides and flooding loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Landslides and erosion due to natural weathering destabilize substrates, damage and destroy individual plants, and alter hydrological patterns (Stearns 1985). Landslides have been reported to be a threat to population of *Labordia pumila* at Kawai'ini (NTBG 2015) (USFWS, 2017).

Stressor: Hurricanes—Loss and degradation of habitat

Exposure:

Response:

Consequence:

Narrative: In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013) (USFWS, 2017).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate

change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Labordia pumila* is highly vulnerable to the impacts of climate change with a vulnerability score of 0.786 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery

Reclassification Criteria:

In addition to achieving 5 to 10 populations with 1,000 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats (USFWS, 2017).

Delisting Criteria:

In addition to achieving 5 to 10 populations with 1,000 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis (USFWS, 2017).

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys (USFWS, 2010a).
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units (USFWS, 2010a).
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape

- modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys (USFWS, 2010a).
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range (USFWS, 2010a).
 - Conduct research on control methods for introduced slugs and avian malaria (USFWS, 2010a).
 - Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction (USFWS, 2010a).
 - Identify threats and prioritize which ones to address first for the two birds (USFWS, 2010a).
 - Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program (USFWS, 2010a).
 - Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security (USFWS, 2010a).
 - Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems (USFWS, 2010a).
 - Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations (USFWS, 2010a).
 - Current Management Actions:
 - Population viability monitoring—USFWS and DOFAW monitor the vegetative cover, vigor, and phenology of *Labordia pumila* regularly within North Bog (Bruegmann 2012).
 - Ungulate monitoring and control—USFWS coordinated with DOFAW to fence the bogs on State land in which *Labordia pumila* occurs (Bruegmann 2002).
 - Invasive plant monitoring and control—Weed control is ongoing within the fenced bogs (Bruegmann 2012) (USFWS, 2017).
 - RECOMMENDATIONS FOR FUTURE ACTIONS
 - Surveys and inventories—Survey for populations of *Labordia pumila* in areas of potentially suitable habitat.
 - Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect individuals of *Labordia pumila*. Control feral ungulates within fenced exclosures.
 - Invasive plant monitoring and control
 - o Control established ecosystem-altering nonnative invasive plant species around all populations.
 - o Control invasive nonnative plant species around all populations that compete with the species.
 - Predator and herbivore monitoring and control—Implement effective control methods for rodents.
 - Captive propagation for genetic storage and reintroduction—Begin propagation efforts for maintenance of genetic stock.
 - Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.
 - Population viability monitoring and analysis—Continue to monitor populations at North Bog, Wainiha, Waialeale, and Kawaikini.
 - Population biology research—Study *Labordia pumila* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats
 - Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms.
 - Based on the recovery criteria above, consider development of a recovery plan (USFWS, 2017).

Conservation Measures and Best Management Practices:

- USFWS and the Hawaii Division of Forestry and Wildlife have fenced 9 montane bogs in the Alakai Plateau, totaling approximately 40 hectares (100 acres). These fenced bogs contain some scattered individuals of *L. pumila* (USFWS, 2010a).
- This species is currently in controlled propagation for genetic storage and/or reintroduction efforts (USFWS, 2010a).

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SPECIES ACCOUNT: *Labordia tinifolia* var. *lanaiensis* (Kamakahala)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/03/1999; Pacific Region (R1) (USFWS, 2016)

Physical Description

A shrub or small tree typically 2-8 m tall, with pale yellowish green or greenish yellow flowers (NatureServe, 2015).

Taxonomy

A member of the logan family (Loganiaceae) (USFWS, 2002). Wagner et al. (1999) recognized three varieties of *Labordia tinifolia*: var. *tinifolia*, from Kauai, Oahu, Molokai, Maui, and Hawaii; var. *wahiawaensis*, restricted to Kauai; and var. *lanaiensis*, from Lanai and Mapulehu on Molokai (USFWS, 2012).

Historical Range

Historically, *Labordia tinifolia* var. *lanaiensis* was known from the entire length of the summit ridge of Lanaihale on the island of Lanai (USFWS, 2012).

Current Range

In recent times, the population has become more restricted to the southeastern end of the summit ridge of Lanaihale, which is privately owned land (USFWS, 2012).

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Labordia tinifolia* var. *lanaiensis* (Kamakahala) under the Endangered Species Act of 1973, as amended (Act) (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Labordia tinifolia* var. *lanaiensis* includes an unknown number of CHUs in Maui County, Hawaii with detailed unit information. All known CHUs are on the island of Lanai and detailed CHU information is not available (81 FR 17790-18110).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Labordia tinifolia* var. *lanaiensis* critical habitat consists of four components. Lowland mesic (Lanai), Lowland wet (Lanai), Montane wet (Lanai) and Wet cliff (Lanai) (81 FR 17790-18110):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<914 m). Annual precipitation: 50–75 in (127–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Ecosystem: Lowland Wet. Elevation: <3,000 ft (<914 m). Annual precipitation: >75 in (>190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Montane Wet. Elevation: 3,000–5,243 ft (914–1,598 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. Understory: Bryophytes, Ferns, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the

conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkii*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Lifespan

Adult: > 10 years (USFWS, 2012)

Breeding Season

Adult: Spring (inferred from USFWS, 2012)

Key Resources Needed for Breeding

Adult: Unknown (USFWS, 2002)

Reproduction Narrative

Adult: While *Labordia tinifolia* var. *lanaiensis* has been described as a short-lived perennial shrub, Hank Oppenheimer (Plant Extinction Prevention Program, pers. comm. 2010) has observed that the species definitely lives longer than ten years, and should be designated as a long-lived shrub, with stabilization, downlisting, and delisting criteria adjusted accordingly. Oppenheimer noted that the fruit of individuals found within the upper Awehi Gulch enclosure are mature during August thus visits before and after August are either too early or too late to collect fruits (USFWS, 2012). Flowering time, pollination vectors, seed dispersal agents, longevity of plants and seeds, specific environmental requirements, and other limiting factors are unknown (U.S. Fish and Wildlife Service 1999b) (USFWS, 2002).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Ohia-uluhe lowland mixed mesic to wet forest (USFWS, 2012)

Geographic or Habitat Restraints or Barriers

Adult: 1,084 - 3,323 (USFWS, 2012)

Spatial Arrangements of the Population

Adult: Scattered individuals (USFWS, 2012; see population narrative)

Habitat Narrative

Adult: Inhabits wet to perhaps mesic forest (NatureServe, 2015). The typical habitat of *Labordia tinifolia* var. *lanaiensis* is gulch slopes in *Metrosideros polymorpha* (ohia)-*Dicranopteris linearis* (uluhe) lowland mixed mesic to wet forest between 550 and 1,013 meters (1,804 and 3,323 feet) elevation (USFWS, 2012).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Very low (inferred from USFWS, 2012; see current range/distribution)

Redundancy:

Very low (inferred from USFWS, 2012)

Number of Populations:

1 (USFWS, 2018)

Population Size:

15 (USFWS, 2018)

Population Narrative:

Currently, there are one to three populations totaling an estimated 300 to 800 scattered individuals on Lanai (USFWS 1999, 2002, 2003, 2010) (USFWS, 2012). In 2012, the 5-year review reported one to three populations on Lānaʻi totaling 300 to 800 individuals; however, botanists believed this estimation was too high. Some botanists estimated there could be three to four populations totaling 200 to 300 individuals, based on the lower number of observed plants (about 30) (Wood 2010, pers. comm.; Oppenheimer 2010, pers. comm). In 2013, the Plant Extinction Prevention Program (PEPP) reevaluated the status of this species, and raised its status from “POP” (potential PEP species) to “PEP,” a species with fewer than 50 individuals in the wild. Currently, only one population is known on the southeast slope of Lānaʻi, with 15 wild individuals actually observed since 2012 (PEPP 2012, 2013, 2105, 2016, 2017a) (USFWS, 2018).

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Ungulate (axis deer and feral mouflon sheep) degradation of habitat (USFWS 1999, 2002, 2003; K. Wood, pers. comm. 2010; H. Oppenheimer, pers. comm. 2010); established ecosystem-altering invasive plant species degradation of habitat (USFWS 1999, 2002, 2003); Landslides and flooding (USFWS 1999, 2002, 2003) (USFWS, 2012).

Stressor: Herbivory (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Herbivory and trampling by axis deer and feral mouflon sheep (USFWS 1999, 2002, 2003; K. Wood, pers. comm. 2010; H. Oppenheimer, pers. comm. 2010) (USFWS, 2012).

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species (USFWS, 2012).

Stressor: Established ecosystem altering invasive plant species degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Habitat degradation and destruction by the nonnative plant *Sphaeropteris cooperi* (Australian tree fern) is an additional threat to *Labordia tinifolia* var. *lanaiensis* as observed at an outplanting site at 'Āwehi (PEPP 2017a) (USFWS, 2018).

Stressor: Drought and erosion degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Drought is observed to be a threat to populations of *L. tinifolia* var. *lanaiensis* at Puhielelu and 'Āwehi (PEPP 2012, 2013, 2015, 2017a; Oppenheimer 2018, in litt.). Over the last 100 years, the Hawaiian Islands have experienced an annual decline in precipitation of over 9 percent, increasing to as much as 15 percent within the last 20 years (US-NSTC 2008; Chu and Chen 2005; Diaz et al. 2005). Drought affects plants directly by desiccation. The increase in drought frequency and intensity leads to a self-perpetuating cycle of increase in cover of nonnative plants, increase in the number of fires, and an increase of erosion (US-GCRP 2009; Warren 2011). Recent episodes of drought have also driven deer farther into urban and forested areas in search of food, increasing their negative impacts to native vegetation from herbivory and trampling (Waring 1996, in litt; Nishibayashi 2001, in litt.) (USFWS, 2018).

Stressor: Fire destruction or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: —Fire is noted as a threat to *L. tinifolia* var. *lanaiensis* for wild and reintroduced individuals at 'Āwehi (PEPP 2013, 2017a). Fire can destroy dormant seeds as well as individual plants. Successive fires burn farther and farther into native habitat and alter microclimate conditions to further alter habitat conditions to favor nonnative plants. Nonnative plants convert native plant communities to nonnative dominated plant communities D'Antonio and Vitousek 1992; Tunison et al. 2002) (USFWS, 2018).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: —Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai'i using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Labordia tinifolia* on the species level is vulnerable to the impacts of climate change, with a vulnerability score of 0.107 (on a scale

of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions may be needed to conserve this taxon into the future (USFWS, 2018).

Stressor: Rodent predation or herbivory

Exposure:

Response:

Consequence:

Narrative: Herbivory by rats is noted to be a threat to *L. tinifolia* var. *lanaiensis* at Puhielelu and 'Āwehi (PEPP 2012, 2013, 2017a). Rats eat virtually every part of plants and at every stage: fleshy fruits, seeds, flowers, stems, leaves, shoot, seedlings, and roots (Russell 1980; Cuddihy and Stone 1990). The effects on plants range from reduced vigor and decreased reproduction to mortality of individuals and complete lack of recruitment (USFWS, 2018).

Stressor: Invertebrate predation or herbivory

Exposure:

Response:

Consequence:

Narrative: Herbivory by slugs is noted as a threat to this variety (PEPP 2015, 2017a). o A tiny beetle, the black twig borer (*Xylosandrus compactus*), is known to infest over 200 plant taxa in Hawai'i, including *L. tinifolia* var. *lanaiensis* on Lāna'i (Davis 1970; PEPP 2017a). The black twig borer attacks living plants and bores into branches, deposits eggs and a fungus called ambrosia which develops as food for the larvae. A severe infestation can kill host plants, including large trees (Extension Entomology and UH-CTAHR IPMP 2006) (USFWS, 2018).

Stressor: Stochastic events—Reduced viability due to low numbers

Exposure:

Response:

Consequence:

Narrative: Small, isolated populations often exhibit reduced levels of genetic variability, which diminishes the species' capacity to adapt and respond to environmental changes, thereby lessening the probability of long-term persistence (Barrett and Kohn 1991; Newman and Pilson 1997). The problems associated with small population size and vulnerability to random demographic fluctuations or natural catastrophes are further magnified by synergistic interactions with other threats, such as anthropogenic impacts like habitat loss from human development or predation by nonnative species. Very small plant populations may experience reduced reproductive vigor due to ineffective pollination or inbreeding depression. Small numbers and small populations may cause of loss of reproductive vigor of *L. tinifolia* var. *lanaiensis* (USFWS, 2018).

Recovery

Reclassification Criteria:

1. A total of five to seven populations should be documented on islands where it now occurs or occurred historically (USFWS, 2002).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 2002).

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 2002).

Delisting Criteria:

1. A total of 8 to 10 populations should be documented on islands where it now occurs or occurred historically (USFWS, 2002).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 2002).

3. Each population should persist at this level for a minimum of five consecutive years (USFWS, 2002).

Recovery Actions:

- Protect habitat and control threats (USFWS, 2002).
- Expand existing wild populations (USFWS, 2002).
- Conduct essential research (USFWS, 2002).
- Develop and maintain monitoring plans (USFWS, 2002).
- Reestablish wild populations within the historic range (USFWS, 2002).
- Validate and revise recovery criteria (USFWS, 2002).
- Construct exclosures to protect populations against axis deer (USFWS, 2002).
- Maintain adequate genetic stock (USFWS, 2002).
- Control competing alien plant species (USFWS, 2002).
- Enhance wild populations and establish new populations (USFWS, 2002).
- New Management Actions: • Surveys and monitoring—PEPP continues to monitor wild and outplanted individuals (PEPP 2013, 2015, 2016, 2017a). • Ungulate monitoring and control—PEPP regularly inspects and maintains exclosure fencing at wild and reintroduced populations (PEPP 2015, 2017a) • Captive propagation for genetic storage and reintroduction— o Five founders from the ‘Āwehi wild individuals are represented in collections and reintroductions (PEPP 2017b). o The Lyon Arboretum Micropropagation Laboratory reports 54 containers of propagules from two individuals at ‘Āwehi. The Lyon Seed Conservation Laboratory has almost 2,000 seeds in storage collected from three founders at ‘Āwehi (Lyon Arboretum 2017). o The National Tropical Botanical Garden (NTBG) reports almost 400 seeds collected from plants at Puhielelu and ‘Āwehi; however, these collections are more than 10 years old (NTBG 2017). o The Olinda Rare Plant Facility (ORPF) has propagated almost 120 potted plants from collections from plants at Puhielelu and ‘Āwehi (ORPF 2013, 2014, 2015). This year, they have sent out 50 plants for outplanting and hold 54 plants in their nursery (ORPF 2018). o PEPP monitors this species and reports collection of seeds from four individuals at Puhielelu and ‘Āwehi (PEPP 2012). In addition, PEPP has elevated the status of this species to “POP,” a potential PEP species, as numbers of individuals are nearing the level of PEP status (fewer than 50 individuals in the wild) and threat levels are high. • Invasive plant monitoring and control—PEPP regularly conducts

- control and removal of nonnative plants at wild and reintroduced populations (PEPP 2013, 2015, 2016, 2017a). • Predator and herbivore monitoring and control—PEPP conducts rat trapping at wild and reintroduced populations (PEPP 2012, 2013, 2017a) (USFWS, 2018).
- Recommendations for Future Actions: Drought, erosion, fire, predation by rats, slugs, and the black twig borer, and low numbers have been identified as new threats to *Labordia tinifolia* var. *lanaiensis*. We are not aware of any significant information regarding the species' biological status since the last 5-year review in 2012. Thus, the following recommendations for future actions are added or reiterated for the 5-year review for 2018.
 - Population viability and monitoring—Continue to survey known localities and suitable habitat areas on Lānaʻi to determine the current status of all populations of *L. tinifolia* var. *lanaiensis*.
 - Ungulate monitoring and control—Continue to construct and maintain exclusion fences to protect *L. tinifolia* var. *lanaiensis* from the impacts of feral ungulates.
 - Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species around all populations.
 - Site and habitat protection—Develop and implement effective measures to reduce the impacts of landslides and flooding.
 - Captive propagation for genetic storage and reintroduction—
 - o Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range.
 - o Evaluate genetic resources currently in storage to determine the need to place additional material into long-term storage due to this species' vulnerability to climate change.
 - o Research potential viability problems and explore alternative methods of propagation (e.g., cuttings, tissue culture).
 - Fire monitoring and control—Develop and implement fire prevention management plans.
 - Herbivory by rodents and invertebrates—
 - o Continue to implement effective control measures for rats.
 - o Develop and implement control measures for slugs.
 - o Develop and implement control measures for the black twig borer.
 - Reintroduction and translocation—Continue to augment current populations and reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.
 - Population biology research—Research the life history of *L. tinifolia* var. *lanaiensis* to affirm that this variety is long-lived.
 - Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use this information to determine future landscape needed for the recovery of the species.
 - Alliance and partnership development—Continue to work with landowners and land managers to initiate planning and contribute to implement of ecosystem-level restoration and management to benefit this taxon (USFWS, 2018).

Conservation Measures and Best Management Practices:

- Captive propagation for genetic storage and reintroduction: Continue to collect seeds from tagged individuals, keeping close track of the maternal source for use in ex situ propagation. Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation (USFWS, 2012).
- Captive propagation protocol development – Explore alternate methods of propagation for *Labordia tinifolia* var. *lanaiensis* (e.g., cuttings, tissue culture) (USFWS, 2012).
- Ungulate exclosures – Complete the Lanaihale fencing project (USFWS, 2012).
- Ungulate control – Remove axis deer within the exclosure once the fencing is complete at Lanaihale (USFWS, 2012).
- Reintroduction / translocation site identification – While surveying for new populations or reintroduced populations, determine which sites are least invaded by invasive introduced plant

species and which appear to have the highest likelihood of maintaining new reintroductions (USFWS, 2012).

- Surveys / inventories – Continue to conduct thorough surveys for *Labordia tinifolia* var. *lanaiensis* in habitats where it has historically been found on Lanai, as well as in other potentially suitable habitats (USFWS, 2012).
- Ecosystem-altering invasive plant species control – Continue to control ecosystem altering invasive plant species around all populations (USFWS, 2012).
- Competitive invasive plant species control – Continue to control invasive introduced plant species around all populations (USFWS, 2012).
- Population biology research – Research the life history of *Labordia tinifolia* var. *lanaiensis* in reference to designating the taxon from a short-lived perennial to long-lived perennial (USFWS, 2012).
- Site / area / habitat protection – Develop and implement effective measures to reduce the impact of landslides and flooding (USFWS, 2012).
- Alliance and partnership development – Work with Castle and Cooke and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2012).
- Threats research – Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2012).

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SPECIES ACCOUNT: *Labordia tinifolia* var. *wahiawaensis* (Kamakahala)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Labordia tinifolia var. *wahiawaensis*, a member of the logania family (Loganiaceae), is a shrub or small tree, usually 2 to 8 m (6.6 to 26.2 ft) tall. The young branches are cylindrical or nearly so and hairless. The elliptic to lance-shaped leaves are usually 4.5 to 21 cm (1.8 to 8.3 in) long and 2 to 5 cm (0.8 to 2 in) wide. The membranous leaves are medium green and hairless, and the veins are not impressed on the upper leaf surface. Normally, 9 to 12 hairless flowers are clustered on a downward curving inflorescence stalk 9 to 22 mm (0.35 to 0.9 in) long, each having an individual stalk 8 to 11 mm (0.2 to 0.4 in) in length. The pale yellowish green flower is narrowly urn-shaped, 17 to 19 mm (0.7 to 0.75 in) long. The tubular portion of the flower is 5.5 to 7.8 mm (0.2 to 0.3 in) long with long, white hairs inside, while the egg-shaped lobes are 1.7 to 2.3 mm (0.07 to 0.09 in) long. The fruit is an egg-shaped capsule, 8 to 17 mm (0.2 to 0.7 in) long, usually with two valves and an apex with a beak 0.5 to 1.5 mm (0.02 to 0.1 in) long. (USFWS, 1998)

Taxonomy

Three varieties of *Labordia tinifolia* are recognized: var. *lanaiensis* on Lanai and Molokai, var. *tinifolia* on Kauai and four other islands, and var. *wahiawaensis*, endemic to Kauai. Variety *wahiawaensis* is distinguished from the other two by its larger corolla. This species differs from others of the genus by having a long common flower cluster stalk, hairless young stems and leaf surfaces, transversely wrinkled capsule valves, and corolla lobes usually 1.7 to 2.3 mm (0.1 in) long (USFWS 1996). (USFWS, 1998)

Historical Range

Historically no additional range. (NatureServe, 2015)

Current Range

Current range: Wahiawa Drainage of Kauai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Labordia tinifolia* var. *wahiawaensis* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Labordia tinifolia* var. *wahiawaensis* includes one unit totaling 2,255 acres in Kauai County, Hawaii. The unit is Kauai 10—*Labordia tinifolia* var. *wahiawaensis*—a.

Kauai 10—*Labordia tinifolia* var. *wahiawaensis*—a: This unit is critical habitat for *Labordia tinifolia* var. *wahiawaensis* and is 912 ha (2,255 ac) on private land. This unit contains Hulua, Iole, Kahili,

Kapalaoa, and Palikea Summits. This unit provides habitat for four populations of 100 mature, reproducing individuals of the long-lived perennial *Labordia tinifolia* var. *wahiawaensis* and is currently occupied with 20 to 30 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, stream banks in lowland wet forest. Although we do not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is of appropriate size so that each potential recovery population on Kauai within the unit is geographically separated enough to avoid their destruction by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Within this unit, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

- (i) Streambanks in lowland wet forests dominated by *Metrosideros polymorpha* and containing one or more of the following associated species: *Antidesma platyphyllum*, *Athyrium microphyllum*, *Cheirodendron* spp., *Cyrtandra* spp., *Dicranopteris linearis*, *Hedyotis terminalis*, or *Psychotria* spp.; and
- (ii) Elevations between 458 and 1,006 m (1,502 and 3,301 ft).

Special Management Considerations or Protections

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 630 and 740 meters within a 0.8 to 1.2 km area (USFWS, 2009)

Environmental Specificity

Adult: Narrow, with several key requirements (USFWS, 2009)

Habitat Narrative

Adult: The taxon has not been discovered beyond its very restricted present habitat in the Wahiawa Drainage from about 630 to 740 meters (2,070 to 2,430 feet) elevation within a 0.8- by 1.2 km (0.5- by 0.75-mile) area (USFWS 1996). *Labordia tinifolia* var. *wahiawaensis* grows along streams in lowland wet forests dominated by ohia and often in association with olapa or uluhe. Plants found in association with this taxon include haiwale, hame, kopiko, manono, and *Athyrium* sp. (USEWS 1996). (USFWS, 1998; USFWS, 2009)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Short-term trends suggest declines of >30% (NatureServe, 2015)

Resiliency:

Very low (inferred from USFWS, 2009)

Redundancy:

Very low (inferred from USFWS, 2009)

Number of Populations:

3 (USFWS, 2017)

Population Size:

22 (USFWS, 2017)

Population Narrative:

Short-term population trends suggest declines of >30%. Perlman (2006) confirmed that a single restricted population of 20 to 30 individuals continued to survive as of September 2005. Our database reflected no change in numbers (USFWS 2008). (USFWS, 2009). New Status Information: • *Labordia tinifolia* var. *wahiawaensis* has been found in two more locations since the time of the last 5-year review in 2009. In 2008, four individuals were found at the upper north fork of Wainiha stream; however, subsequent monitoring shows only six individuals remain (HBMP 2010; NTBG 2013a; PEPP 2017). Three individuals were found in the northern headwaters of Waiahi stream (NTBG 2013b). At the previously only known population of this species in the Wahiawa mountains, 13 individuals currently occur in two separate locations (one location with only one plant) (PEPP 2017). In summary, there are three populations totaling 22 individuals (USFWS, 2017).

Threats and Stressors

Stressor: Invasive plants (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Competition with introduced invasive plant species, especially *Psidium cattleianum* (strawberry guava) remains a threat. (USFWS, 2009)

Stressor: Habitat degradation by pigs (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Habitat degradation by pigs (*Sus scrofa*) is a threat to *Labordia tinifolia* var. *wahiawaensis*. (USFWS, 2009)

Stressor: Human activities (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Human activities from trampling are detrimental to *Labordia tinifolia* var. *wahiawaensis*. (USFWS, 2009)

Stressor: Single catastrophic events (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The threat of single catastrophic events, such as hurricanes or landslides, threaten *Labordia tinifolia* var. *wahiawaensis*. (USFWS, 2009)

Stressor: Small population size (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Reduced reproductive vigor due to small number of extant populations and individuals remains a concern for *Labordia tinifolia* var. *wahiawaensis*. (USFWS, 2009)

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Labordia tinifolia* var. *wahiawaensis* is vulnerable to the impacts of climate change, with a vulnerability score of 0.107 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery**Reclassification Criteria:**

1. A total of five to seven populations of each taxon should be documented on Kauai where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Kauai where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1998)

Recovery Actions:

- Construct enclosures to protect against feral ungulates and control alien plant species. Because so few individuals now exist, emergency measures should be taken immediately to fence the remaining individuals to protect them against further degradation by feral pigs. Once enclosed, those areas should undergo management to remove the alien plants focusing on strawberry guava. (USFWS, 1998)
- Given the degraded nature of the Kauai plant cluster's habitat, their precariously low numbers, and the severity of the threats, the highest priority actions must be aimed at protecting all extant wild individuals and populations, managing habitat to enhance survival and ensuring maintenance of adequate genetic stock ex situ. (USFWS, 1995)
- It is hoped that by eliminating current threats through management, populations of the Kauai cluster taxa will expand naturally. However, in certain special instances, wild populations of the Kauai cluster taxa may need to be augmented. (USFWS, 1995)
- Research into various aspects of the life history, habitat, pollinators, reproductive biology, symbionts, optimum requirements for growth, requirements for population viability, and control of threats to each of the Kauai cluster taxa must be carried out to better understand the requirements necessary for perpetuation of these plants. (USFWS, 1995)
- If necessary to meet recovery objectives, populations should be reestablished in areas where they are known to have occurred historically, particularly if genetically uncontaminated, cultivated materials exist which are known to have originated from the historical site. (USFWS, 1995)

- The scientific validity of the recovery objectives should be reviewed as more information becomes available. (USFWS, 1995)
- A public education program is needed to increase awareness of and support for plant recovery efforts in Hawaii. (USFWS, 1995)
- New Management Actions:
 - Invasive plant monitoring and control—PEPP is monitoring invasive nonnative plants at three populations of *Labordia tinifolia* var. *wahiawaensis* (PEPP 2010, 2011, 2012, 2013, 2014).
 - Predator and herbivore monitoring and control—PEPP is monitoring effects of feral ungulates at three populations and implementing insect control (PEPP 2010, 2011, 2012, 2013, 2014). One population occurs within a recently completed landscape-scale fenced enclosure at Wainiha, the East Alakai Fence (DLNR 2006; Clark 2009, in litt.; Clark 2013, in litt.). PEPP is conducting insect control by applying an insecticide at two populations (PEPP 2011, 2012, 2014).
 - Captive propagation for genetic storage and reintroduction—Over the last several years, PEPP has conducted an extensive hand-pollination effort to produce seeds. These seeds were collected from individuals in the Wahiawa Mountains and were placed in storage. Lyon Arboretum Seed Bank has 13 different crosses from five females and four males totaling over 2,500 seeds (Lyon Arboretum 2017) (USFWS, 2017).
- Recommendations for Future Actions: Predation and herbivory by rats and insects are identified as new threats to this species. Thus, the following recommendations for future actions are added or reiterated for the 5-year review for 2017.
 - Surveys and inventories—Continue to survey for populations of *Labordia tinifolia* var. *wahiawaensis* in areas of potentially suitable habitat.
 - Ungulate monitoring and control—Continue to construct and maintain fenced enclosures around all populations. Protect all occurrences against disturbances from feral ungulates to prevent imminent extinction.
 - Invasive plant monitoring and control—
 - o Control established ecosystem-altering nonnative invasive plant species around all populations.
 - o Control invasive nonnative species that compete with the species around all populations.
 - Predator and herbivore monitoring and control—
 - o Control rats at all populations.
 - o Study *Labordia tinifolia* var. *wahiawaensis* populations to determine level of threat from invertebrate herbivory and need for additional recovery actions.
 - Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock.
 - Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. Evaluate the fence at Kanaele Bog (Wahiawa) which could potentially serve as a reintroduction site.
 - Population biology research—
 - o Study *Labordia tinifolia* var. *wahiawaensis* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats.
 - o Investigate techniques to improve natural recruitment.
 - Human interaction monitoring and management—Develop and implement effective measures to reduce the impacts of hunters, hikers, and trail maintenance.
 - Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Continue to collect material for genetic storage, future propagation and reintroduction. (USFWS, 2009)

- Construct large-scale fences around all naturally occurring and reintroduced individuals to control feral ungulates. (USFWS, 2009)
- Control introduced invasive plant species around wild individuals. (USFWS, 2009)
- Work with the Kauai Watershed Alliance to continue and expand ecosystem-level management of the Wahiawa Bog area. (USFWS, 2009)
- Reintroduce individuals into protected suitable habitat within historical range. (USFWS, 2009)
- Investigate techniques to improve natural recruitment. (USFWS, 2009)
- Assess genetic variability within extant population. (USFWS, 2009)
- Study *Labordia tinifolia* var. *wahiawaensis* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. (USFWS, 2009)

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SPECIES ACCOUNT: *Kokia drynarioides* (Koki`o)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/04/1984; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Kokia drynarioides is a small tree from 4 to 10 m (13 to 35 ft) tall and with a trunk up to 20 cm (8 in) in diameter. The star-shaped leaves are large (7 to 28 cm long or 2.75 to 11 in) with 7 to 9 palmate lobes, and are pale, glossy green, often with distinct red veins. The large and showy flowers are borne singly in leaf axils. Three large bracts below the flower are persistent. The petals are red, 10 to 15 cm (4 to 6 in) long and up to 8 cm (3.1 in) wide. The flowers are similar to *Hibiscus* flowers in that the stamens fuse to form a column around the style. The petals are somewhat twisted in the bud and the spiral pattern remains in the open flower. The fruit is a 5-lobed dry capsule about 2.5 cm (1 in) long. (Lamoureux 1981). (USFWS, 1994)

Taxonomy

Genus endemic to Hawaiian Islands; in the Malvaceae or mallow family. Synonyms listed by Wagner et al. (1990) are *Gossypium drynarioides*, *Hibiscus drynarioides* and *Kokia rockii*. (USFWS, 1994)

Historical Range

See Current Range.

Current Range

Currently known from the North Kona District of western Hawaii Island. (NatureServe, 2015)

Critical Habitat Designated

Yes; 12/4/1984.

Legal Description

On December 4, 1984, the U.S. Fish and Wildlife Service designated critical habitat for *Kokia drynarioides*. This rule implements the protection provided by the Endangered Species Act of 1973, as amended, for *Kokia drynarioides* and its critical habitat (49 FR 47397 - 47401).

Critical Habitat Designation

The critical habitat designation includes three areas totaling 2,600 acres in the North Kona District, Hawaii County, Hawaii.

1. Ka'upulehu Ahupua'a area, bounded as follows: from a point of origin at Universal Transverse Mercator (UTM) coordinate 925880 near or on the west boundary of the Ka'upulehu 1800 - 1801 lava flow (approximately at intersection of said west boundary and 2600 ft. elevation contour); thence west southwesterly approximately 864 ft. to UTM coordinate 909899 (near the 1400 ft. elevation contour); thence east northeasterly approximately 378 ft. to UTM coordinate 913900 (also near the 1400 ft. elevation contour; then south southeasterly approximately 720 ft. to UTM coordinate 916891; thence east northeasterly approximately 320 ft. to UTM coordinate 920892 (near the said west boundary of the 1800 - 1801 lava flow); thence south southeasterly

approximately 1140 ft. to the point of origin. Included in this area is Ka'upulehu Forest Reserve, Section B.

2. Ka'upulehu Ahupua'a and Pu'uwa'awa'a Ahupua'a boundary area, identified as follows: an unnamed kipuka (discontinuity) in 1800 - 1801 lava that straddles the boundary between Ka'upulehu and Pu'uwa'awa'a Ahupua'a and also crosses Mamalahoa Highway between 2400 and 1000 feet of elevation. Excluded is a small tongue of the said kipuka that extends south of UTM coordinate 941885 at approximately 2400 ft. of elevation and above. UTM coordinate 931924 marks the low elevation end of the said kipuka.

3. Pu'uwa'awa'a Ahupua'a area, identified as follows: Halepi'ula 3, Waimea Paddock of Pu'uwa'awa'a Ranch, which lies south of (upslope) and abuts Mamalahoa Highway just east of the boundary between Ka'upulehu and Pu'uwa'awa'a Ahupua'a. East boundary of the 1800 - 1801 Ka'upulehu lava flow is the west boundary of the paddock. The paddock corners are near UTM coordinates 948901 (NW), 985909 (NE) 973886 (SE), and 971879 (SW).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements of critical habitat are:

appropriate soil type, climate, protection from grazing damage, protection from aggressive exotic weeds, and presence of suitable pollinators.

Special Management Considerations or Protections

Any activity that would significantly disturb the soil, topography, or other physical and biological components of the area in which *Kokia drynarioides* occurs could adversely modify its critical habitat. Existing and proposed land uses in the immediate locality of the population and in its surroundings must be carefully examined if such modifications are to be prevented. This might require exclosures to insure the establishment of seedlings and survival of existing trees and the removal of some lands from grazing. The State of Hawaii is currently considering Natural Area Reserve status for a portion of the Pu'uwa'awa'a Ranchlands.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Self-fertilization is possible (USFWS, 1994)

Breeding Season

Adult: Year-round (USFWS, 1994)

Reproduction Narrative

Adult: The reproductive biology of wild plants is completely unknown. Individual, isolated trees do produce viable seed, so self-fertilization is possible with this species. There is some evidence of vegetative reproduction, as three damaged individuals re-sprouted when the trunks were cut. A comment by Young and Popenoe (1916) indicates that a cultivated seedling of *Kokia cookei* began flowering at about age 4 years. Herbarium collections show that *Kokia drynarioides* may flower at any time of the year. (USFWS, 1994)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Rainfall between 75 and 100 cm (30-40 in) a year, with no pronounced wet and dry seasons; temperature varies between 14 and 18 degrees Celsius (USFWS, 1994)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 460 and 900 meters (1,500 to 3,000 feet) (USFWS, 1994)

Environmental Specificity

Adult: Narrow, with several key requirements (USFWS, 1994)

Habitat Narrative

Adult: *Kokia drynarioides* has historically grown between 460 meters (1500 feet) and 900 meters (3000 feet) elevation. The general slope is 50 to 100. The substrate is mostly rough a'ā lava covered by a thin and discontinuous layer of organic soil (Sato et al. 1973, Lamoureux 1981). The steep slope and rugged volcanic features of the landscape impede passage on the ground. The rainfall in this area is about 75 to 100 centimeters (30 to 40 inches) a year, with no pronounced wet and dry seasons (Blumenstock and Price 1961). Air temperature also fluctuates little during the year, with mean monthly temperatures varying between 14 and 18 degrees Celsius (58 and 64 degrees Fahrenheit) (Lamoureux 1982). The moderate rainfall and high insolation in combination with the shallow, excessively drained, soil provides a dry habitat where moisture is probably frequently limiting. The Kaupulehu and Puuwaawaa habitat of *Kokia drynarioides* is Lama/Kauila Forest (*Diospyros/Colubrina oppositifolia*), a subtype of the Lowland Dry Forest (Gagne and Cuddihy 1990). The canopy of this open forest is 5 to 6 meters (16.4 - 19.7 feet) high and is made up of a diversity of native tree species with native shrubs below, and includes several other rare plant species. (USFWS, 1994)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Stable (USFWS, 2015)

Resiliency:

Very low (inferred from USFWS, 2015)

Redundancy:

Very low (inferred from USFWS, 2015)

Population Growth Rate:

Stable (USFWS, 2015)

Number of Populations:

2 (USFWS, 2015)

Population Size:

2-8 wild individuals (USFWS, 2015)

Population Narrative:

In 2013, there were two populations containing 2 to 5 mature individuals, 3 immature individuals, and 21 seedlings of *Kokia drynarioides* (PEPP 2014). Research is ongoing as to whether the individuals currently found at Puu Waawaa are wild (natural) or outplanted (PEPP 2014). Overall, the numbers of individuals have remained stable from the two wild individuals reported in the previous 5-year review to approximately 2 to 8 wild individuals in 2015 (PEPP 2014). (USFWS, 2015)

Threats and Stressors

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Climate change destruction or degradation of habitat – Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Kokia drynarioides* is highly vulnerable to the impacts of climate change. Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2015)

Stressor: Grazing and browsing by ungulates (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Rock (1913), Degener (1946) and others recognized that the rapid disappearance from North Kona of *Caesalpinia kavaensis* and *Kokia drynarioides* was mostly due to forest destruction and community disintegration as a result of cattle ranching in the dry forest. Nearly all of the habitat on the island of Hawaii is or has until recently been managed for commercial cattle production. Seedlings and saplings of both species are highly palatable to cattle. Feral goats and sheep also live in this habitat. (USFWS, 1994)

Stressor: Fountain grass invasion and enhanced fire danger (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Today the most devastating factor within the dry forest habitat of these two species on the island of Hawaii is the invasion by fountain grass that has occurred during this century, resulting in its complete domination of the groundcover in the dry forest habitat of North Kona. Fountain grass has two major negative impacts on the community: the promotion of fire and usurpation of native plant habitat. Fountain grass is a fire-adapted bunch grass that enhances fuel-loading and promotes fire (Tunison in press). Unlike most other alien grasses, fountain grass can invade barren lava flows that were not formerly subject to wildfire. Major fires burned through Puuwaawaa Ranch in 1986 and 1988. Trees of both species, as well as other native dry forest species, were completely eliminated from the burned areas in these fires. Wildfire also burned a major portion of the boundary kipuka section of the *Kokia drynarioides* critical habitat in May, 1993, killing an estimated 80% of the *Kokia drynarioides* and *Caesalpinia kawaiensis* found there (L. Mehrhoff, personal communication 1993). (USFWS, 1994)

Stressor: Non-native plants (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Many other alien plants are naturalized in the North Kona habitat. Two that are widespread and disruptive are lantana (*Lantana camara*) and silk oak (*Grevillea robusta*). Two cultivated plants that have become established locally on the cinder cone of Puuwaawaa itself are the custard apple (*Annona cherimola*) and *Pittosporum viridiflorum* (Takeuchi 1990). (USFWS, 1994)

Stressor: Lack of genetic diversity (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Since the numbers of individuals of both of these two species are very low, it is possible that each species' viability may be reduced due to problems with in-breeding and the depleted gene pool. At this time, it appears that both species produce viable seeds that grow normally when protected. If *Kokia drynarioides* are grown in botanical gardens near other *Kokia* species from other islands, it is possible that cross-pollination leading to hybridization may take place. Such mixing of the gene pools should be avoided by keeping careful records of provenance. (USFWS, 1994)

Stressor: Predation by rats, mice, game birds, and invertebrates (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Predation of seeds of both species by introduced rats, mice and unspecified game birds and invertebrates is well known. Rats eat the seeds of both species while they are still on the tree (Lamoureux 1981, 1982). The large, hard, bean-like seeds of *Caesalpinia kawaiensis* have been found in rat burrows (Lamoureux 1982) as have the seed coats of *Kokia drynarioides* (Derral Herbst, U.S. Fish and Wildlife Service, personal communication 1992). The importance of seed predation has not been scientifically assessed. (USFWS, 1994)

Stressor: Volcanic eruptions (USFWS, 1994)

Exposure:

Response:**Consequence:**

Narrative: The North Kona populations of these two species occur in a relatively restricted area on the side of a dormant volcano that last erupted about 1800 AD. A future eruption could threaten these wild populations. (USFWS, 1994)

Stressor: Drought (USFWS, 1994)

Exposure:**Response:****Consequence:**

Narrative: The North Kona area has experienced drought conditions for several years, and if these two species reproduce only in widely spaced times of favorable climactic conditions, the prolonged drought could be a factor in their recent decline. It is also possible that the drought conditions have exacerbated the insect infestation problems because dry vegetation is more susceptible to such invasion (C. Corn, personal communication 1993). (USFWS, 1994)

Recovery**Reclassification Criteria:**

1. It is observed and documented that the major threats are greatly reduced. (USFWS, 1994)
2. It is observed and documented that following the removal of threats, new trees are being recruited by natural regeneration at a rate adequate to replace individuals lost from the population and preserve long term genetic diversity. (USFWS, 1994)
3. Recovery proceeds for the time, approximately 13 years, needed to provide demographic data to be used in population viability analysis (PVA) to estimate minimum population numbers and densities for effective reproduction. (USFWS, 1994)
4. A thorough review of the environmental dynamics and human activities within the dry forest habitat is conducted to determine the minimum habitat area needed to give a high probability of survival of the species over the next 200 years. (USFWS, 1994)
5. Current habitat has been secured in perpetuity. (USFWS, 1994)
6. Any management practices necessary to maintain the protected habitats have been implemented. (USFWS, 1994)
7. The habitat is populated with the numbers and densities of these two species indicated by the results of research and the PVA (minimum of 100 naturally reproducing individuals in each of 3 populations of each species in North Kona and a minimum of 100 naturally reproducing *Caesalpinia kavaensis*, in each of three populations, on each of Oahu, Lanai, Kauai and Maui). (USFWS, 1994)

Delisting Criteria:

Not available.

Recovery Actions:

- Current habitat of *Caesalpinia kavaensis* and *Kokia drynarioides* should be protected through cooperative agreements with landowners, and threats to current populations should be controlled. (USFWS, 1994)
- Implementing the management plan will require further research to identify and characterize the environmental threats that are preventing natural regeneration of these two species and to develop management techniques. (USFWS, 1994)
- The increase in numbers of these two species should be enhanced by special care and treatment of seeds and seedlings within the management sites. Recruitment from seeds collected on the site or from nearby trees should be promoted by management techniques developed through research. Techniques might include barriers to discourage seed predation, drip irrigation systems, placement of seeds in select microhabitats, and shelters or other features to reduce evapotranspiration. (USFWS, 1994)
- In order to reach the delisting goals of 3 populations of each species on Hawaii island and 3 populations of *Caesalpinia kavaensis* on Oahu, Lanai, Kauai and Maui, new populations of *Caesalpinia kavaensis* will have to be established on Lanai, Kauai and Maui within the historical range of the species. (USFWS, 1994)
- An important role for research is to verify the scientific validity of the stated recovery objectives in this plan. (USFWS, 1994)

Conservation Measures and Best Management Practices:

- Survey geographical and historical range for a current assessment of the species' status. (USFWS, 2015)
- Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. (USFWS, 2015)
- Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change. (USFWS, 2015)
- Maintain existing exclosures and monitor for potential incursions. (USFWS, 2015)
- Eradicate invasive introduced plants within ungulate exclosures and maintain exclosures free of invasive plants. (USFWS, 2015)
- Continue monitoring wild and reintroduced individuals. (USFWS, 2015)
- Develop and implement a fire management plan at the existing exclosures. (USFWS, 2015)
- Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. (USFWS, 2015)
- Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2015)

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SPECIES ACCOUNT: *Kokia kauaiensis* (Koki`o)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

A tree, 5-10 m tall, with shallowly lobed leaves and large, ornamental, brick-red flowers. (NatureServe, 2015)

Taxonomy

The species was originally described as a subspecies, *Kokia rockii* var. *kauaiensis*, in 1919, but was later elevated to a full species. (USFWS, 1996)

Historical Range

Two individuals in Hipalau Valley have not been reported since 1993 (Perlman 2008), and one individual noted in Pohakuao has not been seen since 1999. (USFWS, 2010)

Current Range

Kokia kauaiensis is known from northwestern Kauai in Paaiki Valley; Mahanaloa-Kuia Valley junction, the western side of Kalalau Valley, and Pohakuao Valley, both within Na Pali Coast State Park; and Koaie Stream branch of Waimea Canyon, where some plants may be within the boundary of the Alakai Wilderness Preserve. (USFWS, 1996)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Kokia kauaiensis* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Kokia kauaiensis* includes four units totaling 2,417 acres in Kauai County, Hawaii. The units are Kauai 11—*Kokia kauaiensis*—a, b, c, d.

Kauai 11—*Kokia kauaiensis*—a: This unit is critical habitat for *Kokia kauaiensis* and is 155 ha (384 ac) on State land (Alakai Wilderness Preserve). This unit contains portions of Kawaiiki and Kipalau Valleys. This unit provides habitat for three populations of 100 mature, reproducing individuals of the long-lived perennial *Kokia kauaiensis* and is currently occupied with 70 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, diverse mesic forest. This unit is geographically separated from the other three units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Kokia kauaiensis*—b: This unit is critical habitat for *Kokia kauaiensis* and is 30 ha (74 ac) on State land (Na Pali Coast State Park) within Pohakuau Valley.

This unit provides habitat for one population of 100 mature, reproducing individuals of the long-lived perennial *Kokia kauaiensis* and is currently occupied with two plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, diverse mesic forest. This unit is geographically separated from the other three units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 11—*Kokia kauaiensis*—c: This unit is critical habitat for *Kokia kauaiensis* and is 666 ha (1,648 ac) on State land (Kuia NAR). This unit contains portions of Milolii Ridge, Kuia and Mahanaloa Valleys. This unit provides habitat for two populations of 100 mature, reproducing individuals of the long-lived perennial *Kokia kauaiensis* and is currently occupied with between 78 and 83 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, diverse mesic forest. This unit is geographically separated from the other three units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 11—*Kokia kauaiensis*—d: This unit is critical habitat for *Kokia kauaiensis* and is 127 ha (313 ac) on State land (Na Pali Coast State Park) within Kalalau Valley. This unit provides habitat for two populations of 100 mature, reproducing individuals of the long-lived perennial *Kokia kauaiensis* and is currently occupied with 16 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, diverse mesic forest. This unit is geographically separated from the other three units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

- (i) Diverse mesic forest containing one or more of the following associated native plant species: *Acacia koa*, *Alyxia oliviformis*, *Antidesma* spp., *Bobea* spp., *Chamaesyce celastroides*, *Claoxylon sandwicense*, *Dicranopteris linearis*, *Diellia pallida*, *Diospyros hillebrandii*, *Diospyros sandwicensis*, *Dodonaea viscosa*, *Flueggea neowawraea*, *Hedyotis* spp., *Hibiscus* spp., *Isodendron laurifolium*, *Lipochaeta fauriei*, *Melicope* spp., *Metrosideros polymorpha*, *Nestegis sandwicensis*, *Nototrichium* spp., *Pisonia* spp., *Pleomele aurea*, *Pouteria sandwicensis*, *Psydrax odorata*, *Pteralyxia kauaiensis*, *Rauvolfia sandwicensis*, *Santalum freycinetianum* var. *pyrularium*, *Streblus pendulinus*, *Syzygium sandwicensis*, *Tetraplasandra* spp., or *Xylosma* spp.; and
- (ii) Elevations between 300 and 1,049 m (984 and 3,441 ft).

Special Management Considerations or Protections

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic

material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Unknown (USFWS, 1998)

Lifespan

Adult: More than 10 years (USFWS, 1998)

Reproduction Narrative

Adult: No life history information for this species is currently available. However, it is considered a "long-lived perennial" (i.e., more than 10 years). (USFWS, 1998)

Habitat Type

Adult: Gulch slopes and bottoms. (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Mesic hardwood forests (NatureServe, 2015)

Habitat Narrative

Adult: *Kokia kauaiensis* typically grows in diverse mesic forest at elevations between 1,960 and 2,600 feet. Associated species include ahakea, koa, kukui, *Diospyros sandwicensis* (lama), manono, hala pepe, papala, *Nestegis sandwicensis* (olopua), and ohia (USFWS 1996). (USFWS, 1998)

Dispersal/Migration**Dispersal**

Adult: Unknown

Dispersal/Migration Narrative

Adult: No life history information for this species is currently available. (USFWS, 1998)

Population Information and Trends**Population Trends:**

Declining (USFWS, 2010)

Species Trends:

Declining (USFWS, 2017)

Resiliency:

Low (inferred from USFWS, 2010)

Representation:

Low (inferred from USFWS, 2010)

Redundancy:

Low (inferred from USFWS, 2010)

Number of Populations:

4 (USFWS, 2017)

Population Size:

28 (USFWS, 2017)

Adaptability:

Low (inferred from USFWS, 2010)

Population Narrative:

Overall, current populations and numbers of individuals have declined to an estimated 45 to 50 individuals in five populations. Fossil evidence suggests that this now rare and geographically restricted species was widespread a millennium ago. The species exhibits high survival and rapid growth of outplanted individuals at Makauwahi Cave (D. Burney, National Tropical Botanical Garden, pers. comm. 2008; Burney et al. 2001). (USFWS, 2010). New Status Information: • The number of individuals of *Kokia kauaiensis* has declined since the time of the last 5- year review in 2010. At that time, there were five occurrences totaling between 45 and 50 individuals. Currently, 15 trees remain in Kuia out of the 23 observed in 2004. Eight individuals remain out of the 38 observed in Paaiki in 2000. Two individuals of the six observed in 2005 remain at Kahuamaa Flat. Two individuals are also at Mahanaloa, and one is at Lonomea. All individuals have died at Pohakuao, Koaie, and Kawaiiki (PEPP 2017). The cause of this rapid decline is unknown (USFWS, 2017).

Threats and Stressors

Stressor: Invasive, alien plants (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: A major threat affecting the regeneration and survival of *Kokia kauaiensis* is competition and habitat degradation by a multitude of invasive introduced plant species, ranging from ferns, grasses and herbs, to shrubs and small trees. (USFWS, 2010)

Stressor: Habitat degradation (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Threats include substrate loss, due to habitat degradation by feral goats (*Capra hircus*), pigs (*Sus scrofa*), and mule deer (*Odocoileus hemionus*).

Stressor: Seed predation (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Seed predation by rats (*Rattus* sp.) and insects, including mites (species unknown), leaf hopper (species unknown), and coffee twig borer (*Xylosandrus compactus*) have all been observed on *K. kauaiensis*. (USFWS, 2010)

Stressor: Natural events (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Fire, hurricanes, landslides, and falling rocks are all potential threats. (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to *K. kauaiensis*. However, current climate change models do not allow us to predict specifically what those effects, and their extent, would be for this species. (USFWS, 2010)

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: —Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Kokia kauaiensis* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.758 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Stressor: Stochastic events—Reduced viability due to low numbers

Exposure:

Response:

Consequence:

Narrative: Populations of *Kokia kauaiensis* are declining. Small, isolated populations often exhibit reduced levels of genetic variability, which diminishes the species' capacity to adapt and respond to environmental changes, thereby lessening the probability of long-term persistence (Barrett and Kohn 1991; Newman and Pilon 1997). The problems associated with small population size and vulnerability to random demographic fluctuations or natural catastrophes are further magnified by synergistic interactions with other threats, such as anthropogenic impacts like

habitat loss from human development or predation by nonnative species. Very small plant populations may experience reduced reproductive vigor due to ineffective pollination or inbreeding depression (USFWS, 2017).

Recovery

Reclassification Criteria:

A total of five to seven populations should be documented on Kauai. (USFWS, 1995)

Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials. (USFWS, 1995)

Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1995)

Delisting Criteria:

A total of eight to ten populations should be documented on Kauai. (USFWS, 1995)

Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials. (USFWS, 1995)

Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1995)

Recovery Actions:

- Remove alien plants inside completed enclosures. (USFWS, 1998)
- Expand current populations. (USFWS, 1995)
- Conduct research essential to conservation of the species. (USFWS, 1995)
- Establish new populations as needed to reach recovery objectives. (USFWS, 1995)
- Validate and revise recovery objectives. (USFWS, 1995)
- Devise and implement a public education program. (USFWS, 1995)
- New Management Actions:
 - Captive propagation for genetic storage and reintroduction—Over 300 seeds were collected from Kawaiiki, Paaiki, Koaie, and Kalalau (east and west) populations (NTBG 2017). There are dozens of plants in the NTBG gardens, mostly from Kalalau, and there are a few dozen seedlings in the NTBG nursery from individuals from Kuai (NTBG 2017). Three founders from three different populations are represented at the Lyon Arboretum Seed Bank (Lyon Arboretum 2017).
 - Reintroduction and Translocation—Individuals have been outplanted into managed exclosures at Iapa ridge, Mahanaloa, Nualolo, Piwa, and Limahuli. Currently, there are 101 individuals outplanted (PEPP 2017).
 - Predator and herbivore monitoring and control—PEPP is monitoring all known populations and conducting some rat control (PEPP 2011, 2012, 2013, 2014, 2015).
 - Population biology research—PEPP assisted researchers from the University of Florida in making collections of *Kokia kauaiensis* for leaf miner studies (PEPP 2015) (USFWS, 2017).
- Recommendations for Future Actions: A decline in individuals is a new threat with no known cause. The following recommendations for future actions are reiterated for the 5-year

review for 2017. • Surveys and inventories—Continue to survey geographical and historic range for a thorough current assessment of the species. • Ungulate monitoring and control—Control feral ungulates within fenced exclosures. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative species that compete with the species around all populations. • Captive propagation for genetic storage and reintroduction—Continue to collect seeds for storage and for propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Population viability monitoring and analysis—Monitor growth and survival rates for both wild and reintroduced individuals. • Population biology research—Study *Kokia kauaiensis* populations to determine cause of decline. Determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides, fire, and low numbers (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Continue to collect seeds for full genetic storage and for use in reintroduction efforts. (USFWS, 2010)
- Survey Koaie and Kawaiiki area for additional individuals. (USFWS, 2010)
- Develop a standard monitoring protocol, using tagging and GIS coordinates, to determine reintroduction needs for the species. (USFWS, 2010)
- Monitor growth and survival rates for both wild and reintroduced individuals. (USFWS, 2010)
- Work with Hawaii Division of Forestry and Wildlife and Hawaii State Parks to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2010)

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SPECIES ACCOUNT: *Korthalsella degeneri* (Hulumoa)

Species Taxonomic and Listing Information

Listing Status: Endangered; 9/18/2012; Pacific Region (R1) (USFWS, 2016)

Physical Description

A perennial subshrub with stems that are woody at the base, which is parasitic on the native trees *Sapindus oahuensis* (kaulu) and *Nestegis sandwicensis* (olopua) (USFWS, 2012).

Taxonomy

In the mistletoe family (Viscaceae) (USFWS, 2012).

Historical Range

Recorded in 1938 from Makua Valley on Oahu, but little else is known of its historical range (USFWS, 2012).

Current Range

On Oahu, is known from Makaha Valley. In addition, individuals of this species may also occur in Makua Valley and at Kahanahaikiis (USFWS, 2012).

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On September 18, 2012, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Korthalsella degeneri* (Hulumoa) under the Endangered Species Act of 1973, as amended (Act) (77 FR 57648-57862). The critical habitat designation includes 8 critical habitat units, which encompass approximately 1,449 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Korthalsella degeneri* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Korthalsella degeneri* includes 8 critical habitat units, covering one ecosystem type, which encompasses approximately 1,449 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley.
Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo.
Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge.
Oahu—Dry Cliff—Unit 4 [24 ac

(10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac(105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Korthalsella degeneri* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Korthalsella degeneri* occurs within the indicated ecosystem in the Waianae Mountain caldera complex:

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: *Antidesma*, *Chamaesyce*, *Diospyros*, *Dodonaea*. (E) Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Schiedea*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Korthalsella degeneri* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Pollination potentially abiotic and by insect (EPA, 2016).

Habitat Type

Adult: Terrestrial (USFWS, 2012)

Habitat Vegetation or Surface Water Classification

Adult: Forest in dry cliff ecosystem (USFWS, 2012)

Dependencies on Specific Environmental Elements

Adult: Parasitic on the native trees *Sapindus oahuensis* (kaulu) and *Nestegis sandwicensis* (olopua) (USFWS, 2012).

Geographic or Habitat Restraints or Barriers

Adult: Elevations between 1,100 and 1,500 ft (USFWS, 2012).

Environmental Specificity

Adult: Parasitic to two species of native trees (USFWS, 2012).

Habitat Narrative

Adult: This species occurs in diverse forest in the dry cliff ecosystem at elevations between 1,100 and 1,500 ft (335 and 460 m) in the Waianae Mountains. It is parasitic on the native trees *Sapindus oahuensis* (kaulu) and *Nestegis sandwicensis* (olopua) (USFWS, 2012).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Potential dispersal mechanisms are abiotic and biotic (EPA, 2016).

Population Information and Trends**Population Trends:**

Decline of >10% (NatureServe, 2015)

Species Trends:

Unknown (NatureServe, 2015)

Resiliency:

Medium (inferred from NatureServe, 2015)

Representation:

Medium (inferred from NatureServe, 2015)

Redundancy:

Medium (inferred from NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

250 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Prior to human arrival on Oahu, native mesic forests were widespread and abundant and it is assumed that this species was relatively abundant within this habitat type (USFWS 2003). Long-term decline of >10%. One occurrence is estimated to have between 900 and 1000 individuals (J. Lau, in litt. 2000 cited by USFWS 2011). Two occurrences (J. Lau, in litt. 2000; U.S. Army 2006 cited by USFWS 2011). (NatureServe, 2015). Confirmation of the identification of these

individuals is difficult because another related species, *Korthalsella platycaula*, is also found in Makua Valley (USFWS, 2012).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative plants, animals (pigs and goats), fire, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Fire can destroy dormant seeds as well as the plants themselves, even in steep or inaccessible areas. Successive fires that burn farther and farther into native habitat destroy native plants, and remove habitat for native species by altering microclimate conditions favorable to alien plants. The projected effects of climate change will likely exacerbate the effects of the other threats to the species (USFWS, 2012).

Stressor: Predation and herbivory (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs and goats) is considered an ongoing threat to *Korthalsella degeneri* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2012).

Stressor: Loss of host plants and trampling by humans (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: *Korthalsella degeneri* faces the threat of loss of host plants. *Korthalsella degeneri* is an obligate parasite on two native host plants, *Sapindus oahuensis* and *Nestegis sandwicensis*, which occur in the dry cliff ecosystem of the Waianae Mountains of Oahu. Introduced ungulates are a threat to the host plants, because of trampling and topsoil disruption, leading to erosion and the establishment and spread of nonnative plants (USFWS, 2012).

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor:

Exposure:
Response:
Consequence:
Narrative:

Stressor:
Exposure:
Response:
Consequence:
Narrative:

Stressor:
Exposure:
Response:
Consequence:
Narrative:

Recovery

Reclassification Criteria:
Not available.

Delisting Criteria:
Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

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SPECIES ACCOUNT: *Labordia cyrtandrae* (Kamakahala)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

Labordia cyrtandrae is a short-lived perennial in the Loganiaceae (logania family). This species is a shrub, 0.7 to 2 m (2.3 to 6.6 ft) tall, with ovate to broadly elliptic leaves, 12 to 30 cm (4.7 to 11.8 in) long and 4 to 14 cm (1.6 to 5.5 in) wide. The pale greenish-yellow flowers form compound panicle cymes of eight to 80. The fruit is 3.2 to 3.5 cm (1.3 to 1.4 in) long, and are some of the largest in the genus. *Labordia* is an endemic Hawaiian genus of 12 species that are known to hybridize. However, no hybrids involving *L. cyrtandrae* have been documented even though this species overlaps in range with numerous other taxa in the genus. The New York Botanical Garden has attempted to hybridize this species with other members of the genus without success. *L. cyrtandrae* is distinguished from others in the genus by its fleshy, hairy, cylindrical stem which flattens upon drying, the shape and length of the floral bracts, and the length of the corolla tube and lobes (Wagner et al. 1999).

Historical Range

Historically, *Labordia cyrtandrae* was known from both the Waianae and Koolau Mountains of Oahu. In the Koolau Mountains, this species extended from Kawailoa trail to Waialae Iki, almost the entire length of the mountain range.

Current Range

Currently, there are 19 known *L. cyrtandrae* individuals remaining in six occurrences: Kaalaea (2 individuals), east Makalaea (4), north Mohiakea (1), north Haleauau (3), south Haleauau (3), and Mount Kaala (6). However, there is a great deal of under-surveyed potential habitat for this taxon on the upper slopes of Mt. Kaala. Occurrences of this plant are declining, and those that remain are small and widely dispersed, which puts the species at risk of extinction from naturally occurring events and/or lack of reproductive vigor (Service 1998a; U.S. Army 2003a; K. Kawelo, U.S. Army, pers. comm. 2003; J. Lau, HINHP, pers. comm. 2003).

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Labordia cyrtandrae* (Kamakahala) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Labordia cyrtandrae* (77 FR 57648-57862). The critical habitat designation includes 32 critical habitat units, which encompass approximately 39,247 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Labordia cyrtandrae* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Labordia cyrtandrae* includes 32 critical habitat units, covering four ecosystem types, which encompass approximately 39,247 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7; Oahu—Lowland Wet—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; Oahu—Montane Wet—Unit 1; Oahu—Wet Cliff—Units 1, 2, 3, 4, 5, 6, 7, 8

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

Oahu—Lowland Wet—Unit 1 [541 ac (219 ha)]. This area consists of 428 ac (173 ha) of State land and 112 ac (46 ha) of City and County of Honolulu land in the lowland wet ecosystem on the windward side of the Waianae Mountains, and partially within the Mokuleia and Waianae Kai Forest Reserves. Oahu—Lowland Wet—Unit 2 [20 ac (8 ha)]. This area consists of 19 ac (8 ha) of State land in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puuhapapa. Oahu—Lowland Wet—Unit 3 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puukanehoa. Oahu—Lowland Wet—Unit 4 [27 ac (11 ha)]. This area consists of 27 ac (11 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains on State land at Puukaua. Oahu—Lowland Wet—Unit 5 [74 ac (30 ha)]. This area consists of 74 ac (30 ha) of State land in the lowland wet ecosystem, on the windward side of the Waianae Mountains at Palikea. Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Waialele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Hauula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in

the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikēkee, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet—Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet—Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu—Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamo Ridge.

Oahu—Montane Wet—Unit 1 [370 ac (150 ha)]. This area consists of 18 ac (7 ha) of City and County of Honolulu land, 352 ac (142 ha) of State land, and less than 1 ac (less than one ha) of privately-owned land in the montane wet ecosystem at the summit of the Waianae Mountains at Kaala, and partially within the Mokuleia Forest Reserve and the Kaala Natural Area Reserve.

Oahu—Wet Cliff—Unit 1 [235 ac (95 ha)]. This area consists of 167 ac (68 ha) of State land, 68 ac (28 ha) of City and County of Honolulu land, and less than 1 ac (less than 1 ha) of privately owned land in the wet cliff ecosystem in the Waianae Mountains, near the summit of Kaala, and partially within the Mokuleia and Waianae Kai FRs and the Kaala Natural Area Reserve. Oahu—Wet Cliff—Unit 2 [3 ac (1 ha)]. This area consists of 3 ac (1 ha) of State land in the wet cliff ecosystem in the Waianae Mountains at Puuhapapa, within a small area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Oahu—Wet Cliff—Unit 3 [16 ac (6 ha)]. This area consists of 16 ac (6 ha) in the wet cliff ecosystem on State land in the Waianae Mountains at Puukanehoa, partially within an area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Oahu—Wet Cliff—Unit 4 [23 ac (9 ha)]. This area consists of 23 ac (9 ha) in the wet

cliff ecosystem on State land in the Waianae Mountains at Puukaua, partially overlapping an area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and recently acquired by the State. Oahu—Wet Cliff—Unit 5 [31 ac (13 ha)]. This area consists of 31 ac (13 ha) of State land in the wet cliff ecosystem in the Waianae Mountains, at Palikea and north of Palikea. Oahu—Wet Cliff—Unit 6 [151 ac (61 ha)]. This area consists of 151 ac (61 ha) in the wet cliff ecosystem on State land on the windward side of the Koolau Mountains in Kaipapau Gulch, entirely within the Kaipapau Forest Reserve. Oahu—Wet Cliff—Unit 7 [144 ac (58 ha)]. This area consists of 144 ac (58 ha) in the wet cliff ecosystem in State land on the windward side of the Koolau Mountains in Hauula Gulch, entirely within the Hauula Forest Reserve. Oahu—Wet Cliff—Unit 8 [4,649 ac (1,881 ha)]. This area consists of 1,479 ac (598 ha) of State land, 1,281 ac (519 ha) of City and County of Honolulu land, 5 ac (2 ha) of Federal land, and 1,884 ac (762 ha) of privately owned land, in the wet cliff ecosystem along the summit of the Koolau Mountains, overlapping portions of Sacred Falls State Park, the Waiahole FR (Waiahole and Iolekaa sections), the Kaneohe and Honolulu Watershed FRs, and the Nuana Pali State Wayside.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Labordia cyrtandrae* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Labordia cyrtandrae* occurs within the Lowland mesic, Lowland wet, Montane wet and Wet cliff ecosystems in the Waianae Mountain caldera complex and the Lowland mesic, Lowland wet and Wet cliff ecosystems in the Koolau Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Oahu—Lowland Wet—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (F) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Oahu—Montane Wet—Unit 1. (A) Elevation: 3,300–6,600 ft (1,000-2,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Well-developed soils, montane bogs. (D) Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. (E) Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. (F) Understory: *Ferns*, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Oahu—Wet Cliff—Units 1, 2, 3, 4, 5, 6, 7, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: >65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. (F) Understory: *Bryophytes*, *Ferns*, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Labordia cyrtandrae* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: *Labordia cyrtandrae* mostly flowers from May through June. Fruit appear from July through August, but this species is sporadically fertile year-round. The flowers are functionally unisexual with male and female flowers on separate plants. Little else is known about its flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors (Service 1998a).

Habitat Type

Adult: Mesic to wet forests and shrublands

Habitat Narrative

Adult: *Labordia cyrtandrae* typically grows in shady gulches, slopes, and glens in mesic to wet forests and shrublands dominated by *Metrosideros polymorpha*, *Diplopterygium pinnatum*, and/or *Acacia koa*. It is found between 212 and 1,233 m (695 and 4,044 ft) elevation. Associated native plant species include *Antidesma* sp., *Artemisia australis*, *Bidens torta*, *Boehmeria grandis*, *Broussaisia arguta*, *Chamaesyce* sp., *Coprosma* sp., *Cyrtandra* sp., *Dicranopteris linearis*, *Diplazium sandwichianum*, *Dubautia plantaginea*, *Lysimachia hillebrandii*, *Peperomia membranacea*, *Perrottetia sandwicensis*, *Phyllostegia* sp., *Pipturus albidus*, *Pouteria sandwicensis*, *Psychotria* sp., or *Rumex* sp. (HINHP Database 2001; Service 1998a).

Dispersal/Migration

Population Information and Trends

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Fragility unknown. Currently about 8-9 plants observed. 3 current (between 1982 and 1997) and 13 historical occurrences. (NatureServe, 2015)

Threats and Stressors

Stressor:**Exposure:****Response:****Consequence:**

Narrative: The major threats to *Labordia cyrtandrae* include loss of habitat and degradation of the remaining habitat by non-native plants and animals. The non-native plants threaten *L. cyrtandrae* by altering its habitat and competing with it for nutrients, light, and space. These non-native plants include *Axonopus fissifolius*, *Clidemia hirta*, *Juncus planifolius*, *Psidium cattleianum*, *Rubus argutus*, *Setaria parviflora*, and *Schinus terebinthifolius*. Feral pigs can impact *L. cyrtandrae* by consuming fruits and other plant parts, or by rooting soil which degrades the habitat. Rats also threaten this species by consuming fruits and other plant parts. The small number of individuals of *L. cyrtandrae* and the loss of its normal pollinators may result in decreased genetic variability within and among occurrences over successive generations and could potentially lead to inbreeding depression. The small number of remaining individuals also makes this species vulnerable to extinction from random environmental events. Some individuals are threatened by fire from military activities (HINHP Database 2001; Service 1998a).

Recovery**Conservation Measures and Best Management Practices:**

- A State-wide management plan should be developed and implemented for the long-term conservation of all known occurrences of *Labordia cyrtandrae*. This plan should also include broader landscape actions that are needed for the recovery of this plant throughout its range. The recovery plan for this species identifies important conservation needs for *L. cyrtandrae*. Where feasible, exclosures should be constructed around the remaining occurrences of this plant to reduce impacts from feral pigs. Subsequent control or removal of pigs from these areas and the broader landscape will alleviate their impact on native ecosystems. If fencing is not logistically feasible, other methods of ungulate control are recommended. In this case, removal and control of pigs over a larger landscape is essential to the conservation of *L. cyrtandrae*. Non-native plants should be removed or controlled in the vicinities of all known occurrences. A coordinated fire protection plan for endangered plant species on Federal land needs to be developed and implemented. Occurrences of *L. cyrtandrae* are also seriously threatened by rat predation. Removal and control of rats using approved rodenticides should be emphasized during fruiting season and, when approved, should include aerial dispersal of rodenticides over the broader landscape. To prevent extinction of *L. cyrtandrae*, ex situ propagation should be initiated with material from all known occurrences. To date, ex situ propagation has not been successful. More research must be conducted to determine a successful method of ex situ propagation (Service 1998a).

References

USFWS 2016. Status of the Species and Critical Habitat: *Labordia cyrtandrae* (Kamakahala). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016.

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

U.S. Fish and Wildlife Service. 2012. Endangered and Threatened Wildlife and Plants

Endangered Status for 23 Species on Oahu and Designation of Critical Habitat for 124 Species. Final Rule. 77 FR 57648-57862 (September 18, 2012)

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.”

SPECIES ACCOUNT: *Labordia helleri* (Kamakahala)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (R1) (USFWS, 2016)

Physical Description

A shrub 2 - 4.5 m tall, sometimes climbing. Cymes are pendulous or erect, with 3 - 9 flowers. Corollas are white or pale greenish yellow (NatureServe, 2015).

Taxonomy

A member of the logania family (Loganiaceae) (Wagner et al. 1999, pp. 856–857) (USFWS, 2010b). The genus is widespread in tropics and subtropics, rarely temperate species endemic to Kauai. It is closely related to *L. tinifolia* differs in having longer corolla lobes and in fruit characteristics (NatureServe, 2015).

Historical Range

Historically, *L. helleri* was wide-ranging on Kauai. Collections were made as far south as the Haupu Mountains, through central Kauai to the northwestern coast (HBMP 2007) (USFWS, 2010b).

Current Range

The largest population extends from the Na Pali Kona Forest Reserve into Kuia Natural Area Reserve (NAR). Other populations occur at upper Mahanaloa, Limahuli, Waioli, Kaunuohua ridge, Kohua ridge, Koaie stream, Kawaiiki, southeast Puu Kolo, and Puu Kolo-Kahuamoa (Kauai) (USFWS, 2010b).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Labordia helleri* (Kamakahala) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 17 critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Labordia helleri* includes 17 CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Lowland Mesic—Section 1: Lowland Mesic—Section 1 consists of 2,006 ac (812 ha) in the lowland mesic ecosystem, including mesic forest extending from Awaawapuhi Trail south to Makaha Ridge, in the Na Pali Kona Forest Reserve and the Kuia NAR (Figure 1-A). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plants *Doryopteris angelica*, *Labordia helleri*, *Platydesma rostrata* and *Psychotria hobbdi*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that

is essential to the conservation of these four species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic—Section 1 is not known to be occupied by the species *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Dubautia kenwoodii*, *Pittosporum napaliense*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 2: Lowland Mesic—Section 2 consists of 379 ac (154 ha) in the lowland mesic ecosystem, including mesic forest extending from Keanapuka to Kahuamaa Flat along the rim and cliffs of the Kalalau Valley, in the Na Pali Coast State Park (Figure 1-A, above). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plants *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Pittosporum napaliense*, and *Psychotria hobdyi*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these six species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic—Section 2 is not known to be occupied by the species *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Platydesma rostrata*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 3: Lowland Mesic—Section 3 consists of 124 ac (50 ha) in the lowland mesic ecosystem, including mesic forest extending from Manono Ridge, Pohakuao Valley, to Kanakuu, within the Na Pali Coast State Park (Figure 1- A, above). The entire section is Stateowned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plants *Canavalia napaliensis*, *Chamaesyce eleanoriae*, and *Charpentiera densiflora*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these three species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic—Section 3 is not known to be occupied by the species *Chamaesyce remyi* var. *remyi*, *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Pittosporum napaliense*, *Platydesma rostrata*, *Psychotria hobdyi*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 4: Lowland Mesic—Section 4 consists of 81 ac (33 ha) in the lowland mesic ecosystem, including mesic forest at the head of the Hanakapiai Valley, in the Na Pali Coast State Park (Figure 1-A, above). The entire section is Stateowned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plant *Charpentiera densiflora* and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. Although Lowland Mesic—Section 4 is not known to be occupied by the species *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *Chamaesyce remyi* var. *remyi*, *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Pittosporum napaliense*, *Platydesma rostrata*, *Psychotria hobdyi*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 5: Lowland Mesic—Section 5 consists of 37 ac (15 ha) in the lowland mesic ecosystem, including mesic forest on the slopes of Mt. Haupu, on privately owned land (Figure 1-B). The entire section is within previously designated critical habitat, and falls within Critical Habitat Unit 7 of 50 CFR 17.99(a)(1), Map 23a. This section is occupied by the plants *Chamaesyce remyi* var. *remyi* and *Tetraplasandra bisattenuata*, and includes mesic forest and shrubland, the moisture regime, and subcanopy and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these two species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic—Section 5 is not known to be occupied by the species *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *Charpentiera densiflora*, *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Pittosporum napaliense*, *Platydesma rostrata*, and *Psychotria hobdyi*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 1: Lowland Wet—Section 1 consists of 1,164 ac (471 ha) in the lowland wet ecosystem (117 ac (47.4 ha) on State land; 1,047 ac (424 ha) on private land), including wet forest extending from Kulanalilia into Limahuli Valley to Honoonapali, in the Halelea Forest Reserve (Figure 2-A). The section includes 1,099 ac (445 ha) of State and privately owned land within previously designated critical habitat and 65 ac (26 ha) of newly designated critical habitat on private land. The area that falls within designated critical habitat lies within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and newly designated Critical Habitat Unit 20, Map 217c. This section is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Labordia helleri*, and *Phyllostegia renovans*. This section also contains unoccupied habitat that is essential to the conservation of these four species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory

plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 1 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Melicope paniculata*, *M. puberula*, *Platydesma rostrata*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 2: Lowland Wet—Section 2 consists of 172 ac (70 ha) in the lowland wet ecosystem, including wet forest extending from Alealau to Pohakea, within the Hono o Na Pali NAR and the Na Pali Coast State Park (Figure 2-A, above). The entire section is Stateowned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plant *Melicope puberula*. This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 2 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope paniculata*, *Phyllostegia renovans*, *Platydesma rostrata*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 3: Lowland Wet—Section 3 consists of 756 ac (306 ha) in the lowland wet ecosystem, including wet forest in upper Wainiha Valley, on privately owned land in the Halelea Forest Reserve (Figure 2-B). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyrtandra oenobarba*, *Melicope puberula*, *Phyllostegia renovans*, and *Stenogyne kealiae*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 3 is not known to be occupied by the species *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope paniculata*, *Platydesma rostrata*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 4: Lowland Wet—Section 4 consists of 591 ac (239 ha) in the lowland wet ecosystem, including wet forest at the head of Lumahai Valley, on State (10 ac, 4.1 ha) and privately owned (581 ac, 235 ha) land in the Halelea Forest Reserve (Figure 2-B, above). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyrtandra oenobarba*, *Melicope paniculata*, *Phyllostegia renovans*, and *Platydesma rostrata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 4 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope puberula*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population numbers of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 5: Lowland Wet—Section 5 consists of 1,541 ac (624 ha) in the lowland wet ecosystem, including wet forest extending from the headwaters of the Wailua River at “Blue Hole” south to Iole, on State (442 ac, 179 ha) and privately owned (1,099 ac, 445 ha) land in the Lihue-Koloa Forest Reserve (Figure 2-C). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36a, and is occupied by the plants *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Melicope paniculata*, *Phyllostegia renovans*, and *Platydesma rostrata*. This section also contains unoccupied habitat that is essential to the conservation of these five5 species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 5 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Labordia helleri*, *Melicope puberula*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 6: Lowland Wet—Section 6 consists of 789 ac (319 ha) in the lowland wet ecosystem, including wet forest extending from Kapalaoa to Kanaele Bog and Lauahihaihai in the Wahiawa Mountains, on State (134 ac, 54 ha) and privately owned (655 ac, 265 ha) land in the Lihue-Koloa Forest Reserve (Figure 2-D). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36a, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Platydesma rostrata*, and *Tetraplasandra bisattenuata*. This section also contains unoccupied habitat that is essential to the conservation of these five

species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 6 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Labordia helleri*, *Melicope paniculata*, *M. puberula*, *Phyllostegia renovans*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Montane Mesic—Section 1: Montane Mesic—Section 1 consists of 2,423 ac (980 ha) in the montane mesic ecosystem, including the area above Honopu Valley to Mahanaloa Valley, on State owned land in Kokee State Park, the Na Pali-Kona Forest Reserve, and Kuia NAR (Figure 3-A). The entire section is within previously designated critical habitat for the plant species, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70c, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Labordia helleri*, *Myrsine knudsenii*, *Platydesma rostrata*, *Psychotria grandiflora*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*. This section is also occupied by the akekee and the picture-wing fly; maps of critical habitat for these species can be found at 50 CFR 17.95(b) for the akekee and akikiki (Unit 1—Montane Mesic), and at 50 CFR 17.95(i) for the picture-wing fly (Unit 1—Montane Mesic). This section also contains unoccupied habitat that is essential to the conservation of these nine species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the montane mesic forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane mesic ecosystem (Table 3), as well as species-specific PCEs for the akekee and akikiki (arthropod prey) and picture-wing fly (the larval-stage host plants, *Cheirodendron* sp. and *Tetraplasandra* sp.). Although Montane Mesic—Section 1 is not known to be occupied by the species *Diellia mannii*, *Myrsine mezii*, and the akikiki, we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Montane Mesic—Section 2: Montane Mesic—Section 2 consists of 376 ac (152 ha) in the montane mesic ecosystem and includes a portion of the area surrounding a tributary of Nawaimaka Stream east to Kumuwela Ridge (Figure 3-A, above). The entire section is State-owned within Kokee State Park, and includes 8 ac (3 ha) of newly designated critical habitat. This section is occupied by *Diellia mannii* and the picture-wing fly *Drosophila sharpi*, and includes the montane mesic forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane mesic ecosystem (Table 3), as well as the larval-stage host plants (*Cheirodendron* sp. and *Tetraplasandra* sp.) associated with the picture-wing fly. This section also contains unoccupied habitat that is essential to the conservation of these two species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Montane Mesic—Section 2 is not known to be occupied by the plants *Chamaesyce remyi* var. *remyi*, *Labordia helleri*, *Myrsine knudsenii*, *Myrsine mezii*,

Platydesma rostrata, *Psychotria grandiflora*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*, or by the birds the akekee and akikiki, we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range, as well as species-specific PCEs for the akekee and akikiki (arthropod prey). Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, that portion of the section that overlies previously designated critical habitat falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70c. The previously undesignated land comprises Critical Habitat Unit 21 of 50 CFR 17.99(a)(1), Map 217d. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 2—Montane Mesic), and for the picture-wing fly at 50 CFR 17.95(i) (Unit 2—Montane Mesic).

Kauai—Montane Mesic—Section 3: Montane Mesic—Section 3 consists of 139 ac (56 ha) in the montane mesic ecosystem, including the upper portion of the Nawaimaka Valley up to Kapukapaia Ridge, on State-owned land in the Na Pali-Kona Forest Reserve (Figure 3-B). This section is not in previously designated critical habitat and includes the only montane mesic forest occupied by the plant *Myrsine mezii*, and the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. Although Montane Mesic—Section 3 is not known to be occupied by the plants *Chamaesyce remyi* var. *remyi*, *Labordia helleri*, *Myrsine knudsenii*, *Myrsine mezii*, *Platydesma rostrata*, *Psychotria grandiflora*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*; by the birds the akekee and akikiki; or by the picturewing fly *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. It also provides for the species-specific PCEs for the akekee and akikiki (arthropod prey) and the larval-stage host plants (*Cheirodendron* sp. and *Tetraplasandra* sp.) associated with *D. sharpi*. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, this section comprises Critical Habitat Unit 22 of 50 CFR 17.99(a)(1), Map 217e. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 3—Montane Mesic), and for the picturewing fly at 50 CFR 17.95(i) (Unit 3—Montane Mesic).

Kauai—Montane Wet—Section 1: Montane Wet—Section 1 consists of 13,055 ac (5,257 ha) in the montane wet ecosystem, extending across the Alakai Plateau from Hanakoa to Mount Waialeale, on State (12,628 ac, 5,110 ha) and privately owned (427 ac, 173 ha) land in the Na Pali Coast State Park, the Alakai Wilderness Preserve, the Na PaliKona and Halelea forest reserves, and Hono o Na Pali NAR (Figure 4). It is occupied by the plants *Astelia waialealae*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *K. helenae*, *Labordia helleri*, *L. pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, and *Platydesma rostrata*; by the akekee and akikiki; and by the picture-wing fly. This section also contains unoccupied habitat that is essential to the conservation of these 18 species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the montane wet forest, the moisture regime, and canopy, subcanopy, and understory plant species

identified as PCEs in the montane wet ecosystem (Table 3), and the species-specific PCEs including (1) bogs (identified as PCEs for *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*) (2) bog hummocks (identified as PCEs for *Astelia waialealae* and *Lysimachia daphnoides*); (3) arthropod prey (identified as PCEs for the akekee and the akikiki); and (4) larval-stage host plants, *Cheirodendron* and *Tetraplasandra* sp., (identified as a PCE for the picture-wing fly). Although Montane Wet–Section 1 is not known to be occupied by the plants *Dubautia kalalauensis*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, those portions of the section that overlies previously designated critical habitat fall within two existing Critical Habitat Units of 50 CFR 17.99(a)(1): Unit 10, Map 35a; and Unit 11, Map 64a. The previously undesignated land comprises Unit 23, Map 217f; and Unit 24, Map 217g. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 4–Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 4–Montane Wet).

Kauai—Montane Wet—Section 2: Montane Wet–Section 2 consists of 790 ac (320 ha) in the montane wet ecosystem, extending from Kahuamaa Flat south to the edge of Waimea Canyon, on State-owned land in Kokee State Park (Figure 4, above). The entire section is within previously designated critical habitat, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Dubautia kalalauensis*, *Labordia helleri*, *Melicope puberula*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*, and by the akekee. This section includes montane wet forest, potentially some small-scale boggy areas, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and arthropod prey (identified as a species-specific PCE for the akekee). Although Montane Wet–Section 2 is not known to be occupied by the plants *Astelia waialeale*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialeale*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *Myrsine mezii*, and *Phyllostegia renovans*; by the akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. This area also supports the arthropod prey identified as a PCE for the akikiki, and the larval-stage host plants (*Cheirodendron* and *Tetraplasandra* spp.) identified as a PCE for the picturewing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within previously designated Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 5–Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 5–Montane Wet).

Kauai—Montane Wet—Section 3: Montane Wet–Section 3 consists of 413 ac (167 ha) in the montane wet ecosystem, encompasses the summit of Namolokama, on State (156 ac, 63 ha) and privately owned (257 ac, 104 ha) land in the Halelea Forest Reserve (Figure 4, above). It is entirely within previously designated critical habitat, and is occupied by the plants *Keysseria erici* and *Labordia pumila*. This section includes the montane wet forest, the moisture regime, and the canopy, subcanopy, and understory plant species identified as PCEs in the montane wet

ecosystem (Table 3), and bogs (identified as a species-specific PCE for *K. erici*). Although Montane Wet–Section 3 is not known to be occupied by the plants *Astelia waialeale*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia kalalauensis*, *D. waialeale*, *Geranium kauaiense*, *Keysseria helenae*, *Labordia helleri*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*; by the akekee and akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. It also supports the arthropod prey identified as a PCE for the akekee and akikiki, and the larval-stage host plants (*Cheirodendron* and *Tetraplasandra* spp.) identified as a PCE for the picture-wing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 6–Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 6–Montane Wet).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Labordia helleri* critical habitat consists of four components (Lowland mesic, Lowland wet, Montane mesic, Montane wet) (75 FR 18960-19165):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<914 m). Annual precipitation: 50–75 in (127–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Ecosystem: Lowland Wet. Elevation: <3,000 ft (<914 m). Annual precipitation: >75 in (>190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Montane Wet. Elevation: 3,000–5,243 ft (914–1,598 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Ecosystem: Montane Mesic. Elevation: 3,300–5,243 ft (914–1,598 m). Annual precipitation: 50–75 in (127–190 cm). Substrate: weathered aa lava, rocky mucks, thin silty loams, deep volcanic ash soils. Canopy: *Acacia*, *Metrosideros*, *Psychotria*, *Tetraplasandra*, *Zanthoxylum*. Subcanopy: *Cheirodendron*, *Coprosma*, *Kadua*, *Ilex*, *Myoporum*, *Myrsine*. Understory: *Bidens*, *Dryopteris*, *Leptecophylla*, *Poa*, *Scaevola*, *Sophora*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations

or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to

further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from NatureServe, 2015)

Reproduction Narrative

Adult: *Labordia* species are functionally dioecious (Motley and Carr 1998), potentially making reproduction more difficult in very small occurrences (NatureServe, 2015).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: *Metrosideros-Acacia-Dicranopteris* mesic to wet forest (USFWS, 2010b)

Geographic or Habitat Restraints or Barriers

Adult: 1,200 - 3,900 ft. elevation (USFWS, 2010b)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits moist forests in gulches or on ridges. The environmental specificity is unknown (NatureServe, 2015). It occurs in *Metrosideros-Acacia-Dicranopteris* mesic to wet forest, at elevations between 1,200 and 3,900 ft. (366 and 1,189 m), in the lowland mesic, lowland wet, montane mesic, and montane wet ecosystems (HBMP 2007; TNCH 2007) (USFWS, 2010b).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Resiliency:

Very low (inferred from NatureServe, 2015)

Redundancy:

Low to moderate (inferred from USFWS, 2010a)

Number of Populations:

17 (USFWS, 2017)

Population Size:

30 - 1200 (USFWS, 2017)

Population Narrative:

The long term population trend is unknown. Total estimated AOO is 36 sq. km (NatureServe, 2015). There are ten populations totaling 350 - 550 individuals (USFWS, 2010a). Herbarium specimens document occurrences from 2010 through 2017 at Honopu, Awaawapuhi and Nualolo, Mahanaloa to Milolii, Kohua, Kawaiiki, Nawaimaka, Kumuwela, Koaie, and Kapalaoa (NTBG 2010a-d, 2011a-f, 2012a-i, 2013a-d, 2015ag, 2016a-q, 2017). Numbers of individuals at these nine locations are estimated to total from 300 to possibly over 1,000 or more. The occurrences at Kumuwela and the Kalalau rim to Milolii ridge are the largest. Currently, Flynn (2016) reports eight "subpopulations" (considered "populations" by USFWS) totaling 100 individuals, with the largest population consisting of 50 individuals (USFWS, 2017).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from non-native plants, pigs, goats, deer, hurricanes, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species.

Stressor: Predation and herbivory (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species present an immediate and significant threat to *Labordia helleri* throughout its range due to documented browsing and trampling by pigs, goats, and deer, and documented mechanical damage by rats (USFWS, 2010).

Stressor:**Exposure:****Response:****Consequence:****Narrative:**

Stressor: Ungulate degradation of habitat

Exposure:**Response:****Consequence:**

Narrative: Feral pigs (*Sus scrofa*), goats (*Capra hircus*), and black-tailed deer (*Odocoileus hemionus*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil (Loope 1998; van Riper and van Riper 1982). Feral pigs goats, and blacktailed deer, and evidence of their activities, have been observed at Kalalau to Milolii, Kawaiiki, Honopu, Mahanaloa, Koaie, Makaha, Kohua, Kumuwela, Kapalaoa, Nawaimaka (HBMP 2010; NTBG 2010a-d, 2011af, 2012a-i, 2013a-b, d, 2015c-g, 2016a-n, q, 2017; PEPP 2011, 2014) (USFWS, 2017).

Stressor: Established ecosystem-altering invasive plant modification and degradation of habitat

Exposure:**Response:****Consequence:**

Narrative: Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community (Cuddihy and Stone 1990). Habitat modification and destruction by invasive introduced plants negatively affects *Labordia helleri* at all locations. The nonnative plants with the greatest impacts include *Clidemia hirta* (Koster's curse), *Erigeron karvinskianus* (daisy fleabane), *Hedychium gardnerianum* (kahili ginger), *Lantana camara* (lantana), *Morella faya* (firetree), *Passiflora tarminiana* (banana poka), *Psidium cattleianum* (strawberry guava), *Rubus argutus* (prickly Florida blackberry), *R. rosifolius* (thimbleberry) and *Sphaeropteris cooperi* (Australian tree fern) (HBMP 2010; NTBG 2010a, 2011b-f, 2012a-i, 2013d, 2015c-g, 2016a-n, q) (USFWS, 2017).

Stressor: Landslides and flooding loss or degradation of habitat

Exposure:**Response:****Consequence:**

Narrative: Floods, including tree falls and erosion associated with them, can have a significant effect on small populations. Landslides and erosion due to natural weathering destabilize substrates, damage and destroy individual plants, and alter hydrological patterns (Stearns 1985). Landslides have been reported to be a threat to populations of *Labordia helleri* at Waioli, Kapalaoa, and Honopu (HBMP 2010; NTBG 2010b-c; PEPP 2014) (USFWS, 2017).

Stressor: Hurricanes—Loss and degradation of habitat

Exposure:**Response:****Consequence:**

Narrative: —In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013) *USFWS, 2017).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Labordia helleri* is vulnerable to the impacts of climate change with a vulnerability score of 0.535 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery

Reclassification Criteria:

In addition to achieving 5 to 10 populations with 1,000 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats (USFWS, 2017).

Delisting Criteria:

In addition to achieving 5 to 10 populations with 1,000 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional

information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis (USFWS, 2017).

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys (USFWS, 2010a).
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units (USFWS, 2010a).
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys (USFWS, 2010a).
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range (USFWS, 2010a).
- Conduct research on control methods for introduced slugs and avian malaria (USFWS, 2010a).
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction (USFWS, 2010a).
- Identify threats and prioritize which ones to address first for the two birds (USFWS, 2010a).
- Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program (USFWS, 2010a).
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security (USFWS, 2010a).
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems (USFWS, 2010a).
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations (USFWS, 2010a).
- Current Management Actions: • Population viability monitoring—PEPP has begun monitoring some individuals at Awaawapuhi and Honopu (PEPP 2011, 2014). • Ungulate monitoring and control—In 2009, NTBG completed portions of an ungulate (pig and goat) exclusion fence around the perimeter of Limahuli Valley on Wainiha and Hanakapiai Ridge. In addition, monitoring for feral ungulate breaches within the fenced areas of Limahuli Preserve is ongoing (NTBG 2008). • Invasive plant monitoring and control—Invasive plant

- control is ongoing within Limahuli Preserve (NTBG 2008). • A couple hundred seeds have been collected and stored at NTBG seed bank from five populations. Seeds were also propagated but only one plant had been planted in the gardens, from the Waimea location (NTBG 2013e, 2014, 2015h). Seeds were collected by PEPP in 2011 and sent to the DOFAW propagation facility (USFWS, 2017).
- **RECOMMENDATIONS FOR FUTURE ACTIONS** • Surveys and inventories—Continue to survey for other populations of *Labordia helleri* in areas of potentially suitable habitat. • Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect individuals of *Labordia helleri*. Control feral ungulates within fenced exclosures. • Invasive plant monitoring and control—
 - o Control established ecosystem-altering nonnative invasive plant species around all populations.
 - o Control invasive nonnative plant species around all populations that compete with the species.
 - Predator and herbivore monitoring and control—Implement effective control methods for rodents. • Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms. • Population biology research—Study *Labordia helleri* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. • Based on the recovery criteria above, consider development of a recovery plan (USFWS, 2017).

Conservation Measures and Best Management Practices:

- This species is currently in controlled propagation for genetic storage and/or reintroduction efforts (USFWS, 2010a).

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SPECIES ACCOUNT: *Labordia lorenciana* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2016)

Physical Description

A small tree. Individuals are 10 to 13 ft. (3 to 4 m) tall. The bark is grayish brown and mottled white or dark brown. Leaves are opposite, chartaceous (papery), and hairy. Flowers, functionally unisexual, are green, forming unbranched cymes. Fruit mature to brown capsules 1 to 1.5 in (25 to 37 mm) with ellipsoid 0.08 to 0.12 in (2 to 3 mm) seeds (Wood et al. 2007, pp. 195–197) (USFWS, 2015).

Taxonomy

A member of the Logania family (Loganiaceae) (USFWS, 2015).

Historical Range

Known only from the Kawai`iki Valley, Kauai (NatureServe, 2015).

Current Range

Kawaiiki Valley, Kauai. Additional surveys for *L. lorenciana* have not been successful; however, experts believe this species may occur in other areas (Wood et al. 2007, p. 198) (USFWS, 2015).

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available

Habitat Type

Adult: Terrestrial (USFWS, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Montane mesic forest (USFWS, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at 3,800 ft. elevation (USFWS, 2015)

Habitat Narrative

Adult: This species occurs on the island of Kauai at 3,800 ft. (1,160 m), in forest in the montane mesic ecosystem (Wood et al. 2007, pp. 197–198) (USFWS, 2015). Occurs on a north-facing slope in association with montane mixed mesic forest and is restricted to the lower drainage banks (Wood et al. 2007). The slope is moderate with a substrate composed of brown granular soil with basalt talus and abundant leaf litter (Wood et al. 2007) (NatureServe, 2015).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Very low (inferred from USFWS, 2015)

Redundancy:

Very low (inferred from USFWS, 2015)

Number of Populations:

1 (USFWS, 2015)

Population Size:

4 (USFWS, 2015)

Population Narrative:

Currently, there are four known individuals in Kawaiiki Valley (USFWS, 2015).

Threats and Stressors

Stressor: Nonnative mammals (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Feral pigs and goats modify and destroy the habitat of *Labordia lorenciana* (Wood et al. 2007, p. 198). In Hawaii, pigs dig up forest ground cover consisting of delicate and rare species of orchids, ferns, mints, lobeliads, and other taxa, including their roots, tubers, and rhizomes (Stone and Anderson 1988, p. 137). Goats can be highly destructive to native vegetation and contribute to erosion by: (1) Eating young trees and young shoots of plants before they become established; (2) creating trails that damage native vegetative cover; (3) destabilizing substrate and creating gullies that convey water; and (4) dislodging stones from ledges that results in rockfalls and landslides that damage or destroy native vegetation below (Cuddihy and Stone 1990, pp. 63–64) (USFWS, 2015).

Stressor: Nonnative plants (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Competition with nonnative plant species, including *Lantana camara*, *Passiflora tarminiana* (banana poka), *Psidium cattleianum* (strawberry guava), and *Rubus argutus*, is a

threat to *L. lorenciana*, as these nonnative plants have the ability to spread rapidly and cover large areas in the forest understory, and can outcompete native plants (Smith 1985, pp. 180–250; Vitousek et al. 1987 in Cuddihy and Stone 1990, p. 74; Wood et al. 2007, p. 198) (USFWS, 2015).

Stressor: Small population size/stochastic events (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Randomly occurring natural events, such as landslides, flash floods, fallen tree limbs, and fire, are a likely threat to *L. lorenciana* where it occurs on Kauai (Wood et al. 2007, p. 198). This species may experience reduced reproductive vigor as there is no in situ seedling recruitment and a very small number of individuals remain (Wood et al. 2007, p. 198) (USFWS, 2015).

Stressor: Predation (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Predation of seeds by rats is a likely threat to this species (Wood et al. 2007, p. 198). Herbivory by nonnative slugs is reported to adversely impact this species (USFWS, 2015).

Stressor: Climate change (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to the ecosystem that supports this species. Fortini et al. (2013, pp. 1-134) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013, p. 79) concluded that *Labordia lorenciana* is highly vulnerable to the impacts of climate change (USFWS, 2014).

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- The National Tropical Botanical Gardens on Kauai has several propagated individuals (Wood et al. 2007, pp. 195-199). Current efforts are directed toward creating a reproductively successful ex situ

stock (Wood et al. 2007, pp. 195-199), which if successful, will likely be outplanted in suitable habitat (USFWS, 2014).

- Continue to survey for populations of *Labordia lorenciana* in areas of potentially suitable habitat (USFWS, 2014).
- Continue propagation efforts for maintenance of genetic stock (USFWS, 2014).
- Reintroduce individuals into suitable habitat within historic range that is being managed for additional known threats (e.g., nonnative animals and plants) to this species (USFWS, 2014).

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SPECIES ACCOUNT: *Labordia lydgatei* (Kamakahala)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/20/1991; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Labordia lydgatei is a much-branched shrub or small tree 2 to 3 m (6.5 to 10 ft) tall with sparsely hairy, square stems. The opposite leaves are elliptic, often wider toward the tip, 5 to 10 cm (2 to 4 in) long, and 2 to 7 cm (0.8 to 2.8 in) wide, smooth above and with fine hairs on the lower surface. Intra-petiole stipules are present. The inflorescences are produced at the ends of the stems and comprise 6 to 21 small, slender, tubular pale yellow flowers about 0.7 cm (0.3 in) long. Flower buds were collected in May and mature flowers in July. Green fruits were collected in October. The fruit is a small ovoid capsule with a short, blunt beak. At maturity it splits into two valves to expose the seed mass (Forbes 1916, Sherff 1939, Wagner et al. 1990). (USFWS, 1994)

Taxonomy

Labordia is a Hawaiian endemic genus of 15 woody species related to *Geniostoma* (Sherff 1939, Wagner et al. 1990). The Hawaiian vernacular name for members of this genus is kamakahala. (USFWS, 1994). A member of the logania family (Loganiaceae) (USFWS, 2003).

Historical Range

Historically known from the Wahiawa drainage, Waioli Stream Valley, and Makaleha Mountains on Kauai (USFWS, 2003).

Current Range

Currently known at Pali Elele, Waioli Valley, Lelewi, Lumahai Valley, and Kapalaoa on Kauai (USFWS, 2003).

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Labordia lydgatei* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Labordia lydgatei* includes five units totaling 5,307 acres in Kauai County, Hawaii. The units are Kauai 4—*Labordia lydgatei*—a, Kauai 10—*Labordia lydgatei*—b, and Kauai 11— *Labordia lydgatei*—c, d, e.

Kauai 4—*Labordia lydgatei*—a: This unit is critical habitat for *Labordia lydgatei* and is 587 ha (1,455 ac) on State (Kealia and Moloaa Forest Reserves) and private land. This unit contains Kekoiki, Lelewi, Namahana, and Puu Awa Summits. This unit provides habitat for one population of 250 mature, reproducing individuals of the short-lived perennial *Labordia lydgatei* and is currently occupied with one plant. This unit is essential to the conservation of the taxon because

it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, stream banks in *Metrosideros polymorpha-Dicranopteris linearis* forest. This unit is geographically separated from the other four units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 10—*Labordia lydgatei*—b: This unit is critical habitat for *Labordia lydgatei* and is 1,035 ha (2,558 ac) on State (Lihue-Koloa Forest Reserve) and private land. This unit contains Hulua, Iole, Kahile, and Pilikea Summits. This unit provides habitat for two populations of 250 mature, reproducing individuals of the shortlived perennial *Labordia lydgatei* and is currently occupied with five plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, stream banks in *Metrosideros polymorpha-Dicranopteris linearis* forest. This unit is geographically separated from the other four units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 11—*Labordia lydgatei*—c: This unit is critical habitat for *Labordia lydgatei* and is 325 ha (804 ac) on private land within Lumahai Valley. This unit provides habitat for one population of 250 mature, reproducing individuals of the short-lived perennial *Labordia lydgatei* and is currently occupied with seven plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, stream banks in *Metrosideros polymorpha-Dicranopteris linearis* forest. This unit is geographically separated from the other four units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Labordia lydgatei*—d: This unit is critical habitat for *Labordia lydgatei* and is 82 ha (204 ac) on State land (Halelea Forest Reserve). This unit contains portions of Waioli Valley and Waiopa Summit. This unit provides habitat for one population of 250 mature, reproducing individuals of the short-lived perennial *Labordia lydgatei* and is currently occupied with two plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, stream banks in *Metrosideros polymorpha-Dicranopteris linearis* forest. This unit is geographically separated from the other four units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Labordia lydgatei*—e: This unit is critical habitat for *Labordia lydgatei* and is 119 ha (291 ac) on State (Halelea Forest Reserve, Hono o Na Pali NAR, and Na Pali Coast State Park) and private land. This unit contains Hono O Na Pali and Pali Elele Summits. This unit provides habitat for one population of 300 mature, reproducing individuals of the shortlived perennial *Labordia lydgatei* and is currently occupied with two plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is

currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, stream banks in *Metrosideros polymorpha*-*Dicranopteris linearis* forest. This unit is geographically separated from the other four units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

- (i) Streambanks in *Metrosideros polymorpha*-*Dicranopteris linearis* lowland wet forest containing one or more of the following associated native plant species: *Antidesma platyphyllum* var. *hillebrandii*, *Cyanea* spp., *Cyrtandra* spp., *Dubautia knudsenii*, *Hedyotis terminalis*, *Ilex anomala*, *Labordia hirtella*, *Psychotria* spp., or *Syzygium sandwicensis*; and
- (ii) Elevations between 182 and 1,148 m (597 and 3,737 ft).

Special Management Considerations or Protections

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Breeding Season

Adult: April to October (USFWS, 2009)

Reproduction Narrative

Adult: Motley and Carr (1998) examined flowers of 13 of the 16 Hawaiian endemic species of *Labordia* to confirm that they are functionally dioecious (containing both male and female parts but only one of those parts is fertile). Observation from herbarium vouchers at Bernice P. Bishop Museum (C. Imada, Bernice P. Bishop Museum, pers. comm. 2008), National Tropical Botanical Garden (2008a), and database records from the Hawaii Biodiversity and Mapping Program (2007) noted flowering in all months between April and October; fruiting specimens were noted from March and May through September. (USFWS, 2009)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015); streambanks (USFWS, 2003)

Geographic or Habitat Restraints or Barriers

Adult: Elevations between 597 and 3,427 ft (USFWS, 2003)

Environmental Specificity

Adult: Low, with few key requirements (USFWS, 1994)

Habitat Narrative

Adult: The habitat of *Hesperomannia lydgatei* and *Labordia lydgatei* in the upper Waioli Stream Valley below Namolokama Mtn. at 400 m (1,300 ft) elevation consists of lowland rain forest with *Metrosideros* and *Dicranopteris* dominant (D. Lorence, pers. obser. 1992). This is similar to the species' habitat in the Wahiawa Drainage and the *L. lydgatei* habitat in the Makaleha Mountains. (USFWS, 1994) . Associated native plant species include *Antidesma platyphyllum* var. *hillebrandii* (hame), *Cyanea* spp., *Cyrtandra* spp., *Dubautia knudsenii*, *Hedyotis terminalis*, *Ilex anomala*, *Labordia hirtella* (kamakahala), *Psychotria* spp., or *Syzygium sandwicensis* (USFWS, 2003).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2009)

Redundancy:

Very low (inferred from USFWS, 2009)

Number of Populations:

5 (USFWS, 2009)

Population Size:

29 (USFWS, 2009)

Population Narrative:

In the 2003 rule designating critical habitat, six populations were reported containing 37 individuals located on State (Lihue-Koloa and Halelea Forest Reserves) and privately owned lands at Pali Elele, Waioli Valley, Lelewi, Lumahai Valley, and Kapalaoa. As of 2005, numbers were similar, with five populations containing 29 individuals (USFWS 2008). (USFWS, 2009). New Status Information: • The number of individuals of *Labordia lydgatei* has increased since the time of the last 5- year review in 2009, likely resulting from more intensive surveys in suitable habitat. In 2009, there were five occurrences totaling 29 individuals. Currently, there

are four locations of occurrences. In upper Limahuli from upper Hanakapiai to the Wainiha side there are at least 50 individuals (NTBG 2010a, c, 2011a, c, 2012a-e, i, k-l, 2013b-g, 2014c, e, g). In Wahiawa to Hanapepe and the slopes of Kapalaoa there are seven individuals reported from two locations (2010b, d-f, 2011b, 2012n-o, 2013a). At Iole there is one individual reported, and at Waiahi there is one individual reported (NTBG 2010e, 2012m). These four areas total at least 58 individuals. There were six individuals reported at Makaleha in 2010, but their current status is unknown (PEPP 2010). There are no current reports of individuals last seen in the 1990s at Leleiwi, Waioli, or Iliiliula (HBMP 2010) (USFWS, 2017).

Threats and Stressors

Stressor: Invasive plants (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The major threats to *Labordia lydgatei* include competition from invasive introduced plants species such as *Clidemia hirta* (Koster's curse) and *Rubus rosifolius* (thimbleberry). (USFWS, 2009)

Stressor: Habitat degradation by ungulates (USFWS, 1994; USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Habitat degradation by feral pigs (*Sus scrofa*) and goats (*Capra hircus*) are a major threat. At present feral animals appear to pose a significant threat to the Makaleha area (K. Wood, pers. comm. 1993) and slight to moderate feral pig damage was noted in four areas in the Wahiawa Drainage, and in the Waioli Stream Valley (D. Lorence and T. Flynn, pers. obser. 1991). Rooting was primarily confined to moist, shady valley bottoms along streams. (USFWS, 1994; USFWS, 2009)

Stressor: Seed predation by rats (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Other threats include potential seed predation by rats (*Rattus* spp.). (USFWS, 2009)

Stressor: Landslides (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Although most slopes in these areas are not excessively steep and are usually clothed with vegetation, there is evidence of past landslides in the area, especially after Hurricane Iniki (D. Lorence, pers. obser. 1991-1992). Landslides clearly pose a threat to populations of these species growing on relatively steep slopes or in valley bottoms. (USFWS, 1994)

Stressor: Lack of pollinators (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Two of the species, *Cyanea undulata* and *Labordia lydgatei*, have fruits obviously adapted for bird dispersal. Passage of these seeds through a bird's gut may be necessary to insure their germination, and pollination may be inhibited by a lack of bird or native insect pollinators. (USFWS, 1994)

Stressor: Hurricanes (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: In September 11, 1992 Hurricane Iniki passed directly over Kaua'i with winds gusting up to 175 miles per hour. Considerable damage was inflicted on the native forests in many parts of the island (S. Perlman & K. Wood, pers. comm. 1992). A small part of the Wahiawa Drainage was surveyed on October 7, 1992, to assess hurricane damage to populations of the five endangered species known to occur there (D. Lorence, pers. obser. 1992). Damage to the vegetation varied from slight to severe depending on exposure to the winds, and several landslides had occurred. In this very limited survey at least one or several individuals of each endangered species had been severely damaged or destroyed by winds that uprooted the plants or snapped the main stem, falling trees or branches, or landslides. In the Waioli Stream Valley, two of three *Hesperomania lydgatei* individuals were destroyed by the storm. (USFWS, 1994)

Stressor: Small population size (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: In addition to all of the other threats, species such as *Labordia lydgatei* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding and disease outbreaks. (USFWS, 2009)

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Labordia lydgatei* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.668 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this species has no overlap between current and future climate envelopes, and is unlikely to tolerate expected changes in climate at its current location. This means that this species must persist within suitable microrefugia, or move to newly available climate-compatible areas to avoid extinction. Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery**Reclassification Criteria:**

1. A total of at least three populations of *Cyanea undulata* should be documented, each with at least 250 reproductive individuals. (USFWS, 1994)
2. Each of these populations must be naturally reproducing, stable, or increasing in number, by removal of threats, with adequate percentages of adults, juveniles, and seedlings necessary for long-term maintenance of population numbers and genetic diversity. (USFWS, 1994)
3. The full genetic diversity of each population is backed up as living and stored material at one or more nurseries or botanical gardens. (USFWS, 1994)

Delisting Criteria:

1. The target includes locating or establishing, if necessary, at least two additional wild populations for a total of at least five reproductively stable populations, each with at least 250 reproductive individuals. (USFWS, 1994)
2. These populations should be stable over an estimated ten year period. If new populations are established, they should have optimum genetic composition and be within the historical range of the species. (USFWS, 1994)
3. All five populations should be unmanipulated and able to sustain themselves indefinitely without human intervention (including fencing and introduced invasive plant species control) (USFWS 1994). (USFWS, 1994)

Recovery Actions:

- Secure and manage existing populations. Preservation of the existing habitat at the Wahiawa Drainage, Waioli Stream Valley and Makaleha Mountains is essential to stabilize known populations and prevent the decline of these species, as all the known genetic diversity for the five species occurs here. (USFWS, 1994)
- Conduct basic research essential to the conservation of the five species. Few details regarding the ecology, demographics, propagation, habitat requirements and basic life history of these five species are known and such knowledge is essential to their conservation. (USFWS, 1994)
- Increase population numbers at existing sites. Population sizes of these five species should be increased to viable numbers in the Wahiawa Drainage, Waioli Stream Valley and Makaleha Mountains. Existing populations may be augmented by enhancement of in situ reproduction and by planting viable seeds, cuttings, or air layers in situ, either directly in the ground or in pots containing soil from nearby. (USFWS, 1994)
- Establish new populations. Plans must be developed for establishing new wild populations, including the selection of genetic stock. Ideally, additional populations of each species should be sought on Kaua'i. If these cannot be located or do not exist, and new populations must be established, then a protocol must be formulated for establishing new populations. (USFWS, 1994)
- Verify the scientific validity of the recovery objectives. It is important to determine and verify the scientific validity of the recovery objective proposed herein. (USFWS, 1994)

- **New Management Actions:**
 - Invasive plant monitoring and control—PEPP is monitoring effects of feral ungulates and invasive nonnative plants at several populations of *Labordia lydgatei* (PEPP 2010, 2011, 2012, 2013).
 - Predator and herbivore monitoring and control—PEPP is monitoring several populations and implementing insect control (PEPP 2013).
 - Captive propagation for genetic storage and reintroduction—In 2014 and 2015, 100s of seeds from the larger Limahuli population were collected by individual and placed in storage. There is one founder represented at the Lyon Arboretum Micropropagation Lab. There are 17 collections at the NTBG seed bank representing 11 different founders for short term storage (Lyon Arboretum 2017; NTBG 2017) (USFWS, 2017).
- **Recommendations for Future Actions:** The following recommendations for future actions are reiterated for the 5-year review for 2017.
 - Surveys and inventories—Continue to survey geographical and historic range for a thorough current assessment of the species.
 - Ungulate monitoring and control—Construct enclosure fences to protect individuals from the activities of feral ungulates. Protect all occurrences against disturbances from feral ungulates to prevent imminent extinction.
 - Invasive plant monitoring and control—
 - o Control established ecosystem-altering nonnative invasive plant species around all populations.
 - o Control invasive nonnative species that compete with the species around all populations.
 - Predator and herbivore monitoring and control—
 - o Control rats at all populations.
 - o Investigate impact of insect predation on seeds and determine the need for additional recovery actions.
 - Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock.
 - Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.
 - Genetic research—Assess genetic variability within extant and ex situ individuals.
 - Population biology research—Study *Labordia lydgatei* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats.
 - Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Construct enclosure fences to protect individuals from the activities of feral pigs, and eradicate introduced invasive plant species within the enclosures. (USFWS, 2009)
- Continue collection of genetic resources for storage, future propagation, and reintroduction into protected suitable habitat within historical range. (USFWS, 2009)
- Enhance current natural populations to increase numbers of individuals. (USFWS, 2009)
- Work with the Kauai Watershed Alliance to continue and expand ecosystem-level management of the Wahiawa Bog area and to initiate planning and contribute to implementation of ecosystem level restoration and management to benefit this species in the Makaleha area. (USFWS, 2009)
- Survey geographical and historical range for a thorough current assessment of the status of the species. (USFWS, 2009)
- Assess genetic variability within extant and ex situ individuals. (USFWS, 2009)
- Study *Labordia lydgatei* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. (USFWS, 2009)

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SPECIES ACCOUNT: *Labordia pumila* (Kamakahala)

Species Taxonomic and Listing Information

Listing Status: Endangered; 5/13/2010; Pacific Region (R1) (USFWS, 2016)

Physical Description

A sparingly branched shrub. Cymes are sessile, with up to 15 flowers. Corollas are orange (NatureServe, 2015).

Taxonomy

A member of the logania family (Loganiaceae) (USFWS, 2010b). This genus is endemic to Hawaiian Islands (NatureServe, 2015).

Historical Range

Little is known of the historical locations of *L. pumila* on Kauai. The type specimen was collected by Wawra (1869, 1870) at the summit of Waialeale (USFWS, 2010b).

Current Range

It occurs on the Alakai plateau, at the summit of Waialeale, along the Wainiha rim, and at Namolakama (Kauai) (USFWS, 2010b).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Labordia pumila* (Kamakahala) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Labordia pumila* includes three CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Montane Wet—Section 1: Montane Wet—Section 1 consists of 13,055 ac (5,257 ha) in the montane wet ecosystem, extending across the Alakai Plateau from Hanakoa to Mount Waialeale, on State (12,628 ac, 5,110 ha) and privately owned (427 ac, 173 ha) land in the Na Pali Coast State Park, the Alakai Wilderness Preserve, the Na PaliKona and Halelea forest reserves, and Hono o Na Pali NAR (Figure 4). It is occupied by the plants *Astelia waialealae*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *K. helenae*, *Labordia helleri*, *L. pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, and *Platydesma rostrata*; by the akekee and akikiki; and by the picture-wing fly. This section also contains unoccupied habitat that is essential to the conservation of these 18 species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the montane wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and the species-specific PCEs

including (1) bogs (identified as PCEs for *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*) (2) bog hummocks (identified as PCEs for *Astelia waialealae* and *Lysimachia daphnoides*); (3) arthropod prey (identified as PCEs for the akekee and the akikiki); and (4) larval-stage host plants, *Cheirodendron* and *Tetraplasandra* sp., (identified as a PCE for the picture-wing fly). Although Montane Wet—Section 1 is not known to be occupied by the plants *Dubautia kalalauensis*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, those portions of the section that overlie previously designated critical habitat fall within two existing Critical Habitat Units of 50 CFR 17.99(a)(1): Unit 10, Map 35a; and Unit 11, Map 64a. The previously undesignated land comprises Unit 23, Map 217f; and Unit 24, Map 217g. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 4—Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 4—Montane Wet).

Kauai—Montane Wet—Section 2: Montane Wet—Section 2 consists of 790 ac (320 ha) in the montane wet ecosystem, extending from Kahuamaa Flat south to the edge of Waimea Canyon, on State-owned land in Kokee State Park (Figure 4, above). The entire section is within previously designated critical habitat, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Dubautia kalalauensis*, *Labordia helleri*, *Melicope puberula*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*, and by the akekee. This section includes montane wet forest, potentially some small-scale boggy areas, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and arthropod prey (identified as a species-specific PCE for the akekee). Although Montane Wet—Section 2 is not known to be occupied by the plants *Astelia waialeale*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialeale*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *Myrsine mezii*, and *Phyllostegia renovans*; by the akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. This area also supports the arthropod prey identified as a PCE for the akikiki, and the larval-stage host plants (*Cheirodendron* and *Tetraplasandra* spp.) identified as a PCE for the picturewing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within previously designated Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 5—Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 5—Montane Wet).

Kauai—Montane Wet—Section 3: Montane Wet—Section 3 consists of 413 ac (167 ha) in the montane wet ecosystem, encompasses the summit of Namolokama, on State (156 ac, 63 ha) and privately owned (257 ac, 104 ha) land in the Halelea Forest Reserve (Figure 4, above). It is entirely within previously designated critical habitat, and is occupied by the plants *Keysseria erici* and *Labordia pumila*. This section includes the montane wet forest, the moisture regime, and the canopy, subcanopy, and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and bogs (identified as a species-specific PCE for *K. erici*). Although Montane

Wet—Section 3 is not known to be occupied by the plants *Astelia waialeale*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia kalalauensis*, *D. waialeale*, *Geranium kauaiense*, *Keysseria helenae*, *Labordia helleri*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*; by the akekee and akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. It also supports the arthropod prey identified as a PCE for the akekee and akikiki, and the larval-stage host plants (*Cheirodendron* and *Tetraplasandra* spp.) identified as a PCE for the picture-wing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 6—Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 6—Montane Wet).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Labordia pumila* critical habitat consists of one component (Montane wet). Species-specific PCEs include: Bogs (75 FR 18960-19165):

Ecosystem: Montane Wet. Elevation: 3,000–5,243 ft (914-1,598 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: *Ferns*, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat

caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual: cross-pollination (inferred from NatureServe, 2015)

Reproduction Narrative

Adult: Labordia species are functionally dioecious (Motley and Carr 1998), potentially making reproduction more difficult in very small occurrences (NatureServe, 2015).

Habitat Type

Adult: Terrestrial, wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Metrosideros polymorpha mixed sedge and grass bogs (USFWS, 2010b); wet forest and shrubland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 3,478 - 5,100 ft. elevation (USFWS, 2010b)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits wet forests and shrublands, and montane bogs. The environmental specificity is unknown (NatureServe, 2015). It occurs in the montane wet ecosystem at elevations between 3,478 and 5,100 ft. (1,060 to 1,555 m) in Metrosideros polymorpha mixed sedge and grass bogs (Wagner et al. 1999, p. 860; HBMP 2007; TNCH 2007) (USFWS, 2010b).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Species Trends:

Stable (NatureServe, 2015)

Resiliency:

Very low (inferred from USFWS, 2010b; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2010a)

Number of Populations:

4 (USFWS, 2017)

Population Size:

~500 (USFWS, 2017)

Population Narrative:

The long term population trend is unknown. Apparently, plant numbers fluctuated very little between 2001 and 2004 (Marie Bruegmann, pers. comm. to USFWS 2004) (NatureServe, 2015). There are three populations totaling 500 individuals (USFWS, 2010a). *Labordia pumila* persists in the Waialeale and Kilohana bogs, and in 2013 individuals were found at Kawaikini. Currently, these populations remain the same, with a new population of at least two individuals found further east at Kawaikini (NTBG 2013b, 2015) (USFWS, 2017)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from non-native plants, pigs, hurricanes, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species.

Stressor: Predation and herbivory (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species present an immediate and significant threat to *Labordia pumila* throughout its range due to documented browsing and trampling by pigs, goats, and deer (USFWS, 2010).

Stressor: Ungulate degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Feral pigs (*Sus scrofa*) and goats (*Capra hircus*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil (Loope 1998; van Riper and van Riper 1982). Feral pigs and goats and evidence of their activities have been observed at Waialeale, Wainiha, and Kawaikini (HBMP 2010; NTBG 2011, 2013b, 2014, 2015) (USFWS, 2017).

Stressor: Established ecosystem-altering invasive plant modification and degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community (Cuddihy and Stone 1990). Habitat modification and destruction by invasive introduced plants negatively affects *Labordia pumila* at all locations. The nonnative plants with the greatest impacts include *Andropogon glomeratus* (bushy beardgrass), *Andropogon virginicus* (broomsedge), *Axonopus fissifolius* (narrow-leaved carpetgrass), *Blechnum appendiculatum* (NCN), *Buddleja asiatica* (dog tail), *Clidemia hirta* (Koster's curse), *Cyperus meyenianus* (NCN), *Erigeron karvinskianus* (daisy fleabane), *Hedychium gardnerianum* (kahili ginger), *Juncus planifolius* (rush), *Melastoma septemnerium* (NCN), *Paspalum conjugatum* (Hilo grass), *P. urvillei* (vasey grass), *Psidium cattleianum* (strawberry guava), *Rhodomyrtus tomentosa* (downy myrtle), *Rubus argutus* (prickly Florida blackberry), *R. rosifolius* (thimbleberry), *Sacciolepis indica* (glenwood grass), and *Sphaeropteris cooperi* (Australian tree fern) (HBMP 2010; NTBG 2013b, 2014, 2015) (USFWS, 2017).

Stressor: Landslides and flooding loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Landslides and erosion due to natural weathering destabilize substrates, damage and destroy individual plants, and alter hydrological patterns (Stearns 1985). Landslides have been reported to be a threat to population of *Labordia pumila* at Kawai'ini (NTBG 2015) (USFWS, 2017).

Stressor: Hurricanes—Loss and degradation of habitat

Exposure:

Response:

Consequence:

Narrative: In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013) (USFWS, 2017).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate

change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Labordia pumila* is highly vulnerable to the impacts of climate change with a vulnerability score of 0.786 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery

Reclassification Criteria:

In addition to achieving 5 to 10 populations with 1,000 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats (USFWS, 2017).

Delisting Criteria:

In addition to achieving 5 to 10 populations with 1,000 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis (USFWS, 2017).

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys (USFWS, 2010a).
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units (USFWS, 2010a).
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape

modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys (USFWS, 2010a).

- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range (USFWS, 2010a).
- Conduct research on control methods for introduced slugs and avian malaria (USFWS, 2010a).
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction (USFWS, 2010a).
- Identify threats and prioritize which ones to address first for the two birds (USFWS, 2010a).
- Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program (USFWS, 2010a).
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security (USFWS, 2010a).
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems (USFWS, 2010a).
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations (USFWS, 2010a).
- Current Management Actions:
 - Population viability monitoring—USFWS and DOFAW monitor the vegetative cover, vigor, and phenology of *Labordia pumila* regularly within North Bog (Bruegmann 2012).
 - Ungulate monitoring and control—USFWS coordinated with DOFAW to fence the bogs on State land in which *Labordia pumila* occurs (Bruegmann 2002).
 - Invasive plant monitoring and control—Weed control is ongoing within the fenced bogs (Bruegmann 2012) (USFWS, 2017).
- RECOMMENDATIONS FOR FUTURE ACTIONS
 - Surveys and inventories—Survey for populations of *Labordia pumila* in areas of potentially suitable habitat.
 - Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect individuals of *Labordia pumila*. Control feral ungulates within fenced exclosures.
 - Invasive plant monitoring and control
 - o Control established ecosystem-altering nonnative invasive plant species around all populations.
 - o Control invasive nonnative plant species around all populations that compete with the species.
 - Predator and herbivore monitoring and control—Implement effective control methods for rodents.
 - Captive propagation for genetic storage and reintroduction—Begin propagation efforts for maintenance of genetic stock.
 - Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.
 - Population viability monitoring and analysis—Continue to monitor populations at North Bog, Wainiha, Waialeale, and Kawaikini.
 - Population biology research—Study *Labordia pumila* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats
 - Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms.
 - Based on the recovery criteria above, consider development of a recovery plan (USFWS, 2017).

Conservation Measures and Best Management Practices:

- USFWS and the Hawaii Division of Forestry and Wildlife have fenced 9 montane bogs in the Alakai Plateau, totaling approximately 40 hectares (100 acres). These fenced bogs contain some scattered individuals of *L. pumila* (USFWS, 2010a).
- This species is currently in controlled propagation for genetic storage and/or reintroduction efforts (USFWS, 2010a).

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SPECIES ACCOUNT: *Labordia tinifolia* var. *lanaiensis* (Kamakahala)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/03/1999; Pacific Region (R1) (USFWS, 2016)

Physical Description

A shrub or small tree typically 2-8 m tall, with pale yellowish green or greenish yellow flowers (NatureServe, 2015).

Taxonomy

A member of the logan family (Loganiaceae) (USFWS, 2002). Wagner et al. (1999) recognized three varieties of *Labordia tinifolia*: var. *tinifolia*, from Kauai, Oahu, Molokai, Maui, and Hawaii; var. *wahiawaensis*, restricted to Kauai; and var. *lanaiensis*, from Lanai and Mapulehu on Molokai (USFWS, 2012).

Historical Range

Historically, *Labordia tinifolia* var. *lanaiensis* was known from the entire length of the summit ridge of Lanaihale on the island of Lanai (USFWS, 2012).

Current Range

In recent times, the population has become more restricted to the southeastern end of the summit ridge of Lanaihale, which is privately owned land (USFWS, 2012).

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Labordia tinifolia* var. *lanaiensis* (Kamakahala) under the Endangered Species Act of 1973, as amended (Act) (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Labordia tinifolia* var. *lanaiensis* includes an unknown number of CHUs in Maui County, Hawaii with detailed unit information. All known CHUs are on the island of Lanai and detailed CHU information is not available (81 FR 17790-18110).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Labordia tinifolia* var. *lanaiensis* critical habitat consists of four components. Lowland mesic (Lanai), Lowland wet (Lanai), Montane wet (Lanai) and Wet cliff (Lanai) (81 FR 17790-18110):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<914 m). Annual precipitation: 50–75 in (127–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Ecosystem: Lowland Wet. Elevation: <3,000 ft (<914 m). Annual precipitation: >75 in (>190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Montane Wet. Elevation: 3,000–5,243 ft (914–1,598 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. Understory: Bryophytes, Ferns, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the

conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkii*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Lifespan

Adult: > 10 years (USFWS, 2012)

Breeding Season

Adult: Spring (inferred from USFWS, 2012)

Key Resources Needed for Breeding

Adult: Unknown (USFWS, 2002)

Reproduction Narrative

Adult: While *Labordia tinifolia* var. *lanaiensis* has been described as a short-lived perennial shrub, Hank Oppenheimer (Plant Extinction Prevention Program, pers. comm. 2010) has observed that the species definitely lives longer than ten years, and should be designated as a long-lived shrub, with stabilization, downlisting, and delisting criteria adjusted accordingly. Oppenheimer noted that the fruit of individuals found within the upper Awehi Gulch enclosure are mature during August thus visits before and after August are either too early or too late to collect fruits (USFWS, 2012). Flowering time, pollination vectors, seed dispersal agents, longevity of plants and seeds, specific environmental requirements, and other limiting factors are unknown (U.S. Fish and Wildlife Service 1999b) (USFWS, 2002).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Ohia-uluhe lowland mixed mesic to wet forest (USFWS, 2012)

Geographic or Habitat Restraints or Barriers

Adult: 1,084 - 3,323 (USFWS, 2012)

Spatial Arrangements of the Population

Adult: Scattered individuals (USFWS, 2012; see population narrative)

Habitat Narrative

Adult: Inhabits wet to perhaps mesic forest (NatureServe, 2015). The typical habitat of *Labordia tinifolia* var. *lanaiensis* is gulch slopes in *Metrosideros polymorpha* (ohia)-*Dicranopteris linearis* (uluhe) lowland mixed mesic to wet forest between 550 and 1,013 meters (1,804 and 3,323 feet) elevation (USFWS, 2012).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Very low (inferred from USFWS, 2012; see current range/distribution)

Redundancy:

Very low (inferred from USFWS, 2012)

Number of Populations:

1 (USFWS, 2018)

Population Size:

15 (USFWS, 2018)

Population Narrative:

Currently, there are one to three populations totaling an estimated 300 to 800 scattered individuals on Lanai (USFWS 1999, 2002, 2003, 2010) (USFWS, 2012). In 2012, the 5-year review reported one to three populations on Lānaʻi totaling 300 to 800 individuals; however, botanists believed this estimation was too high. Some botanists estimated there could be three to four populations totaling 200 to 300 individuals, based on the lower number of observed plants (about 30) (Wood 2010, pers. comm.; Oppenheimer 2010, pers. comm). In 2013, the Plant Extinction Prevention Program (PEPP) reevaluated the status of this species, and raised its status from “POP” (potential PEP species) to “PEP,” a species with fewer than 50 individuals in the wild. Currently, only one population is known on the southeast slope of Lānaʻi, with 15 wild individuals actually observed since 2012 (PEPP 2012, 2013, 2105, 2016, 2017a) (USFWS, 2018).

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Ungulate (axis deer and feral mouflon sheep) degradation of habitat (USFWS 1999, 2002, 2003; K. Wood, pers. comm. 2010; H. Oppenheimer, pers. comm. 2010); established ecosystem-altering invasive plant species degradation of habitat (USFWS 1999, 2002, 2003); Landslides and flooding (USFWS 1999, 2002, 2003) (USFWS, 2012).

Stressor: Herbivory (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Herbivory and trampling by axis deer and feral mouflon sheep (USFWS 1999, 2002, 2003; K. Wood, pers. comm. 2010; H. Oppenheimer, pers. comm. 2010) (USFWS, 2012).

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species (USFWS, 2012).

Stressor: Established ecosystem altering invasive plant species degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Habitat degradation and destruction by the nonnative plant *Sphaeropteris cooperi* (Australian tree fern) is an additional threat to *Labordia tinifolia* var. *lanaiensis* as observed at an outplanting site at 'Āwehi (PEPP 2017a) (USFWS, 2018).

Stressor: Drought and erosion degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Drought is observed to be a threat to populations of *L. tinifolia* var. *lanaiensis* at Puhielelu and 'Āwehi (PEPP 2012, 2013, 2015, 2017a; Oppenheimer 2018, in litt.). Over the last 100 years, the Hawaiian Islands have experienced an annual decline in precipitation of over 9 percent, increasing to as much as 15 percent within the last 20 years (US-NSTC 2008; Chu and Chen 2005; Diaz et al. 2005). Drought affects plants directly by desiccation. The increase in drought frequency and intensity leads to a self-perpetuating cycle of increase in cover of nonnative plants, increase in the number of fires, and an increase of erosion (US-GCRP 2009; Warren 2011). Recent episodes of drought have also driven deer farther into urban and forested areas in search of food, increasing their negative impacts to native vegetation from herbivory and trampling (Waring 1996, in litt; Nishibayashi 2001, in litt.) (USFWS, 2018).

Stressor: Fire destruction or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: —Fire is noted as a threat to *L. tinifolia* var. *lanaiensis* for wild and reintroduced individuals at 'Āwehi (PEPP 2013, 2017a). Fire can destroy dormant seeds as well as individual plants. Successive fires burn farther and farther into native habitat and alter microclimate conditions to further alter habitat conditions to favor nonnative plants. Nonnative plants convert native plant communities to nonnative dominated plant communities D'Antonio and Vitousek 1992; Tunison et al. 2002) (USFWS, 2018).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: —Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai'i using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Labordia tinifolia* on the species level is vulnerable to the impacts of climate change, with a vulnerability score of 0.107 (on a scale

of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions may be needed to conserve this taxon into the future (USFWS, 2018).

Stressor: Rodent predation or herbivory

Exposure:

Response:

Consequence:

Narrative: Herbivory by rats is noted to be a threat to *L. tinifolia* var. *lanaiensis* at Puhielelu and 'Āwehi (PEPP 2012, 2013, 2017a). Rats eat virtually every part of plants and at every stage: fleshy fruits, seeds, flowers, stems, leaves, shoot, seedlings, and roots (Russell 1980; Cuddihy and Stone 1990). The effects on plants range from reduced vigor and decreased reproduction to mortality of individuals and complete lack of recruitment (USFWS, 2018).

Stressor: Invertebrate predation or herbivory

Exposure:

Response:

Consequence:

Narrative: Herbivory by slugs is noted as a threat to this variety (PEPP 2015, 2017a). o A tiny beetle, the black twig borer (*Xylosandrus compactus*), is known to infest over 200 plant taxa in Hawai'i, including *L. tinifolia* var. *lanaiensis* on Lāna'i (Davis 1970; PEPP 2017a). The black twig borer attacks living plants and bores into branches, deposits eggs and a fungus called ambrosia which develops as food for the larvae. A severe infestation can kill host plants, including large trees (Extension Entomology and UH-CTAHR IPMP 2006) (USFWS, 2018).

Stressor: Stochastic events—Reduced viability due to low numbers

Exposure:

Response:

Consequence:

Narrative: Small, isolated populations often exhibit reduced levels of genetic variability, which diminishes the species' capacity to adapt and respond to environmental changes, thereby lessening the probability of long-term persistence (Barrett and Kohn 1991; Newman and Pilson 1997). The problems associated with small population size and vulnerability to random demographic fluctuations or natural catastrophes are further magnified by synergistic interactions with other threats, such as anthropogenic impacts like habitat loss from human development or predation by nonnative species. Very small plant populations may experience reduced reproductive vigor due to ineffective pollination or inbreeding depression. Small numbers and small populations may cause loss of reproductive vigor of *L. tinifolia* var. *lanaiensis* (USFWS, 2018).

Recovery

Reclassification Criteria:

1. A total of five to seven populations should be documented on islands where it now occurs or occurred historically (USFWS, 2002).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 2002).

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 2002).

Delisting Criteria:

1. A total of 8 to 10 populations should be documented on islands where it now occurs or occurred historically (USFWS, 2002).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 2002).

3. Each population should persist at this level for a minimum of five consecutive years (USFWS, 2002).

Recovery Actions:

- Protect habitat and control threats (USFWS, 2002).
- Expand existing wild populations (USFWS, 2002).
- Conduct essential research (USFWS, 2002).
- Develop and maintain monitoring plans (USFWS, 2002).
- Reestablish wild populations within the historic range (USFWS, 2002).
- Validate and revise recovery criteria (USFWS, 2002).
- Construct exclosures to protect populations against axis deer (USFWS, 2002).
- Maintain adequate genetic stock (USFWS, 2002).
- Control competing alien plant species (USFWS, 2002).
- Enhance wild populations and establish new populations (USFWS, 2002).
- New Management Actions: • Surveys and monitoring—PEPP continues to monitor wild and outplanted individuals (PEPP 2013, 2015, 2016, 2017a). • Ungulate monitoring and control—PEPP regularly inspects and maintains exclosure fencing at wild and reintroduced populations (PEPP 2015, 2017a) • Captive propagation for genetic storage and reintroduction— o Five founders from the ‘Āwehi wild individuals are represented in collections and reintroductions (PEPP 2017b). o The Lyon Arboretum Micropropagation Laboratory reports 54 containers of propagules from two individuals at ‘Āwehi. The Lyon Seed Conservation Laboratory has almost 2,000 seeds in storage collected from three founders at ‘Āwehi (Lyon Arboretum 2017). o The National Tropical Botanical Garden (NTBG) reports almost 400 seeds collected from plants at Puhielelu and ‘Āwehi; however, these collections are more than 10 years old (NTBG 2017). o The Olinda Rare Plant Facility (ORPF) has propagated almost 120 potted plants from collections from plants at Puhielelu and ‘Āwehi (ORPF 2013, 2014, 2015). This year, they have sent out 50 plants for outplanting and hold 54 plants in their nursery (ORPF 2018). o PEPP monitors this species and reports collection of seeds from four individuals at Puhielelu and ‘Āwehi (PEPP 2012). In addition, PEPP has elevated the status of this species to “POP,” a potential PEP species, as numbers of individuals are nearing the level of PEP status (fewer than 50 individuals in the wild) and threat levels are high. • Invasive plant monitoring and control—PEPP regularly conducts

- control and removal of nonnative plants at wild and reintroduced populations (PEPP 2013, 2015, 2016, 2017a). • Predator and herbivore monitoring and control—PEPP conducts rat trapping at wild and reintroduced populations (PEPP 2012, 2013, 2017a) (USFWS, 2018).
- Recommendations for Future Actions: Drought, erosion, fire, predation by rats, slugs, and the black twig borer, and low numbers have been identified as new threats to *Labordia tinifolia* var. *lanaiensis*. We are not aware of any significant information regarding the species' biological status since the last 5-year review in 2012. Thus, the following recommendations for future actions are added or reiterated for the 5-year review for 2018.
 - Population viability and monitoring—Continue to survey known localities and suitable habitat areas on Lānaʻi to determine the current status of all populations of *L. tinifolia* var. *lanaiensis*.
 - Ungulate monitoring and control—Continue to construct and maintain exclusion fences to protect *L. tinifolia* var. *lanaiensis* from the impacts of feral ungulates.
 - Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species around all populations.
 - Site and habitat protection—Develop and implement effective measures to reduce the impacts of landslides and flooding.
 - Captive propagation for genetic storage and reintroduction—
 - o Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range.
 - o Evaluate genetic resources currently in storage to determine the need to place additional material into long-term storage due to this species' vulnerability to climate change.
 - o Research potential viability problems and explore alternative methods of propagation (e.g., cuttings, tissue culture).
 - Fire monitoring and control—Develop and implement fire prevention management plans.
 - Herbivory by rodents and invertebrates—
 - o Continue to implement effective control measures for rats.
 - o Develop and implement control measures for slugs.
 - o Develop and implement control measures for the black twig borer.
 - Reintroduction and translocation—Continue to augment current populations and reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.
 - Population biology research—Research the life history of *L. tinifolia* var. *lanaiensis* to affirm that this variety is long-lived.
 - Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use this information to determine future landscape needed for the recovery of the species.
 - Alliance and partnership development—Continue to work with landowners and land managers to initiate planning and contribute to implement of ecosystem-level restoration and management to benefit this taxon (USFWS, 2018).

Conservation Measures and Best Management Practices:

- Captive propagation for genetic storage and reintroduction: Continue to collect seeds from tagged individuals, keeping close track of the maternal source for use in ex situ propagation. Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation (USFWS, 2012).
- Captive propagation protocol development – Explore alternate methods of propagation for *Labordia tinifolia* var. *lanaiensis* (e.g., cuttings, tissue culture) (USFWS, 2012).
- Ungulate exclosures – Complete the Lanaihale fencing project (USFWS, 2012).
- Ungulate control – Remove axis deer within the exclosure once the fencing is complete at Lanaihale (USFWS, 2012).
- Reintroduction / translocation site identification – While surveying for new populations or reintroduced populations, determine which sites are least invaded by invasive introduced plant

species and which appear to have the highest likelihood of maintaining new reintroductions (USFWS, 2012).

- Surveys / inventories – Continue to conduct thorough surveys for *Labordia tinifolia* var. *lanaiensis* in habitats where it has historically been found on Lanai, as well as in other potentially suitable habitats (USFWS, 2012).
- Ecosystem-altering invasive plant species control – Continue to control ecosystem altering invasive plant species around all populations (USFWS, 2012).
- Competitive invasive plant species control – Continue to control invasive introduced plant species around all populations (USFWS, 2012).
- Population biology research – Research the life history of *Labordia tinifolia* var. *lanaiensis* in reference to designating the taxon from a short-lived perennial to long-lived perennial (USFWS, 2012).
- Site / area / habitat protection – Develop and implement effective measures to reduce the impact of landslides and flooding (USFWS, 2012).
- Alliance and partnership development – Work with Castle and Cooke and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2012).
- Threats research – Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2012).

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SPECIES ACCOUNT: *Labordia tinifolia* var. *wahiawaensis* (Kamakahala)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Labordia tinifolia var. *wahiawaensis*, a member of the logania family (Loganiaceae), is a shrub or small tree, usually 2 to 8 m (6.6 to 26.2 ft) tall. The young branches are cylindrical or nearly so and hairless. The elliptic to lance-shaped leaves are usually 4.5 to 21 cm (1.8 to 8.3 in) long and 2 to 5 cm (0.8 to 2 in) wide. The membranous leaves are medium green and hairless, and the veins are not impressed on the upper leaf surface. Normally, 9 to 12 hairless flowers are clustered on a downward curving inflorescence stalk 9 to 22 mm (0.35 to 0.9 in) long, each having an individual stalk 8 to 11 mm (0.2 to 0.4 in) in length. The pale yellowish green flower is narrowly urn-shaped, 17 to 19 mm (0.7 to 0.75 in) long. The tubular portion of the flower is 5.5 to 7.8 mm (0.2 to 0.3 in) long with long, white hairs inside, while the egg-shaped lobes are 1.7 to 2.3 mm (0.07 to 0.09 in) long. The fruit is an egg-shaped capsule, 8 to 17 mm (0.2 to 0.7 in) long, usually with two valves and an apex with a beak 0.5 to 1.5 mm (0.02 to 0.1 in) long. (USFWS, 1998)

Taxonomy

Three varieties of *Labordia tinifolia* are recognized: var. *lanaiensis* on Lanai and Molokai, var. *tinifolia* on Kauai and four other islands, and var. *wahiawaensis*, endemic to Kauai. Variety *wahiawaensis* is distinguished from the other two by its larger corolla. This species differs from others of the genus by having a long common flower cluster stalk, hairless young stems and leaf surfaces, transversely wrinkled capsule valves, and corolla lobes usually 1.7 to 2.3 mm (0.1 in) long (USFWS 1996). (USFWS, 1998)

Historical Range

Historically no additional range. (NatureServe, 2015)

Current Range

Current range: Wahiawa Drainage of Kauai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Labordia tinifolia* var. *wahiawaensis* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Labordia tinifolia* var. *wahiawaensis* includes one unit totaling 2,255 acres in Kauai County, Hawaii. The unit is Kauai 10—*Labordia tinifolia* var. *wahiawaensis*—a.

Kauai 10—*Labordia tinifolia* var. *wahiawaensis*—a: This unit is critical habitat for *Labordia tinifolia* var. *wahiawaensis* and is 912 ha (2,255 ac) on private land. This unit contains Hulua, Iole, Kahili,

Kapalaoa, and Palikea Summits. This unit provides habitat for four populations of 100 mature, reproducing individuals of the long-lived perennial *Labordia tinifolia* var. *wahiawaensis* and is currently occupied with 20 to 30 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, stream banks in lowland wet forest. Although we do not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is of appropriate size so that each potential recovery population on Kauai within the unit is geographically separated enough to avoid their destruction by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Within this unit, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

- (i) Streambanks in lowland wet forests dominated by *Metrosideros polymorpha* and containing one or more of the following associated species: *Antidesma platyphyllum*, *Athyrium microphyllum*, *Cheirodendron* spp., *Cyrtandra* spp., *Dicranopteris linearis*, *Hedyotis terminalis*, or *Psychotria* spp.; and
- (ii) Elevations between 458 and 1,006 m (1,502 and 3,301 ft).

Special Management Considerations or Protections

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 630 and 740 meters within a 0.8 to 1.2 km area (USFWS, 2009)

Environmental Specificity

Adult: Narrow, with several key requirements (USFWS, 2009)

Habitat Narrative

Adult: The taxon has not been discovered beyond its very restricted present habitat in the Wahiawa Drainage from about 630 to 740 meters (2,070 to 2,430 feet) elevation within a 0.8- by 1.2 km (0.5- by 0.75-mile) area (USFWS 1996). *Labordia tinifolia* var. *wahiawaensis* grows along streams in lowland wet forests dominated by ohia and often in association with olapa or uluhe. Plants found in association with this taxon include haiwale, hame, kopiko, manono, and *Athyrium* sp. (USEWS 1996). (USFWS, 1998; USFWS, 2009)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Short-term trends suggest declines of >30% (NatureServe, 2015)

Resiliency:

Very low (inferred from USFWS, 2009)

Redundancy:

Very low (inferred from USFWS, 2009)

Number of Populations:

3 (USFWS, 2017)

Population Size:

22 (USFWS, 2017)

Population Narrative:

Short-term population trends suggest declines of >30%. Perlman (2006) confirmed that a single restricted population of 20 to 30 individuals continued to survive as of September 2005. Our database reflected no change in numbers (USFWS 2008). (USFWS, 2009). New Status Information: • *Labordia tinifolia* var. *wahiawaensis* has been found in two more locations since the time of the last 5-year review in 2009. In 2008, four individuals were found at the upper north fork of Wainiha stream; however, subsequent monitoring shows only six individuals remain (HBMP 2010; NTBG 2013a; PEPP 2017). Three individuals were found in the northern headwaters of Waiahi stream (NTBG 2013b). At the previously only known population of this species in the Wahiawa mountains, 13 individuals currently occur in two separate locations (one location with only one plant) (PEPP 2017). In summary, there are three populations totaling 22 individuals (USFWS, 2017).

Threats and Stressors

Stressor: Invasive plants (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Competition with introduced invasive plant species, especially *Psidium cattleianum* (strawberry guava) remains a threat. (USFWS, 2009)

Stressor: Habitat degradation by pigs (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Habitat degradation by pigs (*Sus scrofa*) is a threat to *Labordia tinifolia* var. *wahiawaensis*. (USFWS, 2009)

Stressor: Human activities (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Human activities from trampling are detrimental to *Labordia tinifolia* var. *wahiawaensis*. (USFWS, 2009)

Stressor: Single catastrophic events (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The threat of single catastrophic events, such as hurricanes or landslides, threaten *Labordia tinifolia* var. *wahiawaensis*. (USFWS, 2009)

Stressor: Small population size (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Reduced reproductive vigor due to small number of extant populations and individuals remains a concern for *Labordia tinifolia* var. *wahiawaensis*. (USFWS, 2009)

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Labordia tinifolia* var. *wahiawaensis* is vulnerable to the impacts of climate change, with a vulnerability score of 0.107 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery**Reclassification Criteria:**

1. A total of five to seven populations of each taxon should be documented on Kauai where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Kauai where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1998)

Recovery Actions:

- Construct enclosures to protect against feral ungulates and control alien plant species. Because so few individuals now exist, emergency measures should be taken immediately to fence the remaining individuals to protect them against further degradation by feral pigs. Once enclosed, those areas should undergo management to remove the alien plants focusing on strawberry guava. (USFWS, 1998)
- Given the degraded nature of the Kauai plant cluster's habitat, their precariously low numbers, and the severity of the threats, the highest priority actions must be aimed at protecting all extant wild individuals and populations, managing habitat to enhance survival and ensuring maintenance of adequate genetic stock ex situ. (USFWS, 1995)
- It is hoped that by eliminating current threats through management, populations of the Kauai cluster taxa will expand naturally. However, in certain special instances, wild populations of the Kauai cluster taxa may need to be augmented. (USFWS, 1995)
- Research into various aspects of the life history, habitat, pollinators, reproductive biology, symbionts, optimum requirements for growth, requirements for population viability, and control of threats to each of the Kauai cluster taxa must be carried out to better understand the requirements necessary for perpetuation of these plants. (USFWS, 1995)
- If necessary to meet recovery objectives, populations should be reestablished in areas where they are known to have occurred historically, particularly if genetically uncontaminated, cultivated materials exist which are known to have originated from the historical site. (USFWS, 1995)

- The scientific validity of the recovery objectives should be reviewed as more information becomes available. (USFWS, 1995)
- A public education program is needed to increase awareness of and support for plant recovery efforts in Hawaii. (USFWS, 1995)
- New Management Actions:
 - Invasive plant monitoring and control—PEPP is monitoring invasive nonnative plants at three populations of *Labordia tinifolia* var. *wahiawaensis* (PEPP 2010, 2011, 2012, 2013, 2014).
 - Predator and herbivore monitoring and control—PEPP is monitoring effects of feral ungulates at three populations and implementing insect control (PEPP 2010, 2011, 2012, 2013, 2014). One population occurs within a recently completed landscape-scale fenced enclosure at Wainiha, the East Alakai Fence (DLNR 2006; Clark 2009, in litt.; Clark 2013, in litt.). PEPP is conducting insect control by applying an insecticide at two populations (PEPP 2011, 2012, 2014).
 - Captive propagation for genetic storage and reintroduction—Over the last several years, PEPP has conducted an extensive hand-pollination effort to produce seeds. These seeds were collected from individuals in the Wahiawa Mountains and were placed in storage. Lyon Arboretum Seed Bank has 13 different crosses from five females and four males totaling over 2,500 seeds (Lyon Arboretum 2017) (USFWS, 2017).
- Recommendations for Future Actions: Predation and herbivory by rats and insects are identified as new threats to this species. Thus, the following recommendations for future actions are added or reiterated for the 5-year review for 2017.
 - Surveys and inventories—Continue to survey for populations of *Labordia tinifolia* var. *wahiawaensis* in areas of potentially suitable habitat.
 - Ungulate monitoring and control—Continue to construct and maintain fenced enclosures around all populations. Protect all occurrences against disturbances from feral ungulates to prevent imminent extinction.
 - Invasive plant monitoring and control—
 - o Control established ecosystem-altering nonnative invasive plant species around all populations.
 - o Control invasive nonnative species that compete with the species around all populations.
 - Predator and herbivore monitoring and control—
 - o Control rats at all populations.
 - o Study *Labordia tinifolia* var. *wahiawaensis* populations to determine level of threat from invertebrate herbivory and need for additional recovery actions.
 - Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock.
 - Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. Evaluate the fence at Kanaele Bog (Wahiawa) which could potentially serve as a reintroduction site.
 - Population biology research—
 - o Study *Labordia tinifolia* var. *wahiawaensis* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats.
 - o Investigate techniques to improve natural recruitment.
 - Human interaction monitoring and management—Develop and implement effective measures to reduce the impacts of hunters, hikers, and trail maintenance.
 - Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Continue to collect material for genetic storage, future propagation and reintroduction. (USFWS, 2009)

- Construct large-scale fences around all naturally occurring and reintroduced individuals to control feral ungulates. (USFWS, 2009)
- Control introduced invasive plant species around wild individuals. (USFWS, 2009)
- Work with the Kauai Watershed Alliance to continue and expand ecosystem-level management of the Wahiawa Bog area. (USFWS, 2009)
- Reintroduce individuals into protected suitable habitat within historical range. (USFWS, 2009)
- Investigate techniques to improve natural recruitment. (USFWS, 2009)
- Assess genetic variability within extant population. (USFWS, 2009)
- Study *Labordia tinifolia* var. *wahiawaensis* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. (USFWS, 2009)

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SPECIES ACCOUNT: *Labordia triflora* (Kamakahala)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/03/1999; Pacific Region (R1) (USFWS, 2016)

Physical Description

A shrub with long lax stems. The tubular greenish flowers are borne singly or in clusters of three (NatureServe, 2015).

Taxonomy

A member of the logan family. In the 1990 “Manual of the Flowering Plants of Hawaii” (Manual) (Wagner et al. 1990), this species was considered to be synonymous with *L. tinifolia* var. *lanaiensis*. Timothy Motley recently revised this endemic Hawaiian genus, and resurrected *L. triflora* as a valid species (Motley 1995) (USFWS, 2002).

Historical Range

Until 1990, *Labordia triflora* was known only from the type collection at Mapulehu on the island of Molokai, and was believed to be extinct (USFWS, 2002).

Current Range

Occurs only on the island of Molokai (USFWS 2008; USFWS, 2014).

Critical Habitat Designated

Yes; 3/18/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Labordia triflora* (Kamakahala) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one detailed critical habitat unit (CHU), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Labordia triflora* includes one CHU in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Molokai—Lowland Mesic—Unit 1 (and) *Palmeria dolei*—Unit 37—Lowland Mesic (and) *Pseudonestor xanthophrys*—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Ctenitis squamigera*, *Cyanea dunbariae*, *C. mannii*, *C. profuga*, *Cyperus fauriei*, *Cyrtandra filipes*, *Gouania hillebrandii*, *Labordia triflora*, *Neraudia sericea*, *Santalum haleakalae* var. *lanaiense*, *Schiedea lydgatei*, *S. sarmentosa*, *Silene alexandri*, *S. lanceolata*, *Spermolepis hawaiiensis*, and *Zanthoxylum hawaiiense*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Mesic—Unit 1 is not

known to be occupied by *Asplenium dielerectum*, *Bonamia menziesii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea procera*, *C. solanacea*, *Diplazium molokaiense*, *Festuca molokaiensis*, *Flueggea neowawraea*, *Isodendron pyriformis*, *Kadua laxiflora*, *Melicope mucronulata*, *M. munroi*, *M. reflexa*, *Phyllostegia haliakalae*, *P. mannii*, *P. pilosa*, *Sesbania tomentosa*, *Stenogyne bifida*, or *Vigna o-wahuensis*, or the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Labordia triflora* critical habitat consists of one component. Lowland mesic (Molokai) (81 FR 17790-18110):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those

required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mcelandowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*,

Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Lifespan**

Adult: < 10 years (USFWS, 2014)

Reproduction Narrative

Adult: It is a short-lived perennial (fewer than 10 years) (USFWS, 2014).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Mixed mesic ohia forest (USFWS, 2002)

Geographic or Habitat Restraints or Barriers

Adult: 625 - 3,755 ft. elevation (USFWS, 2002)

Habitat Narrative

Adult: Inhabits moist forests in gulch bottoms and on gulch slopes (NatureServe, 2015). This species occurs on gulch slopes in mixed mesic Metrosideros polymorpha (ohia) forest between 190 and 1,145 meters (625 to 3,755 feet) elevation (USFWS, 2002).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Decreasing (USFWS, 2014)

Resiliency:

Very low (inferred from USFWS, 2014; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2014)

Number of Populations:

1 (USFWS, 2018)

Population Size:

3 wild; 330 outplanted (USFWS, 2018)

Population Narrative:

Overall, *L. triflora* has decreased from 11 individuals reported in the previous 5-year review to approximately 4 wild individuals (3 mature and 1 immature) (PEPP 2012). Unfortunately, the 2012 PEPP annual reports only provides status information for two of the four wild populations as identified in the proposed rule and the 2013 PEPP annual reports only provides status information for one of the four wild populations (USFWS, 2014). New Status Information: • The latest review of the species by IUCN in 2015 reported one occurrence of three individuals on Moloka'i (Chau et al. 2015). • In 2017, the Plant Extinction Prevention Program (PEPP) reported for *Labordia triflora* that five founders have been collected from (two individuals from Wāwā'ia and three individuals from Kua Gulch), and progeny have been outplanted together in Kawela (PEPP 2017a). The wild individuals at Wāwā'ia have died. • In 2016, critical habitat was designated in the lowland mesic ecosystem on Moloka'i for *Labordia triflora* (8,770 ac; 3,549 ha) (81 FR 17790, March 30, 2016) (USFWS, 2018).

Threats and Stressors

Stressor: Stochastic events (USFWS, 2014 and 2002)

Exposure:

Response:

Consequence:

Narrative: Landslides and flooding is reported as a threat to this species and has resulted in loss of individuals of *L. triflora* in Kua Valley on Molokai (PEPP 2010) (USFWS, 2014). Catastrophic extinction could occur through environmental events and reduced reproductive vigor due to the small number of individuals remaining in the only known population (USFWS, 2002).

Stressor: Predation (USFWS, 2014 and 2002)

Exposure:

Response:

Consequence:

Narrative: Herbivory by slugs (unidentified species) has been reported as a severe threat to remote populations of *L. triflora* (PEPP 2010, 2011, 2012, 2013) (USFWS, 2014). Rats eat seeds of this species (USFWS, 2002).

Stressor: Collection (USFWS, 2002)

Exposure:

Response:

Consequence:

Narrative: Potential threats include unrestricted collecting or excessive visits by individuals interested in seeing rare plants (U.S. Fish and Wildlife Service 1999b, 2002c; Motley 1995) (USFWS, 2002).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai'i using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Labordia triflora* is extremely vulnerable to the impacts of climate change, with a vulnerability score of 0.998 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this assessment classified *L. triflora* as a "wink-out" species. "Wink-out" species are those species with no future climate envelope on the islands the species has occurred. No projected suitable climate areas exist for the species to persist in the future. Therefore, additional management actions are needed to conserve this taxon into the future, such as identifying suitable microsites where climate change is anticipated to occur more slowly and considering suitable habitat on islands outside of its known range (USFWS, 2018).

Recovery**Reclassification Criteria:**

1. A total of five to seven populations should be documented on islands where it now occurs or occurred historically (USFWS, 2002).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 2002).
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 2002).

Delisting Criteria:

1. A total of 8 to 10 populations should be documented on islands where it now occurs or occurred historically (USFWS, 2002).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 2002).
3. Each population should persist at this level for a minimum of five consecutive years (USFWS, 2002).

Recovery Actions:

- Protect habitat and control threats (USFWS, 2002).
- Expand existing wild populations (USFWS, 2002).
- Conduct essential research (USFWS, 2002).
- Develop and maintain monitoring plans (USFWS, 2002).
- Reestablish wild populations within historic range (USFWS, 2002).
- Validate and revise recovery criteria (USFWS, 2002).
- Construct exclosures to protect populations against feral ungulates (USFWS, 2002).

- Maintain adequate genetic stock (USFWS, 2002).
- Control competing alien plant species (USFWS, 2002).
- Reduce threats from rodent predation (USFWS, 2002).
- Enhance wild populations and establish new populations (USFWS, 2002).
- New Management Actions:
 - Surveys and monitoring—The PEPP surveys for and monitors populations of *Labordia triflora* on Molokaʻi (PEPP 2012, 2013, 2014, 2015, 2016, 2017b).
 - Ungulate monitoring and control—In 2016, the Hawaiʻi Department of Land and Natural Resources, Division of Forestry and Wildlife and The Nature Conservancy (TNC; for the East Molokaʻi Watershed Partnership) submitted a draft Environmental Assessment for the proposed Pākuʻi Watershed Project. The proposed project's goal is the construction of a 5.5-mile fence, which, in conjunction with the existing Kapualei Extension fence, will enclose the Pākuʻi Unit and protect 2,080 ac of vital watershed on southeast Molokai (TNC 2016). If completed, the fence would provide protection from ungulates to the occurrences of *L. triflora* and other rare plant species at Kua Gulch.
 - Captive propagation for genetic storage and reintroduction—
 - o Currently, five founders are represented in collections (PEPP 2017).
 - o The Lyon Arboretum Micropropagation Laboratory reports two containers of propagules in storage and three propagules in the greenhouse. The Lyon Arboretum Seed Conservation Laboratory reports a little over 1,000 seeds total in storage collected from one individual from Kua gulch and another individual in Wāwāʻia on Molokaʻi (Lyon Arboretum 2017).
 - o The Olinda Rare Plant Facility (ORPF) reports 19 potted plants in storage representing one individual from Wāwāʻia, two potted plants representing two individuals from Kua Gulch, and 16 cuttings taken from four individuals in Kua Gulch (ORPF 2014, 2015). ORPF has sent out 370 plants for outplanting over the last year (ORPF 2018).
 - o PEPP monitors wild individuals and reintroduces plants on Molokaʻi (PEPP 2012, 2013, 2014, 2015, 2016). Currently, 133 individuals were reintroduced individuals at Snail Meadow, 109 individuals reintroduced individuals at Kua Gulch, and 22 individuals reintroduced with Dunbar's enclosure (PEPP 2012, 2013, 2014, 2015, 2016, 2017b) (USFWS, 2018).
- Recommendations for Future Actions: We are not aware of any new threats or significant new information regarding the species' biological status since the last 5-year review in 2014. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2018.
 - Population viability and monitoring—Continue to survey known localities and suitable habitat areas on Molokaʻi determine the current status of all populations of *Labordia triflora*. Search historical habitat on Molokaʻi for occurrences of this species.
 - Ungulate monitoring and control—Construct and maintain exclusion fences, or strategic fencing as appropriate, to protect *L. triflora* from the impacts of feral ungulates.
 - Invasive plant monitoring and control—Control established ecosystemaltering nonnative invasive plant species around all populations.
 - Captive propagation for genetic storage and reintroduction—
 - o Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range.
 - o Evaluate genetic resources currently in storage to determine the need to place additional material into long-term storage due to this species' vulnerability to climate change.
 - Reintroduction and translocation—Augment current populations and continue to reintroduce individuals into suitable habitat within historical range that is being managed for known threats to this species.
 - Rodent predation or herbivory—Implement effective methods to control rats at known populations.
 - Invertebrate predation or herbivory—Determine and implement effective methods to control slugs at known populations.
 - Population viability monitoring and analysis—Study populations to determine viable population size and structure,

geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats to increase natural regeneration in the wild. • Stochastic events—Build resiliency and redundancy—Increase numbers of populations and individuals scattered through suitable habitat to reduce impacts from landslides. • Climate change adaptation strategy—Research the suitability of habitat for reintroduction of this species in the future due to the impacts of climate change. Develop a strategy for prevention of the extinction of this species if no suitable habitat is available in the future. • Alliance and partnership development—Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2018).

Conservation Measures and Best Management Practices:

- Ungulate monitoring and control – Fence remaining populations of *L. triflora* to protect against feral ungulates (USFWS, 2014).
- Captive propagation for genetic storage and reintroduction Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change (USFWS, 2014).
- Reintroduction / translocation – Reintroduce individuals into suitable habitat within the current and historical range in areas where threats are managed (USFWS, 2014).
- Predator / herbivore monitoring and control – Control slugs and rodents within the vicinity of all known *L. triflora* populations (USFWS, 2014).
- Surveys / inventories – Survey the geographical and historical range of *L. triflora* to assess the status of known populations and possible additional populations (USFWS, 2014).
- Invasive plants monitoring and control – Control invasive introduced plants within the vicinity of *L. triflora* populations (USFWS, 2014).
- Climate change adaptation strategy – Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. Develop a strategy for preventing the extinction of this species if no suitable habitat is predicted in the future (USFWS, 2014).
- Population viability monitoring and analysis – Study populations to determine viable population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats to increase natural regeneration in the wild (USFWS, 2014).
- Alliance and partnership development –Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2014).

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SPECIES ACCOUNT: *Lasthenia burkei* (Burke's goldfields)

Species Taxonomic and Listing Information

Listing Status: Endangered; 01/02/1992; Pacific Southwest (R8)

Physical Description

An annual herb that ranges in height from approximately 13 cm (5 in) (Patterson in litt. 2000) to as much as 61 cm (24 in) (Greene 1886), but is typically less than 30 cm (11.8 in) tall (Ornduff 1993). It has hairy stems, which may be simple or branched. The narrow, opposite leaves are no more than 8 cm (3.1 in) long and may be lobed or not. From April to June, the end of each branch bears one daisy-like flower head approximately 1.5 cm (0.6 in) across. The fruits are achenes (dry, one-seeded fruits) less than 1.5 mm (0.06 in) in length. The fruits of *L. burkei* can be distinguished from those of other goldfields by the presence of one long awn (bristle and numerous short scales) (Ornduff 1993). Individual *L. burkei* plants may exhibit some geographic variation in morphology (McCarten 1985 as cited in CH2M Hill 1995, Patterson et al. 1994). A diagnostic feature of *Lasthenia burkei* is the usual presence of a single long awn on the achene intermixed with 8 to 10 short scales (Ornduff 1993, Patterson et al. 1994). However, several occurrences have mixtures of typical achenes with a single awn and atypical achenes with a varied number of awns. Species experts consider these mixed occurrences to represent Burke's goldfields (Ornduff 1969b, Patterson et al. 1994, CNDDDB 2013). (USFWS, 2016)

Taxonomy

The scientific name originally given to Burke's goldfields was *Baeria burkei* (Greene 1886). Both the specific epithet and the common name commemorate J. H. Burke, who collected the type specimen "near Ukiah, Mendocino County" (Greene 1886). Greene later placed the genus *Baeria* within *Lasthenia*, creating the new name *Lasthenia burkei* for Burke's goldfields (Greene 1894). However, for many years other botanists (e.g., Hall 1914, Jepson 1925, Abrams and Ferris 1960) did not believe that Burke's goldfields was distinct from Fremont's goldfields (*Lasthenia fremontii*), a more widespread species to which it is very similar, nor did they agree with Greene's (1894) decision to lump *Baeria* with *Lasthenia*. Not until 1966, when Ornduff (1966) published a comprehensive study of the genus *Lasthenia*, was Burke's goldfields recognized as a distinct species and the name *Lasthenia burkei* accepted widely. Continuing research indicated that Burke's goldfields, Fremont's goldfields, and Contra Costa goldfields (*Lasthenia conjugens*) form a closely related species group (Ornduff 1969b, Crawford and Ornduff 1989). However, Burke's goldfields was found to be genetically distinct from Fremont's and Contra Costa goldfields (Crawford and Ornduff 1989). *Lasthenia burkei* and its relatives are members of the aster family (Asteraceae). (USFWS, 2016)

Historical Range

Endemic to the central California Coastal Range region and has been reported historically to be located within Mendocino, Lake, and Sonoma counties. (USFWS, 2016)

Current Range

In California, within Mendocino, Lake, Napa, and Sonoma Counties. (USFWS, 2019)

Critical Habitat Designated

Yes;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual: insect-pollinated (USFWS, 2016)

Lifespan

Adult: 1 year (USFWS, 2008)

Dependency on Other Individuals or Species

Adult: Pollinators (USFWS, 2016)

Breeding Season

Adult: April - June (USFWS, 2016)

Key Resources Needed for Breeding

Adult: Soil seed bank, insect pollinators. heavy fall rains (USFWS, 2016)

Other Reproductive Information

Adult: Like many other rare vernal pool plants, *Lasthenia burkei* is an annual. *Lasthenia burkei* typically germinates in autumn following heavy rains, although late initiation of rains may delay seedling emergence (Ornduff 1969b). Laboratory germination tests (Rancho Santa Ana Botanical Garden, unpublished data) indicate that germination occurs rapidly in a single flush, with relatively high germination rates (49 to 100 percent). Both the ray and disk flowers of all goldfields species produce achenes, increasing the potential for seed production per head. However, the reproductive output of individual plants is highly variable, depending on plant density and vigor, and probably on pollinator behavior as well. Each flower head can produce as many as 35 achenes, and the number of flower heads per plant can range from 1 to more than 20 (Patterson et al. 1994). Annual survival rates and other demographic parameters have not been investigated. *Lasthenia burkei* has also likely adapted to “risky environments” by producing a persistent seed bank. Some occurrences have reappeared after no plants were evident for 2 years, suggesting that viable seeds remained in the soil during that period (Patterson 1990). (USFWS, 2016)

Reproduction Narrative

Adult: The flowers of *Lasthenia burkei* are predominantly pollinated by outcrossing but they are capable of self-pollination (Sloop et al. 2012c). They are thought to be insectpollinated rather than wind-pollinated. Insects known to visit the flowers of the genus *Lasthenia* include butterflies (Lepidoptera), beetles (Coleoptera), flies (Diptera), true bugs (Hemiptera), bees (Hymenoptera), and wasps (Hymenoptera) (Thorp and Leong 1998). Most of these insects are generalist pollinators. All of the specialist pollinators of *Lasthenia* spp. are solitary bees (family Andrenidae); these include two species in the subgenus *Diandrena* (*Andrena submoesta* and *A. puthua*) and five or six species in the subgenus *Hesperandrena* (*Andrena baeriae*, *A. duboisi*, *A. lativentris*, and two or three undescribed species) (Thorp and Leong 1998). Gilmore, Sloop and Rank (2012) conducted a pollinator study of *L. burkei*, and found that although the solitary bee (*Andrena submoesta*) specializes on *L. burkei* and is apparently dependent on it as a food

source, the plant may not rely on *A. submoesta* for pollination (Gilmore et al. 2012). The Bombyliid fly (also called a bee fly), *Conophorus cristatus*, was found to be the dominant visitor of *L. burkei* and may be its primary pollinator. Syrphid flies (members of several genera in the family Syrphidae (hover flies)) were also found to be an important part of the pollinator community for this plant (Gilmore et al. 2012). (USFWS, 2016)

Habitat Type

Adult: Wetland (USFWS, 2016)

Habitat Vegetation or Surface Water Classification

Adult: Mesic meadow, vernal pool (USFWS, 2016)

Geographic or Habitat Restraints or Barriers

Adult: Wide range, up to 1900 feet in elevation (USFWS, 2016)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Habitat Narrative

Adult: The primary habitats of *Lasthenia burkei* are shallow vernal pools and wet swales within valley grassland and oak woodland habitats (CNDDDB 2013). On the Plain, *L. burkei* grows in the bottoms of pools ranging from less than 25 cm (10 in) in depth to 50 cm (20 in) (Patterson 1990, Patterson et al. 1994, Patterson in litt. 2000). *Lasthenia burkei* grows in naturally-occurring pools that range in surface area from approximately 2 square m (21.5 square ft) to 0.3 ha (0.75 ac (Patterson in litt. 2000)). Most of the vernal pools where *L. burkei* grows are loosely classified as northern vernal pools (Keeler-Wolf et al. 1998), but the Manning Flat occurrence in Lake County is in a northern volcanic ashflow vernal pool (Sawyer and Keeler-Wolf 1995). *Lasthenia burkei* also has been observed occasionally in artificially-created depressions such as drainage ditches and in disturbed sites such as orchards and disked fields (Patterson 1990, Patterson et al. 1994). (USFWS, 2016)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Seed dispersal mechanisms are not known. Pappus awns (needle-like appendages attached to the achene) may assist in windborne seed dispersal. Other seed dispersal mechanisms may include water or wildlife. (USFWS, 2016)

Population Information and Trends**Population Trends:**

Decline of >90% (NatureServe, 2015)

Species Trends:

> 70% decline (NatureServe, 2015)

Number of Populations:

20 or less (NatureServe, 2015)

Population Size:

Variable depending on year; 24,860 - 8.1 million in most recently surveyed populations (USFWS, 2016)

Adaptability:

Low (inferred from NatureServe, 2015)

Population Narrative:

This species inhabits highly vulnerable vernal pool plant endemic to small area, mostly in Sonoma County, California. It has experienced a long term decline of > 90%. It is declining rapidly (> 70% short term) due to runaway urban development in its habitat (Bittman 1998). Numbers fluctuate depending on rainfall; last counts indicated about 100,000 plants at all sites (some may now be extirpated). Known from twenty-eight occurrences. A maximum of twenty occurrences may be extant, but we believe the number to be far lower (fewer than ten viable occurrences) (California Natural Diversity Database, May/1998 report) (NatureServe, 2015). The largest known extant occurrences are at the Alton North Conservation Bank, with approximately 8.1 million plants in 2013; the Alton Lane Vernal Pool Preserve, with approximately 1.4 million plants in 2013; the Wright Preservation Bank, where the number of plants has decreased from approximately 5.3 million down to 1 million over the past 5 years; and Woodbridge Preserve, east of Fulton Road near Piner Road, where the number of plants increased from 350 plants in 1998 to 18.5 million plants in 2009, with 24,860 found at this site in 2012 (CNDDDB 2014, Stromberg 2013) (see Figure 5). Sloop and Ayres (2009) found that thirteen *Lasthenia burkei* occurrences were genetically distinct despite showing some gene flow between them (USFWS, 2016).

Threats and Stressors

Stressor: Development and conversion to agriculture (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Today, the largest continuing threats to this species are urban development and land conversion to agriculture (such as vineyards) and associated agricultural activities and wastewater irrigation. The most recent estimates from the California Department of Conservation (2002) are that about 71,000 acres of Sonoma County have been converted to urban uses (Sonoma County Permit and Resource Management Department 2014). The threat of urban development to these species in the Santa Rosa Plain is expected to continue. In addition to urban development, land conversion to agriculture and associated agricultural activities has reduced occurrences of these plants (CNDDDB 2014). In 1991, at the time of the listing, approximately 34,500 acres of land were in wine grape production in Sonoma County (Sonoma County Agricultural Commissioner 1991). As of 2012, the acreage of wine grapes in Sonoma County had increased to approximately 58,400 acres (Sonoma County Agricultural Commissioner 2013). Additionally, irrigation with recycled water, a practice that began in the Santa Rosa Plain in the 1970s, has emerged as a major threat. Although the California Regional Water Quality Control Board regulations (Water Quality Control Plan for the North Coast Region) prohibit discharge of recycled water to surface waters during the summer, the regulations did not contemplate that recycled water would be used to irrigate vernal pools and other types of

seasonal wetlands (J. Short, pers. comm., 2007). Recycled water, as opposed to wastewater, is tertiary-treated (City of Santa Rosa, in litt. 2015** [comment letter]). Wastewater, however, can come from many sources including livestock waste ponds and runoff from agricultural fields (City of Santa Rosa, in litt. 2015** [comment letter]). (USFWS, 2016)

Stressor: Alteration of hydrology (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Some actions, such as runoff from irrigation or irrigation with recycled water, can result in increased water on the landscape. The vernal pool habitat may receive more water than it normally would or receive it at an inappropriate time, resulting in flooding and death of listed plant seedlings. If water from urban or agricultural runoff continues to fill pools during spring and summer months, the listed plants will disappear because they cannot tolerate permanent inundation; invasion by plant species adapted to permanent inundation will occur. Additionally, irrigation with recycled water and runoff from irrigation can contain chemicals, such as herbicides, and other nutrients (Pereira et al. 1996) that can alter the vernal pool plant community, prevent germination, or kill seedlings. Nitrogen deposition from automobile traffic may also modify habitat by increasing soil nutrients, thus posing a continuing threat to remnant habitat that might otherwise be suitable for these species. Weiss and Luth (2003, p. 1) conducted research on the effects of nitrogen deposition along a highway south of the San Franciscan peninsula in San Francisco County. They found that nitrogen deposition within 100 m to 400 m from the highway was correlated with increased nonnative grass cover within these areas, resulting in competition for space with native plants. An increase in nonnative grass cover through changed habitat conditions could threaten the three plant species by competing for soil moisture and nutrients and inhibiting successful germination. (USFWS, 2016)

Stressor: Off-highway vehicles (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Damage by off-highway vehicles was noted as a threat to this species. Currently, on Department-owned properties that support the listed plants, some damage to preserves from vehicle trespass does occur, but without damage to the vernal pools. The most significant damage to vernal pools from vehicles has resulted from a Mosquito Vector Control vehicle driving through the vernal pools to spray for mosquitoes during the time when the pools were wet in 2014. Disturbance to the pools included physical damage to the pools and swales from tire ruts and crushing and uprooting the plants (S. Martinelli, CDFW, in litt. 2014). The level of this threat is likely to be variable and is difficult to predict or monitor. (USFWS, 2016)

Stressor: Grazing management and thatch accumulation (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Appropriate levels of grazing may provide some control of weedy plants, reduce competition between native plants and invasive plants, and can provide some bare soil for germination of native plants, all of which may provide opportunities for native plants to germinate. Cessation of cattle grazing has been found to exacerbate the negative effects of

invasive nonnative plants on vernal pool inundation period. If grazing is removed, areas of bare soil can be quickly occupied by nonnative, invasive plants. Removal of grazing from vernal pool grasslands where grazing is the traditional land use practice may have devastating impacts on vernal pool habitat, particularly on upland habitat surrounding vernal pools (G. Cooley, in litt., 2014). For example, non-native grasses increased and native grasses decreased in vernal pools when grazing was discontinued at a site in the Southeastern Sacramento Valley, resulting in a 50 to 80 percent reduction in vernal pool inundation (Marty 2005). Since the time of listing, grazing has been removed at many locations and has resulted in thatch build-up. Anecdotal evidence supports the theory that thatch build-up of nonnative vegetation has caused a reduction in the size of extant populations of the listed plants. The Department is re-establishing appropriate grazing practices on some Department-owned lands to reduce thatch build-up and nonnative competitors to the three listed plants (e.g., Todd Road Unit Ecological Preserve). However, reintroduction of grazing may not return a site to its former condition because nonnative plants may continue to occupy the once-vacant niches. For example, harding grass (*Phalaris aquatica*), a robust, invasive perennial grass, can be present in a grazed field, and not be obvious. If grazing is removed, however, the suppressed harding grass can become vigorous and dominate the entire field within a year or two and grazing will not remove this species once it is established (G. Cooley, in litt. 2014). We recognize that there is disagreement among biologists as to the extent of the threat of inappropriate grazing on the three species. As the final rule concluded, we believe that although the effect of well-managed livestock grazing may be beneficial to vernal pool ecosystem. (USFWS, 2016)

Stressor: Loss of Genetic Diversity / Inappropriate Mixing of Populations(USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: An additional potential threat to these three plants is the disruption of normal gene flow due to population restoration efforts that may mix populations, which may cause unanticipated adverse effects such as disruption of locally adapted gene complexes and outbreeding depression (when offspring from individuals from different populations have lower health/fitness than progeny from individuals from the same population). Several sites are proposed as Preserves in the Santa Rosa Plain and include proposals to seed/inoculate created or restored vernal pools. Seed from a limited number of donor occurrences has already been used for several years to inoculate multiple created or restored sites, creating a risk of overrepresentation of a small gene pool (swamping). The threat level of this activity is unknown; however, the 2007 Programmatic Biological Opinion (Service 2007) includes measures to reduce this potential threat as well as the requirement to obtain a collection permit from the Department. (USFWS, 2016)

Stressor: Climate change (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Since the 1950s, the Northern Hemisphere has experienced warmer air temperatures and decreased snowfall (Ackerly et al. 2010, IPCC 2013). By the end of the 21st century, climate change is predicted to result in more intense precipitation events in the form of rain, increased summer continental drying, extreme weather events, and increased wildfire (Ackerly et al. 2010, IPCC 2013). However, current climate change predictions for terrestrial areas in the Northern

Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2013). Climate simulations have shown that California temperatures are likely to increase by 2.7 degrees Fahrenheit (1.5 degrees Celsius) to 8.1 degrees Fahrenheit (4.5 degrees Celsius) depending on the emissions scenario (Cayan et al. 2008). The predicted impacts on California's ecosystems projected with a high certainty include (1) higher sea level and (2) decreased suitable habitat for many terrestrial species as climate change intensifies human impacts [for example isolated patches of vernal pools can be so poorly connected with other patches that migrations required by climate change may be difficult or impossible without human intervention (Field et al. 1999)]. Climate change threatens to increase the loss of pollinators if the abundance of flowers preferred by pollinators decreases. Pollinator emergence times may also be altered by a warming climate. If this occurs, the synchrony of bloom periods and pollinator emergence could be disrupted. The loss of pollinators would further reduce the amount of seed produced by the listed plants because of the plants' limited ability to self-pollinate. Although there currently are no data available regarding changes in plant bloom periods or emergence dates of pollinators in the Santa Rosa Plain in response to climate change, Forister and Shapiro (2003) found that over a period of 31 years, warmer and drier winter conditions were associated with earlier butterfly appearance in the Central Valley of California. Although the loss of seed produced in a single year would not likely lead to the extirpation of the species, the continued reduction of the seed crop or dependence on self-pollination would reduce the seedbank, genetic variation, and the potential for population expansion. Monitoring of vernal pool ecosystems to determine effects from climate change is necessary to determine what adaptive land management practices would be the most appropriate to ensure the sustainability of vernal pool species (Pyke and Marty 2005), including *B. bakeri*, *L. burkei*, and *L. vinculans*. (USFWS 2016)

Stressor: Extirpation due to Stochastic Events, Isolated Occurrences, and Small Size of Occurrences (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Chance events constitute a serious threat to *Blennosperma bakeri*. Because the known occurrences of *B. bakeri* are limited in number and in range, the species are vulnerable to stochastic (random) events—natural but damaging environmental perturbations and catastrophes such as droughts, storm damage, disease outbreaks, and fires, from which large wide-ranging populations can generally recover, but may lead to extirpation of small isolated populations (Gilpin and Soule 1986). The majority of the remaining habitat associated with the three species is vernal pools and swales in the Santa Rosa Plain. The nature of the vernal pool and swale habitat associated with the three plants may also increase the effects of drought. Vernal pools and swales are inundated only briefly and may not fill during dry years. As a result, we consider stochastic events to be of significant concern for these species. Isolated, small occurrences may also be at risk from a decrease in reproductive rate resulting from decreasing population density. The correlation of reproductive rate with population density, called the Allee effect, may be the result of either increased density or quality of compatible mates, or increased pollination, or both (Stephens et al. 1999). In small populations, if either the plants or their pollinators decline, consequences on the reproductive output of the other may result in an extinction vortex in which each generation is more likely to go extinct (Gilpin and Soule 1986, Soule and Mills 1998). (USFWS, 2016)

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: The Service found that many existing regulatory mechanisms were not sufficient to protect plants, including section 404 of the Clean Water Act, the protections of the California Endangered Species Act, and the California Environmental Quality Act. The 1991 final rule also found that listing the plants under the Federal Endangered Species Act would provide better protection by requiring the Army Corps of Engineers (and other Federal agencies) to consult with the Service prior to final determinations on a proposed activity. (USFWS, 2016)

Stressor: Non-native invasive species (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Creating a drier habitat and facilitating the invasion of non-native upland species, may permanently change the plant community and the non-native plants may outcompete the listed species (Bauder 2000, Marty 2005, competition discussed further below). With insufficient water, the distribution of plant species that are normally found higher on the edge of the vernal pools may shift downward along the moisture gradient in response to the introduction of invasive plants that now flourish at pool edges. Non-native grasses maintain dominance at pool edges, sequestering light and soil moisture, promoting thatch build-up, and shortening inundation periods. Species strongly associated with vernal pools may disappear from shallow pools as a result of invasion by upland non-native plants. In addition, the invasive species can further alter the hydrology of the site by reducing the inundation period (Marty 2005). Reduction in inundation period is thought to be due to increased evapo-transpiration associated with dense cover of nonnative plants at the vernal pools (Marty 2005). Once non-native, invasive plants are introduced to vernal pools, competition with native species can come from several interactions including root competition (roots of one species are more efficient at absorbing moisture and nutrients from the soil) and pollination success (one species will set more seed and produce more plants). Plant size can also confer superiority when competing with smaller plants. A larger plant can shade smaller or shorter plants and seedlings, depriving them of adequate sunlight which is necessary for plant and seedling growth and survival, and in some cases necessary for seed germination (Barbour et al. 1987). (USFWS, 2016)

Recovery

Reclassification Criteria:

A/1: Seventy-five percent of extant, native occurrences, not protected as of December 2014, within each core area (Windsor Core Area, Alton Lane Core Area, and Lasthenia burkei Southern Core Area) are permanently protected and managed to maintain the habitat and the current geographic, elevational, and ecological distribution of the species. Priority should be given to occurrences that are isolated and/or genetically unique.(USFWS, 2016)

A/2: The following additional habitat is needed in order to delist or downlist L. burkei. New preserves consist of a minimum of 50 ac in the Windsor Core Area, a minimum 400 ac in the Alton Lane Core Area, and a minimum of 400 ac in the Lasthenia burkei Southern Core Area. These preserves will consist of occupied habitat that is not protected as of December 2014. The

ecological integrity (e.g., water quality, hydrology, and uplands condition) of these areas is not threatened by adverse habitat modification. Buffers between the protected habitat and incompatible land uses must be sufficient to ensure that there are no significant adverse effects to *Lasthenia burkei*, such as changes in hydrology, or contamination by pesticides or herbicides, currently and into the foreseeable future. (USFWS, 2016)

A/3: New preserves (comprised of restored or created habitat) must be 10 ac or greater; however, preserves with existing native occurrences or those providing protection to a large occurrence are less than 10 ac. The preserves are as near to new or existing preserves as possible. (USFWS, 2016)

A/4: New preserves have no greater than 20 percent wetlands at each site (no more than 2 ac of vernal pools and swales in each 10 ac preserve). The total new preserve acreage in the core areas includes a minimum of 125 ac of vernal pools and swales distributed among the Alton Lane Core Area, *Lasthenia burkei* Southern Core Areas, and Windsor Core Area. (USFWS, 2016)

A/5: Service-approved conservation and management plans that protect vernal pool habitat and upland habitat and address effects of invasive plants are developed and are being effectively implemented. (USFWS, 2016)

A/6: Service shall work with Mosquito Abatement Districts so that their practices in the core and management areas are implemented to avoid impacts to the species. (USFWS, 2016)

E/1: All native occurrences, extant as of December 2014, are replicated at 1:2 (tripled in numbers of occurrences) in permanently protected sites in the three core areas. Replication is accomplished by collecting seed or inoculum from a natural occurrence and planting it at additional sites. For example: collecting seed or inoculum at one site and planting it at two additional sites increases the original single occurrence to 3 occurrences (1:2); planting it at three additional sites increases the original occurrence to 4 occurrences (1:3). (USFWS, 2016)

E/2: The preserves noted in Factor A are occupied by *Lasthenia burkei* at a density of 500 plants per square meter when measured on a 25- year moving average which includes at least one above average and one average rainfall year, and a multi-year drought. A multi-year drought is defined as a period of 3 or more years of below average local rainfall. (USFWS, 2016)

E/3: Service-approved conservation and management plans that protect vernal pool habitat and upland habitat and address effects of small occurrence size and climate change, among other threats, are developed and are being effectively implemented. (USFWS, 2016)

Delisting Criteria:

A/1: At least 90 percent of native occurrences of *Lasthenia burkei*, extant as of December 2014, have been protected in perpetuity. (USFWS, 2016)

A/2: New preserves have no greater than 20 percent wetlands at each site (no more than 2 ac of vernal pools and swales in each 10 ac preserve). (USFWS, 2016)

E/1: In addition to replication noted in E/1 of the downlisting criteria for *Lasthenia burkei*, all occurrences in management areas have been replicated at 1:2 at permanently protected appropriate locations. (USFWS, 2016)

E/2: All replicate occurrences in management areas have achieved the same density (500 plants per square meter) as the core area occurrences. (USFWS, 2016)

E/3: All genetically unique and isolated unprotected sites in management areas are permanently protected in situ. Identification of some genetically unique occurrences is not yet known but will be determined during research as defined in the Recovery Plan. (USFWS, 2016)

Recovery Actions:

- 1. Protect extant occurrences and potential habitat for *Lasthenia burkei*. Natural areas that are known to contain species covered in this recovery plan should be protected in perpetuity through land acquisition, conservation easements, or other means. Protection of these areas will need to be followed by identification of threats and application of appropriate and adaptive management to ensure abatement of these threats. In addition to areas that currently support the species, two other types of natural areas also need to be protected or secured: areas where the endangered plants have been found in the past but not been seen recently, and that retain habitat that can be readily restored so that plants can be reintroduced successfully; and areas where the plants have not been found but are appropriate for vernal pool creation, and subsequent introduction of the endangered plants. (USFWS, 2016)
- 2. Develop a central database for survey data from all natural and created occurrences of *Lasthenia burkei* including information on protection status. Data should include numbers of plants; area occupied by the species; presence of invasive species; site condition; land ownership; level of management; disturbance; whether the site is natural, restored, or created; and degree of genetic uniqueness. If the site has been seeded, the origin of the seed should be identified by name and location of parcel where seed was collected, location of specific pools where seed was collected, and date of seed collection. Any observations of pollinators, such as species or type of pollinator, should also be recorded. This information will serve as the current baseline for evaluating progress of the Factor A and Factor E comparative downlisting and delisting recovery criteria for each of the three plant species. This database should be updated regularly and should be available to all management agencies (USFWS, 2016). In addition, the database should track the location of source seed for sites with created occurrences (USFWS, 2019).
- 3. Collect and store seed from all occurrences of *Lasthenia burkei*. Seed collections for each plant taxon should be representative of both population- and species-level genetic diversity; seeds should be collected from multiple plants at each occurrence. Seed collection guidelines published by the Center for Plant Conservation (1991) should be followed. Seed collection should be conducted with caution to ensure that donor populations are not adversely affected by the collection. No more than 5 percent of the reproductive output should be removed from donor populations. Store seeds at two storage facilities certified by the Center for Plant Conservation. Seeds should be collected every 5 years to ensure that seeds in storage are viable. Permits will be required for collecting federally-listed plant seed on federal lands. (USFWS, 2016)
- 4. Survey historical locations and other potential habitat (not previously surveyed) where *Lasthenia burkei* may occur. (USFWS, 2016)

- 5. Conduct research necessary to develop a population viability analysis for *Lasthenia burkei*. Table 2 of the Recovery Plan lists research tasks needed for the development of a population viability analysis for all three species in the Recovery Plan. All research tasks need to be performed for each of the three species. To maximize efficiency, it may be possible to study the effects of an experimental factor on all three species in the Recovery Plan via the same experiment. (USFWS, 2016)
- 6. Conduct necessary biological research on *Lasthenia burkei* and use results to guide recovery efforts. Table 6 of the Recovery Plan the needed research tasks for the recovery of *Blennosperma bakeri*, *Lasthenia burkei*, and *Limnanthes vincularis*. All research tasks need to be performed for each of the three species. To maximize efficiency, it may be possible to study the effects of an experimental factor on all three species via the same experiment. (USFWS, 2016)
- 7. Habitat management for *Lasthenia burkei*. Develop adaptive management plans and implement appropriate management actions for all protected sites. Work with local agricultural commissions to track conversion of agricultural uses to vineyards or other non-suitable agricultural uses. Decrease acreage of vernal pool habitat within priority preservation and restoration areas that are subjected to altered hydrologic regimes through irrigation practices. Develop treatment protocol with mosquito abatement district to avoid impacts to listed species and vernal pool habitat during treatment. (USFWS, 2016)
- 8. Restore or create vernal wetlands, followed by reintroduction of the species per a restoration techniques white paper and a Reintroduction and Genetic Management Plan. As noted in the Factor A discussion, much of the habitat and occurrences of the three listed plants has been destroyed or fragmented by urban development and conversion to agricultural use. Restoration or creation of habitat, when appropriate, will be necessary to maintain the numbers of plants and occurrences at levels sufficient for survival of the species. Restoration and creation of vernal pool habitat has been conducted for many years in the Santa Rosa Plain for the three plants. To better understand these processes and their rates of success, a white paper and a Reintroduction and Genetic Management Plan should be developed. (USFWS, 2016)
- 9. Monitor all protected occurrences. Monitoring plans should be developed and implemented for all protected natural and replicated occurrences. Protected occurrences should be monitored annually for plant density, area occupied by the listed species, site condition, changes in hydrology, application of recycled water and wastewater, effects of grazing, invasive species, vandalism, and whether management is appropriate for the listed species' needs. The responsible party for monitoring should also keep an ongoing record of management activities and precipitation on the site, so that changes in rare plant populations can be related to changes in management activities. Monitoring efforts for co-occurring species should be coordinated to increase efficiency and reduce costs. (USFWS, 2016)
- 10. Engage and educate the public about *Lasthenia burkei* recovery. Public education and outreach is important to inform residents and land managers in the Santa Rosa Plain and other areas that support habitat for the species about the significance of the plants and the importance of management and protection of habitat for their persistence. Education and outreach activities should include: (1) develop a public outreach plan, (2) outreach to enhance public understanding of vernal wetlands in general and of imperiled vernal wetland species in particular, (3) information on regulatory responsibilities with regard to endangered species, (4) programs to encourage local interest and involvement in site

- stewardship, and (5) programs including conservation easements and incentive programs that are available to landowners who may have the vernal pool species on their land. (USFWS, 2016)
- 13. Agency coordination. Partner with California Department of Fish and Wildlife, Army Corps of Engineers, Regional Water Quality Control Board, Sonoma County, Marin/Sonoma Mosquito and Vector Control District, and Cities of Santa Rosa, Cotati, Rohnert Park, and Windsor to ensure resource management practices are aligned with species conservation needs. Resource management practices to be addressed include: irrigation of vernal pool habitat with recycled water and wastewater within priority preservation and restoration areas; protection of habitat buffers; stream ordinances, grading ordinances, and water quality regulations; and vineyard conversion or other agricultural conversion of areas adjacent to vernal pool habitat that contribute to hydrologic regime and/or provide upland habitat for sustaining the Sonoma County California tiger salamander. Provide legal assurances to willing landowners who implement projects that provide a net conservation benefit. (USFWS, 2016)

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Lasthenia burkei (Burke's goldfields)

Limnanthes vicularans (Sebastopol meadowfoam)

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SPECIES ACCOUNT: *Lasthenia conjugens* (Contra Costa goldfields)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/18/1997; Pacific Southwest (R8) (USFWS, 2017)

Physical Description

An annual herb, 1-4 dm tall, that produces showy yellow flower heads in the spring (NatureServe, 2015). The achenes (fruit) of *L. conjugens* are less than 1.5 millimeters (0.06 inch) long and always lack a pappus (the hair-like or scale-like structures attached to an achene, which assist in dispersal; Ornduff 1969, Ornduff 1993) (USFWS, 2013).

Taxonomy

The two closest relatives of *Lasthenia conjugens* are *L. burkei* (Burke's goldfields) and *L. fremontii* (Fremont's goldfields) (USFWS, 2005).

Historical Range

Historically occurred in seven vernal pool regions: Central Coast, Lake-Napa, Livermore, Mendocino, Santa Barbara, Santa Rosa, and Solano-Colusa (Keeler-Wolf et al. 1998). In addition, several historical occurrences in Contra Costa County are outside of the defined vernal pool regions (Keeler-Wolf et al. 1998). Ornduff (1966) reported collections from 13 sites in Alameda, Contra Costa, Mendocino, Napa, Santa Barbara, Santa Clara and Solano counties. Although he cited three specimens each from Contra Costa and Santa Barbara Counties, Ornduff (1966; 1979) noted that the species was most common in Solano County. One additional site in Alameda County was documented in 1959 by G. Thomas Robbins, who collected a specimen (# 3963, housed at the Jepson Herbarium) on the "shore of the San Francisco Bay" south of Russell (Service 2005a; USFWS, 2013).

Current Range

L. conjugens has been reported in ten counties within California: Alameda, Contra Costa, Marin, Mendocino, Monterey, Napa, Santa Barbara, Santa Clara, Solano, and Sonoma (CNDDB 2012; USFWS, 2013).

Critical Habitat Designated

Yes; 8/6/2003.

Legal Description

On August 11, 2005, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Lasthenia conjugens* (Contra Costa goldfields) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes eight critical habitat units (CHUs), in California (70 FR 46924-46999).

Critical Habitat Designation

The critical habitat designation for *Lasthenia conjugens* includes eight CHUs in Alameda, Contra Costa, Mendocino, Napa, and Solano counties, California. This species critical habitat encompasses approximately 14,730 acres (71 FR 7118-7316).

Unit 1: Mendocino County, California. From USGS 1:24,000 scale quadrangle Point Arena.

Unit 2: Napa County, California. From USGS 1:24,000 scale quadrangles Yountville, Capell Valley.

Unit 3: Napa County, California. From USGS 1:24,000 scale quadrangles Napa, Cuttings Wharf.

Unit 4: Solano County, California. (i) Unit 4A: Solano County, California. From USGS 1:24,000 scale quadrangle Fairfield South. (ii) Unit 4B: Solano County, California. From USGS 1:24,000 scale quadrangles Fairfield South. (iii) Unit 4C: Solano County, California. From USGS 1:24,000 scale quadrangles Elmira, Denverton.

Unit 5: Solano County, California. (i) Unit 5A: Solano County, California. From USGS 1:24,000 scale quadrangle Elmira. (ii) Unit 5B: Solano County, California. From USGS 1:24,000 scale quadrangles Elmira, Denverton.

Unit 6: Contra Costa County, California. From USGS 1:24,000 scale quadrangle Benicia.

Unit 7: Contra Costa County, California. From USGS 1:24,000 scale quadrangles Byron Hot Springs, Clifton Court Forebay.

Unit 8: Alameda County, California. (i) Unit 8A: Alameda County, California. (ii) Unit 8B: Alameda County, California. From USGS 1:24,000 scale quadrangles Milpitas, Niles.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Lasthenia conjugens* critical habitat consists of two components (70 FR 46924-46999):

(i) Topographic features characterized by isolated mound and intermound complex within a matrix of surrounding uplands that result in continuously, or intermittently, flowing surface water in the depressional features including swales connecting the pools described below in paragraph (2)(ii), providing for dispersal and promoting hydroperiods of adequate length in the pools;

(ii) Depressional features including isolated vernal pools with underlying restrictive soil layers that become inundated during winter rains and that continuously hold water or whose soils are saturated for a period long enough to promote germination, flowering, and seed production of predominantly annual native wetland species and typically exclude both native and nonnative upland plant species in all but the driest years. As these features are inundated on a seasonal basis, they do not promote the development of obligate wetland vegetation habitats typical of permanently flooded emergent wetlands;

Special Management Considerations or Protections

When designating critical habitat, we assess whether the areas determined to be essential for conservation may require special management considerations or protections. As we undertake the process of designating critical habitat for a species, we first evaluate lands defined by those physical and biological features essential to the conservation of the species for inclusion in the designation pursuant to section 3(5)(A) of the Act. Secondly, we then evaluate lands defined by those features to assess whether they may require special management considerations or

protection. In designating critical habitat, we also have considered how this designation highlights habitat that needs special management considerations or protection. For example, we have many regional HCPs under development, and this designation will be useful in helping applicants determine what vernal pool habitat areas should be highest priority for special management or protection, and where there may be more flexibility in conservation options. This designation will guide them and us in ensuring that all local habitat conservation planning efforts are consistent with conservation objectives for these species. Once a vernal pool habitat has been protected from direct filling, it is still necessary to ensure that the habitat is not rendered unsuitable for vernal pool species because of factors such as altered hydrology, contamination, nonnative species invasions, or other incompatible land uses. Many of the factors that cause the decline and localized extirpation of vernal pool species can be avoided. Actions that should be avoided include the following: (1) Actions that increase competition from invasive species as many of the species addressed in this rule are threatened by invasion of nonnative species (CNDDDB 2001). (2) Alteration of natural hydrology such as construction of dams or other structures that artificially increase the length of vernal pool inundation or construction of ditches that artificially drain vernal pools. (3) Human degradation of vernal pools such as off-road vehicle use, dumping, and vandalism that threatens many of the species addressed in this rule.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual: cross-pollination (USFWS, 2013)

Lifespan

Adult: One year (see physical description)

Breeding Season

Adult: March - June (USFWS, 2013)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 2005)

Reproduction Narrative

Adult: *L. conjugens* flowers from March to June (Ornduff 1966, Ornduff 1976) and is self-incompatible (USFWS, 2013). Although *L. conjugens* has not been the subject of pollinator studies, observations suggest that the same insects visit all outcrossed species of *Lasthenia*, rather than concentrating on any particular species (Thorp 1976). Insect visitors to flowers of *Lasthenia* belong to five orders: Coleoptera, Diptera, Hemiptera (true bugs), Hymenoptera, and Lepidoptera (Thorp and Leong 1998). Most of these insects are generalist pollinators. All of the specialist pollinators of *Lasthenia* are solitary bees (family Andrenidae); these pollinators include two species in the subgenus *Diandrena* (*Andrena submoesta* and *A. puthua*) and five or six species in the subgenus *Hesperandrena* (*Andrena baeriae*, *A. duboisi*, *A. lativentris*, and two or three undescribed species) (Thorp and Leong 1998) (USFWS, 2005).

Habitat Type

Adult: Wetland (USFWS, 2013)

Habitat Vegetation or Surface Water Classification

Adult: Northern Basalt Flow, Northern Claypan, and Northern Volcanic Ashflow vernal pools (USFWS, 2013)

Geographic or Habitat Restraints or Barriers

Adult: Typically occurs < 200 ft. elevation, but may occur up to 1465 ft. (USFWS, 2013)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Inhabits vernal pools in open grassy areas at elevations up to 470 m (NatureServe, 2015). *Lasthenia conjugens* typically grows in vernal pools, swales, and low depressions in open valley and foothill grasslands and have been found in three types of vernal pools: Northern Basalt Flow, Northern Claypan, and Northern Volcanic Ashflow (Sawyer and Keeler-Wolf 1995). This species is commonly found at elevations less than 61 meters (m) (200 feet (ft)) but has been documented at 445 m (1465ft) in Napa County and at 137 m (450ft) in Monterey County (CNDDB 2012)(USFWS, 2013).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Seed dispersal mechanisms in *Lasthenia conjugens* are unknown. However, the lack of a pappus or even hairs on the achenes makes wind dispersal unlikely (Ornduff 1976) (USFWS, 2005).

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Moderate (inferred from current range/distribution)

Representation:

High (inferred from USFWS, 2013)

Redundancy:

Moderate (inferred from USFWS, 2013)

Number of Populations:

19 - 23 (USFWS, 2013)

Population Narrative:

Of the 23 presumed extant records, four occurrences may now be extirpated: (1) an occurrence in Mendocino County has not been observed since 1937; (2) an occurrence in Alameda County has not been observed since 1959; (3) in 1987, a single plant was observed in Napa County and

has not been documented since; (4) an occurrence in Solano County was noted on a field checklist in 1996 and the location is unknown (CNDDDB 2012). Ramp Neale et al. (2008) found high levels of genetic diversity and moderate levels of differentiation among populations (USFWS, 2013).

Threats and Stressors

Stressor: Habitat destruction and modification (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: One of the primary threats to *L. conjugens* is conversion of land use, for example residential and industrial development, wetland drainage, and agricultural land conversion (including vineyards) (USFWS 2008). Since 65% of this species occurs on private land and is not protected, this is an ongoing problem (USFWS 2008). Just as significant are such associated threats as introduced invasive plants (like Italian ryegrass and waxy manna grass), recreational uses (such as off-road, equestrian, and mountain bike traffic), road construction and widening, and the resulting habitat fragmentation (USFWS 2008). Other threats to the species include landfill expansion, gravel mining, and both intensive grazing practices and the lack of grazing (USFWS 2008). Moderate grazing (in stocking numbers, frequency, and duration) is important to keeping invasive plants in check and improving soil conditions when burning is not possible (USFWS 2008) (NatureServe, 2015).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: The Endangered Species Act is the primary Federal law that provides protection for this species since its listing as endangered in 1997. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act. Therefore, the Service believes other laws and regulations have limited ability to protect the species in absence of the Endangered Species Act (USFWS, 2013).

Stressor: Invasive plants (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Competition from invasive plant species poses a primary threat to this species. Non-native grasses occur commonly in vernal pool complexes and have become a threat to native vernal pool species through their capacity to change pool hydrology. Non-native grasses maintain dominance at pool edges, sequestering light and soil moisture. *Lolium multiflorum* and *Glyceria declinata* (waxy manna grass) increase thatch buildup, which leads to increased oxygen depletion in the pools (Dunne and Leopold 1978) and contributes to the shortening of inundation periods through increased evapotranspiration (Marty 2005). As vernal pool complexes become surrounded by residential development and disturbed habitat, the likelihood of invasion by nonnative plants increases (Zedler and Black 2004) (USFWS, 2013).

Stressor: Inappropriate grazing regimes (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Both lack of grazing and excessive grazing may cause an increase in organic matter in the habitat that can eliminate the natural vernal pool invertebrate community and promote opportunistic and invasive nonnative species, such as *Lolium* spp., that outcompete the obligate vernal pool species (Rogers 1998; Rogers 2006). The cessation of cattle grazing has been found to exacerbate the negative effects of invasive non-native plants on vernal pool inundation period. Appropriate levels of grazing may help maintain soil conditions and limit the amount of thatch accumulation near vernal pools (Rogers 2006). Increased grass cover in and around ungrazed pools may lead to an increase in evapotranspiration rates, resulting in a decreased hydroperiod (Marty 2005). In areas where long-term grazing has been in effect, moderate grazing (in both stocking numbers and amount of time) may be an important tool in combating non-native plant species, when burning is not an option. Moderate grazing may be a necessary tool to maintain the species diversity of the natural vernal pool ecosystem (Marty 2005) (USFWS, 2013).

Stressor: Climate change (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: It is unknown at this time if climate change in California will result in a localized, relatively small cooling and drying trend, or a warmer trend with higher precipitation events (Pyke 2005). *Lasthenia conjugens* is dependent upon vernal pool wetlands that signify the importance of water availability on the survival and recovery for this species. If California receives more rainfall through intense precipitation events, suitable vernal pool habitat for *L. conjugens* may increase, which would benefit the species. However, if California enters into a drying trend, the resulting droughts could adversely affect *L. conjugens*. While drought conditions are a normal part of environmental variability in California, a severe drought would exacerbate adverse effects associated with small, disjunct populations of *Lasthenia conjugens*, and would place additional strains on vernal pool ecosystems (USFWS, 2013).

Recovery

Reclassification Criteria:

1. Habitat protection: Accomplish habitat protection that promotes vernal pool ecosystem function sufficient to contribute to population viability of the covered species. 1A. Suitable vernal pool habitat within each prioritized core area for the species is protected. 1B. Species localities distributed across the species' geographic range and genetic range are protected. Protection of extreme edges of populations protects the genetic differences that occur there. 1C. Reintroduction and introductions must be carried out and meet success criteria. 1D. Additional localities that are detected (and determined essential to recovery goals) are permanently protected. 1E. Habitat protection results in protection of hydrology essential to vernal pool ecosystem function, and monitoring indicates that hydrology that contributes to population viability has been maintained through at least one multi-year period that includes above average, average, and below average local rainfall as defined above, a multi-year drought, and a minimum of 5 years of post-drought monitoring (USFWS, 2013).

2. Adaptive Habitat Management and Monitoring: 2A. Habitat management and monitoring plans that facilitate maintenance of vernal pool ecosystem function and population viability have been developed and implemented for all habitat protected, as previously discussed in sections 1A-E. 2B. Mechanisms are in place to provide for management in perpetuity and long-term monitoring of 1A-E, as previously discussed (funding, personnel, etc.). 2C. Monitoring indicates that ecosystem function has been maintained in areas protected under 1A-D for at least one multi-year period that includes above average, average, and below average local rainfall, a multi-year drought, and a minimum of 5 years of postdrought monitoring. 2D. Seed banking actions have been completed for species that would require it as insurance against risk of stochastic extirpations or that will require reintroductions or introductions to contribute to meeting recovery criteria (USFWS, 2013).

3. Status Surveys: 3A. Status surveys, 5-year reviews, and population monitoring show populations within each vernal pool region where the species occur are viable (e.g., evidence of reproduction and recruitment) and have been maintained (stable or increasing) for at least one multiyear period that includes above average, average, and below average local rainfall, a multiyear drought, and a minimum of 5 years of post-drought monitoring. 3B. Status surveys, status reviews, and habitat monitoring show that threats identified during and since the listing process have been ameliorated or eliminated. Site-specific threats identified through standardized site assessments and habitat management planning also must be ameliorated or eliminated (USFWS, 2013).

4. Research: 4A. Research actions necessary for recovery and conservation of the covered species have been identified (these are research actions that have not been specifically identified in the recovery actions but for which a process to develop them has been identified). Research actions (both specifically identified in the recovery actions and determined through the process) on species biology and ecology, habitat management and restoration, and methods to eliminate or ameliorate threats have been completed and incorporated into habitat protection, habitat management and monitoring, and species monitoring plans, and refinement of recovery criteria and actions. 4B. Research on genetic structure has been completed (for species where necessary - for reintroduction and introduction, seed banking) and results incorporated into a habitat protection plan to ensure that within- and among-population genetic variation is fully representative by populations protected in the Habitat Protection section of this document, described previously in sections 1A-E. 4C. Research necessary to determine appropriate parameters to measure population viability for each species has been completed (USFWS, 2013).

5. Participation and Outreach: 5A. Recovery Implementation Team is established and functioning to oversee rangewide recovery efforts. 5B. Vernal pool regional working groups are established and functioning to oversee regional recovery efforts. 5C. Participation plans for each vernal pool region have been completed and implemented. 5D. Vernal pool region working groups have developed and implemented outreach incentive programs that develop partnerships contributing to achieving recovery criteria 1- 4 (USFWS, 2013).

Delisting Criteria:

See reclassification criteria.

Recovery Actions:

- Protect vernal pool habitat in the largest blocks possible from loss, fragmentation, degradation, and incompatible uses (USFWS, 2005).
- Manage, restore, and monitor vernal pool habitat to promote the recovery of listed species and the long-term conservation of the species of concern (USFWS, 2005).
- Conduct range-wide status surveys and status reviews for all species addressed in this recovery plan to determine species status and progress toward achieving recovery of listed species and long-term conservation of species of concern (USFWS, 2005).
- Conduct research and use results to refine recovery actions and criteria, and guide overall recovery and long-term conservation efforts (USFWS, 2005).
- Develop and implement participation programs (USFWS, 2005).

Conservation Measures and Best Management Practices:

- *L. conjugens* occurrences that are currently protected and managed for the benefit of the species include: (1) the North Suisun Mitigation Bank, in Solano County, (2) Travis AFB, in Solano County, (3) the State Route 4 Preserve, in Contra Costa County, (4) Don Edwards San Francisco Bay NWR, in Alameda County, and (5) the former Fort Ord, in Monterey County. Protection of additional localities of this species is necessary to recover this species. Protecting occurrences in Sonoma, Marin, and Napa Counties should be a priority over the next five years, as this is the northwestern edge of the species' range, and no occurrences in these counties are protected at this time (USFWS, 2013).
- Once additional sites are protected, management plans should be prepared. Results from standardized monitoring discussed in item 3, below, should be included in the management plans for these protected sites. Grazing management and invasive weed control should be primary components of these management plans (USFWS, 2013).
- Conduct research at as many of the presumed extant localities as possible to incorporate research recommendations outlined in the Recovery Plan. The following research should be prioritized over the next five years: a. Develop a standardized method to monitor species status and population trends at all known locations. This will better our understanding of potential threats to the species, and will aid in the development of methods to ameliorate these threats. b. Conduct research on invasive weedy plant species to determine the most appropriate methods to control these plants and increase population numbers of *L. conjugens* and other listed vernal pools plants. c. Conduct further research on the genetic structure of the species to determine the feasibility of introducing *L. conjugens* to biologically appropriate vernal pool regions and soil types from which status surveys indicate the species has been extirpated (USFWS, 2013).
- Regional vernal pool working groups should be created in regions where *L. conjugens* is known to occur to aid with monitoring and management efforts (USFWS, 2013).
- Conduct additional research on how *L. conjugens* is pollinated. If certain insects are found to be important to pollination, and therefore to seed production, their habitat must be protected in each core area to contribute to the recovery of *L. conjugens* (USFWS, 2013).

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SPECIES ACCOUNT: *Layia carnosa* (Beach layia)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/22/1992; Pacific Southwest (R8) (USFWS, 2017); Proposed Reclassification to Threatened

Physical Description

The unbranched to highly branched plants range up to 6 inches tall and 16 inches across. Characteristics distinguishing *Layia carnosa* from similar species include its fleshy leaves, inconspicuous flower heads with short, 0.08 to 0.1 inch long white ray flowers and yellow disk flowers, and bristles around the top of the one-seeded achene, or dry fruit (USFWS 1998). The number of seed-heads on individual plants varies with plant size. Typically unbranched, short plants on dry, exposed sites will produce a single head, while highly branched plants in moist dune hollows may produce more than 100 heads (USFWS, 2012).

Taxonomy

A member of the sunflower family (Asteraceae) (USFWS, 2012). In 1841, Thomas Nuttall described this species as *Madaroglossa carnosa* based on specimens he collected in 1835. In 1843, John Torrey and Asa Gray transferred this species to the genus *Layia*. In 1892, Edward Greene transferred it to the genus *Blepharipappus*. However, subsequent taxonomic considerations of this species agreed with Torrey and Gray (Munz and Keck 1959; Ferris 1960) (USFWS, 1998).

Historical Range

California endemic; Humboldt, Monterey, Marin, and Santa Barbara counties. Believed to be extirpated from San Francisco county (NatureServe, 2015).

Current Range

The current distribution includes occurrences spread across six very isolated dune systems (Freshwater Lagoon, Humboldt Bay, mouth of the Mattole River, Point Reyes, Monterey Peninsula, Vandenberg [a part of the Guadalupe-Nipomo Dunes], over about 500 miles of shoreline in northern and central California. Beginning at Freshwater Lagoon Spit in northern Humboldt County, *Layia carnosa* occurs intermittently over 70 miles of shoreline as far south as the mouth of the Mattole River. From there, it jumps some 170 miles to Point Reyes NS (Marin County), and then another 120 miles to the Monterey Peninsula (Monterey County). From Monterey, a gap of about 150 miles separates it from the southernmost site at Vandenberg AFB, in Santa Barbara County. Five historical occurrences located in San Francisco, Monterey and Humboldt counties are believed to have been extirpated (U.S. Department of the Interior 1998) (USFWS, 2012).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (based on closely related species) (NatureServe, 2015)

Lifespan

Adult: One year (USFWS, 2012)

Breeding Season

Adult: April - June (USFWS, 2012)

Key Resources Needed for Breeding

Adult: Spring rains (NatureServe, 2015)

Reproduction Narrative

Adult: Based on other *Layia* species, which are self-incompatible, this species would be an obligate outcrosser. It is dependent on spring rains as an annual (NatureServe, 2015). As a winter annual, *Layia carnosa* germinates during the rainy season between fall and mid-winter, blooms in spring (April to June), and completes its life cycle before the dry season (USFWS, 2012). The number of seed-heads on individual plants varies with plant size, ranging from unbranched, short, erect plants on dry, exposed sites with a single head to highly branched plants in moist hollows in dunes with over 100 heads (USFWS, 1998).

Habitat Type

Adult: Terrestrial (USFWS, 2012)

Habitat Vegetation or Surface Water Classification

Adult: Coastal sand dune (USFWS, 2012)

Geographic or Habitat Restraints or Barriers

Adult: Excessive shading (inferred from USFWS, 2012); typically occurs between 0 - 100 ft. elevation (USFWS, 2012)

Spatial Arrangements of the Population

Adult: Patchy colonies (USFWS, 2012)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (USFWS, 2012)

Habitat Narrative

Adult: The environmental specificity is very narrow; it is only known from narrow coastal strand in three main areas in California (NatureServe, 2015). Populations tend to be patchy and subject to large annual fluctuations in size and dynamic changes in local distribution associated with the shifts in dune blowouts, remobilization, and natural dune stabilization that occur in the coastal dune ecosystem. Colonies often occur where sparse vegetation traps wind-dispersed seeds, but causes minimal shading. *Layia carnosa* is restricted to openings in coastal sand dunes ranging in elevation from 0 to over 100 feet, where it colonizes sparsely vegetated, semi-stabilized dunes

and blowouts. The species often occurs in narrow bands of moderately disturbed habitat along the edges of trails and roads (USFWS, 2012).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seeds are dispersed by wind mostly during late spring and summer months (USFWS 1998; USFWS, 2012).

Population Information and Trends

Population Trends:

Decline of 50-70% (NatureServe, 2015); stable distribution since listing (USFWS, 2012)

Resiliency:

Moderate (inferred from current distribution)

Redundancy:

Moderate (inferred from NatureServe, 2015)

Number of Populations:

18 (NatureServe, 2015)

Population Size:

Unknown, > 10 million (USFWS, 2012)

Adaptability:

Low (NatureServe, 2015)

Population Narrative:

Highly vulnerable due to annual habit and sensitivity of coastal habitat. Long term trend is severe decline (50-70%). Numbers of this annual fluctuate depending on spring rain and available open sand. In 2005, the CNDDDB knew of 24 total EO's, 6 of which were historical or extirpated (NatureServe, 2015). No significant change in the distribution of *Layia carnosa* has occurred since the species was listed. Accurate estimation of population size is difficult and costly for diminutive, short-lived annual species such as *Layia carnosa*, which tends to occur in small patches scattered across large areas of habitat. Overall total habitat occupied by *Layia carnosa*, based on data collected between 1999 and 2010, is estimated on the order of 456 acres, which may be conservative given the difficulty in detecting the plant and conducting thorough surveys. The Humboldt Bay population clearly is the largest across the range, likely exceeding 10 million individuals. The population at the mouth of the Mattole, estimated in the millions, occupies about 27 acres, and at least for the present, is relatively free of invasive species. The Point Reyes population has not been accurately censused, but appears to number in the 10's of thousands or higher (USFWS, 2012).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2012)

Exposure:**Response:****Consequence:**

Narrative: The threat of off-road vehicles has reduced significantly, with the exception of some of the privately held habitat located in Humboldt County. The remaining occupied habitat most susceptible to human destruction or modification includes the dunes located near the mouth of McNutt Gulch, and the Signal Hill Dunes on the Monterey Peninsula. Although livestock trampling was indicated as a threat when *Layia carnosa* was listed, the only population known to be currently exposed to livestock is near the mouth of McNutt Gulch. No information is available on the size of that population, or degree of impacts by livestock. Many populations of *Layia carnosa* across its range continue to be impacted by uncontrolled pedestrian or equestrian traffic. However, evidence suggests that, for many sites where natural dune processes may be lacking, at least some recreation-related mortality may be a necessary consequence of the need for adequate disturbance to preclude overstabilization of the habitat. Acute levels of foot traffic clearly directly eliminate *Layia carnosa* from the center of traveled pathways, but at the same time, monitoring data and anecdotal evidence has consistently documented a strong preference by *Layia carnosa* for moderately disturbed habitat located along roads and trails (whether pedestrian or equestrian) in what otherwise would be unoccupied habitat.

Stressor: Climate change (USFWS, 2012)

Exposure:**Response:****Consequence:**

Narrative: It is expected that sea level may rise at least 16 inches along the California coast by 2050, with a 50-inch rise predicted by 2100 (Heberger et al. 2009). Beyond the direct influence of ocean-rise in potentially inundating the lower range of *Layia carnosa* habitat, even small changes in water level may cause significant changes in wave energy and the potential for shoreline damage from wave forces (California Coastal Commission 2001). Another coastal process that has the potential to affect *Layia carnosa* habitat, at least at Humboldt Bay, is vertical land deformation. Recent investigation suggests that deformation is occurring both during and between seismic events, and appears to vary in its direction (i.e., subsidence or uplift) and magnitude across the bay region (Walters 2011). Enhanced dune erosion may already be occurring in portions of the Humboldt Bay dune system, evidenced by the recent development of two unusually large, moving dune blowouts that show no sign of stabilizing, as well as a general loss of dune habitat on the North Spit (A. Pickart, pers. comm. 2011b) (USFWS, 2012).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2012)

Exposure:**Response:****Consequence:**

Narrative: While those and other statutes (CEQA, California Coastal Act, Federal Coastal Zone Management Act) all provide limited protections for *Layia carnosa* on private and public property, many of its current threats are either unregulated, or of a kind not affected by land use regulations (invasive species encroachment, pedestrian impacts). Thus regulatory restrictions, even when applicable, are currently inadequate to conserve this species (USFWS, 2012).

Stressor: Invasive plants (USFWS, 2012)

Exposure:

Response:**Consequence:**

Narrative: *Layia carnosa* was listed, in part, due to the past introduction and invasion of its habitat by a variety of invasive, non-native plant species. These species threaten virtually the entire distribution of *Layia carnosa*, through direct competition for space, stabilization of the dunes, and in some cases, enrichment of the soils which then stimulates invasion by other aggressive species. In Humboldt County the primary threats are invasive annual grasses, European beachgrass, yellow bush lupine, iceplant, and jubata grass (*Cortaderia jubata*). Iceplant, annual grasses, and in some cases European beachgrass, are the primary threats farther south in its range. Evidence suggests these taxa will continue to invade *Layia carnosa* habitat, necessitating routine and long-term management action. While the threat posed by invasive species has been addressed to some extent, at least temporarily, no mechanism has been implemented which ensures continued funding and implementation of an invasive species control program, or the monitoring necessary to effectively implement such a program (USFWS, 2012).

Stressor: Stochastic events (USFWS, 2012)

Exposure:**Response:****Consequence:**

Narrative: Annual species such as *Layia carnosa* are vulnerable to random fluctuations (stochasticity) and variation in annual weather patterns or other environmental factors (USFWS 1998). All of the Monterey and Santa Barbara County populations, and the Freshwater Lagoon Spit site in Humboldt County, due to their relatively small size and area of occupied habitat, continue to be vulnerable to stochastic extinction (USFWS, 2012).

Recovery**Reclassification Criteria:**

Not available

Delisting Criteria:

Protection of habitat presently occupied by the species, with long-term commitments to conserving the species and the native vegetation (USFWS, 1998).

In protected habitat, successful control of invasive non-native plants (and snails) and successful management of lesser problems, including grazing, pedestrians, and off-road vehicles. Management success must be demonstrated through ten years of biological monitoring. The time is needed to observe the effectiveness of management in dry and wet years (USFWS, 1998).

The threatened *Chorizanthe pungens* var. *pungens* may be considered for delisting when permanent protection has been implemented, as currently planned, in the Fort Ord disposal and reuse process and the coastal populations receive protected status (USFWS, 1998).

Recovery Actions:

- Protect existing populations and habitats (USFWS, 1998).
- Minimize the threats to the plants and butterfly (USFWS, 1998).

- Develop management strategies incorporating ecological and land use strategies (USFWS, 1998).
- Manage populations and habitats to achieve delisting (USFWS, 1998).
- Monitor population trends to evaluate recovery success (USFWS, 1998).
- Coordinate recovery actions to protect other listed and sensitive species (USFWS, 1998).
- Develop and implement an outreach program (USFWS, 1998).

Conservation Measures and Best Management Practices:

- Continued collaboration with Redwood NP, CDPR, BLM, Manila CSD, City of Eureka, Point Reyes NS, Vandenberg AFB, and perhaps private landowners is essential to the successful recovery of this species (USFWS, 2012).
- The type locality population for *Layia carnosa* at the Point Pinos dunes has not been detected since 1919 (CDFG 2007). The Point Pinos dunes are currently undergoing restoration and endangered species augmentation as part of a plan related to expansion of the golf course and transfer of the property from the US Coast Guard to the City of Pacific Grove. Unfortunately *Layia carnosa* was not included in the restoration plan. An attempt should be made to reintroduce *Layia carnosa* to Point Pinos from seed collected at nearby Asilomar SB or Indian Dunes. Whether or not the recovery goal for that population can be met is unknown. However, the attempt to establish a vigorous population there is called for under one of the delisting criteria, and could reestablish a historically significant population. In addition, the planned reintroduction of *Layia carnosa* to restored habitat near the historical occurrence at the mouth of Little River should be pursued (Forys 2006) (USFWS, 2012).
- Population and Occupied Habitat Inventories: Habitat owned by the USFWS, BLM, City of Eureka, Manila CSD, Point Reyes NS, CDPR and Pebble Beach Company (Indian Village Dunes) have been the focus of one or more dunes restoration projects. Periodic reassessment of these populations and occupied habitat at these sites, employing consistent methodology, is critical to establish trends, provide feedback on the restoration efforts, and determine whether the current recreational management is compatible with conservation of the species. Baseline population and habitat inventories are needed for the City of Eureka Elk River Spit, the privately held dunes near the mouth of McNutt Gulch, and the Signal Hill site owned by Pebble Beach Company on the Monterey Peninsula. Where populations are too large to census, a uniform methodology similar to that utilized by the USFWS and BLM at Humboldt Bay should be adopted (USFWS, 2012).
- Disturbance Monitoring: Habitat disturbance is known to be a necessary element in the ecology of *Layia carnosa*; however, too much or too little disturbance is detrimental. Therefore, in order to effectively tailor recreational management to the needs of *Layia carnosa*, quantitative data are needed indicating its response to specific recreational use. Research is needed to measure the rate of establishment and mortality of *Layia carnosa* in response to varying types and levels of disturbance (USFWS, 2012).
- Priorities for increased protection, by fee acquisition, conservation easement, or other legal protective mechanism, include: • Signal Hill Dunes, on the Monterey Peninsula • City of Eureka dunes habitat located on the North Spit, and Elk River Spits of Humboldt Bay. • Private owned dunes habitat on the North Spit of Humboldt Bay, and north of the mouth of the Mattole River. The monitoring and restoration conservation easement proposed by Pebble Beach Company as part of the Spyglass Hill Golf Course project could serve as a template for future agreements needed to ensure future conservation of critical dunes habitat for this species. Such agreements would in many cases contribute to recovery of multiple listed species, including the Monterey spineflower (*Chorizanthe pungens* var. *pungens*, sand gilia (*Gilia tenuiflora* ssp. *arenaria*), Tidestrom's lupine (*Lupinus tidestromii*) and Menzies' wallflower (*Erysimum menziesii* ssp. *menziesii*) on the Monterey

Peninsula; Tidestrom's lupine at Point Reyes NS; and Menzies wallflower (*E. m. Eurekaense*) in the Humboldt Bay portion of the range (USFWS, 2012).

- Due to the vulnerability of its habitat to stabilization by invasive species, and as a result, the highly transient nature of its habitat, the requirement to ensure future maintenance of *Layia carnosa* habitat is paramount to the recovery effort. It is imperative that efforts to control invasive species continue across the range, and that restoration methods incorporate the most cost-effective means available. Manual removal, or where existing populations will not be impacted, mechanical removal or burning followed with herbicide post-treatment has shown to be particularly effective. The problem species could change overtime, but inevitably, encroachment by invasive species and resulting over-stabilization of its habitat will continue to threaten *Layia carnosa* in perpetuity. Therefore, habitat monitoring followed by removal of invasive species, when warranted, must be considered a permanent element in maintaining *Layia carnosa*, even after the delisting (USFWS, 2012).
- Efforts should be made to determine which of the following three options for ensuring long-term protection best applies to individual sites and ownership: 1) endowment of conservation easements specifically written to include the necessary monitoring and habitat maintenance needed to conserve the species; 2) incorporation of language within the management guidance documents for each of the agencies that own property supporting significant populations of *Layia carnosa*, which emphasizes invasive species monitoring and control efforts in perpetuity, and at least some level of *Layia carnosa* population monitoring, even after it is delisted; 3) implementation of conservation agreements which combine the necessary elements of the above two options in ensuring future maintenance of *Layia carnosa* habitat after it is delisted (USFWS, 2012).
- Permanent Funding: With respect to the privately held habitat, the level of funding necessary to adequately monitor *Layia carnosa* populations and habitat, and implement maintenance actions prior to onset of population decline needs to be determined. Opportunities should then be pursued to secure permanent funding in the form of an endowment or trust fund, which ensures that the responsive management is conducted in perpetuity (USFWS, 2012).
- The California Shoreline Mapping Project, implemented in 2010, will provide high resolution LIDAR photography enabling development of accurate DEM's (California Ocean Protection Council 2011). Those data should be analyzed in conjunction with occupied habitat maps and periodic population monitoring data for sites across the range, particularly the Humboldt Bay, Mattole River, and Point Reyes populations, to help evaluate future trends in population and habitat as they correlate with elevation (USFWS, 2012).
- Future dunes habitat restoration projects across the range, but most importantly at Humboldt Bay, the mouth of the Mattole River, and at Point Reyes should utilize elevation data available from the DEM for those areas, and begin focusing restoration efforts in areas at sufficient elevation, and if possible, located geographically so as to insulate *Layia carnosa* as much as possible from the effects of ocean-rise (USFWS, 2012).
- Research should include a comparison of climate and soil factors, and other factors that may affect reproductive success in populations of *Layia carnosa*, both at the limits of its range, and within the center of its range (for example, Humboldt Bay). As soon as those results are available, the feasibility and practicality of meeting the existing delisting recovery criteria for the species should be evaluated, and recommendations made regarding adequacy of the existing recovery criteria (USFWS, 2012).
- Focused inventories for *Layia carnosa* should be conducted at all the significant dune systems located along the coast between the Monterey Peninsula and Vandenberg AFB, which constitutes a 150 mile long gap in the known distribution for the species (USFWS, 2012).

- Initial efforts have been made to restore near-shore dunes habitat at Vandenberg AFB, and expand the relatively small population of *Layia carnosa*. The results of the *Layia carnosa* life history study, scheduled to be initiated in fall 2011, hopefully should indicate whether range limiting factors, or simply the absence of an appropriate disturbance regime is preventing this population from expanding. Due to the fact it is the southernmost site for the species, and in accordance with the recovery plan, seed from this site should be deposited at an approved seedbank as soon as adequate seed are available (USFWS, 2012).

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SPECIES ACCOUNT: *Leavenworthia crassa* (Fleshy-fruit glade cress)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 8/1/2014

Physical Description

A winter annual from a basal rosette of leaves. Flowers (March-May) are whitish-yellow with yellow to orange claws. The first flowers are borne on erect stalks; those forming later usually are borne in loose clusters on true stems arising from the axils of the rosette leaves. Fruits are fleshy, 6-12 mm long. (NatureServe, 2015)

Taxonomy

Two questionably distinct varieties (*crassa* and *elongata*) are often recognized (e.g., Rollins, 1993; Kartesz 1994 and 1999). The USFWS (2004) does not maintain the varieties, citing evidence that the ranges of variation in fruit lengths overlap (McDaniel and Lyons, unpublished status report, 1987). (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Endemic to a 13-mile radius area in Lawrence and Morgan counties in northwest Alabama. (NatureServe, 2015)

Critical Habitat Designated

Yes; 8/26/2014.

Legal Description

On August 26, 2014, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Leavenworthia crassa* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes seven critical habitat units (CHUs), in Alabama (79 FR 50990-51039).

Critical Habitat Designation

The critical habitat designation for *Leavenworthia crassa* includes seven CHUs in Lawrence and Morgan Counties, Alabama. This species critical habitat encompasses approximately 20.6 acres (ac) (8.4 hectares (ha)) (79 FR 50990-51039).

Unit 1: Bluebird Glades: Unit 1 consists of 0.2 ha (0.5 ac) of privately owned land located in southeast Lawrence County, Alabama. The unit contains two subpopulations and is located along Alabama State Route 157 approximately 3.5 km (2.2 mi) southeast of the intersections of State Routes 36 and 157, approximately 3.7 km (2.3 mi) southwest of Danville, Alabama. These plants are located within a highly disturbed, limestone glade within a former mobile home site. Well-lighted, open areas (PCE 2), with shallow soils and exposed limestone bedrock or gravel that are dominated by characteristic glade vegetation (PCE 1), are present within the unit. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of the invasion of exotic species into open glades

and possible changes in land use, including road widening or development. Due to human-caused disturbances, exotic species, most notably Chinese privet and Japanese honeysuckle, threaten this site (Schotz 2009, pp. 13–14).

Unit 2: Stover Branch Glades: Unit 2 consists of 3.2 ha (7.8 ac) of privately owned land located in southeast Lawrence County, Alabama. The unit contains two subpopulations; one subpopulation is located on the southwest side of County Road 203 approximately 1.4 km (0.9 mi) southsoutheast of Alabama State Route 157, and one subpopulation is located along the southwest side of State Route 157, approximately 1.6 to 2.1 km (1 to 1.3 mi) southeast of State Route 36, in Speake, Alabama. These subpopulations are located within a pasture and are actively maintained by livestock grazing. Well-lighted, open areas (PCE 2), with shallow soils and exposed limestone bedrock or gravel that are dominated by characteristic glade vegetation (PCE 1), are present within the unit. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of invasive species into open glades and incompatible livestock grazing. Invasive species encroachment and continuous livestock grazing during the plant's reproductive cycle constitute ongoing threats to this site (Schotz 2009, pp. 15–16).

Unit 3: Indian Tomb Hollow Glade: Unit 3 consists of 0.5 ha (1.1 ac) of federally owned land located within the Bankhead National Forest in Lawrence County, Alabama. The unit is located on the west and northwest side of County Road 86 at a point roughly 4.5 km (2.8 mi) south of State Route 36 near Speake, Alabama. Habitat in this unit consists of a relatively small glade characterized by a flat limestone outcrop that is heavily buffered by nearly impenetrable tangles of eastern red cedar and upland swamp privet. Well-lighted, open areas (PCE 2), with shallow soils and exposed limestone bedrock or gravel that are dominated by characteristic glade vegetation (PCE 1), are present within the unit. The U.S. Forest Service provides management to control encroachment of invasive species (PCE 3). The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of the invasion of exotic species into open glade and damage from vehicles. Moderate encroachment of exotic species, most notably Chinese privet and Japanese honeysuckle, threatens this site along the glade periphery (Schotz 2009, pp. 18–19). This site also shows minimal incidence of trash disposal and damage from recreational vehicles.

Unit 4: Cedar Plains South: Unit 4 consists of 0.04 ha (0.1 ac) of privately owned land located in Morgan County, Alabama. This unit is located on Cedar Plains Road, 1.2 km (0.75 mi) south of County Road 55 and approximately 8 km (5 mi) west of the junction of U.S. Highway 31 and County Road 55 in Falkville. This population represents an excellent landscape context but contains the smallest number of plants of any of the known occurrences. Habitat in this unit consists of a well-lighted limestone glade opening (PCE 2) located within a limestone forest primarily comprised of eastern red cedar and various other hardwoods. Herbaceous vegetation characteristic of glade communities is present within the well-lighted glade (PCE 1), and competition and shading from native and invasive, nonnative plants are currently not a threat to the habitat in this unit (PCE 3). The features essential to the conservation of the species in this unit may require special management considerations or protections to prevent future adverse effects due to competition and shading caused by encroachment of native and invasive, nonnative plants.

Unit 5: Cedar Plains North: Unit 5 consists of 1.7 ha (4.2 ac) of privately owned land located in Morgan County, Alabama. This unit is located on Cedar Plains Road, from 0.6 to 1 km (0.4 to 0.6 mi) north of County Road 55, approximately 8 km (5 mi) west of the junction of U.S. Highway 31 and County Road 55 in Falkville. These populations are located within a pasture and are actively maintained by livestock grazing. Well-lighted, open areas (PCE 2), with shallow soils and exposed limestone bedrock or gravel that are dominated by characteristic glade vegetation (PCE 1), are present within the unit. This glade complex, although subjected to ongoing agricultural interests, represents the greatest concentration of plants currently known for the species. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of invasive species into open glades and incompatible livestock grazing. Invasive species encroachment and continuous livestock grazing during the plant's reproductive cycle constitute ongoing threats to this site (Schotz 2009, pp. 23–24).

Unit 6: Massey Glade: Unit 6 consists of 2.75 ha (6.8 ac) of privately owned land located in Morgan County, Alabama. This unit is located on County Road 55, 0.3 to 0.6 km (0.2 to 0.4 mi) west of Cedar Plains Road, approximately 8.3 km (5.2 mi) west of the junction of U.S. Highway 31 and County Road 55 in Falkville. This population is located within a highly disturbed complex of limestone pavement barrens scattered in an actively utilized pasture and within the yards and fields of nearby homes. Welllighted, open areas (PCE 2), with shallow soils and exposed limestone bedrock or gravel that are dominated by characteristic glade vegetation (PCE 1), are present within the unit. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of invasive species into open glades and incompatible livestock grazing. Invasive species encroachment and continuous livestock grazing during the plant's reproductive cycle constitute ongoing threats to this site (Schotz 2009, pp. 25–26).

Unit 7. Hillsboro Glade: Unit 7 consists of 0.04 ha (0.1 ac) of privately owned land in Lawrence County, Alabama. This unit is currently occupied and is located within a powerline right-of-way approximately 400 feet south of the intersection of County Roads 217 and 222, near Hillsboro. Habitat in this unit consists of a relatively small limestone glade outcrop within a powerline right-of-way that is bordered by a forested area. Wellilluminated, open areas (Primary Constituent Element (PCE 2), with shallow soils and exposed limestone bedrock that are dominated by characteristic glade vegetation (PCE 1), are present within the unit. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of the invasion of exotic species into open glades, indiscriminate herbicide use or mowing for electrical transmission line right-of-way maintenance, and possible changes in land use, including agriculture or development.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Leavenworthia crassa* critical habitat consists of three components (79 FR 50990-51039):

- (i) Shallow-soiled, open areas with exposed limestone bedrock or gravel that are dominated by herbaceous vegetation characteristic of glade communities.

(ii) Open or well-lighted areas of exposed limestone bedrock or gravel that ensure fleshy-fruit gladeceess plants remain unshaded for a significant portion of the day.

(iii) Glade habitat that is protected from both native and invasive, nonnative plants to minimize competition and shading of fleshy-fruit gladeceess.

Special Management Considerations or Protections

The features essential to the conservation of fleshy-fruit gladeceess may require special management considerations or protection to reduce the following threats: (1) Actions that remove the soils and alter the surface geology of the glades; (2) building or paving over the glades; (3) construction or excavation up slope that alters water movement (sheet flow or seepage) down slope to gladeceess sites; (4) planting trees adjacent to the edges of an outcrop resulting in shading of the glade and accumulations of leaf litter and tree debris; (5) encroachment by nonnative and native invading trees, shrubs, and vines that shade the glade; (6) the use and timing of application of certain herbicides that can harm gladeceess seedlings; and (7) access by cattle to gladeceess sites where habitat and plants may be trampled. Management activities that could ameliorate these threats include (but are not limited to): (1) Avoiding limestone glades when planning development, conversion to agriculture, and other disturbances to glade complexes; (2) avoiding above-ground construction and/or excavations in locations that would interfere with natural water movement to gladeceess habitat sites; (3) locating suitable habitat and determining the presence or absence of the species and identifying areas with glade complexes and protecting or restoring as many complexes as possible; (4) reaching out to all landowners, including private and State landowners, to raise awareness of the plant and its specialized habitat; (5) providing technical or financial assistance to landowners to help in the design and implementation of management actions that protect the plant and its habitat; (6) avoiding pine tree plantings near glades; and (7) managing, including brush removal, to maintain an intact native glade vegetation community. More information on the special management considerations for each critical habitat unit is provided in the individual unit descriptions below.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (USFWS, 2013)

Reproduction Narrative

Adult: Fleshy-fruit gladeceess is an annual, spring-flowering member of the mustard family (Brassicaceae). As an annual, the seeds germinate in the fall, overwinter as rosettes, and commence a month-long flowering period beginning in mid-March. The first seeds mature in late April, and during most years the plants dry and drop all of their seeds by the end of May. It is unlikely that all seeds produced in spring germinate the next fall, but the length of dormancy in the soil is not known (McDaniel and Lyons 1987, p. 10); thus we do not know whether the species is capable of forming a seed bank. Native bees in the families' Andrenidae and Halictidae (sweat bees), including the species *Halictus ligatus* (sweat bee), were observed carrying pollen from *Leavenworthia crassa* (fleshy-fruit gladeceess) and *L. alabamica* (Alabama gladeceess) in northern Alabama (Lloyd 1965) (USFWS, 2013).

Habitat Type

Adult: Glades (USFWS, 2013)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 2013)

Site Fidelity

Adult: High (inferred from USFWS, 2013)

Habitat Narrative

Adult: This species is a component of glade flora and occurs in association with limestone outcroppings. The terms “glade” and “cedar glades” are used interchangeably to refer to shallow soiled, open areas that are dominated by herbaceous plants and characterized by exposed sheets of limestone or gravel. Eastern red cedar (*Juniperus virginiana*) trees are frequent in the deeper soils along the edges of the glades (Hilton 1997, p. 1; Baskin et al. 1986, p. 138; Baskin and Baskin 1985, p. 1). Glades can vary in size from as small as a few square meters to larger than 1 square kilometer (km²) (0.37 square miles (mi²)) and are characterized as having an open, sunny aspect (lacking canopy) (Quarterman 1950, p. 1; Rollins 1963, p. 5). Historically, glades in northern Alabama occurred as glade complexes where sparsely vegetated patches of exposed, or nearly exposed, limestone occurred in a matrix of woody vegetation to form a mosaic of habitats grading into one another (Hilton 1997, pp. 1, 5, 64). Herbaceous diversity was irregular over these complexes, affected by changes in soil gradient and moisture, and the presence or absence of a woody vegetation component. Few undisturbed examples of this community type remain (Hilton 1997, pp. 5, 8; McDaniel and Lyons 1987, p. 11; Baskin and Baskin 1985, p. 1; Rollins 1963, p. 5–6) (USFWS, 2013). High ecological integrity of the population and site fidelity along with low tolerance ranges are inferred based on this species specific habitat requirements.

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Decreasing (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Narrative:

Being a seed-banking winter annual, this species has good survival but poor competitive abilities (USFWS 2004). The very low numbers of fruiting individuals seen most years suggest that the populations may be highly vulnerable to stochastic factors as well. The plants are usually self-incompatible (Rollins 1993), thus requiring cross-pollination for seed production. However, given proper habitat conditions, this species is able to grow and reproduce quickly. More than 50% of the appropriate glade habitat has been lost in north-central Alabama, with only five glades remaining in good condition (Hilton 1997 cited by Everson 2009). Fifteen historical occurrences have been lost. Also, the range may have contracted significantly, if an unconfirmed historical record from Lauderdale County is accepted. Some of the extant occurrences have been degraded by grazing, road construction, and plowing or cultivation (Everson 2009). Decline of 70-90% Population size value left blank for this seed-banking annual because the large number of individuals suggests a sense of security that is not warranted. Abundant locally, with some sites containing thousands of individuals. Individual populations range from <50 individuals to up to 10,000. In March 2009, a total of approximately 12,000 individuals were counted in the six occurrences (Schotz 2009). Endemic to northwest Alabama, where six occurrences were verified extant in 2009 (Schotz 2009) (NatureServe, 2015). NatureServe (2015) notes that the short term trend is a decline of 30-50% and the Long-term trend is a decline of 70-90%. USFWS (2013) notes there are 5 extant populations. Low resiliency, representation and redundancy are inferred based on the number of populations and the relatively small geographic area this species is known to inhabit.

Threats and Stressors

Stressor: Agricultural conversion (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Conversion of this species habitat to agriculture (pasture) is listed as a threat to this species (USFWS, 2013).

Stressor: Incompatible agricultural practices (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Agricultural practices such as herbicide use at the wrong time of year are listed as a threat to this species (USFWS, 2013).

Stressor: Rights-of-way maintenance (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Rights-of way maintenance (including herbicide use and mowing prior to seed set) is listed as a threat to this species (USFWS, 2013).

Stressor: Industrial development (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Industrial development is listed as a threat to this species (USFWS, 2013).

Stressor: Shading and competition (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Shading and competition by non-native exotic plants and natural forest succession are listed as a major threat to this species (USFWS, 2013).

Stressor: Off-road vehicle use (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat/loss of individual plants

Narrative: Off-road vehicle use is listed as a threat to this species (USFWS, 2013).

Recovery

Recovery Actions:

- A recovery plan has not been issued for this species.

References

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

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USFWS. 2015. Environmental Conservation Online System (ECOS) – Species Profile. <http://ecos.fws.gov/speciesProfile/>. Accessed April 2016.

U.S. Fish and Wildlife Service. 2014. Endangered and Threatened Wildlife and Plants

Designation of Critical Habitat for *Physaria globosa* (Short's bladderpod), *Helianthus verticillatus* (whorled sunflower), and *Leavenworthia crassa* (fleshy-fruit glade cress). 79 FR 50990-51039 (August 26, 2014).

U.S. Fish and Wildlife Service. 2013. Endangered and Threatened Wildlife and Plants

Endangered Status for *Physaria globosa* (Short's bladderpod), *Helianthus verticillatus* (whorled sunflower), and *Leavenworthia crassa* (fleshy-fruit glade cress). Proposed Rule, FR Vol. 79, No. 149. Pages 47109-47134.

Endangered Status for *Physaria globosa* (Short's bladderpod), *Helianthus verticillatus* (whorled sunflower), and *Leavenworthia crassa* (fleshy-fruit glade cress). Proposed Rule, FR Vol. 79, No. 149. Pages 47109-47134

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A."

SPECIES ACCOUNT: *Leavenworthia exigua laciniata* (Kentucky glade cress)

Species Taxonomic and Listing Information

Listing Status: Threatened; 06/05/2014; Southeast Region (Region 4) (USFWS, 2016)

Physical Description

A winter annual. Plants are about 5 to 10 cm (1.97 to 3.94 in) in height with early leaves that are simple with a slender petiole (central stalk of the leaf) and mature leaves that are sharply lobed (appear as disconnected pieces along the main leaf vein), somewhat squarish at the ends and arranged as a rosette (circular cluster of leaves) (Evans and Hannan 1990). The flowers are small (3 to 6 mm (0.12 to 0.24 in)), white to lilac in color with four petals, green rather than lavender sepals (the outer of two floral leaves that make up the flower), and leafless stems. Leaves typically disappear by the time the plant is in fruit (Evans and Hannan 1990). The fruit is flat and pod-shaped. Flowering begins in March, with seed dispersal occurring by mid-May. (USFWS, 2016; NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Kentucky: Bullitt and Jefferson counties. (NatureServe, 2015)

Critical Habitat Designated

Yes; 5/6/2014.

Legal Description

On May 6, 2014, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Leavenworthia exigua laciniata* (Kentucky glade cress) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six critical habitat units (CHUs), in Kentucky (79 FR 25689-25707).

Critical Habitat Designation

The critical habitat designation for *Leavenworthia exigua laciniata* includes six CHUs (sixteen sub-units) in Bullitt and Jefferson Counties, Kentucky. This species critical habitat encompasses approximately 2,053 acres (ac) (830 hectares (ha)) (79 FR 25689-25707).

Unit 1: McNeely Lake, Jefferson County, Kentucky: Unit 1 consists of 18 acres (ac) (7 hectares (ha)) within McNeely Lake Park in Jefferson County, Kentucky. This critical habitat unit is under county government ownership. This critical habitat unit occurs at the northwestern edge of the species' range, where there is little remaining habitat and few occurrences, and therefore this unit is important to the distribution of the species. Habitat degradation (e.g., erosion, invasive species) is impacting the species' ability to persist within this unit; however, the landowner has received funding and is working with the Service and KSNPC to develop a management plan for the site and to implement habitat improvement practices. These planned activities are expected to improve population numbers and viability at this important site. This unit helps to maintain

the geographical range of the species and provides opportunity for population growth. Within Unit 1, the features essential to the conservation of the species may require special management considerations or protection to address potential adverse effects associated with encroachment by nonnative plants or forage species, and forest encroachment due to fire suppression.

Unit 2, Subunits A, B, and C: Old Mans Run, Jefferson and Bullitt Counties, Kentucky: Unit 2 consists of three subunits totaling 1,014 ac (410 ha) in Bullitt and Jefferson Counties, Kentucky. It is located just south of the Jefferson/Bullitt County line and extends north of Old Mans Run. This critical habitat unit includes four element occurrences. Subunit 2B represents the best remaining populations and habitat for *L. exigua* var. *laciniata* in Jefferson County. Subunits 2A and 2C are important areas at the northern extent of the species' range. These three subunits represent the northeastern extent of the population's range and increase population redundancy within the species' range. The features essential to the conservation of the species in Unit 2 may require special management considerations or protection to address potential adverse effects associated with development on private land, incompatible agricultural or grazing practices, ORV or horseback riding, competition from lawn grasses, and forest encroachment. Subunit 2A is 102 ac (41 ha) in size and is located west of US 150 and northwest of Floyds Fork. It is in private ownership. While all PCEs are present within this subunit, it contains few native plant associates for *L. exigua* var. *laciniata*, and the increased competition from lawn grasses may decrease the ability of *L. exigua* var. *laciniata* to persist. This subunit is important for maintaining the northern distribution of *L. exigua* var. *laciniata*. Subunit 2B is 870 ac (352 ha) in size and is located east of US 150 and extends north and south of Old Mans Run. It is in private ownership. This is the largest of the subunits and contains the two highest ranked (1-B and 1-C) occurrences in Jefferson County. It represents the best remaining habitat in this portion of the range and may contain more than half of the total *L. exigua* var. *laciniata* population based on a 2011 survey by KSNPC, which estimated more than 20,000 individuals at 4 sites within this subunit. In this subunit, competition from lawn grasses impacts *L. exigua* var. *laciniata* and may decrease the plant's ability to persist. Subunit 2C is 42 ac (17 ha) in size and is located west of US 150 and east of Floyds Fork, extending into both Bullitt and Jefferson Counties. It is in private ownership. This subunit is primarily pasture, and habitat for *L. exigua* var. *laciniata* is impacted by competition from lawn grasses. Habitat management within this subunit to improve habitat for *L. exigua* var. *laciniata* is important for maintaining the northern distribution of the species.

Unit 3, Subunits A, B and C: Mount Washington, Bullitt County, Kentucky: Unit 3 consists of 42 ac (17 ha) and includes three subunits in Bullitt County, Kentucky, primarily within or adjacent to the city limits of Mount Washington. This critical habitat unit includes three element occurrences and provides an important link between the northern and southern portions of the species' range. Within Unit 3, the features essential to the conservation of the species may require special management considerations or protection to address potential adverse effects associated with development on private land, incompatible agricultural or grazing practices, ORV or horseback riding, competition from lawn grasses, and forest encroachment due to fire suppression. Subunit 3A is 25 ac (10 ha) in size and is located northeast of Mount Washington. It is in private ownership. Habitat for *L. exigua* var. *laciniata* within this subunit is degraded and would improve with management. It represents important habitat on the eastern extent of the species' range. In this subunit, habitat conversion and ORV use impact *L. exigua* var. *laciniata* habitat and may decrease the species' ability to persist at this site. Subunit 3B is 7 ac (3 ha) in size and is located east of Hubbard Lane and south of Keeneland Drive. It is in private ownership. The glade habitat has been degraded by adjacent land use and would benefit from improved management. The

subunit represents an important link between other subunits. Subunit 3C is 10 ac (4 ha) in size and is located east of US 150 and south of Highway 44E. It is in private ownership. The subunit represents an important and high quality cedar glade in an area of ongoing, intensive development. Land use surrounding the glade remnant appears stable and the glade contains several native plant species associated with *L. exigua* var. *laciniata*.

Unit 4, Subunits A, B, C, D, E, F, G, and H: Cedar Creek, Bullitt County, Kentucky: Unit 4 consists of 547 ac (221 ha) and includes eight subunits, all in Bullitt County, Kentucky. This unit is located south of the Salt River and northeast of Cedar Grove and seems to represent the core of the remaining high-quality habitat for *L. exigua* var. *laciniata*. It includes eight element occurrences. In addition to being a stronghold for the species, these subunits are generally within close proximity (less than 0.5 miles (0.8 km)) to each other and represent the best opportunity for genetic exchange between occurrences. Within Unit 4, the features essential to the conservation of the species may require special management considerations or protection to address potential adverse effects associated with development on private land, incompatible agricultural or grazing practices, ORV or horseback riding, competition from lawn grasses, and forest encroachment due to fire suppression. Subunit 4A is 91 ac (37 ha) in size and is located south of Cedar Creek and west of Pine Creek Trail. This subunit is owned by The Nature Conservancy and encompasses most of the Pine Creek Barrens Preserve. This excellent-quality glade represents the only remaining "A" rank occurrence for *L. exigua* var. *laciniata*. Subunit 4B is 69 ac (28 ha) in size and is located along an unnamed tributary to Cedar Creek, and south of KY 1442. This good-quality glade includes the Apple Valley Glade State Nature Preserve, owned by KSNPC (approximately 30 percent of subunit), as well as private land, including some under permanent conservation easement (approximately 41 percent of subunit) to protect *L. exigua* var. *laciniata*. Approximately 29 percent of this subunit is under private ownership without any protections for *L. exigua* var. *laciniata*. Subunit 4C is 83 ac (34 ha) in size and located north of Cedar Creek and south of Apple Valley State Nature Preserve. It is in private ownership. This subunit contains high-quality glades with a community of native plants present. Subunit 4D is 46 ac (19 ha) in size and is located north of Cedar Creek and south of Victory Church. It is in private ownership. This subunit has been degraded and would benefit from improved management. Native plants associated with *L. exigua* var. *laciniata* occur within this subunit, but competition from lawn grasses, as well as forest encroachment due to fire suppression, impacts *L. exigua* var. *laciniata* and may decrease its ability to persist. Subunit 4E is 102 ac (41 ha) in size and is located southeast of subunit 4D and across Cedar Creek. It is in private ownership. It contains a large number of *L. exigua* var. *laciniata* (several thousand), but the habitat has been degraded by adjacent land use and would benefit from improved management. Competition from lawn grasses, as well as forest encroachment due to fire suppression, affects *L. exigua* var. *laciniata* and may decrease the plant's ability to persist. Subunit 4F is 120 ac (49 ha) in size and is south of the confluence of Cedar Creek and Greens Branch. It is in private ownership. This is a degraded glade that still contains native plants associated with *L. exigua* var. *laciniata*. The subunit is disturbed by existing and surrounding land uses, as well as utility line maintenance and ORV use, which may decrease the species' ability to persist. Subunit 4G is 20 ac (8 ha) in size and is located along either side of KY 480 near White Run Road. It is in private ownership. This site contains a large number of plants; however, improved habitat conditions are needed for longterm viability of the *L. exigua* var. *laciniata* occurrence. Impacts to *L. exigua* var. *laciniata*, which may decrease its ability to persist at this site, include incompatible agricultural or grazing practices, ORV use, competition from lawn grasses, and forest encroachment due to fire suppression. Subunit 4H is 16 ac (6 ha) in size and is located 0.95 miles southeast of the KY 480/KY 1604 intersection. It is in private ownership. Within this

subunit, several patches of good habitat for *L. exigua* var. *laciniata* remain as well as a good diversity of native plant associates. However, competition from lawn grasses, as well as forest encroachment due to fire suppression, affects *L. exigua* var. *laciniata* and may decrease its ability to persist.

Unit 5, Subunits A and B: Cox Creek, Bullitt County, Kentucky: Unit 5 consists of 58 ac (23 ha) and includes two subunits, both in Bullitt County, Kentucky. It includes two element occurrences, representing the most easterly occurrences south of the Salt River. These subunits are important for maintaining the distribution and genetic diversity of the species. Within Unit 5, the features essential to the conservation of the species may require special management considerations or protection to address potential adverse effects associated with illegal waste dumps, development on private land, incompatible agricultural or grazing practices, ORV or horseback riding, competition from lawn grasses, and forest encroachment due to fire suppression. Subunit 5A is 8 ac (3 ha) in size and is located east of Cox Creek and west of KY 1442. It is in private ownership. This site is threatened by ORV use and would benefit from improved habitat management. Subunit 5B is 50 ac (20 ha) in size and is located west of Cox Creek near the Bullitt/Spencer County line. It is in private ownership. Incompatible agricultural practices and ORV use impacts *L. exigua* var. *laciniata* and may decrease its ability to persist. The native flora is mostly intact, and *L. exigua* var. *laciniata* would benefit from improved habitat management.

Unit 6: Rocky Run, Bullitt County, Kentucky: Unit 6 consists of 374 ac (151 ha) in Bullitt County, Kentucky. This critical habitat unit includes habitat that is under private ownership, including one 16-acre registered natural area. It includes one element occurrence. This unit appears to represent the largest intact glade habitat remaining within the range of the species. Within Unit 6, the features essential to the conservation of the species may require special management considerations or protection to address potential adverse effects associated with development on private land, incompatible agricultural or grazing practices, competition from lawn grasses, and forest encroachment due to fire suppression.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Leavenworthia exigua laciniata* critical habitat consists of two components (79 FR 25689-25707):

(i) Cedar glades and gladelike areas within the range of *L. exigua* var. *laciniata* that include: (A) Areas of rock outcrop, gravel, flagstone of Silurian dolomite or dolomitic limestone, and/or shallow (1 to 5 centimeters (0.393 to 1.97 inches)), calcareous soils; (B) Intact cyclic hydrologic regime involving saturation and/or inundation of the area in winter and early spring, then drying quickly in the summer; (C) Full or nearly full sunlight; and (D) An undisturbed seed bank.

(ii) Vegetated land around glades and gladelike areas that extends up and down slope and ends at natural (e.g., stream, topographic contours) or manmade breaks (e.g., roads).

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. Threats to those features that define primary constituent elements for *L. exigua* var.

laciniata include (but are not limited to): (1) Residential and commercial development on private land; (2) construction and maintenance of roads and utility lines; (3) incompatible agricultural or grazing practices; (4) off-road vehicle (ORV) use or horseback riding; (5) encroachment by nonnative plants or forage species; and (6) forest encroachment due to fire suppression. These threats are in addition to random effects of droughts, floods, or other natural phenomena. Special management considerations or protection are required within critical habitat areas to address these threats. Management activities that could address these threats include (but are not limited to): (1) Avoiding cedar glades (or suitable gladelike habitats) when planning the location of buildings, lawns, roads (including horse or ORV trails), or utilities; (2) avoiding aboveground construction and/or excavations in locations that would interfere with natural water movement to suitable habitat sites; (3) protecting and restoring as many glade complexes as possible; (4) research supporting the development of management recommendations for grazing and other agricultural practices; (5) technical or financial assistance to landowners that may help in the design and implementation of management actions that protect the plant and its habitat; (6) avoiding lawn grass or tree plantings near glades; and (7) habitat management, such as brush removal, prescribed fire, and/or eradication of lawn grasses to maintain an intact native glade vegetation community.

Life History**Food/Nutrient Resources****Lifespan**

Adult: 1 year (USFWS, 2016)

Breeding Season

Adult: Begins in March (USFWS, 2016)

Reproduction Narrative

Adult: A winter annual. *L. exigua* var. *laciniata* persist through the winter as rosettes, and flowering begins in late February to early March (Baskin and Baskin 1981; Evans and Hannan 1990). Seeds are set and plants die in April and May as the glade habitats dry out (Baskin and Baskin 1985; Solbrig 1971). At maturity, most of these seeds are dormant and will not germinate following dispersal, even if the soils are moist (Baskin and Baskin 1985). During the summer, these seeds undergo physical changes known as after-ripening and move from dormancy to conditional dormancy and finally, become non-dormant for fall germination (Baskin and Baskin 1985). (USFWS, 2016)

Habitat Type

Adult: Terrestrial (USFWS, 2016)

Habitat Vegetation or Surface Water Classification

Adult: Cedar glades (USFWS, 2016)

Geographic or Habitat Restraints or Barriers

Adult: Shade intolerant and prefers sparse vegetation (USFWS, 2016)

Habitat Narrative

Adult: *L. exigua* var. *laciniata* appears to be adapted to environments with shallow soils interspersed with flat-bedded, Silurian dolomite and dolomitic limestones, which is an uncommon geological formation in Kentucky (Rollins 1963; Evans and Hannan 1990). The soil on these horizontally bedded limestone areas is often only a few inches in depth or may be completely lacking in some areas (Rollins 1963). Because of the thin soils and underlying limestones, these habitats, called cedar or limestone glades, are extremely wet from late winter to early spring and quickly become dry in May and June. The natural habitat for *L. exigua* var. *laciniata* is these cedar glades (Baskin and Baskin 1981), but the taxon is also known from overgrazed pastures, eroded shallow soil areas with exposed bedrock, and areas where the soil has been scraped off the underlying bedrock (Evans and Hannan 1990). *L. exigua* var. *laciniata* does not appear to compete well with other vegetation and is shade intolerant (Evans and Hannan 1990) (USFWS, 2016).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Short-term trends suggest declines of 10-50% (NatureServe, 2015)

Number of Populations:

21 - 80 (NatureServe, 2015)

Population Size:

1000 - 100,000 individuals (NatureServe, 2015)

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: The greatest threat to *Leavenworthia exigua* var. *laciniata* is the destruction and degradation of glades through development, roads, utilities, and conversion to lawns. Documented impacts from horseback riding, off-road vehicle use, and changes in grazing practices have resulted in the loss or degradation of several *L. exigua* var. *laciniata* occurrences. These activities are expected to continue in the future but to an unknown extent. Forest encroachment is expected to continue in areas without active management. Climate change has the potential to impact this species, but to what extent cannot be predicted (USFWS, 2014).

Stressor: Narrow range and small populations (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: *Leavenworthia exigua* var. *laciniata* has a narrow range, occurring in only small portions of two counties. Within this range, *L. exigua* var. *laciniata* is restricted to cedar glades and similar shallow-soiled areas that occur sporadically across the range. More than half of the remaining occurrences had low (fewer than 100 individuals) population counts at the time of the most recent survey. Additionally, the presumed low genetic diversity within individual occurrences of *L. exigua* var. *laciniata* could place those occurrences at a high risk of extirpation as their capacity for adaptation to change is reduced (USFWS, 2014).

Recovery

Reclassification Criteria:

Reclassification criteria are not available.

Delisting Criteria:

Delisting criteria are not available.

Recovery Actions:

- Recovery actions are not available.

Conservation Measures and Best Management Practices:

- Conservation measures are not available.

References

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

USFWS. 2016. Environmental Conservation Online System (ECOS) – Species Profile. <http://ecos.fws.gov/ecp/>. Accessed July 2016

U.S. Fish and Wildlife Service. 2014. Endangered and Threatened Wildlife and Plants

Designation of Critical Habitat for *Leavenworthia exigua* var. *laciniata* (Kentucky Glade Cress). Final Rule. 79 FR 25689-25707 (May 6, 2014).

USFWS. 2014. Determination of Threatened Status for *Leavenworthia exigua* var. *laciniata* (Kentucky Glade Cress)

Final Rule. 79 Federal Register 87, May 6, 2014. Pages 25683 - 25688.

SPECIES ACCOUNT: *Leavenworthia texana* (Texas golden Gladecress)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/11/2013; Southwest Region (Region 2)

Physical Description

A weakly rooted, glabrous (smooth, glossy), winter annual (completes its life cycle in 1 year). Texas golden gladecress is small in stature, less than 3.9 inches (in) (10 centimeters (cm)) in height, making it difficult to find except during flowering or when it bears fruit. The leaves are 0.8-3.1 in (2-8 cm) long and 0.4-0.6 in (1-1.5 millimeters (mm)) wide, forming rosettes at the base of the plant. Terminal leaf segments are wider-than-long, and usually distinctly lobed, with angular teeth. Flowers are bright yellow and borne on scapes (leafless flowering stems or stalks arising from the ground) that are 1.2-3.5 in (3-9 cm) long early in the flowering season. Later in the season, the flowers occur on unbranched flower clusters that come off a single central stem from which the individual flowers grow on small stalks, at intervals. The four petals are bright golden-yellow with a slightly darker base, narrowly obovate (tongue-shaped), 0.3-0.4 in (7-10 mm) long and 0.1-0.2 (3.5-5 mm) wide. The fruit is a slender seed capsule, known as a silique, with a length (0.6-1.2 in (15-30 mm)) that is more than twice its width (0.08-0.22 in (2-5.5 mm)) and that contains 5 to 11 flattened, circular or spherically shaped seeds. (USFWS, 2013a)

Taxonomy

In the mustard family (Brassicaceae). Dr. M. C. Leavenworth, an Army physician, first collected the taxon in Choctaw County, Oklahoma, in 1835, and the specimens were later described as a new species, *Leavenworthia aurea*, by Torrey (Mahler 1981, pp. 76-77). From 1836 to 1837, Leavenworth collected similar specimens near the present-day town of San Augustine, San Augustine County, Texas, and these were also identified as *L. aurea*. E. J. Palmer (1915 and 1918), and D. S. and H. B. Correll (1961 to 1962) as cited by Mahler (1981, pp. 83) made later collections of the plant in the San Augustine area. George and Nixon (1990, pp. 117-127) studied and mapped populations in this area between 1979 and 1980. W. H. Mahler studied the collected specimens and their habitat, and described the Texas plants as a new species, *Leavenworthia texana* (Mahler 1987, pp. 239-242), based on differences in morphological characteristics of flowers and leaves, and in chromosome number, between the Oklahoma and Texas plants (Mahler 1987, pp. 239-242). According to Mahler (1987, p. 240), Texas golden gladecress flower petals were a brighter, deeper yellow than those of *L. aurea*, and the petals were egg-shaped and flat instead of being broad and notched. The *L. texana* had wider-than-long terminal leaf segments that were usually distinctly lobed while *L. aurea*'s terminal leaves were essentially unlobed, flat, and more circular. Texas plants had a chromosome number of $2n = 22$ (Nixon 1987, pers. comm. in Mahler 1987, pp. 239, 241) while the Oklahoma *L. aurea* had $2n = 48$ (Rollins 1963, pp. 9-11; Beck et al. 2006, p. 156). We are aware that a recently completed monograph of the genus may have taxonomic implications for the Texas and Oklahoma *Leavenworthia* species in the future, but several questions, including the differences in chromosome number, remain unresolved and no supporting information that would change the current status of Texas golden gladecress has been published to date (Poole 2011a, pers. comm.). (USFWS, 2013a)

Historical Range

Texas golden glade cress is known from eight locations (historic and extant), including one introduced population, all within a narrow zone that parallels SH 21 in San Augustine, Sabine, and Nacogdoches Counties (Texas Natural Diversity Database (TXNDD) 2012b). (USFWS, 2013a)

Current Range

San Augustine and Sabine Counties in eastern Texas, on a particular geologic formation (the Weches Formation). (USFWS, 2013a)

Critical Habitat Designated

Yes; 10/11/2013.

Legal Description

On September 11, 2013, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective October 11, 2013) for *Leavenworthia texana* (Texas golden Glade cress) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four critical habitat units (CHUs), in Sabine and San Augustine Counties, Texas. (USFWS, 2013b)

Critical Habitat Designation

The critical habitat designation for *Leavenworthia texana* includes four CHUs in Sabine and San Augustine Counties, Texas. This species critical habitat encompasses approximately 1,353 acres (ac) (548 hectares (ha)). Brief descriptions are provided below; maps depicting these areas are included in the Final Rule. (USFWS, 2013b)

Unit 1: Geneva: Unit 1 consists of 388 ac (157 ha) of private and State land located in northwest Sabine County, Texas. The unit is located 1.5 mi (2.3 km) south of Geneva, Texas, and 4.8 mi (7.7 km) north of Milam, Texas, and is bisected by SH 21.

Unit 2: Chapel Hill: Unit 2 consists of 150 ac (61 ha) of privately owned land, with one county road ROW, in northwestern San Augustine County, Texas. This unit is located 1.0 mi (1.6 km) south of SH 21, due west of the San Augustine-Sabine County line, and lies alongside County Road (CR) 151. This unit is linear in shape, running from southeast to northwest. Aside from CR 151, all other land in Unit 2 is privately owned. Current land cover appears to be approximately 70 percent woody cover; much of the forest being rows of pine trees.

Unit 3: Southeast Caney Creek Glades: Unit 3 consists of 39.9 ac (16.2 ha) just southeast of the City of San Augustine, San Augustine County, Texas. Approximately 99 percent of the land within this unit is privately owned, with the other 1 percent being county ROW under the management of TXDOT. This unit is located 0.8 mi (1.2 km) south from SH 21 near San Augustine, Texas, along the north side of FM 3483. This unit is located across Sunrise Road from a glauconite quarry.

Unit 4: Northwest Caney Creek Glades: Unit 4 consists of 775.3 ac (313.7 ha) that extends in a diagonal line from northeast to southwest, to the north and south of SH 21 just east of the City of San Augustine, San Augustine County, Texas. The unit is approximately 0.7 mi (1.1 km) wide.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Leavenworthia texana* critical habitat consists of three components (USFWS, 2013b):

(i) Exposed outcrops of the Weches Formation within Weches prairies. Within the outcrop sites, there must be bare, exposed bedrock on top-level surfaces or rocky ledges with small depressions where rainwater or seepage can collect. The openings should support Weches Glade native herbaceous plant communities.

(ii) Thin layers of rocky, alkaline soils, underlain by glauconite clay (greenstone, ironstone, bluestone), that are found only on the Weches Formation. Appropriate soils are in the series classifications Nacogdoches clay loam, Trawick gravelly clay loam, or Bub clay loam, ranging in slope from 1– 15 percent.

(iii) The outcrop ledges should occur within the glade such that Texas golden gladeceess plants remain unshaded for a significant portion of the day, and trees should be far enough away from the outcrop(s) that leaves do not accumulate within the gladeceess habitat. The habitat should be relatively clear of nonnative and native invasive plants, especially woody species, or with only a minimal level of invasion.

Special Management Considerations or Protections

Texas golden gladeceess may require special management considerations or protection to reduce the following threats: quarrying or other excavations, including pipeline installations; building over the top of occupied glades; construction or excavation upslope that alters water movement (sheet flow or seepage) downslope to Texas golden gladeceess sites; pine tree plantings near glades; and invasive (native and nonnative) plants. Refer to the five-factor analysis in the listing determination for the Texas golden gladeceess for more information on these threats. The features essential to the conservation of Texas golden gladeceess may require special management considerations or protection to reduce the following threats: • Actions that remove the soils and alter the surface geology of the glades; • Building or paving over the glades; • Construction or excavation upslope that alters water movement (sheet flow or seepage) downslope to Texas golden gladeceess sites; • Planting trees adjacent to the edges of an outcrop resulting in shading of the glade and accumulations of leaf litter and tree debris; • Encroachment by nonnative and native invading trees, shrubs, and vines that shade the glade; • The use and timing of application of certain herbicides that can harm Texas golden gladeceess mature plants and seedlings; and • Fence placement such that livestock are likely to be directed through gladeceess sites where habitat and plants may be trampled. Management activities that could ameliorate these threats include (but are not limited to): • Avoiding Weches glades when planning the location of quarries, well pads, roads, other facilities or structures, or pipeline routes, through glade complexes; • Avoiding above-ground construction or excavations in locations that would interfere with natural water movement to Texas golden gladeceess habitat sites; • Locating suitable habitat and determining the presence or absence of the species and identifying areas with glade complexes and protecting or restoring as many complexes as possible; • Extending outreach to all landowners, including private and State, to raise awareness of the plant and its specialized habitat; • Providing technical or financial assistance to landowners to help in the design and implementation of management actions that protect the plant and its habitat; • Avoiding pine tree plantings near glades; and • Brush removal, to maintain an intact native glade vegetation community. (USFWS, 2013b)

Life History

Food/Nutrient Resources**Breeding Season**

Adult: March to April (NatureServe, 2015)

Reproduction Narrative

Adult: A winter annual, 2-10 cm tall, that produces bright yellow flowers in March and April. (NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Wet glades, herbaceous communities (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Vernal wet environment (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Habitat Narrative

Adult: Herbaceous communities in vernal wet glades with shallow, calcareous soils on Weches Formation ironstone outcrops. Associated species include the rare white bladderpod (*Lesquerella pallida*), as well as flat stemmed spike-rush (*Eleocharis compressa*), and rock stonecrop (*Sedum pulchellum*). (NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Long-term trends indicate a decline of 30-70%, whereas short-term trends suggest a decline of 30-50% (NatureServe, 2015)

Number of Populations:

3 (NatureServe, 2015)

Population Size:

250 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Long-term population trends indicate a decline of 30-70%, whereas short-term trends suggest a decline of 30-50%. The small population size and low number of sites make this taxon vulnerable to effects of stochastic phenomena and catastrophic events; it has very low numbers in drought

years (USFWS, 2004). At least two historical sites have been lost due to glauconite mining (USFWS 2012). Numbers of (growing) plants vary somewhat year-to-year. In 2009, the three extant sites had 98, 29, and 260 plants respectively (USFWS 2012). Three natural occurrences with intact habitat as of 2011 (USFWS 2012). An introduced site had plants through 2009 but a 2011 survey found the plants had been removed by a pipeline installation (USFWS 2012). Seed banks may persist at two historical sites (USFWS 2012). (NatureServe, 2015)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: The most significant threat to habitat of Texas golden gladeceess is surface quarrying of glauconite and the exploration and development of oil and natural gas wells and associated roads and pipelines have destroyed 50 percent of the known populations between the mid-1990s and 2011. In addition, excavations may occur when pipelines for water, sewer lines, gas connections to homes, and communication lines are installed may damage populations and habitat. Texas golden gladeceess also faces threats throughout its range from competition for light and nutrients from both native and nonnative, invasive, woody plants, including the nonnative Macartney rose. Additionally, herbicides used to control Macartney rose may be a threat to the Texas golden gladeceess if applied to or persisting in the soil during the species' period of growth, from late fall through early summer. A recent, ongoing trend in local land use is the conversion of open pasture to pine plantations. However, densely planted pine trees may degrade the species' habitat due to competition for light and nutrients and by contributing masses of leaf litter onto formerly sparsely vegetated glades. Finally, the information regarding climate change is not yet specific enough for us to determine the potential long-term effects to the Texas golden gladeceess's habitat. However, long-term drought has negatively affected and will likely continue to negatively affect the reproduction and germination of Texas golden gladeceess seeds (USFWS, 2013).

Stressor: Small populations (USFWS, 2013a)

Exposure:

Response:

Consequence:

Narrative: Texas golden gladeceess is a historically rare species with some adaptations, such as a mixed mating system, that help to alleviate part of the inherent risks of small population size. The continued existence of Texas golden gladeceess is negatively impacted by natural factors including being limited to only a few remaining populations that contain very small numbers of individual plants with a distribution restricted to extremely small areas of outcrop. The species' current, reduced occurrences across a range that has been highly fragmented by past and ongoing human activities increase its vulnerability. With only three remaining populations, loss of an entire population could be catastrophic for this species' long-term viability. Therefore, the small number of remaining populations, all of which are small in size, in conjunction with the threats to habitat, constitutes a threat to the species and greatly exacerbates other the threats identified for this species (USFWS, 2013a).

Recovery

Reclassification Criteria:

Reclassification criteria are not available.

Delisting Criteria:

Delisting criteria are not available.

Recovery Actions:

- Recovery actions are not available.

Conservation Measures and Best Management Practices:

- Conservation measures are not available.

References

USFWS. 2013a. Determination of Endangered Status for Texas Golden Gladecress and Threatened Status for Neches River Rose-Mallow

Final Rule. 78 FR 56025 – 56069 (September 11, 2013).

USFWS. 2013b. Designation of Critical Habitat for Texas Golden Gladecress and Neches River Rose-Mallow. Final Rule. 78 FR 56072-56120 (September 11, 2013).

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

NatureServe. 2015. NatureServe Explorer: an encyclopedia of life [web application]. Accessed July 2016

USFWS. 2013a. Determination of Endangered Status for Texas Golden Gladecress and Threatened Status for Neches River Rose-Mallow

Final Rule. 78 FR 56026 - 56069 (September 11, 2013).

SPECIES ACCOUNT: *Lepidium arbuscula* (ʻAnaunau)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

Lepidium arbuscula is a short-lived perennial in the Brassicaceae (mustard) family. This species is a gnarled shrub, 0.6 to 1.2 m (2 to 4 ft) tall, with leaves crowded at the ends of the branches. The leaves are 2.6 to 6.0 cm (1.0 to 2.4 in) long and 0.8 to 1.8-cm (0.3 to 0.7 in) wide. The small white flowers form one to three erect simple racemes, 7 to 15 cm (2.8 to 5.9 in) long. The fruit is short and ovate to suborbicular in shape, and 3.5 to 4 mm (0.1 to 0.2 in) long and wide. The reddish brown seeds are 1.5 to 2.0 mm (0.1 in) long. *Lepidium arbuscula* is the only native *Lepidium* in the Waianae Mountains and is distinguished from others in the genus by its height (Wagner et al 1999) (USFWS, 2016). A gnarled shrub 6-12 dm tall, with leaves crowded at the ends of the branches. (NatureServe, 2015)

Historical Range

Historically, *Lepidium arbuscula* was known from scattered localities throughout the Waianae Mountains (USFWS, 2016).

Current Range

Endemic to Waianae Mountains, Oahu (NatureServe, 2015). Currently, approximately 900 individuals in 10 small, widely dispersed occurrences are distributed from Kuaokala in the northern Waianae Mountains to Lualualei-Nanakuli Ridge in the southern Waianae Mountains. These occurrences include Ohikilolo, Makua-Keaau Ridge, Kapuhi Gulch, and Manini Gulch, Pahoa and Halona, northwest of Puu Kaua, Halona, Lualualei-Nanakuli Ridge, Kamaileunu Ridge, and Mohiakea Gulch (Table SB 23) (USFWS, 2015).

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Lepidium arbuscula* (ʻAnaunau) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Lepidium arbuscula* (77 FR 57648-57862). The critical habitat designation includes 8 critical habitat units, which encompass approximately 1,449 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Lepidium arbuscula* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Lepidium arbuscula* includes 8 critical habitat units, covering one ecosystem type, which encompasses approximately 1,449 acres on the Island of Oahu,

Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8 .

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac (105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Lepidium arbuscula* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Lepidium arbuscula* occurs within the indicated ecosystem in the Waianae Mountain caldera complex:

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: *Antidesma*, *Chamaesyce*, *Diospyros*, *Dodonaea*. (F) Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Schiedea*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Lepidium arbuscula* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Breeding Season

Adult: *Lepidium arbuscula* has been observed in flower in February but little else is known about its flowering cycles (USFWS, 2016).

Reproduction Narrative

Adult: *Lepidium arbuscula* has been observed in flower in February but little else is known about its flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors (Service 1998a) (USFWS, 2016).

Habitat Type

Adult: Ridge tops and cliff faces (USFWS, 2016)

Habitat Narrative

Adult: *Lepidium arbuscula* generally grows on exposed ridge tops and cliff faces in mesic and dry vegetation communities between 131 and 978 m (430 and 3,208 ft) in elevation. This species is typically associated with native plant species such as *Artemisia australis*, *Bidens* sp., *Carex meyenii*, *C. wahuensis*, *Chamaesyce multiformis*, *Dodonaea viscosa*, *Dryopteris unidentata*, *Dubautia* sp., *Eragrostis variabilis*, *Leptecophylla tameiameia*, *Lysimachia hillebrandii*, *Metrosideros polymorpha*, *Peperomia* sp., *Psydrax odorata*, *Rumex albescens*, *Schiedea ligustrina*, *Sida fallax*, or *Sophora chrysophylla* (USFWS, 2016).

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Unknown

Number of Populations:

10 populations (USFWS, 2016)

Population Size:

~900 individuals (USFWS, 2016)

Population Narrative:

Currently, approximately 900 individuals in 10 small, widely dispersed occurrences are distributed from Kuaokala in the northern Waianae Mountains to Lualualei-Nanakuli Ridge in the southern Waianae Mountains. These occurrences include Ohikilolo, Makua-Keaau Ridge, Kapuhi Gulch, and Manini Gulch, Pahoia and Halona, northwest of Puu Kaua, Halona, Lualualei-Nanakuli Ridge, Kamaileunu Ridge, and Mohiakea Gulch (Table SB 23).

Threats and Stressors

Stressor: Non-native plants (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Non-native plants compete with *L. arbuscula* for nutrients, light, and space (USFWS, 2016).

Stressor: Feral animals (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Feral goats threaten *L. arbuscula* by browsing on plants, trampling individuals, and causing general habitat destruction (USFWS, 2016).

Stressor: Fire (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals.

Narrative: The occurrences located on military land are threatened by fire caused by military training actions (USFWS, 2016).

Stressor: Roads (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The occurrence at the head of Kapuhi Gulch is also threatened by its proximity to a road (USFWS, 2016).

Recovery

Conservation Measures and Best Management Practices:

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References

USFWS 2016. Status of the Species and Critical Habitat: *Lepidium arbuscula* (Anaunau). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

U.S. Fish and Wildlife Service. 2012. Endangered and Threatened Wildlife and Plants

Endangered Status for 23 Species on Oahu and Designation of Critical Habitat for 124 Species. Final Rule. 77 FR 57648-57862 (September 18, 2012)

USFWS. 2016. Status of the Species and Critical Habitat: *Lepidium arbuscula* (Anaunau). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016

USFWS 2016. Status of the Species and Critical Habitat: *Lepidium arbuscula* (Anaunau). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016.

USFWS. 2016. Status of the Species and Critical Habitat: *Lepidium arbuscula* (Anaunau). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016.

SPECIES ACCOUNT: *Lepidium barnebyanum* (Barneby ridge-cress)

Species Taxonomic and Listing Information

Listing Status: Endangered; 9/28/1990; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

Barneby ridge-cress is a perennial, herbaceous plant in the mustard family, approximately 2 to 6 inches tall, typically with raised clumps or cushions up to 8 inches wide. The species arises from a deep woody taproot; its stems are smooth and hairless with narrow leaves clustering at the base of the plant. The cream-colored flowers are about 0.25 inches across and alternate along a stem rising above the base of the plant. (USFWS, 2016)

Taxonomy

The plant was first described as *Lepidium montanum* ssp. *Demissum* and later renamed by James Reveal as *Lepidium barnebyanum*. (USFWS, 1990)

Historical Range

The current species distribution is essentially the same as the historical distribution known from past records. (USFWS, 1993)

Current Range

Barneby ridge-cress is known from one population with three separate stands endemic to thin limestone caps on ridge lines near Indian Canyon approximately 3 miles south and southwest of the town of Duchesne, Utah. It occurs entirely on Ute Indian reservations. (USFWS, 2011)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 2016)

Lifespan

Adult: Long-lived (USFWS, 2016)

Dependency on Other Individuals or Species

Adult: Pollinators unknown (USFWS, 2016)

Breeding Season

Adult: Flowers April to May (USFWS, 2016)

Reproduction Narrative

Adult: Reproduction is sexual, with flowering occurring from April to May and fruiting occurs May to June. The specific pollination mechanism and vectors are not known. (USFWS, 2016) It

has an apparent low rate of reproduction (Davern pers. comm. 1988; England pers. comm. 2008). This could be due to a very low ratio of ovules developing into seeds, which may result in embryonic failure and a loss of reproductive capacity (Weins et al. 1989). Reasons for this are unknown. (USFWS, 2011)

Habitat Type

Adult: Shale barrens (USFWS, 1993)

Habitat Vegetation or Surface Water Classification

Adult: Mixed desert shrub and pinyon-juniper community (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Soils (USFWS, 1993)

Environmental Specificity

Adult: Very narrow specialist with key requirements scarce (inferred from USFWS, 1993)

Site Fidelity

Adult: Very high (inferred from USFWS, 1993)

Habitat Narrative

Adult: The habitat is poorly developed soils derived from white, marly shale outcrops of the Uinta Formation in pinyon-juniper communities. It occurs at 1890 and 1985 m elevation. (NatureServe, 2015) The soil characteristics of the habitat are not common within the species range, and effectively form "islands" of suitable habitat within a "sea" of unsuitable soil types derived from other differing geologic substrates. (USFWS, 1993)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: No dispersal information has been provided in USFWS or NatureServe documents. However, very specific soil requirements that occur as small "islands" within the pinyon juniper community limit the dispersal of the species. (USFWS, 1993)

Population Information and Trends**Population Trends:**

Stable (USFWS, 2011)

Species Trends:

Declining (USFWS, 1993)

Resiliency:

Very low (USFWS, 2011)

Representation:

Very low (USFWS, 2011)

Redundancy:

Very low (USFWS, 2011)

Population Growth Rate:

Poor (USFWS, 2011)

Number of Populations:

1 (USFWS, 2011)

Population Size:

2500 - 10,000 individuals (NatureServe, 2015). As of 2019: at least 7633 individuals (USFWS, 2019).

Adaptability:

Very low (USFWS, 2011)

Population Narrative:

The Barneby ridge-crest is known from one population with three distinct stands with a total range about 5 miles. The total population is estimated to be about 5,000 individuals with an occupied habitat of less than 500 acres. (USFWS, 1993). Survey data collected between 2010 and 2016 indicates that there are at least 7,633 known Barneby ridge-crest individuals occupying 500 acres of suitable habitat. In 2014, a new disjunct subpopulation of 24 Barneby ridge-crest individuals was located on privately owned property (EIS 2014). This new subpopulation is the most western known stand and is approximately 4.7 miles from the nearest known occupied habitat. In 2015, approximately 1,090 individuals were located on land owned by the State of Utah Department of Wildlife Resources that is managed as a wildlife management area (USFWS 2015). The 2015 survey on state lands was not a complete census and we expect that additional individuals are located on State lands. The majority of the population and habitat are located within the Uintah and Ouray Reservation of the Ute Indian Tribe; however, two subpopulations of Barneby ridge-crest also occur on private and state owned lands. (USFWS, 2019).

Threats and Stressors

Stressor: Off-road vehicles (UFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: In the listing package and Recovery Plan, off-highway vehicles were cited as a significant threats due to its narrow distribution along ridgelines (55 FR 39862; USFWS 1993). Since listed, recreational (trail riding and hunting related) OHV use within the species' occupied habitat has been very light due in large part to Tribal control and active policing to prevent trespass. Therefore, we now consider the threat of recreational OHV to be low throughout the species' range. (USFWS, 2011)

Stressor: Oil and gas energy development (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The location of the species' habitat on the top of relatively level ridgelines in an area of very steep topographic relief exposes the species to an increased likelihood of habitat destruction from oil and gas industry related activities (i.e., OHV use, pipeline installation, and road and well-site construction). These threats affect all stands of the species' single population (UDOGM 2009; Chester pers. comm. 2008; O'Hearn pers. comm. 2008; Secakuku pers. comm. 2008). Oil and gas field development is the current action that has the greatest potential to adversely affect the species. The entire area containing the known population has been leased for development. (USFWS, 2011)

Stressor: Low reproductive success (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The species has a very low ratio of ovules developing into seeds, which may result in embryonic failure and a loss of reproductive capacity (Weins et al. 1989). Reasons for this are unknown. Seedlings of Barneby ridge-cross are rare, and more research is needed to determine the conservation implications of these preliminary observations. (USFWS, 2011)

Stressor: Invasive weeds (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Introduced weeds (*Bromus tectorum* and *Halogeton glomeratus*) are invading in disturbed areas near roads and well pads (Chester pers. comm. 2008; England pers. comm. 2008; Secakuku pers. comm. 2008). The presence of *Bromus tectorum* shortens fire return intervals and allows the weed to out-compete native shrubs and grasses that are adapted to longer fire return intervals (Gorrell et al. 2005; Zouhar 2003). Fires within areas infested with exotic weeds also tend to occur earlier in the season leading to further damage to native vegetation (Zouhar 2003). (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Climate change could potentially impact *Lepidium barnebyanum* or its pollinators, although the specific impacts of altered temperature and precipitation regimes are unknown. *L. barnebyanum*'s phenology could be altered and could result in disruption of pollinator availability and activity, germination, or other life history needs. (USFWS, 2011)

Recovery**Reclassification Criteria:**

A total population of 20,000 individuals is documented for 5 years (USFWS, 1993)

Five separate stands of at least 2,000 individuals each are maintained and have been demonstrated to be at minimum viable population level with formal land management designations in place to protect the species and its habitat. (USFWS, 1993)

Delisting Criteria:

1. A Conservation Agreement (CA) has been developed and implemented for Barneby ridge-cress that addresses all five listing factors on the lands it would cover. (USFWS, 2019).
2. An ex-situ seed bank collection is maintained at a Center for Plant Conservation affiliated institution and contains a minimum of 500 seeds. The ex-situ seed bank contains genetic material collected from each known subpopulation across the range of the species and is collected over a period of at least five-years. (USFWS, 2019).
3. Maintain a viable and self-sustaining metapopulation consisting of at least five subpopulations. This will be determined through a population viability analysis indicating the sub-populations are at or above minimum viable population levels, or through monitoring data indicating a stable or increasing trend in the metapopulation and at least five sub-populations (λ equal to or greater than one) over a period of at least ten years. (USFWS, 2019).

Recovery Actions:

- Control activities that affect the habitat of *L. barnebyanum* through sections 7 and 9 of the Endangered Species Act and other relevant laws and regulations. (USFWS, 1993)
- Inventory suitable habitat for *L. barnebyanum* and determine with a reasonable degree of accuracy the population and distribution of the species. (USFWS, 1993)
- Establish and conduct minimum viable population studies on at least three different populations of *L. barnebyanum*, (USFWS, 1993)
- Document the presence of or, if necessary, establish formal land management designations that would provide for long term, undisturbed habitat for *L. barnebyanum*. (USFWS, 1993)
- Develop public awareness, appreciation, and support for the conservation of *L. barnebyanum*. (USFWS, 1993)

Conservation Measures and Best Management Practices:

- Revise the Recovery Plan to include the delisting criteria, reevaluate threats, and provide updated conservation recommendations. (USFWS, 2011)
- The BIA, with support of the Tribe and the USFWS, should conduct population surveys within the species' known range and potential habitat in the general region (Uinta Basin of northeast Utah) to better understand the species' range, abundance and potential threats. (USFWS, 2011)
- The BIA, with support of the Tribe and the USFWS, should conduct population monitoring to determine natural population dynamics and trends. (USFWS, 2011)
- The BIA, with support of the Tribe and the USFWS, should conduct monitoring to avoid impacts to the species' habitat from oil and gas development and other possible threats. (USFWS, 2011)
- The BIA, with cooperation of the Tribe and the Service, should conduct research of the species' life history including reproduction. (USFWS, 2011)
- We will ensure that the Section 7(a)(2) process addresses threats posed by invasive plants, dust, habitat fragmentation from road development and other indirect impacts from oil and gas development. (USFWS, 2011)
- We will work with the Tribe and BIA to evaluate the potential to establish a conservation area or a management plan to protect the species in perpetuity. (USFWS, 2011)
- We will investigate the species' response to climate factors by collecting the appropriate data during monitoring and by compiling relevant information from surrogate species. (USFWS, 2011)

- Denver Botanic Gardens currently has several thousand seeds of *Lepidium barnebyanum* in long term storage, although the collection is not considered complete. We will work with Denver Botanic Gardens to determine how much additional seed collection is needed, and we will work with the Tribe and BIA to obtain additional seeds. (USFWS, 2011)

References

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SPECIES ACCOUNT: *Lepidium orbiculare* (Anaunau)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2016)

Physical Description

A branching shrub, more than 33 cm tall. Leaves are clustered at the branch tips. Leaf blades are 4.5 - 7.5 cm long, 1.9 - 2.9 cm wide, oblanceolate. Panicle is 17 cm long, with several racemes. Petals are 4, 0.8 mm long, and white. Capsules are 3.5 - 4 mm in diameter, orbicular (NatureServe, 2015).

Taxonomy

A member of the mustard family (Brassicaceae) (USFWS, 2015). Kartesz (1999) includes *Lepidium orbiculare* in *L. serra*, however, Wagner et al. (1999) resurrected it from synonymy with *L. serra*; now generally treated as distinct (NatureServe, 2015).

Historical Range

Known only from the island of Kauai in the Hawaiian Islands. To date it has been found at only two sites near Haupu (peak) in the Haupu Range on the southeastern side of the island. (NatureServe, 2015). Historically, *Lepidium orbiculare* species was known from widely scattered occurrences on Kauai (Wagner et al. 1999, p. 409) (USFWS, 2015).

Current Range

It occurs on Mt. Haupu, on the island of Kauai (USFWS, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available

Habitat Type

Adult: Terrestrial (USFWS, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Lowland mesic forest (USFWS, 2015)

Habitat Narrative

Adult: This species occurs in mesic forest in the lowland mesic ecosystem (Wagner et al. 1999, p. 409; HBMP 2010; PEPP 2014, p. 34; TNCH 2007) (USFWS, 2015).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Very low (inferred from USFWS, 2015)

Redundancy:

Very low (inferred from USFWS, 2015)

Number of Populations:

1 (USFWS, 2015)

Population Size:

< 50 (USFWS, 2015)

Population Narrative:

Currently, there is one occurrence of fewer than 50 individuals (USFWS, 2015).

Threats and Stressors

Stressor: Feral pigs (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Feral pigs are extremely destructive and have both direct and indirect impacts on native plant communities. While rooting in the earth in search of invertebrates and plant material, pigs directly impact native plants by disturbing and destroying vegetative cover, and by trampling plants and seedlings. Feral pigs have been documented to modify and destroy habitat of other rare and endangered native plant species at the same location on Mt. Haupū, Kauai (Lorence et al. 2010, p. 140) (USFWS, 2015).

Stressor: Nonnative plants (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Nonnative plants adversely impact native habitat in Hawaii by: (1) Modifying the availability of light; (2) altering soil-water regimes; (3) modifying nutrient cycling; and (4) altering fire regimes of native plant communities (e.g., by fostering series of fires that burn successively farther into native habitat, destroying native plants and removing native plant habitat by altering microclimatic conditions to favor nonnative species), thus ultimately converting native-dominated plant communities to nonnative plant communities (Smith 1985, pp. 180–181; Cuddihy and Stone 1990, p. 74; D'Antonio and Vitousek 1992, p. 73; Vitousek et al. 1997, p. 6).

Nonnative plants degrade native habitat and outcompete native plants, are found at the last known location of *L. orbiculare* (USFWS, 2015).

Stressor: Small population size/stochastic events (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: *Lepidium orbiculare* may experience reduced reproductive vigor due to reduced levels of genetic variability, leading to diminished capacity to adapt to environmental changes, and thereby lessening the probability of long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361; PEPP 2014, p. 34). Natural events such as landslides are a threat to the only known occurrence of the species (HBMP 2010). These events have the potential to eliminate one or more isolated populations of a species that currently persists in low numbers and a limited geographic range, resulting in reduced redundancy and resilience of the species. The small number of individuals may limit this species' ability to adapt to environmental change (USFWS, 2015).

Stressor: Climate change (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to the ecosystem that supports this species. Fortini et al. (2013, pp. 1-134) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013, p. 79) concluded that *Lepidium orbiculare* is highly vulnerable to the impacts of climate change (USFWS, 2014).

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- There are no known conservation measures implemented at this time, although since *Lepidium orbiculare* is a Plant Extinction Prevention Program (PEPP) species, it will likely be surveyed in the near future, with the intent to collect seeds, propagate, and implement restoration outplanting in suitable habitat (USFWS, 2014).
- Survey for populations of *Lepidium orbiculare* in areas of potentially suitable habitat (USFWS, 2014).
- Begin propagation efforts for maintenance of genetic stock (USFWS, 2014).

- Reintroduce individuals into suitable habitat within historical range that is being managed for additional known threats (e.g., nonnative animals and plants) to this species (USFWS, 2014).

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SPECIES ACCOUNT: *Lepidium papilliferum* (Slickspot peppergrass)

Species Taxonomic and Listing Information

Listing Status: Threatened; 09/16/2016; Pacific Region (R1)

Physical Description

An intricately branched, tap-rooted plant, averaging 2 to 8 in. tall, but occasionally reaching up to 16 in. tall. Leaves and stems are covered with fine, soft hairs, and the leaves are divided into linear segments. Flowers are numerous, 0.11 to 0.15 in. in diameter, white, and four-petalled. Fruits (silicles, which are seed capsules that are less than twice as long as they are wide) are 0.10 to 0.15 in. wide, round in outline, flattened, and two-seeded (Moseley 1994, pp. 3, 4; Holmgren et al. 2005, p. 260). (USFWS, 2020)

Taxonomy

Slickspot peppergrass is a member of the Mustard Family (Brassicaceae). Louis Henderson originally described slickspot peppergrass as *L. montanum* var. *papilliferum* in 1900. It was renamed *L. papilliferum* by Aven Nelson and J. Francis Macbride in 1913 based on its distinctive growth habit, short lifespan, and unusual pubescence (Nelson and Macbride 1913, p. 474). Hitchcock regarded slickspot peppergrass as *L. montanum* var. *papilliferum* influencing several publications including *Flora of Idaho* and *Flora of the Pacific Northwest* (Davis 1952, p. 347; Hitchcock et al. 1964, p. 516; Hitchcock and Cronquist 1973, p. 170; Steele 1981, p. 55; Moseley 1994, p. 2). In a 1993 review of taxa in the mustard family (Brassicaceae), Reed Rollins maintained the species based on differences in the physical features between the slickspot peppergrass and *L. montanum* (mountain pepperweed): • Slickspot peppergrass has trichomes (hair-like structures) occurring on the filaments of stamens (part of flower that produces pollen), but mountain pepperweed does not; • All the leaves on slickspot peppergrass are pinnately divided whereas mountain pepperweed has some leaves that are not divided; • The shape of the silicle [silique] (seed capsule) of slickspot peppergrass is different from that of mountain pepperweed; and • The silicle of slickspot peppergrass has no wings, or even vestiges of wings, at its apex (end of the capsule), unlike that of mountain pepperweed (Rollins 1993, p. 578; Moseley 1994, p. 2). Common names for this plant include slickspot peppergrass (Holmgren et al. 2005, p. 259), slick spot peppergrass (Moseley 1994, p. 1), and Idaho pepperweed (ITIS 2018, p. 1). The common name refers to its typical habitat—in or near slick spot microsites, and the peppery taste of the seeds. ‘Grass’ is a misnomer, and most members of the genus *Lepidium* are referred to as peppergrass, pepperweed, or pepperwort (IDFG in litt. 2018, p. 2). Throughout this SSA, we refer to the species as slickspot peppergrass. (USFWS, 2020)

Historical Range

Historical extent is unknown. (USFWS, 2020)

Current Range

Slickspot peppergrass occurs only in southwestern Idaho in Ada, Canyon, Gem, Elmore, Payette, and Owyhee counties. This species is from three geographic areas based on landform: the Foothills geographic area, the Snake River Plain geographic area, and the Jarbidge geographic area. (USFWS, 2020)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Seed Production: Depending on an individual plant's vigor, the effectiveness of its pollination, and whether it is functioning as an annual or a biennial, each slickspot peppergrass plant produces varying numbers of seeds (Quinney 1998, pp. 15, 17). Biennial plants normally produce many more seeds than annual plants (Meyer et al. 2005, p. 15). Average seed output for annual plants at the Idaho Army National Guard's (IDARNG) Orchard Combat Training Center (OCTC) was 125 seeds per plant in 1993 and 46 seeds per plant in 1994. In contrast, seed production of biennials at this site in 1993 and 1994 averaged 787 and 105 seeds per plant, respectively (Meyer et al. 2005, p. 16). Based on data collected from a 4-year demography study on the OCTC, survivorship of the annual form of slickspot peppergrass was demonstrated to be higher than survivorship of biennials (Meyer et al. 2005, p. 16). Meyer et al. (2005, p. 21) hypothesize that the reproductive strategy of slickspot peppergrass is a plastic response, meaning that larger plants will flower and produce seed in their first season, whereas smaller plants that stand less chance of successfully setting seed in their first season will delay reproduction until the following year. Thus, the biennial life form is maintained, despite the higher risk of mortality. Like many short-lived plants growing in arid environments, above-ground numbers of slickspot peppergrass individuals can fluctuate widely from year to year, depending on seasonal precipitation patterns (Mancuso and Moseley 1998, p. 1; Meyer et al. 2005, pp. 4, 12, 15; Palazzo et al. 2005, p. 9; Menke and Kaye 2006a, p. 8; Menke and Kaye 2006b, pp. 10, 11; Sullivan and Nations 2009, p. 44). Mancuso and Moseley (1998, p. 1) note that sites with thousands of above-ground plants one year may have none the next, and vice versa. Above ground plants represent only a portion of the population; the seed bank (a reserve of dormant seeds generally found in the soil) contributes the other portion and in many years, constitutes the majority of the population (Mancuso and Moseley 1998, p. 1). Seed banks are adaptations for survival in a "risky environment" because they buffer a species from stochastic (random) impacts, such as lack of soil moisture (Baskin and Baskin 2001, p. 160). Seed Viability and Germination: The seeds of slickspot peppergrass are found primarily within the slickspot microsites where the plants are found (Meyer and Allen 2005, pp. 5–6). Slickspots, also known as mini-playas or natric (high sodium content) sites, are visually distinct openings in the sagebrush-steppe created by unusual soil conditions characterized by significantly greater sodium and clay content relative to the surrounding area (Moseley 1994, p. 7). The vast majority of slickspot peppergrass seeds in slickspots have been located near the soil surface, with lower numbers of seeds located in deeper soils (Meyer et al. 2005, p. 19; Palazzo et al. 2005, p. 3). Slickspot peppergrass seeds have been found in slickspots even if no above-ground plants are present (Meyer et al. 2005, p. 22; Palazzo et al. 2005, p. 10). When above-ground plants are present, flowering usually occurs in late April and May, fruit set occurs in June, and the seeds are released in late June or early July. Seeds produced in a given year are dormant for at least a year before any germination takes place. Following this year of dormancy, approximately 6 percent of the initially viable seeds produced in a given year germinate annually (Meyer et al. 2005, pp. 17–18). When combined with an average annual 3 percent loss of seed viability, approximately 9 percent of the original seed cohort per year is lost after the first year. Thus, after 12 years, all seeds in a given cohort will likely have either died or germinated,

resulting in a maximum estimated longevity of 12 years for seeds in the seed bank (Meyer et al. 2005, p. 18). The primary seed dispersal mechanism for slickspot peppergrass is not known (Robertson and Ulappa 2004, p. 1708), although viable seeds have been found outside of slickspots, indicating that some seed dispersal is occurring beyond slickspot habitat (Palazzo et al. 2005, p. 10). Slickspot peppergrass seeds located near the soil surface show higher rates of germination and viability (Meyer and Allen 2005, pp. 6–8; Palazzo et al. 2005, p. 10) and the greatest seedling emergence success rate (Meyer and Allen 2005, pp. 6–8). Viable seeds were more abundant and had greater germination rates from the upper 2 in. of soil (Palazzo et al. 2005, pp. 8, 10), while Meyer and Allen (2005, pp. 6–8) observed the upper 0.08 in. as optimal for germination. Deep burial of slickspot peppergrass seeds (average depths greater than 5.5 in.) can entomb viable seeds and may preserve them beyond the 12-year period previously assumed as the maximum period of viability for slickspot peppergrass seeds (Meyer and Allen 2005, pp. 6, 9). However, seeds buried at such depth, even if they remain viable, are unlikely to regain the surface for successful germination. The effects of environmental factors, such as wildfire, on slickspot peppergrass seed dormancy and viability are unknown although slickspot peppergrass abundance is reduced in burned areas. Pollination: Slickspot peppergrass is primarily an outcrossing species requiring pollen from separate plants for more successful fruit production and has a low seed set in the absence of insect pollinators (Robertson 2003, p. 5; Robertson and Klemash 2003, p. 339; Robertson and Ulappa 2004, p. 1707; Billinge and Robertson 2008, pp. 1005–1006). Slickspot peppergrass is able to self-pollinate, with a selfing rate (rate of self-pollination) of 12 to 18 percent (Billinge 2006, p. 40; Robertson et al. 2006a, p. 40). In pollination experiments where researchers moved pollen from one plant to another, fruit production was higher when pollen from distant sources was used (4 to 12.4 miles (mi)) between patches of plants than when pollen from plants within the same patch was used (246 to 330 feet (ft)) between plants within the same patch) (Robertson and Ulappa 2004, p. 1705; Robertson et al. 2006a, p. 3). Fruits produced from fertilized flowers reach full size approximately two weeks after pollination (Robertson and Ulappa 2004, p. 1706). Each fruit typically bears two seeds that drop to the ground when the fruit dehisces (splits open) in midsummer (Billinge and Robertson 2008, p. 1003). Known slickspot peppergrass insect pollinators include several families of bees (Hymenoptera), including Apidae, Halictidae, Sphecidae, and Vespidae; beetles (Coleoptera), including Dermestidae, Meloidae, and Melyridae; flies (Diptera), including Bombyliidae, Syrphidae, and Tachinidae; and others (Robertson and Klemash 2003, p. 336; Robertson et al. 2006b, p. 6). In slickspot peppergrass insect pollinator studies conducted at three study sites, seed set was not limited by the number of pollinators at any study site (Robertson et al. 2004, p. 14). Studies have shown a strong positive correlation between insect diversity and the number of slickspot peppergrass plants flowering at a site (Robertson and Hannon 2003, p. 8). Measuring fruit set per visit revealed considerable variability in the effectiveness of pollination by different types of insects, ranging from 0 percent in dermestid beetles to 85 percent in honeybees (*Apis mellifera*) (Robertson et al. 2006b, p. 15).

Habitat Type

Adult: Volcanic plains

Habitat Narrative

Adult: The range of slickspot peppergrass is restricted to the volcanic plains of southwest Idaho, occurring primarily in the Snake River Plain and its adjacent northern foothills, with a single disjunct population on the Owyhee Plateau. The plant occurs at elevations ranging from

approximately 2,200 to 5,400 ft in Ada, Canyon, Gem, Elmore, Payette, and Owyhee Counties (Moseley 1994, pp. 3–9). Based on differences in topography, soil, and relative abundance, we have divided the extant slickspot peppergrass populations into three physiographic regions: the Boise Foothills, the Snake River Plain, and the Owyhee Plateau. The nature and severity of factors affecting the species also vary between the three physiographic regions for the purposes of analysis. For example, urban and rural development, agriculture, and infrastructure development has been substantial in the sagebrush-steppe habitat of the Boise Foothills and the Snake River Plain regions, while very little of these types of development have occurred within the Owyhee Plateau region. The biological soil crust, also known as a microbiotic crust or cryptogamic crust, is one component of quality habitat for slickspot peppergrass. Such crusts are commonly found in semiarid and arid ecosystems and are formed by living organisms, primarily bryophytes, lichens, algae, and cyanobacteria, that bind together surface soil particles (Moseley 1994, p. 9; Johnston 1997, p. 4). Microbiotic crusts play an important role in stabilizing the soil and preventing erosion, increasing the availability of nitrogen and other nutrients in the soil and regulating water infiltration and preventing the establishment of invasive plants (Brooks and Pyke 2001, p. 4 and references therein; Serpe et al. 2006, pp. 174, 176). These crusts are sensitive to disturbances that disrupt crust integrity, such as compression due to livestock trampling or off highway vehicle (OHV) use and are subject to damage by fire; recovery from disturbance is possible but occurs very slowly (Johnston 1997, pp. 10–11). Slickspot peppergrass occurs in slickspot habitat microsites scattered within the greater semiarid sagebrush-steppe ecosystem of southwestern Idaho. On a broad scale, the Snake River Plains and the Owyhee Plateau physiographic regions are volcanic in nature and underlain by Tertiary basalt or rhyolite; the adjacent Boise Foothill sites are underlain by Pliocene/Quaternary lacustrine deposits (Moseley 1994, p. 8). Slickspots are visually distinct openings characterized by natric soils and distinct clay layers; they tend to be highly reflective and relatively light in color, making them easy to detect on the landscape (Fisher et al. 1996, p. 3). Slickspots are distinguished from the surrounding sagebrush matrix as having the following characteristics: microsites where water pools when rain falls (Fisher et al. 1996, pp. 2, 4); sparse native vegetation, distinct soil layers with a columnar or prismatic structure, higher alkalinity and clay content, and natric properties (Fisher et al. 1996, pp. 15–16; Meyer and Allen 2005, pp. 3–5, 8; Palazzo et al. 2008, p. 378); and reduced levels of organic matter and nutrients due to lower biomass production (Meyer and Quinney 1993, pp. 3, 6; Fisher et al. 1996, p. 4). Fisher et al. (1996, p. 11) describe slickspots as having a “smooth, panlike surface” that is structureless and slowly permeable when wet, moderately hard and cracked when dry. Although the low permeability of slickspots appears to help hold moisture (Moseley 1994, p. 8), once the thin crust dries out, slickspot peppergrass seedling survival depends on its ability to extend its taproot into the argillic horizon (soil layer with high clay content) to extract moisture from the deeper natric zone (Fisher et al. 1996, p. 13). How long slickspots take to form is unknown, but is hypothesized to take several thousands of years (Nettleton and Peterson 1983, p. 193; Seronko 2006, in litt. p. 2). Climate conditions that allowed slickspot formation in southwestern Idaho are thought to have occurred during a wetter Pleistocene period. Holocene additions of wind-carried salts (often loess deposits) produced the natric soils characteristic of slickspots (Nettleton and Peterson 1983, p. 191; Seronko 2006, in litt., p. 2). Several hundred years may be necessary to alter or lose slickspots through natural climate change or severe natural erosion (Seronko 2006, in litt. p. 2). However, some researchers hypothesize that new slickspots are no longer being created given current climatic conditions (Nettleton and Peterson 1983, pp. 166, 191, 206). As slickspots in southwest Idaho appear to have formed during the Pleistocene and current climate conditions may not allow for the formation of new slickspots, the loss of slickspot microsites appears to be

permanent. Some slickspots subjected to past light disturbance may be capable of reforming (Seronko 2006, in litt. p.2). However, disturbances that alter the physical properties of the soil layers, such as deep disturbance and the addition of organic matter, may lead to the destruction and permanent loss of slickspots. For example, deep soil tilling and adding organic matter and gypsum have been recommended for eliminating slickspots from agricultural lands in Idaho (Peterson 1919, p. 11; Rasmussen et al. 1972, p. 142). Slickspot soils are especially susceptible to mechanical disturbances when wet (Rengasamy et al. 1984, p. 63; Seronko 2004, in litt. pp. 1–2). Such disturbances disrupt the soil layers important to slickspot peppergrass seed germination and seedling growth and alter hydrological function. Meyer and Allen (2005, p. 9) suggest that if sufficient time passes following the disturbance of slickspot soil layers, the slickspot soil layers may regain their pre-disturbance configuration yet not support the species. Thus, while the slickspot appears to have regained its former character, some essential component required to sustain the life history requirements of slickspot peppergrass has apparently been lost, or the active seed bank is no longer present. Most slickspots are between 10 and 20 square feet (ft²) in size although some are as large as 109 ft² (Mancuso et al. 1998, p. 1). Slickspots cover a relatively small cumulative area within the larger sagebrush-steppe matrix, and only a small percentage of slickspots are known to be occupied by slickspot peppergrass. Slickspot peppergrass has infrequently been documented outside of slickspots on disturbed soils, such as along graded roadsides and badger mounds. These are rare observations and the vast majority of plants documented over the past 19 years of surveys and monitoring for the species were within slickspot microsite habitats (USFWS 2006b, p. 20). For example, in 2002, a complete census of an 11,070-ac area recorded approximately 56,500 slickspots (Air Force 2003 in litt., p. 15), of which approximately 2,450 (about 4.0 percent) were occupied by slickspot peppergrass plants (Bashore, pers. comm. 2003, p. 1). Of the approximately 11,300 slickspot peppergrass plants documented during the survey effort, only 11 plants (less than 1 percent) were documented outside of slickspots (Air Force 2002, summary attachment, entire). Not all potential slickspot peppergrass habitats in southwest Idaho have been surveyed, and additional slickspot peppergrass sites may be found outside of areas known to be occupied. Recent modeling was completed to develop a high-quality, predictive-distribution model of slickspot peppergrass to identify potential habitat (Colket 2008, p. 1). The Bureau defines potential habitat as areas within the known range of slickspot peppergrass that have certain general soil and elevation characteristics that indicate the potential for the area to support slickspot peppergrass although the presence of slickspots or the plant is unknown (USBLM 2009, p. B–2). Although surveys were conducted in 2008 in some areas identified as previously unsurveyed habitat with potential to contain the species, these surveys did not result in any new locations of the species (Colket 2008, pp. 4–6). Slickspot peppergrass has also been surveyed for in eastern Oregon, but the species has never been found there (Findley 2003 in litt., p. 1). We have no historical records indicating that slickspot peppergrass has ever been found anywhere outside of its present range in southwestern Idaho.

Dispersal/Migration

Population Information and Trends

Population Trends:

Decline of 30 to 70 percent

Species Trends:

Declining

Number of Populations:

21 to 80; ~45 extant occurrences

Population Size:

45,569 (USFWS, 2016)

Population Narrative:

The number of above-ground plants fluctuates widely from year to year and is strongly correlated with spring precipitation (Menke and Kaye 2006). Seeds can remain viable in the seed bank for at least 12 years (USFWS 2007). The persistent seed bank appears essential for population persistence in this species (Meyer et al. 2006). Also, the species may rely on years with extremely favorable environmental conditions to restock this seed bank; if every year were average in its desert environment, the species might not persist (Meyer et al. 2006). In 2011, 2012, and 2013 the total number of *Lepidium papilliferum* plants counted was the lowest since 2005, when complete counts for this species were initiated (16,462 plants in 2011; 9,245 plants in 2012; and 6,351 in 2013) (Kinter 2012, in litt.; Kinter 2015, in litt.). In 2014, however, 45,569 total plants were counted, which represented the third highest number of plants observed over the 10 years of HIP monitoring (Kinter 2015, in litt.). Previously, the lowest total number of plants counted occurred in 2006, with 17,543 plants, and the highest count was in 2010, with 58,921 plants (Idaho Department of Fish and Game (IDFG) 2012, p. 5) (USFWS, 2016).

Threats and Stressors

Stressor: Increased Frequency and Intensity of Wildfire (USFWS, 2020)

Exposure:

Response:

Consequence:

Narrative: The altered wildfire regime is one of the two primary causes of reduced quality of habitat for slickspot peppergrass. Across the intermountain west, increased frequency, severity, intensity, and extent of wildfire has converted vast areas of former sagebrush steppe ecosystem to nonnative annual grasslands. Invasive nonnative annual grasses, such as cheatgrass and medusahead, have contributed to increases in the amount and continuity of fine fuels across the landscape. As a result, the wildfire frequency interval of sagebrush steppe habitat has been drastically shortened from a historical range of approximately 60 to over 300 years (depending on the species of sagebrush and other site specific characteristics) to less than 5 years in many areas of the sagebrush steppe ecosystem (Billings 1990, pp. 307–308; Whisenant 1990, p. 4; USGS 1999, in litt., pp. 1–9; West and Young 2000, p. 262; Bukowski and Baker 2013, p. 557). Not only are wildfires burning far more frequently, but these wildfires tend to be larger and burn more uniformly than those that occurred historically, resulting in fewer patches of unburned vegetation, which affects the post-fire recovery of native sagebrush steppe vegetation (Whisenant 1990, p. 4). However, because estimates of increased fire frequency are critically dependent on the spatial area and period over which authors use for their computations, each estimate of fire frequency in sagebrush steppe provides a perspective on the role of fire in the sagebrush ecosystem that must be interpreted using the appropriate scale (Miller et al. 2011, p. 165). (USFWS, 2020)

Stressor: Introduction and Spread of Invasive Nonnative Plants (USFWS, 2020)

Exposure:

Response:

Consequence:

Narrative: Invasive, nonnative annual grasses can alter various attributes of ecosystems including geomorphology, wildfire regime, hydrology, microclimate, nutrient cycle, and productivity (for a summary, see Dukes and Mooney 2003, entire). Additionally, invasive nonnative annual grasses can negatively affect native plants, including rare plants such as slickspot peppergrass, through competitive exclusion, niche displacement, hybridization, and competition for insect pollinators. Examples of these negative effects are widespread among different taxa, locations, and ecosystems (D'Antonio and Vitousek 1992, pp. 63–87; Olson 1999, p. 5; Mooney and Cleland 2001, p. 1). (USFWS, 2020)

Stressor: Highly Competitive Nonnative Seeded Species (USFWS, 2020)

Exposure:

Response:

Consequence:

Narrative: Highly competitive nonnative seeded species are considered separately from invasive nonnative unseeded species, which includes annual invasive nonnative grasses and perennial noxious weeds. Both native and nonnative deep-rooted perennial bunchgrasses can play key roles in the ecological resilience of habitat to disturbances (such as wildfire and improper livestock grazing) and of ecological resistance to invasive nonnative annual grass establishment. Established perennial plants with well-developed root systems (Figure 17) can effectively compete with invasive nonnative annual grasses for water and nutrients. Both established native and nonnative deep-rooted perennial grasses can limit the spread of invasive nonnative annual grasses such as cheatgrass (Davies and Johnson 2017, p. 748; Clements et al. 2017, pp. 179-180, Ott et al. In press, pp. 6, 10). Seeded deep-rooted nonnative perennial species, such as crested wheatgrass and forage kochia, have been extensively used for post-fire soil stabilization efforts in the Great Basin, including within the range of slickspot peppergrass, due to their ability to decrease soil erosion risk, exclude cheatgrass at a lower cost than native species, and their relative ease of establishment compared with native perennial bunchgrasses (Davies et al. 2013, p. 472). (USFWS, 2020)

Stressor: Development (USFWS, 2020)

Exposure:

Response:

Consequence:

Narrative: In the Service's 2009 listing rule, residential, commercial, and agricultural development was identified as a secondary threat to slickspot peppergrass in the Foothills and Snake River Plain geographic areas (74 FR 52036-52037). More recently, residential and commercial development, inclusive of infrastructure, was identified as one of the most extreme and widespread disturbances documented to impact the species within the Foothills and Snake River Plain geographic areas (Miller and Kinter 2018, p. 38). Development can affect slickspot peppergrass through direct destruction of populations and loss of slick spot microsites. Development can also have indirect impacts by contributing to nonnative plant invasions, particularly along associated utility lines and roads, which act as corridors for nonnative plant invasions (Forman and Alexander 1998, p. 210; Gelbard and Belnap 2003, pp. 424-425, 430-431; Bradley and Mustard 2006, p. 1142); increased human-caused ignition of wildfires, presumably

by increasing the area of the urban-wildland interface (e.g., Keeley et al. 1999, p. 1829; Romero-Calcerrada et al. 2008, pp. 341, 351; Syphard et al. 2008, pp. 610-611); increased off road vehicle use; and increased habitat fragmentation, which can pose problems for slickspot peppergrass by creating barriers in the landscape to pollinators that prevent effective genetic exchange within or among populations (Robertson et al. 2004, pp. 2-4). (USFWS, 2020)

Stressor: Owyhee harvester ants (USFWS, 2020)

Exposure:

Response:

Consequence:

Narrative: While effects of herbivory on slickspot peppergrass by mammals and most insects has not been identified as a significant stressor (IDFG in litt. 2018, p. 6), in recent years, concern has emerged over potential detrimental effects of seed predation by Owyhee harvester ants. Owyhee harvester ants are a native species that thrive in open grassy areas throughout southwest Idaho, including areas occupied by slickspot peppergrass where shrubs have been lost. These ants consume the seeds of small-seeded species (including slickspot peppergrass) preferentially over large-seeded species such as cheatgrass (Schmasow and Robertson 2016, p. 955). Studies have shown that Owyhee harvester ants can remove up to 90 percent of slickspot peppergrass fruits and seeds from individual plants, either directly from the plant or by scavenging seeds that drop to the ground (White and Robertson 2009b, p. 511; Robertson and Crossman 2012, pp. 14-15; Jeffries 2016, entire). The extent to which seed predation by harvester ants impacts slickspot peppergrass seed recruitment within slick spots and populations is currently under investigation. Slick spots with low numbers of flowering slickspot peppergrass plants are likely to suffer high levels of seed loss in a given year (based on the results of White and Robertson 2009b, Robertson and Crossman 2012, and Jeffries 2016), whereas slick spots with large numbers of plants may overwhelm the ants' capacity to consume seeds (Robertson 2018, personal communication). (USFWS, 2020)

Stressor: Improper Livestock Grazing (USFWS, 2020)

Exposure:

Response:

Consequence:

Narrative: Livestock use is widespread across the range of slickspot peppergrass. Livestock use in areas that contain slickspot peppergrass can result in both positive and negative effects on the species, depending on factors such as intensity, timing, and duration of use. Livestock grazing may be used as a tool to ameliorate the primary threats of wildfire and invasive annual grasses on slickspot peppergrass. Domestic cattle are not known to feed on slickspot peppergrass, and domestic sheep have been observed uprooting but not consuming plants (D. Quinney and J. Weaver pers. comm. 1998). Although direct herbivory of slickspot peppergrass by livestock has not been documented to occur, livestock grazing can impact slickspot peppergrass through trampling and interactions with the nonnative invasive plant cycle. (USFWS, 2020)

Stressor: Climate Change (USFWS, 2020)

Exposure:

Response:

Consequence:

Narrative: Warmer temperature regimes and changes in precipitation associated with global climate change represent another risk factor for slickspot peppergrass. Consequences of climate

change, if current projections occur, are likely to exacerbate existing primary threats (modified wildfire regime and invasive nonnative plants, particularly cheatgrass) to slickspot peppergrass conservation. Researchers confirmed “experimentally that, in an intact ecosystem, elevated carbon dioxide may enhance the invasive success of *Bromus* spp. in arid ecosystems,” and suggest that this enhanced success will then expose these arid areas to accelerated wildfire cycles (Smith et al. 2000, p. 81). Chambers and Pellant (2008, p. 32) also suggest that higher carbon dioxide levels are likely increasing cheatgrass fuel loads due to increased productivity, with a resulting increase in wildfire frequency and extent. Furthermore, current climate change models predict future climatic conditions within the range of slickspot peppergrass will favor further invasion by cheatgrass (Smith et al. 1987, pp. 142-143; Smith et al. 2000, p. 81; Brown et al. 2004, p. 384; Neilson et al. 2005, pp. 150, 156; Chambers and Pellant 2008, pp. 31-32). These and other models (Littell et al. 2009, p. 1019; Abatzoglou and Kolden 2013, p. K; Westerling et al. 2014, p. 91; McKenzie and Littell 2017, p. 29) also project that wildfire frequency will continue to increase, and the extent and severity of wildfires may increase as well. Thus, the projected consequences of climate change are acting to exacerbate the primary threats of frequent wildfire and invasive nonnative plant species on slickspot peppergrass throughout its range. (USFWS, 2020)

Recovery

Reclassification Criteria:

Not applicable.

Delisting Criteria:

Not available; a Recovery Plan has not been issued.

Recovery Actions:

- Not available; a Recovery Plan has not been issued.

Conservation Measures and Best Management Practices:

- Currently, there are six formalized plans that incorporate specific conservation measures for slickspot peppergrass: • The Candidate Conservation Agreement for Slickspot Peppergrass between the State of Idaho, BLM, Idaho Army National Guard and nongovernmental cooperators (private landowners who also hold livestock grazing permits on BLM lands) (State of Idaho et al. 2003, as updated in 2006); • The BLM and U.S. Fish and Wildlife Service Conservation Agreement for existing BLM land use plans (USBLM and USFWS 2006, as updated in 2009, 2013, and 2014). Once conservation measures of identical or greater conservation value are incorporated into all applicable BLM land management plans, the term of this Conservation Agreement will be concluded. One applicable BLM land management plan where conservation measures have yet to be incorporated (the Four Rivers Resource Management Plan) remains. Conservation measures with identical or greater conservation value than this Conservation Agreement have been incorporated into two recent BLM land use plans: o The 2008 Morley Nelson Snake River Birds of Prey National Conservation Area Resource Management Plan (as contained within Appendix 8 of the 2008 Record of Decision), and o The 2015 Jarbidge Approved Resource Management Plan. • The Idaho Army National Guard’s Integrated Natural Resource Management Plan for the Orchard Combat Training Center (National Guard 1991, as updated in 1997, 2004, 2008, and 2013); and • The Mountain Home Air Force Base’s Integrated Natural Resource Management Plan, which includes the Juniper Butte Range (Air Force 2004, as updated in 2012 and 2018). (USFWS, 2020)

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Threatened Status for *Lepidium papilliferum* (Slickspot Peppergrass) Throughout Its Range. Final rule. 81 FR 55057 - 55084 (August 17, 2016).

SPECIES ACCOUNT: *Leptocereus grantianus* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 2/26/1993

Physical Description

A sprawling, suberect, nearly spineless cactus which may reach up to 2 meters in height and 3 to 5 centimeters in diameter. The elongated stems have 3 to 5 prominent ribs with broadly scalloped edges. Ribs of young joints are thin, and the small areoles may bear one to three minute, nearly black spines (less than 1 millimeter long) which disappear as the joints grow older and the ribs become thicker. The flowers are solitary at the terminal areoles, 3 to 6 centimeters long, and nocturnal. The ovary and flower tube bear distinct areoles. The outer perianth segments are linear, green, and tipped by an areole like those of the tube and ovary. The inner perianth segments are numerous, cream-colored, oblong-ovate, obtuse and about 8 millimeters long. Stamens are many and have yellow anthers. The stigma lobes are several and short. The fruit is subglobose to ellipsoid and about 4 centimeters in diameter (Britton 1933, Proctor 1991) (USFWS, 1994).

Historical Range

See current range/distribution.

Current Range

Known only from one location on Culebra, an island off the northeastern coast of Puerto Rico. The one known population, which consists of approximately 50 individuals, occurs in dry thickets along a rocky shore near Punta Melones, on the southwestern part of the island (USFWS, 1994).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Vegetative reproduction (USFWS, 2015)

Reproduction Narrative

Adult: The species in the wild is apparently dependent of vegetative reproduction instead of sexual reproduction (USFWS, 2015). Little is known about the species' phenology, natural recruitment, and habitat requirements for seeds germination in the wild. The low number of individuals per population, absent of recruits, and its limited spatial distribution may suggest that the species currently depends on vegetative reproduction for population growth (C. Pacheco, Service, pers. obs., 2013). The species is able to produce flowers and fruits, and germination experiments have demonstrated that seeds are viable (M, Caraballo, University of Puerto Rico-Rio Piedras, pers. comm., 2012). However, no germination has been observed in the wild, and it is not clear if competition with exotic species (e.g., *Megathyrsus maximus*) is

affecting the natural recruitment of *L. grantianus*. In addition, it has not been determined if the species is missing a fruit disperser (e.g., bird, bat) (USFWS, 2015).

Habitat Type

Adult: Steep, rocky slopes (USFWS, 1994)

Environmental Specificity

Adult: Narrow/specialist (USFWS, 1994)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1994)

Site Fidelity

Adult: High (inferred from USFWS, 1994)

Habitat Narrative

Adult: Culebra and the surrounding small islands comprise an area of only 3,116 hectares (7,700 acres). Topography is irregular and the highest elevation is that of Monte Resaca (200 meters; 650 feet). Culebra and the cays adjacent to it are underlain by volcanic and intrusive rocks which are upper Cretaceous in age. Andesitic lava underlies most of the island, and the north coast is underlain by andesitic tuff. In north central Culebra this tuff and lava have been intruded by diorite. The diorite has weathered to round boulders which may reach more than a meter in diameter. Slopes in these areas are often greater than 60 percent (USFWS, 1994). On Culebra *Leptocereus grantianus* grows on rocky, steep slopes adjacent to the narrow beach. Associated species on this rocky slope are almacigo (*Busera simaruba*), ucar (*Bucida buceras*), sea grape (*Coccoloba uvifera*), sebucan (*Pilosocereus royenii*), and mesquite (*Prosopis pallida*). Adjacent uplands have been mostly deforested, historically for agricultural use and grazing, and more recently for proposed residential/tourist development (USFWS, 1994). High ecological integrity of the population and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species and the low number of known populations.

Dispersal/Migration**Dispersal**

Adult: Low (inferred from USFWS, 1994)

Dispersal/Migration Narrative

Adult: Low dispersal and no immigration/emigration are inferred based on this species dependence on vegetative reproduction in the wild.

Population Information and Trends**Population Trends:**

Increasing (USFWS, 2015)

Resiliency:

Low (inferred from USFWS, 2015)

Representation:

Low (inferred from USFWS, 2015)

Redundancy:

Low (inferred from USFWS, 2015)

Number of Populations:

Six (USFWS, 2015)

Population Size:

267 total individuals (USFWS, 2015)

Additional Population-level Information:

From 1996 to 2013, the Service produced over 360 individuals of *L. grantianus* from cuttings in tree nursery conditions, and has planted 193 of them in seven sites on private property with a landowner's conservation agreement and within the Culebra Island National Wildlife Refuge (CINWR) (e.g., Flamenco peninsula, Luis Pena Island, Culebrita Island). In 2013, the Service conducted a rapid assessment of the introduced population of *L. grantianus* and visited all planted individuals. Less than 5% had survived due to anthropogenic factors (i.e., intentional fires) and predation by exotic mammals (i.e., deer and goats) (R. Colon-Merced and C. Pacheco, Service unpubl. data, 2014; USFWS 2015). (USFWS, 2019). Recently, additional propagation and introduction efforts have been implemented on Culebra in partnership with Villa Mi Terruiio and CINWR. Since 2011, the Service and Fundaci6n Mi Terruiino, Inc. signed a Cooperative Agreement (F12AC01199) under the Coastal and Partners for Fish and Wildlife Programs, to conduct joint efforts for the recovery of the three populations currently located within Villas Mi Terruiio private land (USFWS 2015). Since the recovery plan was approved, five new populations of this species have been discovered on Culebra. Additionally, *L. grantianus* has been successfully propagated by cuttings and introduced in seven protected sites managed for conservation on the island (USFWS 2015). Propagation efforts have resulted in the following new populations within protected areas: 60 individuals in two new sites within Villa Mi Terruiio property, 20 individuals in two new patches within Punta Soldado natural reserve, 25 individuals within Punta Flamenco, 20 individuals within Resaca beach, 3 individuals within the Observation Point, and 2 individuals within Culebrita Island. (USFWS, 2019).

Population Narrative:

New information on *L. grantianus* indicates that the overall species abundance has increased since the recovery plan was approved in 1995. Since that year, five new populations of *L. grantianus* have been discovered along the southeast coast of Culebra Island. In addition, the species has been propagated and planted in seven sites in Culebra; including two offshore cays (Figure 1). Currently, the species' abundance is estimated at around 267 adult individuals (about 261 in natural populations; Table 1), and six in introduction sites (Table 2) (USFWS, 2015). The assessment on *L. grantianus* conducted by the Service in 2013 is the most up-to-date information on the status of the species on Culebra. Based on our observations and recorded data, the overall abundance of *L. grantianus* has increased. The current estimate for the species is now around 261 adult individuals in natural populations, 188 individuals in greenhouses, and 6 individuals planted (Tables 1 and 2, Monsegur and Pacheco, USFWS, unpublished data 2009) (USFWS, 2015). Low resiliency, representation and redundancy are inferred based on the low number of known populations and individuals. As of 2019, individual locations are as follows:

191 individuals in three localities within Villas Mi Terruino; 20 individuals in Playa Melones; and 50 individual in two sites within Punta Soldado (USFWS 2015). Of these sites, the three sites within Villas Mi Terruino and one site in Punta Soldado are on private lands. One of the sites within Punta Soldado is located within the natural reserve managed by the Puerto Rico Department of Natural and Environmental Resources (PRDNER). The individuals at Playa Melones are located within the maritime zone also managed by the PRDNER. (USFWS, 2019).

Threats and Stressors

Stressor: Agricultural activities (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Agricultural activities result in deforestation, which is a threat to this species habitat (USFWS, 2015).

Stressor: Urban development (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Deforestation for urban development is listed as a threat to this species (USFWS, 2015).

Stressor: Tourism (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Deforestation for tourism projects and trails used by tourists that are in or near this species habitat are listed as a threat to this species.

Stressor: Landscaping/deforestation (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of individual plants/Loss of habitat

Narrative: Landscaping has resulted in a more xeric environment and erosion in some areas that are still forested (USFWS, 2015). Individual plants have also been affected by landscaping in some areas.

Stressor: Exotic mammals (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat/loss of individual plants

Narrative: Exotic mammals such as white-tailed deer and wild domestic animals such as feral goats modify the forest structure through over-grazing and are also a threat to individual plants due to trampling (USFWS, 2015)

Stressor: Predation (USFWS, 2015)

Exposure:

Response:**Consequence:** Loss of individual plants

Narrative: Predation of young stems by hermit crabs (*Coenobita clypeatus*) has been observed on the Island of Culebra (Ross 2002). Ross (2002) also reported black rats (*Rattus rattus*) feeding on the stems of introduced populations on the Island of Culebrita. Service biologists have also reported predation of the apex of young stems and flower buds during the evaluation of natural and introduced populations. Although we have no evidence of this predator, we suspect introduced goats or deer most likely caused the damage (Figure 3) (USFWS, 2015).

Stressor: Limited distribution (USFWS, 2015)**Exposure:****Response:****Consequence:** Danger of extinction

Narrative: *Leptocereus grantianus* is vulnerable to extinction due to low population numbers and its limited distribution (i.e., only six populations and 267 individuals reported), coupled with habitat loss or alteration (R. Colón-Merced and C. Pacheco, Service unpubl. data, 2013). Ross (2002) reported landslides as one of the factors affecting the introduced individuals on the Island of Culebrita. Presently, about 38.5% of the known adult individuals are located along the shoreline, subject to coastal erosion and landslides. In addition, the limited distribution of the species may also have exacerbated its vulnerability to natural or anthropogenic factors such as hurricanes, wildfires, and genetic variation, compromising the continued existence of this species (USFWS, 2015).

Stressor: Genetic variation (USFWS, 2015)**Exposure:****Response:****Consequence:** Lack of genetic diversity

Narrative: Given the extremely limited geographic distribution of *L. grantianus*, it is highly likely that its genetic variability is very low. This would result in a loss of alleles by random genetic drift, which would limit the species' ability to respond to changes in the environment (Honnay and Jacquemyn, 2007). In order to safeguard the remaining genetic diversity, the protection and monitoring of known adult individuals should be considered as a high priority for the conservation of the species. Based on the above, we consider the potential lack of genetic variation as a possible threat to the species (USFWS, 2015).

Stressor: Hurricanes/landslides (USFWS, 2015)**Exposure:****Response:****Consequence:** Loss of habitat

Narrative: Due to the extremely limited range of *L. grantianus*, low number of individuals, and lack of information about its natural recruitment and habitat requirements, we believe that stochastic events such as severe tropical storms or hurricanes may have an adverse impact on the species. In the absence of such information, it is difficult to predict the recovery of the species after natural events such as hurricanes and tropical storms impacts. Therefore, since *L. grantianus* has only six known populations, we consider this threat as high in magnitude, but not imminent because the frequency and intensity of hurricanes passing over Culebra Island are not predictable (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Changes in climate can cause a number of direct and indirect impacts on species, and can exacerbate the effects of other threats. Rather than assessing “climate change” as a single threat in and of itself, we examine the potential consequences to species and their habitats that arise from changes in environmental conditions associated with various aspects of climate change. Vulnerability to climate change impacts is a function of sensitivity to those changes, exposure to those changes, and adaptive capacity (IPCC 2007; Glick et al. 2011). An expected effect of the climate change is the increase in intensity of hurricanes and tropical storm followed by an extended period of drought (IPCC 2012). This climate change may alter the microclimate and the surrounding vegetation around the populations of *L. grantianus*. Hurricane effects followed by extended period of drought may result in changes in soil conditions and microclimate and may allow other plants (native or nonnative, herbaceous or woody) adapted to drier conditions to become established (Lugo 2000). Invasive species (e.g. *Megathyrus maximus*) may spread and colonize *L. grantianus* habitat, and they could alter microclimate and nutrient cycling of the habitat that the species depends on. Due to its limited distribution and number of natural populations, we consider the cumulative effects of hurricanes, genetic variation, and exotic and invasive species (plants and animals) to be detrimental to the *L. grantianus* as a whole. The population dynamics of the species is poorly known (e.g., depressed genetic variability and its competitive abilities), there are only few known natural populations, and there is a lack of information to determine what constitutes a viable population. Therefore, we consider the above mentioned threats as high in magnitude because the species has only a few known populations; but not imminent because threats (i.e. hurricanes, landslides, climate change, among others) are not likely to occur in the near future (USFWS, 2015).

Stressor: Low reproductive capacity (USFWS, 2015)

Exposure:

Response:

Consequence: Low genetic variability

Narrative: Little is known about the species’ phenology, natural recruitment, and habitat requirements for seeds germination in the wild. The low number of individuals per population, absent of recruits, and its limited spatial distribution may suggest that the species currently depends on vegetative reproduction for population growth (C. Pacheco, Service, pers. obs., 2013). The species is able to produce flowers and fruits, and germination experiments have demonstrated that seeds are viable (M. Caraballo, University of Puerto Rico-Rio Piedras, pers. comm., 2012). However, no germination has been observed in the wild, and it is not clear if competition with exotic species (e.g., *Megathyrus maximus*) is affecting the natural recruitment of *L. grantianus*. In addition, it has not been determined if the species is missing a fruit disperser (e.g., bird, bat). The above mentioned factors, coupled with habitat loss or alteration, may also exacerbate the vulnerability of *L. grantianus* to natural or anthropogenic events such as hurricanes and fires, compromising the continued existence of this species (R. Colón-Merced and C. Pacheco, Service unpubl. data, 2013). In the absence of knowledge on the natural recruitment capacity and habitat requirement of this species, it is difficult to predict its recovery (USFWS, 2015).

Stressor: Human-induced fires. (USFWS, 2019).

Exposure:
Response:
Consequence:
Narrative:

Recovery

Reclassification Criteria:

An Agreement among the Service, the municipality of Culebra, and the Puerto Rico Department of Natural and Environmental Resources (PRDNER) has been prepared and implemented for the protection of the species (USFWS, 2015).

New populations (the number of which should be determined following the appropriate studies) capable of self-perpetuation have been established within the units of the CINWR (USFWS, 2015).

Delisting Criteria:

1. Existing three (3) populations on Culebra show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factor A and E). (USFWS, 2019).
2. Establish two (2) additional populations on Culebra offshore cays with a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factor C and E). (USFWS, 2019).
3. Threat reduction and management activities (e.g. eradication and control of invasive predators) have been implemented to a degree that the species will remain viable into the foreseeable future (addresses Factor C). (USFWS, 2019).

Recovery Actions:

- The first criterion has been partially met. Presently, five of the six known natural populations of *L. grantianus* occur within private lands, and one occurs within a Commonwealth land managed by the PRDNER. A Cooperative Agreement between the Service and PRDNER is in place since 1984 to establish and implement a vigorous endangered species program within the Commonwealth of Puerto Rico under Section 6 of the ESA. However, this agreement does not provide specific actions to protect and conserve the existing population of *L. grantianus* in Culebra. Currently, three *L. grantianus* populations are located within Villa Mi Terruño (VMT), private land subject to residential and tourism development (Dubón 2013). In 2011, the Service and Fundación Mi Terruño, Inc. signed a Cooperative Agreement (F12AC01199) under the Coastal and Partners for Fish and Wildlife Programs, to conduct joint efforts for the recovery of the species. Fundación Mi Terruño, Inc. is a scientific, educational and conservation partner of VMT. The agreement includes (1) the protection of *L. grantianus* within the VMT property, (2) planting 60 individuals of the species to establish at least 6 two populations within the VMT property, and (3) enhancement of 21 cuerdas (20.4 ac; 8.3 ha) of habitat for the species by planting 1,265 native trees. The other two populations occurring on private lands are not covered under any agreement with the landowner. Agreements should be established with the private landowners at Playa Melones and Punta Soldado to protect the existing *L. grantianus* populations in those areas. The agreement with the municipality of Culebra is not practical

since the municipality does not manage or have jurisdiction of any of the currently known populations (USFWS, 2015).

- Criterion 2 has been partially met. This criterion states that new populations of *L. grantianus* should be established within protected areas in Culebra. Since the recovery plan was approved, five new populations of this species have been discovered in Culebra. Additionally, *L. grantianus* has been successfully propagated by cuttings and introduced in seven protected sites managed for conservation on the island (Figure 1). Presently, over 140 individuals of *L. grantianus* are maintained in pods at two shade houses in the Island of Culebra for this purpose. These individuals will be planted during the spring of 2015 in lands managed for conservation in Culebra. Hence, propagation and planting efforts of *L. grantianus* should continue as suggested in the recovery plan. Once populations are established, long term monitoring is needed to ensure that they are self sustainable to fully meet the recovery criteria (USFWS, 2015).
- New in 2019: Develop and implement monitoring protocols to ensure that the cactus mealy bug does not pose a threat to unaffected *L. grantianus* populations. This recovery action will be coordinated with PRDNER, APHIS, and the Service's National Wildlife Refuge System. (USFWS, 2019).

Conservation Measures and Best Management Practices:

- 1. We will work with partners (e.g., PRDNER) to update the recovery plan for *L. grantianus* as new information is available. Such collaboration should lead to establishing measurable criteria to delist the species (USFWS, 2015).
- 2. All populations, natural and introduced, should be monitored on a regular basis, and additional surveys should be conducted after hurricanes, landslides, fires, or other major disturbances. The natural populations should be monitored on a long-term basis to determine the species' trends (USFWS, 2015).
- 3. Conservation Agreements should be established between the Service and private landowners to protect natural populations in Playa Melones, Villa Mi Terruño and Punta Soldado on Culebra (USFWS, 2015).
- 4. Propagation efforts of *L. grantianus* should continue to enhance wild populations and establish additional self-sustainable populations in protected areas. Due to the current threat of infestation of wild populations with the *Harrisia* cactus mealybug, priority should be given to the establishment of a seed bank to ensure the availability of healthy plants for future recovery projects. Before taking this action, we will carefully evaluate and take into consideration the effects of seed and/or seedling removal on the species, existing threats, genetic variations, and consider ways to propagate by cuttings (USFWS, 2015).
- 5. Seeds and cuttings from the populations located along the shoreline of Culebra should be collected for propagation to preserve the genetic diversity of these populations. The selection of sites to establish new populations should be carefully evaluated considering coastal erosion and future sea level rise. Due to the small size of the populations, care must be taken to avoid over collection for scientific purposes. Seed collection should follow the Center for Plant Conservation (CPC) protocols, and some seeds should be preserved in a long-term seed storage facility approved by the CPC (USFWS, 2015).
- 6. A detailed demographic study of this plant's populations is needed since the ecology of the species, including pollinators, seed dispersers, germination requirements and habitat requirements is largely unknown (USFWS, 2015).

- 7. Genetic studies should be conducted to determine the patterns of genetic variation, genetic drift and its potential to affect the recovery of the species (USFWS, 2015).
- 8. The effects of competition with exotic plant species and predation by exotic animals need to be evaluated (USFWS, 2015).

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SPECIES ACCOUNT: *Lespedeza leptostachya* (Prairie bush-clover)

Species Taxonomic and Listing Information

Listing Status: Threatened; 01/09/1987; Great Lakes - Big Rivers Region (R3) (USFWS, 2016)

Physical Description

Herbaceous perennial; sericeous stems of mature plants are erect, up to a meter tall, and may be either simple or branched. The linear or narrowly oblong leaflets of the trifoliate leaves are 2-4 cm long and 2-8 mm wide with appressed pubescence above and silky hairs below. The longer terminal leaflets are less than half as wide as long, with petioles 2-10mm long. Petals of the chasmogamous (open, potentially outcrossing) flowers are white, or yellowish-white to light pink with a magenta mark in the center of the keel and are between 4 and 6 mm in length. The cream-colored petals of closed, obligately self-pollinating cleistogamous flowers develop within and are usually surrounded by the calyx, which reaches a length of 4.5 to 5 mm when fully developed. Both types of flowers may occur on a single plant or an individual plant may exhibit cleistogamous flowers only (USFWS, 1988).

Taxonomy

In the pea family (Fabaceae). There are 40 members of this genus, of which 12 are native to North America. Also known as slender-leaved bush clover (USFWS, 1988)

Historical Range

Former range included 27 counties in Minnesota, Wisconsin, Iowa, and Illinois (USFWS, 1988).

Current Range

It is presently known in 24 counties in northern Illinois, southern and western Wisconsin, southern Minnesota, and Iowa (USFWS, 1988).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: self-pollination, cross-pollination (NatureServe, 2015)

Lifespan

Adult: 10+ years (USFWS, 1988)

Breeding Season

Adult: July - September (NatureServe, 2015; USFWS, 1988)

Key Resources Needed for Breeding

Adult: Insect pollinators, possibly scarification/fire (NatureServe, 2015)

Reproduction Narrative

Adult: Blooms mainly in mid-July. Lespedeza species produce both larger, showy chasmogamous flowers and greatly reduced cleistogamous flowers. The cleistogamous flowers are obligately self-pollinated. Clewell (1966a) demonstrated that the chasmogamous flowers of other members of the genus are more often self-pollinated than cross-pollinated, thus Lespedeza has a strong tendency towards autogamy. In one study, only 20% of pods contained seeds (Baskin pers. comm.). Pollinators for some other Lespedeza species are known: *Bombus fraternus* (*L. capitata* and *L. virginica*), *Xylocopa micans* (*L. steuvei*, *L. angustifolia*), *Campsomeris plumipes* (same species), and *Epargyreus clarus* (same species). Haugen and Fitch (1955) have suggested that surface fire might cause scarification in *Lespedeza bicolor*. Clewell (1966a) found that germination success of *L. cuneata* increased following heating in an oven 90C for 30 minutes. On the other hand, *L. leptostachya* has been germinated in both Illinois and Kentucky without scarification (Kurz and Bowles 1981, Baskin pers. comm.). Smith (pers. comm.) has observed germination in the absence of fire every year for four years at one site in Minnesota (NatureServe, 2015). Plants under cultivation have been observed to flower the same year they germinated, whereas wild plants may require 5 or more years to reach maturity. Mature plants have been observed to flower repeatedly over four sequential sampling seasons. It is estimated that individual plants frequently live ten years or more. Growth and development of terminal inflorescences continues into early September (USFWS, 1988).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Dry to mesic gravel and sandy prairie (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Possibly a disturbance regime (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: 0.3 - 1.9 per sq. m (USFWS, 1988)

Tolerance Ranges/Thresholds

Adult: Moderate (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits dry gravel prairies and dry-mesic prairies in Illinois (Steyermark and Swink 1955, Kurz and Bowles 1981), dry-mesic prairies in Minnesota (Smith 1981) and Iowa (Huston 1981), dry prairie and sandy prairie in Wisconsin (Tans and Read 1975). Characteristics of dry gravel and dry-mesic prairies in Illinois include steep, well-drained, usually calcareous soil sites (White and Madany 1978). Smith (1981) noted that five of six Minnesota sites are north or northwest-facing slopes of 10 to 15 degrees, all well drained (the sixth site was on level ground). Apparently withstands moderate grazing. May require disturbance for reproduction and to reduce competition (NatureServe, 2015). Estimates of density in 1986 range from 0.3 to 1.9 plants per square meter (USFWS, 1988).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Within the genus there are no special structures to aid in seed dispersal, and seed dispersal is probably via animals consuming the fruits and passing the seeds. Clewell (1966a) tested 108 seeds of other members of the genus that were consumed by bobwhite quail (*Colinus virginianus*) and obtained 100% germination success. He also tested 16 seeds that were consumed by small mammals, and obtained 89% germination success (NatureServe, 2015).

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Moderate to high (inferred from USFWS, 1988; see current range/distribution)

Redundancy:

High (inferred from NatureServe, 2015)

Number of Populations:

~32 (NatureServe, 2015)

Population Size:

24,530 (USFWS, 1998)

Population Narrative:

There are about 32 extant populations, and many of these are small (<150 stems) (NatureServe, 2015). Total population size in peripheral populations is 1,923 and 22,607 in core populations (USFWS, 1988).

Threats and Stressors

Stressor: Habitat loss and degradation (USFWS, 1988)

Exposure:

Response:

Consequence:

Narrative: Threatened by loss of habitat due to agriculture and urbanization, may be threatened by plant succession, lack of natural disturbance (which prevents shrub invasion) at individual sites, and slow germination and seedling establishment rates. Specific threats to occurrences include use of herbicides or run-off containing herbicides at Cihak Prairie (Jackson Co., Minnesota; Smith 1981). Quarry operations threaten the Morton Outcrop (Renville Co., Minnesota; Smith 1981) site and the Winnebago Co. (IL) site (Kurz and Bowles 1981). At least four sites are presently being grazed (USFWS 1987). Woody species invasion threatens two sites in Wisconsin and two in Minnesota (USFWS 1987). Roadside mowing and weedy vegetation is threatening a site near a housing development in Wisconsin (Richardson pers. comm.) (USFWS, 1988).

Stressor: Herbivory (USFWS, 1988)

Exposure:

Response:**Consequence:**

Narrative: Herbivory by both insects and mammals may contribute to mortality. Insect herbivory has been reported for Illinois, Minnesota and Iowa populations. Young leaves and growing tips of young plants are damaged by insects throughout the summer. There is evidence of infestation by Cuculionid or Brucid beetles in Minnesota populations. At time, damage by mammals may reach significant proportions in localized areas (USFWS, 1988).

Stressor: Succession (USFWS, 1988)

Exposure:**Response:****Consequence:**

Narrative: Tentative evidence suggest that *L. leptostachya* is detrimentally affected by woody invasion but no data are available adequately to evaluate the threats (USFWS, 1988).

Stressor: Hybridization (NatureServe, 2015)

Exposure:**Response:****Consequence:**

Narrative: Hybridization with *L. capitata* is known to have occurred at two sites in Minnesota, one in Iowa, and one in Illinois (USFWS 1988).

Recovery**Reclassification Criteria:**

Not available

Delisting Criteria:

1. Protect and bring under appropriate management a minimum of twenty viable naturally-occurring populations of prairie bush-clover within the core habitat area (USFWS, 1988).
2. Protect and manage a minimum of fifteen viable naturally-occurring populations (representing the full range of habitat types) outside the core habitat area (USFWS, 1988).

Recovery Actions:

- Protect selected viable populations and their habitat. Initiate landowner awareness and permanent protection activities. Stabilize protection with long-term management plans and agreements (USFWS, 1988).
- Provide appropriate management at each protected site (USFWS, 1988).
- Inventory to locate additional populations. Search historical sites where prairie bush clover has been found and habitat is still present. Identify and search potential new sites (USFWS, 1988).
- Monitor population trends at known sites (USFWS, 1988).
- Establish artificial seed banks for selected populations (USFWS, 1988).
- Provide appropriate public information (USFWS, 1988).
- Conduct appropriate research. Determine important habitat parameters, including characterization of soils. Increase knowledge of species and population biology (life history,

population structure and dynamics, competition, predation). Determine natural seed bank (USFWS, 1988).

- Study the response of populations to a variety of potential management techniques (fire, grazing, mowing, pesticides, shrub and tree removal) (USFWS, 1988).
- Determine genetic diversity within and between populations (USFWS, 1988).

Conservation Measures and Best Management Practices:

- Management objectives should include maintaining population size in good condition occurrences and increasing population size in degraded occurrences. Monitoring should be used to track the accomplishment of these objectives. Monitoring will be critical at Anderson Prairie, Iowa, where the herbicides Banvel and 2,4,D were applied to an area with two stands of *L. leptostachya* in June 1985 (Roosa pers. comm.) (NatureServe, 2015).
- In Minnesota, Smith (pers. comm.) has been monitoring one population using a bi-coordinate system that enables workers to map and relocate individual plants and to record demographic data each year. Smith's method has also been adapted for use at another site in Minnesota (Sather 1987) and one in Iowa (Nekola 1985) (NatureServe, 2015).
- In Illinois, yearly stem counts are taken at sites being monitored for management response (Schwegman pers. comm., Packard pers. comm.) (NatureServe, 2015).
- In Wisconsin, stem counts are made each year (Martin, Richardson, pers. comm.) (NatureServe, 2015).

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SPECIES ACCOUNT: *Lesquerella congesta* (Dudley Bluffs bladderpod)

Species Taxonomic and Listing Information

Listing Status: Threatened; 02/06/1990; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

A small, cushion-shaped, herbaceous perennial, up to 3 cm in diameter, with a congested mass of bright yellow flowers and silvery leaves rising from a long, thin taproot (NatureServe, 2015).

Taxonomy

A member of the mustard family (USFWS, 1993). Renamed *Physaria congesta* (USFWS, 2008).

Historical Range

Known from Rio Blanco County, Colorado (NatureServe, 2015).

Current Range

It is found only along the Piceance and Yellow Creek drainages. Estimated range is 88 square kilometers (34 square miles), calculated in GIS by drawing a minimum convex polygon around the known occurrences (NatureServe, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 2008)

Lifespan

Adult: 2+ years (NatureServe, 2015).

Breeding Season

Adult: April - May (USFWS, 2016)

Key Resources Needed for Breeding

Adult: Bee pollinators (USFWS, 2008)

Reproduction Narrative

Adult: A perennial species (NatureServe, 2015). Pollinators reported for the bladderpod are *Andrena hicksii* and two other unidentified species of *Andrena*. These are native, solitary bees that nest in ground holes or in dead wood (USFWS, 2008). In late April to late May the Dudley Bluffs bladderpod is easy to spot when its bright yellow flowers bloom (USFWS, 2016).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: White shale outcrops (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Erosion from downcutting of streams (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits barren white shale outcrops of the Green River and Uinta Formations that have been exposed along drainages through erosion from downcutting of streams in the Piceance Basin. Grows on level surfaces at the points of ridges (NatureServe, 2015).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Resiliency:

Low (inferred from USFWS, 2008)

Redundancy:

Low (inferred from USFWS, 2008)

Number of Populations:

7 (USFWS, 2008)

Population Size:

550,576 - 602,576 (USFWS, 2008)

Adaptability:

High (inferred from USFWS, 2008)

Population Narrative:

Vulnerable to any surface disturbance. The long term population trend is unknown (NatureServe, 2015). There are seven known occurrences of bladderpod. The current estimated total occupied habitat is 201 to 207 ha (496 to 512 ac) on BLM, State, and private lands in the northern Piceance Basin in Rio Blanco County. The estimated total number of plants is 550,576 to 602,576 (CNHP 2006b). CNHP has assigned estimated viability ranks of A (excellent) to D (poor) for each recorded occurrence based on population size, condition of the plants, quality of habitat, viability, and defensibility. The average rank for the seven bladderpod occurrence was A-minus (USFWS, 2008).

Threats and Stressors

Stressor: Oil and gas development (NatureServe, 2015; USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Mining and oil and gas development are considered to be the primary threats to the species at this time (Rondeau et al. 2011). Mining of oil shale and/or nahcolite solution could impact up to 100% of the occupied habitat. A new nahcolite plant at Yankee Gulch, across from Dudley Bluffs was built in 2000. The lease may extend into Ryan Gulch. Additionally, a new drill pad was observed near Dudley Bluffs in 2000 (CNAP 2000) (NatureServe, 2015). Air pollution from diesel truck exhaust and from proposed coal-fired power plants for oil shale production could be a potential impact. Likewise, dust from heavy use of nearby roads may impede growth of the plants; information on likely impacts is not available (USFWS, 2008).

Stressor: Trampling (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: The bladderpod has been trampled by horses and cows at the Duck Creek ACEC. Cattle trampling remains at a low level (BLM-WRFO 2002a). Monitoring in this ACEC from 1996 to 2002 shows fluctuations in plant numbers that are attributed to drought more than to livestock damage (BLM-WRFO 1990, BLM-WRFO 2002a) (USFWS, 2008).

Stressor: Produced water (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Overspray from a produced-water evaporation pond on private land has reached an adjacent BLM plant occurrence; effects on the plants have yet to be determined. Accidental release of produced water from gas wells has been observed to kill sagebrush and associated vegetation near a few well pads (USFWS, 2008).

Stressor: Loss of pollinators (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: These species rely exclusively on insect pollination. Increasing ground disturbance in the vicinity of occupied plant habitat may be curtailing nesting resources for ground nesting bee pollinators. Increasing vehicle traffic may cause mortality of pollinators. Available information regarding these potential threats is not sufficient to show that larger buffer areas would benefit the pollinators (USFWS, 2008).

Stressor: Climate change (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Drought years result in a loss of plants. When occurrences also are impacted by other factors during drought years, they may require several years to recover. Dislodging of plants

while monitoring during drought years has been cited as a factor in population decline at two ACEC sites (BLM-WRFO 1989; BLM-WRFO 2002b). Climate change may exacerbate the frequency and intensity of droughts in this area (USFWS, 2008).

Recovery

Delisting Criteria:

1. Protect and/or enhance all known occurrences on public and private lands. Establish land management designations, and develop and implement habitat management programs (USFWS, 2008).
2. Protect the species from impacts via consultation under Section 7 and protection under Section 9 of the Endangered Species Act (ESA) (USFWS, 2008).
3. Minimum viable populations are defined and documented as being maintained for the species (USFWS, 2008).

Recovery Actions:

- Inventory any remaining potential habitat (USFWS, 1993).
- Establish formal land management designations to maintain and protect existing populations on public land (USFWS, 1993).
- Protect sites on private land with land exchanges and/or conservation easements (USFWS, 1993).
- Conduct life history/ecology research and soil analysis (USFWS, 1993).
- Monitor trend of existing populations with permanent plots (USFWS, 1993).

Conservation Measures and Best Management Practices:

- Publish a technical correction in the Federal Register noting the change in taxonomy from *Lesquerella congesta* to *Physaria congesta*, and correcting 50 CFR 17.12 (USFWS, 2008).
- Revise the recovery plan so that it reflects the best scientific and commercial information available. The revised recovery plan should include objective, measurable criteria which, when met, will result in a determination that the species be removed from the Federal List of Endangered and Threatened Plants. Recovery criteria should address all threats meaningfully impacting the species. The recovery plan should also estimate the time required and the cost to carry out those measures needed to achieve the goal for recovery and delisting (USFWS, 2008).
- Designate critical habitat for the species. "Critical habitat" is defined as: (1) specific areas within the geographical area occupied by the species at the time of listing, if they contain physical or biological features essential to conservation, and those features may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species if the agency determines that the area itself is essential for conservation. This could be done concurrently, in a single rule, with other neighboring plant species (USFWS, 2008).
- Recommend at least a 200 m (656 ft) buffer between occupied or suitable habitat and ground disturbance or other activities that may affect the plants or their habitat (USFWS, 2008).
- Develop and implement consistent conservation measures in the WRFO RMP revision that will avoid and minimize impacts from all development, ORV, and grazing activities. Include protection for all occupied and suitable habitat in the conservation measures. Expand existing ACECs to include contiguous occupied and suitable habitat for the plants and their pollinators. Designate the Yellow

Creek occurrence as an ACEC as was proposed in the recovery plan, plus contiguous occupied and suitable habitat (USFWS, 2008).

- Inventory remaining potential habitat on public and private lands. Report results to CNHP, BLM, and the Service (USFWS, 2008).
- Map all potential habitat, occupied habitat, and areas of existing and proposed leases, applications to drill, and development activities in GIS format (USFWS, 2008).
- Develop and implement permanent conservation agreements for occurrences on private lands (USFWS, 2008).
- Monitor the effects of development activities located within 200 m (656 ft) of plant occurrences on plants, pollinators, and habitat. Change buffers as determined by monitoring results (USFWS, 2008).
- Conduct annual status evaluations including estimates of mean density and population sizes at all Element Occurrences for the duration of intense energy activities within the range of the species (USFWS, 2008).
- Research the function of pollinators in the life history needs of the species, determine the habitat requirements of key pollinators, and adjust energy development best management practices accordingly (USFWS, 2008).

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SPECIES ACCOUNT: *Lesquerella kingii* ssp. *bernardina* (San Bernardino Mountains bladderpod)

Species Taxonomic and Listing Information

Listing Status: Endangered; 08/24/1994; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial herb that forms a basal rosette of leaves. Stems, mostly 5-15 cm tall, arise from the rosette and bear yellow flowers, followed by round, plump seed pods (NatureServe, 2015).

Taxonomy

A member of the member of the (Brassicaceae) mustard family. The genus *Lesquerella* is now considered united with the genus *Physaria*. The name now recognized for San Bernardino Mountains bladderpod is *Physaria kingii* (S. Watson) O’Kane & Al-Shehbaz subsp. *bernardina* (Munz) O’Kane and Al-Shehbaz (Al-Shehbaz and O’Kane 2002, p. 319) (USFWS, 2009).

Historical Range

San Bernardino Mountains bladderpod is endemic to the San Bernardino Mountains, San Bernardino County, California. At the time of listing, San Bernardino Mountains bladderpod was known from two areas on either side of Bear Valley (USFWS 1994, p. 43654). One cluster of occurrences is on the north side of Bear Valley towards the east end of Bertha Ridge. The other cluster is on the north facing slope of Sugarlump Ridge to the south of the valley (USFWS 1994, p. 43654) (USFWS, 2009).

Current Range

Since listing, there have been no significant changes in the known range of the taxon. Recent assessments indicate that there is about 210 acres (85 hectares) of occupied habitat for San Bernardino Mountains bladderpod (USFS 2005a, p. 272) (USFWS, 2009).

Critical Habitat Designated

Yes; 12/24/2002.

Legal Description

On December 24, 2002, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Lesquerella kingii* ssp. *bernardina* (San Bernardino Mountains bladderpod) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat unit (CHUs), in California (67 FR 78570-78610).

Critical Habitat Designation

The critical habitat designation for *Lesquerella kingii* ssp. *bernardina* includes two CHUs (4 subunits) in San Bernardino County, California (67 FR 78570-78610).

Unit 2: Bertha Ridge Unit, San Bernardino County, California (275 ha (685 ac)). The Bertha Ridge Unit includes four separate polygons encompassing important occurrences of the carbonate plants. This unit is located on the north side of Big Bear Lake adjacent to Big Bear City, California. It is near the east end of Bertha Ridge on its south facing slope. The majority of lands within this

unit contain soils derived from carbonate substrates (particularly dolomite) that are essential to the survival and conservation of both carbonate plant species. This unit contains important core occurrences of two of the five carbonate plants: *Eriogonum ovalifolium* var. *vineum* and *Lesquerella kingii* ssp. *bernardina*.

Sugarlump Ridge Unit, San Bernardino County, California. (i) From USGS 1:24,000 quadrangle map Moonridge, California.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Lesquerella kingii* ssp. *bernardina* critical habitat consists of three components (67 FR 78570-78610):

(i) Soils derived primarily from Bonanza King Formation and Undivided Cambrian parent materials that occur on hillsides or on large rock outcrops at elevations between 2,098 and 2,700 m (6,883 and 8,800 ft);

(ii) Soils with intact, natural surfaces that have not been substantially altered by land use activities (e.g., graded, excavated, recontoured, or otherwise altered by grounddisturbing equipment); and

(iii) Associated plant communities that have areas with an open canopy cover and little accumulation of organic material (e.g., leaf litter) on the surface of the soil.

Special Management Considerations or Protections

The SBNF is planning a revision of their Resource Management Plan in the near future that, among other functions, would provide conservation benefits to the two carbonate plant species and their habitat in this unit. These lands, however, currently do not have approved management provisions for the carbonate plants and their habitat, and habitat degradation may still be occurring due to ongoing activities identified in the final listing rule for these species (see USFWS 2001b). Therefore, the subject lands continue to require special management and protection to ensure the conservation of these species and their habitat. The core occurrences of the two carbonate plants in this unit are important as potential sources for the colonization events (e.g., seed dispersal) necessary to maintain the natural population dynamics of the species. Every carbonate plant occurrence in this unit is important as a seed source to colonize unoccupied sites and therefore maintain an equilibrium between local colonization and extirpation events. Every carbonate plant occurrence in this unit potentially provides important genetic material through pollen and seed dispersal which may help maintain genetic diversity and reduce the likelihood of regional extirpation events.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 2009)

Lifespan

Adult: 2+ years (NatureServe, 2015)

Breeding Season

Adult: May - June (USFWS, 2009)

Key Resources Needed for Breeding

Adult: Possibly a soil seed bank (USFWS, 1997)

Reproduction Narrative

Adult: Flowers are borne in terminal racemes and bloom from May to June. The fruits are spherical, pubescent, two-chambered, and contain 2 to 4 seeds per chamber (Rollins 1993, p. 430) (USFWS, 2009). Anecdotal observations of increases in population size following drought suggest that a persistent seed bank may be necessary for this taxon's survival (USFWS, 1997). This is a perennial plant (NatureServe, 2015).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Pine-juniper woodlands, fir forests (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 2100 - 2700 m elevation (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Occurs on dolomite substrates, typically on open, gentle to moderate slopes within pine-juniper woodlands and fir forests at 2100-2700 m elevation. Soils typically have little accumulation of organic material. It is tolerant of light disturbance: found on old roads and undeveloped lots. The environmental specificity is very narrow; it is a narrow carbonate endemic (NatureServe, 2015). The primary constituent elements of San Bernardino Mountains bladderpod designated critical habitat include: 1) soils derived primarily from Bonanza King Formation and Undivided Cambrian parent materials that occur on hillsides or on large rock outcrops at elevations between 6,883 and 8,800 feet (2,098 and 2,700 meters); 2) soils with intact, natural surfaces that have not been substantially altered by land use activities (e.g., graded, excavated, re-contoured, or otherwise altered by ground-disturbing equipment); and 3) associated plant communities that have areas with an open canopy cover and little accumulation of organic material (e.g., leaf litter) on the surface of the soil (USFWS 1994, p. 78577) (USFWS, 2009).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends

Population Trends:

Decline of 70-90% (NatureServe, 2015)

Species Trends:

30 - 50% decline (NatureServe, 2015)

Resiliency:

Very low (inferred from USFWS, 1997)

Redundancy:

Low (inferred from USFWS, 1997)

Number of Populations:

2 (USFWS, 1997)

Population Size:

Uncertain; ~25,000 known (NatureServe, 2015)

Population Narrative:

This species has experienced a long term decline of 70-90%. The short term trend has been downwards (30 - 50%) for this plant due to development, OHV use, other recreational uses, grazing, mining and weeds. There are perhaps 25,000 plants known to the California Natural Diversity Database, but the actual total population size is uncertain. Of 8 total EO's, 5 are non-historic, and 3 are historic (NatureServe, 2015). The species is known from two areas, on either side of Bear Valley (USFWS, 1997).

Threats and Stressors

Stressor: Off-highway vehicles (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Off-road (off-highway) vehicle use was identified as a threat in the final listing rule (USFWS 1994, p. 43659). Since listing, some level of impact from off-road vehicles continues to impact the species. About 2 acres (one hectare) of occupied habitat and 10 acres (4 hectares) of designated critical habitat overlap with roads and trails (USFWS 2005a, p. 273) (USFWS, 2009).

Stressor: Development (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The San Bernardino Mountains bladderpod populations on the east end of Bertha Ridge near Big Bear City were described in the final listing rule as being threatened by impacts associated with urban development (USFWS 1994, p. 43659). Habitat continues to be affected

due to proximity with urban development through mountain biking off roads and trails, particularly in the area north of Whispering Forest, where several trails connect U.S. Forest Service and private lands (USFS 2005a, p. 313). An additional threat to the San Bernardino Mountains bladderpod described in the final listing rule was from the proposed addition of a downhill ski run to Sugarlump Ridge (USFWS 1994, p. 43660). On January 26, 1995, the Service issued a biological opinion for the Bear Mountain Ski Resort Expansion Project. This project involved the loss of 0.55 acres (0.22 hectares) of previously disturbed San Bernardino Mountains bladderpod habitat (USFWS 1995, p. 2) (USFWS, 2009).

Stressor: Mining (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Prospecting and working on gold mining claims continue to impact this species (USFS 2005a, p. 313). About 10 percent of San Bernardino Mountains bladderpod occupied habitat is under claim for gold mining (USFS 2005a, p. 313) (USFWS, 2009).

Stressor: Fire suppression activities (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Fire suppression activities, not identified as a threat in the final listing rule, can result in ground disturbance and other impacts to habitat through trampling, fire line construction, retardant and water drops, establishment of fire camps, and exposure to conditions favorable to nonnative invasive plants (USFWS, 2009).

Stressor: Stochastic events (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Among the threats identified in the final listing rule for this species was the potential for stochastic extinction resulting from random events, and this threat still exists. A significant drop in San Bernardino Mountains bladderpod populations occurred between 1980 and 1988 and may have been due to years of drought conditions (USFWS 1994, p. 43662). Because this species is restricted to certain, limited soils, it is likely that its population has always been small. The potential for stochastic extinction is enhanced by habitat loss and fragmentation. Habitat fragmentation can result in areas too limited and isolated to support pollinators or other seed dispersal agents (USFWS 1997, p. 16). Global climate change may further increase likelihood of stochastic extinction (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Some evidence suggests that global climate change may be a particular concern to montane species. Summary papers have cited studies documenting shifts in the distribution of various taxa in response to climatic warming trends. These shifts are often found from the southern and lower elevation ends of the species' range to the northern or higher elevation of

the range (Field et al. 1999, pp. 38–39). San Bernardino Mountains bladderpod is endemic to isolated occurrences of dolomite and limestone derived soils in the San Bernardino Mountains. Therefore, any combination of environmental conditions, such as those attributed to climate change above, that force an upward shift in the distribution of the species poses a profound threat to the taxon's persistence and recovery. If this species is affected by elevational shifts resulting from climate change, then there will be no suitable habitat when the elevational range exceeds the species' maximum elevation. As this occurs, the density and distribution may concentrate the taxon into a smaller area. This, in turn, may make the species even more susceptible to stochastic extinction. To date, no species-specific monitoring has been conducted to detect an elevational shift in its range (USFWS, 2009).

Recovery

Reclassification Criteria:

1. The priority ranked habitat areas have been protected. Priority for protection shall be determined according, but not limited, to: 1) population size, 2) habitat quality, 3) manageability/defensibility of site, and 4) connectivity. The initial preserve area should be 2,000 hectares (5,000 acres) based on known areas occupied by the plants. To count toward reclassification of the plants, reserves must have been designed to minimize or eliminate indirect threats due to adjacent land uses. This includes protection of carbonate plant habitat from human disturbance to hydrology, soil integrity, fire ecology, habitat microclimates, and light regimes. Appropriate management and restorative measures should reduce habitat-degrading effects such as surface disturbances, windblown sediments, fugitive night lighting, and off-highway vehicle use (USFWS, 2009).
2. Protect additional lands needed to complete otherwise isolated reserves, to protect new populations that may be discovered in the future, and to provide strategic buffer zones and potential population reintroduction and/or expansion areas. The interim estimate of additional lands needed to secure habitat connectivity, buffers, and natural community context is 1,860 hectares (4,600 acres) (USFWS, 2009).
3. Adaptive population monitoring/adaptive management programs must be functioning so that early detection is assured for any population instability or other problems in the reserve system. Studies will have shown whether there is a need for reintroductions and/or augmentations of existing populations. Research results to support adaptive management will be available, including at least preliminary results on pollination ecology, seed dispersal mechanisms, population dynamics, microclimate effects of vegetation removal/bare areas, seedbank dynamics, and fire ecology (USFWS, 2009).

Delisting Criteria:

The reserve system designed to allow downlisting is intended to suffice for delisting, provided that monitoring and research demonstrate that the reserves work as planned to remove the threats identified during the listing process. As monitoring and research results become available, delisting criteria will be established (USFWS, 2009).

Recovery Actions:

- Protect significant extant populations by developing a system of reserves on Federally owned land. Initially, preserves covering about 2,000 hectares (5,000 acres) are needed,

based on known areas occupied by the plants. The reserve system includes buffer zones and maintenance of selected habitat connections. The land managing agencies will conserve these plants in the context of applicable laws (including the mining laws) and regulations (USFWS, 1997).

- Restore habitat and conduct reintroductions and/or population enhancements where appropriate and feasible (USFWS, 1997).
- Identify and implement appropriate management measures (USFWS, 1997).
- Monitor populations (USFWS, 1997).
- Conduct limited surveys and taxonomic assessments to find new populations and resolve questions about the identity of several populations identified in the text (USFWS, 1997).

Conservation Measures and Best Management Practices:

- Prepare a new threats-based recovery plan specific to San Bernardino Mountains bladderpod that identifies a recovery strategy, objectives, and criteria for reclassification to threatened, objectives and specific criteria for removal from the list of endangered and threatened species, and prioritizes recovery actions. In the interim, seek implementation of elements of the Carbonate Habitat Conservation Strategy that have direct benefit to the conservation of *Physaria kingii* subsp. *Bernardina* (USFWS, 2009).
- Work with the San Bernardino National Forest to conduct systematic monitoring of San Bernardino Mountains bladderpod throughout known and potentially occupied sites as necessary to track the status of the species and identify management priorities. There is a need to continue to obtain quantitative information regarding the status of this species to evaluate the effectiveness of conservation efforts over time, especially in light of potential effects associated with global climate change (USFWS, 2009).
- Work with partners, such as the San Bernardino National Forest, to help conserve San Bernardino Mountains bladderpod by identifying opportunities to: a) Continue monitoring programs for the effectiveness of measures to protect San Bernardino Mountains bladderpod from recreational activities and make adjustments to signs, barriers, and roads as necessary. b) Avoid new developments in or near San Bernardino Mountains bladderpod habitat (USFWS, 2009).

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SPECIES ACCOUNT: *Lesquerella lyrata* (Lyrate bladderpod)

Species Taxonomic and Listing Information

Listing Status: Threatened; 9/29/1990; Southeast Region (R4) (USFWS, 2015)

Physical Description

An annual made up of one to several, usually simple and erect stems of 1 to 3 decimeters (din) (4 to 12 inches) (in.) in length. Leaves and stems are shortly pubescent. The outer stems are usually decumbent at the base. Basal leaves are stalked and lyrate-shaped, 2 to 7 centimeters (cm). (0.8 to 2.8 in.) long and 6 to 15 millimeters (mm) (0.2 to 0.6 in.) wide. The terminal lobes are large and orbicular to elliptic in shape. The stem leaves are ovate to broadly oblong and obtuse, 5 to 20 mm (0.2 to 0.8 in.) long and 4 to 10 mm (0.2 to 0.4 in.) wide, and sessile with prominent ear-like projections (auricles) at the bases. The margins of the stems are nearly smooth to coarsely toothed. Inflorescences are dense. The flowers are ascending on densely pubescent stalks 1 to 1.5 cm (0.4 to 0.6 in.) long. Sepals are pubescent, yellowish, oblong, 3 to 4 mm (0.1 to 0.2 in.) long and 1.2 to 1.5 mm (0.1 in.) wide. Petals are yellow, broadly ovate, 5 to 7 mm (0.2 to 0.3 in.) long and 3.5 to 4 mm (0.1 to 0.2 in.) wide, and slightly rounded. The fruits are siliques, which are glabrous, globose in shape, 2.5 to 3.5 mm (0.1 in.) high and 3 to 4 mm (0.1 to 0.2 in.) broad. Seeds are flattened, brown, oval to nearly orbicular in outline, and margined, and range from 1.5 to 2.5 mm (0.1 in.) on the longest dimension (USFWS, 1996).

Taxonomy

Rollins (1955) considered *L. lyrata* to be an evolutionary link between *L. densipila* and *L. auriculata*, the somewhat closer relationship being with the former. Kral (1983) noted the close resemblance of *L. lyrata* and *L. densipila*, that the fruits of *D. lyrata* were slightly smaller and that both the fruit and the persistent styles are perfectly glabrous. McDaniel (1987) suggested that this difference, while consistent, was insufficient to justify recognition at the species level, and stated that assignment to varietal rank would be more appropriate. However, no worker has formally provided data to support such a change in taxonomic status (USFWS, 1996).

Historical Range

The current and historical distribution of *D. lyrata* is confined to parts of Franklin, Colbert, and Lawrence counties in Alabama. (USFWS, 1996)

Current Range

The current and historical distribution of *D. lyrata* is confined to parts of Franklin, Colbert, and Lawrence counties in Alabama. (USFWS, 1996)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: ~1 year (USFWS, 2009)

Breeding Season

Adult: March - April (USFWS, 2009)

Reproduction Narrative

Adult: The lyrate bladderpod is a winter annual with a long-lived seed bank. Flowering takes place usually from mid-March to April (USFWS, 2009).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Limestone outcropping/hill, glades (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Early successional habitats, disturbance (USFWS, 2009)

Geographic or Habitat Restraints or Barriers

Adult: Shading (USFWS, 2009)

Environmental Specificity

Adult: Moderate (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits red soils, limestone outcroppings and hills, disturbed cedar glades and glade-like areas (open pastures, cultivated fields, bottomlands, and roadsides in calcareous areas) (FNA 2010) (NatureServe, 2015). The lyrate bladderpod appears to be an early successional species that historically colonized the shallow soils on or adjacent to cedar glade habitats. This species slowly disappears as the soil layer develops and other competing plants establish themselves (U.S. Fish and Wildlife Service 1996). Shading causes decreased vigor and death and decreases the number of seeds at the site (Baskin and Baskin 1998, 2000). Disturbance is needed primarily to remove competing vegetation and also to bring seeds to the soil surface for germination (Baskin and Baskin 2000, U.S. Fish and Wildlife Service 1990, 1996; Webb and Kral 1986). The need for ground disturbance to maintain populations is evidenced in the fact that the best populations are those that are subject to some type of recurring disturbance such as grazing, plowing, and mowing (USFWS, 2009).

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Stable to increasing (USFWS, 2009)

Resiliency:

Low (inferred from NatureServe, 2015)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

6 - 20 (NatureServe, 2015)

Population Narrative:

Six extant occurrences and an additional 10 that are historic or extirpated (NatureServe Central Database 2015) (NatureServe, 2015). USFWS (2009) notes that most of the largest population is permanently protected and consistently managed, and shown to be stable to increasing in size. Low resiliency, representation and redundancy are inferred based on the low number of known populations of this species.

Threats and Stressors

Stressor: Herbicide Use (USFWS, 1996)

Exposure:

Response:

Consequence: Loss of habitat/Loss of individual plants

Narrative: The use of pre-emergent herbicides on agricultural crops as well as the use of herbicides as part of road side/easement maintenance is listed as threat to this species (USFWS, 1996).

Stressor: Road improvement (USFWS, 1996)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Road improvement is listed as a threat to this species (USFWS, 1996)

Stressor: Proposed rock quarry (USFWS, 1996)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: At the time of the 1996 Recovery Plan a proposed rock quarry was threatening the habitat of this species. It is unclear whether this quarry was ever developed (USFWS, 1996).

Stressor: Development/Urbanization (USFWS, 1996)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Development for commercial, industrial and housing are listed as a threat to this species (USFWS, 1996)

Stressor: Trash dumping (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Trash dumping has destroyed or negatively impacted this species habitat (USFWS, 2009).

Stressor: Woody succession (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Lack of disturbance can result in competition (and shade) from invading perennials (USFWS, 2009).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat/Loss of individual plants

Narrative: There are no State laws in Alabama protecting the lyrate bladderpod and its habitat. Otherwise, protection is afforded to this species under Section 7 and Section 9 of the ESA. The majority of one of the populations is permanently protected and consistently managed due to its location in a Nature Conservancy preserve. An adjacent portion of this population is currently being managed for the lyrate bladderpod under a voluntary Wildlife Cooperative Extension Agreement (WCEA) until the year 2017 (Hurt 2008a). The management outlined in the WCEA has been beneficial for the species, however, it does not provide for the permanent protection and management of this site (USFWS, 2009).

Recovery

Reclassification Criteria:

Not available

Delisting Criteria:

Species will be considered for delisting when nine demonstrably secure and self-sustaining populations exist. A demonstrably secure population is defined as one for which legal protection and active, successful management have been established. A self-sustaining population is defined as a population that is shown by monitoring data to be reproducing and relatively stable for at least a 10-year period (USFWS, 1996).

Recovery Actions:

- Protect and manage known populations. Negotiate with State and local highway departments and landowners. Develop management plans for each population and site (USFWS, 1996).
- Search for new populations. Conduct searches for additional populations. Continue to re-examine historic occurrence localities. Search for potential relocation/establishment sites for possible use in the future (USFWS, 1996)
- Conduct ecological research. Conduct hybridization studies, studies on seedbank size and seed viability. Study germination relative to natural conditions and agricultural practices (1996).
- Conduct long-term site and population monitoring. Implement population monitoring. Monitor management techniques and results (USFWS, 1996).

- Maintain seeds and plants ex situ. Maintain seeds and plants (USFWS, 1996).
- Provide information to the public. Conservation efforts with the greatest successes are those with the greatest amount of public support. Plans should be developed to disperse information on *D. lyrata* to the local public, particularly to agricultural landowners (USFWS, 1996).

Conservation Measures and Best Management Practices:

- Continue management and monitoring on Lawrence County population (USFWS, 2009).
- Work to secure protection and implement appropriate management for all other populations, most likely through conservation easements (USFWS, 2009).
- Renew contact with State and county highway department to ensure proper protective measures are implemented for those areas where plants occur onto roadside rights-of-way (USFWS, 2009).
- Survey in vicinity of known populations and revisit all known historical sites regularly (USFWS, 2009).
- Work with landowners to reintroduce some type of ground disturbance activity at historical sites during appropriate time of year and follow with survey of sites next flowering season (USFWS, 2009).
- Gather base-line data on all populations and initiate long-term monitoring as means to track population trends and evaluate management efforts (USFWS, 2009).
- Expand species' biology studies to include field experiments (USFWS, 2009).
- Ensure preservation of genetic material from all populations through long-term seed storage through coordination with USDA Seed Storage Laboratory in Fort Collins, Colorado (USFWS, 2009).
- Implement all other tasks identified in the recovery plan, as appropriate (USFWS, 2009).
- Update recovery plan (USFWS, 2009).

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SPECIES ACCOUNT: *Lesquerella pallida* (White bladderpod)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/11/1987; Southwest Region (R2) (USFWS, 2016)

Physical Description

White bladderpod is an annual member of the Brassicaceae or Mustard Family. The plant overwinters as a tap-rooted, leafy rosette, reaching a maximum height of two feet as an erect plant or may be spreading. The white flowers appear in April and May and are composed of four one-half inch long petals. It produces pea shaped “bladderpods” that enclose the seeds before dying as its harsh habitat dries in the summer heat. Seed set occurs from late May to early June and the dormant stage begins in July and usually last until October.

Current Range

White bladderpods are known to occur only on the Weches Outcrops of San Augustine County, Texas.

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Habitat Type

Adult: Glades within pine-oak forests

Habitat Narrative

Adult: The white bladderpod occurs in natural openings or glades within pine-oak forests on shallow, stony, calcareous sandy loam or sandy clay loam over glauconite or ironstone of the Weches Formation; in addition, these glades are seep-moistened during the winter and spring but become desiccated during the summer (Poole et al. 2007, p. 378). White bladderpod population numbers are heavily influenced by local environmental conditions, such as winter or spring moisture and spring frost, as well as invasion of woody and herbaceous plants that tend to out-compete the white bladderpod.

Dispersal/Migration

Population Information and Trends

Number of Populations:

Eight

Population Size:

112 - 10,000

Population Narrative:

Currently, there are eight known populations of the white bladderpod. Seven of the sites are located on private property, and the eighth site is located on private property and the adjacent road ROW of SH 21. Three of the populations were last surveyed in 2001 and found to have an extant population, four other populations were last surveyed in 2006 with extant populations, and the remaining population was surveyed in 2009 and found to have an extant population. White bladderpod population size varies drastically from year-to-year and appears to be due to differences in winter and spring moisture and spring frost or grazing by animals (Service 1992). The population numbers vary from 10,000 to 112 individual plants (see Table 1. for the most recent survey results for the known extant populations of the white bladderpod).

Threats and Stressors

Stressor:

Exposure:

Response:

Consequence:

Narrative: The primary threats to white bladderpod are the invasion of woody and herbaceous plants into their limited habitat as well as overgrazing (Service 1992). Pasture improvement through the use of herbicides, plowing, and the introduction of non-native pasture grasses can destroy white bladderpod populations and habitat. Since all populations occur partly or wholly on private property, any major changes in land use are detrimental. In addition to home or other building construction, road construction is a threat to the populations of white bladderpod that occur within road ROWs. Rock quarrying poses a significant threat to the species since crushed rock from the Weches formation is used for gravel roads. Areas of suitable habitat within San Augustine County have already been lost to quarrying. Small populations could be prone to extirpation if a series of unfavorable years greatly reduces seed production and depletes the soil seed bank. Recolonization after a population has been lost would require long distance seed dispersal, which appears to be poor in white bladderpod (Service, 1992).)

Recovery

Recovery Actions:

- The Recovery Plan requires the establishment of 12 self-sustaining populations of white bladderpod and the establishment of agreements for the protection and management of these populations in order to downlist the species from endangered to threatened. The Recovery Plan calls for the protection and management of the populations and habitat, the gathering of biological information necessary for management, establishing a botanical garden population, the search for new populations, and the establishment of new populations as necessary to meet downlisting criteria (Service, 1992). For more detailed information regarding recovery actions for the white bladderpod, please refer to White Bladderpod (*Lesquerella pallida*) Recovery Plan (Service 1992) (Recovery Plan). Shrub removal from three privately owned white bladderpod sites in 1995 proved to be beneficial, resulting in more plants being present the following spring. However, ongoing brush control is necessary to maintain suitable habitat at these sites. Three seed propagation facilities have been established and maintained, and the Nature Conservancy of Texas has developed a "Conservation Area Plan for the San Augustine Glades" under a Cooperative Agreement with the Service.

References

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NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

SPECIES ACCOUNT: *Lesquerella perforata* (Spring Creek bladderpod)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/23/1996; Southeast Region (R4) (USFWS, 2015)

Physical Description

A herbaceous annual, stems several to many, outer ones usually decumbent (a plant that has its base lying on the ground and a stem that grows upward) at base, inner ones erect, simple or branched, 10 to 15 cm tall, stems and leaves are covered with fine or coarse hairs. Leaves at the base (rosette) have a petiole (leafstalk) and are lyrate (several lobes, which increase in size toward one large terminal lobe) lobed with pointed teeth on the margins. The stem leaves are sessile (stalkless and attached directly at the base), auriculate (ear shaped), oblong to obovate (egg shaped), with few to many teeth on the margins. The cross-shaped flowers are arranged in a raceme (stalked flowers arranged singly along an elongated unbranched axis), have white to pale lavender petals with a yellow base, and are 7 to 9 mm long. The fruits, or pods, are broadly obovoid (egg shaped) to pear-shaped, very inflated, 4 to 7 mm long, and divided into two halves. The outer surface of the pod is papery with very sparse hairs and the inside is densely hairy. The septum (the internal partition between the two halves) is perforated or nearly absent with only a small portion attached to the fruit wall. There are up to 10 round seeds in a pod measuring 1.5 to 2.5 mm long, strongly flattened and surrounded by a thin margin (USFWS, 2006)..

Taxonomy

Lesquerella is a genus of the Brassicaceae, the mustard family, named for the seventeenth century Swiss and American botanist Leo Lesquereux. There are approximately 75 taxa of *Lesquerella* with the majority occurring in the western states; only a few taxa are found in the Interior Low Plateau of Tennessee, Alabama, and Kentucky (Al-Shehbaz 1987). Only one species, *Lesquerella lescurii* (Nashville mustard), had been described in the eastern states prior to the 1950's work of Dr. Reed C. Rollins, a Harvard University expert on the Brassicaceae. From 1952 to 1955, Rollins described three new species of *Lesquerella* endemic to the Central Basin of Tennessee, *L. densipila* (Duck River bladderpod), *L. stonensis* (Stones River bladderpod), and *L. perforata* (Spring Creek bladderpod) (USFWS, 2006).

Historical Range

See current range/distribution.

Current Range

Known only from Wilson County, Tennessee (USFWS, 2006).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Flowering usually occurs in March and April. The fruit splits open upon maturity in late April and early May, and the enclosed seeds are dispersed and lie dormant until autumn. The plant dies back soon after the fruits mature (USFWS, 2006).

Reproduction Narrative

Adult: Lesquerella perforata is an annual that germinates between September and early October, overwinters as a small rosette of leaves, and fully develops and flowers the following spring. Full sunlight is required for optimum growth. Flowering usually occurs in March and April. The fruit splits open upon maturity in late April and early May, and the enclosed seeds are dispersed and lie dormant until autumn. The plant dies back soon after the fruits mature. Germination can only occur when the correct temperature coincides with adequate moisture (Pearson 1967). Upon germination, the cycle starts over again. The seeds of L. stonensis can remain viable in the seed bank for at least 6 years, and perhaps those of L. perforata can do the same (Rollins 1955, Kral 1983, Baskin & Baskin 1990, Fitch 2004) (USFWS, 2006).

Habitat Type

Adult: Limestone outcrops (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: This species is found mainly where sites have been disturbed by flooding or by cultivation, and tends to occur in areas of full sun on well-drained soils, as well as (rarely) on limestone rock outcrops. Most historic and current occurrences are on flood plains, where periodic flooding removes encroaching grasses and woody plants. Also occurs in places where other types of disturbances "substitute," such as on annually cultivated bottom land fields (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species and the low number of known populations.

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: No information found.

Population Information and Trends**Resiliency:**

Low (inferred from NatureServe, 2015)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

Fluctuates widely from year to year (USFWS, 2006)

Population Narrative:

Known from four populations consisting of 13 extant sites in Wilson County, Tennessee. Three additional sites no longer support the species. (U.S. Fish and Wildlife Service 1996) (NatureServe, 2015). Low resiliency, representation and redundancy are inferred by the low number of known populations and the specific habitat requirements of this species.

Threats and Stressors

Stressor: Cropland conversion to pasture (USFWS, 2006)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The conversion of cropland to pastures that contain grasses (e.g.) fescue poses a threat because of competition and lack of annual disturbance (USFWS, 2006).

Stressor: Urbanization/Development (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Those sites on private lands in the City of Lebanon, primarily in Barton's Creek drainage, remain at high risk of loss to urbanization (USFWS, 2011). This includes placing fill material on this species habitat and road building.

Recovery

Reclassification Criteria:

Spring Creek bladderpod will be considered for reclassification to threatened status when there are 15 protected occurrences, five of which are located within the floodplain of each of three creeks (Spring Creek, Barton's Creek, and Cedar Creek). These occurrences, located on either public or private land, must be protected by a permanent conservation easement with a management agreement. Each occurrence must consist of an average of 500 plants over a five-year period, with no less than 100 plants in any given year (USFWS, 2011).

Delisting Criteria:

Spring Creek bladderpod will be considered for delisting when there are 25 protected occurrences, with at minimum five occurrences located within the floodplain of each of the three creeks (Spring Creek, Barton's Creek, and Cedar Creek). Each occurrence located on either

public or private land must be protected by a permanent conservation easement with a management agreement. Each occurrence must consist of an average of 500 plants over a ten-year period, with no less than 100 plants in any given year (USFWS, 2011).

Recovery Actions:

- We have not met the criteria for reclassifying Spring Creek bladderpod to threatened. No occurrences are protected by conservation easement; though three are protected by non-binding cooperative management agreements. Spring Creek bladderpod abundance fluctuates considerably over time (Table 1). While 500 or more plants have been observed at most of the occurrences at some point in time, fewer than 100 have also been observed at most occurrences at some point in time (USFWS, 2011).

Conservation Measures and Best Management Practices:

- Continued efforts to implement recovery actions identified in the species' recovery plan, improve monitoring techniques, and refine guidance for managing Spring Creek bladderpod are necessary. Specific emphasis should be placed on determining whether additional occurrences exist in the Cedar Creek drainage, and efforts should be redoubled to work with private and municipal landowners to ensure long-term protection of known occurrences through conservation easements (USFWS, 2011).

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SPECIES ACCOUNT: *Lesquerella thamnophila* (Zapata bladderpod)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/22/1999; Southwest Region (R2)

Physical Description

Zapata bladderpod is a pubescent, silvery-green, herbaceous perennial of the Brassicaceae family, with sprawling stems 17 to 34 inches long. Basal leaves are narrowly elliptical to oblanceolate and acute, 1.5 to 4.8 inches long, and 0.3 to 0.6 inch wide, with entirely or slightly-toothed margins. Stems leaves are linear to narrowly elliptical and acute, 1 to 1.5 inches long and 0.1 to 0.3 wide, and have entire or slightly toothed margins. Cauline or stem leaves are linear to narrowly elliptical and acute, 3 to 4 cm (1 to 1.5 in) long and 2 to 8 mm (0.1 to 0.3 in) wide, with margins similar to basal leaves. The presence of stellate trichomes (small hair-like structures) on the leaves produces the plant's appearance of a whitish or silvery-green color. The inflorescence is a loose raceme of bright, yellow-petaled flowers. The flowers appear throughout the year depending upon temperature and rainfall, and are arranged along an axis with the lower flowers maturing first. Fruits are round and 4.5 to 6.5 mm (0.2 to 0.8 in) in diameter on short, downward curving pedicels (Poole 1989). (USFWS, 2004)

Taxonomy

Zapata bladderpod was first described as *Lesquerella thamnophila* Rollins and Shaw, based on specimens collected in Starr and Zapata counties (now EOs 1, 2, and 3) (Rollins and Shaw 1973). Al-Shehbaz and O'Kane (2002), citing molecular, morphological, cytological, biogeographic, and ecological data, transferred 91 taxa of *Lesquerella* to *Physaria*, including *P. thamnophila*. Genetic analyses, based on DNA sequences of the internal transcribed spacer of nuclear ribosomal DNA and length variation of inter-simple sequence repeat regions, revealed that *Physaria*, as previously recognized, was nested within and evolved more than once from *Lesquerella*. The former genus was polyphyletic, and the latter was paraphyletic. These authors united the two into a single monophyletic genus, conserving the earlier-published name of *Physaria*. This taxonomic revision is supported by the Flora of North America (O'Kane 2015), the Integrated Taxonomic Information Service (2015), Poole et al. (2007), and the Tropicos database (Tropicos 2015). (USFWS, 2015)

Historical Range

Starr and Zapata Counties, Texas.

Current Range

Starr and Zapata Counties, Texas. (USFWS, 2015)

Critical Habitat Designated

Yes; 1/22/2001.

Legal Description

On December 22, 2000, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective January 22, 2001) for *Lesquerella thamnophila* (Zapata bladderpod) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes eight critical habitat units (CHUs), in Texas (65 FR 81182-81212).

Critical Habitat Designation

The critical habitat designation for *Lesquerella thamnophila* includes eight CHUs in Starr County, Texas. This species critical habitat encompasses approximately 5,158 acres (ac) (2,088 hectares (ha)). Legal descriptions are presented below. Maps for general information purposes depicting the CH units are available in the Final Rule (65 FR 81182-81212).

Unit 1, Cuellar Tract (18 hectares (ha); 45 acres (ac))—(Segment 669). Note: All bearings are based on the Texas State Plane Coordinate System, South Zone, as referenced by the National Geodetic Survey Triangulation Station “LABRA” (not found) having State plane coordinates of N = 331,881.065, E = 1,794,777.75. The scale factor used is 0.9999252, and the theta angle is $\angle 00^{\circ} 37' 32''$. All areas and distances are true surface measurements. Beginning at a standard U.S. Fish and Wildlife Service (FWS) aluminum monument set for corner on the southeasterly line of Porcion No. 59 and the northeast corner of Share 35 and stamped “Tract 669, COR. No. 1, R.P.L.S. #4303” and having a State plane coordinate value of N = 320,083.51, E = 1,799,578.77, from which triangulation station “LABRA”, bears N $22^{\circ} 08' 38''$ W, 12,737.98 feet; thence, in a southwesterly direction along the common line of Porcion 59 and 60, S $54^{\circ} 32' 24''$ W, 2,290.19 feet, to a standard FWS aluminum monument set for corner, being the common corner of Shares 35 and 26 and stamped “Tract 669, COR. No. 2, R.P.L.S. No. 4303; thence, in a northwesterly direction along the common line of Share 35 with Shares 26 and 27, N $35^{\circ} 27' 36''$ W, 640.00 feet to a standard FWS aluminum monument set for corner, being the most southerly common corner of Shares 35 and 34 and stamped “Tract 669, COR. No. 3, R.P.L.S. No. 4303”; thence, in a northeasterly direction along the common line of Shares 35 and 34; N $54^{\circ} 32' 24''$ E, 2,290.19 feet to a standard FWS aluminum monument set for corner, being the most northerly common corner of shares 35 and 34 and stamped “Tract 669, COR. No. 4, R.P.L.S. No. 4303; thence, in a southeasterly direction along the common line of Shares 35 and 36 Parcel—A; S $35^{\circ} 27' 36''$ E, 640.00 feet to the point of beginning and containing 33.648 acres of land. (Cuellar Tract—Segment 672). Note: All bearings are based on the Texas State Plane Coordinate System, South Zone, as referenced by U.S. Fish and Wildlife Service GPS Monument No. 105 having State plane coordinates (NAD 27) of N = 311,099.90, E = 1,799,824.45. The scale factor used is 0.9999252, and the theta angle is $\angle 00^{\circ} 37' 32''$. All areas and distances are true surface measurements. Beginning at a standard FWS aluminum monument set for corner on the common line between Porcions 59 and 60, and being the northeast corner of Share 26 and stamped “Tract 672, COR. No. 1, R.P.L.S. No. 3680” and having a State plane coordinate value of N = 318,737.64, E = 1,797,725.36, from which FWS GPS Monument No. 105 bears S $15^{\circ} 22' 02''$ E, 7,920.94 feet; thence, in a southeasterly direction along the common line of Porcion 59 and 60, S $54^{\circ} 27' 12''$ W, 806.50 feet to a standard FWS aluminum monument set for corner, being the southeast corner of said north one-half (1/2) of Share 26, same being the northeast corner of the south one-half (1/2) of Share 26 and stamped “Tract 672, COR. No. 2, R.P.L.S. No. 3680”; thence, in a northwesterly direction along the common line of said north and south one-half (1/2) of Share 26; N $35^{\circ} 27' 36''$ W, 463.31 feet to a standard FWS aluminum monument set for corner in the common line between Shares 26 and 27 and stamped “Tract 672, COR. No. 3, R.P.L.S. No. 3680”; thence, in a northeast direction along the common line of Shares 26 and 27; N $54^{\circ} 32' 24''$ E, 806.50 feet to a standard FWS aluminum monument set for corner, being the most northerly common corner of Shares 26 and 27 in the south line of Share 35 and stamped “Tract 672, COR. No. 4, R.P.L.S. No. 3680”; thence, in a southeasterly direction along the common line of Shares 35 and 26; S $35^{\circ} 27' 36''$ E, 462.09 feet to the point of beginning and containing 8.567 acres of land. (Cuellar Tract—Segment 673). Note: All bearings are based on the Texas State Plane

Coordinate System, South Zone, as referenced by FWS GPS Monument No. 105 having State plane coordinates (NAD 27) of N = 311,099.90, E = 1,799,824.45. The scale factor used is 0.9999252, and the theta angle is $\angle 00^{\circ} 37' 32''$. All areas and distances are true surface measurements. Beginning at a standard FWS aluminum monument set for the common north corner of Shares 26 and 27, in the south line of Share 35 and stamped "Tract 672, COR. No. 4, R.P.L.S. No. 3680" and having a state plane coordinate value of N = 319,114.02, E = 1,797,457.29, from which FWS GPS Monument No. 105 bears S $16^{\circ} 27' 21''$ E, 8,356.40 feet; thence, in a southwesterly direction along the common line of Shares 26 and 27, S $54^{\circ} 32' 24''$ N, 806.50 feet to a standard FWS aluminum monument set for corner, being the southeast corner of said north one-half (1/2) of Share 27, same being the northeast corner of the south one-half (1/2) of Share 27 and stamped "Tract 672, COR. No. 3, R.P.L.S. No. 3680"; thence, in a northwesterly direction along the common line of said north and south one-half (1/2) of Share 27; N $35^{\circ} 27' 36''$ W, 592.30 feet to a standard FWS aluminum monument set for corner in the common line between Shares 27 and 28 and stamped "Tract 674, COR. No. 3, R.P.L.S. No. 3680"; thence, in a northeasterly direction along the common line of Shares 27 and 28, N $54^{\circ} 32' 24''$ E, 806.50 feet to a standard FWS aluminum monument set for corner, being the most northerly common corner of Shares 27 and 28 in the south line of Share 34 and stamped "Tract 674, COR. No. 2, R.P.L.S. No. 3680"; thence, in a southeasterly direction along the common line of Shares 34 and 27, S $35^{\circ} 27' 36''$ E, 592.30 feet to the point of beginning and containing 10.966 acres of land. (Cuellar Tract—Segment 672). Note: All bearings are based on the Texas State Plane Coordinate System, South Zone, as referenced by FWS GPS Monument No. 105 having State plane coordinates (NAD 27) of N = 311,099.90, E = 1,799,824.45. The scale factor used is 0.9999252, and the theta angle is $\angle 00^{\circ} 37' 32''$. All areas and distances are true surface measurements. Beginning at a standard FWS aluminum monument set replacing a 1-inch iron pipe found for the common north corner of Shares 28 and 29, in the south line of Share 33 and stamped "Tract 674, COR. No. 1, R.P.L.S. No. 3680"; and having a state plane coordinate value of N = 320,078.90, E = 1,796,770.06, from which FWS GPS Monument No. 105 bears S $18^{\circ} 47' 11''$ E, 9,484.36 feet; thence, in a southeasterly direction along the common line of Share 28 and Shares 33 and 34, S $35^{\circ} 27' 36''$ E, 592.30 feet to a standard FWS aluminum monument set for corner, being the common northerly corner of Shares 28 and 27 and stamped "Tract 674, COR. No. 2, R.P.L.S. No. 3680"; thence, in a southwesterly direction along the common line of said Share 28 and 27; S $54^{\circ} 32' 24''$ W, 806.50 feet to a standard FWS aluminum monument set for the southeasterly corner of said north one-half (1/2) of Share 28, same being the northeasterly corner of the south one-half (1/2) of Share 28 and stamped "Tract 674, COR. No. 3, R.P.L.S. No. 3680"; thence, in a northwesterly direction along the common line of the north and south one-half (1/2) of Share 28, N $35^{\circ} 27' 36''$ W, 592.30 feet to a standard FWS aluminum monument set for corner in the common line between Shares 28 and 29 and stamped "Tract 674, COR. No. 4, R.P.S. No. 3680"; thence, in a northeasterly direction along the common line of Shares 28 and 29; N $54^{\circ} 32' 24''$ E, 806.50 feet to the point of beginning and containing 10.966 acres of land.

Unit 2, Chapeno Tract (28 ha; 69 ac)— (Chapeno Tract—Segment 660). Note: All bearings and distances are based on the International Boundary Commission Monuments as referenced by the U.S.C. & G.S. Triangulation Station "LABRA." The scale factor used is 0.9999252, and the theta angle is $\angle 00^{\circ} 37' 32''$ (NAD 1927). All areas shown are true ground areas. Commencing for reference at the U.S.C. & G.S. triangulation station "LABRA," having coordinate values: x = 1,794,777.75, y = 331,881.06; thence, S $02^{\circ} 08' 43''$ W, a distance of 9,020.47 feet to the northwesterly boundary line of said 44,900-acre tract for the northmost corner of said Share No. 17 and being corner No. 1 and the northernmost corner and place of beginning of the tract

herein-described; thence, along the northeasterly boundary line of Share No. 17 and the southwesterly boundary line of a 35-foot perpetual easement, S 32° 11' 36" E, 840.62 feet to the easternmost corner of said Share No. 17 and being corner No. 2 of this tract; thence, along the southeasterly boundary line of Share No. 17 and the northwesterly boundary line of Share No. 18, S 47° 29' 30" W, 293.59 feet to a said point on a fence line along the southwesterly boundary line of said 44.900-acre tract for the southernmost corner of said Share No. 17 and being corner No. 3 of this tract; thence, following said fence line along the southwesterly boundary line of Share No. 17 and the southwesterly boundary line of said 44.900-acre tract, N 30° 16' 28" W, 166.16 feet to a standard FWS aluminum monument stamped "Tract (660), R.P.S. No. 4731" set for a corner of said 44.900-acre tract and being corner No. 4 of this tract; thence, continuing along said fence line along the southwesterly boundary line of Share No. 17 and the southwesterly boundary line of said 44.900-acre tract, N 31° 04' 59" W, 684.02 feet to a standard FWS aluminum monument stamped "Tract (660), R. P. S. No. 4731" set for the westernmost corner of said 44.900-acre tract and being corner No. 5 of this tract, thence, following a fence line along the northwesterly boundary line of Share No. 17 and the northwesterly boundary line of said 44.900-acre tract, N 48° 42' 36" E, 273.46 feet to the place of beginning and containing 5.396 acres of land. (Chapeno Tract—Segment 661). Note: All bearings and distances are based on the International Boundary Commission Monuments as referenced by the U.S.C. & G.S. triangulation station "LABRA." The scale factor used is 00.9999252, and the theta angle is $\angle 00^{\circ} 37' 32"$ (NAD 1927). All areas shown are true ground areas. Commencing for reference at the U.S.C. & G.S. triangulation station "LABRA," having coordinate values: $x = 1,794,777.75$, $y = 331,881.06$; thence, S 00° 48' 20" E, a distance of 9,702.45 feet to the northernmost corner of said Share No. 18 and being corner No. 1 and the northernmost corner and place of beginning of the tract herein-described; thence, along the northeasterly boundary line of Share No. 18 and the southwesterly boundary line of Share No. 19, S 42° 40' 05" E, 623.01 feet to a point on a fence line along the southeasterly boundary line of said 44.900-acre tract for the easternmost corner of said Share No. 18 and being corner No. 2 of this tract; thence, following said fence line along the southeasterly boundary line of Share No. 18 and the southeasterly boundary line of said 44.900-acre tract, S 54° 58' 43" W, 14.82 feet to a standard FWS aluminum monument stamped "Tract (661), R. P. S. No. 4731" set for a corner of said 44.900-acre tract and being corner No. 3 of this tract; thence, continuing along said fence line along the southeasterly boundary line of Share No. 18 and the southeasterly boundary line of said 44.900-acre tract, S 54° 17' 40" W, 442.61 feet to a standard FWS aluminum monument stamped "Tract (661), R. P. S. No. 4731" set for the southernmost corner of said 44.900-acre tract and being corner No. 4 of this tract; thence, following a fence line along the southwesterly boundary line of Share No. 18 and the southwesterly boundary line of said 44.900-acre tract, N 30° 16' 28" W, 581.86 feet to a point for the westernmost corner of said Share No. 18 and being corner No. 5 of this tract; thence, along the southeasterly boundary line of Share No. 17 and the northwesterly boundary line of Share No. 18, N 47° 29' 30" E, 329.16 feet to the place of beginning and containing 5.396 acres of land. (Chapeno Tract—Segment 662). Note: All bearings and distances are based on the International Boundary Commission Monuments as referenced by the U.S.C. & G.S. triangulation station "LABRA." The scale factor used is 00.9999252, and the theta angle is $\angle 00^{\circ} 37' 32"$ (NAD 1927). All areas shown are true ground areas. Commencing for reference at the U.S.C. & G.S. triangulation station "LABRA," having coordinate values: $x = 1,794,777.75$, $y = 331,881.06$; thence, S 00° 53' 22" E, a distance of 9,308.09 feet to the northernmost corner of said Share No. 19 and being corner No. 1 and the northernmost corner and the place of beginning of the tract herein-described; thence, along the northeasterly boundary line of Share No. 19 and the southwesterly boundary line of Share No. 20, S 41° 14' 45" E, 941.54 feet to a point on a fence line along the

southeasterly boundary line of said 44.900-acre tract for the easternmost corner of said Share No. 19 and being corner No. 2 of this tract; thence, following said fence line along the southeasterly boundary line of Share No. 19 and the southeasterly boundary line of said 44.900-acre tract, S 55° 22' 51" W, 8.49 feet to a standard FWS aluminum monument stamped "Tract (662), R. P. S. No. 4731" set for a corner of said 44.900-acre tract and being corner No. 3 of this tract; thence, continuing along said fence line along the southeasterly boundary line of Share No. 19 and the southeasterly boundary line of said 44.900-acre tract, S 54° 58' 43" W, 243.72 feet to the southernmost corner of Share No. 19 and being corner No. 4 of this tract; thence, along the northeasterly boundary line of Share No. 18 and the southwesterly boundary line of Share No. 19, N 42° 40' 05" W, 623.01 feet to a corner of Share No. 19 and being corner No. 5 of this tract; thence, along the northeasterly boundary line of a 35-foot perpetual easement and the southwesterly boundary line of Share No. 19, N 32° 08' 41" W, 293.64 feet to the westernmost corner of said Share No. 19 and being corner No. 6 of this tract; thence, along the southeasterly boundary line of a 35-ft. perpetual easement and the northwesterly boundary line of Share No. 19, N 48° 23' 35" E, 219.73 feet to the place of beginning and containing 5.396 acres of land. (Chapeno Tract—Segment 663). Note: All bearings and distances are based on the International Boundary Commission Monuments as referenced by the U.S.C. & G.S. triangulation station "LABRA." The scale factor used is 00.9999252, and the theta angle is 00° 37' 32" (NAD 1927). All areas shown are true ground areas. Commencing for reference at the U. S. C. & G. S. triangulation station "LABRA," having coordinate values: x = 1,794,777.75, y = 331,881.06; thence, S 01° 55' 50" E, a distance of 9,166.26 feet to the northernmost corner of said share No 20, and being corner No. 1, and the northernmost corner and place of beginning of the tract herein-described; thence, along the northeasterly boundary line of Share No. 20 and the southwesterly boundary line of Share No. 21, S 44° 17' 45" E, 975.87 feet to a point on a fence line along the southeasterly boundary line of said 44.900-acre tract for the easternmost corner of said Share No. 20 and being corner No. 2 of this tract; thence, following said fence line along the southeasterly boundary line of Share No. 20 and the southeasterly boundary line of said 44.900-acre tract; S 55° 22' 51" W, 273.48 feet to the southernmost corner of Share No. 20 and being corner No. 3 of this tract; thence, along the northeasterly boundary line of Share No. 19 and the southwesterly boundary line of Share No. 20, N 41° 14' 45" W, 941.54 feet to the westernmost corner of Share No. 20 and being corner No. 4 of this tract; thence, along the southeasterly boundary line of a 35-ft. perpetual easement and the northwesterly boundary line of Share No. 20, N 48° 23' 35" E, 219.73 feet to the place of beginning and containing 5.396 acres of land. (Chapeno Tract—Segment 664). Note: All bearings and distances are based on the International Boundary Commission Monuments as referenced by the U.S.C. & G.S. triangulation station "LABRA." The scale factor used is 00.9999252, and the theta angle is 00° 37' 32" (NAD 1927). All areas shown are true ground areas. Commencing for reference at the U.S.C. & G.S. triangulation station "LABRA," having coordinate values: x = 1,794,777.75, y = 331,881.06; thence, S 03° 00' 15" E, a distance of 9,027.56 feet to the northernmost corner of said Share No. 21 and being corner No. 1 and the northernmost corner and place of beginning of the tract herein-described; thence, along the northeasterly boundary line of Share No. 21 and the southwesterly boundary line of Share No 22, S 46° 18' 57" E, 1,008.60 feet to a point on a fence line along the southeasterly boundary line of said 44.900-acre tract for the easternmost corner of Share No. 21 and being corner No. 2 of this tract; thence, following said fence line along the southeasterly boundary line of Share No. 21 and the southeasterly boundary line of said 44.900-acre tract, S 54° 17' 59" W, 56.04 feet to a standard FWS aluminum monument stamped "Tract (664), R. P. S. No. 4731" set for a corner of said 44.900-acre tract and being corner No. 3 of this tract; thence, continuing along said fence line along the southeasterly boundary line of Share No. 21 and the

southeasterly boundary line of said 44.900-acre tract, S 55° 22' 51" W, 202.51 feet to the southernmost corner of Share No. 21 and being corner No. 4 of this tract; thence, along the northeasterly boundary line of Share No. 20 and the southwesterly boundary line of Share No. 21, N 44° 17' 45" W, 975.87 feet to the westernmost corner of Share No. 21 and being corner No. 5 of this tract; thence, along the southeasterly boundary line of a 35-foot perpetual easement and the northwesterly boundary line of Share No. 21, N 48° 23' 35" E, 219.73 feet to the place of beginning and containing 5.396 acres of land. (Chapeno Tract—Segment 665). Note: All bearings and distances are based on the International Boundary Commission Monuments as referenced by the U.S.C. & G.S. Triangulation station "LABRA." The scale factor used is 00.9999252, and the theta angle is $\angle 00^{\circ} 37' 32"$ (NAD 1927). All areas shown are true ground areas. Commencing for reference at the U.S.C. & G.S. Triangulation station "LABRA," having coordinate values: $x = 1794,777.75$, $y = 331,881.06$; thence, S 04° 06' 38" E, a distance of 8,892.12 feet to the northernmost corner of said Share No. 22 and being corner No. 1 and the northernmost corner and place of beginning of the tract herein-described; thence, following a fence line along the northeasterly boundary line of Share No. 22 and the southwesterly boundary line of Share No. 23, S 47° 33' 31" E, 1,036.06 feet to a point on a fence line along the southeasterly boundary line of said 44.900-acre tract for the easternmost corner of said Share No. 22 and being corner No. 2 of this tract; thence, following said fence line along the southeasterly boundary line of Share No. 22 and the southeasterly boundary line of said 44.900-acre tract, S 54° 17' 59" W, 245.67 feet to the southernmost corner of Share No. 22 and being corner No. 3 of this tract; thence, along the northeasterly boundary line of Share No. 21 and the southwesterly boundary line of Share No. 22, N 46° 18' 57" W, 1,008.60 feet to the westernmost corner of Share No. 22 and being corner No. 4 of this tract; thence, along the southeasterly boundary line of a 35-foot perpetual easement and the northwesterly boundary line of Share No. 22, N 48° 23' 35" E, 219.73 feet to the place of beginning and containing 5.396 acres of land. (Chapeno Tract—Segment 666). Note: All bearings and distances are based on the International Boundary Commission Monuments as referenced by the U.S.C. & G.S. triangulation station "LABRA." The scale factor used is 00.9999252, and the theta angle is $\angle 00^{\circ} 37' 32"$ (NAD 1927). All areas shown are true ground areas. Commencing for reference at the U.S.C. & G.S. Triangulation station "LABRA," having coordinate values: $x = 1,794,777.75$, $y = 331,881.06$; thence, S 05° 15' 03" E, a distance of 8,710.10 feet to the northernmost corner of said Share No. 23 and being corner No. 1 and the northernmost corner and place of beginning of the tract herein-described; thence, following a fence line along the northeasterly boundary line of Share No. 23 and the southwesterly boundary line of said Share No. 24, S 48° 10' 23" E, 1,061.62 feet to a point on a fence line along the southeasterly boundary line of said 44.900-acre tract for the easternmost corner of Share No. 23 and being corner No. 2 of this tract; thence, following said fence line along the southeasterly boundary line of Share No. 23 and the southeasterly boundary line of said 44.900-acre tract, S 54° 17' 59" W, 234.95 feet to the southernmost corner of Share No. 23 and being corner No. 3 of this tract; thence, along the northeasterly boundary line of Share No. 22 and the southwesterly boundary line of Share No. 23, N 47° 33' 31" W, 1,036.06 feet to the westernmost corner of Share No. 23 and being corner No. 4 of this tract; thence, along the southeasterly boundary line of a 35-ft. perpetual easement and the northwesterly boundary line of Share No. 23, N 48° 23' 35" E, 219.73 feet to the place of beginning and containing 5.396 acres of land. (Chapeno Tract—Segment 667). Note: All bearings and distances are based on the International Boundary Commission Monuments as referenced by the U.S.C. & G.S. Triangulation station "LABRA." The scale factor used is 00.9999252, and the theta angle is $\angle 00^{\circ} 37' 32"$ (NAD 1927). All areas shown are true ground areas. Commencing for reference at the U.S.C. & G.S. Triangulation station "LABRA," having coordinate values: $x = 1,794,777.75$, $y = 331,881.06$; thence, S 06° 25' 32" E, a

distance of 8,631.65 feet to the northeasterly boundary line of said 44.900-acre tract for corner No. 1 and the place of beginning of the tract herein-described; thence, following a fence line along the northeasterly boundary line of share No. 24 and the northeasterly boundary line of said 44.900-acre tract, S 51° 42' 47" E, 679.97 feet to a standard FWS aluminum monument stamped "Tract (667), R. P. S. No. 4731" set for a corner of said 44.900-acre tract and being corner No. 2 of this tract; thence, continuing along the fence line along the northeasterly boundary line of Share No. 24 and the northeasterly boundary line of said 44.900-acre tract, S 01° 11' 48" E, 136.46 feet to a standard FWS aluminum monument stamped "Tract (667), R. P. S. No. 4731" set for a corner of said 44.900-acre tract and being corner No. 3 of this tract; thence, continuing along the fence line along the northeasterly boundary line of Share No. 24 and the northeasterly boundary line of said 44.900-acre tract, S 54° 15' 17" E, 309.21 feet to a standard FWS aluminum monument stamped "Tract (667), R. P. S. No. 4731" set on a fence line for the easternmost corner of Share No. 24 and being on the southeasterly boundary line of said 44.900-acre tract and being corner No. 4 of this tract; thence, following said fence line along the southeasterly boundary line of share No. 24 and the southeasterly boundary line of said 44.900-acre tract, S 54° 17' 59" W, 197.94 feet to the southernmost corner of Share No. 24 and being corner No. 5 of this tract; thence, following said fence line along the southwesterly boundary line of Share No. 24 and the northeasterly boundary line of Share No. 23, N 48° 10' 23" W, 1,061.62 feet to the westernmost corner of Share No. 24 and northernmost corner of Share No. 23 and being corner No. 6 of this tract; thence, along the southeasterly boundary line of a 35-ft. perpetual easement and the northwesterly boundary line of Share No. 24, N 48° 23' 35" E, 219.73 feet to the place of beginning and containing 5.396 acres of land.

Unit 3, Arroyo Morteros Tract (41 ha; 102 ac)—Note: All bearings are based on the Texas State Plane Coordinate System, South Zone, (NAD 27), as referenced by FWS GPS Monument No. 105 having State plane coordinates of N = 311,099.90, E = 1,799,824.45. The scale factor used is 0.9999252, and the theta angle is $\pm 00^{\circ} 37' 32''$. All areas and distances are true surface measurements. Beginning at a 1/2-inch iron rod found for corner No. 1 on the common line between Porcions 59 and 60, and being the northwest corner of that certain 127.71-acre tract and having a State plane coordinate value of N = 315,746.07, E = 1,793,538.58, from which FWS GPS monument No. 105 bears S 53° 31' 49" E, 7,816.59 feet; thence, in a northeasterly direction along the common line of Porcion 59 and 60; N 54° 27' 12" E, 510.43 feet to a standard FWS aluminum monument set for corner replacing a 1/2-inch iron rod found, being the northwest corner of the herein described tract and stamped "Tract 670, Cor. No. 2, R. P. L. S. No. 3680"; thence, in a easterly direction through the interior of said 536.485 acre tract; S 35° 20' 27" E, 3,621.01 feet to a standard FWS aluminum monument set for corner replacing a 1/2-inch iron rod found, being the northeast corner of the herein-described tract and stamped "Tract 670, Cor. No. 3, R.P.L.S. No. 3680"; thence, in a southerly direction continuing through the interior of said 536.485 acre tract; S 61° 18' 54" W, 219.24 feet to a fence corner post found for a northwesterly corner of that certain 17.408 acre tract and being corner No. 4; thence, in a easterly direction along the common line between said 17.408 acre tract and the herein described tract; S 88° 47' 16" W, 110.41 feet to a fence post found for angle point and corner No. 5; thence, in a easterly direction continuing along said common line between a 17.408 acre tract and herein described tract; N 79° 11' 33" W, 67.63 feet to a fence post found for angle point and corner No. 6; thence, in a easterly direction continuing along said common line between a 17.408 acre tract and herein described tract; S 71° 49' 04" W, 50.57 feet to a fence post found for angle point and corner No. 7; thence, in a southerly direction continuing along said common line between a 17.408 acre tract and herein described tract; S 15° 40' 49" W, 44.43 feet to a fence post found for angle point

and corner No. 8; thence, in a southerly direction continuing along said common line between a 17.408 acre tract and herein described tract; S 00° 18' 59" E, 253.83 feet to a fence post found for angle point and corner No. 9; thence, in a southerly direction continuing along said common line between a 17.408 acre tract and herein described tract; S 06° 36' 21" W, 182.88 feet to a fence post found for angle point and corner No. 10; thence, in a southerly direction continuing along said common line between a 17.408 acre tract and herein described tract; S 26° 38' 19" W, 125.18 feet to a fence post found for angle point and corner No. 11; thence, in a southerly direction continuing along said common line between a 17.408 acre tract and herein described tract; S 67° 33' 26" W, 129.76 feet to a fence post found for angle point and corner No. 12; thence, in a southerly direction continuing along said common line between a 17.408-acre tract and herein described tract; S 45° 58' 19" W, 73.00 feet to a fence post found for angle point and corner No. 13; thence, in a southerly direction continuing along said common line between a 17.408 acre tract and herein described tract; S 35° 10' 19" W, 113.60 feet to a fence post found for angle point and corner No. 14; thence, in a southerly direction continuing along said common line between a 17.408 acre tract and herein described tract; S 19° 34' 19" W, 42.80 feet to a fence post found for angle point and corner No. 15; thence, in a southerly direction continuing along said common line between a 17.408-acre tract and herein described tract; S 15° 23' 41" W, 28.84 feet to a 1/2-inch iron rod found on the apparent gradient boundary of the Rio Grande for the southeast corner hereof and corner No. 16; thence, in a westerly direction along said apparent gradient boundary of the Rio Grande; N 62° 26' 09" W, 81.47 feet to a point on said apparent gradient boundary of the Rio Grande for corner No. 7; thence, in a northwesterly direction continuing along said apparent gradient boundary of the Rio Grande; N 36° 34' 14" W, 122.63 feet to a point on said apparent gradient boundary of the Rio Grande for corner No. 18; thence, in a northerly direction continuing along said apparent gradient boundary of the Rio Grande; N 20° 15' 10" W, 58.91 feet to a point on said apparent gradient boundary of the Rio Grande for corner No. 19; thence, in a northwesterly direction continuing along said apparent gradient boundary of the Rio Grande; N 34° 02' 20" W, 118.95 feet to a point on said apparent gradient boundary of the Rio Grande for Corner No. 20; thence, in a westerly direction continuing along said apparent gradient boundary of the Rio Grande; S 73° 36' 56" W, 17.73 feet to a point on said apparent gradient boundary of the Rio Grande for corner No. 21; thence, in a northwesterly direction continuing along said apparent gradient boundary of the Rio Grande; N 43° 36' 30" W, 118.21 feet to a point on said apparent gradient boundary of the Rio Grande corner No. 22; thence, in a northerly direction continuing along said apparent gradient boundary of the Rio Grande; N 28° 12' 58" W, 168.21 feet to a point on said apparent gradient boundary of the Rio Grande for corner No. 23; thence, in a northwesterly direction continuing along said apparent gradient boundary of the Rio Grande; N 49° 09' 29" W, 149.82 feet to a point on said apparent gradient boundary of the Rio Grande for corner No. 24; thence, in a westerly direction continuing along said apparent gradient boundary of the Rio Grande; N 66° 23' 26" W, 123.27 feet to a point on said apparent gradient boundary of the Rio Grande for corner No. 25; thence, in a westerly direction continuing along said apparent gradient boundary of the Rio Grande; N 77° 18' 49" W, 240.49 feet to a point on said apparent gradient boundary of the Rio Grande for corner No. 26; thence, in a westerly direction continuing along said apparent gradient boundary of the Rio Grande; S 80° 06' 32" W, 129.98 feet to a point on said apparent gradient boundary of the Rio Grande for corner No. 27; thence, in a westerly direction continuing along said apparent gradient boundary of the Rio Grande; N 79° 54' 48" W, 218.17 feet to a point on said apparent gradient boundary of the Rio Grande for corner No. 28; thence, in a westerly direction continuing along said apparent gradient boundary of the Rio Grande; S 81° 13' 28" W, 136.03 feet to a 1/2-inch iron rod found on said apparent gradient boundary of the Rio Grande for the southeast

corner of the aforementioned 127.71 acre tract, same being the southwest corner hereof and corner No. 29; thence, in a northerly direction along the common line between said 127.71-acre tract and the herein described tract; N 06° 09' 33? W, 237.00 feet to a fence post found for angle point and corner No. 30; thence, in a northerly direction continuing along the common line between said 127.71-acre tract and the herein described tract; N 05° 51' 34? W, 198.49 feet to a fence post found for angle point and corner No. 31; thence, in a Northerly direction continuing along the common line between said 127.71-acre tract and the herein described tract; N 07° 49' 27? E, 161.97 feet to a fence post found for angle point and corner No. 32; thence, in a Northerly direction continuing along the common line between said 127.71-acre tract and the herein described tract; N 07° 47' 00? E, 302.39 feet to a fence post found for angle point and corner No. 33; thence, in a northerly direction continuing along the common line between said 127.71 acre tract and the herein described tract; N 07° 17' 37? E, 493.82 feet to a fence post found for angle point and corner No. 34; thence, in a northeasterly direction continuing along the common line between said 127.71-acre tract and the herein described tract, as fenced; N 46° 28' 41? E, 643.50 feet to a fence post found for angle point and corner No. 35; thence, in a northwesterly direction continuing along the common line between said 127.71 acre tract and the herein described tract; N 47° 51' 47? W, 1,087.49 feet to a fence post found for angle point and corner No. 36; thence, in a northerly direction continuing along the common line between said 127.71-acre tract and the herein described tract; N 21° 22' 25? W, 375.05 feet to the point of beginning and containing 89.90 acres of land.

Unit 4, Las Ruinas Tract (104 ha; 256 ac)—Note: All bearings are based on the Texas State Plane Coordinate System, South Zone, as referenced by National Geodetic Survey (NGS.) Triangulation Station “GORGORA” having State plane coordinates (NAD 27) of N = 275,335.73, E = 1,833,217.01. The scale factor used is 0.9999421, and the theta angle is -00° 16' 22?. All areas and distances are true surface measurements. Beginning at a 2- inch iron pipe having State plane coordinates of N = 280,488.40, E = 1,804,584.01 for the northerly southeast corner of the herein described tract, from which said triangulation station “GORGORA” bears S 79° 47' 55? E, a distance of 29,092.93 feet, same being the southwest corner of Share 96, of said Porcion 66, and the southwest corner of a 1455.52-acre tract of land as described, same being in the north line of Share 94, of said Porcion 66, same being in the north line of Tract “K”, a 26.82-acre tract of land as described, for corner No. 1 and point of beginning of the herein described tract of land. Thence, westerly along the common line between said northerly line of tract “K” and the southerly line hereof N 80° 30' 29? W, 871.09 feet to a 6? iron pipe found for corner No. 2, same being the northwest corner of said Tract “K”; thence, southerly along the common line between the westerly line of said Tract “K” and the easterly line hereof S 09° 22' 35? W, 837.18 feet, to a 13/4? iron pipe found for the southwest corner of said tract “K” and the northwest corner of a 23.5131-acre tract of land at corner No. 3, thence, southerly along the common line between said 23.5131-acre tract and the most southerly easterly line hereof, S 09° 22' 35? W, 540.00 feet to a standard FWS aluminum monument set, said monument being in the north line of a 56.82-acre tract of land as described for corner No. 4 and stamped “Tract 630, Ref. No. 4, RPLS 3680”; thence, westerly along the common northerly line between said 56.82 acre tract and the southerly line hereof, N 80° 31' 16? W, 3295.18 feet to the apparent gradient boundary of the Rio Grande, and passing a standard FWS aluminum monument set for reference at a distance of 3,210.08 feet and stamped “Tract 630, Ref. No. 5, RPLS 3680”; thence, northerly along the apparent gradient boundary of the Rio Grande N 63° 00' 17? E, 192.97 feet to a point on the apparent gradient boundary of the Rio Grande for Corner No. 6; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 62° 39' 49? E, 398.99 feet to a point

on the apparent gradient boundary of the Rio Grande for Corner No. 7; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 60° 14' 39" E, 722.34 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 8; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 57° 28' 43" E, 416.75 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 9; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 57° 55' 40" E, 171.44 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 10; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 47° 49' 48" E, 287.44 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 11; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 43° 00' 00" E, 246.79 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 12; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 39° 40' 14" E, 295.08 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 13; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 35° 41' 43" E, 380.79 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 14; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 31° 28' 24" E, 370.58 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 15; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 33° 19' 15" E, 293.00 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 16; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 13° 43' 08" E, 146.31 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 17; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 11° 00' 57" E, 189.14 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 18; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 02° 10' 54" W, 305.51 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 19; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 01° 31' 51" W, 416.25 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 20; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 00° 01' 29" W, 441.45 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 21; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 03° 29' 26" E, 405.03 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 22; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 08° 08' 02" E, 308.09 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 23; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 39° 03' 01" E, 218.95 feet to a point on the apparent gradient boundary line of the Rio Grande, for corner No. 24 and northwest corner of this tract, same being the southwest corner of a 60.77-acre tract of land; thence, easterly along the common line between the south line of said 60.77- acre tract and the northerly line hereof S 80° 31' 16" E, 1942.92 feet to a standard FWS aluminum monument set and stamped "Tract 630, Ref. No. 25, RPLS 3680" for corner No. 25, same being the southeast corner of said 60.77- acre tract, same being in the west line of Share 339 of said Porcion 66, same being in the west line of said 1,455.52- acre tract of land, and passing a standard FWS aluminum monument set for Reference at a distance of 38.95 feet and stamped "Tract 630, Ref. No. 24, RPLS 3680"; thence, southerly along the common line between the west line of said Share 339, Share 319, Share 227, Share 231, Share 230, Share 229, Share 518, Share 226, Share 225, Share 224, and said Share 96, same being the west line of said 1,455.52-acre tract and the east line hereof S 09° 28' 44" W, 3,845.12 feet and passing a 2-inch iron pipe found for the southwest corner of Share 339, same being the northwest corner of Share

319 at a distance of 315.48 feet, and being 0.46 feet easterly of and perpendicular to this line, and also passing a 1-1/2 inch iron pipe found for the southwest corner of Share 319, same being the northwest corner of Share 227 at a distance of 711.48 feet, and being 0.39 feet easterly of and perpendicular to this line, and also passing a 2-inch iron pipe found for the southwest corner of Share 231, same being the northwest corner of Share 230 at a distance of 1,320.71 feet, and being 0.09 feet easterly of and perpendicular to this line, to the point of beginning of the herein described tract and containing 254.42 acres of land.

Unit 5, Arroyo Ramirez Tract (273 ha; 675 ac)—Formal surveying of the tract has not been performed. Described as, “All of Share 79, Porcion 68, Abstract 191, Former Jurisdiction of Mier, Mexico, now Starr County, Texas, and all of Share 166, Porcion 69, Abstract No. 160, Former Jurisdiction of Mier, Mexico, now Starr County, Texas. Description by approximated latitude/longitude coordinates (attached maps): Beginning at Latitude/Longitude 26° 24' 00.9" N/099° 03' 23.9" W, westward to Latitude/Longitude 026° 24' 04.7" N/ 099° 03' 46.5" W, northward to Lat/Long 026° 24' 25.2" N/099° 03' 43.3" W, westward to Lat/Long 026° 24' 26.0" N/ 099° 03' 49.8" W, northward to Lat/Long 026° 25' 05.5" N/099° 03' 42.6" W, eastward to Lat/Long 026° 24' 56.6" N/ 099° 02' 40.3" W to the apparent gradient boundary of the Rio Grande River.

Unit 6, Los Negros Creek Tract (47 ha; 116 ac)—The following described tract of land is located in Starr County, Texas, about 1 mile northwest of the town of Roma, being 111.67 acres out of Share 13, Porcion 70, and being more particularly described as follows: Beginning at Cor. No. 1, an iron pin set for the northeast corner of Share No. 13 of Porcion No. 70 ; thence, along an old fence line and the dividing line between Share Nos. 13, 1-B and 12-A, S 09° 15' W, 2,694.00 feet to Cor. No. 2 an iron pin set on the Old High Bank of the Rio Grande and the southeast corner of this tract; thence leaving said fence line and along said Old High Bank with the following two courses, N 63° 17' 27" W, 1,161.54 feet to Cor. No. 3 and N 87° 10' 00" W, 612.00 feet to Cor. No. 4, a set iron pin and the southwest corner of this tract; thence leaving said Old High Bank and along the dividing line of Tract 2 and 3 of said Share 13 and an old fence line with the following three courses, N 09° 15' E, 841.30 feet to Cor. No. 5, a set iron pin; N 80° 45' W, 397.50 feet to Cor. No. 6, a set iron pin; and N 09° 15' E, 1,572.60 feet to Cor. No. 7 & iron pin set for the northwest corner of this tract; thence leaving said dividing line and along the north line of this tract and an old fence line, S 80° 45' E, 2,113.70 feet to Cor. No. 1 and the true place of beginning, containing 111.67 acres of land bounded on the West, North, and East by lands of unknown owner and on the South by the Rio Grande.

Unit 7, La Puerta Tract (1,577 ha; 3,895 ac) (Segment 590). Note: All bearings and distances are based on the Texas State Plane Coordinate System, South Zone, as referenced by National Geodetic Survey (NGS) triangulation station “Fordyce 2” and NGS triangulation station “Monument”. Scale factor used was 0.99993949; theta angle used was 00° 06' 15". All areas are true ground measured areas. Beginning at corner No. 1, a standard U.S. Fish and Wildlife Service (FWS) aluminum monument stamped “TR 590 COR 1” set in the west boundary of Porcion 86, said point being at the southwest corner of the aforementioned 8,061-acre tract, and also being the northeast corner of a 160-acre tract recorded in volume 60, pages 47–48, Deed Records, Starr County, Texas, from which NGS triangulation station “Monument” bears N. 68° 59' 27" W, 8,477.20 feet; thence, from corner No. 1, along the western boundary line of said 8,061-acre tract and Porcion 86, N 09° 02' 27" E, 25,125.17 feet to corner No. 2, a standard FWS aluminum monument stamped “TR 590 COR 2”, set at a fence corner from which NGS triangulation station “Monument” bears S 28° 34' 49" W, 24,795.18 feet; said corner No. 2 also being the northwest

corner of the herein described tract, thence, from corner No. 2, departing said western boundary line, with fence, S. 78° 52' 36" E, 1,889.04 feet, to corner No. 3, a standard FWS aluminum monument stamped "TR 590 COR 3" set at fence corner; thence, from corner No. 3, continuing with fence, N 06° 16' 07" E, 1,007.99 feet to corner No. 4, a standard FWS aluminum monument stamped "TR 590 COR 4" set at fence corner; thence, from corner No. 4, continuing with fence, S 78° 42' 12" E, 2,691.33 feet to corner No. 5, a standard FWS aluminum monument stamped "TR 590 COR 5" set for angle; thence from corner No. 5, continuing with fence, S 72° 35' 38" E, 2,000.57 feet to corner No. 6, a standard FWS aluminum monument stamped "TR 590 COR 6" set at fence corner, said point being a perpendicular distance of 20.20 feet from the eastern boundary line of Porcion 87, said point also being the Northeast corner of the herein described tract; thence, from corner No. 6, continuing with fence, S 09° 01' 08" W, 10,831.38 feet to corner No. 7, a standard FWS aluminum monument stamped "TR 590 COR 7" set for angle adjacent to a found 5/8-inch iron pin; thence, from corner No. 7, continuing with fence, S 08° 56' 57" W, 10,030.04 feet, to corner No. 8, a standard FWS aluminum monument stamped "TR 590 COR 8" set for angle point, said point being at the intersection of said fence with the east boundary line of Porcion 87; thence, from corner No. 8, departing said fence, along the east boundary line of Porcion 87, S 09° 02' 27" W, 4,824.69 feet to corner No. 9, a standard FWS aluminum monument stamped "TR 590 COR 9" set for corner; thence, from corner No. 9, departing said east line, N 80° 47' 09" W, 6,527.80 feet to the place of beginning and containing 3,844.674 acres. (La Puerta 590a). Note: All bearings and distances are based on the Texas State Plane Coordinate System, South Zone, (NAD 27), as referenced by the National Geodetic Survey (NGS) Triangulation Station "Monument" having a coordinate value of N = 250,167.56; E = 1,912,489.81. Scale factor applied equals 0.99993949; theta angle equals $\pm 00^{\circ} 06' 15"$. All areas are based on true ground measurements. Beginning at corner No. 1, a standard FWS aluminum monument stamped "TR 590A COR 1" set over a 2-inch iron pipe found in the west boundary line of Porcion 87, east boundary line of Porcion 86, at the northwest corner of said Lot 22, also being the northeast corner of a 2.83-acre tract as described by deed recorded in Volume 516, Page 62, Official Records, Starr County, Texas and being in the south boundary line of USA Tract (590) as described by deed recorded in Volume 608, Page 309, Official Records, Starr County, Texas said point having a coordinate value of N = 246,550.96; E = 1,923,962.74 and bearing S 72° 30' 13" E, 12,029.47 feet from NGS Triangulation Station "Monument"; thence from corner No. 1, with south boundary line of said USA Tract (590), the north boundary line of said Lot 22, S 80° 47' 09" E, 2,922.00 feet to corner No. 2, a standard FWS aluminum monument stamped "TR 590 COR 9" found at the southeast corner of said USA Tract (590), also being the northeast corner of said Lot 21, and being in the east boundary line of Porcion 87, west boundary line of Porcion 88 for the northeast corner of the herein-described tract of land; thence, from Corner No. 2, with the said east boundary line of Porcion 87, west boundary line of Porcion 88, and also being the east boundary line of said Lot 21, S 08° 18' 30" W, 1,130.60 feet to corner No. 3, a standard FWS aluminum monument stamped "TR 590A COR 3" set in the existing north right-of-way line of U.S. Highway 83 with the intersection of said east boundary line of Porcion 87, west boundary line of Porcion 88 for the southeast corner of the herein described tract of land; thence, from corner No. 3, with and along the said existing north right-ofway line of U.S. Highway 83, N 66° 14' 23" W, 18.20 feet to corner No. 4, a standard FWS aluminum monument stamped "TR 590A COR 4" set for an angle point; thence, from corner No. 4, continuing along said existing north right-of-way line, N 60° 31' 23" W, 100.39 feet to corner No. 5, a standard FWS aluminum monument stamped "TR 590A COR 5" set for an angle point; thence, from corner 5, continuing along said existing north right-of-way line, N 66° 14' 23" W, 499.97 feet to corner No. 6, a standard FWS aluminum monument stamped "TR 590A COR 6" set for an angle point; thence, from corner No.

6, continuing along said existing north right-of-way line, N 71° 57' 23? W, 100.39 feet to a corner No. 7, a standard FWS aluminum monument stamped "TR 590A COR 7" set for an angle point; thence, from corner No. 7, continuing along said existing north right-of-way line, N 66° 14' 14? W, 1,084.94 feet to corner No. 8, a 5/8-inch iron rod found at the intersection of the said existing north right-of-way line with the proposed north right-of-way line of U.S. Highway 83; thence, from corner No. 8, departing said existing north right-of-way line with and along the proposed north right-of-way line of U.S. Highway 83, N 60° 43' 04? W, 200.90 feet to corner No. 9, a 5/8-inch iron rod found for an angle point; thence, from corner No. 9, continuing along said proposed north right-of-way line, N 69° 54' 31? W, 300.83 feet to corner No. 10, a 5/8-inch iron rod found at the intersection of said proposed north right-of-way line with the existing north right-of-way line of U.S. Highway 83; thence, from corner No. 10, with the said existing north right-of-way line of U.S. Highway 83, N 66° 16' 51? W, 399.70 feet to corner No. 11, a standard FWS aluminum monument stamped "TR 590A COR 11" set over a 1/2-inch iron rod found for an angle point; thence, from corner No. 11, continuing along said existing North right-of-way line, N 64° 31' 54? W, 335.45 feet to corner No. 12, a standard FWS aluminum monument stamped "TR 590A COR 12" set at the intersection of said existing north right-of-way line with the west boundary line of Porcion 87, east boundary line of Porcion 86; thence, from corner No. 12, departing said existing north right-of-way line with the said west boundary line of Porcion 87, east boundary line of Porcion 86, N 08° 56' 59? E, 357.90 feet to corner No. 1, the point of beginning and containing 50.033 acres of land. (La Puerta Tract—Segment 590b). Note: All bearings and distances are based on the Texas State Plane Coordinate System, South Zone, (NAD 27), as referenced by the National Geodetic Survey (NGS) Triangulation Station "Monument" having a coordinate value of N = 250,167.56' E = 1,912,489.81. Scale factor applied equals 0.00003040; theta angle equals 00° 06' 15?. All areas are based on true ground measurements. Beginning at corner No. 1, a 5/8-inch iron rod found at the intersection of the west boundary line of Porcion 87, east boundary line of Porcion 86 with the proposed south right-of-way line of U.S. Highway 83, said point bears S 08° 57' 33? W, 139.55 feet from a 5/8-inch iron rod found in the existing south right-of-way line of U.S. Highway 83, said point having a coordinate value of N = 245,880.85, E = 1,923,857.21 and bearing S 69° 20' 18? E, 12,148.81 feet from NGS Triangulation Station "Monument"; thence, from corner No. 1, with the said proposed south right-of-way line, S 66° 14' 23? E, 3,043.33 feet to corner No. 2, a 5/8-inch iron rod found at the intersection of the east boundary line of Porcion 87, the west boundary line of Porcion 88 and the said proposed south right-of-way line, thence, from corner No. 2, with the said east boundary line of Porcion 87, west boundary line of Porcion 88, S 08° 59' 29? W, 2,925.70 feet to corner No. 3, a standard FWS aluminum monument stamped "TR 590B COR 3" set over a 1/2-inch iron rod found at the intersection of said east boundary line of Porcion 87, west boundary line of Porcion 88 with the north right-of-way line of the Missouri-Pacific Railroad; thence, from corner No. 3, with the said north right-of-way line of the Missouri-Pacific Railroad, N 52° 58' 07? W, 3,333.49 feet to corner No. 4, a standard FWS aluminum monument stamped "TR 590B COR 4" set over a 3/8-inch iron rod found at the intersection of the said north right-of-way line with the said west boundary line of Porcion 87, the east boundary line of Porcion 86, said point also being the southeast corner of a 39.492-acre tract, thence from corner No. 4, with the said west boundary line of Porcion 87, east boundary line of Porcion 86, N 08° 56' 13? E, 1,715.55 feet to corner No. 5, a standard FWS aluminum monument stamped "TR 590B COR 5" set over a 1/2-inch iron rod found at the southeast corner of a 2.0-acre tract, thence, from corner No. 5, continuing along said west boundary line of Porcion 87, east boundary line of Porcion 86, N 09° 08' 05? E, 418.93 feet to corner No. 1, the point of beginning and containing 170.950 acres of land.

Unit 8-Private ranch site comprises 0.552 hectares (1.36 acres) within the Universal Transverse Mercator, Zone 14 and begins at UTM 490706 E, 2929709 N; thence to 490729 E, 2929706 N; to 490748 E, 2929720 N; to 490762 E, 2929722 N; to 490767 E, 2929704 N; to 490767 E, 2929679 N; to 490769 E, 2929654 N; to 490770 E, 2929637 N; to 490770 E, 2929629 N; to 490760 E, 2929619 N; to 490743 E, 2929614 N; to 490732 E, 2929612 N; to 490720 E, 2929614 N; to 490709 E, 2929670 N; and thence to point of beginning.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Lesquerella thamnophila* critical habitat consists of three components (65 FR 81182-81212):

- (a) Arid upland habitats of various soil types, including highly calcareous sandy loam to loamy sand, with low to moderate salinity levels on low sloping hills;
- (b) Absence of substantial previous soil disturbance and seeding or sodding of exotic grasses; and
- (c) A sparse overstory of shrub species typical of the Tamaulipan biotic province, but lacking a complete canopy as might be provided by a continuous overstory dominated by mesquite (*Prosopis glandulosa*).

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Zapata bladderpod blooms from April through September and produces bright yellow flowers. Plants will bloom throughout most of the year with adequate temperature and rainfall. Fruits are round, 0.2 to 0.8 inch in diameter, and are on short, downward curving pedicels (Poole 1989). Zapata bladderpod is known to be opportunistic, with the density of Zapata bladderpod plants and size of populations fluctuating with temperature levels and amount of rainfall. Zapata bladderpod is a perennial plant that sprouts above ground levels and produces stems more readily during periods of favorable weather. It can respond dramatically to rainfall events and increase from small, barely-detectable above-ground plants, to thousands of plants (USFWS 2004).

Habitat Type

Adult: Shrublands

Habitat Narrative

Adult: Zapata bladderpod is endemic to South Texas, where it occupies cenizo and/or guajillo (*Acacia berlandieri*) shrublands. It can occur on graveled to sandy-loam, upland terraces above the Rio Grande flood plain. The soils on which the species is known to occur vary depending on location. In Starr County, documented populations occur within the Jimenez-Quemado soil association and on Catarina series soils. In Zapata County, they occur within the Zapata-Maverick soil association and may also occur within the Copita-Zapata soils (USFWS 2004). Zapata bladderpod may occur within areas of sparse vegetation or under canopy of associated shrub species. The shrub species may serve as nurse plants for Zapata bladderpod, potentially

reducing the amount of sunlight on the soil surface and helping to maintain moisture in the root area. Adjacent shrubs also provide protection from soil erosion and may serve as a deterrent to browsing animals. Associated plants include mesquite, granjeno, Spanish dagger (*Yucca treculeana*), lotebush, guayacan (*Guaiacum angustifolium*), cenizo (*Leucophyllum frutescens*), and blackbrush (*Acacia ridgula*) (USFWS 2004).

Dispersal/Migration

Population Information and Trends

Number of Populations:

8 extant populations; 2 populations of unknown status (USFWS, 2015)

Population Narrative:

The recovery plan stated that there are 7 extant populations, while the TXNDD now lists 8 extant populations and two of unknown status. Of the latter, EO 2 is a historic record north of Roma for which the precise location is unknown. EO17 was detected during a survey of private land in 1994, also north of Roma, and the site has not since been re-visited. The recovery plan also states that there are 11 documented occurrences, but this figure confounds known populations and designated areas of critical habitat. We believe the EOs reported by TXNDD correctly represent our current knowledge of the populations and distribution of Zapata bladderpod. (USFWS, 2015) Four of the seven populations known historically to occur in Starr County still support Zapata bladderpod plants (USFWS 2004). Two of these seven are in the highway ROWs between Zapata and Falcon, and one on private property in Siesta Shores subdivision. The populations that occur on the LRGV NWR tracts in Starr County continue to maintain the largest number of plants (USFWS 2004). Three refuge tracts and the private ranch have fairly large populations. These populations number in the thousands of individuals in rainy years but occur within a very restricted area covering only a few acres (Best 2006, personal comm.). In Zapata County, three of the four historically documented sites still support Zapata bladderpod. The predominance of private lands in South Texas limits access for surveys, therefore the species range may be more extensive than what is currently known. The size of populations fluctuates depending on rainfall and weather cycles increasing the difficulty in locating the plants (USFWS 2004).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: • Buffelgrass is more prevalent in disturbed soils; not highly competitive in Zapata bladderpod habitat. • Soils are extremely prone to erosion. Root- plowing and other forms of soil disturbance exacerbate erosion. • Overgrazing increases soil erosion. • Foot and ATV traffic associated with border security destroys plants by trampling and leads to soil erosion. • Rapid local population growth, highway construction between Laredo and Rio Grande City. • Petroleum development and pipeline construction continues at rapid pace. (USFWS, 2015)

Stressor: The inadequacy of existing regulatory mechanisms (USFWS, 2015)

Exposure:**Response:****Consequence:**

Narrative: The Endangered Species Act (ESA) does provide some legal protection for federally-listed plants on land under federal jurisdiction, including the three populations on tracts of Lower Rio Grande Valley NWR. However, as described above, Endangered Species Act provisions, including section 7 consultation, can be waived by DHS to expedite construction of border barriers. Federally-listed plants occurring on private lands have very limited protection under the ESA, unless also protected by State laws; the State of Texas also provides very little protection to listed plant species on private lands. Therefore, Zapata bladderpod populations and habitats on private land are not subject to federal or state protection unless there is a federal nexus, such as provisions of the Clean Water Act or a federally-funded project. (USFWS, 2015)

Stressor: Other natural or man-made factors affecting its continued existence (USFWS, 2015)

Exposure:**Response:****Consequence:**

Narrative: • Some EOs within developed areas or along highway ROWs are vulnerable. • Periodic vegetation shredding along utility ROWs may have beneficial effect, provided that soil is not disturbed. • Small isolated populations subject to genetic drift and inbreeding. • Historic conversion of shrub savanna to dense shrubs and cessation of wildfire may have affected populations. • Potential impacts of climate changes. (USFWS, 2015)

Recovery**Reclassification Criteria:**

1. Maintain or establish 12 geographically distinct, self-sustaining populations located within the species' historical range in the United States, with at least one population in each of the 3 geologic formations from which the species is currently known to occur. Each population should consist of at least 2,000 reproductive individuals (have flowered at least once or are capable of flowering) as determined during years when precipitation patterns have stimulated growth and reproduction. The numbers of reproductive individuals at each of the 12 population sites must be stable or increasing. (USFWS, 2019)

2. To count toward reclassification, all populations must be appropriately protected and actively managed to reduce or eliminate threats to the species. Agreements for the protection and appropriate management of the 12 self-sustaining populations must be in place. Perpetual protection on public land will be assured via Service-approved management plans (e.g. National Wildlife Refuge Comprehensive Conservation Plans). Formal stewardship agreements (e.g. conservation easements or similar instruments) must be in place to ensure perpetual long-term, species-appropriate management on privately-owned land. (USFWS, 2019)

Delisting Criteria:

1. Over a 30-year period following reclassification of the species to threatened, monitoring of 12 fully protected, self-sustaining populations consisting of at least 2,000 reproductive individuals per population shows that the populations are stable or increasing. These populations will be located within the species' historical range in the United States, with at least one population in each of the three geologic formations from which the species is currently known to occur.

2. Populations continue to be protected through perpetual management agreements. Threats to each population have been reduced or eliminated through appropriate site management that may include such actions as limiting erosion by excluding vehicles, foot traffic, and/or overgrazing by livestock, diminishing woody vegetation using means that do not disturb the soil, or potentially controlling invasion by non-native grasses. The effectiveness of this management would be determined by monitoring the condition of habitat and the status of the species' such that it is stable or increasing in number

Recovery Actions:

- 1. Protect known bladderpod populations in the United States. The known populations of Zapata bladderpod must be protected from habitat destruction or degradation and other relevant threats. Relationships with private landowners, soil conservation district agencies, roadway construction agencies, oil and gas exploration/production agencies, and rural development agencies should be developed to raise awareness of and conserve the habitat where bladderpod populations are located. (USFWS, 2004)
- 2. Search for new populations. Surveys should be conducted to locate Zapata bladderpod populations in the United States and Mexico. Many areas of native habitat have not been surveyed for this species due to lack of access. This species is difficult to detect without an intensive search due to its ephemeral tendencies during drought conditions. Information on the Zapata bladderpod's appearance, rarity, and vulnerability should be provided to Federal, State, and private landowners. To ensure accuracy, surveys should be conducted at favorable times to locate the plants, (e.g., after rainfall) focusing on associated soil types. Federal (i.e. USFWS, USDA, etc.) and State (TPWD, TDA, etc.) agencies as well as non-governmental organizations (TNC) should increase efforts to form relationships with private landowners to search for and protect populations. (USFWS, 2004)
- 3. Conduct studies to gather information about Zapata bladderpod for management and recovery in the wild. Information on the ecology, life history, population biology, and pollination for the Zapata bladderpod in its native habitat is lacking. Efforts to understand and manage the species are therefore hindered. Studies conducted to gather basic biological information on the species should focus on factors that will enable a better understanding of habitat and provide insight into effective management for the species. Information obtained from the studies should be incorporated into management plans as appropriate to assist recovery of the species. New information should be incorporated into future recovery plan revisions. (USFWS, 2004)
- 4. Establish a botanical garden population and seed bank. Specimens from the known population(s) should be maintained at different institutions. A seed bank should be established for the species and maintained at the National Seed Storage Laboratory in Fort Collins, Colorado. The San Antonio Botanical Garden has indicated an interest in conducting research on propagation techniques and seedling production for the Zapata bladderpod, and to establish an educational botanical garden population (Cox 2002 pers. comm.). At least two refugia collections and seed bank reserves should be established and maintained to provide assurance against extinction if a loss of natural populations should occur. Cultivated plants could provide individual plants for research and provide a plant source for possible reintroductions. (USFWS, 2004)
- 5. Establish new populations as necessary to meet downlisting criteria. Due to the apparent rarity of the Zapata bladderpod within its range, reintroductions of the species may be necessary to aid recovery. The Service defines reintroduction as placing species in its historic

range. As some of the collection data for this species is ambiguous, any reintroduction will need to be undertaken in areas of appropriate habitat within the historic range of the species. Reintroduction efforts could be implemented on Federal lands such as those within the LRGV Refuge Complex or on State or private lands volunteered for use. Any reintroduction efforts will follow Service policy on controlled propagation of endangered and threatened species, and incorporate the most recent reintroduction guidelines available (Falk et al. 1996). (USFWS, 2004)

- 6. Develop a public information and awareness program. Public awareness and cooperation are essential for the success of the Zapata bladderpod recovery program. An informative program about the Zapata bladderpod, threats to the species, the Recovery Plan, and the Endangered Species Act in general, should be developed for presentation to private landowners, agency personnel, and other interested groups. The program should include the identification of recovery tasks that the individuals or groups being addressed can accomplish to participate in recovery of the species. Additionally, information on the Zapata bladderpod should be included within any Lower Rio Grande or Mexico/United States Bi-national Ecosystem program so that a coordinated approach to recovery can be implemented. (USFWS, 2004)
- 7. Develop delisting criteria and a post-recovery monitoring plan. Once the needed information on distribution, life history, ecology, and genetics are obtained, delisting criteria and a post-delisting monitoring plan can be developed. Future criteria should be developed that incorporate measures to alleviate threats identified under the five listing factors and identify when the species will no longer be threatened with endangerment. All information needs for Zapata bladderpod that have been determined as critical during the course of recovery-oriented research must be evaluated prior to delisting. If the downlisting criteria are no longer being met, the species should be returned to the status of endangered. Post-delisting monitoring for a minimum of five years is required by the ESA. (USFWS, 2004)

Conservation Measures and Best Management Practices:

- Revise the recovery plan and recovery criteria to define both down-listing and de-listing criteria. (USFWS, 2015)
- Consider revising criteria to allow larger numbers of smaller populations to contribute to recovery; use frequency of recruitment as a measure of demographic trends. • Conduct public outreach in Starr and Zapata counties to raise local awareness of Zapata bladderpod. Support conservation of wild populations on private lands with willing landowners through the USFWS Partners for Fish and Wildlife Program, section 6funded grants, cooperative efforts with Natural Resources Conservation Service, or nongovernmental partners. Establish a private landowner support group for conservation of Zapata bladderpod (and perhaps other plant species of concern known from that region), similar to the group now actively working to conserve Texas snowbells (*Styrax platanifolius* ssp. *texanus*). (USFWS, 2015)
- Support scientific investigation of the reproductive biology and pollination, genetic structure of the wild populations, response to shrub cutting and prescribed burning, and degree of tolerance or requirement for gypsum (gypsovagy versus gypsophily). (USFWS, 2015)
- Prohibit vehicle traffic, including ATVs, from Zapata bladderpod occupied habitats at LRGV NWR, and limit foot traffic to the greatest extent possible. (USFWS, 2015)
- Develop a potential habitat model based on geological and soil factors. Conduct expanded surveys based on this model on private lands (with landowner permission) in Texas as well as Tamaulipas

and Nuevo León (pending the resolution of security issues on the Mexican side of the border). (USFWS, 2015)

- Collect seeds from the most vulnerable populations, develop propagation methods, and reintroduce the propagated Zapata bladderpod plants into suitable protected habitats to create refugia for the vulnerable populations.

References

USFWS. 2015. Zapata Bladderpod, *Physaria thamnophila* (Rollins & E.A. Shaw) O’Kane & Al-Shehbaz (Synonym: *Lesquerella thamnophila* Rollins & E.A. Shaw), 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Corpus Christi, Texas. 41 pp. August 18, 2015.
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SPECIES ACCOUNT: *Lesquerella tumulosa* (Kodachrome bladderpod)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/06/1993; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

A perennial herb that forms a low rounded clump, about 1-4 cm tall and 5 cm broad. The plants are covered with tiny yellow flowers in early summer, followed by a dense covering of globe-like fruits (NatureServe, 2015).

Taxonomy

Kodachrome bladderpod (*Lesquerella tumulosa*) is in the Mustard family (Cruciferae or Brassicaceae). Barneby (1966) described the plant as *Lesquerella hitchcockii* ssp. *tumulosa*, comparing the taxon with *Lesquerella hitchcockii* ssp. *rubicundula* (now *Lesquerella rubicundula*) from the nearby Paunsaquut Plateau. James Reveal, in his taxonomic treatment of the *Lesquerella hitchcockii* complex of species, elevated Barneby's *L. hitchcockii* ssp. *tumulosa* to species rank as *L. tumulosa* (Reveal 1970) (USFWS, 2009).

Historical Range

Rupert Barneby discovered the Kodachrome bladderpod in 1966 from a site in the Kodachrome Basin of the Paria River drainage in northern Kane County, Utah (USFWS, 2009).

Current Range

Kodachrome bladderpod is an endemic found only in Kane County, Utah (USFWS, 2009).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 2009)

Lifespan

Adult: 2+ years (NatureServe, 2015)

Breeding Season

Adult: April - May (USFWS, 2009)

Reproduction Narrative

Adult: A perennial species (NatureServe, 2015). The fruit contains 2 - 4 seeds. The species' reproduction is sexual. Asexual reproduction is unknown. The species' pollinators are unknown. In most years, the plants begin flowering in late April and continue through May with seed dispersal occurring in June (Franklin 1990). Field observations in 2009 documented good

flowering, presence of potential pollinators, and seed set (A. Hughes, pers. comm., 2009) (USFWS, 2009).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Bouteloua grassland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs ~5,700 feet elevation (USFWS, 2009); high vegetative cover (inferred from USFWS, 2009)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Inhabits extremely dry, sparsely vegetated, white shale knolls with thin soils derived from the Windsor Member of the Carmel Formation. Associated with scattered Utah juniper (*Juniperus osteosperma*) within a Bouteloua grassland (NatureServe, 2015). Kodachrome bladderpod is restricted to very xeric shale outcrops at about 1,740 meters (5,700 feet). Visually, occupied habitats contain harder, rockier soils than unoccupied habitats (A. Hughes, pers. comm., 2009). Kodachrome bladderpod occupies sites with very little vegetative cover (USFWS, 2009).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Very low (USFWS, 2009)

Redundancy:

Very low (inferred from USFWS, 2009)

Number of Populations:

1 (USFWS, 2009)

Population Size:

~20,000 (USFWS, 2009)

Population Narrative:

The species is restricted to one population of scattered occurrences in the Kodachrome Flats area of the Paria River Drainage. The species is found in an area about 4 km (2.5 mi) long and 1.2 km (0.75 mi) wide. The Utah Natural Heritage Program (Heritage Program) documented 20,000 individuals covering approximately 300 hectares (ha) (700 acres (ac)) (Franklin 1990) (USFWS, 2009).

Threats and Stressors

Stressor: Off-highway vehicle use (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The largest threat to the Kodachrome bladderpod is illegal OHV use. The habitat of the species is characterized by low rolling hills with little native vegetation, providing easy access and preferred terrain for OHV users. Impacts from OHV users likely increased mortality rates at established monitoring sites (Van Buren 1999, 1999; Van Buren and Harper 2001, 2002) (USFWS, 2009).

Stressor: Cattle grazing (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The BLM Dry Valley grazing allotment completely overlaps the range of the Kodachrome bladderpod. Grazing leases or permits existing at the creation of GSENM continue today and are subject to BLM's grazing regulations and other laws and regulations governing grazing on public lands (BLM 1999). While this allotment permits 699 Animal Unit Months or 166 cows, since 1999 it has run at about 75 percent of permitted levels. However, cattle grazing occurs outside of the flowering and seed setting period for Kodachrome bladderpod. Cattle are not known to feed on Kodachrome bladderpod; however, cattle may be a low threat to the species with occasional trampling, soil compaction, and erosion (Meiji 1982, A. Hughes, M. Ulloa, pers. comm., 2007) (USFWS, 2009).

Stressor: Stochastic events (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The original listing (58 FR 52027, October 6, 1993) concluded that the species' existence in a single known population makes the species vulnerable to extinction due to a catastrophic event. Drought conditions likely resulted in high mortality (76 percent) and lower flower and fruit production at two Kodachrome bladderpod monitoring sites (Van Buren and Harper 2001, 2002). Although plants still occur at these monitoring sites, it is possible that extended and severe drought could cause the species to be lost in some areas (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Drought conditions led to a noticeable decline in survival, vigor and reproductive output of rare plants in the Southwest during the drought years of 2001 through 2004 (Clark and Clark 2007; Hughes 2005; Roth 2008 a, 2008 b; Van Buren and Harper 2002 and 2003). Effects related to climate change, such as persistent or prolonged drought conditions, are likely to reduce the frequency and duration of flowering and/or germination events, lower the recruitment of individuals, compromise the viability of the population, impact pollinator availability and, therefore, adversely affect the long-term persistence of Kodachrome bladderpod and lessen its recovery potential. Prolonged droughts combined with increases in the frequency of heavy rainfall events may increase erosion in Kodachrome bladderpod habitat (USFWS, 2009).

Recovery

Reclassification Criteria:

Not available - recovery plan not developed.

Delisting Criteria:

Not available - recovery plan not developed.

Recovery Actions:

- Evaluate all known habitat components analyzing geospatial data and conduct range surveys including searches for additional occurrences in areas containing characteristics highly related to occupancy (USFWS, 2009).
- Identify sites in urgent need of habitat conservation, such as fencing, and increased protective actions. Areas particularly impacted by OHV use will be targeted (USFWS, 2009).
- Support research on Kodachrome bladderpod's life history and ecology, including soil needs and pollinators (USFWS, 2009).
- Encourage investigations that project Kodachrome bladderpod's response to climate changes in its habitat (USFWS, 2009).

Conservation Measures and Best Management Practices:

- Not available

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SPECIES ACCOUNT: *Lessingia germanorum* (=L.g. var. *germanorum*) (San Francisco lessingia)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A slender annual herb, mostly 1-3 dm tall. The flower heads have bright yellow disk flowers; they lack rays (NatureServe, 2015).

Taxonomy

Lessingia germanorum is the type species for its genus (the first plant selected by taxonomists to represent the group; the exemplar for all related species). San Francisco lessingia is currently considered a distinct species, it was formerly thought to be most closely related to *Lessingia glandulifera* A. Gray var. *pectinata* Jeps. (Howell 1929, S. Markos, pers. comm. 1998) (USFWS, 2003). It is a member of the aster family (Asteraceae) (USFWS, 2012).

Historical Range

Historically, *L. germanorum* occurred within central dune scrub habitats throughout the San Francisco peninsula. At the time of listing in 1997, *Lessingia germanorum* was restricted to the Presidio area of the San Francisco peninsula (five occurrences), and the Hillside Park occurrence in Daly City near the base of San Bruno Mountain (one occurrence) (USFWS, 2012).

Current Range

Currently the species is known to occur at seven locations in the Presidio (M. Chassé, National Park Service, in litt., October 26, 2011, p. 1; M. Chassé in litt., September 29, 2011) and at one occurrence near Hillside Park in Daly City (USFWS, 2012).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (USFWS, 2012)

Lifespan

Adult: 1 year (USFWS, 2012)

Breeding Season

Adult: August - November (USFWS, 2012)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 2012); wind (USFWS, 2003)

Reproduction Narrative

Adult: *L. germanorum* is an annual plant typically flowers between August and November. Spence (1964) determined that *Lessingia* species are generally self-incompatible (infertile when restricted to self-fertilization) making the presence of appropriate pollinators necessary for seed production. Information on California pollinators which was published in 1979 (Krombein et al. 1979), lists five species of native bees that visit the *Lessingia germanorum*. They include *Andrena baeriae*, *Hoplitis productus gracilis*, *Anthophora urbana urbana*, *Exomalopsis nitens*, and *Ashmeadiella californica californica* (Krombein et al. 1979, pp. 1799, 2018, 2026, 2118, and 2164) (USFWS, 2012). Reproductive output of individual plants is highly variable. Pogge (1998) found a range from 1 to over 1,400 flowerheads per plant, depending on plant size. Large plants in sparsely vegetated areas may produce many hundreds of flowerheads, each bearing up to 40 florets (potential seeds; Lane 1993), but actual average number of seeds per flowerhead is about 26 (Pogge 1998), implying that the largest individuals may produce up to 36,400 seeds. Pollination is possibly achieved by wind as well (Spence 1964) (USFWS, 2003).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Dune scrub (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Natural disturbance (USFWS, 2003)

Geographic or Habitat Restraints or Barriers

Adult: 80 - 300 ft. elevation (USFWS, 2012); dense vegetation (USFWS, 2003)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 2003)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2012)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from USFWS, 2003)

Habitat Narrative

Adult: Inhabits dune scrub habitats; now restricted to remnant sand dunes and terraces (NatureServe, 2015). It grows in open areas with blowing sand at an elevation range between 24 to 91 m (80 to 300 ft). Most populations are found in vegetation gaps in stabilized old sand dunes or sandy soils derived from ancient sandy coastal deposits (USFWS, 2012). Spence (1964) observed that annual *Lessingia* species were typical of dry, open, and somewhat disturbed habitats, occurring in small, dense, disjunct populations. Nearly all historic collections of San Francisco *lessingia* with specific locality and habitat information have been made in areas with disturbed dune deposits. Undisturbed areas of dune scrub or nonnative grassland with high density and cover of vegetation show little tendency to become invaded by San Francisco *lessingia*, even when they are adjacent to source populations of this species (P. Baye, pers.

observ. 1997 to 1998). In contrast, San Francisco lessingia can spread vigorously under favorable climate conditions when extensive substrate disturbance occurs (USFWS, 2003).

Dispersal/Migration

Dispersal

Adult: Low (inferred from USFWS, 2003)

Dispersal/Migration Narrative

Adult: The seeds, which are attached to a crown of hairlike bristles, are light and easily carried by the wind (USFWS, 2012). Seed dispersal distance has not been studied, but seedling distribution tends to be contagious around parent plants. Landscape barriers to dispersal, such as tree plantations, may be more significant barriers to dispersal than inherent dispersal ability of achenes. Seeds may also possibly be passively dispersed by humans, by adherence of seed to footwear or clothing (J. Cannon, pers. comm. 1997) (USFWS, 2003).

Population Information and Trends

Population Trends:

Not available

Resiliency:

Very low (inferred from USFWS, 2012)

Representation:

High (inferred from USFWS, 2012)

Redundancy:

Low (inferred from USFWS, 2012)

Number of Populations:

8 (USFWS, 2012)

Population Size:

Variable depending on year; 500,000 - 2,000,000 overall range (USFWS, 2003)

Population Narrative:

Currently, there are seven known occurrences at the Presidio and one population near Hillside Park. The occurrences on the Presidio occupy 2.4 ha (6 ac) and consist of an estimated mean of 129,133 plants (M. Chassé, in litt., October 18, 2011, p. 2). In any given year, however, the area occupied and the numbers of plants will vary due to factors such as vegetation changes and levels of stewardship (M. Chassé, in litt., October 18, 2011, p. 2). Approximately 300 plants were found in a portion of the Hillside Park occurrence in 2011 (T. Corelli, in litt., September 14, 2011). Research by Markos and Baldwin (2002) indicates that there is distinct genetic variation between the Presidio populations and the Hillside Park population (USFWS, 2012). The overall rangewide number of San Francisco lessingia plants, though highly fluctuating and quantified with variable accuracy and precision, ranges over a magnitude around 500,000 to 2,000,000 plants (USFWS, 2003).

Threats and Stressors

Stressor: Nonnative plants and succession (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Currently, nonnative annual grasses and forbs are still a threat to *Lessingia germanorum* on the Presidio; the most dominant nonnative grass within *L. germanorum* habitat is *Bromus diandrus* (M. Chassé, in litt., October 18, 2011, p. 2). In the absence of disturbance, back dunes on the Presidio that are capable of supporting *Lessingia germanorum* go through a succession to stable dune scrub which does not support the species. Large scale projects that result in the removal of dune scrub will need to be considered to maintain the *L. germanorum* over time (M. Chassé, in litt., October 18, 2011, p 3) (USFWS, 2012).

Stressor: Urbanization (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: The threats to *L. germanorum* from pedestrians, and hikers are considered to be low; digging dogs are a moderate threat. Since the time of listing, 0.3 acre of *Lessingia germanorum* habitat on the Presidio in the Lobos Dunes occurrence was adversely affected at the base of Landfill 10. Landfill 10 was in the process of remediation by the Presidio Trust when heavy rain storms in late 2009 and early 2010, eroded loose soil from the landfill, burying *L. germanorum* plants and habitat downslope. The owner of two parcels that support part of the Hillside Park occurrence recently submitted plans to the City of Daly City for development of a nine-lot subdivision, known as the Hillside Park Court Subdivision, on these parcels (J. Naughton, City of Daly City Planning and Zoning Department, pers. comm., December 6, 2011; K. McIntire, San Bruno Mountain Watch, in litt., November 29, 2011). In addition, a road to access the development is proposed to be constructed through a third parcel that is part of Hillside Park and is also occupied by *L. germanorum* (K. McIntire, in litt., November 29, 2011) (USFWS, 2012).

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. Although there is uncertainty on the effects of climate change on this species, the vulnerability of the species to significant shifts in climate is increased by the natural and artificial barriers to dispersal (M. Chassé, in litt., October 18, 2011, p 3) (USFWS, 2012).

Stressor: Loss of pollinators (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Habitat fragmentation increases the risk at all occurrences to reduced seedset from loss of pollinators. Two recent studies of bee diversity have been conducted at several sites in the

Presidio (Wood et al. 2005, Van Den Berg et al. 2010). The study conducted in 2004 (Wood et al, 2005) established a baseline of species and numbers of bees found at nine sites on the Presidio. The study conducted in 2008 (Van Den Berg et al. 2010) resampled three of these sites and added a new previously unsampled site. A comparison of the results of the two studies at the three sites in common, Thompson Reach, Lobos Dunes (the site of a *L. germanorum* occurrence), and the World War II Memorial, revealed a number of differences between the studies. Overall, the average bee species richness and abundance at the three previously samples sites were greater in 2004 with 47 species and 1,283 individuals compared to 36 species and 878 individuals in 2008 (Van Den Berg et al. 2010, p. 4). At the World War II Memorial site; however, a different trend was observed in 2008. Bee diversity increased from 15 species in 2004 to 26 species in 2008 although five species including the common bumblebee, *Bombus vosnesenskii*, had declined dramatically. Abundance of bees at this site more than doubled from 192 individuals in 2004 to 391 in 2008 (Van Den Berg et al. 2010, p. 5). The identity of the plants being visited by the pollinators monitored in these studies was not recorded (USFWS, 2012).

Recovery

Reclassification Criteria:

1. Long-term expansion of existing populations and reduction of nonnative vegetation occurs in dune reserves in the Presidio Recovery Unit (Lobos Creek, Battery Caulfield, Wherry, Rob Hill, and Public Health Services Hospital sites). The populations in these reserves are expected to fluctuate but should not decline below 50,000, 1,000, 5,000, 5,000, and 5,000, respectively. Cover of nonnative vegetation in these reserves should be less than 5 percent, 20 percent, 5 percent, 20 percent, and 20 percent, respectively. Research and monitoring are expected to determine the most efficient methods for control of nonnative vegetation and may result in modification of these recovery criteria (USFWS, 2003).
2. The population of the Daly City reserve shows no net long-term decrease. Populations are expected to fluctuate but should not decline below 50,000 plants. Cover of nonnative vegetation should show no progressive increase over more than 2 years (USFWS, 2012).
3. Recreation management needs for maintenance of a dune scrub community in the Fort Funston Reserve are established through sitespecific studies, and a reintroduced population has persisted over a full precipitation cycle. The population is expected to fluctuate but should achieve a minimum self-sustaining population size of approximately 500,000 plants within the first ten years after founders are transplanted (USFWS, 2012).
4. At least 1,000 seeds representing both the existing Presidio and Daly City populations are stored and maintained in qualified botanical gardens as insurance against extinction in the wild (USFWS, 2012).
5. The Lobos Dunes unit has expanded to Battery Caulfield Road and upper Baker Beach (USFWS, 2012).

Delisting Criteria:

1. Expanded, restored reserves with natural vegetation and dune dynamics are established in the Presidio Recovery Unit. The area including Baker Beach dunes, Lobos Dunes and nearby conifer groves, Wherry Dunes and Housing sites, and the Battery Caulfield Road site must be

restored to a contiguous dune field (approximately 44 hectares [110 acres]) with unobstructed wind fetch to the Golden Gate, locally steep dune slopes, and a natural successional mosaic of active and stabilizing dune blowouts (population at least 500,000 plants; nonnative vegetative cover must not exceed 5 percent during the first 10 years of restoration and must decline over the first 15 years). Dune habitat at the Rob Hill reserve area must increase to 2 hectares (5 acres) and the southwest slope of Rob Hill must be restored to dune scrub (population at least 100,000 plants; nonnative vegetative cover must not exceed 5 percent). At least 3 hectares (7 acres) of the Public Health Services Hospital dune area above the slope must be restored to native dune vegetation (population at least 50,000 plants; nonnative vegetative cover must not exceed 5 percent). Research and monitoring are expected to determine the most efficient methods for control of nonnative vegetation and may result in modification of these recovery criteria (USFWS, 2003).

2. At least 1.2 hectares (3 acres) of Daly City Reserve in the Southern Recovery Unit are cleared of nonnative vegetation and intensively managed (population at least 50,000 plants; no increases in nonnative vegetation (USFWS, 2003).

3. Dune restoration and vegetation management should be done on 30 hectares (75 acres) at Fort Funston Reserve in the Southern Recovery Unit sufficient to establish ecosystem function and support a self-sustaining population of San Francisco lessingia. Site-specific studies of recreational use management compatible with maintenance of a dune scrub community must be completed to further define the restoration and management strategies. Buffers of landscape vegetation around all historic structures and buffer management needs will also need to be identified. A population should be reintroduced from the Daly City seed source (population at least 10,000 plants after 5 years; must reach 500,000 plants after 10 years; new colonies must spontaneously establish within 10 years). Nonnative woody vegetative cover must be below 1 percent; iceplant and European beachgrass cover must decline and be below 10 percent after 10 years. Research and monitoring are expected to determine the most efficient methods for control of nonnative vegetation and may result in modification of these recovery criteria (USFWS, 2003).

4. Populations must be introduced in the Satellite Recovery Unit (should reach 100,000 plants within 10 years, with minimum size of 5,000 plants). This criterion is preliminary subject to additional information. The locations of dune areas suitable for management within this Recovery Unit are scattered around the western half of San Francisco County. The specific size, number, and configuration of reserves needs to be determined on the basis of more detailed site-specific information (USFWS, 2003).

Recovery Actions:

- Protect and restore a series of ecological urban wildland reserves (USFWS, 2003).
- Promote population increases of target species within urban wildland reserves and reintroduce target species to restored habitat (USFWS, 2003).
- Long-term removal (local eradication) or suppression of invasive, nonnative vegetation within and around all reserves and subsequent reestablishment of native communities compatible with endangered species within the ecological reserves (USFWS, 2003).

Conservation Measures and Best Management Practices:

- Identify a lead organization to monitor and manage the Hillside Park occurrence in Daly City. Encourage a volunteer weeding program at this site with coordination and assistance from City of Daly City, San Bruno Mountain Watch, California Native Plant Society, other environmental groups, landowners, and school groups (USFWS, 2012).
- Continue control of invasive plants, particularly annual grasses and forbs, through ongoing stewardship on the Presidio (USFWS, 2012).
- Expand *Lessingia germanorum* habitat in the Presidio through implementation of the Presidio Vegetation Management Plan objectives, particularly in the Wherry Reserve area (USFWS, 2012).
- Collect seed from all populations for accession at approved seed banking facilities and for outplanting within the Presidio and at other suitable habitat within the historic range of the species (USFWS, 2012).
- Formulate adaptive management strategies for native dune scrub succession that would mimic natural disturbance where such natural processes have been reduced or eliminated entirely (USFWS, 2012).

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SPECIES ACCOUNT: *Liatris helleri* (Heller's blazingstar)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/19/1987; Southeast Region (R4) (USFWS, 2015)

Physical Description

A perennial herb that grows from a cormlike rootstock (underground stem) 2.0 to 5.0 centimeters (cm) (0.8 to 2.0 inches (in)) broad. One or more erect or arching stems arise from a tuft of narrow pale green basal (growing from the base of a stem) leaves. The stems reach up to 15.7 in in height and are topped by a showy spike of lavender flowers 7.0 to 20.0 cm (2.8 to 7.9 in) long. (USFWS, 2013).

Taxonomy

Nesom (2005) has questioned whether *Liatris helleri* T.C. Porter (1891) and *L. turgida* Gaiser (1946) are valid and distinct species, proposing that these should be treated as a single taxon (*L. helleri*, because this name has nomenclatural seniority). This issue has not been resolved; the Service expects to reach resolution on this issue in the next five year review for this species (USFWS, 2013).

Historical Range

Endemic to summits in the northern Blue Ridge Mountains in the North Carolina counties of Ashe, Avery, Burke, Caldwell, Mitchell, and Watauga counties (USFWS, 2013).

Current Range

Extant populations occur in the following North Carolina counties: Ashe, Avery, Burke, Caldwell, and Watauga (USFWS, 2013).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Abiotic, Insect (EPA, 2016)

Lifespan

Adult: 15 - 34 years (USFWS, 1999)

Dependency on Other Individuals or Species

Adult: Possibly insect-pollinated (EPA, 2016)

Breeding Season

Adult: July to September (flowering); late September to mid-October (fruiting) (EPA, 2016)

Reproduction Narrative

Adult: Reproduction is thought to be abiotic or by insect. Life span is 15 to 34 years, with first reproduction around 9 years. Flowering is from July to September, with fruiting from late September to mid-October (EPA, 2016; USFWS, 1999).

Habitat Type

Adult: Terrestrial (EPA, 2016)

Habitat Vegetation or Surface Water Classification

Adult: Rock outcrops, ledges, cliffs, and balds (EPA, 2016)

Geographic or Habitat Restraints or Barriers

Adult: High elevations (3,500 to 5,999 feet) (EPA, 2016)

Spatial Arrangements of the Population

Adult: Clumps (USFWS, 2013)

Habitat Narrative

Adult: Habitat is rock outcrops, ledges, cliffs, and balds at high elevations (3,500 to 5,999 feet) (EPA, 2016); species grows in clumps (USFWS, 2013), in shallow, acidic soils that form on and around exposed granite ledges, outcrops, and balds at high elevations. In full sun with grasses, sedges, and other composites (NatureServe, 2015).

Dispersal/Migration**Dispersal**

Adult: Low (inferred from USFWS, 2013)

Dispersal/Migration Narrative

Adult: The seeds are transported primarily by the wind, germinating (sprouting) and growing only when they land in locations with suitable habitat (EPA, 2016). This is a narrow-ranging endemic with limited dispersal capabilities (USFWS, 2013).

Population Information and Trends**Population Trends:**

Decline of 10-50% (NatureServe, 2015)

Species Trends:

Declining (USFWS 2013)

Population Growth Rate:

Unknown (USFWS 2013)

Number of Populations:

11 extant populations (USFWS, 2013)

Population Size:

1000 - 2500 individuals (NatureServe, 2015)

Population Narrative:

Population decline of 10-50%; In 1996 about 3,000 clumps or rosettes were known, not counting populations augmented by greenhouse grown plants. Approximately 11 extant populations remain (USFWS, 2013) representing 1000 - 2500 individuals (NatureServe, 2015). Species status is declining; remaining extant populations continue to be threatened by recreational use or poaching (USFWS, 2013).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Recreating public and the construction of facilities for the public are principal sources of habitat destruction affecting *L. helleri*. Trampling compacts the plant's rhizome and can shear plants from the rocks in which they are anchored. Soils that have developed over geologic time frames can also be destroyed, making recolonization of these sites (by this or other species) exceedingly difficult. Numerous populations of the species exist in extremely close proximity to boardwalks or roped trails; maintenance of facilities must be conducted in a manner that does not damage the plants found immediately adjacent to the boardwalk or trail. Landowners should discourage the construction of trails directing visitors to the populations. (USFWS, 2013)

Stressor: Inadequacy of existing regulatory mechanism (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: State laws protecting rare plant species have limited authority, and North Carolina rare plant statutes do not protect the species from habitat destruction from recreational use on federal lands (where many populations occur and remain vulnerable to this threat). (USFWS, 2013)

Stressor: Accelerated global climate change (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Accelerated global climate change is likely to disrupt patterns of climate variability to which *Liatris helleri* has become adapted, and as such is likely to exacerbate threats already mentioned. In 2010, NPS (Blue Ridge Parkway) personnel reported significant mortality of adult plants, seemingly as a result to prolonged and extreme drought. The higher temperatures expected under most global climate change models would appear likely to exacerbate this threat. However, the current scale of most global models of climate change offers little insight into the changes that will likely occur on southern Appalachian high peaks. (USFWS, 2013)

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

1. The eight extant populations are protected (USFWS, 1999).
2. Any necessary management actions have been undertaken for these populations by the landowners or cooperating agencies and it has been documented that this management is successfully ensuring the continued survival of these populations (USFWS, 1999).
3. Through introduction and/or discovery of new populations, at least one additional self-sustaining population exists within the species' historical range (it is believed that at least nine populations are required to ensure that the species will not become endangered in the foreseeable future) (USFWS, 1999).
4. All nine populations and their habitat are protected from present and foreseeable human-related and natural threats that may interfere with their survival (USFWS, 1999).

Recovery Actions:

- Survey suitable habitat for additional populations (USFWS, 1999).
- Monitor and protect existing populations (USFWS, 1999).
- Conduct research on the biology of and threats to the species (USFWS, 1999).
- Establish new populations or rehabilitate marginal populations to the point where they are self-sustaining (USFWS, 1999).
- Investigate and conduct necessary management activities at all key sites (USFWS, 1999).
- Obtain public and landowner support through educational outreach (USFWS, 1999).

Conservation Measures and Best Management Practices:

- Numerous populations of the species exist in extremely close proximity to boardwalks or roped trails; maintenance of these facilities must be conducted in a manner that does not damage the plants found immediately adjacent to the boardwalk or trail. Landowners should discourage the construction of trails directing visitors to the populations.

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SPECIES ACCOUNT: *Liatris ohlingerae* (Scrub blazingstar)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/28/1989; Southeast Region (R4)

Physical Description

The scrub blazing star (*Liatris ohlingerae*), a member of the aster family, is a long-lived perennial herb having a thickened, cylindric root. Its stems are erect, usually unbranched, and it can grow up to 1 m tall. Its leaves are fleshy and narrow (1 to 2.5 mm), and generally 3 to 8 cm long (Wunderlin et al. 1980). Flower heads are well separated on the stem with individual disc flowers up to 1 cm broad; the inflorescences are up to 3 cm across. The corollas are bright purplish-pink in color. The broad flower heads and narrow leaves distinguish *L. ohlingerae* from the eight other *Liatris* species in central Florida. (USFWS, 1999)

Taxonomy

Blake (1923) placed *L. ohlingerae* in the blazing star genus, naming it *Lacinaria ohlingerae*. Small (1924) created a new genus for this plant, which became *Ammopursus ohlingeri*. Robinson (1934) reinstated the scrub blazing star in the large genus of the blazing stars as *Liatris ohlingerae*. Gaiser's (1946) treatment of *Liatris*, and Cronquist's (1980) floristic treatment of the aster family in the Southeast retains this plant in the genus *Liatris*, although Lakela (1964) argued in favor of reinstating *Ammopursus* as a genus containing only one species. (USFWS, 1999)

Historical Range

Highlands and Polk Counties, Florida (USFWS, 1999)

Current Range

Southern Lake Wales Ridge of southern Polk and Highlands Counties, Florida (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Dependency on Other Individuals or Species

Adult: pollinators

Breeding Season

Adult: Peak flowering of scrub blazing star is from June through August.

Other Reproductive Information

Adult: The growth of new basal leaves begins in March and the elongation of stems begins in April. Flowering and fruiting occurs from summer through fall. Flowering begins in May and June, but the peak occurs in August with a rapid decline toward the middle of September. The seeds start to disperse in August and peak in October. Each plant produces approximately eight

filled (presumably viable) seeds a year. The plant's above ground parts die back in October to November or by the first freeze. *Liatris ohlingerae* can remain in a dormant state through at least one growing season. The seedling growth rate for *L. ohlingerae* is slow compared to most other scrub endemics. Many others grow to reproductive maturity in only one season, while the juvenile stage for *L. ohlingerae* was found to be at least 2 years. Interestingly, cultivated *L. ohlingerae* mature to flowering in 8 months. Limited water and nutrients are believed to be responsible for the difference between wild populations and cultivated plants. (USFWS, 1999)

Reproduction Narrative

Adult: *Liatris ohlingerae* requires cross-pollination to reproduce. Butterflies, especially skippers (Hesperiidae), are thought to be the primary pollinators, although other insects may also contribute to pollination (FWS 1996). Flowering and fruiting in this species all more abundant in shaded microhabitats. Individuals in open and edge habitats only produce one-quarter as many mature flower heads (Herndon 1996). The seeds of this species are short-distance wind dispersers, with bristles and hairs that assist in "planting" the seeds correctly. Low germination on leaf litter-covered soil suggests that many seeds in shade (the favored microhabitat) may get trapped in the leaf litter and fail to sprout or die shortly after sprouting (Herndon 1996). (USFWS, 1999)

Habitat Type

Adult: Rosemary bald habitats and adjoining scrubby flatwoods

Habitat Narrative

Adult: The species is found in rosemary scrub and also along the ecotone between rosemary scrub and scrubby flatwoods. It can also be found scattered in surrounding scrub. Scrub blazing star has important microhabitat requirements, particularly its preference for shade. Unlike most other scrub endemics, scrub blazing star appears to thrive in lightly shaded areas and does not specialize in open microsites (Herndon 1999, Weekley et al. 2008b). Both rosemary scrub and scrubby flatwoods are pyrogenic (fire-maintained) communities. Historical FRI in rosemary scrub ranged from 20 to 100 years, while scrubby flatwoods have a 5 to 20 year average FRI. (USFWS, 2019)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: No information available.

Population Information and Trends

Population Trends:

Declining (inferred) (USFWS, 2019)

Number of Populations:

~90 to 100 occurrences (USFWS, 2019)

Population Narrative:

Scrub blazing star is extant on the Lake Wales Ridge (roughly 90 to 100 occurrences) and Winter Haven Ridge (one occurrence) in Highlands and Polk Counties. Its range extends from Lake Blue

in Polk County south along the Lake Wales Ridge to ABS at the south end of the Ridge in Highlands County (FNAI 2009a). The last FNAI Element Tracking Summary (FNAI 2015) reported 70 extant occurrences, 45 of which were on managed areas. This was a significant decrease (approximately 23 percent) from the last 5-year status review (Service 2010a), which reported 91 extant occurrences. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat destruction or modification

Exposure:

Response:

Consequence:

Narrative: This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 million persons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

Stressor: Lack of adequate fire management

Exposure:

Response:

Consequence:

Narrative: Fire is necessary to maintain the scrub habitats upon which this species depends. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time (Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species. (USFWS, 2019)

Stressor: Limited geographic range

Exposure:

Response:

Consequence:

Narrative: This species occurs within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

Recovery

Reclassification Criteria:

1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to assure 20 to 90 percent probability of persistence for 100 years (USFWS, 1999)
2. When these sites, within the historic range of *L. ohlingerae*, are adequately protected from further habitat loss, degradation, and fragmentation (USFWS, 1999)
3. When these sites are managed to maintain the rosemary bald of the xeric oak scrub community to support *L. ohlingerae* (USFWS, 1999)
4. When monitoring programs demonstrate that these sites support the appropriate numbers of self-sustaining populations, and those populations are stable throughout the historic range of the species (USFWS, 1999)

Delisting Criteria:

1. At least 40 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)
2. Populations (as defined in criterion 1) in rosemary scrub or scrubby flatwoods habitats are distributed across the known range of the species. (USFWS, 2019)
3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

Recovery Actions:

- Determine current distribution of *L. ohlingerae*. This species is difficult to survey. It is easily overlooked when not in bloom and does not grow in the typical open gaps of scrub. A thorough survey is needed to determine the distribution for this species. Survey efforts should be focused from August through October. (USFWS, 1999)

- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection. (USFWS, 1999)
- Conduct research on life history characteristics. Though recent work has greatly increased the base of knowledge for this species, more work on its basic biology and ecology is necessary for effective recovery. (USFWS, 1999)
- Monitor existing populations of *L. ohlingerae*. (USFWS, 1999)
- Provide public information about *L. ohlingerae*. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Care is needed, though, to avoid revealing specific location information. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of *L. ohlingerae* and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- Develop delisting criteria. Once reclassification is achieved, research and monitoring results may provide data necessary to develop delisting criteria. (USFWS, 1999)
- Habitat-Level Recovery Actions: Prevent degradation of existing habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

References

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SPECIES ACCOUNT: *Lilaeopsis schaffneriana* var. *recurva* (Huachuca water-umbel)

Species Taxonomic and Listing Information

Listing Status: Endangered; 1997, Southwest Region (R2)

Physical Description

Lilaeopsis schaffneriana ssp. *recurva* is a semi-aquatic to fully aquatic herbaceous perennial in the carrot family (Apiaceae). The root system is comprised of both long horizontal rhizomes and connected shorter vertical rhizomes. Hollow linear leaves that taper to a point are produced singly or in clusters at the top of short rhizomes. The leaves vary greatly in length from 2.5 to 33 centimeters (cm) (0.98 to 12.99 inches (in)) depending on their habitat, with shorter leaves typically found in dryer environments and longer when submerged in water. Umbels (umbrella-like flower structures) are born on stalks shorter than the leaves and contain three to ten 1.0 to 2.0 mm (0.04 to 0.08 in) wide perfect flowers with five white to slightly maroon tinted petals and maroon anthers. Fruits are spherical and dry, 1.6 to 2.3 mm (0.6 to 0.09 in) long by 1.2 to 2.0 mm (0.04 to 0.08 in) broad, with five distinct spongy ribs that make the seed buoyant and easily dispersed by water.

Taxonomy

Lilaeopsis schaffneriana ssp. *recurva* is a member of the carrot family (Apiaceae). Within the Apiaceae, *Lilaeopsis* is in tribe Oenantheae and subfamily Apioideae. In general, researchers consider plants west of the Continental Divide in Sonora to be ssp. *recurva* and those to the east, ssp. *schaffneriana* (64 FR 37441, p. 37442). Genetic analysis is warranted to better understand the relationship of occurrences within and between localities in southeastern Arizona, northern Sonora, and northwestern Chihuahua, Mexico (USFWS, 2017).

Historical Range

The type specimen of *L. schaffneriana* ssp. *recurva* was collected in the Santa Cruz Valley of southern Arizona near Tucson on May 19, 1881, in an area that is now encompassed by the City of Tucson and no longer provides suitable habitat for the species.

Current Range

Within the Santa Cruz, San Pedro, and Rio Yaqui watersheds in southern Arizona, we are aware of 17 locations supporting extant occurrences of *L. schaffneriana* ssp. *recurva*, 8 locations where all *L. schaffneriana* ssp. *recurva* occurrences are considered extirpated, and 6 locations where historical occurrences have not been seen in recent years. Within the Santa Cruz, San Pedro, Rio Yaqui, Rio Sonora, and Rio Concepcion watersheds in Sonora, Mexico, we are aware of 21 locations supporting *L. schaffneriana* ssp. *recurva* occurrences, though most of these locations have not been revisited in recent years (USFWS, 2017).

Critical Habitat Designated

Yes; 7/12/1999.

Legal Description

On July 12, 1999, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Lilaeopsis schaffneriana* var. *recurva* (Huachuca water-umbel) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes seven critical habitat units (CHUs), in Arizona(64 FR 37441-37453).

Critical Habitat Designation

The critical habitat designation for *Lilaeopsis schaffneriana* var. *recurva* includes seven CHUs in Cochise and Santa Cruz counties, Arizona. Designated habitat includes a total of 83.2 kilometers (km) (51.7 miles (mi)) of streams or rivers (64 FR 37441-37453).

Unit 1. Santa Cruz County, Arizona. From USGS 7.5' quadrangle map Sonoita, Arizona. Gila and Salt Principal Meridian, Arizona: T. 20 S., R. 16 E., beginning at a point on Sonoita Creek in sec. 34 at approx. 31°39'19" N latitude and 110°41'52" W longitude proceeding downstream (westerly) to a point in sec. 33 at approx. 31°39'07" N latitude and 110°42'46" W longitude covering approx. 2 km (1.25 mi.).

Unit 2. Santa Cruz County, Arizona. From USGS 7.5' quadrangle map Lochiel, Arizona. That portion of the Santa Cruz River beginning in the San Rafael De La Zanja Grant approx. at 31°22'30" N latitude and 110°35'45" W longitude downstream (southerly) to Gila and Salt Principal Meridian, Arizona, T. 24 S., R. 17 E., through secs. 11 and 14, to the south boundary of sec. 14 covering approx. 4.4 km (2.7 mi.). Also, a tributary that begins in T. 24 S., R. 17 E., sec. 13 at approx. 31°21'10" N latitude and 110°34'16" W longitude downstream (southwesterly) to its confluence with the Santa Cruz River covering approx. 3 km (1.9 mi.).

Unit 3. Cochise County, Arizona. From USGS 7.5' quadrangle map Huachuca Peak, Arizona. Gila and Salt Principal Meridian, Arizona: That portion of Scotia Canyon beginning in T. 23 S., R. 19 E., sec. 3 at approx. 31°27'19" N latitude and 110°23'44" W longitude downstream (southwesterly) through secs. 10, 9, 16 and to approx. 31°25'22" N latitude and 110°25'22" W longitude in sec. 21 covering approx. 5.4 km (3.4 mi.).

Unit 4. Cochise County, Arizona. From USGS 7.5' quadrangle map Huachuca Peak, Arizona. Gila and Salt Principal Meridian, Arizona: That portion of Sunnyside Canyon beginning in T. 23 S., R. 19 E., on the east boundary of sec. 10 downstream (southwesterly) to the south boundary of sec. 10 covering approx. 1.1 km (0.7 mi.).

Unit 5. Cochise County, Arizona. From USGS 7.5' quadrangle map Miller Peak, Arizona. That portion of Garden Canyon in the Fort Huachuca Military Reservation beginning at approx. 31°27'13" N latitude and 110°22'33" W longitude downstream (northwesterly) to approx. 31°28'45" N latitude and 110°20'11" W longitude covering approx. 6.1 km (3.8 mi.).

Unit 6. Cochise County, Arizona. From USGS 7.5' quadrangle map Miller Peak, Arizona. Gila and Salt Principal Meridian, Arizona: That portion of Bear Canyon beginning at a point in T. 24 S., R. 19 E., sec. 1 at approx. 31°22'30" N latitude and 110°21'47" W longitude upstream through T. 23 S., R. 19 E., sec. 36 to a point in sec. 31 at approx. 31°23'18" N latitude and 110°21'22" W longitude covering approx. 1.7 km (1.0 mi.). Also, continuing up an unnamed tributary beginning at a point in T. 23 S., R. 19 E., sec. 31 at approx. 31°23'18" N latitude and 110°21'22" W longitude upstream (northerly) to a point in T. 23 S., R. 19 E., sec. 30 at approx. 31°23'44" N latitude and 110°21'14" W longitude covering approx. 0.9 km (0.5 mi.). Also, that portion of Lone Mountain

Canyon beginning at its confluence with Bear Creek at a point in T. 23 S., R. 19 E., sec. 36 at approx. 31°22'54" N latitude and 110°21'43" W longitude to a point in sec. 36 at approx. 31°23'26" N latitude and 110°21'58" W longitude, thence up an unnamed tributary northwesterly into sec. 25 thence northerly to a point at approx. 31°24'13" N latitude and 110°21'54" W longitude covering approx. 2.7 km (1.7 mi.). Also that portion of Rattlesnake Canyon beginning at its confluence with Lone Mountain Canyon in T. 23 S., R. 19 E., sec. 36 upstream northeasterly into sec. 25 to a point at approx. 31°22'08" N latitude and 110°21'31" W longitude covering approx. 1.5 km (1.0 mi.).

Unit 7. Cochise County, Arizona. From USGS 7.5' quadrangle maps: Hereford, Ariz.; Tombstone SE, Ariz.; Nicksville, Ariz.; Lewis Springs, Ariz.; Fairbank, Ariz.; Land, Ariz. Gila and Salt Principal Meridian, Arizona: That portion of the San Pedro River beginning in the San Rafael Del Valle Grant at a point approx. 200 meters upstream (south) of the Hereford Road bridge at approx. 31°26'16" N latitude and 110°06'24" W longitude continuing downstream (northerly) through the San Rafael Del Valle Grant; T. 21 S., R. 22 E.; T. 21 S., R. 21 S.; through the San Juan De Las Boquilla y Nogales Grant to a point at approx. 31°48'28" N latitude and 110°12'32" W longitude covering approx. 54.2 km (33.7 mi.).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Lilaeopsis schaffneriana* var. *recurva* critical habitat consists of four components (64 FR 37441-37453):

- (1) Sufficient perennial base flows to provide a permanently or nearly permanently wetted substrate for growth and reproduction of *Lilaeopsis*;
- (2) A stream channel that is relatively stable, but subject to periodic flooding that provides for rejuvenation of the riparian plant community and produces open microsites for *Lilaeopsis* expansion;
- (3) A riparian plant community that is relatively stable over time and in which nonnative species do not exist or are at a density that has little or no adverse effect on resources available for *Lilaeopsis* growth and reproduction; and
- (4) In streams and rivers, refugial sites in each watershed and in each reach, including but not limited to springs or backwaters of mainstem rivers, that allow each population to survive catastrophic floods and recolonize larger areas.

Life History

Food/Nutrient Resources

Food Source

Adult: Substrate nutrients

Food/Nutrient Narrative

Adult: Organic, perennially wet (or nearly so) soils comprised of silt or clay (Titus and Titus 2008) provide the nutrients needed for growth.

Reproductive Strategy

Adult: Vegetative (clonal), experiments suggest that most if not all *Lilaeopsis* spp. are self-compatible.

Dependency on Other Individuals or Species

Adult: Although the pollinator(s) of this taxon is unknown, Radke (pers. comm. April 22, 2014) documented a formica ant species feeding on the nectar of *Lilaeopsis schaffneriana* ssp. *recurva* flowers along the San Pedro River in both 2012 and 2013; he believes this may be an important pollinator for the taxon.

Breeding Season

Adult: Flowering has been observed episodically between March and October, peaking in July and occurring with abundance irregularly (Warren et al. 1991, p. 15). Germination occurs one to two weeks after seeds disperse (Gori 1995, p. 3) and flowering can begin within three months of germination.

Key Resources Needed for Breeding

Adult: Hydrologic regime; intermediate level of flooding (not scouring)

Reproduction Narrative

Adult: Although *Lilaeopsis schaffneriana* ssp. *recurva* is capable of reproducing both sexually, through seed, and asexually, through rhizomes, vegetative reproduction is likely the primary form of reproduction. Never-the-less, natural seed banks are important for the persistence of rare species and observations in the field suggest *L. schaffneriana* ssp. *recurva* seed may remain viable for 5 to 10 years, an important survival strategy during times of drought. Another important survival strategy of *L. schaffneriana* ssp. *recurva* are its rhizomes, which enable occurrences to rapidly expand or contract in size between years, seasons, or both, in response to local environmental conditions including temperature and water availability. The taxon can re-root if clumps of rhizomes are dispersed via floods to new habitats. Periodic low to moderate flooding provides disturbed open space for re-colonization, reduces competition (FWS 1999), and acts as a dispersal mechanism for seeds and dislodged clumps (Titus and Titus 2008, FWS 1997). Dislodged clumps only survive if they are deposited in sites that provide the necessary habitat (see sheltering) (Titus and Titus 2008). Flowering has been observed episodically between March and October, peaking in July and occurring with abundance irregularly (Warren et al. 1991, p. 15). Germination occurs one to two weeks after seeds disperse (Gori 1995, p. 3). Although the pollinator(s) of this taxon is unknown, Radke (pers. comm. April 22, 2014) documented a formica ant species feeding on the nectar of *Lilaeopsis schaffneriana* ssp. *recurva* flowers along the San Pedro River in both 2012 and 2013; it is believed this may be an important pollinator for the taxon (USFWS, 2017).

Habitat Type

Adult: Cienegas (marshes), rivers, streams, and springs in permanently wet (or nearly so) muddy or silty substrates with some organic content; generally found in shallow and slow-flowing waters that are relatively stable, or in active stream channels containing refugial sites where the plants can escape the effect of scouring floods. The taxon occurs in both full sun and understory shade of Fremont cottonwood-Goodding willow forests. Found between 610 to 2,170 m (2,001-

7,060 ft) elevation in the US, the range of the taxon crosses the Sierra Madrean Region of southeastern Arizona and adjacent portions of Sonora, Mexico (USFWS, 2017).

Habitat Vegetation or Surface Water Classification

Adult: (1) Forest & Woodland, (2) Shrubland & Grassland, (3) Semi-desert, (5) Aquatic Vegetation

Dependencies on Specific Environmental Elements

Adult: Yes; see key resources needed

Environmental Specificity

Adult: High

Tolerance Ranges/Thresholds

Adult: Low

Site Fidelity

Adult: None

Habitat Narrative

Adult: *Lilaeopsis schaffneriana* ssp. *recurva* is restricted to cienegas, rivers, streams, and springs in permanently wet (or nearly so) muddy or silty substrates with some organic content (64FR 37441, pp. 37441-37442). The taxon is generally found in shallow and slow-flowing waters that are relatively stable, or in active stream channels containing refugial sites where the plants can escape the effect of scouring floods (62FR 665 p. 667; 64FR 37441, p. 37442). Through both rhizomes and seeds, the taxon can survive short periods without water, though is generally considered a taxon of perennial water environments. Found between 855 and 2,170 meters (m) (2,805 and 7,120 feet [ft]) in elevation, the range of the taxon crosses the Sierra Madrean Region of southeastern Arizona and adjacent portions of Sonora, Mexico (Titus and Titus 2008c, p. 459; Vernadero Group and the Desert Botanical Garden 2012, p. 1).

Dispersal/Migration**Motility/Mobility**

Adult: Low

Dispersal

Adult: Usually through flood waters, but long-distance dispersal of seeds or rhizomes by birds or other vectors might be responsible for geographically distant occurrences.

Dispersal/Migration Narrative

Adult: Surface and groundwater development has disrupted aquatic habitat connectivity that once provided opportunities for expansion of the population into new, downstream habitats after flood events. After a flood, *Lilaeopsis* can rapidly expand its population and occupy disturbed habitat until interspecific competition exceeds its tolerance. In rivers and streams, the expansion and contraction of *Lilaeopsis* populations appears to depend on the presence of “refugia” where the species can escape the effects of scouring floods, a watershed that has an unaltered flow regime, and a healthy riparian community that stabilizes the channel. (USFWS

1999). At present, the known populations are largely isolated from other waterways. Long-distance dispersal of seeds or rhizomes by birds or other vectors might be responsible for geographically distant occurrences.

Population Information and Trends

Population Trends:

Declining

Species Trends:

Stable or declining across range

Number of Populations:

30 naturally-occurring locations in the U.S. and 21 in Sonora, Mexico.

Population Size:

Individual *L. schaffneriana* ssp. *recurva* plants are difficult to identify due to their clonal reproduction and clustered growth habit. In addition, the taxon is difficult to detect due to its diminutive size.

Additional Population-level Information:

The clonal nature of the taxon may also reduce genetic diversity, increasing vulnerability to extinction. Occurrences are in many cases isolated which makes the chance of natural recolonization after extirpation less likely (USFWS, 2017).

Population Narrative:

Within the Santa Cruz, San Pedro, and Rio Yaqui watersheds in southern Arizona, we are aware of 17 locations supporting extant occurrences of *L. schaffneriana* ssp. *recurva*, 8 locations where all *L. schaffneriana* ssp. *recurva* occurrences are considered extirpated, and 6 locations where historical occurrences have not been seen in recent years. Within the Santa Cruz, San Pedro, Rio Yaqui, Rio Sonora, and Rio Concepcion watersheds in Sonora, Mexico, we are aware of 21 locations supporting *L. schaffneriana* ssp. *recurva* occurrences, though most of these locations have not been revisited in recent years. The greatest quantities of *L. schaffneriana* ssp. *recurva* are found within the San Pedro River, the western Huachuca Mountains and Cienega Creek (USFWS, 2017).

Threats and Stressors

Stressor: Aquatic habitat degradation

Exposure: Not assessed; see narrative

Response: Not assessed; see narrative

Consequence: Not assessed; see narrative

Narrative: Human activities that contribute to aquatic habitat loss and degradation within the historical range of *L. schaffneriana* ssp. *recurva* include: groundwater overdrafts, surface water diversions, impoundments, channelization, improper livestock grazing, agriculture, mining, sand and gravel operations, road building, non-native species introductions, urbanization, wood cutting, wildfires, and recreation (Hendrickson and Minckley 1984, p. 161; Bahre 1991, pp. 177-178; Hereford 1993, p. 2). Flood control projects that permanently alter stream flow

characteristics may reduce or eliminate stream sinuosity and associated pool and backwater habitats that are critical to *L. schaffneriana* ssp. *recurva*. Ground water pumping may lead to perennial reaches becoming intermittent or ephemeral and to springs drying out, resulting in the loss of *L. schaffneriana* ssp. *recurva* occurrences (Warren et al. 1991, p. 7; 60FR 16836, p. 16838; Service 2014b, pp. 148-149). Such activities are widespread in Arizona.

Stressor: Wildfire and associated sedimentation and scouring

Exposure:

Response:

Consequence:

Narrative: Fire would generally not burn the wetland habitat of *L. schaffneriana* ssp. *recurva* due to high humidity; however it has the potential to burn adjacent upland habitats causing indirect effects on *L. schaffneriana* ssp. *recurva* and its habitat throughout the range of the taxon (Service 2009a, p. 21). Effects include increased runoff of floodwaters, deposition of debris and sediment originating in the burned area, and potential for scouring of *L. schaffneriana* ssp. *recurva* individuals and habitat (Service 2014b, p. 145). Since the mid-1980s, wildfire frequency in western forests has nearly quadrupled compared to the average of the period 1970 to 1986 (Westerling et al. 2006, p. 941). The timing, frequency, extent, and destructiveness of wildfires are likely to increase (Westerling et al. 2006, p. 943) and with them changes in vegetation community composition and structure, increased presence of invasive exotic plants, and alterations in the hydrologic and nutrient cycles (Griffis et al. 2000, p. 243; Crawford et al. 2001, p. 265; Hart et al. 2005, p. 167; Smithwick et al. 2005, p. 165; Stephens et al. 2014, p. 42). Post-fire flooding and associated sedimentation can strip out, bury, or stunt growth of *L. schaffneriana* ssp. *recurva* patches, or transform habitat from wet or marshy to dry, sandy, or gravelly (Service 2009a, p. 24; Service 2013a, p. 4). At lower elevations, the spread of non-native invasive grasses has been increasing in recent decades and these non-native grasses not only out-compete native grassland species, but they have a completely different fire regime than the native grasses, tending to form dense stands that promote higher intensity fires more frequently (USFWS, 2017).

Stressor: invasive, non-native plant competition

Exposure:

Response:

Consequence:

Narrative: *Lilaeopsis schaffneriana* ssp. *recurva* are most abundant in areas with ample sunlight and low competition with other native and non-native species (Titus and Titus 2008c, p. 459). The best available scientific and commercial information indicates that invasive exotic plants have increased their presence within aquatic habitat of southeastern Arizona, and this invasion and expansion of infestations are expected to continue. Because *L. schaffneriana* ssp. *recurva* is sensitive to competition from both native and non-native herbaceous plants, the continued increase in such species as *S. halepense*, *C. dactylon*, *N. officinale*, and *R. discolor* can only lead to a decrease in the presence of *L. schaffneriana* ssp. *recurva* throughout the range of the taxon (USFWS, 2017).

Stressor: Livestock grazing

Exposure:

Response:

Consequence:

Narrative: *Lilaeopsis schaffneriana* ssp. *recurva* are affected by livestock grazing in the following ways: 1) trampling, 2) direct impacts from construction of range improvement projects, 3) changes in stream geomorphology that lead to erosion, sedimentation, and downcutting, 4) watershed degradation and resulting adverse effects to stream hydrology, and 5) consumption (Service 1999, p. 237; Anderson 2006, p. 28). Observations of *L. schaffneriana* ssp. *recurva* response to grazing indicate the taxon is capable of experiencing light to moderate grazing with negligible impact (Simms pers. comm. October 26, 2011; Anderson 2006, pp. 22, 31; Edwards pers. comm. February 21, 2001; Rorabaugh 2013, entire). However, grazing during dry periods when cattle spend a disproportionate amount of their time, if not controlled, in riparian areas, may result in harmful effects to *L. schaffneriana* ssp. *recurva* and other riparian obligates (Edwards pers. comm. February 21, 2001; Service 2002a, pp. 76-77; Krueper 1996, p. 287; Malcom and Radke 2008, p. 81; Service 2014a, pp. 3, 6-7). In such instances, severe and widespread trampling may occur; roots and soil structure can be damaged; vegetation species composition and structure can shift; soil can become compacted; stream banks can be degraded; runoff and soil erosion from storm events may increase with higher peak flows; and stream entrenchment may occur; all of which would have harmful effects on *L. schaffneriana* ssp. *recurva* habitat and existing occurrences (Service 2002a, p. 138; Krueper 1996, pp. 287-288; Simms pers. comm. October 26, 2011). In instances where natural disturbance is low or infrequent, occasional trampling and grazing by domestic livestock could improve habitat for *L. schaffneriana* ssp. *recurva*; poorly managed livestock use, however, can be detrimental to the taxon and its habitat (USFWS, 2017).

Stressor: Drought and climate change

Exposure:

Response:

Consequence:

Narrative: *Lilaeopsis schaffneriana* ssp. *recurva* evolved in the Southwest and has persisted in many locations throughout its range through historical droughts such as those of the 1950s. However, given the severity and persistence of the present multi-year drought, it is unknown how long *L. schaffneriana* ssp. *recurva* will maintain viability in de-watered habitat. It has been suggested that seed from this taxon may persist for 5 to 10 years in such situations (Titus and Titus 2008a, p. 319; Titus and Titus 2008b, p. 398; Titus and Titus 2008c, p. 463). There is a reasonable likelihood that the current drought and rise in temperatures will continue for many more years throughout the range of *L. schaffneriana* ssp. *recurva*. It is unknown how long *L. schaffneriana* ssp. *recurva* can remain dormant during an extended drought. The projected drought will likely contain periods of high year-to-year precipitation variability characteristic of Southwest climate. Rise in temperature is also likely to continue for many more years. Whether this variability will be enough to preserve occurrences *L. schaffneriana* ssp. *recurva* remains unknown.

Stressor: Recreation

Exposure:

Response:

Consequence:

Narrative: Recreational activities, such as hiking and camping, if poorly managed, can result in soil compaction, streambank destabilization, erosion and sedimentation, increases in the presence of invasive non-native plant species, and trampling of *L. schaffneriana* ssp. *recurva* and other riparian plant species, thus reducing habitat quality (USFWS 2017).

Recovery**Reclassification Criteria:**

A minimum cumulative extent of 2,000 square meters (0.2 ha / 0.5 ac) of naturally occupied habitat exists in the San Pedro Watershed, 20 percent of which occurs in tributary streams, springs, or cienegas; and a minimum of 2,000 square meters (0.2 ha / 0.5 ac) in the Santa Cruz Watershed, 90 percent of which occurs in tributary streams, springs, or cienegas, distributed among the areas of Cienega Creek (35 percent), Sonoita Creek (10 percent), the San Rafael Valley uplands and mainstem (10 percent), and the western Huachuca Mountains (35 percent); and a minimum of 125 square meters (0.01 ha / 0.03 ac) exists in the Rio Yaqui Watershed; this level of occupancy is sustained or improved for a minimum of 10 years over a 15 year period. (USFWS, 2017)

At least 3 separate introduced occurrences with a minimum cumulative extent of 150 square meters (0.015 ha / 0.037 ac) of occupied habitat are placed in each of the three United States watersheds and are stable or increasing over a 10 year period (USFWS, 2017).

Threats to the taxon and its habitat have been managed and reduced, and management is in place for a minimum of 20 years to ensure the persistence of occurrences with minimum cumulative extent (as reflected by the achievement and maintenance of downlisting criteria 1 and 2) in each of the three United States watersheds (USFWS, 2017).

A living collection of as many plugs as resources allows, collected from genetically distinct regions (e.g. Fort Huachuca / SPRNCA north; San Rafael / Las Cienegas / Sonoita; SPRNCA south / San Bernardino), from both the San Pedro and the Santa Cruz watersheds is maintained in at least one botanical garden in southern Arizona for recovery and educational purposes (USFWS, 2017).

Seeds of *L. schaffneriana* ssp. *recurva* are collected following Center For Plant Conservation guidelines, which include collecting from no more than 10 percent of the standing seed crop from 50 individual seed bearing plants per population (if the population size permits), and collecting from a variety of microsites and physical characteristics within the stand of plants. These seeds are stored at both the Agricultural Research Service National Center for Genetic Resources Preservation in Fort Collins, Colorado and stored according to protocols at a local facility such as the Desert Botanical Gardens in Phoenix, Arizona, for long-term conservation and recovery purposes (USFWS, 2017).

Delisting Criteria:

To delist *L. schaffneriana* ssp. *recurva*, the criteria for down-listing must be met and the level of occupancy in the downlisting criteria is sustained or increasing for a minimum of 20 years over a 30 year period (USFWS, 2017).

Recovery Actions:

- Maintain or enhance groundwater hydrography, as measured by both well observations and stream gages, by reducing water withdrawal and increasing water conservation and recharge (USFWS, 2017).

- Conserve historical, existing, newly discovered, and newly established *L. schaffneriana* ssp. *recurva* occurrences and their seedbanks through the protection of occupied habitat, unoccupied corridors, and habitat quality; augment existing and establish new *L. schaffneriana* ssp. *recurva* occurrences in appropriate habitat using appropriate genetic stock to increase the redundancy (number of occurrences) and resiliency (size of occurrences) of the taxon to help ensure the long-term survival of the taxon in southern Arizona; establish plants at botanical gardens and other Service approved facilities for research, recovery, and educational purposes; and maintain seeds for conservation and recovery at seed storage facilities (USFWS, 2017).
- Remove stressors related to invasive plants and poorly managed livestock grazing to historical, existing, newly discovered, and newly established *L. schaffneriana* ssp. *recurva* occurrences and their habitats (USFWS, 2017).
- Work toward a standardized monitoring technique and continue monitoring occurrences (USFWS, 2017).
- Conduct research and monitoring that will facilitate better understanding of: a) the distribution and genetics of the taxon in both the United States and Mexico, b) population and metapopulation dynamics and trends, c) life history, d) response to threats, and e) other relationships key to recovery of the species (USFWS, 2017).
- Develop collaborative partnerships with Federal and State land managers, private landowners, museums and botanical gardens, seed storage facilities, and others; provide outreach to the public as needed to accomplish recovery; promote the achievement of conservation and recovery in Mexico, resulting in long-term protection of *L. schaffneriana* ssp. *recurva* and its habitat; in coordination with stakeholders, revise this plan as needed as new information comes to light so that the recovery strategy and actions implement recovery in as efficient a manner as possible (USFWS, 2017).
- The principal recovery strategy is to conserve the habitat of *L. schaffneriana* ssp. *recurva* by decreasing groundwater pumping, increasing water conservation and recharge, and protecting *L. schaffneriana* ssp. *recurva* occurrences and their seed banks (USFWS, 2018).
- Monitoring, surveying, scientific study, outreach and partnership development, augmentation and introduction, and reduction or removal of stressors (USFWS, 2018).

Conservation Measures and Best Management Practices:

- Introduction and Augmentation of occurrences: There has been success in establishing *L. schaffneriana* ssp. *recurva* into locations with suitable habitat within the historical range of the taxon (e.g. Audubon Research Ranch, Las Cienegas National Conservation Area, Fort Huachuca, and on the San Pedro Riparian National Conservation Area). Other attempts to establish this taxon have ultimately failed (e.g. Leslie Canyon National Wildlife Refuge and Sonoita Creek). Still other attempts have had mixed results (e.g. San Bernardino National Wildlife Refuge).
- Easements: Since 1990, the Nature Conservancy has held a conservation easement on one private property on Sonoita Creek which supports *L. schaffneriana* ssp. *recurva* (Killeen pers. comm. April 29, 2014). Although the easement was created for a purpose other than the protection of *L. schaffneriana* ssp. *recurva*, the taxon benefits from this land protection. Several additional conservation easements on the Babacomari River are held by The Nature Conservancy, Fort Huachuca, and the Bureau of Land Management; collectively these easements protect several miles of perennial water in the Babacomari River (Duncan pers. comm. April 29, 2014).
- In 1999, Arizona State Parks purchased 1,440 ha (3,557 ac) of land in the San Rafael Valley including the Santa Cruz River which supports small occurrences of *L. schaffneriana* ssp. *recurva*. The land is

rested from livestock grazing, protected from development through an easement, and is managed to minimize the impacts of non-native species. In 2013, the Arizona Land Trust protected 3.2 km (2 mi) of Sonoita Creek on the Circle Z Ranch, including perennial stretches.

- In Sonora, Mexico, Rancho El Aribabi is a federally designated private reserve, which recognizes ecological values and also precludes mineral entry. The Ranch, which contains *L. schaffneriana* ssp. *recurva*, is managed for its ecological values and ecotourism. Similarly, Rancho los Fresnos, which also supports an occurrence of *L. schaffneriana* ssp. *recurva*, is owned and managed for its ecological values by the conservation organization Naturalia. Livestock have been removed from the property and management includes the use of prescribed burning. At Rancho San Bernardino, in Sonora, the Cuenca los Ojos Foundation actively manages lands known to have historically supported and may currently support *L. schaffneriana* ssp. *recurva*. Management includes extensive restoration of grasslands and waterways, resulting in the many-fold increase in extent of perennial water in Rio San Bernardino creating habitat for the taxon.
- Conservation and Management Plans: There are three conservation plans currently in place that provide some benefit to *L. schaffneriana* ssp. *recurva*. First, the 2008 Malpai Borderlands Habitat Conservation Plan ensures that no cattle grazing occurs within San Bernardino National Wildlife Refuge, thereby protecting *L. schaffneriana* ssp. *recurva* from trampling and overgrazing impacts (MBHCPTWG and Lehman 2008, p. 105). Second, the 2009 Leslie Canyon Watershed Safe Harbor Agreement incorporates management actions related to the recovery of the taxon, including its propagation and establishment in existing aquatic habitats, the maintenance of wetland levels, and the exclusion of humans and livestock that may excessively trample the taxon (Service 2009b, p. 7). Lastly, although most *L. schaffneriana* ssp. *recurva* occur outside of Pima County, the Draft Pima County Multi-Species Conservation Plan includes monitoring of a) *L. schaffneriana* ssp. *recurva* every 2 to 3 years, b) habitat conditions at Bingham Cienega, and c) post restoration efforts (Pima County 2012, pp. 70, 81).
- Fort Huachuca participates in water conservation efforts, effluent reuse or recharge, the purchase of conservation easements, and storm water recharge; all which benefit *L. schaffneriana* ssp. *recurva* and its habitat (Service 2014b, p. 21). In addition, Fort Huachuca personnel monitor *L. schaffneriana* ssp. *recurva* both on the Fort and on the San Pedro National Conservation Area regularly (Service 2014b, p. 20). There is no livestock grazing allowed on Fort Huachuca, eliminating the threat *L. schaffneriana* ssp. *recurva* of overgrazing and measures are taken to ensure recreational trampling does not occur (Service 2014b, p. 21). In addition, transplanting of plugs has occurred in the past and may continue in the future (Service 2014b, p. 21).
- Conservation Areas: The Bureau of Land Management manages the Las Cienegas National Conservation Area which encompasses much of the upper Cienega Creek watershed, an area supporting multiple patches of *L. schaffneriana* ssp. *recurva*. The area was set aside to conserve, protect, and enhance this resource and is managed under a comprehensive management plan which includes assurance that riparian and wetland sites are properly functioning (Bureau of Land Management 2003, pp. 7-9). The Bureau of Land Management also conducts periodic monitoring of *L. schaffneriana* ssp. *recurva* along upper Cienega Creek and has plans for introducing plugs at up to 11 locations over a 10 year period (Service 2008, p. 3). In addition, to protect these sensitive riparian and wetland habitats, the Bureau of Land Management designated this area as the Empire-Cienega Area of Critical Environmental Concern. The goal of the designation is to protect and enhance watershed, grassland, and threatened/endangered wildlife resources, emphasizing total ecosystem management (Bureau of Land Management 2003, p. A6-1).

References

USFWS. 2014. Huachuca water umbel (*Lilaeopsis schaffneriana* ssp. *recurva*) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Arizona Ecological Services Tucson Sub-Office, Tucson, Arizona, August 21, 2014, 60 p.

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SPECIES ACCOUNT: *Limnanthes floccosa* ssp. *californica* (Butte County meadowfoam)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/08/1992; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A densely pubescent, winter annual herb. Stems from 3-25 cm in length, generally prostrate with tips curved upward. Flowers are white with dark yellow veins at the base of each of 5 petals (Fish and Wildlife Service 1992) (NatureServe, 2015).

Taxonomy

Before 1973, Butte County meadowfoam was not differentiated from the more widespread woolly meadowfoam (*Limnanthes floccosa* ssp. *floccosa*). An alternative common name, Shippee meadowfoam, is derived from the type locality (California Department of Fish and Game 1987a, Ornduff 1993c). *Limnanthes floccosa* ssp. *californica* is a member of the meadowfoam or false mermaid family (Limnanthaceae), which is a small family comprising only 2 genera and 10 species (Ornduff 1993c) (USFWS, 2005).

Historical Range

Endemic to California, only known from Butte County (Skinner 1997) (NatureServe, 2015). Known historically and currently to occur only in Butte County within the Northeast Sacramento Valley Vernal Pool Region (USFWS, 2008).

Current Range

At least eight new occurrences of *Limnanthes floccosa* ssp. *californica* have been discovered since 1988 (USFWS, 2005).

Critical Habitat Designated

Yes; 2/10/2006.

Legal Description

On August 11, 2005, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Limnanthes floccosa* ssp. *californica* (Butte County meadowfoam) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four critical habitat units (CHUs), in California (70 FR 46924-46999).

Critical Habitat Designation

The critical habitat designation for *Limnanthes floccosa* ssp. *californica* includes four CHUs in Tehama and Butte Counties, California. This species critical habitat encompasses approximately 16,363 acres (71 FR 7118-7316).

Unit 1: Tehama and Butte Counties. (i) Unit 1A: Tehama and Butte Counties, California. From USGS 1:24,000 scale quadrangles Richardson Springs NW, Campbell Mound, Richardson Springs. (ii) Unit 1B: Butte County, California. From USGS 1:24,000 scale quadrangle Richardson Springs.

Unit 2: Butte County, California. From USGS 1:24,000 scale quadrangle Richardson Springs.

Unit 3: Butte County, California. From USGS 1:24,000 scale quadrangle Richardson Springs, Paradise West, Chico.

Unit 4: Butte County, California. From USGS 1:24,000 scale quadrangles Oroville, Shippee.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Limnanthus floccosa* ssp. *californica* critical habitat consists of two components (70 FR 46924-46999):

(i) Topographic features characterized by isolated mound and intermound complex within a matrix of surrounding uplands that result in continuously, or intermittently, flowing surface water in the depressional features including swales connecting the pools described in PCE (ii), providing for dispersal and promoting hydroperiods of adequate length in the pools.

(ii) Depressional features including isolated vernal pools with underlying restrictive soil layers that become inundated during winter rains and that continuously hold water or whose soils are saturated for a period long enough to promote germination, flowering, and seed production of predominantly annual native wetland species and typically exclude both native and nonnative upland plant species in all but the driest years. As these features are inundated on a seasonal basis, they do not promote the development of obligate wetland vegetation habitats typical of permanently flooded emergent wetlands.

Special Management Considerations or Protections

Existing manmade features and structures, such as buildings, roads, railroads, airports, runways, other paved areas, lawns, and other urban landscaped areas do not contain one or more of the primary constituent elements. Federal actions limited to those areas, therefore, would not trigger a consultation under section 7 of the Act unless they may affect the species and/ or primary constituent elements in adjacent critical habitat.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination, self-pollination (USFWS, 2008)

Lifespan

Adult: One year (USFWS, 2008)

Breeding Season

Adult: February - April (USFWS, 2008)

Key Resources Needed for Breeding

Adult: Insect pollinators, based on closely related species (USFWS, 2008)

Reproduction Narrative

Adult: This is an annual plant. *Limnanthes floccosa* ssp. *californica* typically begins flowering in February, reaches peak flowering in March, and may continue into April if conditions are suitable. Nutlets are produced in March and April, and the plants die back by early May (Jokerst 1989, Dole and Sun 1992). *Limnanthes floccosa* ssp. *californica* has floral adaptations that allow for cross-pollination by insects, but self-pollination mechanisms take over to ensure seed set if insect pollination is unsuccessful. The particular pollinators of *L. floccosa* ssp. *californica* have not been identified; however, other meadowfoam species are pollinated by the native burrowing bees *Andrena limnanthis* and *Panurginus occidentalis* (Thorp and Leong 1998) and by honeybees (Kesseli and Jain 1984), beetles, flies, true bugs (order Hemiptera), butterflies, and moths (Mason 1952, Thorp and Leong 1998) (USFWS, 2008).

Habitat Type

Adult: Wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Valley and foothill grasslands, ephemeral drainages, vernal pool depressions (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Mima mound topography (USFWS, 2008)

Geographic or Habitat Restraints or Barriers

Adult: 165 - 1,167 ft. elevation (USFWS, 2008)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from USFWS, 2008)

Habitat Narrative

Adult: Inhabits valley and foothill grasslands (mesic soils) (Skinner 1997). Associates are *Limnanthes alba* ssp. *alba*, *L. douglasii* var. *rosea*, and *L. floccosa* ssp. *floccosa*. Grows in three types of seasonal wetlands: ephemeral drainages, vernal pool depressions in ephemeral drainages, and occasionally around the edges of isolated vernal pools (Fish and Wildlife Service 1992) (NatureServe, 2015). This species occurs on alluvial terraces in annual grasslands with mima mound topography. The occurrences are found at 165 to 1,167 feet in elevation (McNeill and Brown 1979, CNDDDB 2007). *Limnanthes floccosa* ssp. *californica* occurs in different soils on Tuscan-Igo-Anita Complex Fan terraces of 0-3 percent slope, 0-50 percent rock cobble with an underlying clay durapan. According to the 2006 Butte Area Soil Survey, *L. floccosa* ssp. *californica* is found on 32 different "Musym" classes of soil, but always with an underlying durapan, rock cobble and common hydrological factors (J. Marr, CDFG, in litt. January 2007, Natural Resource Conservation Service 2006). *Limnanthes floccosa* ssp. *californica* has also been found occasionally in disturbed areas, such as drainage ditches, firebreaks, and graded sites (McNeill and Brown 1979, Jokerst 1989, Kelley and Associates Environmental Sciences 1992b, BioSystems Analysis, Inc. 1993, Kelley and Associates Environmental Sciences 1993a) (USFWS, 2008).

Dispersal/Migration**Dispersal**

Adult: Low (USFWS, 2008)

Dispersal/Migration Narrative

Adult: Nutlets of *L. floccosa* ssp. *californica* are apparently dispersed by water and can remain afloat for up to 3 days (Hauptli et al. 1978). Most meadowfoam nutlets are dispersed only short distances. Birds and livestock are potential sources of long distance seed dispersal, but specific instances of such dispersal have not been documented (Jain 1978) (USFWS, 2008).

Population Information and Trends**Population Trends:**

Unknown (USFWS, 2008)

Resiliency:

Very low (inferred from USFWS, 2008; see historical range/distribution)

Redundancy:

Moderate (inferred from USFWS, 2008)

Number of Populations:

20 (USFWS, 2008)

Population Narrative:

In 1989, less than 200,000 plants likely existed in the censused populations (Fish and Wildlife Service 1992) (NatureServe, 2015). There are 20 total extant natural occurrences. Quantitative information on the numbers of plants and area occupied by *Limnanthes floccosa* ssp. *californica* has not been collected in a consistent and systematic manner at all occurrences since the time of listing; therefore, definitive range-wide abundance and population trend information is not yet available (USFWS, 2008).

Threats and Stressors

Stressor: Development (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: 11 occurrences are located on privately owned land and are unprotected. Habitat loss or degradation from urbanization continues to be the greatest threat to all occurrences of the subspecies, even to those that are protected from development. Habitat degradation results from changes in the amount of surface and subsurface water hydrology, introduction of invasive plants, and in areas adjacent to agricultural or residential uses, introduction of pesticides and herbicides. In addition to the threats from development projects that have already been proposed, rapid population growth is predicted for all of Butte County and its urban areas. The City of Chico predicts the construction of approximately 20,000 new housing units and a 61

percent increase in population by 2030 (Butte County Association of Governments 2006). The population of Butte County is expected to increase by 48 percent by 2030 (Butte County Association of Governments 2006). The need for additional housing and associated development will likely threaten the remaining unprotected occurrences of *Limnanthes floccosa* ssp. *californica* which are mostly located in or near existing urban areas or roads (USFWS, 2008).

Stressor: Nonnative plants (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: The Draft Land Management Plan for the Doe Mill Preserve (Center for Natural Lands Management 1996) noted that the occurrence of *Limnanthes floccosa* ssp. *californica* was “healthy” in 1991 but was reduced in numbers in 1996 and stressed from competition with the nonnative grass, *Taeniatherum caput-medusae* (medusa-head). *Glyceria declinata* (waxy manna grass) is a nonnative, perennial grass which may become a threat to *Limnanthes floccosa* ssp. *californica*. *Glyceria declinata* forms dense stands and is able to invade vernal pool habitat and displace native plants (The Nature Conservancy 2006) (USFWS, 2008).

Stressor: Drought and climate change (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Maintenance of the natural hydrology of these wetlands is necessary for the survival and recovery of this subspecies. Drought or flood conditions will place additional strains on the vernal pool ecosystems supporting *L. floccosa* ssp. *californica* occurrences. Climate is predicted to change in California during the 21st century (Lenihan et al. 2006, Cayan et al. 2005, Field et al. 1999). Even modest changes in warming could result in a reduction of the spring snowpack, earlier snowmelt, and more runoff in winter with less runoff in spring and summer, more winter flooding, and drier summer soils (Cayan et al. 2005, Field et al. 1999). Although the specific effects of climate change on *L. floccosa* ssp. *californica* are not yet known, the predicted shift in precipitation of increased winter runoff and reduced spring and summer rainfall have the potential to adversely affect this subspecies (USFWS, 2008).

Stressor: Off-road vehicles (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Impacts from off-road vehicles continue to threaten to the subspecies. In 2006, a vehicle driving off-road in Bidwell Ranch became stuck in the mud near an area supporting *L. floccosa* ssp. *californica* (B. Vlamis, pers. comm., 2007). Vehicles can crush the plants and seeds, and compact the soil, thus making germination more difficult, and alter the hydrology of the habitat. Portions of many *L. floccosa* ssp. *californica* occurrences are located adjacent to roads and are unfenced thereby exposing them to potential damage from off-road driving (USFWS, 2008).

Recovery

Reclassification Criteria:

See delisting criteria.

Delisting Criteria:

1. Suitable vernal pool habitat within each prioritized core area for the species is protected (USFWS, 2008).
2. Species occurrences distributed across the species geographic range and genetic range are protected. Protection of extreme edges of populations protects the genetic differences that occur there (USFWS, 2008).
3. Reintroductions must be carried out and meet success criteria established in the recovery plan (USFWS, 2008).
4. Additional occurrences identified through future site assessments, GIS and other analyses, and status surveys that are determined essential to recovery are protected. Any newly found occurrences may count towards recovery goals if the occurrences are permanently protected as described in the recovery plan (USFWS, 2008).
5. Habitat protection results in protection of hydrology essential to vernal pool ecosystem function, and monitoring indicates that hydrology that contributes to population viability has been maintained through at least one multi-year period that includes above average, average, and below average local rainfall as defined above, a multi-year drought, and a minimum of 5 years of post-drought monitoring (USFWS, 2008).
6. Habitat management and monitoring plans that facilitate maintenance of vernal pool ecosystem function and population viability have been developed and implemented for all habitat protected (USFWS, 2008).
7. Mechanisms are in place to provide for management in perpetuity and long-term monitoring of criterion 1 - 5 (USFWS, 2008).
8. Monitoring indicates that ecosystem function has been maintained in the areas protected under criterion 1 - 4 for at least one multi-year period that includes above average, average, and below average local rainfall, a multi-year drought, and a minimum of 5 years of post-drought monitoring (USFWS, 2008).
9. Seed banking actions have been completed for species that would require it as insurance against risk of stochastic extirpations or that will require reintroductions or introductions to contribute to meeting recovery criteria (USFWS, 2008).
10. Status surveys, 5-year status reviews, and population monitoring show populations within each vernal pool region where the species occur are viable (e.g., evidence of reproduction and recruitment) and have been maintained (stable or increasing) for at least one multi-year period that includes above average, average, and below average local rainfall, a multi-year drought, and a minimum of 5 years of post-drought monitoring (USFWS, 2008).
11. Status surveys, status reviews, and habitat monitoring show that threats identified during and since the listing process have been ameliorated or eliminated. Site-specific threats identified

through standardized site assessments and habitat management planning also must be ameliorated or eliminated (USFWS, 2008).

12. Research actions necessary for recovery and conservation of the covered species have been identified (these are research actions that have not been specifically identified in the recovery actions but for which a process to develop them has been identified). Research actions (both specifically identified in the recovery actions and determined through the process) on species biology and ecology, habitat management and restoration, and methods to eliminate or ameliorate threats have been completed and incorporated into habitat protection, habitat management and monitoring, and species monitoring plans, and refinement of recovery criteria and actions (USFWS, 2008).

13. Research on genetic structure has been completed (for species where necessary – for reintroduction and introduction, seed banking) and results incorporated into habitat protection plans to ensure that within and among population genetic variation is fully representative by populations protected in the Habitat Protection section of this document, described previously in criterion 1 - 5 (USFWS, 2008).

14. Research necessary to determine appropriate parameters to measure population viability for each species have been completed (USFWS, 2008).

15. Recovery Implementation Team is established and functioning to oversee rangewide recovery efforts (USFWS, 2008).

16. Vernal pool regional working groups are established and functioning to oversee regional recovery efforts (USFWS, 2008).

17. Vernal pool region working groups have developed and implemented outreach and incentive programs that develop partnerships contributing to achieving recovery criteria (USFWS, 2008).

Recovery Actions:

- Establish a range-wide recovery implementation team (USFWS, 2005).
- Establish working groups and develop participation plans for each vernal pool region (USFWS, 2005).
- Develop and implement adaptive management plans based on monitoring data and best available science (USFWS, 2005).
- Assist local governments in developing habitat conservation plans and developing land use protection measures (USFWS, 2005).
- Assist private landowners in developing landowner agreements (USFWS, 2005).
- Acquire habitat, where necessary (USFWS, 2005).
- Track losses and protection of suitable habitat and occurrences within core areas (USFWS, 2005).
- Ensure mechanisms are in place to provide for the perpetual management and monitoring of core areas, vernal pool regions, or for each management unit within a vernal pool region, as appropriate (USFWS, 2005).

Conservation Measures and Best Management Practices:

- Permanently protect remaining occurrences through conservation easements, fee title, or other protective methods. Implement existing approved management plans for *Limnanthes floccosa* ssp. *californica*. Develop and implement management plans for all occurrences for which management plans have not yet been developed (USFWS, 2008).
- Conduct a status survey of all recorded locations of *Limnanthes floccosa* ssp. *californica* to verify the identity of the plants and determine the status, area occupied, micro-site and hydrology analysis, pollinators, and threats of plants present. Many of the occurrences in CNDDDB have not been thoroughly surveyed for over 15 years. The one presumed extirpated site should also be revisited and surveyed (USFWS, 2008).
- Conduct surveys on potential *Limnanthes floccosa* ssp. *californica* habitat in Butte County for additional occurrences, including the area northeast of Highway 99 between the City of Chico and the intersection of Highways 70 and 149 (USFWS, 2008).
- Conduct studies to determine the effects of grazing and burning on *Limnanthes floccosa* ssp. *californica* and appropriate management at each *L. floccosa* ssp. *californica* occurrence based on individual conditions of each location such as soil type and grass species present (USFWS, 2008).
- Conduct a study to determine the effects of nonnative, invasive plants on *Limnanthes floccosa* ssp. *californica* and appropriate management at *L. floccosa* ssp. *californica* occurrences (USFWS, 2008).

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SPECIES ACCOUNT: *Limnanthes floccosa* ssp. *grandiflora* (Large-flowered woolly Meadowfoam)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/9/2002; Pacific Region (R1)

Physical Description

an upright annual herb with simple stems that occasionally branch near the base. The plants reach 5 to 10 centimeters (2 to 4 inches) high, are mostly glabrous throughout, and have pinnate leaves which are divided into five to nine divisions. The plant's petals are 7.5 to 8 millimeters (0.30 to 0.31 inches) long and equal the sepal length (Figure II-10). The petals are glabrous with the exception of two rows of inside hairs. Each flower produces three to five nutlets. The flowers are white in color with an occasional slight yellow tinge at the base of the petals. (USFWS, 2010)

Taxonomy

Limnanthes pumila ssp. *pumila*, a member of the false mermaid family (Limnanthaceae), was first collected from the top of Table Rock, Jackson County, Oregon, and then described by Howell in 1897 as *Limnanthes pumila*. M.E. Peck revised the name to *Limnanthes bellingeriana* in 1937 (Abrams 1951), but C. T. Mason reassigned the name to *Limnanthes pumila* (Mason 1952). Arroyo (1973) treated the taxon as a subspecies within *Limnanthes floccosa*, but it is currently assigned to *Limnanthes pumila* ssp. *pumila* based on hybridization trials and molecular data (Chambers and Meyers 2011) (USFWS, 2010). In recognition of recent taxonomic changes, on June 23, 2015, we published a technical correction in the Federal Register officially changing the name of the species from *Limnanthes floccosa* ssp. *grandiflora* to *Limnanthes pumila* ssp. *grandijora* (80 FR 35860, p. 35863) (USFWS, 2019).

Historical Range

Endemic to the Middle Rogue River of Jackson County, Oregon. (USFWS, 2010)

Current Range

Endemic to the Middle Rogue River of Jackson County, Oregon. (USFWS, 2019)

Critical Habitat Designated

Yes; 8/20/2010.

Legal Description

On July 21, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective August 20, 2010) for *Limnanthes floccosa* ssp. *grandiflora* (Large-flowered woolly Meadowfoam) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes eight critical habitat units (CHUs), in Oregon (75 FR 42490-42570).

Critical Habitat Designation

The critical habitat designation for *Limnanthes floccosa* ssp. *grandiflora* includes eight CHUs in Jackson County, Oregon. This species critical habitat encompasses approximately 5,840 acres (ac) (2,363 hectares (ha)). All critical habitat units in Jackson County are located within the Middle

Rogue River Basin or “Agate Desert.” Brief descriptions are presented below. Detailed coordinates of and maps depicting the CH units are available in the Final Rule (USFWS, 2010).

Unit RV1 for *Limnanthes floccosa* ssp. *grandiflora*: Shady Cove, Jackson County, Oregon. (i) Unit RV1 consists of approximately 8 ha (20 ha) of intact vernal pool– mounded prairie habitat. The unit is located 460 m (1,500 ft) west of Highway 62 and parallels a 430-m (1,411-ft) stretch of the highway. The unit is 0.8 km (0.5 mi) south of Shady Cove, 1.3 km (0.8 mi) northeast of Takelma Park, and 122 m (400 ft) east of the Rogue River.

Unit RV2 for *Limnanthes floccosa* ssp. *grandiflora*: Hammel Road, Jackson County, Oregon. (i) Unit RV2 is composed of four subunits and comprises approximately 69 ha (169 ac) of vernal pool–mounded prairie. The unit is located 1.2 km (0.75 mi) northeast of the confluence of Reese Creek and the Rogue River, 1.3 km (0.8 mi) west of Highway 62, and 430 m (1,400 ft) east of the Rogue River.

Unit RV3 for *Limnanthes floccosa* ssp. *grandiflora*: North Eagle Point, Jackson County, Oregon. (i) Unit RV3 is composed of four subunits and totals 490 ha (1,210 ac) of intact vernal pool habitat. The unit is located southwest of Mosser Mountain and northeast of Long Mountain. The four subunits loosely follow a 6.9-km (4.3-mi) stretch of Hog Creek beginning at its origin. Originating 3.8 km (2.4 mi) east of Highway 62 in subunit RV3D, Hog Creek runs through RV3C, crosses Highway 62, flows between RV3B (located 100 m (328 ft) west of Highway 62) and RV3A (located 600 m (1,970 ft) west of Highway 62), before emptying into the Rogue River after 2.4 km (1.5 mi). Subunit RV3A is located 560 m (1,837 ft) southeast of the confluence of Reese Creek and the Rogue River. Subunit RV3B is located 100 m (328 ft) west of Highway 62 at the intersection of Ball Road and extends along an 835- m (2,740-ft) stretch of Hog Creek. Subunit RV3C is located 2 km (1.2 mi) north of Eagle Point (see Index map) and extends 2.6 km (1.6 mi) south of the junction of Ball Road and Reese Creek Road. Subunit RV3D is located 3.2 km (2 mi) east of Long Mountain and is 2.4 km (1.5 mi) southeast of the junction of Highway 62 and Ball Road. It extends along a 1.8-km (1.1-mi) stretch of Hog Creek.

Unit RV4 for *Limnanthes floccosa* ssp. *grandiflora*: Rogue Plains, Jackson County, Oregon. (i) Unit RV4 consists of 243 ha (600 ac) of partially intact vernal pool– mounded prairie habitat. The unit is located 122 m (400 ft) southeast of the junction of Highway 234 and Modoc Road. It extends 2 km (1.2 mi) south along Modoc Road from the intersection, is located 1.4 km (0.87 mi) southwest of Dodge Bridge, and is 1.0 km (0.6 mi) northwest of Rattlesnake Rapids on the Rogue River.

Unit RV5 for *Limnanthes floccosa* ssp. *grandiflora*: Table Rock Terrace, Jackson County, Oregon. (i) Unit RV5 includes 49 ha (122 ac) of intact vernal pool–mounded prairie habitat. The unit is located on privately owned land 670 m (2,200 ft) north of the junction of Modoc and Antioc Roads, is 1.4 km (0.9 mi) east of Upper Table Rock, and is 650 m (2,300 ft) west of the Rogue River. This unit follows along an 800-m (2,600-ft) stretch of Modoc Road to the east of the unit and along a 700- m (2,300-ft) stretch of Antioc Road to the west of the unit.

Unit RV6 for *Limnanthes floccosa* ssp. *grandiflora*: White City, Jackson County, Oregon. (i) Unit RV6 for *Limnanthes floccosa* ssp. *grandiflora* consists of eight subunits totaling 740 ha (1,829 ac) in size and includes intact vernal pool– mounded prairie and swale habitats. The unit is located around White City, is 1.6 km (1.0 mi) southwest of Eagle Point, and is 440 m (1,444 ft) southeast of the confluence of the Rogue River and Little Butte Creek. Subunit RV6A is located north of

Whetstone Creek and is 500 m (1,200 ft) west of the junction of Highway 62 and Antelope Road. Subunits RV6B, RV6C, RV6D, and RV6E are located north of Avenue G in White City, south of Little Butte Creek, and 670 m (2,200 ft) southwest of Antelope Creek. Subunits RV6F and RV6G are located approximately 500 feet west of Dry Creek and are east of Highway 62 in White City. Subunit RV6H is located north of Whetstone Creek and south of Antelope Road. Subunit RV6H roughly encircles the Hoover Ponds, east of Highway 62, and is 850 m (2,790 ft) east of subunit RV6A.

Unit RV7 for *Limnanthes floccosa* spp. *grandiflora*: Agate Lake, Jackson County, Oregon. (i) Unit RV7 consists of 421 ha (1,039 ac) of intact vernal pool–mounded prairie and swale habitat. The unit is located 500 m (1,640 ft) east of the Agate Reservoir, lies along a 5.4-km (3.4-mi) stretch roughly parallel and between Dry Creek and Antelope Creek, is 330 m (1,080 ft) north of Tater Hill, and is 1.4 km (0.9 mi) southeast of the confluence of Dry Creek and Antelope Creek.

Unit RV8 for *Limnanthes floccosa* spp. *grandiflora*: Whetstone Creek, Jackson County, Oregon. (i) Unit RV8 consists of 344 ha (850 ac) of intact vernal pool–mounded prairie and swale habitat. The unit is located approximately 1.4 km (0.9 mi) southeast of the confluence of the Rogue River and Whetstone Creek, 2.2 km (1.4 mi) southwest of Tou Velle State Park, and 2.9 km southeast of the confluence of Bear Creek and the Rogue River. The unit roughly parallels a 2.6-km (1.6-mi) stretch of Whetstone Creek to the south.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Limnanthes floccosa* spp. *grandiflora* critical habitat consists of the following habitat components (75 FR 42490-42570):

(i) Vernal pools or ephemeral wetlands and the adjacent upland margins of these depressions that hold water for a sufficient length of time to sustain *Limnanthes floccosa* spp. *grandiflora* germination, growth, and reproduction, occurring in the Rogue River Valley vernal pool landscape. These vernal pools or ephemeral wetlands are seasonally inundated during wet years but do not necessarily fill with water every year due to natural variability in rainfall, and support native plant populations. Areas of sufficient size and quality are likely to have the following characteristics: (A) Elevations from 372 to 469 m (1,220 to 1,540 ft); (B) Associated dominant native plants including, but not limited to: *Alopecurus saccatus*, *Deschampsia danthonioides*, *Eryngium petiolatum*, *Lasthenia californica*, *Myosurus minimus*, *Navarretia leucocephala* spp. *leucocephala*, *Phlox gracilis*, *Plagiobothrys bracteatus*, *Trifolium depauperatum*, and *Triteleia hyacinthina*. (C) A minimum area of 8 ha (20 ac) to provide intact hydrology and protection from development and weed sources.

(ii) The hydrologically and ecologically functional system of interconnected pools, ephemeral wetlands, or depressions within a matrix of surrounding uplands that together form vernal pool complexes within the greater watershed. The associated features may include the pool basin or depressions; an intact hardpan subsoil underlying the surface soils up to 0.75 m (2.5 ft) in depth; and surrounding uplands, including mound topography and other geographic and edaphic features, that support these systems of hydrologically interconnected pools and other ephemeral wetlands (which may vary in extent depending on site-specific characteristics of pool size and depth, soil type, and hardpan depth).

(iii) Silt, loam, and clay soils that are of alluvial origin, with a 0 to 3 percent slope, primarily classified as Agate– Winlo complex soils, but also including Coker clay, Carney clay, Provig–Agate complex soils, and Winlo very gravelly loam soils.

(iv) No or negligible presence of competitive, nonnative, invasive plant species. Negligible is defined for the purpose of this rule as a minimal level of nonnative plant species that will still allow *Limnanthes floccosa* ssp. *grandiflora* to continue to survive and recover.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain the features that are essential to the conservation of the species and that may require special management considerations or protection. All areas we are designating as critical habitat require some level of management to address current and future threats to *Limnanthes floccosa* ssp. *grandiflora*, to maintain or enhance the physical or biological features essential to their conservation, and to ensure the recovery and survival of these species. The major threats to the PCEs in the areas identified as critical habitat for *Limnanthes floccosa* ssp. *grandiflora* include: development on private lands; mining activities; ground disturbance that affects surface hydrology, including ORV use and road construction or maintenance activities; incompatible agricultural and grazing practices; garbage dumping; the succession of meadow habitat to forested habitat due to fire suppression; and encroachment and displacement by nonnative plants. In all of the units in Jackson County, special management is needed to reduce or eradicate the threats posed by development, habitat fragmentation, ground disturbance that affects surface hydrology, and incompatible grazing practices. In all of the units in Josephine County, special management is needed to reduce or eradicate the threats posed by development, ORV use, mining activities, garbage dumping, and woody vegetative succession. Please refer to the unit descriptions in the Critical Habitat Designation section for further discussion of special management considerations or protection of the PCEs related to geographically specific threats to *Limnanthes floccosa* ssp. *grandiflora*. In addition, for all units, special management is needed to control and monitor the encroachment of nonnative, invasive plant species to maintain intact vernal pool–mounded prairies and wet meadow ecosystems such that they can continue to support populations of *Limnanthes floccosa* ssp. *grandiflora*. Special management considerations or protection of the vernal pool–mounded prairies and wet meadow habitats that may be needed to support reproduction and growth of *Limnanthes floccosa* ssp. *grandiflora* include: controlled burning and vegetation clearing to maintain early seral stages (early stages of plant succession in the progression toward a climax community); control of nonnative, invasive plant species; grazing management; the reestablishment of hydrology; re-seeding with native plants; monitoring; and protection from development (Borgias 2004, pp. 47–53; ONHDB 1994, pp. 13–20). (USFWS, 2010)

Life History

Food/Nutrient Resources

Breeding Season

Adult: Meadowfoam typically begins flowering in March, reaches peak flowering in April, and may continue into May if conditions are suitable (USFWS, 2016).

Reproduction Narrative

Adult: Meadowfoam produces one to three flowers per flower stalk; each flower will produce a cluster of 1 to 5 hard nutlets by mid-May that will quickly drop in the drying mud. Over much of its range, meadowfoam is restricted to the relatively wetter, inner fringe of vernal pools in the Rogue Valley plains. Meadowfoam typically begins flowering in March, reaches peak flowering in April, and may continue into May if conditions are suitable. Nutlets are produced in late April, and the plants begin to die back by mid-May or when the soil becomes dry (Borgias 2004). Nutlets of meadowfoam apparently are dispersed by water; they can remain afloat for up to three days (USFWS 2012). However, the nutlets of the plant are normally dispersed only short distances. Thus, meadowfoam nutlets would not be expected to disperse beyond their pool or swale of origin. Birds and livestock are potential sources of long-distance seed dispersal, but specific instances of dispersal have not been documented (Jain 1978) (USFWS, 2016).

Habitat Type

Adult: Vernal pools (USFWS, 2016)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (Natureserve, 2015)

Habitat Narrative

Adult: Meadowfoam is endemic to vernal pool habitats within Jackson County, Oregon. The majority of the extant and historical sites for meadowfoam in the Rogue Valley occur on soil formations characterized by Agate-Winlo silty clay loam series (deep, poorly drained soils present in depressions in alluvial stream terraces) at elevations of 366 to 400 m (1,200 to 1,310 feet) (USFWS 2012). According to Arroyo (1973), the plant occurs generally near the wetter, inner edges of pools, as opposed to the drier outer fringes, which harbor the slightly more common *L. floccosa* ssp. *floccosa* (USFWS 2012). However, meadowfoam has been observed on the outside edges of vernal pools, sympatric with *L. floccosa* ssp. *floccosa*, and has even been observed in some areas on low upland mounds. The deeper basins are dominated by *Plagiobothrys stipitatus*, *Eryngium petiolatum*, *Navarretia leucocephala* ssp. *leucocephala*, and *Myosurus minimus*. *Alopecurus saccatus* (Pacific foxtail), and *Deschampsia danthonioides* are also common plant associates. The inner vernal pool edges occupied by meadowfoam often have up to 10 to 15% exposed soil, due partly to gopher or vole foraging activity (USFWS< 2016).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Birds and livestock are potential sources of long-distance seed dispersal, but specific instances of dispersal have not been documented (Jain 1978) (USFWS, 2016).

Population Information and Trends**Population Trends:**

Unknown (USFWS, 2016)

Population Growth Rate:

Suspected. Decline of 30-50% (NatureServe, 2015)

Number of Populations:

18 (USFWS, 2019)

Population Size:

10,000 - 100,000 individuals (NatureServe, 2015; USFWS, 2016))

Population Narrative:

Since the adoption of the 2012 recovery plan, *Limnanthes pumila* ssp. *grandiflora* remains at 18 known populations (or occurrences) with two new populations documented and one population (Eagle Point) lost since 2011 (Table 1) (Figure 1). In addition, a new population of 160 individual plants at the Pacific Corps Substation was discovered on City of Medford owned land, but also quickly became extirpated during this period. The east Agate Desert, Whetstone Savannah, Highway 140, ODOT Dutton Road site, and Jackson Sports Park populations previously considered separate are combined herein due to their close proximity. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Nearly 50% of *Limnanthes pumila* ssp. *grandiflora* sites have been severely altered (Meyers 2008). In 1999, a function and value assessment of vernal pool quality, abundance, and distribution determined that habitat with intact hydrology and only moderately altered vegetation accounted for just 3,600 acres or 17.6% of the original landform; approximately 2,104 acres of this contained well-distributed and abundant vernal pools (Oregon Natural Heritage Program 1999) (USFWS, 2016).

Stressor: Development (USFS, 2016).

Exposure:

Response:

Consequence:

Narrative: Road construction, housing, industrial and commercial development are listed as threats to this species. Other development in Medford, occurring in 2006, resulted in the loss of habitat (USFWS, 2016).

Stressor: ORV use (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Off-road vehicle use is listed as a threat to this species. Recreational off-road vehicle activities have also impacted two meadowfoam populations in the White City area (USFWS, 2016).

Stressor: Dumping (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Fill and contaminant dumping are listed as threats to this species (USFWS, 2016). Since 2002, a known meadowfoam population in the Agate Desert near Table Rocks Road was partially impacted due to disposal of contaminants (perhaps herbicide) that removed native vegetation from a 0.75 acre portion of vernal pools. The source of the spill was not determined (USFWS, 2016).

Stressor: Non-native plants (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Invasion of non-native annual grasses and herbs is listed as a threat to this species (USFWS, 2016).

Stressor: Herbicide spraying (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Herbicide spraying is listed as a threat to this species (USFWS, 2016).

Stressor: Livestock grazing (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Poorly managed livestock grazing is listed as a threat to this species (USFWS, 2016).

Stressor: Predation (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: There is a potential threat of predation by meadowfoam fly (*Scaptomyza apicalis*) larvae (USFWS 2012). The meadowfoam fly, which occurs in northern California and Southern Oregon, is the only insect pest of significance on species of meadowfoam. The larvae of the meadowfoam fly have been known to cause severe damage to both vegetative and reproductive tissue in *Limnanthes alba* and may be present on meadowfoam in the Agate Desert, though the fly has not been observed (USFWS 2012) (USFWS, 2016).

Recovery

Reclassification Criteria:

Reclassification from Endangered to Threatened status may be considered for *Limnanthes pumila* ssp. *grandiflora* when the following criteria are met: a. At least 16 of the 18 documented and extant occurrences (approximately 90 percent) have been protected from development. If extant occurrences become extirpated, protection of reintroduced or introduced occurrences may be substituted. Introduced or newly discovered populations outside of currently known core areas may be substituted if deemed equivalent in their contribution to recovery. (USFWS, 2010)

b. At least 90 percent of suitable vernal pool habitat acreage within the four Rogue Valley Priority 1 core areas has been protected, and at least 85 percent of suitable vernal pool habitat acreage within the five Rogue Valley Priority 2 core areas has been protected (see Tables IV-2 and IV-4 of the Recovery Plan). All suitable vernal pool habitat must include soils and hydrology that support *Limnanthes pumila* ssp. *grandiflora*. This habitat includes both occupied and suitable habitat. Suitable habitat that is not currently known to be occupied must be protected to provide for corridors and dispersal habitat, restoration dynamics, provide for reintroduction/introduction sites, and to protect currently undiscovered populations. (USFWS, 2010)

c. Management plans for each protected area are developed for species protection and conservation and implemented as soon as feasible. The management plans should address vegetation control, include a set of methods to reduce thatch buildup and noxious weed control, set a monitoring schedule to assess population levels to quantitatively determine trends, include a set of methods to maintain hydrological functions, outline an outreach plan for neighboring landowners, and set a plan to deter garbage dumping. Management plans should take an ecosystem approach to management, conserving associated wetland and upland species. (USFWS, 2010)

d. Additional *Limnanthes pumila* ssp. *grandiflora* occurrences identified through future site assessments, GIS and other analyses, and status surveys that are determined necessary to recovery are protected. (USFWS, 2010)

e. Achievement of self-sustaining *Limnanthes pumila* ssp. *grandiflora* populations within core areas will be determined through species monitoring and status surveys in each protected occurrence. In order to be considered self-sustaining, populations should demonstrate evidence of reproduction by seed set or presence of seedlings and exhibit population trends that are stable, increasing or show only minor declines from high population levels for 10 years prior to consideration for reclassification. (USFWS, 2010)

f. Seed collection is accomplished within each core area as insurance against the risk of stochastic extirpations and to ensure that genetic variation can be restored if extirpations occur. Seed banking may also be necessary in order to complete the reintroductions or introductions required to meet recovery criteria (see Table IV-4 of the Recovery Plan). (USFWS, 2010)

Delisting Criteria:

Delisting may be considered for *Limnanthes pumila* ssp. *grandiflora* when all downlisting criteria plus the following criteria are met: (USFWS, 2010)

a. Status surveys, status reviews, and population monitoring show the populations are self-sustaining. Population trends must be shown to be stable, increasing or exhibiting only slight declines from high population levels during a 10-year period prior to consideration following downlisting (e.g., evidence of reproduction and recruitment) and have been determined to be stable, increasing or showing only minor declines from high population levels, and implementation of management plans is effectively managing or eliminating threats. (USFWS, 2010)

b. At least 17 of 18 *Limnanthes pumila* ssp. *grandiflora* occurrences (approximately 95 percent of documented/extant occurrences) have been protected from development. If extant occurrences become extirpated, protection of reintroduced or introduced occurrences may be substituted. Introduced or newly discovered populations outside of currently known core areas may be substituted if deemed equivalent in their contribution to recovery. (USFWS, 2010)

c. At least 95 percent of suitable vernal pool habitat acreage within each Priority 1 core area and 90 percent of suitable vernal pool habitat acreage within Priority 2 core areas has been protected from development. All suitable vernal pool and wet meadow habitat must include soils and hydrology that support *Limnanthes pumila* ssp. *grandiflora*. Reintroductions and introductions are accomplished, as necessary and applicable, to replace populations where status surveys indicate the species has been extirpated (Table IV-4). (USFWS, 2010)

d. A post-delisting monitoring plan has been developed for *Limnanthes pumila* ssp. *grandiflora*. (USFWS, 2010)

Recovery Actions:

- 1. Protect vernal pool and wet meadow habitat from loss, fragmentation, degradation, and incompatible uses. Protection of vernal pool and wet meadow habitat is the broader objective of this recovery plan, because listed species addressed in the plan are now found in mostly fragmented habitat remnants. The first step is to identify and protect remaining relatively higher quality habitat. Although we have identified core areas of suitable habitat for listed species largely based on aerial photo interpretation, Geographic Information Systems soil data layers, topographic maps, historic species occurrence data, and species population mapping, there are uncertainties that can only be resolved by conducting ground level surveys. Complementary actions (1.1 and 1.2) may be necessary steps prior to actual habitat protection actions and are presented sequentially in order as Priority 2 actions. Priority 1 actions will focus habitat protection within identified Priority 1 and 2 recovery core areas, while lower priority actions may include actions outside of core areas. In general, actions which address the most critical threats (loss, fragmentation, or degradation of habitat) are the highest priority actions. (USFWS, 2010)
- 2. Manage, monitor, and restore vernal pool and wet meadow habitat. Management plans are encouraged to be developed to conserve the listed species occurring at each site. Elements of plans may include: restriction of off-road vehicle use by fencing access roads into preserves using proper signage to restrict vehicle access and avoid inadvertent habitat destruction; habitat restoration and noxious weed prevention programs; use of mowing, burning, or managed grazing to reduce density of native and nonnative vegetation; monitoring effects of management actions for effectiveness, employing adaptive modification; continued monitoring of known *Limnanthes pumila* ssp. *grandiflora* populations on extant sites; surveys for new sites in appropriate habitat; or population introductions into unoccupied habitat. Management plans should identify responsibilities of the management agency or organization to protect species. (USFWS, 2010)
- 3. Conduct rangewide population status surveys. A status survey is a process comprising literature review, examination of herbarium or museum specimens, and a series of surveys conducted throughout a species' range. Historical localities of a species are identified, potential locations where the species may occur are predicted based on distributional and ecological data, and historical and potential locations are surveyed for presence of a species. Ground surveys may be a follow-up to determine if species still occur at site. (USFWS, 2010)

- 4. Conduct research essential to the conservation of these species. In addition to or in conjunction with current monitoring efforts, provide opportunities for further research with schools, State and local governments, or private endeavors. Study pollination vectors between and among populations. Research role of mammals, insects, birds, and wind as cyst and seed dispersal vectors. Evaluate techniques to reduce impacts from encroachment of native woody plant succession. Conduct research on prescribed burning, mowing, and native planting on introduced annual grasses. Refine research on appropriate grazing practices. Research genetic and morphologic traits among individuals and populations. Investigate restoration and recovery methods of historical vernal pool ecosystems that were degraded due to biosolid fill, and log debris fill. Determine incidence of herbivory or predation on *Limnanthes pumila* ssp. *grandiflora* populations. Develop offsite and onsite cultivation and propagation techniques for *Limnanthes pumila* ssp. *grandiflora*. Research associated soil crusts as indicators for vernal pool health and function. (USFWS, 2010)
- 5. Enhance public awareness and participation in recovery of the species. Seek to involve stakeholders in the recovery implementation process. Stakeholders are those parties that may be affected by proposed recovery actions, and may include, but are not limited to, Federal and State agencies, Tribal governments, county and city governments, nongovernmental organizations, and private landowners. Through schools, local community meetings, recovery team meetings, county, city, and State fairs, or other venues, we seek to establish contacts with private landowners to provide information about the species. (USFWS, 2010)
- 6. Develop post-delisting monitoring plans. Prior to delisting, a 5-year post-delisting monitoring plan should be developed and in effect. Monitoring and research results should be used to guide the long-term conservation of the species. These tasks are considered a lower priority until more significant and urgent conservation actions can be achieved. Complete post-delisting monitoring plan for *Limnanthes pumila* ssp. *grandiflora*. (USFWS, 2010)
- Recommended Future Actions: Develop conservation easements or conservation programs for existing occurrences on private lands . Assist Jackson County School District #9 with habitat management for *Limnanthes pumila* ssp. *grandiflora* . Augment *Limnanthes pumila* ssp. *grandiflora* on protected habitat in the Rogue Airfield and North Eagle Point core areas
 - Assist the Bureau of Reclamation with *Limnanthes pumila* ssp. *grandiflora* habitat restoration
 - Conduct best management practices studies for *Limnanthes pumila* ssp. *grandiflora*. (USFWS, 2019)

Conservation Measures and Best Management Practices:

- All of the General Plant Conservation Measures (Section 3.13.1) apply for meadowfoam. In additional, livestock grazing will not be used to control or remove invasive and non-native vegetation at project sites occupied by large-flowered meadowfoam, unless approved by the local Service office. Also, this plant can be associated with vernal pool habitats, which can support Cook's desert parsley and vernal pool fairy shrimp (other listed species), and additional PDC, restrictions, and conservation measures may apply for vernal pool fairy shrimp (USFWS, 2016).

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SPECIES ACCOUNT: *Limnanthes vinculans* (Sebastopol meadowfoam)

Species Taxonomic and Listing Information

Listing Status: Endangered; 01/02/1992; Pacific Southwest (R8)

Physical Description

An annual herb of the false meadowfoam family (Limnanthaceae) with weak, somewhat fleshy, decumbent stems up to 30 cm (11.8 in) long (stems grow longest when the plant is submerged while actively growing). The seedlings are unusual among *Limnanthes* species in that they have entire leaves. Leaves of mature plants are up to 10 cm (3.9 in) long and have 3 to 5 leaflets that are narrow and unlobed with rounded tips. Although the first leaves are narrow and undivided, leaves on the mature plant have three to five undivided leaflets along each side of a long stalk (petiole). The length of the petiole also appears to be promoted by submergence. The shape of the leaves distinguishes *L. vinculans* from other members of the *Limnanthes* genus. *Limnanthes vinculans* has fragrant, white flowers during April and May. The flowers are borne in the leaf axils (upper angle between leaf and stem), are bell- or dishshaped, with petals 12 to 18 mm (0.47 to 0.71 in) long. The sepals (green outermost whorl of flower parts that enclose the bud) are shorter than the petals, which turn outward as the nutlets (small, dry nuts) mature. The nutlets are dark brown, 3 to 4 mm (0.12 to 0.16 in) long, and covered with knobby pinkish tubercles (small wartlike projections) (Ornduff 1969a, Brown and Jain 1977, Hauptli et al. 1978, Wainwright 1984, Patterson et al. 1994, Ornduff and Morin 2012). The seeds of *L. vinculans* germinate after the first significant rains in fall. Repeated drying and filling of pools in the spring favors development of large plants with many branches and long stems. (USFWS 2016)

Taxonomy

The earliest collection of *Limnanthes vinculans* was made in 1946 “between Bodega and Petaluma, south of Sebastopol” but this record most likely represents a site near Sebastopol (Wainwright 1984). The species was not described until 1969, when Ornduff (1969a) officially published the name *L. vinculans*. Another common name for this species is Cunningham Marsh meadowfoam (Wainwright 1984, Patterson et al. 1994). The type locality for *L. vinculans* is Todd Road, just west of the intersection with Llano Road, which is near Sebastopol in Sonoma County (Ornduff 1969a). *Limnanthes vinculans* is similar to *L. douglasii* var. *nivea* (snowy meadowfoam) and *L. alba* (white meadowfoam) in flower characteristics, and to *L. bakeri* (Baker’s meadowfoam) in leaf characteristics. However, seedlings of *L. douglasii* and *L. alba* have lobed leaves and the mature leaves have more, deeper lobes called leaflets (5 to 13 leaflets as compared to 3 to 5 leaflets in *L. vinculans*). In addition, the petals of white meadowfoam curve inward as the nutlets mature. *L. bakeri* has smaller flowers than *L. vinculans*, occasionally has two or three lobes on the leaflets, and occurs only in Mendocino County (Ornduff and Crovello 1968, Ornduff 1969a, Brown and Jain 1977, Wainwright 1984, Ornduff and Morin 2013). (USFWS, 2016)

Historical Range

In California, in Sonoma and Napa Counties. (USFWS, 2016)

Current Range

In California, in Sonoma, Napa, and Lake Counties. (USFWS, 2019)

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual: self-pollination, cross-pollination (USFWS, 2016)

Lifespan

Adult: One year (USFWS, 2016)

Dependency on Other Individuals or Species

Adult: Pollinators such as Conophorus flies and Limnanthes bees (USFWS, 2016)

Key Resources Needed for Breeding

Adult: Seed bank (USFWS, 2008); fall rains, insect pollinators (USFWS, 2016)

Reproduction Narrative

Adult: According to Patterson et al. (1994), the seeds of *Limnanthes vinculans* germinate after the first significant rains in fall, although late initiation of rains may delay seed germination. *L. vinculans* plants grow slowly underwater during the winter, and growth rates increase as the pools dry. Repeated drying and filling of pools in the spring favors development of large plants with many branches and long stems. *L. vinculans* begins flowering as the pools dry, typically in March or April. The largest plants can produce 20 or more flowers. Flowering may continue as late as mid-June, although in most years the plants have set seed and died back by then. Each plant can produce up to 100 nutlets. Nutlets of *Limnanthes vinculans* likely remain dormant in the soil, as has been noted in other species of *Limnanthes* (Patterson et al. 1994). For example, in the late 1980s and early 1990s, a site in Cotati remote from other *L. vinculans* occurrences was surveyed for several years by independent qualified botanists. None of these botanists identified flowering occurrences of *L. vinculans* on the project site. Conditions of the pools on the site were highly degraded by wallowing hogs (*Sus scrofa*) and subsequent eutrophication (over enrichment by nutrients) of the pools. Following several years of negative surveys, 12 plants of Sebastopol meadowfoam emerged simultaneously in one pool in the first year following removal of hogs. (USFWS, 2016)

Habitat Type

Adult: Wetland (USFWS, 2016)

Habitat Vegetation or Surface Water Classification

Adult: Northern Basalt Flow and Northern Hardpan vernal pools (USFWS, 2016)

Geographic or Habitat Restraints or Barriers

Adult: 50 - 380 ft. elevation (USFWS, 2016)

Spatial Arrangements of the Population

Adult: Linear, patchy (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Habitat Narrative

Adult: This species grows in northern basalt flow and northern hardpan vernal pools (Sawyer and Keeler-Wolf 1995), wet swales and meadows, on the banks of streams, and in artificial habitats such as ditches (Wainwright 1984; CNDDDB 2002). *Limnanthes vinculans* grows in both shallow and deep areas, but is most frequent in pools 25 to 51 cm (10 to 20 in) deep (Patterson et al. 1994). The species is most abundant in the margin habitat at the edge of vernal pools or swales (Pavlik et al. 2000, 2001). Most confirmed occurrences of *L. vinculans* on the Plain grow on Wright loam or Clear Lake clay soils (Patterson et al. 1994, CNDDDB 2002). A few occurrences are on other soil types, including Pajaro clay loam, Cotati fine sandy loam, Haire clay loam (Patterson et al. 1994) and Blucher fine sandy loam (Wainwright 1984). (USFWS, 2016)

Dispersal/Migration**Dispersal**

Adult: Low, based on closely related species (USFWS, 2016)

Dispersal/Migration Narrative

Adult: Mechanisms for dispersal of nutlets in this species have not been studied. Likely dispersal agents include water (Wainwright 1984), birds, and livestock (Jain 1978). Jain (1978) studied dispersal of nutlets similar to those of *L. vinculans* in two species of meadowfoam, *L. bakeri* (Baker's meadowfoam) and *L. striata* (striped meadowfoam). Nutlets of *L. bakeri* did not disperse beyond the point where they were placed. Nutlets of *L. striata* moved a short distance within the same pool where they were placed but did not disperse to other pools (Hauptli et al. 1978, Jain 1978). (USFWS, 2016)

Population Information and Trends**Population Trends:**

90% of vernal pool habitat destroyed (NatureServe, 2015)

Species Trends:

Primarily unknown or decreasing (USFWS, 2008)

Number of Populations:

10 hydrologically separate (USFWS, 2008); 37 occurrences (USFWS, 2016)

Population Size:

1 - 1000 individuals (NatureServe, 2015); variable from year to year (USFWS, 2008)

Population Narrative:

The available vernal pool habitat is limited as 90% of the vernal pool habitat has been destroyed by urbanization or agricultural development (CPC 2006) (NatureServe, 2015). Populations can vary greatly in size from year to year. Patterson et al. (1994) estimated only 10 hydrologically separate populations of *L. vinculans* exist. The CNDDDB (2008) reports 32 extant occurrences,

with the trend for most occurrences either unknown or decreasing. The genetic variability of *Limnanthes vinculans* is low compared to other *Limnanthes* species (Jain 1984). However, populations of this species do differ in genetic makeup (Jain in litt. 1980) (USFWS, 2008). The current status of numerous *Limnanthes vinculans* occurrences is unknown; however, the most current information from CNDDB, from survey data collected by the Adopt-a-Vernal Pool program, and from species experts indicates that there are 37 occurrences of *L. vinculans* that are presumed extant of which at least three have been introduced (USFWS, 2016).

Threats and Stressors

Stressor: Development and conversion to agriculture (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Today, the largest continuing threats to this species are urban development and land conversion to agriculture (such as vineyards) and associated agricultural activities and wastewater irrigation. The most recent estimates from the California Department of Conservation (2002) are that about 71,000 acres of Sonoma County have been converted to urban uses (Sonoma County Permit and Resource Management Department 2014). The threat of urban development to these species in the Santa Rosa Plain is expected to continue. In addition to urban development, land conversion to agriculture and associated agricultural activities has reduced occurrences of these plants (CNDDB 2014). In 1991, at the time of the listing, approximately 34,500 acres of land were in wine grape production in Sonoma County (Sonoma County Agricultural Commissioner 1991). As of 2012, the acreage of wine grapes in Sonoma County had increased to approximately 58,400 acres (Sonoma County Agricultural Commissioner 2013). Additionally, irrigation with recycled water, a practice that began in the Santa Rosa Plain in the 1970s, has emerged as a major threat. Although the California Regional Water Quality Control Board regulations (Water Quality Control Plan for the North Coast Region) prohibit discharge of recycled water to surface waters during the summer, the regulations did not contemplate that recycled water would be used to irrigate vernal pools and other types of seasonal wetlands (J. Short, pers. comm., 2007). Recycled water, as opposed to wastewater, is tertiary-treated (City of Santa Rosa, in litt. 2015** [comment letter]). Wastewater, however, can come from many sources including livestock waste ponds and runoff from agricultural fields (City of Santa Rosa, in litt. 2015** [comment letter]). (USFWS, 2016)

Stressor: Alteration of hydrology (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Some actions, such as runoff from irrigation or irrigation with recycled water, can result in increased water on the landscape. The vernal pool habitat may receive more water than it normally would or receive it at an inappropriate time, resulting in flooding and death of listed plant seedlings. If water from urban or agricultural runoff continues to fill pools during spring and summer months, the listed plants will disappear because they cannot tolerate permanent inundation; invasion by plant species adapted to permanent inundation will occur. Additionally, irrigation with recycled water and runoff from irrigation can contain chemicals, such as herbicides, and other nutrients (Pereira et al. 1996) that can alter the vernal pool plant community, prevent germination, or kill seedlings. Nitrogen deposition from automobile traffic

may also modify habitat by increasing soil nutrients, thus posing a continuing threat to remnant habitat that might otherwise be suitable for these species. Weiss and Luth (2003, p. 1) conducted research on the effects of nitrogen deposition along a highway south of the San Franciscan peninsula in San Francisco County. They found that nitrogen deposition within 100 m to 400 m from the highway was correlated with increased nonnative grass cover within these areas, resulting in competition for space with native plants. An increase in nonnative grass cover through changed habitat conditions could threaten the three plant species by competing for soil moisture and nutrients and inhibiting successful germination. (USFWS, 2016)

Stressor: Off-highway vehicles (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Damage by off-highway vehicles was noted as a threat to this species. Currently, on Department-owned properties that support the listed plants, some damage to preserves from vehicle trespass does occur, but without damage to the vernal pools. The most significant damage to vernal pools from vehicles has resulted from a Mosquito Vector Control vehicle driving through the vernal pools to spray for mosquitoes during the time when the pools were wet in 2014. Disturbance to the pools included physical damage to the pools and swales from tire ruts and crushing and uprooting the plants (S. Martinelli, CDFW, in litt. 2014). The level of this threat is likely to be variable and is difficult to predict or monitor. (USFWS, 2016)

Stressor: Grazing management and thatch accumulation (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Appropriate levels of grazing may provide some control of weedy plants, reduce competition between native plants and invasive plants, and can provide some bare soil for germination of native plants, all of which may provide opportunities for native plants to germinate. Cessation of cattle grazing has been found to exacerbate the negative effects of invasive nonnative plants on vernal pool inundation period. If grazing is removed, areas of bare soil can be quickly occupied by nonnative, invasive plants. Removal of grazing from vernal pool grasslands where grazing is the traditional land use practice may have devastating impacts on vernal pool habitat, particularly on upland habitat surrounding vernal pools (G. Cooley, in litt., 2014). For example, non-native grasses increased and native grasses decreased in vernal pools when grazing was discontinued at a site in the Southeastern Sacramento Valley, resulting in a 50 to 80 percent reduction in vernal pool inundation (Marty 2005). Since the time of listing, grazing has been removed at many locations and has resulted in thatch build-up. Anecdotal evidence supports the theory that thatch build-up of nonnative vegetation has caused a reduction in the size of extant populations of the listed plants. The Department is re-establishing appropriate grazing practices on some Department-owned lands to reduce thatch build-up and nonnative competitors to the three listed plants (e.g., Todd Road Unit Ecological Preserve). However, reintroduction of grazing may not return a site to its former condition because nonnative plants may continue to occupy the once-vacant niches. For example, harding grass (*Phalaris aquatica*), a robust, invasive perennial grass, can be present in a grazed field, and not be obvious. If grazing is removed, however, the suppressed harding grass can become vigorous and dominate the entire field within a year or two and grazing will not remove this species once it is established (G. Cooley, in litt. 2014). We recognize that there is disagreement among biologists as to the extent

of the threat of inappropriate grazing on the three species. As the final rule concluded, we believe that although the effect of well-managed livestock grazing may be beneficial to vernal pool ecosystem. (USFWS, 2016)

Stressor: Loss of Genetic Diversity / Inappropriate Mixing of Populations(USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: An additional potential threat to these three plants is the disruption of normal gene flow due to population restoration efforts that may mix populations, which may cause unanticipated adverse effects such as disruption of locally adapted gene complexes and outbreeding depression (when offspring from individuals from different populations have lower health/fitness than progeny from individuals from the same population). Several sites are proposed as Preserves in the Santa Rosa Plain and include proposals to seed/inoculate created or restored vernal pools. Seed from a limited number of donor occurrences has already been used for several years to inoculate multiple created or restored sites, creating a risk of overrepresentation of a small gene pool (swamping). The threat level of this activity is unknown; however, the 2007 Programmatic Biological Opinion (Service 2007) includes measures to reduce this potential threat as well as the requirement to obtain a collection permit from the Department. (USFWS, 2016)

Stressor: Climate change (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Narrative: Since the 1950s, the Northern Hemisphere has experienced warmer air temperatures and decreased snowfall (Ackerly et al. 2010, IPCC 2013). By the end of the 21st century, climate change is predicted to result in more intense precipitation events in the form of rain, increased summer continental drying, extreme weather events, and increased wildfire (Ackerly et al. 2010, IPCC 2013). However, current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2013). Climate simulations have shown that California temperatures are likely to increase by 2.7 degrees Fahrenheit (1.5 degrees Celsius) to 8.1 degrees Fahrenheit (4.5 degrees Celsius) depending on the emissions scenario (Cayan et al. 2008). The predicted impacts on California's ecosystems projected with a high certainty include (1) higher sea level and (2) decreased suitable habitat for many terrestrial species as climate change intensifies human impacts [for example isolated patches of vernal pools can be so poorly connected with other patches that migrations required by climate change may be difficult or impossible without human intervention (Field et al. 1999)]. Climate change threatens to increase the loss of pollinators if the abundance of flowers preferred by pollinators decreases. Pollinator emergence times may also be altered by a warming climate. If this occurs, the synchrony of bloom periods and pollinator emergence could be disrupted. The loss of pollinators would further reduce the amount of seed produced by the listed plants because of the plants' limited ability to self-pollinate. Although there currently are no data available regarding changes in plant bloom periods or emergence dates of pollinators in the Santa Rosa Plain in response to climate change, Forister and Shapiro (2003) found that over a period of 31 years, warmer and drier winter conditions were associated with earlier butterfly appearance in the Central Valley of California. Although the loss of seed produced in a single year

would not likely lead to the extirpation of the species, the continued reduction of the seed crop or dependence on self-pollination would reduce the seedbank, genetic variation, and the potential for population expansion. Monitoring of vernal pool ecosystems to determine effects from climate change is necessary to determine what adaptive land management practices would be the most appropriate to ensure the sustainability of vernal pool species (Pyke and Marty 2005), including *B. bakeri*, *L. burkei*, and *L. vinculans*. (USFWS 2016)

Stressor: Extirpation due to Stochastic Events, Isolated Occurrences, and Small Size of Occurrences (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Chance events constitute a serious threat to *Blennosperma bakeri*. Because the known occurrences of *B. bakeri* are limited in number and in range, the species are vulnerable to stochastic (random) events—natural but damaging environmental perturbations and catastrophes such as droughts, storm damage, disease outbreaks, and fires, from which large wide-ranging populations can generally recover, but may lead to extirpation of small isolated populations (Gilpin and Soule 1986). The majority of the remaining habitat associated with the three species is vernal pools and swales in the Santa Rosa Plain. The nature of the vernal pool and swale habitat associated with the three plants may also increase the effects of drought. Vernal pools and swales are inundated only briefly and may not fill during dry years. As a result, we consider stochastic events to be of significant concern for these species. Isolated, small occurrences may also be at risk from a decrease in reproductive rate resulting from decreasing population density. The correlation of reproductive rate with population density, called the Allee effect, may be the result of either increased density or quality of compatible mates, or increased pollination, or both (Stephens et al. 1999). In small populations, if either the plants or their pollinators decline, consequences on the reproductive output of the other may result in an extinction vortex in which each generation is more likely to go extinct (Gilpin and Soule 1986, Soule and Mills 1998). (USFWS, 2016)

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: The Service found that many existing regulatory mechanisms were not sufficient to protect plants, including section 404 of the Clean Water Act, the protections of the California Endangered Species Act, and the California Environmental Quality Act. The 1991 final rule also found that listing the plants under the Federal Endangered Species Act would provide better protection by requiring the Army Corps of Engineers (and other Federal agencies) to consult with the Service prior to final determinations on a proposed activity. (USFWS, 2016)

Stressor: Non-native invasive species (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Creating a drier habitat and facilitating the invasion of non-native upland species, may permanently change the plant community and the non-native plants may outcompete the listed species (Bauder 2000, Marty 2005, competition discussed further below). With insufficient water,

the distribution of plant species that are normally found higher on the edge of the vernal pools may shift downward along the moisture gradient in response to the introduction of invasive plants that now flourish at pool edges. Non-native grasses maintain dominance at pool edges, sequestering light and soil moisture, promoting thatch build-up, and shortening inundation periods. Species strongly associated with vernal pools may disappear from shallow pools as a result of invasion by upland non-native plants. In addition, the invasive species can further alter the hydrology of the site by reducing the inundation period (Marty 2005). Reduction in inundation period is thought to be due to increased evapo-transpiration associated with dense cover of nonnative plants at the vernal pools (Marty 2005). Once non-native, invasive plants are introduced to vernal pools, competition with native species can come from several interactions including root competition (roots of one species are more efficient at absorbing moisture and nutrients from the soil) and pollination success (one species will set more seed and produce more plants). Plant size can also confer superiority when competing with smaller plants. A larger plant can shade smaller or shorter plants and seedlings, depriving them of adequate sunlight which is necessary for plant and seedling growth and survival, and in some cases necessary for seed germination (Barbour et al. 1987). (USFWS, 2016)

Recovery

Reclassification Criteria:

A/1: Of all extant, native occurrences in the Plain not protected as of December 2014, 75 percent of the *Limnanthes vinculans* Northern Core Area occurrences, and 80 percent of the *Limnanthes vinculans* Southern Core Area occurrences are permanently protected to maintain the current geographic, elevational, and ecological distribution of the species. Priority should be given to occurrences that have been shown to be isolated and/or genetically unique. (USFWS, 2016)

A/2: New preserves protect a total of 500 ac in two general areas: 200 ac in the *Limnanthes vinculans* Northern Core Area and 300 ac in the *Limnanthes vinculans* Southern Core Area. These preserves consist of occupied habitat that was not protected as of December 2014. The ecological integrity (e.g., water quality, hydrology, and uplands condition) of these areas is not threatened by adverse habitat modification. Buffers between the protected habitat and incompatible land uses is sufficient to ensure that there are no significant adverse effects to *Limnanthes vinculans*, such as changes in hydrology or contamination by pesticides or herbicides, currently and into the foreseeable future (USFWS, 2016).

A/3: New preserves (comprised of restored or created habitat) must be 10 ac or greater; however, preserves with existing native occurrences may be less than 10 ac. The preserves should be as near to new or existing preserves as possible. (USFWS, 2016)

A/4: The total new preserve acreage among all core areas consists of a minimum of 70 ac of vernal pools and swales (40 ac in the *Limnanthes vinculans* Northern Core Area and 30 ac in the *Limnanthes vinculans* Southern Core Area). However, new preserves are no more than 35 percent wetland which is based on general wetland to upland percentages. (USFWS, 2016)

A/5: Service-approved conservation and management plans that protect vernal pool habitat and upland habitat and address effects of invasive plants are developed and are being effectively implemented. (USFWS, 2016)

A/6: Service shall work with Mosquito Abatement Districts so that their practices in the core and management areas are implemented to avoid impacts to the species. (USFWS, 2016)

E/1: All native occurrences, extant as of December 2014, in the *Limnanthes vinculans* Northern Core Area as well as the Theiller (owned by CDFW) and Haroutounian (owned by Sonoma County Open Space) sites in the southern portion of the *Limnanthes vinculans* Southern Core Area, are replicated at 1:3 (quadrupled in numbers of occurrences) in permanently protected appropriate sites. The remaining occurrences in *Limnanthes vinculans* Southern Core Area are replicated at 1:1 because they are genetically similar. Replication is accomplished by collecting seed or inoculum from a natural occurrence and planting it at additional sites. For example: collecting seed or inoculum at one site and planting it at two additional sites increases the original single occurrence to 3 occurrences (1:2); planting it at three additional sites increases the original occurrence to 4 occurrences (1:3). (USFWS, 2016).

E/2: The preserves noted in Factor A are occupied by *Limnanthes vinculans* at a density of 1,500 seeds per square meter when measured on a 25-year moving average which includes at least one above average and one average rainfall year, and a multi-year drought. A multi-year drought is defined as a period of 3 or more years of below average local rainfall. (USFWS, 2016)

E/3: Service-approved conservation and management plans that protect vernal pool habitat and upland habitat and address effects of small occurrences of the listed plants and climate change, are developed and are being effectively implemented. (USFWS, 2016)

Delisting Criteria:

A/1: At least ninety percent of all known occurrences of *Limnanthes vinculans* that are extant as of December 2014, have been protected in perpetuity. (USFWS, 2016)

E/1: In addition to replication noted in criterion 7 of the downlisting criteria for *Limnanthes vinculans*, all occurrences in management areas have been replicated at 1:2 at permanently protected at appropriate locations. (USFWS, 2016)

E/2: All replicate occurrences in management areas have achieved the same density (1,500 seeds per square meter) as the core area occurrences. (USFWS, 2016)

E/3: If *Limnanthes vinculans* is found at the Knights Valley site, the northernmost location, this occurrence should be replicated at 1:2 in permanently protected appropriate locations. (USFWS, 2016)

E/4: All genetically unique and isolated unprotected sites in management areas are permanently protected in situ. Identification of some genetically unique occurrences is not yet known but will be determined during research listed in Table 6 of the Recovery Plan. (USFWS, 2016)

Recovery Actions:

- 1. Protect extant occurrences and potential habitat for *Limnanthes vinculans*. Natural areas that are known to contain species covered in this recovery plan should be protected in perpetuity through land acquisition, conservation easements, or other means. Protection of these areas will need to be followed by identification of threats and application of

- appropriate and adaptive management to ensure abatement of these threats. In addition to areas that currently support the species, two other types of natural areas also need to be protected or secured: areas where the endangered plants have been found in the past but not been seen recently, and that retain habitat that can be readily restored so that plants can be reintroduced successfully; and areas where the plants have not been found but are appropriate for vernal pool creation, and subsequent introduction of the endangered plants. (USFWS, 2016)
- 2. Develop a central database for survey data from all natural and created occurrences of *Limnanthes vinculans* including information on protection status. Data should include numbers of plants; area occupied by the species; presence of invasive species; site condition; land ownership; level of management; disturbance; whether the site is natural, restored, or created; and degree of genetic uniqueness. If the site has been seeded, the origin of the seed should be identified by name and location of parcel where seed was collected, location of specific pools where seed was collected, and date of seed collection. Any observations of pollinators, such as species or type of pollinator, should also be recorded. This information will serve as the current baseline for evaluating progress of the Factor A and Factor E comparative downlisting and delisting recovery criteria for each of the three plant species. This database should be updated regularly and should be available to all management agencies (USFWS, 2016). In addition, the database should track the location of source seed for sites with created occurrences (USFWS, 2019).
 - 3. Collect and store seed from all occurrences of *Limnanthes vinculans*. Seed collections for each plant taxon should be representative of both population- and species-level genetic diversity; seeds should be collected from multiple plants at each occurrence. Seed collection guidelines published by the Center for Plant Conservation (1991) should be followed. Seed collection should be conducted with caution to ensure that donor populations are not adversely affected by the collection. No more than 5 percent of the reproductive output should be removed from donor populations. Store seeds at two storage facilities certified by the Center for Plant Conservation. Seeds should be collected every 5 years to ensure that seeds in storage are viable. Permits will be required for collecting federally-listed plant seed on federal lands. (USFWS, 2016)
 - 4. Survey historical locations and other potential habitat (not previously surveyed) where *Limnanthes vinculans* may occur. (USFWS, 2016)
 - 5. Conduct research necessary to develop a population viability analysis for *Limnanthes vinculans*. Table 2 of the Recovery Plan lists research tasks needed for the development of a population viability analysis for all three species in the Recovery Plan. All research tasks need to be performed for each of the three species. To maximize efficiency, it may be possible to study the effects of an experimental factor on all three species in the Recovery Plan via the same experiment. (USFWS, 2016)
 - 6. Conduct necessary biological research on *Limnanthes vinculans* and use results to guide recovery efforts. Table 6 of the Recovery Plan the needed research tasks for the recovery of *Blennosperma bakeri*, *Lasthenia burkei*, and *Limnanthes vinculans*. All research tasks need to be performed for each of the three species. To maximize efficiency, it may be possible to study the effects of an experimental factor on all three species via the same experiment. (USFWS, 2016)
 - 7. Habitat management for *Limnanthes vinculans*. Develop adaptive management plans and implement appropriate management actions for all protected sites. Work with local agricultural commissions to track conversion of agricultural uses to vineyards or other non-

- suitable agricultural uses. Decrease acreage of vernal pool habitat within priority preservation and restoration areas that are subjected to altered hydrologic regimes through irrigation practices. Develop treatment protocol with mosquito abatement district to avoid impacts to listed species and vernal pool habitat during treatment. (USFWS, 2016)
- 8. Restore or create vernal wetlands, followed by reintroduction of the species per a restoration techniques white paper and a Reintroduction and Genetic Management Plan. As noted in the Factor A discussion, much of the habitat and occurrences of the three listed plants has been destroyed or fragmented by urban development and conversion to agricultural use. Restoration or creation of habitat, when appropriate, will be necessary to maintain the numbers of plants and occurrences at levels sufficient for survival of the species. Restoration and creation of vernal pool habitat has been conducted for many years in the Santa Rosa Plain for the three plants. To better understand these processes and their rates of success, a white paper and a Reintroduction and Genetic Management Plan should be developed. (USFWS, 2016)
 - 9. Monitor all protected occurrences. Monitoring plans should be developed and implemented for all protected natural and replicated occurrences. Protected occurrences should be monitored annually for plant density, area occupied by the listed species, site condition, changes in hydrology, application of recycled water and wastewater, effects of grazing, invasive species, vandalism, and whether management is appropriate for the listed species' needs. The responsible party for monitoring should also keep an ongoing record of management activities and precipitation on the site, so that changes in rare plant populations can be related to changes in management activities. Monitoring efforts for co-occurring species (e.g. *Blennosperma bakeri* and *Limnanthes vinculans* at Wright Mitigation Bank) should be coordinated to increase efficiency and reduce costs. (USFWS, 2016)
 - 10. Engage and educate the public about *Limnanthes vinculans* recovery. Public education and outreach is important to inform residents and land managers in the Santa Rosa Plain and other areas that support habitat for the species about the significance of the plants and the importance of management and protection of habitat for their persistence. Education and outreach activities should include: (1) develop a public outreach plan, (2) outreach to enhance public understanding of vernal wetlands in general and of imperiled vernal wetland species in particular, (3) information on regulatory responsibilities with regard to endangered species, (4) programs to encourage local interest and involvement in site stewardship, and (5) programs including conservation easements and incentive programs that are available to landowners who may have the vernal pool species on their land. (USFWS, 2016)
 - 13. Agency coordination. Partner with California Department of Fish and Wildlife, Army Corps of Engineers, Regional Water Quality Control Board, Sonoma County, Marin/Sonoma Mosquito and Vector Control District, and Cities of Santa Rosa, Cotati, Rohnert Park, and Windsor to ensure resource management practices are aligned with species conservation needs. Resource management practices to be addressed include: irrigation of vernal pool habitat with recycled water and wastewater within priority preservation and restoration areas; protection of habitat buffers; stream ordinances, grading ordinances, and water quality regulations; and vineyard conversion or other agricultural conversion of areas adjacent to vernal pool habitat that contribute to hydrologic regime and/or provide upland habitat for sustaining the Sonoma County California tiger salamander. Provide legal assurances to willing landowners who implement projects that provide a net conservation benefit. (USFWS, 2016)

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SPECIES ACCOUNT: *Lindera melissifolia* (Pondberry)

Species Taxonomic and Listing Information

Listing Status: Endangered; 7/31/1996; Southeast Region (R4) (USFWS, 2015)

Physical Description

A deciduous, aromatic shrub. 0.5 to 2 meters tall. Plants are stoloniferous and generally grow in clones of numerous, usually unbranched, stems. The species is dioecious. and the flowers of both sexes are small and pale yellow. Pistillate flowers are less conspicuous than staminate flowers. Fruits are about 1 centimeter long at maturity and are bright red (USFWS, 1993).

Taxonomy

In the order Laurales, family Lauraceae (Laurel family) (NatureServe, 2015).

Historical Range

Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, Missouri, North Carolina, and South Carolina (USFWS, 2014).

Current Range

Alabama, Arkansas, Georgia, Mississippi, Missouri, North Carolina, and South Carolina (USFWS, 2014).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect (EPA, 2016)

Breeding Season

Adult: February-March (flowering); March - fall (fruiting) (EPA, 2016)

Key Resources Needed for Breeding

Adult: Possibly seasonal floods (USFWS, 2014)

Reproduction Narrative

Adult: Species is insect-pollinated; flowering occurs from February to March, with fruiting from March to the fall (EPA, 2016). Seeds are tolerant of prolonged flooding and may not be able to form a seed bank without seasonal floods. The seeds do not germinate while submerged, but readily germinate once they are no longer submerged (USFWS, 2014).

Habitat Type

Adult: Seasonally flooded wetlands (USFWS, 2014)

Habitat Vegetation or Surface Water Classification

Adult: Carolina bays, limestone or limesink ponds, sand ponds, and lowland sand prairie depressions (USFWS, 2014); on the bottoms and edges of shallow seasonal ponds in old dune fields, along the margins of ponds and depressions in pinelands, around the edges of sinkholes in coastal areas with karst topography, and along the borders of Sphagnum bogs (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Needs closed canopy and standing water during some part of the year (NatureServe, 2015)

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Habitat Narrative

Adult: Pondberry is found within seasonally flooded wetlands that broadly include riverine bottomland hardwood forests and geographically isolated wetlands in the Atlantic and Gulf Coastal Plains and Mississippi Alluvial Valley of the southeastern United States. Four primary types of geographically isolated wetlands are known to support pondberry populations and include Carolina bays, limestone or limesink ponds, sand ponds, and lowland sand prairie depressions (USFWS, 2014). Can apparently occupy a variety of habitats as long as hydrological requirements are met. Occurs in seasonally flooded wetlands such as floodplain/bottomland hardwood forests and forested swales, on the bottoms and edges of shallow seasonal ponds in old dune fields, along the margins of ponds and depressions in pinelands, around the edges of sinkholes in coastal areas with karst topography, and along the borders of Sphagnum bogs. Usually in shade, but tolerates full sun. Needs closed canopy and standing water during some part of the year (NatureServe, 2015).

Dispersal/Migration**Dispersal**

Adult: Low (inferred from NatureServe, 2015)

Dependency on Other Individuals or Species for Dispersal

Adult: *Catharus guttatus* (hermit thrush) (USFWS, 2014)

Dispersal/Migration Narrative

Adult: Dispersal mechanisms of pondberry remain poorly understood. Pondberry's bright red fruits suggest that animals (including black bears) may play an important role in the dispersal of the species. While numerous animals have been associated with pondberry plants, only the hermit thrush (*Catharus guttatus*) has been confirmed as a dispersal agent of pondberry (USFWS, 2014).

Population Information and Trends**Population Trends:**

Decline of 30 - 70% (NatureServe, 2015a)

Species Trends:

Stable to declining (USFWS, 2014)

Resiliency:

High (inferred from USFWS, 2014)

Redundancy:

High (inferred from USFWS, 2014)

Number of Populations:

61 (USFWS, 2014)

Population Size:

10,000 - 1,000,000 individuals (NatureServe, 2015b)

Population Narrative:

Since listing, new colonies and populations have been discovered in Alabama, Arkansas, Georgia, Mississippi, Missouri, North Carolina, and South Carolina. However, while new colonies/populations have been discovered in each of these states, with the exception of Alabama, populations have also been extirpated from these states during this time (USFWS, 2014). Flower and fruit production can be highly variable. This species appears to require some sort of pollinator (bagged flowers do not set fruit), but does not appear limited by pollinator supply (supplemental pollination does not improve fruit set) (Devall et al. 2001). Even when flower production is high, fruit production may be limited because female clones are absent from many stands, and many sites are isolated. Furthermore, even when fruit production is significant, seedlings are rarely observed (Devall et al. 2001). In combination, these observations suggest a very low rate of sexual reproduction in the wild. Moreover, natural dispersal appears limited (at least in current times), as many populations occur in small habitat patches surrounded by an unsuitable matrix (e.g. agricultural fields), limiting colony establishment opportunities. In the past, seeds could have been disseminated by floodwater, but floodwaters are controlled throughout the species' range today. Devall et al. (2001) believe it unlikely that new colonies will be established without human intervention. This species has probably always been [relatively] rare (Devall et al. 2001). Nevertheless, occurrences of the habitat types in which it is known to thrive have been greatly reduced in number and quality in recent and historic times (USFWS 1985). When this species was proposed for Federal listing in 1985, the US Fish and Wildlife Service noted that "almost all populations known in 1985 had declined since their discovery, some severely." Rangewide, 17 occurrences are thought to be extirpated. A decline of 30-70% is reported. Census figures for many extant populations are lacking. At least 12 extant sites scattered throughout the range report several hundred to several thousand stems (ramets); one Arkansas site has "tens, if not hundreds of thousands of stems; dominant shrub on 100+ acres." Consistent with this information, the Missouri Natural Heritage Program notes that the species "can occur by the tens of thousands at the best [rangewide] sites." Nevertheless, although some of these populations appear quite large, many of the plants may be clones rather than different genetic individuals. Also, many of the other sites appear to have only small populations; McCue (2002) reports that "the number of stems at any given site varies from a few to several hundred" and Devall et al. (2001) indicate that "many of the existing colonies are small, and occupy only a portion of the apparently suitable habitat." Approximately 99 extant occurrences are currently mapped, of which 2-3 are reintroductions (2 in Missouri and

possibly 1 in Arkansas). An additional 17 occurrences are likely extirpated. However, the true number of extant populations may be less than 99, as some currently-mapped occurrences are in close proximity. For example, 19 EOs in Mississippi derive from one USFS inventory of the Delta National Forest, and 18 EOs in Arkansas derive from one status survey in Jackson and Lawrence counties. If more data on these occurrences were available, perhaps they could be delineated as a smaller number of populations (NatureServe, 2015a).

Threats and Stressors

Stressor: Small population sizes and inbreeding depression (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Inbreeding depression or the low number of genetically different individuals (genets) in most or all eastern populations may reduce pondberry's ability to cope with environmental stochasticity, disease, and ultimately threaten the existence of these populations (USFWS, 2014).

Stressor: Climate change (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Climate change has the potential to affect distribution and abundance of plants by influencing seasonal weather patterns, frequency and timing of severe weather events, and myriad plant physiological responses (Hawkins et al. 2008). The specific impacts of climate change to pondberry populations are poorly understood; however, a variety of impacts are possible (USFWS, 2014).

Stressor: Habitat destruction, fragmentation, altered hydrology, and encroaching vegetation (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Geographically isolated wetlands that once sustained pondberry have been cleared for agriculture or timber operations. Similarly, agricultural and silvicultural activities adjacent to some pondberry sites have deleteriously affected these sites by altering hydrological regimes. Other sites have been extirpated by or are threatened by hogs or domestic cattle. Encroaching vegetation can reduce the suitability of some sites for pondberry (USFWS, 2014)

Stressor: Disease (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: All populations are susceptible to the lethal laurel wilt disease, which has spread rapidly since its discovery in 2003 and is likely to continue spreading (USFWS, 2014).

Stressor: Domestic animal and wildlife disturbance (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Trampling by domestic cattle (Service 1993; NatureServe 2012) and hog disturbance (Service 2007; Gustafson 2011; NatureServe 2012; Pittman 2012, in litt.) pose an apparently small risk to pondberry range-wide, but may pose a severe, highly localized threat to some colonies and populations (e.g., Service 1993). (USFWS, 2014)

Recovery**Reclassification Criteria:**

The protection of 15 self-sustaining populations (USFWS, 1993)

Delisting Criteria:

The permanent protection of 25 self-sustaining populations (USFWS, 1993).

Recovery Actions:

- Search for new populations and protect and monitor existing populations (USFWS, 1993).
- Study the species and its habitat (USFWS, 1993).
- Determine the management requirements of the species and implement actions essential for recovery and protection (USFWS, 1993).
- Place selected material into cultivation and place seeds from all populations into seed banks (USFWS, 1993).
- Conduct a public education program (USFWS, 1993).

Conservation Measures and Best Management Practices:

- Further study and characterize potential threats posed by laurel wilt disease. Identify methods and management practices to limit this disease's potential to negatively impact pondberry and its associated habitats (USFWS, 2014).
- Work with federal and state entities, non-governmental organizations, and private individuals to permanently protect and manage existing habitats and populations, including the development and implementation of management plans, as needed (USFWS, 2014).
- Form recovery team to update the recovery plan, which will incorporate and address recent advances in our knowledge and understanding of pondberry genetics, physiology, ecology, threats, and management needs (USFWS, 2014).
- Define what characterizes a "self-sustaining" pondberry population (USFWS, 2014).
- Update existing and develop new monitoring and habitat management methods (USFWS, 2014).
- Continue and expand conservation genetics work to include all populations and determine effective population sizes (USFWS, 2014).
- Characterize genetic diversity and representation of current ex situ safeguarded collections. Expand ex situ preservation of genetic stock to represent all populations with increased emphasis placed on preserving and safeguarding individual genets within and across populations (USFWS, 2014).
- Study the feasibility of and necessary methodology to augment genetically depauperate and sexually limited populations (USFWS, 2014).
- Develop guidelines to efficiently establish plants and seedlings in natural habitats (USFWS, 2014).
- Further study the effects of various types of disturbance (e.g., fire, prolonged flooding, overstory disturbance, etc.) on pondberry survivorship and reproduction (USFWS, 2014).

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SPECIES ACCOUNT: *Linum arenicola* (Sand flax)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/31/2016; Southeast Region (R4)(USFWS, 2017)

Physical Description

Linum arenicola is a small, perennial herb that is 35 to 53 cm (14 to 21 in) tall with yellow flowers that are similar in appearance those of a buttercup (*Ranunculus* spp.). When not in flower, it resembles a short, wiry grass. Plants have one to several stems arising from their base. Leaves are linear in shape, 7–10 millimeters (mm) (0.3–0.4 in) long, 0.6–1 mm (0.02–0.04 in) wide, and arranged alternately along stems, and they have glands scattered along their edges. Flowers are produced on stems consisting of a few slender, spreading branches. The individual flowers are on small stalks 2 mm (0.08 in) long or shorter. The flowers have five yellow, egg-shaped petals that are 4.5–5.5 mm (0.18–0.22 in) long, and five green, lance-shaped to egg-shaped sepals that are 2.4–3.2 mm (0.09–0.13 in) long. The seeds are ovate, 1.2–1.4 mm (0.05–0.06 in) long, and 0.7–0.8 mm (0.027–0.031 in) wide (Rogers 1963, pp. 103–104) (USFWS, 2015). The fruit is an elongate pod, roughly similar to that of a pea, 33–45 millimeters (mm) (1.3–1.8 inches (in)) long and 4.5–5.0 mm (0.19–0.17 in) wide, with a soft fuzzy texture, which turns gray with age and eventually splits open to release seeds (Irwin and Barneby 1982, p. 757; Small 1933, pp. 662–663) (USFWS, 2016).

Taxonomy

Linum arenicola was first described by Small in 1907 as *Cathartolinum arenicola* from plants he collected in Miami-Dade County in 1904. This treatment was consistently followed by Small (1913a, p. 69; 1913b, p. 96; 1933, p. 752). In 1931, Winkler included *Cathartolinum* within the genus *Linum*, renaming the plants *Linum arenicola* (Winkler 1931, p. 30). Others have followed this treatment, including Rogers (1963, p. 103), Long and Lakela (1971, p. 505), Robertson (1971, p. 649), Wunderlin (1998, p. 100), and Wunderlin & Hansen (2003, p. 100) (Hodges and Bradley 2006, p. 37). Synonyms include *Cathartolinum arenicola* Small (Wunderlin and Hansen 2004, p. 5). The Integrated Taxonomic Information System (2015, p. 1) uses the name *Linum arenicola* and indicates that this species' taxonomic standing is accepted. The online Atlas of Florida Vascular Plants (Wunderlin and Hansen 2008, p. 1) uses the name *L. arenicola*. There is consensus that *L. arenicola* is a distinct taxon. We have carefully reviewed the available taxonomic information to reach the conclusion that the species is a valid taxon (USFWS, 2015).

Historical Range

The historical range of *Linum arenicola* consists of central and southern Miami-Dade County and Monroe County in the lower Florida Keys (Bradley and Gann 1999, p. 61). In Miami-Dade County, records for the species were widespread from the Coconut Grove area to the southern part of the County, close to what is now the main entrance to Everglades National Park and Turkey Point (Bradley and Gann 1999, p. 61). In the Florida Keys (Monroe County), there are records of the species from Big Pine Key, Ramrod Key, Upper and Lower Sugarloaf Keys, Park Key, Boca Chica Key, Middle Torch Key (Bradley and Gann 1999, p. 61), and Big Torch Key (Hodges 2010, p. 10) (USFWS, 2015).

Current Range

The current range of *Linum arenicola* consists of eight extant populations in Miami-Dade County and four islands in the Florida Keys: Big Pine Key, Upper and Lower Sugarloaf Keys, and Big Torch Key (USFWS, 2015).

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual

Breeding Season

Adult: Flowers are produced from February to September, with a peak around March and April

Reproduction Narrative

Adult: Little is known about the life history of *Linum arenicola*, including pollination biology, seed production, or dispersal. Reproduction is sexual, with new plants generated from seeds. The species produces flowers from February to September, with a peak around March and April. *L. arenicola* population demographics or longevity have not been studied (Bradley and Gann, 1999, p. 65; Hodges and Bradley 2006, p. 41; Hodges 2007, p. 2).

Habitat Type

Adult: Temporary pools; Forest/Woodland, Old field, Woodland - Conifer, Woodland - Mixed

Habitat Narrative

Adult: Pine Rocklands: *Linum arenicola* occurs in pine rocklands, disturbed pine rocklands, dry marl prairie, and disturbed areas on rocky soils adjacent to these habitats (Bradley and Gann 1999, p. 61; Hodges and Bradley 2006, p. 37). *L. arenicola* grows in thin soil over limestone or in small soil patches caught in surface irregularities of exposed limestone (Kernan and Bradley, 1996, p. 2). Sites most likely to support *L. arenicola* have a grass- and herbdominated understory, abundant pine regeneration, and high cover of exposed rock (Ross and Ruiz 1996, pp. 5–6). The pine rocklands and marl prairies where this species occurs require periodic fire to maintain an open, shrub-free subcanopy, and to reduce litter levels (Bradley and Saha 2009, p. 4). Pine rocklands habitat is described in detail for *Chamaecrista lineata* var. *keyensis*, above. Roadsides and Other Disturbed Sites: While pine rocklands historically were the primary habitat of *Linum arenicola*, the species is currently rare in relatively undisturbed pine rocklands, with the exception of plants on Big Pine Key. Several occurrences are in scraped (scarified) pine rocklands remnants that are dominated by native pine rocklands species, but have little or no pine canopy or subcanopy (Bradley and Van Der Heiden 2013, pp. 9–12). Two populations in Miami-Dade County occur entirely on levees composed of crushed oolitic limestone that are surrounded by sawgrass marsh (Bradley and Gann 1999, p. 61; Bradley and Van Der Heiden 2013, pp. 7–9). Roadsides and other disturbed sites are important habitat for *L. arenicola* because they imitate upland herbaceous habitat (Hodges and Bradley 2006, p. 40). The most robust roadside populations occur in areas adjacent to pine rocklands or rockland hammocks (Hodges 2010, p. 3). Where *L. arenicola* is found on roadsides, the ground cover is dominated

mostly by native herbs and grasses where exotic lawn grasses have not been planted (Bradley 2006, p. 37). Infrequent mowing of some roadsides, and of disturbed sites such as Homestead Air Reserve Base (HARB) and U.S. Special Operations Command South Headquarters (SOC SOUTH), a unified command of all four services in the Department of Defense (DOD) has likely allowed the species to persist by preventing these sites from being taken over by hardwoods. Because *Linum arenicola* seems to only rarely occur within intact pine rocklands, but more frequently adjacent to this habitat, developing conservation and management plans for this species is exceptionally difficult. Its persistence on roadsides is not fully understood. *L. arenicola* was at one time more common in pine rocklands in Miami-Dade County, but a lack of periodic fires in most pine rocklands fragments over the last century have pushed this species into more sunny, artificial environments (Bradley and Gann 1999, p. 61). It is also possible that the species has evolved to persist along roadsides as fire regimes and natural areas were altered and destroyed over the last century (Hodges and Bradley 2006, p. 41). Dry Marl Prairie: Marl prairie is a sparsely vegetated, grass-dominated community found on marl substrates in South Florida. Marls are fine, white, calcareous muds formed from calcite precipitated by a mixture of green algae, blue green algae, and diatoms, known as periphyton. It is seasonally inundated (2 to 4 months) to a shallow depth averaging about 20 cm (8 in). Marl prairie is a diverse community that may contain over 100 species. Marl prairie normally dries out during the winter and is subject to fires at the end of the dry season (FNAI 2010, p. 1). Occurrences reported from marl prairie are at sites that have been artificially drained (Bradley and Van Der Heiden 2013, p. 11), or are scraped pine rocklands that function more like marl prairie (Kernan and Bradley 1996, p. 11). As with roadside populations of *Linum arenicola*, it is possible that dry marl prairies have become refugia for the species as fire regimes and natural areas were altered and destroyed over the last century. Accordingly, the Service does not consider marl prairie to be a primary habitat for *L. arenicola* (USFWS, 2015).

Dispersal/Migration

Population Information and Trends

Population Trends:

In the 5 populations where data are sufficient to assess trend, 3 appear stable and 2 appear declining

Number of Populations:

12

Population Narrative:

The large area of potential habitat and scarcity and diminutive size of *L. arenicola* make thorough surveys for this species difficult (Hodges and Bradley 2006, p. 37). Based on a compilation of all survey work through 2013, including Austin (1980), Kernan and Bradley (1996, pp. 1–30), Bradley and Gann (1999, pp. 61–65), Hodges and Bradley (2006, pp. 37–41), Bradley and Saha (2009, p. 10), Bradley (2009, p. 3), Hodges (2010, pp. 4–5, 15), Bradley and van der Heiden (2013, pp. 6–12, 19), and Bradley et al. (2015, pp. 28–29), of 26 historical population records for *Linum arenicola*, 12 populations are extant and 14 are extirpated, a loss of roughly 54 percent of known populations, from the early 1900s to the present. reliable population trends can be derived from past surveys for 5 of the 12 extant populations. Populations on Big Pine Key and Big Torch Key have shown clear declines. Three populations appear to be stable (data

suggest they have not declined appreciably). Data are insufficient to determine trends for the remaining seven populations. The data also show that 5 of the 12 extant populations are rather small, having fewer than 100 plants.

Threats and Stressors

Stressor: Habitat loss, fragmentation, and degradation (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Habitat loss, fragmentation, and degradation, and associated pressures from increased human population, are major threats; these threats are expected to continue, placing these plants at greater risk. The species may be impacted when pine rocklands are converted to other uses or when lack of fire causes the conversion to hardwood hammocks or other unsuitable habitat conditions. Any populations of this species found on private property could be destroyed by development; the limited pine rocklands, rockland hammock, and coastal berm habitat on public lands can also be affected by development of recreational facilities or infrastructure projects. Although efforts are being made to conserve publicly and privately owned natural areas and apply prescribed fire, the long-term effects of large-scale and wide-ranging habitat modification, destruction, and curtailment will last into the future, while ongoing habitat loss due to population growth, development, and agricultural conversion continues to pose a threat. Therefore, based on the best information available, we have determined that the threats to the species from habitat destruction, modification, or curtailment are occurring throughout the entire range of the species and are expected to continue into the future (USFWS, 2015).

Stressor: Disease or Predation (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: No diseases or incidences of predation have been reported for *Chamaesyce deltoidea* ssp. *serpyllum* or *Argythamnia blodgettii*. Key deer are known to occasionally browse plants indiscriminately, including *Chamaecrista lineata* var. *keyensis* and *Linum arenicola*. Key deer do not appear to feed on *Argythamnia blodgettii*, probably due to potential toxicity (Hodges and Bradley 2006, p. 19). Seed predation by an insect occurs in *Chamaecrista lineata* var. *keyensis*, and seems to be exacerbated by habitat fragmentation. Individuals at the urban edge suffer higher insect seed predation than those inside the forest (Liu and Koptur 2003, p. 1184). While seed predation and occasional Key deer browsing may be a stressor, they do not appear to rise to the level of threat at this time. Therefore, the best available data do not indicate that disease or predation is a threat to *Chamaecrista lineata* var. *keyensis* or *Linum arenicola* (USFWS, 2015).

Stressor: The Inadequacy of Existing Regulatory Mechanisms (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Currently, *Chamaecrista lineata* var. *keyensis*, *Chamaesyce deltoidea* ssp. *serpyllum*, *Linum arenicola*, and *Argythamnia blodgettii* are found on Federal, State, and County lands; however, there is no regulatory mechanism in place that provides substantive protection of

habitat or protection of potentially suitable habitat at this time. NPS and USFWS Refuge regulations provide protection at ENP and the Florida Keys Wildlife Refuge Complex, respectively. The Act provides some protection for candidate species on NWRs and during intraService section 7 consultations. State regulations provide protection against trade, but allow private landowners or their agents to clear or remove species on the Florida Regulated Plant Index. State Park regulations provide protection for plants within Florida State Parks. The NFC program in Miami is designed to protect rare and important upland (non-wetlands) habitats in south Florida; however, this regulatory strategy has several limitations (as described above) that reduce its ability to protect the four plants and their habitats. Although many populations of the four plants are afforded some level of protection because they are on public conservation lands, existing regulatory mechanisms have not led to a reduction or removal of threats posed to these plants by a wide array of sources (see discussions under Factor A, above, and Factor E, below) (USFWS, 2015).

Stressor: Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: We have analyzed threats from other natural or manmade factors including: nonnative, invasive plants; management practices used on roadsides and disturbed sites (such as mowing, sodding, and herbicide use); pesticide spraying and its effects on pollinators; environmental stochasticity; effects from small population size and isolation; and the effects of climate change, including SLR. The related risks from hurricanes and storm surge act together to impact populations of all four plants. Some of these threats (e.g., nonnative species) may be reduced on public lands due to active programs by Federal, State, and county land managers. Many of the remaining populations of these plants are small and geographically isolated, and genetic variability is likely low, increasing the inherent risk due to overall low resilience of these plants (USFWS, 2015).

Recovery

Reclassification Criteria:

Not available- this species does not have a recovery plan.

References

USFWS. 2015. Endangered Species Status for *Chamaecrista Lineata* Var. *Keyensis* (Big Pine Partridge Pea), *Chamaesyce Deltoidea* Ssp. *Serpyllum* (Wedge Spurge), and *Linum Arenicola* (Sand Flax), and Threatened Species Status for *Argythamnia Blodgettii* (Blodgett's Silverbush)

Proposed Rule. 80 FR 58536-58567 (September 29, 2015).

USFWS. 2016. Endangered Species Status for *Chamaecrista lineata* var. *keyensis* (Big Pine Partridge Pea), *Chamaesyce deltoidea* ssp. *serpyllum* (Wedge Spurge), and *Linum arenicola* (Sand Flax), and Threatened Species Status for *Argythamnia blodgettii* (Blodgett's Silverbush)

Final Rule. 81 FR 66842 - 66865 (September 29, 2016).

Proposed Rule. 80 FR 58536-58567 (September 29, 2015).

SPECIES ACCOUNT: *Linum carteri carteri* (Carter's small-flowered flax)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/06/2014; Southeast Region (R4) (USFWS, 2015)

Physical Description

Annual or short-lived perennial herb with an erect stem, 230–360 millimeters (mm) (9.0–14.2 inches (in)) tall, commonly branched near the base and puberulent (covered with minute hairs). Its leaves are slender (18–26 mm (0.7–1.0 in) long and 0.8–1.2 mm (0.03– 0.05 in) wide), entire, alternate, and closely overlap at the base of the plant. This variety has stipules with paired dark glands. Its inflorescence is an ascending or spreading cyme (usually flat-topped or convex flower cluster in which the main axis and each branch end in a flower that opens before the flowers below or to the side of it), with yellow petals that are broadly obovate (egg-shaped), 9–17 mm (0.35– 0.67 in) long, and quickly deciduous. The fruit is straw-colored, ovoid, 4.1– 4.6 mm (0.16– 0.18 in) long, 3.4–3.7 mm (0.13–0.15 in) in diameter, and dehisces (opens spontaneously at defined places) into five two-seeded segments; seeds are narrowly ovoid-elliptic, 2.3–2.8 mm (0.09–0.11 in) long, 1.0–1.3 mm (0.04– 0.05 in) wide. In habit and flower, the plant closely resembles *Piriqueta cistoides* ssp. *caroliniana* (pitted stripeseed) in the family Turneraceae (USFWS, 2014).

Taxonomy

In the order Laurales, family Lauraceae (Flax family). *Linum carteri* was named by Small in 1905; in 1907, he put it in a segregate genus, calling it *Cathartolinum carteri*. In 1963, Rogers renamed the plants as a variety of *Linum rigidum*, noting the close relationship of Florida plants to those in the Western United States. In 1968, he split the taxon into two varieties, calling pubescent plants *Linum carteri* var. *carteri*, and segregating the glabrous plants as *Linum carteri* var. *smallii*, basing the division on new genetic data from Mosquin and Hayley (1967) and his own morphological data (Bradley and Gann 1999). *L. c.* var. *carteri* was treated as endemic to Miami-Dade County, while *L. c.* var. *smallii* was slightly more widespread in southern Florida. ITIS (2013) uses the name *Linum carteri* var. *carteri* and indicates that this species' taxonomic standing is accepted. Based upon the best available scientific information, *Linum carteri* var. *carteri* is a distinct taxon, endemic to Miami-Dade County in Florida. (USFWS, 2013)

Historical Range

First collected in 1903 between the Coconut Grove and Cutler areas of Miami, Florida, and since that time, it has been found in pine rocklands from as far north as the Brickell Hammock area to as far south as the Naranja area (USFWS, 2013).

Current Range

Currently found in eastern Miami-Dade County, Florida, from R. Hardy Matheson Preserve (near Pinecrest) southwest to Naranja/ Modello, with a distance of approximately 27.3 km (17 mi) between the farthest locations (USFWS, 2013).

Critical Habitat Designated

Yes; 9/16/2015.

Legal Description

On August 17, 2015, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective September 16, 2015) for *Linum carteri carteri* (Carter's small-flowered flax) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes seven critical habitat units (CHUs), in Florida (80 FR 49846-49886).

Critical Habitat Designation

The critical habitat designation for *Linum carteri carteri* includes seven CHUs (49 sub-units) in Miami-Dade County, Florida. This species critical habitat encompasses approximately 2,706 acres (ac) (1,095 hectares (ha)). Brief descriptions are presented below. Maps depicting the CH units are available in the Final Rule. (80 FR 49846-49886)

Unit LCC1: Trinity Pineland and Surrounding Areas, Miami-Dade County, Florida: Unit LCC1 consists of 19 ac (48 ha) in Miami-Dade County. Within Unit LCC1, there are three subunits—LCC1A and LCC1B (primarily County-owned), and LCC1C (combination of State lands and private ownership). The unit is comprised of State lands within Trinity Pineland County Park (4 ac (10 ha)); County lands primarily within Tropical Park and A. D. “Doug” Barnes Park (7 ha (18 ac)); and parcels in private ownership (8 ha (19 ac)). This unit is bordered on the north by SW 24 Street, on the south by the Snapper Creek Expressway (State Road (SR) 878), on the east by SW 67 Avenue, and on the west by SW 87 Avenue.

Unit LCC2: Nixon Smiley Pineland Preserve and Surrounding Areas, Miami-Dade County, Florida: Unit LCC2 consists of approximately 113 ha (278 ac) of habitat in MiamiDade County. Within Unit LCC2, there are six subunits (LCC2A–LCC2F) comprising primarily conservation lands and including four larger areas plus two smaller areas. The unit is comprised of State lands within Camp Matecumbe, Tamiami Pineland Complex Addition, and Rockdale Pineland (53 ha (131 ac)); County/local lands within Nixon Smiley Pineland Preserve, Tamiami #8 (Nixon Smiley Addition) Pineland, Pine Shore Pineland Preserve, Ron Ehman Park, and Rockdale Pineland Addition (59 ha (147 ac)); and parcels in private or other ownership (<1 ha (<1 ac)). This unit is bordered on the north by SW 104 Street, on the south by SW 152 Street (Coral Reef Drive), on the east by U.S. 1 (South Dixie Highway), and on the west by SW 177 Avenue (Krome Avenue).

Unit LCC3: USDA Subtropical Horticultural Research Station and Surrounding Areas, Miami-Dade County, Florida: Unit LCC3 consists of approximately 128 ha (316 ac) of habitat in MiamiDade County. Within Unit LCC3, there are nine subunits (LCC3A–LCC3I), including two larger areas (USDA and Deering Estate at Cutler) plus seven smaller areas surrounding these. The unit is comprised of Federal lands within the USDA Subtropical Horticultural Research Station (59 ha (145 ac)); State lands within the R. Hardy Matheson Preserve, Ludlam Pineland, Deering Estate at Cutler, and Deering Estate South Addition (45 ha (112 ac)); County/local lands within Coral Reef Park, Ned Glenn Nature Preserve, and Bill Sadowski Park (15 ha (38 ac)); and parcels in private ownership (8 ha (21 ac)). This unit is bordered on the north by SW 112 Street, on the south by the intersection of Old Cutler Road and Franjo Road (County Road (CR) 977), on the east by the Atlantic Ocean, and on the west by U.S. 1 (South Dixie Highway).

Unit LCC4: Richmond Pinelands and Surrounding Areas, Miami-Dade County, Florida: Unit LCC4 consists of approximately 386 ha (952 ac) in Miami-Dade County. Within Unit LCC4, there are four subunits (LCC4A–LCC4D), primarily within the Richmond Pinelands complex (made up of Federal and County-owned lands, as well as land owned by the University of Miami). The unit is comprised of Federal lands owned by USCG, ACOE, U.S. Prison Bureau, and NOAA (75 ha (185

ac)); County/local lands within and adjacent to Larry and Penny Thompson Park, Martinez Pineland, Zoo Miami, and Eachus Pineland (240 ha (592 ac)); and parcels in private or other ownership (71 ha (175 ac)). This unit is bordered on the north by SW 152 Street (Coral Reef Drive), on the south by SW 200 St (Quail Drive/SR 994), on the east by U.S. 1 (South Dixie Highway), and on the west by SW 177 Avenue (Krome Avenue).

Unit LCC5: Quail Roost Pineland and Surrounding Areas, Miami-Dade County, Florida: Unit LCC5 consists of approximately 98 ha (242 ac) in Miami-Dade County. Within Unit LCC5, there are 10 subunits (LCC5A–LCC5J), including 4 larger areas plus 6 smaller areas surrounding these. The unit is comprised of State lands within Quail Roost Pineland, Goulds Pineland and Addition, and Silver Palm Groves Pineland (39 ha (97 ac)); County/ local lands including Medsouth Park, Black Creek Forest, Rock Pit #46, and lands owned by the School Board of Miami-Dade County (18 ha (44 ac)); and parcels in private ownership (41 ha (101 ac)), including Porter-Russell Pineland owned by the Tropical Audubon Society. This unit is bordered on the north by SW 200 St (Quail Drive/SR 994), on the south by SW 248 Street, on the east by the Florida Turnpike, and on the west by SW 194 Avenue.

Unit LCC6: Camp Owaissa Bauer and Surrounding Areas, Miami-Dade County, Florida: Unit LCC6 consists of approximately 128 ha (315 ac) of habitat in MiamiDade County. Within Unit LCC6, there are 21 subunits (LCC6A–LCC6U), composed of 1 larger area (Camp Owaissa Bauer and its addition) and 20 smaller areas surrounding it. The unit is comprised of State lands within Owaissa Bauer Pineland Addition, Ingram Pineland, West Biscayne Pineland, and Fuchs Hammock Addition (20 ha (51 ac)); County/local lands including Camp Owaissa Bauer, Pine Island Lake Park, Seminole Wayside Park, and Northrop Pineland (63 ha (156 ac)); and parcels in private ownership (44 ha (109 ac)), including the private conservation area, Pine Ridge Sanctuary. This unit is bordered on the north by SW 248 Street, on the south by SW 312 Street, on the east by SW 112 Avenue, and on the west by SW 217 Avenue.

Unit LCC7: Navy Wells Pineland Preserve and Surrounding Areas, Miami-Dade County, Florida: Unit LCC7 consists of approximately 201 ha (497 ac) of habitat in MiamiDade County. Within Unit LCC7, there are seven subunits (LCC7A–LCC7G), including one larger area (Navy Wells Pineland Preserve) and six smaller outlying areas. The unit is comprised of State lands within Palm Drive Pineland, Navy Wells Pineland #39, Navy Wells Pineland Preserve (portion), and Florida City Pineland (53 ha (132 ac)); County/ local lands including primarily Sunny Palms Pineland and Navy Wells Pineland Preserve (portion) (125 ha (309 ac)); and parcels in private ownership (23 ha (56 ac)). This unit is bordered on the north by SW 320 Street, on the south by SW 368 Street, on the east by U.S. 1 (South Dixie Highway), and on the west by SW 217 Avenue.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Linum carteri carteri* critical habitat consists of three components (80 FR 49846-49886):

(i) Areas of pine rockland habitat that contain: (A) Open canopy, semi-open subcanopy, and understory; (B) Substrate of oolitic limestone rock; and (C) A plant community of predominately native vegetation that may include, but is not limited to: (1) Canopy vegetation dominated by *Pinus elliottii* var. *densa* (South Florida slash pine); (2) Subcanopy vegetation that may include, but is not limited to, *Serenoa repens* (saw palmetto), *Sabal palmetto* (cabbage palm),

Coccothrinax argentata (silver palm), *Myrica cerifera* (wax myrtle), *Myrsine floridana* (myrsine), *Metopium toxiferum* (poisonwood), *Byrsonima lucida* (locustberry), *Tetrazygia bicolor* (tetrazygia), *Guettarda scabra* (rough velvetseed), *Ardisia escallonioides* (marlberry), *Psidium longipes* (mangroveberry), *Sideroxylon salicifolium* (willow bustic), and *Rhus copallinum* (winged sumac); (3) Short-statured shrubs that may include, but are not limited to, *Quercus pumila* (running oak), *Randia aculeata* (white indigoberry), *Crossopetalum ilicifolium* (Christmas berry), *Morinda royoc* (redgal), and *Chiococca alba* (snowberry); and (4) Understory vegetation that may include, but is not limited to: *Andropogon* spp.; *Schizachyrium gracile*, *S. rhizomatum*, and *S. sanguineum* (bluestems); *Aristida purpurascens* (arrowfeather threeawn); *Sorghastrum secundum* (lopsided Indiangrass); *Muhlenbergia capillaris* (hairawn muhly); *Rhynchospora floridensis* (Florida white-top sedge); *Tragia saxicola* (pineland noseburn); *Echites umbellata* (devil's potato); *Croton linearis* (pineland croton); *Chamaesyce* spp. (sandmats); *Chamaecrista deeringiana* (partridge pea); *Zamia integrifolia* (coontie); and *Anemia adiantifolia* (maidenhair pineland fern).

(ii) A disturbance regime that naturally or artificially duplicates natural ecological processes (e.g., fire, hurricanes, or other weather events) and that maintains the pine rockland habitat described in paragraph (2)(i) of this entry.

(iii) Habitats that are connected and of sufficient area to sustain viable populations of *Linum carteri* var. *carteri* in the pine rockland habitat described in paragraph (2)(i) of this entry.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographic area occupied by the species at the time of listing contain features which are essential to the conservation of the species and which may require special management considerations or protection. The features essential to the conservation of *Linum carteri* var. *carteri* may require special management considerations or protection to reduce threats related to habitat loss, fragmentation, and modification primarily due to development; inadequate fire management; nonnative, invasive plants; and sea level rise. Destruction of the pinelands for economic development has reduced pine rockland habitat on the Miami Rock Ridge outside of ENP by over 98 percent, and remaining habitat in this area is highly fragmented. *Linum carteri* var. *carteri* occurs on a mix of private and publicly owned lands, only some of which are managed for conservation. Populations of the plants that occur on private land or non-conservation public land are vulnerable to habitat loss, while populations on conservation lands are vulnerable to the effects of habitat degradation if natural disturbance regimes are disrupted (e.g., through inadequate fire management). Prolonged lack of fire in pine rockland typically results in succession to rockland hammock, and displacement of native species by invasive, nonnative plants often occurs. Further development and degradation of pine rocklands increase fragmentation and decrease the conservation value of the remaining functioning pine rockland habitat. In addition, pine rocklands are expected to be further degraded and fragmented due to anticipated sea level rise, which would fully or partially inundate some pine rocklands along the coast and in the southern portion of Miami-Dade County (near Navy Wells Pineland Preserve), and cause increases in the salinity of the water table and soils resulting in vegetation shifts in additional pine rocklands across the Miami Rock Ridge. Many existing pine rockland fragments are also projected to be developed for housing as the human population grows and adjusts to changing sea levels. Special management considerations and protections that will address these threats include increased coordination and conservation of these plants and their habitat on

Federal lands, and improved habitat restoration and management efforts (including fire management and nonnative plant treatments) of high-priority and high-elevation sites. (USFWS, 2013)

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (USFWS, 2013)

Lifespan

Adult: 1 - 2 years (USFWS, 2013)

Breeding Season

Adult: Flowers year-round (USFWS, 2013)

Key Resources Needed for Breeding

Adult: May be pollinated by Insects (USFWS, 2013)

Reproduction Narrative

Adult: The reproductive ecology and biology of *Linum carteri* var. *carteri* is not well understood, but reproduction is sexual. This species is capable of flowering throughout the year, but tends to have most abundant flowering and fruiting following rain. While specific pollinators are unknown, flower morphology suggests this variety may be pollinated by butterflies, bees, or both; self-pollination has also been suggested. For adult reproductive plants, average plant growth was fairly constant from July through October, flowering and fruit production were most abundant in July, and plant mortality increased during the fall months (USFWS, 2013).

Habitat Type

Adult: Terrestrial (USFWS, 2013)

Habitat Vegetation or Surface Water Classification

Adult: Pine rocklands that have undergone some sort of substrate disturbance (USFWS, 2013)

Dependencies on Specific Environmental Elements

Adult: Disturbed areas (e.g. firebreaks, canal banks, edges of railway beds) (USFWS, 2013)

Geographic or Habitat Restraints or Barriers

Adult: Elevations of approximately 1.6–4.8 m (USFWS, 2013)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2013)

Habitat Narrative

Adult: *Linum carteri* var. *carteri* habitat are areas of pine rockland habitat that contain open canopy, semi-open subcanopy, and understory, a substrate of oolitic limestone rock, and a plant community of predominately native vegetation. A disturbance regime is also present that

naturally or artificially duplicates natural ecological processes (e.g., fire, hurricanes, or other weather events) and that maintains the pine rockland habitat (USFWS, 2014). Its known populations are found at elevations ranging from approximately 1.6–4.8 m (5.2 - 15.9 ft) (USFWS, 2013).

Dispersal/Migration

Dependency on Other Individuals or Species for Dispersal

Adult: Unknown (USFWS, 2013)

Dispersal/Migration Narrative

Adult: Dispersers are unknown, although historically water may have played a role in dispersal when summer high- water conditions in adjacent wet prairies may have inundated portions of pine rocklands (USFWS, 2013).

Population Information and Trends

Population Trends:

Not available.

Species Trends:

Declining (USFWS, 2014)

Population Growth Rate:

Low (inferred from USFWS, 2014)

Number of Populations:

7 (USFWS, 2014)

Population Size:

250 - 2500 individuals (NatureServe, 2015)

Population Narrative:

Only small and fragmented occurrences of *L. c. var. carteri* remain. Four of the seven remaining populations have fewer than 20 individual plants. There are great differences in plant numbers from year to year, probably because individuals typically live 1–2 years and grow from seed. This trait makes them more vulnerable than perennials to changes in environment. Viable plant populations for small, short-lived herbs may consist of tens of thousands of plants. Indications are that most existing populations are at best marginal (USFWS, 2014).

Threats and Stressors

Stressor: Habitat loss, fragmentation, and degradation (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Habitat modification caused by development (i.e., conversion to both urban and agricultural land uses) is a primary threat, in addition to habitat modification and degradation

through inadequate fire management, which includes both the lack of prescribed fire and suppression of natural fires. Habitat fragmentation reduces the size of plant populations, and increases spatial isolation of remnants (USFWS, 2013)

Stressor: Competition from nonnative invasive plants (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Nonnative plants have significantly affected pine rocklands, and threaten all occurrences of *Linum carteri* var. *carteri* to some degree. Nonnative invasive plants compete with native plants for space, light, water, and nutrients, and make habitat conditions unsuitable for this species, which responds positively to open conditions; the invasive plants also affect the characteristics of a fire when it does occur (USFWS, 2013).

Stressor: Climate change (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Extreme weather events could be catastrophic on isolated, small populations. The narrow distribution makes them more susceptible to extirpation from a single catastrophic event (USFWS, 2013).

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available

References

USFWS. 2015. Environmental Conservation Online System (ECOS) – Species Profile.
<http://ecos.fws.gov/speciesProfile/>. Accessed April 2016

USFWS. 2013. Proposed Endangered Status for *Brickellia mosieri* (Florida Brickell-bush) and *Linum carteri* var. *carteri* (Carter’s Small-flowered Flax)

Proposed Rule. 78 FR 61273 - 61293 (October 3, 2013). USFWS. 2015. Designation of Critical Habitat for *Brickellia mosieri* (Florida Brickell-bush) and *Linum carteri* var. *carteri* (Carter’s Small-flowered Flax)

Final Rule. 80 FR 49846 - 49886 (August 17, 2015).

USFWS. 2015. Designation of Critical Habitat for *Brickellia mosieri* (Florida Brickell-bush) and *Linum carteri* var. *carteri* (Carter's Small-flowered Flax). Final Rule. 80 FR 49846-49886 (August 17, 2015).

USFWS. 2013. Proposed Designation of Critical Habitat for *Brickellia mosieri* (Florida Brickell-bush) and *Linum carteri* var. *carteri* (Carter's Small-flowered Flax). Proposed Rule. 78 FR 61293 - 61320 (October 3, 2013).

USFWS, 2013. Proposed Endangered Status for *Brickellia mosieri* (Florida Brickell-bush) and *Linum carteri* var. *carteri* (Carter's Small-flowered Flax)

Proposed Rule. 78 Federal Register 192. October 3, 2013. Pages 61273 - 61293

USFWS, 2014. Endangered Species Status for *Brickellia mosieri* (Florida Brickell-bush) and *Linum carteri* var. *carteri* (Carter's Small-flowered Flax)

Final Rule. 79 Federal Register 171. September 4, 2014. Pages 52567 - 52575.

NatureServe. 2015. NatureServe Central Databases. FSTF received dataset on 08_11_2015. Arlington, Virginia

Proposed Rule. 78 Federal Register 192. October 3, 2013. Pages 61273 - 61293.

SPECIES ACCOUNT: *Lipochaeta fauriei* (Nehe)

Species Taxonomic and Listing Information

Listing Status: Endangered; 2/25/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

Lipochaeta fauriei is a perennial herb with somewhat woody, erect or climbing stems. This short-lived perennial species differs from other species on Kauai by having a greater number of disk and ray flowers per flower head, longer ray flowers, and longer leaves and leaf stalks (Gardner 1976, 1979; Service 1995; Wagner et al. 1985, 1990). (USFWS, 2003)

Taxonomy

Lipochaeta fauriei has been moved into the genus *Melanthera* by Wagner and Robinson (2001). The five-year review recognized the new generic term, but the official listing has not yet caught up and still uses *Lipochaeta*. (USFWS, 2010)

Historical Range

Lipochaeta fauriei is restricted to the island of Kauai. It was historically found in Olokele Canyon, but has not been seen in that valley since 1910. Several other populations of *M. fauriei* have never been relocated, including Hikimoe Valley observed in 1969, the lower drainage of Kawaiiki Valley observed both in 1987 and 1990, and Poopooiki Valley observed in 1987 (Wood 2008). (USFWS, 2010)

Current Range

Lipochaeta fauriei is now known from northwest Kauai at Haeleele Valley, Kalalau Valley, Kawaiiki, Koaie Canyon, Kuia Valley, Mahanaloa, Pohakuao, Poomau Canyon, and Waialae, Wood, 2008). Perlman also reports an occurrence on Waimea Canyon Rim (Perlman 2008). (USFWS, 2010)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Lipochaeta fauriei* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Lipochaeta fauriei* includes two units totaling 1,609 acres in Kauai County, Hawaii. The units are Kauai 11—*Lipochaeta fauriei*—a, b.

Kauai 11—*Lipochaeta fauriei*—a: This unit is critical habitat for *Lipochaeta fauriei* and is 106 ha (262 ac) on State land (Alakai Wilderness Preserve), containing portions of Kipalau Valley. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial *Lipochaeta fauriei* and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is important to the establishment of additional populations on Kauai in order to reach recovery goals. The habitat features contained

in this unit that are essential for this species include, but are not limited to, sides of steep gulches in diverse mesic forests. This unit is geographically separated from the other unit designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Although we do not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is at an appropriate distance from the other unit to avoid their destruction by one naturally occurring catastrophic event. Kauai 11—*Lipochaeta fauriei*—b: This unit is critical habitat for *Lipochaeta fauriei* and is 545 ha (1,347 ac) on State land (Kuia NAR). This unit contains portions of Mahanaloa and Kuia Valleys. This unit provides habitat for four populations of 300 mature, reproducing individuals of the shortlived perennial *Lipochaeta fauriei* and is currently occupied with 70 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, sides of steep gulches in diverse mesic forests. This unit is geographically separated from the other unit designated as critical habitat for this islandendemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Although we do not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is at an appropriate distance from the other unit to avoid their destruction by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

- (i) Moderate shade to full sun on the sides of steep gulches in diverse lowland mesic forests and containing one or more of the following native species: *Acacia koa*, *Carex meyenii*, *Carex wahuensis*, *Dicranopteris linearis*, *Diospyros* spp., *Dodonaea viscosa*, *Euphorbia haeleeleana*, *Hibiscus waimeae*, *Kokia kauaiensis*, *Myrsine lanaiensis*, *Nestegis sandwicensis*, *Pleomele aurea*, *Psychotria greenwelliae*, *Psychotria mariniana*, or *Sapindus oahuensis*; and
- (ii) Elevations between 438 and 948 m (1,438 and 3,108 ft).

Special Management Considerations or Protections

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources**

Reproductive Strategy

Adult: Unknown (USFWS, 2003)

Lifespan

Adult: Unknown (USFWS, 2003)

Dependency on Other Individuals or Species

Adult: Unknown pollinators (USFWS, 2003)

Reproduction Narrative

Adult: Little is known about the life history of *Lipochaeta fauriei*. Flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown (Service 1995). (USFWS, 2003)

Habitat Type

Adult: Diverse mesic forests (USFWS, 1995)

Habitat Vegetation or Surface Water Classification

Adult: Hardwood forest and woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Specific environmental requirements unknown (USFWS, 1995)

Spatial Arrangements of the Population

Adult: Clumped (inferred from USFWS, 1995)

Environmental Specificity

Adult: Narrow (inferred by limited distribution in USFWS, 1995)

Site Fidelity

Adult: High (inferred from USFWS, 1995)

Habitat Narrative

Adult: This species most often grows in moderate shade to full sun and is usually found on the sides of steep gulches in diverse lowland mesic forests at an elevation of about 480 to 900 meters (1,570 to 2,950 feet). The associated native plant taxa include *lama* and *Hibiscus waimeae* (*kokio keokeo*) and associated alien plants include basketgrass, kukui and lantana (USFWS 1994a). (USFWS, 1995)

Dispersal/Migration**Dispersal**

Adult: Unknown (USFWS, 2003)

Dispersal/Migration Narrative

Adult: The seed dispersal agents for *Lipochaeta fauriei* are unknown (USFWS, 2003)

Population Information and Trends

Population Trends:

Apparently stable (USFWS, 2010)

Species Trends:

Apparently stable (USFWS, 2010)

Resiliency:

Low (USFWS, 2010)

Representation:

Low (USFWS, 2010)

Redundancy:

Low (USFWS, 2010)

Number of Populations:

10 (USFWS, 2010)

Population Size:

~320 (USFWS, 2017)

Adaptability:

Low (USFWS, 2010)

Population Narrative:

Melanthera [=Lipochaeta] fauriei is now known from 10 populations with an estimated total of 185 to 240 individuals, based on the last survey dates ranging from 1991 to 2010 for the various populations. An increase in population numbers and individuals since listing is attributable to increased surveys. The overall numbers of individuals remain low, where in some locations there are less than 10 individuals; the largest population is 50-70 individuals. (USFWS, 2010). New Status Information: In addition to those populations cited in the previous 5-year review, new observations include the following: • Melanthera fauriei has been reported from one new location on Kauai since the time of the last 5-year review in 2010; an occurrence of ten individuals in Makaha Valley (NTBG 2014a, c). Current populations at four previously known sites are Koaie (two individuals), Kuia (two individuals), Waialae (about 30 individuals), and Waimea Canyon Rim (southeast of Kukui Peak) (more than 50 individuals) (NTBG 2011, 2013ab, 2014a-e, 2015a-c; PEPP 2015). There are no current reports regarding populations at Haeleele, Kalalau, Kawaiiki, Mahanaloa, Pohakuao, and Poomau. • Walsh (2015) reports ten “subpopulations” (considered as populations or occurrences by USFWS) totaling 222 individuals, with the largest population consisting of 50 individuals. It is uncertain how many are mature. • In 2001, Wagner and Robinson transferred 14 Hawaiian Lipochaeta to the genus Melanthera, including Lipochaeta fauriei. This change in genus has been recognized in the most recent treatment of the Hawaiian flora (Wagner and Herbst 2003; Wagner et al. 2012) (USFWS, 2017).

Threats and Stressors

Stressor: Non-native invasive species (USFWS, 1994)

Exposure:**Response:****Consequence:**

Narrative: The major threats to *Lipochaeta fauriei* are degradation of its habitat by feral goats and competition with invasive alien plant taxa, especially lantana. Feral pigs pose a potential threat to the species. (USFWS, 1994)

Stressor: Small numbers (USFWS, 1995)

Exposure:**Response:****Consequence:**

Narrative: The small total number of individuals comprises a threat of stochastic extinction and/or reduced reproductive vigor to this species (USFWS 1994a). (USFWS, 1995)

Stressor: Fire (USFWS, 1995)

Exposure:**Response:****Consequence:**

Narrative: Fire is a significant threat because *Lipochaeta fauriei* occurs with molasses grass, a fire-adapted alien grass. (USFWS, 1995)

Stressor: Climate change loss or degradation of habitat

Exposure:**Response:****Consequence:**

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Melanthera fauriei* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.82 (on a scale of 0 to 1). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery**Reclassification Criteria:**

A total of five to seven populations should be documented on Kauai. (USFWS, 1995)

Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1995)

Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1995)

Delisting Criteria:

A total of eight to ten populations should be documented on Kauai. (USFWS, 1995)

Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1995)

Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1995)

Recovery Actions:

- Protect current populations, control threats and monitor. (USFWS, 1995)
- Expand current populations. (USFWS, 1995)
- Conduct research essential to conservation of the species. (USFWS, 1995)
- Establish new populations as needed to reach recovery objectives. (USFWS, 1995)
- Validate and revise recovery objectives. (USFWS, 1995)
- Devise and implement a public education program. (USFWS, 1995)
- New Management Actions: • Population viability monitoring and analysis—PEPP is surveying for new populations and monitoring known populations on Kauai (PEP 2015). • Captive propagation for genetic storage and reintroduction—There are 24 plants from one collection at the Kokee Rare Plant Facility (DOFAW 2016). There are seeds in the NTBG seed bank from two different collections (NTBG 2017) (USFWS, 2017).
- Recommendations for Future Actions: The following recommendations for future actions are reiterated for the 5-year review for 2017. • Surveys and inventories—Survey formerly identified locations for current status of the species. • Ungulate monitoring and control—Protect all occurrences against browsing and disturbances from feral ungulates. Continue to construct and maintain fenced exclosures around all populations. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative species that compete with the species around all populations. • Predator and herbivore monitoring and control— o Study *Melanthera fauriei* populations to determine level of threat from invertebrate herbivory, including the black twig borer, and any additional recovery actions needed. o Control rodents around existing populations. • Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Reintroduce individuals into protected suitable habitat within historic range that is being managed for known threats to this species. • Population biology research—Study *Melanthera fauriei* populations to determine viable population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. • Fire monitoring and control—Develop and implement fire-management plans for all wild and reintroduced populations. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides. • Federal Register updates—Update the listed entity on 50 CFR 17.12 to match the currently recognized taxonomy as *Melanthera fauriei* (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Protect all occurrences against trampling, browsing, and disturbances from feral ungulates. (USFWS, 2010)
- Control introduced invasive plant species around wild plants. (USFWS, 2010)

- Survey formerly identified locations for current status of species. (USFWS, 2010)
- Assess the genetic variability of extant populations. (USFWS, 2010)
- Work with Hawaii Division of Forestry and Wildlife and Hawaii State Parks to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2010)
- Investigate techniques to improve natural recruitment. (USFWS, 2010)
- Update the listed entity on 50 CFR 17 to match the currently recognized taxonomy. (USFWS, 2010)

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SPECIES ACCOUNT: *Lipochaeta lobata* var. *leptophylla* (Nehe)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

A low and somewhat woody perennial herb with lance-shaped leaves. The flowers are yellow. (NatureServe, 2015)

Taxonomy

In 1999, Wagner et al. determined that the subspecific ranking for this species should be subspecies, not variety, so the valid taxonomic name for the listed entity should be *Lipochaeta lobata* subsp. *leptophylla* (Wagner et al. 1999) and will be referred to the subspecific ranking throughout this document. In 2001, taxonomists placed some Hawaiian species of the genus *Lipochaeta* into the genus *Melanthera*, but this species is still properly referred to as *Lipochaeta lobata* subsp. *leptophylla* (Wagner and Robinson 2001). (USFWS, 2011)

Historical Range

Historically known on Oahu from the southern Waianae Mountains, from Kolekole Pass to Lualualei (USFWS 1998).

Current Range

Since 2004, known from two populations on Oahu (Mikilua and Kolekole trail) (USFWS, 2011).

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Lipochaeta lobata* var. *leptophylla* (Nehe) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Lipochaeta lobata* var.

leptophylla (77 FR 57648-57862). The critical habitat designation includes 8 critical habitat units, which encompass approximately 1,449 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Lipochaeta lobata* var. *leptophylla* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Lipochaeta lobata* var. *leptophylla* includes 8 critical habitat units, covering one ecosystem type, which encompasses approximately 1,449 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley.

Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo.

Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge.

Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys.

Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua.

Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea.

Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea.

Oahu—Dry Cliff—Unit 8 [259 ac (105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawana, and partially within the Nanakuli Forest Reserve.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Lipochaeta lobata* var. *leptophylla* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Lipochaeta lobata* var. *leptophylla* occurs within the indicated ecosystem in the Waianae Mountain caldera complex:

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: *Antidesma*, *Chamaesyce*, *Diospyros*, *Dodonaea*. (F) Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Schiedea*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Lipochaeta lobata* var. *leptophylla* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Flowering of *Lipochaeta lobata* var. *leptophylla* is probably rain-induced. Populations may consist of fewer distinct individuals than it appears because many “individuals” are connected underground by the roots and are probably clones (USFWS1995). (USFWS, 1998)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest edge, forest/woodland, shrubland/chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 460 to 760 meters (USFWS, 1998)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1998)

Habitat Narrative

Adult: *Lipochaeta lobata* var. *leptophylla* is found in dry to moist shrublands and forests usually on open ridges or cliff faces. It is found less often in the forest understory. This species typically grows in dry shrubland at an elevation of 460 to 760 meters (1,500 to 2,500 feet) (USFWS 1995). Associated plants include *aalii*, *alaala wai nui*, and *kookoolau* (USFWS 1995). (USFWS, 1998; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Low (inferred from USFWS, 2011)

Redundancy:

Very low (inferred from USFWS, 2011)

Number of Populations:

2 (USFWS, 2011)

Population Size:

~150 (USFWS, 2011)

Population Narrative:

In total, there may have been at least 182 individuals in four populations on Oahu observed from 1991 to 1999, instead of the 147 individuals reported when critical habitat was designated. However, since 2004, at least 350 individuals have been observed in only two populations on Oahu (Mikilua and Kolekole trail). (USFWS, 2011)

Threats and Stressors

Stressor: Habitat degradation by feral pigs and goats (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: On Oahu, feral pigs (*Sus scrofa*), goats (*Capra hircus*) are threats to the habitat of *Lipochaeta lobata* subsp. *leptophylla*. Feral goats are one of the main threats to the survival of rare plants in Lualualei. Several feral goats were seen in Puu Kaua during the 2004 survey (Hawaii Natural Heritage Program 2004). (USFWS, 2011)

Stressor: Non-native plants (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Threats from invasive introduced plants such as *Acacia farnesiana* (klu), *Bryophyllum pinnatum* (airplant), *Cenchrus ciliaris* (buffelgrass), *Chamaecrista nictitans* (partridge pea), *Grevillea robusta* (silk oak), *Lantana camara* (lantana), *Leucaena leucocephala* (haole koa), *Melinis minutiflora* (molasses grass), *Morella faya* (fire tree), *Opuntia* sp. (prickly pear cactus), *Passiflora suberosa* (corky stem passionflower), and *Stachytarpheta* sp. (Jamaican vervain) compete, shade, and crowd out native plants in the area (Perlman 2009; Wood 2009). (USFWS, 2011)

Stressor: Predation (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Goats are reported to chew, trample, and knock down plants of *Lipochaeta lobata* subsp. *leptophylla* (Perlman 2009). Rats (*Rattus* spp.) and slugs (unidentified species) are also reported to eat or damage this species (Perlman 2009). (USFWS, 2011)

Stressor: Fire (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Fires have occurred in the Waianae Mountains, and this threat would increase substantially if *Pennisetum setaceum* (fountain grass) were to become established in the area (Hawaii Natural Heritage Program 2004). (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations (USFWS, 2011).

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1998)

Recovery Actions:

- Construct enclosures to protect populations against feral goats. (USFWS, 1998)
- Control competing alien plant species within enclosures. (USFWS, 1998)
- Provide protection from fire. (USFWS, 1998)

Conservation Measures and Best Management Practices:

- Collect seeds from as many fruiting individuals as possible for long-term genetic storage and reintroduction. (USFWS, 2011)
- Construct large-scale fences around all naturally occurring and any future reintroduced individuals to control feral ungulates. (USFWS, 2011)
- Propagate for reintroduction into protected suitable habitat. (USFWS, 2011)
- Control invasive introduced plant species around existing populations. (USFWS, 2011)
- Control rats in the vicinity of these populations. (USFWS, 2011)
- Develop and implement methods to control slugs. (USFWS, 2011)
- Develop and implement fire management plans for each population. (USFWS, 2011)
- Work with U.S. Navy to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2011)

- Update the listed entity on 50 CFR 17 to match the currently recognized taxonomy. (USFWS, 2011)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2011)

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SPECIES ACCOUNT: *Lipochaeta micrantha* (Nehe)

Species Taxonomic and Listing Information

Listing Status: Endangered; 2/25/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

Lipochaeta micrantha, a member of the aster family, is a somewhat woody perennial herb. The 1.6 to 6.6 feet long stems grow along the ground and root at the nodes, with the tip of the stem growing upward. The leaves are roughly triangular, about four inches long and 3 inches wide. The flower heads are in clusters of two or three, with each head containing four to five ray florets and five to nine disk florets. The two recognized varieties of this species, *exigua* and *micrantha*, are distinguished by differences in leaf length and width, degree of leaf dissection, and the length of the ray florets. (USFWS, 1994)

Taxonomy

There are two varieties of *Lipochaeta micrantha* that are listed: *L. m. micrantha* (Nehe) and *L. m. exigua* (Lesser nehe). (USFWS, 1994) The species has been moved into the genus *Melanthera* by Wagner and Robinson (2001). The five-year review recognized the new generic term, but the official listing has not yet caught up and still uses *Lipochaeta*. (USFWS, 2012)

Historical Range

Historically, *Lipochaeta micrantha* was known from diverse mesic forest on Kauai from 300 to 400 meters (985 to 1,320 feet) elevation. Two varieties have been recognized and occupy separate ranges: variety *exigua* is historically found only in the Haupu Range, and variety *micrantha* is historically found only in Olokele, Hanapepe, and Koloa (Wagner et al. 1999; USFWS 1994, 1995a, 2003). (USFWS, 2012)

Current Range

As of 2010, *Lipochaeta micrantha* existed on the island of Kauai at the Haupu Range (*L. micrantha* var. *exigua*, two populations) and within the State-owned Na Pali-Kona Forest Reserve at Koaie Canyon and Kawaiiki Valley (*L. micrantha* var. *micrantha*, two to four populations). (USFWS, 2012)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Lipochaeta micrantha* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Lipochaeta micrantha* includes 1,365 acres in Kauai County, Hawaii. The units are Kauai 7—*Lipochaeta micrantha*—a and and Kauai 11—*Lipochaeta micrantha*— b.

Kauai 7—*Lipochaeta micrantha*—a: This unit is critical habitat for *Lipochaeta micrantha* and is 340 ha (843 ac) on private land. This unit contains Hokulei Peak, Haupu and Naluakeina Summits, and Queen Victoria's Profile. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial *Lipochaeta micrantha* and is currently occupied with 50 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, cliffs, ridges, stream banks, or slopes in mesic to wet mixed communities. This unit is geographically separated from the other unit designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Although the Services does not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is at an appropriate distance from the other unit to avoid their destruction by one naturally occurring catastrophic event.

Kauai 11—*Lipochaeta micrantha*—b: This unit is critical habitat for *Lipochaeta micrantha* and is 212 ha (523 ac) on State land, containing portions of Kaluahaulu Ridge. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial *Lipochaeta micrantha* and is currently occupied with at least one plant. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, cliffs, ridges, stream banks, or slopes in mesic to wet mixed communities. This unit is geographically separated from the other unit designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Although the Service does not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is at an appropriate distance from the other unit to avoid their destruction by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Within these units the currently known primary constituent elements of critical habitat for *Lipochaeta micrantha* are the habitat components provided by:

(i) Cliffs, ridges, stream banks, or slopes in mesic to wet mixed communities and containing one or more of the following associated native plant species: *Acacia koa*, *Antidesma* spp., *Artemisia australis*, *Bidens sandvicensis*, *Bobea* spp., *Chamaesyce celastroides* var. *hanapepensis*, *Diospyros* spp., *Dodonaea viscosa*, *Eragrostis grandis*, *Eragrostis variabilis*, *Hibiscus kokio*, *Lepidium bidentatum*, *Lobelia niihauensis*, *Melicope* spp., *Metrosideros polymorpha*, *Neraudia kauaiensis*, *Nototrichium* spp., *Pipturus* spp., *Plectranthus parviflorus*, *Pleomele aurea*, *Psydrax odorata*, *Rumex albescens*, *Sida fallax*, or *Xylosma hawaiiense*; and

(ii) Elevations between 127 and 1,090 m (418 and 3,574 ft).

Special Management Considerations or Protections

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic

material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Lifespan**

Adult: Unknown (USFWS, 2012)

Dependency on Other Individuals or Species

Adult: Pollination vectors unknown (USFWS, 2012)

Breeding Season

Adult: Flowers in December (USFWS, 2012)

Reproduction Narrative

Adult: *Lipochaeta micrantha* has been observed in flower during the month of December (National Tropical Botanical Garden 2010). Little else is known about the life history for *L. micrantha* at this time. Its pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown (USFWS 1994, 1995, 2003). (USFWS, 2012)

Habitat Type

Adult: Dry slopes in mesic forests (USFWS, 2012)

Habitat Vegetation or Surface Water Classification

Adult: Hardwood forests and woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Specific environmental requirements unknown (USFWS, 2012)

Spatial Arrangements of the Population

Adult: Clumped (inferred from USFWS, 2012)

Environmental Specificity

Adult: Narrow (inferred by limited distribution in USFWS, 2012)

Site Fidelity

Adult: High (inferred from USFWS, 2012)

Habitat Narrative

Adult: Both subspecies of *Melanthera* [=Lipochaeta] *micrantha* are often found on exposed rocky slopes in diverse lowland *Metrosideros polymorpha* (ohia) mesic forests between 300 and 720 meters (1,000 and 2,360 feet) elevation. The specific environmental requirements and limiting factors are unknown. (USFWS, 2012)

Dispersal/Migration

Dispersal

Adult: Seed dispersal agents unknown (USFWS, 2012)

Dispersal/Migration Narrative

Adult: Little is known about the life history, including mechanisms for seed dispersal. (USFWS, 2012)

Population Information and Trends

Population Trends:

Stable or fluctuating (USFWS, 2012)

Species Trends:

Stable or fluctuating (USFWS, 2012)

Resiliency:

Low (USFWS, 2012)

Representation:

Low (inferred from USFWS, 2012)

Redundancy:

Low (inferred from USFWS, 2012)

Number of Populations:

4-6 (USFWS, 2012)

Population Size:

100-500 individuals (USFWS, 2017)

Adaptability:

Low (inferred from USFWS, 2012)

Population Narrative:

There are currently four to six populations of *Lipochaeta micrantha* containing about 250 to 720 individuals, with populations at the Haupu Range (*L. micrantha* var. *exigua*, two populations, 100 to 150 individuals), and Koaie Canyon and Kawaiiki Valley (*L. micrantha* var. *micrantha*, two to four populations, 150 to 570 individuals). New Status Information: In addition to those populations cited in the previous 5-year review, new observations include the following: • In 2001, Wagner and Robinson transferred 14 Hawaiian *Lipochaeta* to the genus *Melanthera*, including *Lipochaeta micrantha*. This change in genus has been recognized in the most recent

treatment of the Hawaiian flora. There are also now two subspecies recognized, *Melanthera micrantha* ssp. *exigua* and *Melanthera micrantha* ssp. *micrantha* (Wagner and Herbst 2003; Wagner et al. 2012). • *Melanthera micrantha* ssp. *exigua* was historically known from two populations in the Haupū Range totaling 100 to 500 individuals. This taxon was last seen in 1990 and is possibly extinct. Additional surveys are needed to confirm (Clark 2016). • *Melanthera micrantha* ssp. *micrantha* has been reported from one small area at Koaie stream and canyon on Kauai since the time of the last 5-year review in 2012 (NTBG 2005, 2014; PEPP 2013, 2015). Only seven individuals remain of this taxon at this location (Clark 2016) (USFWS, 2017).

Threats and Stressors

Stressor: Ungulates (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Feral pigs (*Sus scrofa*) and goats (*Capra hircus*) impact the habitat of both subspecies (K. Wood, pers. comm. 2010). Herbivory of species by ungulates is a potential threat. Hunting regulations inadequate to control ungulate effects on habitat. (USFWS, 2012)

Stressor: Invasive plants (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: The species habitat is being degraded by non-native invasive plants (daisy fleabane, lantana, Chinaberry, molasses grass, strawberry guava, guava, downy or rose myrtle, prickly Florida blackberry, Christmasberry) that have become established and alter the entire ecosystem. Other invasive species (*Blechnum* sp., airplant, mysore thorn, white moho, Asian melastome, sourbush, Jamaica vervain, Sacramento bur) compete directly with *Lipochaeta micrantha*. (USFWS, 2012)

Stressor: Landslides and flooding (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Landslides and flooding (USFWS 1994, 1995, 2003; Hawaii Biodiversity and Mapping Program 2010a, b; K. Wood, pers. comm. 2010) are indicated as threats, but no details are presented. (USFWS, 2012)

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. (USFWS, 2012)

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:**Consequence:**

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Melanthera micrantha* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.82 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery**Reclassification Criteria:**

A total of five to seven populations should be documented on Kauai and at least one other island where they now occur or occurred historically. (USFWS, 1995)

Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1995)

Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1995)

Delisting Criteria:

A total of eight to ten populations should be documented on Kauai and at least one other island where they now occur or occurred historically. (USFWS, 1995)

Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1995)

Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1995)

Recovery Actions:

- Protect current populations, control threats and monitor. (USFWS, 1995)
- Expand current populations. (USFWS, 1995)
- Conduct research essential to conservation of the species. (USFWS, 1995)
- Establish new populations as needed to reach recovery objectives. (USFWS, 1995)
- Validate and revise recovery objectives. (USFWS, 1995)
- Devise and implement a public education program. (USFWS, 1995)
- New Management Actions: • Population viability monitoring and analysis—PEPP is surveying for new populations and monitoring known populations at Koaie (PEP 2013, 2014, 2015). • Captive propagation for genetic storage and reintroduction—There are no ex situ collections of *Melanthera micrantha* ssp. *exigua*. NTBG continues to collect and propagate seeds and cuttings of *Melanthera micrantha* ssp. *micrantha* in their nursery (NTBG 2017). • Stochastic

events—Build resilience and redundancy—There are outplantings of *Melanthera micrantha* ssp. *micrantha* in a DOFAW enclosure at Kalalau (three individuals) and at Piwa (15 to 25 individuals) (NTBG 2012; PEPP 2012, 2013, 2014) (USFWS, 2017).

- Recommendations for Future Actions: The following recommendations for future actions are reiterated for the 5-year review for 2017. • Surveys and inventories—Conduct surveys in the historic habitat of the species to achieve a clearer understanding of population numbers that will drive future management decisions. Relocate the population of *Melanthera micrantha* ssp. *micrantha* at Haupu, which has not been visited since 1991. • Ungulate monitoring and control—Protect all occurrences against browsing and disturbances from feral ungulates. Construct and maintain fenced enclosures around all populations. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative species that compete with the species around all populations. • Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Population biology research—Study *Melanthera micrantha* populations to determine viable population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides. • Federal Register updates—Update the listed entity on 50 CFR 17.12 to match the currently recognized taxonomy as *Melanthera micrantha* (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Captive propagation for genetic storage and reintroduction: (1) Collect cuttings or seed from tagged individuals, keeping close track of the maternal source for use in ex situ propagation. (2) Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation and storage. (USFWS, 2012)
- Reintroduction / translocation implementation – Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2012)
- Reintroduction / translocation protocol development – Maximize the genetic variation among individuals at each reintroduction site, based on microsatellite data and detailed information from crossing records. (USFWS, 2012)
- Surveys / inventories: (1) Conduct surveys in the historic habitat of the species to achieve a clearer understanding of population numbers that will drive future management decisions. (2) Relocate the disjunct population of *Melanthera micrantha* subsp. *micrantha* from Haupu, which has not been visited since 1991. (USFWS, 2012)
- Ungulate control – Protect all populations against browsing and disturbances from feral ungulates. (USFWS, 2012)
- Ungulate enclosures – Construct and maintain fenced enclosures around all populations. (USFWS, 2012)
- Established ecosystem-altering invasive plant species control – Control established ecosystem-altering invasive plant species around all populations. (USFWS, 2012)
- Competitive invasive plant species control – Control invasive nonnative plant species around all populations that compete with the species. (USFWS, 2012)

- Site / area / habitat protection – Implement erosion control measures to prevent landslides and flooding. (USFWS, 2012)
- Federal Register updates – Update the Federal Register to reflect changes in taxonomy to the taxa. (USFWS, 2012)
- Population biology research – Study *Melanthera micrantha* populations with regard to population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. (USFWS, 2012)
- Alliance and partnership development – Work with Hawaii Department of Forestry and Wildlife, and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2012)
- Threats research – Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2012)

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SPECIES ACCOUNT: *Lipochaeta venosa* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/29/1979; Pacific Region (R1) (USFWS, 2016)

Physical Description

Lipochaeta venosa is in the Asteraceae, or aster family. It is a low-growing, perennial herb with curved, spreading stems that are 50 centimeters (20 inches) long. The species is partly deciduous and loses leaves during periods of drought. The leaves are triangular with two basal lobes, pinnately dissected throughout, and 2.1 to 2.8 centimeters (0.8 to 1.1 inches) long and 1.5 to 2.2 centimeters (0.6 to 0.9 inch) wide. The upper surface of the leaves has minute, straight, appressed hairs. On the lower surface, the hairs are denser. Flower heads are solitary or in clusters of two. Ray floret achenes are 2 to 2.4 millimeters (0.08 to 0.09 inch) long and 1.5 to 1.8 millimeters (0.06 to 0.07 inch) wide with minute wings. The disk floret achenes are about the same size but wingless. *Lipochaeta venosa* is closely related to *L. subcordata*, a species that occurs on the islands of Hawaii and Kauai, and formally Lanai. The two species can be distinguished by leaf morphology (U.S. Army 2003a).

Historical Range

See current range/distribution

Current Range

Lipochaeta venosa is a narrow endemic species found on the island of Hawaii. The taxon was first collected at the Nohonaohae cinder cone. The species was later found on Puu Holoholoku and an unnamed puu, the Heihei cinder cone, and the 1859 Mauna Kea lava flow. Currently, the species is known from five occurrences on the Keamuku Parcel and Parker Ranch including Puu Papapa, Puu Holoholoku, Puu Heihei, Puu Nohonaohae, and an unnamed puu east-northeast of Nohonaohae (see Figure 41 in the Transformation Biological Assessment). All occurrences are on the leeward side, northwest flank of Mauna Kea (U.S. Army 2003a).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Breeding Season

Adult: *Lipochaeta venosa* is known to flower between March and June

Reproduction Narrative

Adult: *Lipochaeta venosa* is known to flower between March and June, but flowering periods may extend beyond this period. In 2002, plants were noted flowering in July. Most plants found on the Nohonaohae cinder cone were mature during the 2002 survey. Flowers do not appear to be specialized. The species roots readily in greenhouse cultivation indicating that vegetative reproduction may occur in nature (U.S. Army Garrison 2002).

Habitat Type

Adult: montane dry shrublands/cindercones

Habitat Narrative

Adult: *Lipochaeta venosa* is typically found on cinder cones in montane dry shrublands, dominated by non-native grasses (e.g., *Pennisetum setaceum*) with some native shrubs (e.g., *Dodonaea viscosa*, *Chenopodium oahuense*, and *Osteomeles anthyllidifolia*), typically at elevations from 725 to 1,136 meters (2,379 to 3,727 feet). In the absence of grazing pressures this species most likely would be more widespread. On the Keamuku Parcel, the species occurs on very stony soils of a cinder cone. The species is known to rootsprout and can recolonize areas following fire.

Dispersal/Migration***Population Information and Trends*****Species Trends:**

Declining (USFWS, 2017)

Number of Populations:

1 (USFWS, 2017)

Population Size:

122 individuals (USFWS, 2017)

Population Narrative:

Fragility unknown. Over 2000 plants known. Fewer than 3000 plants are thought to remain. 5 current (between 1982 and 1997) and 1 historical occurrence. (NatureServe, 2015).

Lysimachia venosa numbers are declining and individuals persist in only one location. Currently, Walsh (2015) reports 122 individuals total in the Kawaikini to Iole headwaters area (USFWS, 2017).

Threats and Stressors**Stressor:****Exposure:****Response:****Consequence:**

Narrative: The primary threat to *Lipochaeta venosa* today is grazing and trampling by cattle and ungulates, which is thought to have strongly influenced the species distribution. The species has also been impacted by habitat loss and modification due to land conversion, competition with non-native plant species (particularly *Pennisetum setaceum*), and wildfires. Cinder cone mining, military activities, and ranching pressures are all continuing threats to *L. venosa*. Due to the very limited distribution of this species, a single natural or human-caused environmental disturbance could be catastrophic and the species could be lost (U.S. Army 2003a).

Stressor: Ungulate degradation of habitat

Exposure:

Response:**Consequence:**

Narrative: Feral pigs (*Sus scrofa*) and goats (*Capra hircus*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil (Loope 1998; van Riper and van Riper 1982). Feral pigs and goats are reported to be a threat to the habitat of the only known occurrences of *Lysimachia venosa* (HBMP 2010; NTBG 2012a-b, 2015a; PEPP 2015; Walsh 2015) (USFWS, 2017).

Stressor: Established ecosystem-altering invasive plant modification and degradation of habitat

Exposure:**Response:****Consequence:**

Narrative: Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community (Cuddihy and Stone 1990). Invasive introduced plants with the greatest impacts on *Lysimachia venosa* include *Axonopus fissifolius* (narrow-leaved carpetgrass), *Blechnum appendiculatum* (NCN), *Buddleja asiatica* (dog tail), *Clidemia hirta* (Koster's curse), *Cyperus meyerianus* (NCN), *Erigeron karvinskianus* (daisy fleabane), *Juncus planifolius* (rush), *Melastoma septemnerium* (NCN), *Paspalum conjugatum* (Hilo grass), *Psidium cattleianum* (strawberry guava), *Rhodomyrtus tomentosa* (downy myrtle), *Rubus rosifolius* (thimbleberry), *Sphaeropteris cooperi* (Australian tree fern), and *Sacciolepis indica* (glenwood grass), (NTBG 2012a, 2015a; Wood 2013) (USFWS, 2017).

Stressor: Landslides and flooding destruction or degradation of habitat

Exposure:**Response:****Consequence:**

Narrative: *Lysimachia venosa* occurs on steep slopes and cliffs. Landslides and erosion due to disturbance by feral ungulates and by natural weathering destabilize substrates, damage and destroy individual plants, and alter hydrological patterns (NTBG 2015; Stearns 1985; Walsh 2015) (USFWS, 2017).

Stressor: Climate change loss or degradation of habitat

Exposure:**Response:****Consequence:**

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Lysimachia venosa* is extremely vulnerable to the impacts of climate change with a vulnerability score of 0.926 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery

Reclassification Criteria:

In addition to achieving 5 to 10 populations with 500 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats (USFWS, 2017).

Delisting Criteria:

In addition to achieving 5 to 10 populations with 500 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis (USFWS, 2017).

Recovery Actions:

- Current Management Actions: • Population viability monitoring—PEPP monitors this occurrence regularly (PEPP 2012, 2015). • Captive propagation for genetic storage and reintroduction—Seeds from the Kawaikini summit area were collected from *Lysimachia venosa* by NTBG and PEPP in 2014. The seed bank has 260 seeds from one collection. An additional 118 seeds were sown for propagation and currently there are six plants in the NTBG gardens. There are seven plants in the nursery from another collection where 63 seeds were sown. (NTBG 2017) (USFWS, 2017).
- RECOMMENDATIONS FOR FUTURE ACTIONS • Surveys and inventories—Survey for populations of *Lysimachia venosa* in areas of potentially suitable habitat. • Ungulate monitoring and control—Construct fenced exclosures to exclude feral ungulates from wild populations. Protect all occurrences against browsing and disturbances from feral ungulates. • Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations that alter habitat and compete with the species. • Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and hurricanes. • Based on the recovery criteria above, consider development of a recovery plan (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Important conservation actions needed for *Lipochaeta venosa* include the following: identified threats must be controlled by construction and maintenance of ungulate-proof fences around each occurrence; establishment of fire breaks and development of a fire response and suppression plan for all sites; establishment of a germ plasm reserve; control of *Pennisetum setaceum* and other non-native plants species; restoration of native habitat; outplanting to enhance remaining occurrences and establishment of new occurrences within its historic range (Service 1994). In addition, a State-wide management plan that identifies areas and landscapes for the long-term conservation of all known occurrences of *L. venosa* is needed. As part of this management plan, landowners and managers should delineate management units to conserve this species and other native species through threat control and habitat restoration.

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SPECIES ACCOUNT: *Lipochaeta waimeaensis* (Nehe)

Species Taxonomic and Listing Information

Listing Status: Endangered; 2/25/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

Lipochaeta waimeaensis, a member of the aster family, is a low growing, somewhat woody perennial herb with stems 3 to 6.5 feet long that root at the nodes. The linear or narrowly elliptical leaves are about two inches long and one-third inch wide. Flower heads are borne singly in clusters of two or three. The fruits are knobby, winged achenes. (USFWS, 1994)

Taxonomy

Lipochaeta waimeaensis has been moved into the genus *Melanthera* by Wagner and Robinson (2001). The five-year review recognized the new generic term, but the official listing has not yet caught up and still uses *Lipochaeta*. (USFWS, 2010)

Historical Range

Historically, the species is not known to have any additional range beyond the current. (NatureServe, 2015)

Current Range

Current range includes type locality at rim of Waimea Canyon, Kauai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Lipochaeta waimeaensis* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Lipochaeta waimeaensis* includes one unit totaling 139 acres in Kauai County, Hawaii. The unit is Kauai 13—*Lipochaeta waimeaensis*—a.

Kauai 13—*Lipochaeta waimeaensis*—a: This unit is critical habitat for *Lipochaeta waimeaensis* and is 56 ha (139 ac) on State land, containing portions of Waimea Canyon. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Lipochaeta waimeaensis* and is currently occupied with at least 100 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, precipitous, shrub-covered gulches in diverse lowland forest. Although there may not be sufficient habitat designated to reach the recovery goal of 8 to 10 populations, this species is a very narrow endemic and may never naturally occurred in more than a single or a few populations.

Primary Constituent Elements/Physical or Biological Features

Within this unit, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

- (i) Precipitous, shrub-covered gulches in diverse lowland forest and containing one or more of the following associated native plant species: *Artemisia australis*, *Chamaesyce celastroides*, *Dodonaea viscosa*, *Lipochaeta connata*, *Santalum freycinetianum*, *Schiedea spergulina*, or *Panicum* spp.; and
- (ii) Elevations between 44 and 409 m (145 and 1,340 ft).

Special Management Considerations or Protections

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Unknown (USFWS, 2003)

Lifespan

Adult: Unknown (USFWS, 2003)

Dependency on Other Individuals or Species

Adult: Unknown pollinators (USFWS, 2003)

Reproduction Narrative

Adult: Little is known about the life history of *Lipochaeta waimeaensis*. Flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown. (USFWS, 2003)

Habitat Type

Adult: Diverse lowland mesic forest (USFWS, 2003)

Habitat Vegetation or Surface Water Classification

Adult: Dry steep shrubby slopes (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Specific environmental requirements unknown (USFWS, 2003)

Spatial Arrangements of the Population

Adult: Clumped (inferred from USFWS, 2003)

Environmental Specificity

Adult: Very narrow (USFWS, 2003)

Site Fidelity

Adult: High (inferred from USFWS, 2003)

Habitat Narrative

Adult: This single population grows on eroded soil on a precipitous, shrub-covered gulch in a diverse lowland mesic forest at an elevation between 1,150 and 1,300 feet. The vegetation at the site is predominantly alien consisting of silk oak, koa haole, and Natal redtop; however, the native taxa *aalii* and *Lipochaeta connata* (nehe) also occur here (USFWS 1994a). (USFWS, 2003)

Dispersal/Migration**Motility/Mobility**

Adult: Unknown (USFWS, 2003)

Dispersal/Migration Narrative

Adult: The seed dispersal agents for *Lipochaeta waimeaensis* are unknown (USFWS, 2003)

Population Information and Trends**Population Trends:**

Declining (USFWS, 2017)

Species Trends:

Increasing (USFWS, 2010)

Resiliency:

Low (USFWS, 2010)

Representation:

Low (USFWS, 2010)

Redundancy:

Low (USFWS, 2010)

Number of Populations:

One (USFWS, 2017)

Population Size:

~40 individuals (USFWS, 2017)

Adaptability:

Low (inferred from USFWS, 2010)

Population Narrative:

Lipochaeta waimeaensis is still represented by just one population in Waimea Canyon at 1,100 to 1,260 feet elevation. In April 2001, 50 mature individuals, 30 immature individuals, and 50 seedlings were seen. Subsequently in May of that year, 100 mature individuals, 50 immature individuals, and 30 seedlings were seen. (USFWS, 2010). *Melanthera waimeaensis* occurs along the western rim of Waimea Canyon. The last 5- year review (2010) reported one population totaling 100 mature individuals (USFWS 2010). Currently, there are no more than 40 individuals in the same area (Clark 2016; NTBG 2014) (USFWS, 2017).

Threats and Stressors

Stressor: Competition (USFWS, 2003)

Exposure:

Response:

Consequence:

Narrative: The major threat to *Lipochaeta waimeaensis* is competition from alien plants such as koa haole, Natal redtop, silk oak, and prickly pear. (USFWS, 2003)

Stressor: Soil erosion (USFWS, 2003)

Exposure:

Response:

Consequence:

Narrative: The existing soil erosion problem is exacerbated by the presence of feral goats. (USFWS, 2003)

Stressor: Small numbers (USFWS, 2003)

Exposure:

Response:

Consequence:

Narrative: The single population, and thus the entire species, is threatened by stochastic extinction and/or reduced reproductive vigor due to the small number of existing individuals. Over-collecting for scientific purposes also poses a threat (USFWS 1994a). (USFWS, 2003)

Stressor: Predation (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Predation has been observed by mice (*Mus* sp.), rats (*Rattus* spp.), and various insects, including spittle bugs (*Claspoptera xanthocephala*), on leaves (Perlman 2008). (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to *Melanthera waimeaensis*. However, current climate change models do not allow us to predict specifically what those effects, and their extent, would be for this species. (USFWS, 2010)

Stressor: Ungulate degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Black-tailed deer (*Odocoileus hemionus*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil (Loope 1998; van Riper and van Riper 1982). Deer have been noted to be a threat to the population of *Melanthera waimeaensis* along Waimea Canyon rim (NTBG 2013a) (USFWS, 2017).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Melanthera waimeaensis* is extremely vulnerable to the impacts of climate change, with a vulnerability score of 0.994 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this assessment also concluded that *M. waimeaensis* is classified as a “wink-out” species. “Wink-out” species are those species with no future climate envelope, meaning that no projected suitable climate areas exist for the species to persist in the future. The few known individuals of *M. waimeaensis* only occur in a narrow range along Waimea Canyon rim on Kauai. Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Stressor: Fire destruction or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Fire can destroy dormant seeds as well as individual plants. Successive fires burn farther and farther into native habitat and alter microclimate conditions to further alter habitat conditions to favor nonnative plants. Nonnative plants convert native plant communities to nonnative dominated plant communities (D’Antonio and Vitousek 1992; Tunison et al. 2002). Fire is noted to be a threat to *Melanthera waimeaensis* (NTBG 2011, 2013a) (USFWS, 2017).

Stressor: Ungulate predation or herbivory

Exposure:

Response:

Consequence:

Narrative: Predation or herbivory by black-tailed deer is an additional threat to *Melanthera waimeaensis* (NTBG 2013a) (USFWS, 2017).

Recovery**Reclassification Criteria:**

A total of five to seven populations should be documented on Kauai. (USFWS, 1995)

Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1995)

Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1995)

Delisting Criteria:

A total of eight to ten populations should be documented on Kauai. (USFWS, 1995)

Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1995)

Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1995)

Recovery Actions:

- Protect current populations, control threats and monitor. (USFWS, 1995)
- Expand current populations. (USFWS, 1995)
- Conduct research essential to conservation of the species. (USFWS, 1995)
- Establish new populations as needed to reach recovery objectives. (USFWS, 1995)
- Validate and revise recovery objectives. (USFWS, 1995)
- Devise and implement a public education program. (USFWS, 1995)
- New Management Actions: • Population viability monitoring and analysis—PEPP is surveying for new populations and monitoring the known population of *Melanthera waimeaensis* (PEPP 2010, 2011, 2012, 2014, 2015). • Captive propagation for genetic storage and reintroduction—NTBG has several collections of this taxon planted on their grounds and being propagated in their nursery (NTBG 2017). PEPP is collecting seeds for storage at Lyon Arboretum, which currently holds collections from over 50 individuals (Lyon Arboretum 2017) and cuttings for propagation at DOFAW and NTBG (PEPP 2010, 2015). • Reintroduction and translocation—PEPP is reintroducing individuals into a fenced and monitored enclosure (PEPP 2014, 2015). Of the almost 300 individuals outplanted, 90 currently remain (PEPP 2015). • Invertebrate predator and herbivore monitoring and control—PEPP assisted a researcher from the University of Florida in gathering plant materials for investigation on the effects of leaf miner predation on *Lipochaeta waimeaensis* and other native plants (PEPP 2015) (USFWS, 2017).
- Recommendations for Future Actions: Habitat destruction and modification, and predation and herbivory, by black-tailed deer, and fire destruction or degradation of habitat, have been noted as new threats to *Melanthera waimeaensis*. Thus, the following recommendations for future actions are added and reiterated for the 5-year review for 2017. • Surveys and inventories—Survey for populations of *Melanthera waimeaensis* in

areas of potentially suitable habitat. • Ungulate monitoring and control—Protect all occurrences against disturbances from feral ungulates. Construct and maintain fenced enclosures around all populations. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative species that compete with the species around all populations. • Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Predator and herbivore monitoring and control— o Implement effective control methods for rodents. o Study *Melanthera waimeaensis* populations to determine level of threat from invertebrate herbivory and any additional recovery actions needed. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides. • Human interaction monitoring and management—Develop and implement effective measures to reduce the impact of collecting. • Federal Register updates—Update the listed entity on 50 CFR 17.12 to match the currently recognized taxonomy as *Melanthera waimeaensis* (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Collect material for genetic storage and propagation for reintroduction. (USFWS, 2010)
- Determine methods to control goats in the steep terrain. (USFWS, 2010)
- Control introduced invasive plant species around wild plants. (USFWS, 2010)
- Assess other sites with potential suitable habitat to protect and establish reintroductions. (USFWS, 2010)
- Work with Hawaii Division of Forestry and Wildlife and Hawaii State Parks to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2010)
- Investigate techniques to improve natural recruitment. (USFWS, 2010)
- Update the listed entity on 50 CFR 17 to match the currently recognized taxonomy. (USFWS, 2010)

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SPECIES ACCOUNT: *Lithophragma maximum* (San Clemente Island woodland-star)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/07/1997; Pacific Southwest (R8)

Physical Description

Lithophragma maximum flowers from April to June (California Native Plant Society 2001). It is a rhizomatous (bearing horizontal subterranean stems), perennial herb with basal leaves and two or three stout flowering stems from 40 to 60 centimeters (cm) (16-24 inches (in.)) high. Each flower bearing stem produces 20 or more white to pinkish, bisexual, campanulate (bell shaped) flowers, each about 1 cm (0.5 in.) in length (Bacigalupi 1963; Junak and Wilken 1998). The fruit is a 3-valved capsule with numerous seeds (Bacigalupi 1963). The leaves are palmately compound (with the blade divided into leaflets that radiate from a common point) and arise from the base on slender petioles 15 cm. (6 in.) long. (USFWS, 2007)

Taxonomy

A member of the saxifrage family (Saxifragaceae). The species was described in 1963 from a single pressed herbarium specimen (Bacigalupi 1963). In 1978, living plants were rediscovered in Eagle and Bryce Canyons. (USFWS, 1984) *Lithophragma maximum* is the only species within its genus known to occur on San Clemente Island (U. S. Department of the Navy 2001) (USFWS, 2007).

Historical Range

In California (Los Angeles County), endemic to the east side of San Clemente Island, only in canyons (US Navy land) (USFWS, 2007).

Current Range

On San Clemente Island, Los Angeles County, California. Restricted and dissected distribution with one major concentration of plants in the branched canyons north of Mosquito Cove Canyon, a small to moderate sized population in Mosquito Cove Canyon, and three very small peripheral populations in the canyons at the southern and northern limits of its range. (USFWS, 2007)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (NatureServe, 2015); asexual: vegetative (USFWS, 2007)

Lifespan

Adult: 2+ years (NatureServe, 2015)

Breeding Season

Adult: April - June (USFWS, 2007)

Key Resources Needed for Breeding

Adult: Insect pollinators, especially moths, based on closely related species (USFWS, 2007)

Reproduction Narrative

Adult: This species is a perennial. Nectary disk often present in the family. Seeds are numerous and small. Reproduction is sexual (NatureServe, 2015). It flowers from April to June (California Native Plant Society 2001). Most of what is known is inferred from studies of other species in the genus. White, sometimes scented flowers within *Lithophragma* suggest plants may rely on moths for pollination (Taylor 1965; Kellogg and Kellogg 1994). During three years of field work, one genus of moth (*Lampronia*) and four genera of bees (*Andrena*, *Apis*, *Osmia* and *Chloralictus*) were collected during a study of several species of *Lithophragma* (Taylor 1965). Based on its growth habit and knowledge of vegetative reproduction in other *Lithophragma*, *L. maximum* is likely capable of vegetative reproduction via rhizomes and bulblets (Bacigalupi 1963; Taylor 1965; U. S. Department of the Navy 2001). Studies to characterize sexual reproduction in the genus found that of seven species studied (including two subspecies of one species, for a total of eight taxa), four were entirely self-incompatible and the remaining species were partially so, with just 12-50 percent seed set resulting from self-pollination (Taylor 1965). Evidence that a self-incompatibility system operates within the genus suggests that *L. maximum* may also be partially or completely self-incompatible (Taylor 1965; Junak and Wilken 1998). Helenurm (1998) found seed germination and seedling survival rates under greenhouse conditions to be very low. A 1998 effort at the Rancho Santa Ana Botanic Gardens to grow plants from seed obtained about 3 percent germination success, resulting in the propagation of 6 plants from 350 seeds (C. Ames pers. comm. 2006) (USFWS, 2007).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Coastal bluff scrub and coastal scrub (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 400 - 1,200 ft. elevation (USFWS, 2007)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Dependency on Other Individuals or Species for Habitat

Adult: Possibly *Lyonothamnus floribundus* ssp. *aspleniifolius* (USFWS, 2007)

Habitat Narrative

Adult: Inhabits coastal bluff scrub and coastal scrub. Persists on moist, shaded, north-facing canyon walls. The plants may also have occupied a plateau area before the introduction of non-native grasses. The environmental specificity is very narrow; it is only known from three canyons on San Clemente Island (NatureServe, 2015). Plants are generally found in shady conditions on

ledges on canyon walls and on gentle north-facing slopes in moist canyon bottoms between elevations of 120 to 366 meters (m) (400-1200 feet (ft.)) (Junak and Wilken 1998; Junak 2006; S. Junak pers. comm. 2006). Soils are usually at least vernal moist and are generally loams of varying depth that are derived from rock of volcanic origin (Ferguson and Beauchamp 1981; Junak pers. comm. 2006). A number of populations are found downslope from sizable groves of *Lyonothamnus floribundus* ssp. *aspleniifolius* (Santa Cruz Island ironwood), suggesting a possible association with this species (Junak and Wilken 1998; S. Junak pers. comm. 2006) (USFWS, 2007).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seeds are assumed wind dispersed (NatureServe, 2015).

Population Information and Trends

Population Trends:

Decline of 30-50% (NatureServe, 2015); presumed extinct until 1979 (USFWS, 2007)

Species Trends:

Stable (NatureServe, 2015)

Number of Populations:

11 - 17 (USFWS, 2007)

Population Size:

~641 (USFWS, 2007)

Adaptability:

Low (inferred from NatureServe, 2015)

Population Narrative:

This plant is vulnerable due to presence on eroding habitat and small population sizes. The long term trend was certainly declining due to feral goats and pigs but now that these are removed, the vegetation is recovering. This species has experienced a long term decline of 30-50%. Only about 30 total plants are known. Three sites are known from three canyons. The short term trend has been relatively stable, due to removal of feral herbivores from the island (NatureServe, 2015). *L. maximum* was presumed extinct until its rediscovery in 1979. At the time of listing in 1997, there were 11 known populations from the southeastern portion of San Clemente Island (62 FR 42692). Based on a recent compilation of records in Carlsbad Fish and Wildlife Office (CFWO) files, it appears that around 17 locations have now been documented for the species (Figure 1 and Appendix 1). However, this may not accurately represent the total number of extant occurrences since multiple records within the same canyon often reflect an accumulation of records made by independent observers using different mapping methods over a span of years. If one ignores the potential that more than one record could represent the same population and sums the most recent approximate count of individuals per occurrence measured since 1979, then about 641 individuals of *L. maximum* have been documented

throughout its range. Lack of variation among the large number of loci studied (24) indicates that genetic variation in *L. maximum* is unusually low (Helenurm 1997). (USFWS, 2007).

Threats and Stressors

Stressor: Erosion (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: The decline of *L. maximum* and the decline of all of San Clemente's endemic flora is primarily attributed to the introduction of non-native animal and plant species by Euro-Americans during the last 200 years (62 FR 42692). Goats (*Capra hircus*) were present on San Clemente Island as early as 1827 (Dunkle 1950), and sheep (*Ovis aries*) were introduced around 1868 (Kellogg and Kellogg 1994). Other large-stature herbivores historically introduced to San Clemente Island included cattle (*Bos taurus*), pigs (*Sus scrofa*), and mule deer (*Odocoileus hemionus*) (62 FR 42692). In particular, ranching of sheep and, following their removal, proliferation of goats led to severe overgrazing, trampling of vegetation, and denudation of the island (O'Malley 1994; Dunkle 1950). With intensive grazing pressure leading to near complete consumption of grasses, sheep and goats fed on less palatable shrubs and trees causing a tremendous loss of shrub and tree cover (Kellogg & Kellogg 1994; O'Malley 1994). Creation of bare trails and denuded areas led to severe erosion causing the stripping of vegetation and soil. Accelerated erosion was likely exacerbated by reduction in vegetation cover associated with periods of drought and fire (Johnson 1980). Loss of soil within island woodlands along the eastern escarpment where *L. maximum* occurs has led to much root exposure and subsequent death of trees (Kellogg and Kellogg 1994) (USFWS, 2007).

Stressor: Nonnative plants (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Exotic species have potential to compete with *L. maximum* for space or other resources such as light, water, and nutrients. Exotic invasives can also alter habitat structure, ecological processes such as nutrient cycling (Zink et al. 1995), and the prevalence of fire (Brooks 1999). By 1992, 99 exotic species were documented as occurring on San Clemente Island (Kellogg and Kellogg 1994), with many of them having become naturalized and a significant component of island habitats. Since then, new exotics continue to be discovered, which may represent new introductions from military personnel, vehicles, and/or equipment (e.g., *Schismus* sp., *Brassicae tournefortii*) (J. Dunn pers. comm. 2006; E. Kellogg pers. comm. 2006; S. Junak pers. comm. 2006). Although no single invasive non-native plant species has been identified as posing a specific competitive threat to this species, invasive annual grasses may pose the biggest threat over the long term (S. Junak pers. comm. 2006) due to their ability to rapidly colonize and exploit many different microhabitats. Ripgut grass (*Bromus diandrus*) is one of several exotic plant species that have been found to co-occur with *L. maximum* (Junak and Wilken 1998) (USFWS, 2007).

Stressor: Military training activities (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: San Clemente is owned by the U. S. Department of the Navy. With its associated offshore range complex, it is the primary maritime training area for the Navy Pacific Fleet Navy Sea, Air, and Land (SEALS), and it supports training by the U. S. Marine Corps, the U. S. Air Force, and others. As the last range in the eastern Pacific Basin where many training operations are performed prior to troop deployments, portions of the island receive intensive use. Associated with training operations is an elevated risk of fire (e.g. 117 wildfires that burned 10,645 ha/26,304ac. were recorded on San Clemente Island between 1990 and 2001: U. S. Department of the Navy 2001). The distribution of *L. maximum* occurs entirely within the Shore Bombardment Area (SHOBA) on San Clemente Island. SHOBA encompasses approximately the southern one-third of the island and supports a variety of training operations involving both live and non-live munitions fire (U. S. Department of the Navy 2001) (USFWS, 2007).

Stressor: Stochastic events (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Because *L. maximum* is an insular endemic species that is narrowly distributed within only five canyons on San Clemente Island, the species is vulnerable to a number of stochastic factors such as demographic stochasticity, environmental stochasticity, genetic stochasticity, and natural catastrophes (Shaffer 1981) (USFWS, 2007).

Stressor: Access to SHOBA (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Because SHOBA is used for ship-to-shore bombardment, as well as other munitions training exercises, access to this area is often restricted for non-military personnel. These restrictions can influence both the timing and locations where access is granted. This access limitation and the lead time needed for range scheduling can undermine the effectiveness of surveys and invasive species control efforts by limiting the ability to time these activities during optimal times in the life cycle of target organisms (e.g., spraying herbicide prior to an invasive plant setting seed) (USFWS, 2007).

Recovery**Reclassification Criteria:**

Downlisting of San Clemente Island woodland star may be considered when all of the following criteria have been met to address threats to the species: (USFWS, 2019)

A.1: Habitat loss from invasive herbivores is effectively managed and recovery of native vegetation is evident where San Clemente Island woodland star occurs. (USFWS, 2019)

A.2: A survey methodology is developed which identifies encroaching vegetation and allows tracking of persistence of San Clemente Island woodland star over time and relative changes in abundance at some selected number of occurrences; the locations will be determined based upon feasibility of maintaining consistent access. Information is quantitative in nature and includes a standardized estimate of abundance at occurrences that can be tracked over time,

and indicators of demographic status (e.g., flowering; production of viable seed; relative estimated age of plants within the monitored occurrence; evidence of fruit or seed depredation; potential pollinators). (USFWS, 2019)

A.3: The response of San Clemente Island woodland star to fire is assessed and monitored post burn to measure persistence. (USFWS, 2019)

E.1: A minimum of five canyons support San Clemente Island woodland star as demonstrated with persistence of at least one occurrence per canyon for a minimum of 10 years through consistent monitoring. Grove, Keco, and Mosquito canyons are included as three of the five canyons addressed by this criterion. At least one occurrence within each of the five canyons is managed for long-term persistence. (USFWS, 2019)

E.2: A Fire Management Plan is developed and implemented to ensure the persistence of San Clemente Island woodland star in the canyons along the eastern escarpment where the species occurs. (USFWS, 2019)

E.3: Erosion potential from anthropomorphic activities is assessed at localities selected in Criterion E.1 (e.g., comparative assessment of on-site slope, aspect, vegetation cover, landuse, and fire-history) and managed, as feasible, to ensure long-term persistence of the species. (USFWS, 2019)

Delisting Criteria:

Delisting of San Clemente Island woodland star may be considered when all of the following additional criteria have been met to address threats to the species: (USFWS, 2019)

A.5: Changes to land use (e.g. training) are addressed through an INRMP, management program, or consultation in cooperation with the Service, such that training expansion does not directly or indirectly pose a threat to the persistence of San Clemente Island woodland star. (USFWS, 2019)

E.4: Consistent with the downlisting criteria, a minimum of five canyons support San Clemente Island woodland star as demonstrated with consistent monitoring at each site for 20 years. A subset of the occurrences within each canyon is managed for long-term persistence through implementation of A.2 above. (USFWS, 2019)

Recovery Actions:

- Recommended Action from 2007 5-Year Review: Study the reproductive ecology and mating system of *L. maximum* to determine whether populations suffer from low pollinator visitation and/or have a self-incompatibility mechanism (e.g. have genes that preclude mating among closely related individuals) that limits sexual reproduction in the species (USFWS, 2007).
- Recommended Action from 2007 5-Year Review: Perform additional genetic studies on *L. maximum* using randomly amplified polymorphic DNA (RAPDs) or other appropriate genetic markers to see if there is any detectable genetic variation in the species that will allow for inferences about relatedness of adjoining individuals, trends in genetic variation, patterns of gene flow, or other evolutionary processes (USFWS, 2007).

- Recommended Action from 2007 5-Year Review: Use existing or new seed collections to propagate and establish additional populations of *L. maximum* in appropriate habitat to help safeguard the species. Results from the prior two recommended actions should be used to select seed from the most genetically diverse source populations and to determine if transplantation into existing populations should be used to improve seed production and fitness of populations (USFWS, 2007).
- Recommended Action from 2007 5-Year Review: Work with the military to adopt a set of access policies for the shore bombardment area on San Clemente Island to facilitate effective management and monitoring of *L. maximum*. These policies should allow for greater flexibility in the timing of study and survey efforts and should prioritize providing access during critical times in the life cycle of *L. maximum* and invasive weeds (USFWS, 2007).
- Recommended Action from 2007 5-Year Review: Work with the military to incorporate into the proposed Fire Management Plan an active commitment to use back-fires or other appropriate techniques to prevent wildfires from spreading east of Ridge Road (USFWS, 2007).
- 1. Habitat restoration: To restore habitat to provide a more suitable environment for these E/T species, revegetation, control of erosion, and removal of exotic species will be necessary. (USFWS, 1984)
- 2. Implement management recommendations for E/T species. Numerous actions have been proposed to maintain and restore populations of these E/T species. Re-establish listed plant species on San Clemente Island revegetation. Modify existing management plans to minimize habitat disturbance. (USFWS, 1984)
- 3. Habitat protection. Survival and eventual recovery of these species is dependent on adequate protection of their habitat. Regardless of other management actions to conserve these E/T species, if habitat is not properly managed, recovery will not be possible. (USFWS, 1984)
- 4. Develop delisting criteria (i.e., the size of populations and amount of suitable habitat necessary before reclassification can be considered). Before consideration can be given for reclassifying a species (either upgrading to threatened status or delisting) it is necessary to determine the number of organisms, the size of the secure habitat, or the number of such populations/habitats required to support viable, self-sustaining populations. To obtain this information and to properly manage these taxa, additional research studies are necessary. (USFWS, 1984)
- 5. Evaluate success of management actions. All E/T taxa must be monitored throughout the course of the recovery program to assess its success and determine if additional actions or modifications of activities are necessary. (USFWS, 1984)
- 6. Increase public support. Public support for the conservation of these E/T species can be enhanced by increasing the public's awareness of the sensitivity and uniqueness of the island's ecosystems. (USFWS, 1984)
- 7. Use existing laws and regulations protecting E/T species. All Federal and State laws pertaining to the protection and conservation of E/T species should be used to further the recovery effort. (USFWS, 1984)

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SPECIES ACCOUNT: *Lobelia koolauensis* (= *L. gaudichaudii* ssp. *koolauensis*) (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

Lobelia gaudichaudii ssp. *koolauensis* is a short-lived perennial in the Campanulaceae (bellflower family). This species is an unbranched, woody shrub, 0.3 to 1 m (1 to 3.5 ft) tall with lance or oblong shaped leaves, 8 to 19 cm (3.1 to 7.5 in) long and 1.3 to 2.8 cm (0.5 to 1.1 in) wide. The greenish or yellowish-white flowers are 5 to 7.5 cm (2 to 3 in) long and 8 to 15 mm (0.3 to 0.6 in) wide, and two to six branched. The ovoid-shaped fruit is 1.5 to 2 cm (0.6 to 0.8 in) long and the seeds are brown, ovoid, and slightly winged. There are more than 350 species of *Lobelia* known worldwide, including 13 endemic Hawaiian species. *L. gaudichaudii* ssp. *koolauensis* is distinguished from others in the genus by the length of the stem, the length and color of the corolla, the leaf width, the length of the floral bracts, and the length of the calyx lobes. The subspecies *koolauensis* is distinguished by the greenish or yellowish white petals and the branched flowering stalks (Wagner et al. 1999).

Historical Range

See current range/distribution

Current Range

Historically, *Lobelia gaudichaudii* ssp. *koolauensis* was known from two occurrences in the central Koolau Mountains on Oahu. Currently, this subspecies is known from two occurrences totaling 263 individuals; one occurrence in Waiawa-Waimano containing 237 individuals, and one occurrence of 26 individuals in south Kaukonahua (HINHP Database 2001; U.S. Army 2003a; K. Kawelo, U.S. Army, pers. comm. 2003; J. Lau, HINHP, pers. comm. 2003). Occurrences of *L. gaudichaudii* ssp. *koolauensis* are declining, and those that remain are small and widely dispersed (U.S. Army 2003a; 61 FR 53089).

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Lobelia koolauensis* (= *L. gaudichaudii* ssp. *koolauensis*) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Lobelia koolauensis* (= *L. gaudichaudii* ssp. *koolauensis*) (77 FR 57648-57862). The critical habitat designation includes 11 critical habitat units, which encompass approximately 25,112 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Lobelia koolauensis* (= *L. gaudichaudii* ssp. *koolauensis*) includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by

providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Lobelia koolauensis* (= *L. gaudichaudii* ssp. *koolauensis*) includes 11 critical habitat units, covering one ecosystem type, which encompasses approximately 25,112 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16.

Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Haula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikēkee, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet—Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet—Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu—Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamo Ridge.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Lobelia koolauensis* (= *L. gaudichaudii* ssp. *koolauensis*) critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Lobelia koolauensis* (= *L. gaudichaudii* ssp. *koolauensis*) occurs within the indicated ecosystem in the Koolau Mountain caldera complex:

Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (F) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Lobelia koolauensis* (= *L. gaudichaudii* ssp. *koolauensis*) to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: *L. gaudichaudii* ssp. *koolauensis* has been observed in flower in September and in fruit in December. Little else is known about its flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors (Service 1998a).

Habitat Type

Adult: Wet shrublands and bogs

Habitat Narrative

Adult: *Lobelia gaudichaudii* ssp. *koolauensis* typically grows on moderate to steep slopes in *Metrosideros polymorpha* lowland wet shrublands and bogs at elevations between 383 and 867 m (1,256 and 2,844 ft). Associated native plant species include *Bidens* sp., *Broussaisia arguta*, *Cibotium* sp., *Dicanthelium koolauense*, *Isachne distichophylla*, *Machaerina angustifolia*, *Melicope* sp., *Sadleria pallida*, *Scaevola* sp., or *Vaccinium dentatum* (ohelo) (HINHP Database 2001; U.S. Army 2003a).

Dispersal/Migration***Population Information and Trends***

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Fragility unknown. Currently 237 plants observed. 2 current (between 1982 and 1997) and 1 historical occurrences. (NatureServe, 2015)

Threats and Stressors**Stressor:****Exposure:****Response:****Consequence:**

Narrative: The primary threats to *Lobelia gaudichaudii* ssp. *koolauensis* include loss and degradation of habitat by non-native plants and animals. The non-native plants such as *Axonopus*, *Clidemia hirta*, *Psidium cattleianum*, *Pterolepis glomerata*, and *Sacciolepis indica* threaten *L. gaudichaudii* ssp. *koolauensis* by altering its habitat and competing for nutrients, light, and space. Feral pigs can impact *L. gaudichaudii* ssp. *koolauensis* by consuming fruits and other plant parts and by rooting up soil, which degrades the habitat. Rats also threaten this species by consuming fruits and other plant parts. Non-native slugs and snails threaten the species by feeding on its leaves, stems, and seedlings. Occurrences of *L. gaudichaudii* ssp. *koolauensis* found along trails are threatened by trampling from foot traffic. Because these plants are often found on steep, they are also vulnerable to damage caused by landslides. The few remaining individuals make this species vulnerable to extinction from random environmental events and/or reduced reproductive vigor (HINHP Database 2001; 61 FR 53089).

Recovery***Conservation Measures and Best Management Practices:***

- A State-wide management plan should be developed and implemented for the long-term conservation of all known occurrences of *Lobelia gaudichaudii* ssp. *koolauensis*. This plan should also include broader landscape actions that are needed for the recovery of this plant throughout its range. The recovery plan for this species identifies important conservation actions. Exclosures should be constructed around the all known occurrences of *L. gaudichaudii* ssp. *koolauensis* to reduce impacts from feral pigs. Pigs should be controlled or removed from these areas and the broader landscape to alleviate their impact on native ecosystems. Where fencing is not feasible due to topography or potential damage to sensitive habitat, other means of ungulate control including snaring should be judiciously used. Non-native plants should be controlled or removed from the vicinity of all known occurrences of *L. gaudichaudii* ssp. *koolauensis*. To prevent its extinction, a program of ex situ propagation for *L. gaudichaudii* ssp. *koolauensis* should be initiated. Propagation material should be collected immediately from the remaining occurrences (Service 1998a). Ongoing Conservation Actions: The National Tropical Botanical Garden has seeds of this species in storage (Service 2002). The Service is currently not aware of any other conservation efforts for this species.

References

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NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.”

SPECIES ACCOUNT: *Lobelia monostachya* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

A prostrate woody shrub with stems 15 to 25 cm (6 to 10 in) long. The species is distinguished from others in the genus by its narrow, linear leaves without stalks and its short pink flowers (USFWS, 2003).

Taxonomy

In the bellflower family (Campanulaceae) (USFWS, 2003).

Historical Range

Historically known from the Koolau Mountains of Oahu (USFWS, 2003).

Current Range

Southern Koolau Mountains of Oahu. (NatureServe, 2015)

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Lobelia monostachya* under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Lobelia monostachya* (77 FR 57648-57862). The critical habitat designation includes 4 critical habitat units, which encompass approximately 1,939 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Lobelia monostachya* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Lobelia monostachya* includes 4 critical habitat units, covering one ecosystem type, which encompasses approximately 1,939 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 4, 5, 6, 7.

Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on

the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Lobelia monostachya* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Lobelia monostachya* occurs within the indicated ecosystem in the Koolau Mountain caldera complex:

Oahu—Lowland Mesic—Units 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Lobelia monostachya* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: This species has been observed in flower in May and June (R. Fenstermacher, pers. comm. 1998). (USFWS, 1998)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliff, grassland/herbaceous, savanna, shrubland/chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Prefers steep slopes and sparsely vegetated cliffs; found at elevations of about 290 meters (USFWS, 1998)

Environmental Specificity

Adult: Medium to high, with several key requirements (USFWS, 1998)

Habitat Narrative

Adult: *Lobelia monostachya* is found on dry to moist cliffs and steep slopes with native grasses and shrubs. This species occurs on steep, sparsely vegetated cliffs in mesic shrubland at an elevation of about 290 meters (950 feet) (USFWS 1996b). Associated plants include ahinahina, *Carex meyenii*, *Psilotum nudum* (moa), and kawelu (USFWS 1996b). (USFWS, 1998; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2012)

Redundancy:

Very low (inferred from USFWS, 2012)

Number of Populations:

2 (USFWS, 2012)

Population Size:

13 (USFWS, 2012)

Population Narrative:

In 2008, the population located at Wailupe Valley contained 10 mature healthy individuals. During the same year, the second population located at Waialae Nui Ridge consisted of a single mature and two immature individuals. None of the individuals observed at these locations contained mature fruit at the time (Perlman 2012). Three additional individuals were found in Wailupe Valley, bringing the current number of naturally occurring individuals up from eight reported in the last five-year reviews to 13 (Plant Extinction Prevention Program [PEPP] 2012b). (USFWS, 2012)

Threats and Stressors

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Climate change - Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC)

funded climate modeling that will help resolve these spatial limitations. High spatial resolution climate outputs are expected to be available sometime in 2013. (USFWS, 2012)

Stressor: Drought (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Drought is considered a threat at both Wailupe and Waialae Nui Ridge populations (Oahu PEPP 2012). (USFWS, 2012)

Stressor: Rats (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Rats (*Rattus* sp.) are also considered a threat to *Lobelia monostachya* (Oahu PEPP 2012). (USFWS, 2012)

Stressor: Invasive plant species (USFWS, 1998; USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: The major threats to *Lobelia monostachya* include competition with invasive introduced plant species (Christmas berry, *Hamakua pamakani*, air plant, and molasses grass). All seven individuals of the species occur on steep cliffs where removal of invasive plants is virtually impossible (Oahu Plant Extinction Prevention Program 2007). (USFWS, 1998; USFWS, 2008)

Stressor: Small population size (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: In addition to all of the other threats, species like *Lobelia monostachya* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes and disease outbreaks. (USFWS, 2008)

Stressor: Landslides (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Landslides are a threat to *Lobelia monostachya*, given their precarious location on cliffs. (USFWS, 2008)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)

3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1998)

Recovery Actions:

- Control competing alien plant species. The remaining population should be weeded and protected immediately. (USFWS, 1998)
- Reduce threat of rat predation. The only population of *Lobelia monostachya* may be seriously threatened by rat predation. (USFWS, 1998)

Conservation Measures and Best Management Practices:

- Continue weed control as possible. (USFWS, 2008)
- Continue reintroducing individuals into protected suitable habitat. (USFWS, 2008)
- Continue collecting fruit from any additional individuals that set seed to add to the genetic diversity of the ex situ material. (USFWS, 2008)
- Continue to collect seeds from tagged individuals, keeping close track of the maternal source for use in ex situ propagation. (USFWS, 2012)
- Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation. (USFWS, 2012)
- Continue to reintroduce the species back into its known historical range. (USFWS, 2012)
- Control invasive introduced plant species around all populations. (USFWS, 2012)
- Continue to conduct thorough surveys of all suitable habitats where *Lobelia monostachya* was historically seen. (USFWS, 2012)
- Assess the modeled effects of climate change on this species, and use results to determine future landscape needed for the recovery of the species. (USFWS, 2012)
- Explore measures to mitigate the effects of drought. (USFWS, 2012)
- Study populations of *Lobelia monostachya* with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. (USFWS, 2012)
- Initiate planning and contribute to implementation of ecosystem-level management and restoration to benefit this species. (USFWS, 2012)

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SPECIES ACCOUNT: *Lobelia niihauensis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

A sprawling shrub branching near the base. Each branch bears a terminal rosette of leaves. The magenta flowers are borne on unbranched terminal inflorescences. (NatureServe, 2015)

Historical Range

Historically, *Lobelia niihauensis* was known from the Waianae Mountains of Oahu (Uluhulu Gulch to Nanakuli Valley), Kauai, and Niihau (USFWS, 2016).

Current Range

It is now known to be extant only on Kauai and Oahu. On Oahu, this species is found on Ohikilolo Ridge, Kaimokuiki-Manuwai Ridge, Kamaileunu Ridge, Mt. Kaala, Makaha-Waianae Kai, Makua, Nanakuli, South Mohiakea Gulch, east of Puu Kalena, Kahanahaiki Valley, between Puu Hapapa and Puu Kanehoa, Puu Kailio, between Kolekole Pass and Puu Hapapa, North of Palikea, Puu Kaua-Kauhiuhi-Pahoa-Halona subdistricts, and Lualualei Naval Magazine (Table SB 24) (USFWS, 2016).

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Lobelia niihauensis* under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Lobelia niihauensis* (77 FR 57648-57862). The critical habitat designation includes 11 critical habitat units, which encompass approximately 7,372 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Lobelia niihauensis* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Lobelia niihauensis* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Lobelia niihauensis* includes 11 critical habitat units, covering two ecosystem types, which encompass approximately 7,372 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3; Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and

277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac (105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

The critical habitat designation for *Lobelia niihauensis* includes two units totaling 5,164 acres in Kauai County, Hawaii. The units are Kauai 11—*Lobelia niihauensis*—a, b.

Kauai 11—*Lobelia niihauensis*—a: This unit is critical habitat for *Lobelia niihauensis* and is 89 ha (220 ac) on State land (Alakai Wilderness Preserve), containing portions of Kipalau Valley. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial *Lobelia niihauensis* and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is important to the establishment of additional populations on Kauai in order to reach recovery goals. It provides habitat for the westernmost range of the species that is unique to Kauai. The habitat features contained in this unit that are essential for this species include, but are not limited to, exposed mesic mixed shrubland or coastal dry cliffs. This unit provides for two populations within this multi-island species' historical range on Kauai that are some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event. Kauai 11—*Lobelia niihauensis*—b: This unit is critical habitat for *Lobelia niihauensis* and is 2,003 ha (4,950 ac) on State (Haena State Park and Hono o Na Pali NAR) and private land. This unit contains Hanakapiai, Hanakoa, Kalalau, and Limahuli Valleys, Kaaalahina and Manono Ridges, Kanakou and Makana Summits, Hoolau and Waiahuakua

Streams. This unit provides habitat for five populations of 300 mature, reproducing individuals of the short-lived perennial *Lobelia niihauensis* and is currently occupied with 168 to 1,108 plants. This unit is important to the conservation of the taxon because it supports an extant colony of this species. It provides habitat for the westernmost range of the species that is unique to Kauai. The habitat features contained in this unit that are essential for this species include, but are not limited to, exposed mesic mixed shrubland or coastal dry cliffs. This unit provides for five populations within this multi-island species' historical range on Kauai that are some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Lobelia niihauensis* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Lobelia niihauensis* occurs within the Lowland mesic and Dry cliff ecosystems in the Waianae Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: *Antidesma*, *Chamaesyce*, *Diospyros*, *Dodonaea*. (F) Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Schiedea*.

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

- (i) Exposed mesic mixed shrubland or coastal dry cliffs and containing one or more of the following associated native plant species: *Artemisia australis*, *Bidens sandvicensis*, *Chamaesyce celastroides*, *Charpentiera* spp., *Eragrostis variabilis*, *Hibiscus kokio* ssp. *saint-johnianus*, *Lipochaeta connata* var. *acris*, *Lythrum* spp., *Nototrichium* spp., *Plectranthus parviflorus*, *Schiedea apokremnos*, or *Wilkesia hobbdi*; and
- (ii) Elevations between 36 and 888 m (117 and 2,911 ft).

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Lobelia niihauensis* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Lifespan

Adult: up to 20 years (USFWS, 2016)

Reproduction Narrative

Adult: *Lobelia niihauensis* flowers in late summer and early fall. Fruits mature one month to six weeks later. Plants are known to live as long as 20 years. Few juveniles are observed in the wild (U.S. Army Garrison 1999a) (USFWS, 2016).

Habitat Type

Adult: Cliffs (USFWS, 2016)

Habitat Narrative

Adult: Exposed mesic to dry vertical rock cliffs. (NatureServe, 2015). *Lobelia niihauensis* typically grows on exposed mesic to dry cliffs at elevations of 100 to 830 m (330 to 2,720 ft). Associated plants include *Artemisia australis*, *Bidens* spp., *Eragrostis variabilis*, *Lipochaeta* sp., and *Plectranthus parviflorus* (USFWS, 2016).

Dispersal/Migration

Population Information and Trends

Population Trends:

Unknown

Number of Populations:

~40 (USFWS, 2016)

Population Size:

350-400 individuals (USFWS, 2016)

Population Narrative:

It is estimated there are 40 occurrences of *L. niihauensis* with a total population of between 350 and 400 individuals on Federal, State, city, and county lands (68 FR 35950) (USFWS, 2016). *Lobelia niihauensis* has been found in three more locations on Kauai since the time of the last 5-year review in 2011. These locations are Awaawapuhi (two individuals), Koaie Canyon cliffs (common), and Kipu Kai (one individual) (NTBG 2011a-b, 2015a, 2016b). This species has also been re-observed at Kalalau, with at least 10 individuals found between the Kalalau lookouts (NTBG 2016a). There are no current reports regarding other populations reported in the previous 5-year review (2011) at Limahuli, Pohakuao, Hanakoa, and Milolii. In summary, there are four populations on Kauai totaling at least 100 individuals. • Populations on Oahu remain the same: nine populations at 13 locations, currently totaling at least 280 individuals, including over 100 mature individuals. However, most locations have not been revisited since their initial discovery and most recent population estimates (HBMP 2010; U.S. Army 2016) (USFWS, 2017).

Threats and Stressors

Stressor: Feral goats (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: On Oahu and Kauai habitat degradation and predation by feral goats are listed as major threats to this species (USFWS, 2016).

Stressor: Non-native plants

Exposure:

Response:

Consequence: Loss of habitat

Narrative: On Oahu and Kauai competition from non-native plants is listed as a threat to this species (USFWS, 2016).

Stressor: Rats and slugs (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: On Oahu, rats and slugs are listed as threats to this species (USFWS, 2016).

Stressor: Fire (USFWS, 2016)

Exposure:

Response:**Consequence:** Loss of habitat/loss of individuals**Narrative:** On Oahu, fire is listed as a threat to this species (USFWS, 2016).**Stressor:** Military activities (USFWS, 2016)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** On Oahu, military activities are listed as a threat to this species (USFWS, 2016).**Stressor:** Climate change loss or degradation of habitat**Exposure:****Response:****Consequence:****Narrative:** Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Lobelia niihauensis* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.741 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).**Stressor:** Fire destruction or degradation of habitat**Exposure:****Response:****Consequence:****Narrative:** Fire continues to be a threat to *Lobelia niihauensis*. In 2012, a fire that started on private land near the Army training area on Oahu traveled upslope and posed a threat to known occurrences of *L. niihauensis* and other endangered plants along the Kamaileunu Ridge and 1,000 m (3,280 ft) to the northwest (U.S. Army 2012). Coordinated efforts between State and Army fire response teams were able to address the fire and extinguish it before it damaged this taxon and its habitat (U.S. Army 2012) (USFWS, 2017).**Stressor:** Ungulate degradation of habitat**Exposure:****Response:****Consequence:****Narrative:** —Black-tailed deer (*Odocoileus hemionus*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil (van Riper and van Riper 1982; Loope 1998). Black-tailed deer and evidence of their activities have been observed at the Awaawapuhi and Koaie canyon occurrences of *Lobelia niihauensis* (NTBG 2011a-b, 2016b) (USFWS, 2017).**Recovery****Recovery Actions:**

- **New Management Actions:**
 - **Invasive plant monitoring and control**—Requirements for mitigation of incidental damage to the species is covered by the Biological Opinion of the USFWS for U.S. Army Military Training at Makua Military Reservation (USFWS 2007). The Army has completed a fence that runs the south and southeast perimeter of Makua Valley, protecting the plants on Ohikilolo Ridge on Oahu. Continuing nonnative plant management activities include weeding, fuel modification, firebreak management, and habitat restoration.
 - **Predator and herbivore monitoring and control**—The U.S. Army is also conducting ungulate, rat, and slug control for plants within training area management units at Makua and Ohikilolo on Oahu.
 - **Captive propagation for genetic storage and reintroduction**—Between 1995 and 2005, Lyon Arboretum had over 120 containers of *Lobelia niihauensis* in micropropagation, but does not currently store this taxon. The Lyon Arboretum Seed Bank has research collections of this species to determine proper storage protocols, and a couple founders from Oahu represented (Lyon Arboretum 2017). The NTBG Seed Bank has collections from three locations on Kauai (NTBG 2017) (USFWS, 2017).
- **Recommendations for Future Actions:** Habitat destruction and modification, and predation and herbivory, by black-tailed deer (Kauai) have been identified as new threats to *Lobelia niihauensis*. No other significant new information regarding the species biological status has come to light since the last 5-year review in 2011. Thus, the following recommendations for future actions are added or reiterated for the 5-year review for 2017.
 - **Surveys and inventories**—Continue to survey for populations of *Lobelia niihauensis* in areas of potentially suitable habitat.
 - **Ungulate monitoring and control**—Continue to construct and maintain fenced exclosures around all populations. Protect all occurrences against disturbances from feral ungulates to prevent imminent extinction.
 - **Invasive plant monitoring and control**—
 - o Control established ecosystem-altering nonnative invasive plant species around all populations.
 - o Control invasive nonnative species that compete with the species around all populations.
 - **Predator and herbivore monitoring and control**—
 - o Implement effective control methods for rodents.
 - o Determine and implement effective control methods for slugs.
 - **Captive propagation for genetic storage and reintroduction**—Continue collection efforts for maintenance of genetic stock.
 - **Reintroduction and translocation**—Determine if reintroduction is needed to reach the recovery criteria.
 - **Human interaction monitoring and control**—Develop and implement effective measures to reduce the impacts of military activities.
 - **Fire monitoring and control**—Develop and implement fire management plans for all wild and reintroduced populations.
 - **Population biology research**—Study *Lobelia niihauensis* populations to determine viable population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats.
 - **Stochastic events**—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and drought (USFWS, 2017).

References

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USFWS. 2016. Status of the Species and Critical Habitat: *Lobelia niihauensis* (No Common Name). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016.

U.S. Fish and Wildlife Service. 2017. 5-YEAR REVIEW. Short Form Summary. Species Reviewed: *Lobelia niihauensis* (No common name).

SPECIES ACCOUNT: *Lobelia oahuensis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/28/1994; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

A shrub, usually with a single erect stem 10-30 dm long, topped with a rosette of leaves. The blue flowers are borne on a large branched terminal inflorescence up to 1.5 m long. (NatureServe, 2015)

Taxonomy

Genus found throughout tropical & temperate regions, world- wide. Species endemic to koolau mts, oahu. Lammers in Wagner et al. Maintained this species. According to rock this species is related to lobelia hypoleuca. (NatureServe, 2015)

Historical Range

Historically, *Lobelia oahuensis* was known from Kahana Ridge, Kipapa Gulch, and the southeastern Koolau Mountains of Oahu (USFWS 1996b; St John and Hosaka 1935). (USFWS, 1998)

Current Range

Koolau Mountains, and one recent occurrence in the Waianae Mountains, Oahu. (NatureServe, 2015)

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Lobelia oahuensis* under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Lobelia oahuensis* (77 FR 57648-57862). The critical habitat designation includes 25 critical habitat units, which encompass approximately 31,425 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Lobelia oahuensis* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Lobelia oahuensis* includes 25 critical habitat units, covering three ecosystem types, which encompass approximately 31,425 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Wet—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; Oahu—Montane Wet—Unit 1; Oahu—Wet Cliff—Units 1, 2, 3, 4, 5, 6, 7, 8

Oahu—Lowland Wet—Unit 1 [541 ac (219 ha)]. This area consists of 428 ac (173 ha) of State land and 112 ac (46 ha) of City and County of Honolulu land in the lowland wet ecosystem on the windward side of the Waianae Mountains, and partially within the Mokuleia and Waianae Kai Forest Reserves. Oahu—Lowland Wet—Unit 2 [20 ac (8 ha)]. This area consists of 19 ac (8 ha) of State land in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puuhapapa. Oahu—Lowland Wet—Unit 3 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puukanehoa. Oahu—Lowland Wet—Unit 4 [27 ac (11 ha)]. This area consists of 27 ac (11 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains on State land at Puukaua. Oahu—Lowland Wet—Unit 5 [74 ac (30 ha)]. This area consists of 74 ac (30 ha) of State land in the lowland wet ecosystem, on the windward side of the Waianae Mountains at Palikea. Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihihi, Waialele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Haula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikē, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet—Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet—Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu—Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest

Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamoa Ridge.

Oahu—Montane Wet—Unit 1 [370 ac (150 ha)]. This area consists of 18 ac (7 ha) of City and County of Honolulu land, 352 ac (142 ha) of State land, and less than 1 ac (less than one ha) of privately-owned land in the montane wet ecosystem at the summit of the Waianae Mountains at Kaala, and partially within the Mokuleia Forest Reserve and the Kaala Natural Area Reserve.

Oahu—Wet Cliff—Unit 1 [235 ac (95 ha)]. This area consists of 167 ac (68 ha) of State land, 68 ac (28 ha) of City and County of Honolulu land, and less than 1 ac (less than 1 ha) of privately owned land in the wet cliff ecosystem in the Waianae Mountains, near the summit of Kaala, and partially within the Mokuleia and Waianae Kai FRs and the Kaala Natural Area Reserve. Oahu—Wet Cliff—Unit 2 [3 ac (1 ha)]. This area consists of 3 ac (1 ha) of State land in the wet cliff ecosystem in the Waianae Mountains at Puuhapapa, within a small area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Oahu—Wet Cliff—Unit 3 [16 ac (6 ha)]. This area consists of 16 ac (6 ha) in the wet cliff ecosystem on State land in the Waianae Mountains at Puukanehoa, partially within an area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Oahu—Wet Cliff—Unit 4 [23 ac (9 ha)]. This area consists of 23 ac (9 ha) in the wet cliff ecosystem on State land in the Waianae Mountains at Puukaua, partially overlapping an area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and recently acquired by the State. Oahu—Wet Cliff—Unit 5 [31 ac (13 ha)]. This area consists of 31 ac (13 ha) of State land in the wet cliff ecosystem in the Waianae Mountains, at Palikea and north of Palikea. Oahu—Wet Cliff—Unit 6 [151 ac (61 ha)]. This area consists of 151 ac (61 ha) in the wet cliff ecosystem on State land on the windward side of the Koolau Mountains in Kaipapau Gulch, entirely within the Kaipapau Forest Reserve. Oahu—Wet Cliff—Unit 7 [144 ac (58 ha)]. This area consists of 144 ac (58 ha) in the wet cliff ecosystem in State land on the windward side of the Koolau Mountains in Hauula Gulch, entirely within the Hauula Forest Reserve. Oahu—Wet Cliff—Unit 8 [4,649 ac (1,881 ha)]. This area consists of 1,479 ac (598 ha) of State land, 1,281 ac (519 ha) of City and County of Honolulu land, 5 ac (2 ha) of Federal land, and 1,884 ac (762 ha) of privately owned land, in the wet cliff ecosystem along the summit of the Koolau Mountains, overlapping portions of Sacred Falls State Park, the Waiahole FR (Waiahole and Iolekaa sections), the Kaneohe and Honolulu Watershed FRs, and the Nuana Pali State Wayside.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Lobelia oahuensis* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Lobelia oahuensis* occurs within the Lowland wet, Montane wet and Wet cliff ecosystems in the Waianae Mountain caldera complex and the Lowland wet and Wet cliff ecosystems in the Koolau Mountain caldera complex:

Oahu—Lowland Wet—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (F) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Oahu—Montane Wet—Unit 1. (A) Elevation: 3,300–6,600 ft (1,000–2,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Well-developed soils, montane bogs. (D) Canopy: Acacia, Charpentiera, Cheirodendron, Metrosideros. (E) Subcanopy: Broussaisia, Cibotium, Eurya, Ilex, Myrsine. (F) Understory: Ferns, Carex, Coprosma, Leptecophylla, Oreobolus, Rhynchospora, Vaccinium.

Oahu—Wet Cliff—Units 1, 2, 3, 4, 5, 6, 7, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: >65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: Broussaisia, Cheirodendron, Leptecophylla, Metrosideros. (F) Understory: Bryophytes, Ferns, Coprosma, Dubautia, Kadua, Peperomia.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Lobelia oahuensis* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: This species was observed in flower during November 1991 (USFWS 1996a). (USFWS, 1998)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Shrubland/chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 850 and 920 meters (2,800 and 3,000 feet); found in areas of low-shrub cover on summit cliffs in cloud swept forests (USFWS, 1998)

Environmental Specificity

Adult: Narrow, with several key requirements (USFWS, 1998)

Habitat Narrative

Adult: *Lobelia oahuensis* populations are between elevations of 850 and 920 meters (2,800 and 3,000 feet) on summit cliffs in cloud-swept wet forests or in areas of low-shrub cover that are frequently exposed to heavy wind and rain (USFWS 1996a, Lanimers 1990). Associated plants include akia, kanawao, manono, hapuu, ohia, uluhe, pilo, uki, *Cheirodendron trigynum* (olapa),

Dubautia laxa (naenae pua melemele), and Labordia hosakana (kamakahala) (HHP 1997; USFWS 1996a). (USFWS, 1998)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Resiliency:

Low (inferred from USFWS, 2011)

Redundancy:

Medium (inferred from USFWS, 2011)

Number of Populations:

7-8 (USFWS, 2011)

Population Size:

48 to 68 (USFWS, 2011)

Population Narrative:

Currently, there are approximately 48 to 68 individuals of Lobelia oahuensis known from seven or eight locations on the island of Oahu, on both the Koolau and Waianae Mountain ranges. (USFWS, 2011)

Threats and Stressors

Stressor: Invasive plants (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: In the Koolau Mountains, threats include habitat modification by invasive introduced species including Clidemia hirta (Koster's curse), Paspalum conjugatum (Hilo grass), and Erigeron karvinskianus (daisy fleabane). Invasive introduced species in the Waianae Mountains are Ageratum conyzoides (billygoat weed), Ageratina riparia (spreading mist flower), Axonopus fissifolius (narrow-leaved carpetgrass), Blechnum appendiculatum (hammock fern), Bryophyllum pinnatum (airplant), Clidemia hirta (Koster's curse), Conyza bonariensis (hairy horseweed), Cuphea carthagenensis (tarweed), Erigeron karvinskianus (daisy fleabane), Grevillea robusta (silk oak), Psidium cattleianum (strawberry guava), Rubus argutus (blackberry), Sacciolepis indica (Glenwood grass), Schinus terebinthifolius (Christmas berry), and Verbena litoralis (vervain) (Hawaii Biodiversity and Mapping Program 2009; Oahu Plant Extinction Prevention Program 2009; Perlman 2009; Wood 2009). (USFWS, 2011)

Stressor: Habitat modification by feral pigs and goats (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Feral pigs (*Sus scrofa*) disturb the ground and uproot native seedlings, creating erosion (Perlman 2009; Wood 2009). In the Waianae Mountains, feral pigs and feral goats (*Capra hircus*) degrade habitat (Wood 2009). (USFWS, 2011)

Stressor: Predation by rats and slugs (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Rats (*Rattus* spp.) and slugs (unidentified species) are fruit predators or herbivores of *Lobelia* and other *Campanulaceae* species in Hawaii (Perlman 2009; Wood 2009). (USFWS, 2011)

Stressor: Loss of pollinators (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Loss of pollinators and seed dispersers are believed to be limiting the regeneration of this species (Wood 2009). (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2011)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)

3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1998)

Recovery Actions:

- Construct enclosures to protect populations against feral pigs. (USFWS, 1998)
- Control competing alien plant species within enclosures. (USFWS, 1998)
- Reduce threat of rat predation. (USFWS, 1998)

Conservation Measures and Best Management Practices:

- Collect propagules from all known populations for genetic storage and reintroduction. (USFWS, 2011)
- Survey known populations and historical range to determine current status of the species. (USFWS, 2011)
- Fence all known populations to provide protection from the negative impacts of feral ungulates. (USFWS, 2011)
- Remove competing invasive introduced plant species. (USFWS, 2011)
- Control rats in the vicinity of these populations. (USFWS, 2011)
- Develop and implement methods to control slugs. (USFWS, 2011)
- Propagate for reintroduction, and reintroduce individuals into protected suitable habitat within historic range. (USFWS, 2011)
- Research pollinators and seed distributors to determine limiting factors; investigate techniques to improve natural recruitment. (USFWS, 2011)
- Work with Hawaii Division of Forestry and Wildlife, U.S. Army Garrison, and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2011)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2011)

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SPECIES ACCOUNT: *Lomatium cookii* (Cook's lomatium)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/9/2002; Pacific Region (R1)

Physical Description

A perennial herb that grows 15 to 50 centimeters (6 to 20 inches) tall with a slender, twisted taproot (Figure II-3). The base often branches at or below ground level, forming multiple stems. The leaves are glossy bluish-green, minutely interdivided, and strictly basal (growing directly from the root crown, out of the ground, not along the stems). The pale yellow flowers are clustered into 5- centimeter (2-inch) umbels (umbrella-like formation of flower clusters). Each flowering stalk produces either primarily male or female umbels. Through one flowering season, *L. cookii* may produce up to eight male or female (sometimes both) flowering stalks. The bracts found below the umbels are thin, lance-shaped and have an entire margin. An umbel of female flowers will develop boat-shaped fruits 8 to 13 millimeters (0.3 to 0.5 inch) long with thickened margins. The flowering stalk very rarely forms leaves, unlike the closely associated *L. utriculatum* (foothills desert parsley). The single umbel bracts best distinguish *L. cookii* from *L. bradshawii* (Bradshaw's lomatium), indigenous to wet prairies from the southern Willamette Valley in Oregon to southwest Washington, and *L. humile* (alkali desert parsley), found in vernal pools in northern California (Kagan 1986). The umbel bracts can be used to distinguish *L. cookii* from the much wider, toothed, and overlapping umbel bracts of *L. utriculatum*. (USFWS, 2010)

Taxonomy

In the parsley family (Apiaceae). *Lomatium cookii* was first collected in 1981 and subsequently described from vernal pools in the Agate Desert, Jackson County, Oregon (Kagan 1986). Additional populations were found at French Flat in the Illinois Valley, Josephine County, Oregon in 1988 (Oregon Natural Heritage Information Center 2008). Slight morphological differences exist between *L. cookii* populations in the Agate Desert and French Flat, but these differences are not considered significant enough to separate the species into subspecies (M. Gitzendanner, pers. comm. 2002). (USFWS, 2010)

Historical Range

In southwestern Oregon, in Jackson and Josephine Counties. (USFWS, 2010)

Current Range

In Oregon, known from the Agate Desert, just north of the City of Medford in Jackson County's Rogue Valley, and from the French Flat or Illinois Valley sites in Josephine County. (USFWS, 2019)

Critical Habitat Designated

Yes; 8/20/2010.

Legal Description

On July 21, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective August 20, 2010) for *Lomatium cookii* (Cook's lomatium) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes sixteen critical habitat units (CHUs), in Oregon (75 FR 42490-42570).

Critical Habitat Designation

The critical habitat designation for *Lomatium cookii* includes sixteen CHUs in Jackson and Josephine Counties, Oregon. This species critical habitat encompasses approximately 6,289 acres (ac) (2,545 hectares (ha)) (75 FR 42490-42570). All critical habitat units in Jackson County are located within the Middle Rogue River Basin or “Agate Desert.” Brief descriptions are presented below. Detailed coordinates of and maps depicting the CH units are available in the Final Rule (USFWS, 2010).

Unit RV6, subunits A, F, G, and H, for *Lomatium cookii*: White City, Jackson County, Oregon. (i) Unit RV6, subunits A, F, G, and H for *Lomatium cookii* comprises 546 ha (1,349 ac) of vernal pool–mounded prairie and swale habitats. RV6 is located around White City, is 1.6 km (1.0 mi) southwest of Eagle Point, and is 440 m (1,444 ft) southeast of the confluence of the Rogue River and Little Butte Creek. Subunit RV6A is located north of Whetstone Creek and is 500 m (1,200 ft) west of the junction of Highway 62 and Antelope Road. Subunits RV6F and RV6G are located approximately 500 feet west of Dry Creek and are east of Highway 62 in White City. Subunit RV6H is located north of Whetstone Creek and south of Antelope Road. Subunit RV6H roughly encircles the Hoover Ponds, east of Highway 62, and is 850 m (2,790 ft) east of subunit RV6A.

Unit RV8 for *Lomatium cookii*: Whetstone Creek, Jackson County, Oregon. (i) Unit RV8 for *Lomatium cookii* consists of 344 ha (850 ac) of vernal pool–mounded prairie and swale habitat. Unit RV8 is located approximately 1.4 km (0.9 mi) southeast of the confluence of the Rogue River and Whetstone Creek, 2.2 km (1.4 mi) southwest of Tou Velle State Park, and 2.9 km southeast of the confluence of Bear Creek and the Rogue River. The unit roughly parallels a 2.6-km (1.6-mi) stretch of Whetstone Creek to the south.

Unit RV9, subunits A, B, C, D and E, for *Lomatium cookii*: Medford Airport, Jackson County, Oregon. (i) Unit RV9, subunits A through E, consists of 34 ha (83 ac) of slightly degraded vernal pool–mounded prairie habitat. The five subunits of RV9 are located mostly within the Rogue Valley International–Medford Airport, approximately 2 km (1.2 mi) west of Coker Butte and 1.5 km (0.9 mi) northeast of Bear Creek. Subunit RV9A is located 1.4 km (0.9 mi) north of the Rogue Valley International–Medford Airport and is 300 m (980 ft) east of the junction of Vilas Road and Table Rock Road. Subunits RV9B through E are located between Upton Slough and Bear Creek, 2 mi (1.2 km) southeast of the junction of Vilas Road and Table Rock Road, and 1.7 km northeast of the junction of Interstate 5 and Highway 62.

Unit IV1 for *Lomatium cookii*: Anderson Creek, Josephine County, Oregon. (i) Units IV1A and B comprise 35 ha (85 ac) of wet meadow and sloped mixed conifer habitat. Unit IV1A is located 3.5 km (2.2 mi) north of Selma, and 14 km (8.8 mi) north of Cave Junction; it is along a 1.0-km (0.6-mi) stretch of Anderson Creek and Highway 199, 2.0 km (1.2 mi) southwest of Hays Hill Summit. It is also 1.7 km (1.0 mi) northwest of the junction of Draper Valley Road and Indian Creek Road. Unit IV1B is located 3.5 km (2.2 mi) north of Selma, 3.4 km (2.1 mi) southwest of Hays Hill Summit, and 0.8 km (0.5 mi) west of the junction of Draper Valley Road and Highway 199.

Unit IV2 for *Lomatium cookii*: Draper Creek, Josephine County, Oregon. (i) Unit IV2 is composed of 28 ha (70 ac) of intact wet meadow habitat. It is located 2.7 km (1.7 mi) northeast of Selma and 13.5 km (8.4 mi) north of Cave Junction; it is along a 900-m (2,900-ft) stretch of Draper Creek, and is located 800 m (2,600 ft) east of Anderson Creek. The unit is 800 m (2,600 ft) north-

northwest of the confluence of Draper Creek and Davis Creek and is 200 m (650 ft) southeast of the junction of Draper Valley Road and Indian Creek Road.

Unit IV3 for *Lomatium cookii*: Reeves Creek North, Josephine County, Oregon. (i) Unit IV3 consists of 152 ha (374 ac) of sloped, mixed-conifer and shrubby habitat. The unit is located 1.4 km (0.9 mi) east of the confluence between Reeves Creek and the Illinois River and extends along a 2.0-km (1.2-mi) stretch of Reeves Creek, beginning 800 m (2,600 ft) northeast of the junction of Highway 199 and Reeves Creek Road.

Unit IV4 for *Lomatium cookii*: Reeves Creek East, Josephine County, Oregon. (i) Unit IV4 consists of 83 ha (204 ac) of sloped, partially open, mixed-conifer and shrubby habitat. It is located 6.2 km (3.9 mi) south of Selma and 5.3 km (3.3 mi) northwest of Cave Junction. It occurs along a 500-m (1,640-ft) stretch of Reeves Creek located 700 m (2,300 ft) southeast of Unit IV3.

Unit IV5 for *Lomatium cookii*: Reeves Creek South, Josephine County, Oregon. (i) Unit IV5 consists of 165 ha (407 ac) of sloped, partially open, mixed-conifer and understory shrub habitat. The unit is roughly parallel to Highway 199 for 2.5 km (1.6 mi), which is 500 m (1,640 ft) west of the unit. The unit is located 1.6 km (1.0 mi) north of Cave Junction, 1 km (0.6 mi) southeast of Sauers Flat, 800 m (2,600 ft) east of Kerby, and 1.2 km (0.7 mi) east of the confluence between Holton Creek and the Illinois River.

Unit IV6 for *Lomatium cookii*: Laurel Road, Josephine County, Oregon. (i) Unit IV6 totals 182 ha (449 ac) of intact wet meadow habitat. It is located west and alongside of the base of Lime Rock, 1.2 km (0.7 mi) east of the city of Cave Junction; it follows along Highway 46 for 1.5 km (0.9 mi). Subunit IV6A is located 1.2 km (0.7 mi) west of Lime Rock summit, 1.0 km east of the junction of Laurel Road and Highway 199; it is also roughly parallel to Highway 199 for 1.3 km (0.8 mi). Highway 199 lies approximately 1.0 km (0.6 mi) west of the subunit. Subunit IV6B is 2.7 km (1.7 mi) east of the confluence of the east and west forks of the Illinois River and from the intersection of Holland Loop Road and Highway 46; it extends approximately 1.8 km (1.1 mi) to the northeast and 2.7 km (1.7 mi) to the north.

Unit IV7 for *Lomatium cookii*: Illinois River Forks State Park, Josephine County, Oregon. (i) Unit IV7 consists of 55 ha (136 ac) of intact wet meadow habitat. The unit is located 500 m (1,640 ft) west of the city of Cave Junction and 600 m (1,970 ft) southeast of Pomeroy Dam; it is also 230 m (750 ft) east of the confluence of the east and west forks of the Illinois River. The unit occurs along a 2.8-km (1.7-mi) stretch of the West Fork Illinois River.

Unit IV8 for *Lomatium cookii*: Woodcock Mountain, Josephine County, Oregon. (i) Unit IV8 consists of 234 ha (579 ac) of wet meadow and shrubby habitat. The unit is located 2.4 km (1.5 mi) southwest of the city of Cave Junction, 5.3 km (3.3 mi) north of O'Brien, and 140 m (ft) west of the confluence of Woodcock Creek and the West Fork Illinois River. It occurs along a 3.3-km (2.0-mi) stretch of West Side Road. Unit IV7 is 400 m (ft) west of Highway 199 and roughly parallels the highway for 5.0 km (3.1 mi).

Unit IV9 for *Lomatium cookii*: Riverwash, Josephine County, Oregon. (i) Unit IV9 consists of 12 ha (30 ac) of intact wet meadow and streambank habitat. It is located 4.2 km (2.6 mi) south of Cave Junction and 6.1 km (3.8 mi) north-northeast of O'Brien. It is located along the east bend of the

West Fork Illinois River, 700 m (2,300 ft) south (upstream) of the confluence between Woodcock Creek and the West Fork Illinois River.

Unit IV10 for *Lomatium cookii*: French Flat North, Josephine County, Oregon. (i) Unit IV10 consists of 45 ha (110 ac) of intact wet meadow habitat. The unit is located 3.7 km (2.3 mi) south of Cave Junction, 900 m (2,950 ft) north of the intersection of Sherrier Drive and Raintree Drive, and 1.7 km (1.1 mi) southwest of the confluence of Althouse Creek and the East Fork Illinois River. It parallels a 300-m (980-ft) stretch of Rockydale Road.

Unit IV11 for *Lomatium cookii*: Rough and Ready Creek, Josephine County, Oregon. (i) Unit IV11 consists of 118 ha (292 ac) of intact wet meadow habitat. The unit roughly follows along and is adjacent to a 1.9-km (1.2-mi) stretch of Airport Drive. It is located 3 km (1.9 mi) north of O'Brien, 900 m (2,950 ft) west of the Rough and Ready Forest Wayside State Park, and 122 m (400 ft) east of the confluence with the Illinois River and Rough and Ready Creek.

Unit IV12 for *Lomatium cookii*: French Flat Middle, Josephine County, Oregon. (i) Unit IV12 consists of 492 ha (1,216 ac) of intact wet meadow habitat. The unit is located 4.5 km (2.8 mi) east of Cave Junction, 3.7 km (2.3 mi) northeast of O'Brien, 140 m (460 ft) north and 560 m (1,830 ft) west of Esterly Lakes, 1.4 km (0.9 mi) northeast of Indian Hill, and 300 m (960 ft) east of the confluence of Rough and Ready Creek and the West Fork Illinois River. It also follows along a 1.6-km (1.0-mi) stretch of Rockydale Road until the junction with Waldo Road.

Unit IV13 for *Lomatium cookii*: Indian Hill, Josephine County, Oregon. (i) Unit IV13 consists of 22 ha (54 ac) of intact wet meadow habitat. The unit is located adjacent to and lies east of a 900-m (2,950-ft) stretch of the West Fork Illinois River. It is located approximately 300 m south (upstream) of the confluence of Rough and Ready Creek and the West Fork Illinois River. The unit is 1.8 km (1.1 mi) northeast of O'Brien and 350 m (1,150 ft) northwest of Indian Hill.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Lomatium cookii* critical habitat consists of the following components (75 FR 42490-42570): (USFWS, 2010)

(i) In the Rogue River Valley: (A) Vernal pools and ephemeral wetlands and depths and the adjacent upland margins of these depressions that hold water for a sufficient length of time to sustain *Lomatium cookii* germination, growth, and reproduction. These vernal pools or ephemeral wetlands support native plant populations and are seasonally inundated during wet years but do not necessarily fill with water every year due to natural variability in rainfall. Areas of sufficient size and quality are likely to have the following characteristics: (1) Elevations from 372 to 411 m (1,220 to 1,350 ft); (2) Associated dominant native plants including, but not limited to: *Alopecurus saccatus*, *Achnatherum lemmonii*, *Deschampsia danthonioides*, *Eryngium petiolatum*, *Lasthenia californica*, *Myosurus minimus*, *Navarretia leucocephala* ssp. *leucocephala*, *Phlox gracilis*, *Plagiobothrys bracteatus*, *Trifolium depauperatum*, and *Triteleia hyacinthina*; and (3) A minimum area of 8 ha (20 ac) to provide intact hydrology and protection from development and weed sources.

(B) The hydrologically and ecologically functional system of interconnected pools or ephemeral wetlands or depressions within a matrix of surrounding uplands that together form vernal pool

complexes within the greater watershed. The associated features may include the pool basin and ephemeral wetlands; an intact hardpan subsoil underlying the surface soils up to 0.75 m (2.5 ft) in depth; and surrounding uplands, including mound topography and other geographic and edaphic features that support systems of hydrologically interconnected pools and other ephemeral wetlands (which may vary in extent depending on sitespecific characteristics of pool size and depth, soil type, and hardpan depth).

(C) Silt, loam, and clay soils that are of ultramafic and nonultramafic alluvial origin, with a 0 to 3 percent slope, classified as Agate–Winlo or Provig– Agate soils.

(D) No or negligible presence of competitive, nonnative invasive plant species. Negligible is defined for the purpose of this rule as a minimal level of nonnative plant species that will still allow *Lomatium cookii* to continue to survive and recover.

(ii) In the Illinois River Valley: (A) Wet meadows in oak and pine forests, sloped mixed-conifer openings, and shrubby plant communities that are seasonally inundated and support native plant populations. Areas of sufficient size and quality are likely to have the following characteristics: (1) Elevations from 383 to 488 m (1,256 to 1,600 ft); (2) Associated dominant native plants including, but not limited to: *Achnatherum lemmonii*, *Arbutus menziesii*, *Arctostaphylos viscida*, *Camassia* spp., *Ceanothus cuneatus*, *Danthonia californica*, *Deschampsia cespitosa*, *Festuca roemerii* var. *klamathensis*, *Poa secunda*, *Ranunculus occidentalis*, and *Limnanthes gracilis* var. *gracilis*; (3) Occurrence primarily in bottomland *Quercus garryana*–*Quercus kelloggii*–*Pinus ponderosa* (Oregon white oak–California black oak– ponderosa pine) forest openings along seasonal creeks; and (4) A minimum area of 8 ha (20 ac) to provide intact hydrology and protection from development and weed sources.

(B) The hydrologically and ecologically functional system of streams, slopes, and wooded systems that surround and maintain seasonally wet alluvial meadows underlain by relatively undisturbed ultramafic soils within the greater watershed.

(C) Silt, loam, and clay soils that are of ultramafic and nonultramafic alluvial origin, with a 0 to 40 percent slope, classified as Abegg gravelly loam, Brockman clay loam, Copsey clay, Cornutt–Dubakel complex, Dumps, Eightlar extremely stony clay, Evans loam, Foehlin gravelly loam, Josephine gravelly loam, Kerby loam, Newberg fine sandy loam, Pearsoll–Rock outcrop complex, Pollard loam, Riverwash, Speaker–Josephine gravelly loam, Takilma cobbly loam, or Takilma Variant extremely cobbly loam.

(D) No or negligible presence of competitive, nonnative invasive plant species. Negligible is defined for the purpose of this rule as a minimal level of nonnative plant species that will still allow *Lomatium cookii* to continue to survive and recover.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain the features that are essential to the conservation of the species and that may require special management considerations or protection. All areas we are designating as critical habitat require some level of management to address current and future threats to *Lomatium cookii*, to maintain or enhance the physical or biological features essential to their conservation, and to ensure the recovery and survival of these species. The major threats to the PCEs in the areas identified as critical habitat for

Lomatium cookii include: development on private lands; mining activities; ground disturbance that affects surface hydrology, including ORV use and road construction or maintenance activities; incompatible agricultural and grazing practices; garbage dumping; the succession of meadow habitat to forested habitat due to fire suppression; and encroachment and displacement by nonnative plants. Herbivory by voles may also affect *Lomatium cookii* in the Illinois River Valley. In all of the units in Jackson County, special management is needed to reduce or eradicate the threats posed by development, habitat fragmentation, ground disturbance that affects surface hydrology, and incompatible grazing practices. In all of the units in Josephine County, special management is needed to reduce or eradicate the threats posed by development, ORV use, mining activities, garbage dumping, and woody vegetative succession. Please refer to the unit descriptions in the Critical Habitat Designation section for further discussion of special management considerations or protection of the PCEs related to geographically specific threats to *Limnanthes floccosa* ssp. *grandiflora* and *Lomatium cookii*. In addition, for all units, special management is needed to control and monitor the encroachment of nonnative, invasive plant species to maintain intact vernal pool–mounded prairies and wet meadow ecosystems such that they can continue to support populations of *Lomatium cookii*. Special management considerations or protection of the vernal pool–mounded prairies and wet meadow habitats that may be needed to support reproduction and growth of *Lomatium cookii* include: controlled burning and vegetation clearing to maintain early seral stages (early stages of plant succession in the progression toward a climax community); control of nonnative, invasive plant species; grazing management; the reestablishment of hydrology; re-seeding with native plants; monitoring; and protection from development (Borgias 2004, pp. 47–53; ONHDB 1994, pp. 13–20). (USFWS, 2010)

Life History

Food/Nutrient Resources

Habitat Type

Adult: Seasonally wet (vernal soil) (USFWS, 2016)

Habitat Narrative

Adult: Desert parsley in the Illinois Valley grows on seasonally wet soils. For much of its range in the Rogue River Valley, the plant occurs on upland mounds, at the bottom of rocky vernal pools, and on vernal pools flanks. It occurs in either strongly expressed or weakly expressed vernal pool formations and appears to tolerate various types of disturbance. In the Rogue River Valley, populations of desert parsley are found in shallow Agate-Winlo complex in sparse prairie vegetation. Common plant associates include *Lupinus bicolor* (bicolor lupine), *Collinsia sparsiflora* (sparse-flowered collinsia), *Clarkia purpurea* (purple clarkia), *Erodium cicutarium* (filaree), foothills desert-parsely, *Achnatherum lemmonii* (Lemmon’s needlegrass), *Poa bulbosa* (bulbous bluegrass), *Brodiaea elegans* (elegant brodiaea), *Madia* spp (tarweed), *Lasthenia californica* (goldfields), *Hemizonia fitchii* (Fitch’s tarweed), and *Plagiobothrys* spp (popcornflower). In the Illinois Valley, desert parsley occurs in open wet meadows and along roadsides adjacent to meadows on Brockman clay loam, Josephine gravelly loam, Pollard loam, Eightlar extremely stony clay, Takilma cobbly loam, Abegg clay loam, and Newberg loam soils. Brockman clay loam soils in the French Flat area average 61 to 89 cm (24 to 35 inches) in depth. These seasonally wet soils have the ability to block water permeability through the soil, similar to the Agate Desert vernal pools, but lack that region’s distinctive mound and swale topography.

Soils in the Illinois Valley are partially derived from serpentine formations that occur on surrounding slopes and hilltops. Common species in the Illinois Valley associated with desert parsley include *Danthonia californica* (California oatgrass), *Chlorogalum pomeridianum* (soap plant), *Plagiobothrys bracteatus* (bracted popcornflower), *Hesperichiron californica* (hesperichiron), *Horkelia californica* (California horkelia), *Calochortus uniflorus* (short-stemmed mariposa lily), and wedge-leaved buckbrush. Two rare plants that may occasionally occur with desert parsley in the Illinois Valley are *Senecio hesperius* (western senecio) and *Microseris howellii* (Howell's microseris) (USFWS, 2016).

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Unknown (USFWS, 2019)

Number of Populations:

36 (USFWS, 2019)

Population Size:

10,000 - 1,000,000 individuals (NatureServe, 2015)

Additional Population-level Information:

Based on representative population assessments at the monitored locations provided in the 2019 5-Year Review, as well as assuming the other known populations are still occupied by *Lomatium cookii*, we conclude the overall distribution remains unchanged. *Lomatium cookii* remains concentrated within the Illinois and Rogue River Valleys of southwestern Oregon and within its known historical range. Even with the extirpation of one population and the addition of one populations, range contraction or expansion of the species has not occurred. (USFWS, 2019)

Population Narrative:

There are a total of 36 populations of *Lomatium cookii*, 11 in the Rogue Valley and 25 in the Illinois Valley. Here we present the most recent information available through the individual monitoring programs for most of the 36 sites that have been assessed since the last census. This includes information for one new population record of *Lomatium cookii* (Waldo Road in the Illinois Valley). Information is not available for 15 known occurrences of the species (Table 1). It should be noted that *L. cookii* population parameters fluctuate annually depending on seasonal precipitation and temperature; therefore, it is not unexpected that the species population size estimate will vary from year to year. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat or population loss due to development (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Factor A listing threats include habitat or population loss due to development, either through present or threatened destruction, modification or curtailment of habitat or range (USFWS 2002). Factor A threats to *Lomatium cookii* in the Rogue and Illinois River valleys include habitat impacts resulting from residential, urban, and commercial development; aggregate and mineral mining; agricultural development (including leveling, ditching, tilling, and stock pond construction or water impoundments); road construction and maintenance; off-road vehicle (ORV) use that affects surface hydrology; incompatible grazing practices; and encroachment by nonnative plants (ONHDB 1994; USFWS 2002). The adverse effects of residential, urban, and commercial development are more evident in the Rogue River Valley while the threat of mining is a more conspicuous threat in the Illinois River Valley (USFWS 2002; USFWS 2010). Factor A impacts resulting from residential, urban, agricultural, industrial, and commercial development between 1940 to present, resulted in over 60 percent loss of the vernal pool landscape in the Rogue River Valley due to removal of habitat, altered hydrology, or altered topography (ONHP 1997; Wille and Petersen 2006). (USFWS, 2011)

Stressor: Vandalism (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Vandalism are Factor A threats in the form of intentional disregard or dismantling of signage or fencing intended to protect certain wetland areas from unauthorized ORV use, and subsequent damage resulting from that use, has resulted in negative effects on the hydrology of the habitat for *Lomatium cookii* (for example, by altering the surface hydrology, resulting in excess or a lack of hydrology in otherwise suitable habitat). (USFWS, 2011)

Stressor: Grazing (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The effect of grazing on suitable habitat depends on how the grazing is managed. There are various reports showing how grazing practices can positively or negatively affect native plant species' richness (Marty 2005). Marty's (2005) study indicates that wet season grazing resulted in a decrease of native forb species at vernal pool edge habitat, but year-round grazing actually improved species' richness (Factor A listing threats). (USFWS, 2011)

Stressor: Non-native plants and small population size (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: *Lomatium cookii* is also threatened by encroachment of nonnative plants and small population size (Factor E listing threats). Nonnative plants that can outcompete *L. cookii* include annual grasses and herbs. Nonnative grasses, namely *Hordeum marinum* ssp. *gussoneanum* (Mediterranean barley), *Lolium* spp. (perennial and annual rye), and *Taeniantherum caput-medusae* (medusahead), form a dense thatch layer that inhibits plant growth (USFWS 2010). (USFWS, 2011)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2011)

Exposure:

Response:**Consequence:**

Narrative: Depending on whether intentions were deliberate or inadvertent, Factor D, the lack of legal protection for all federally or state listed plants on privately owned property could be partially responsible for much habitat loss in recent years due to development in areas that were incorrectly assumed to be outside of jurisdictional wetlands (USFWS 2006). (USFWS, 2011)

Recovery**Reclassification Criteria:**

Reclassification from Endangered to Threatened status may be considered for *Lomatium cookii* when the following criteria are met: (USFWS, 2010)

a. At least 32 of 36 documented/extant *Lomatium cookii* occurrences (approximately 90 percent) have been protected from development. If extant occurrences become extirpated, protection of reintroduced or introduced occurrences may be substituted. Introduced or newly discovered populations outside of currently known core areas may be substituted if deemed equivalent in their contribution to recovery. (USFWS, 2010)

b. At least 90 percent of suitable habitat acreage within each Priority 1 core area (one core area in the Rogue Valley and seven core areas in the Illinois Valley) has been protected from development. At least 85 percent of suitable habitat acreage within Priority 2 core areas (three core areas in the Rogue Valley and six core areas in the Illinois Valley) has been protected from development. (See Tables IV-1, IV-2, and IV-4 of the Recovery Plan). All suitable vernal pool and wet meadow habitat must include soils and hydrology that support *Lomatium cookii*. This habitat includes both occupied and suitable habitat. Suitable habitat that is not currently known to be occupied must be protected to provide for corridors and dispersal habitat, restoration dynamics, provide for reintroduction/introduction sites, and to protect currently undiscovered populations. (USFWS, 2010)

c. Management plans for each protected core area are developed and implemented as soon as feasible for *Lomatium cookii* protection and conservation. The management plans should address vegetation control, including thatch buildup and noxious weeds; monitoring of threats and population levels in detail sufficient to quantitatively assess population trends; maintaining hydrological functions; and outreach to neighboring landowners. Management plans should take an ecosystem approach to management by ensuring the long-term maintenance of wetland and adjacent upland plant associates. (USFWS, 2010)

d. Additional *Lomatium cookii* occurrences identified through future site assessments, GIS and other analyses, and status surveys that are determined essential to recovery are protected. (USFWS, 2010)

e. Achievement of self-sustaining *Lomatium cookii* populations will be determined through species monitoring and status surveys in each protected occurrence. Population trends must be shown to be stable, increasing or showing only minor declines from high population levels for 10 years prior to consideration for reclassification. (USFWS, 2010)

f. Seed collection is accomplished at each core area as insurance against the risk of stochastic extirpations and to ensure that genetic variation can be restored if extirpations occur. Seed banking may also be necessary in order to complete the reintroductions or introductions required to meet recovery criteria (see Table IV-4 of the Recovery Plan). (USFWS, 2010)

g. Reintroductions and introductions must be carried out as described in Table IV-4 of the Recovery Plan. Introductions may replace extirpated occurrences that cannot be restored to the same site as the original occurrence. (USFWS, 2010)

Delisting Criteria:

Delisting may be considered for *Lomatium cookii* when all downlisting criteria plus the following criteria are met: (USFWS, 2010)

a. Status surveys, status reviews, and population monitoring show the populations are self-sustaining. Population trends must be shown to be stable, increasing or exhibiting only slight declines from high population levels during a 10-year period prior to consideration following downlisting (e.g., evidence of reproduction and recruitment) and have been determined to be stable, increasing or showing only minor declines from high population levels, and implementation of management plans is effectively managing or eliminating threats. (USFWS, 2010)

b. At least 34 of 36 *Lomatium cookii* occurrences (approximately 95 percent of documented/extant occurrences) have been protected from development. If extant occurrences become extirpated, protection of reintroduced or introduced occurrences may be substituted. Introduced or newly discovered populations outside of currently known core areas may be substituted if deemed equivalent in their contribution to recovery. (USFWS, 2010)

c. At least 95 percent of suitable vernal pool habitat acreage within each Priority 1 core area and 90 percent of suitable vernal pool habitat acreage within Priority 2 core areas has been protected from development. All suitable vernal pool and wet meadow habitat must include soils and hydrology that support *Lomatium cookii*. Reintroductions and introductions are accomplished, as necessary and applicable, to replace populations where status surveys indicate the species has been extirpated (Table IV-4). (USFWS, 2010)

d. A post-delisting monitoring plan has been developed for *Lomatium cookii*. (USFWS, 2010)

Recovery Actions:

- 1. Protect vernal pool and wet meadow habitat from loss, fragmentation, degradation, and incompatible uses. Protection of vernal pool and wet meadow habitat is the broader objective of this recovery plan, because listed species addressed in the plan are now found in mostly fragmented habitat remnants. The first step is to identify and protect remaining relatively higher quality habitat. Although we have identified core areas of suitable habitat for listed species largely based on aerial photo interpretation, Geographic Information Systems soil data layers, topographic maps, historic species occurrence data, and species population mapping, there are uncertainties that can only be resolved by conducting ground level surveys. Complementary actions (1.1 and 1.2) may be necessary steps prior to actual habitat protection actions and are presented sequentially in order as Priority 2 actions. Priority 1 actions will focus habitat protection within identified Priority 1 and 2 recovery

core areas, while lower priority actions may include actions outside of core areas. In general, actions which address the most critical threats (loss, fragmentation, or degradation of habitat) are the highest priority actions. (USFWS, 2010)

- 2. Manage, monitor, and restore vernal pool and wet meadow habitat. Management plans are encouraged to be developed to conserve the listed species occurring at each site. Elements of plans may include: restriction of off-road vehicle use by fencing access roads into preserves using proper signage to restrict vehicle access and avoid inadvertent habitat destruction; habitat restoration and noxious weed prevention programs; use of mowing, burning, or managed grazing to reduce density of native and nonnative vegetation; monitoring effects of management actions for effectiveness, employing adaptive modification; continued monitoring of known *Lomatium cookii* populations on extant sites; surveys for new sites in appropriate habitat; or population introductions into unoccupied habitat. Management plans should identify responsibilities of the management agency or organization to protect species. (USFWS, 2010)
- 3. Conduct rangewide population status surveys. A status survey is a process comprising literature review, examination of herbarium or museum specimens, and a series of surveys conducted throughout a species' range. Historical localities of a species are identified, potential locations where the species may occur are predicted based on distributional and ecological data, and historical and potential locations are surveyed for presence of a species. Ground surveys may be a follow-up to determine if species still occur at site. (USFWS, 2010)
- 4. Conduct research essential to the conservation of these species. In addition to or in conjunction with current monitoring efforts, provide opportunities for further research with schools, State and local governments, or private endeavors. Study pollination vectors between and among populations. Research role of mammals, insects, birds, and wind as cyst and seed dispersal vectors. Evaluate techniques to reduce impacts from encroachment of native woody plant succession. Conduct research on prescribed burning, mowing, and native planting on introduced annual grasses. Refine research on appropriate grazing practices. Research genetic and morphologic traits among individuals and populations. Investigate restoration and recovery methods of historical vernal pool ecosystems that were degraded due to biosolid fill, and log debris fill. Determine incidence of herbivory or predation on *Lomatium cookii* populations. Develop offsite and onsite cultivation and propagation techniques for *Limnanthes pumila* ssp. *grandiflora*. Research associated soil crusts as indicators for vernal pool health and function. (USFWS, 2010)
- 5. Enhance public awareness and participation in recovery of the species. Seek to involve stakeholders in the recovery implementation process. Stakeholders are those parties that may be affected by proposed recovery actions, and may include, but are not limited to, Federal and State agencies, Tribal governments, county and city governments, nongovernmental organizations, and private landowners. Through schools, local community meetings, recovery team meetings, county, city, and State fairs, or other venues, we seek to establish contacts with private landowners to provide information about the species. (USFWS, 2010)
- 6. Develop post-delisting monitoring plans. Prior to delisting, a 5-year post-delisting monitoring plan should be developed and in effect. Monitoring and research results should be used to guide the long-term conservation of the species. These tasks are considered a lower priority until more significant and urgent conservation actions can be achieved. Complete post-delisting monitoring plan for *Limnanthes pumila* ssp. *grandiflora*. (USFWS, 2010)

- Recommendations for Future Actions: • Develop conservation easements or conservation programs for existing occurrences of *Lomatium cookii* on private lands. • Make visits to historical *Lomatium cookii* occurrences in the Illinois and Rogue Valleys to determine whether the plants are still present or have become extirpated. • Augment *Lomatium cookii* on protected habitat in appropriate locations in the Illinois and Rogue Valley areas. • Conduct best management practices studies for *Lomatium cookii*. (USFWS, 2019)

References

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SPECIES ACCOUNT: *Lupinus aridorum* (Scrub lupine)

Species Taxonomic and Listing Information

Listing Status: Endangered; 5/7/1987; Southeast Region (R4) (USFWS, 2015)

Physical Description

Woody, perennial herb, with sprawling stems up to 1 m long. The leaves are obovate-elliptic, 4 to 7 cm long and 2 to 4 cm wide. The base and end of the leaf are rounded with a sharp point at the leaf's end. The petioles are 2.0 to 4.5 cm long and the stipules are very small or absent. A silvery pubescence covers the leaves and stems. The flowers are a pale flesh-colored pink and are 4 to 5 cm long. The upper petal (standard) has a black center surrounded by a maroon area. Flowers are arranged in racemes with stalks 4 to 13 cm long. Each raceme has 5 to 14 flowers, but up to 25 on occasion. Fruits are long, woody, and elliptical with a pointed end. It is differentiated from *L. villosus*, the only other pink flowering lupine, in that *L. aridorum* is not prostrate, has hairs on the leaves and stem, and is the only upright pink-flowering lupine in Florida. (USFWS, 1999).

Taxonomy

Until being named *L. aridorum* in 1982, this taxon was identified as *L. diffusus* and *L. westianus* (52 FR 11172). Isley (1986, 1990) evaluated the systematics of *L. aridorum* in his floristic treatment of the pea family (Fabaceae) in the Southeast and concluded that *L. aridorum* belongs to the same species as *L. westianus* of the Gulf Coast of northwest Florida, which differs mainly in flower color (blue). Isley's taxonomic status for the central Florida plant is *L. westianus* var. *aridorum* (McFarlin ex Beckner) Isley. However, the former classification *L. aridorum* was used to list the species (52 FR 11172), and will be used here to maintain consistency. (USFWS, 1999; USFWS, 2016)

Historical Range

Historical range is two areas of central Florida: western Orange and extreme northwestern Osceola counties on the southern Mount Dora Ridge and in north-central Polk County on the Winter Haven Ridge (USFWS, 2007).

Current Range

Currently found on two interior ridges in central Florida: Winter Haven Ridge in Polk County and Mount Dora Ridge in Orange and Osceola Counties. (USFWS, 2016)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Flowers in late March-May (USFWS, 1999)

Reproduction Narrative

Adult: The scrub lupine has been found in bloom between March and May. The seed pods mature by June, and the seeds fall off the plant and take root nearby or remain in a long-lived seedbank. Recent information indicates the plant may bloom from one to three times throughout its life, though few seeds are produced the first year. Pollinators of this species are unknown (USFWS, 1999).

Habitat Type

Adult: Terrestrial (USFWS, 1999)

Habitat Vegetation or Surface Water Classification

Adult: Sandy openings in sand pine-rosemary-oak scrub (USFWS, 1999)

Dependencies on Specific Environmental Elements

Adult: Soils are very dry and have very little organic accumulation, and quite acidic with a pH from 4.0 to 4.5 (USFWS, 1999).

Habitat Narrative

Adult: Habitat is sandy openings in sand pine-rosemary-oak scrub. Soils are very dry and have very little organic accumulation, and quite acidic with a pH from 4.0 to 4.5. The scrub lupine will not grow near rosemary (*Ceratiola ericoides*) because of rosemary's allelopathic effects. Most of the sites where *L. aridorum* is now found are moderately to severely disturbed by soil scraping, road construction, land clearing, or off-road vehicles (USFWS, 1999; NatureServe, 2015).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Dispersal is not well described (USFWS, 1999).

Population Information and Trends**Population Trends:**

Declining (USFWS, 2007)

Species Trends:

3 - 4 populations extirpated since 2003 (USFWS, 2007)

Number of Populations:

6 to 7 (USFWS, 2007)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

There has been a documented decline in the spatial distribution and historic range of scrub lupine. As of 2003, the historical records of 40 populations had declined to 11 extant lupine populations occupying about 23 acres. Three or four of these populations have been extirpated since 2003, leaving six to seven scrub lupine populations (USFWS, 2007).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Habitat destruction, modification, and degradation on private lands remain the primary threat range-wide to the species. Populations occurring on private lands remain subject to adverse human activity, predominately development. Additionally, lack of management — especially fire suppression — on private lands degrades the habitat over time resulting in less suitability to maintain population viability. These human activities are no longer threats to populations on public conservation lands because of protection afforded and restricted use; however, budget constraints and prioritizing available resources may preclude proper, necessary management activities on conservation lands at times. Only three natural populations occur on public lands with the majority of the populations in private ownership. Little opportunity exists for future protection or management opportunities on these lands because of the urban matrix where they occur. (USFWS, 2016)

Stressor: Disease or predation (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Several species of fungus have been observed on *L. aridorum* plant tissues: charcoal root rot (*Macrophomina phaseolina*), black leaf spot (*Diplocarpon rosae*), and recently an unknown black fungus. Little is known about the unidentified black fungus that appears to be confined to the seed coat on *L. aridorum*. The seed pod looks totally normal but upon opening it the fungus is apparently just on the seeds. Examinations of seed development (Stout 2016) in 2014 at the Lake McLeod NWR documented seeds from 11 of 15 plants (73%) were lost due to this fungal growth. Ten of 20 plants (50%) examined in 2015 had seed loss from fungal sources. No evidence of fungal infested seeds was detected in 2016 (30 plants in sample). Bacteria-induced wilt continues to be observed in *L. aridorum* populations. It is speculated that the bacteria blocks the conducting xylem tissue to the leaf. The sudden death of plants undergoing wilt may occur anytime during the year. Medium to large plants may be more subject to wilt than smaller recruits. Less than 5% of a population may die from this agent in a typical year. The moth, *Uresiphita reversalis*, has been a source of mortality to the lupine populations (*L. aridorum*, *L. diffusus*) studied during the last 5 years (Stout 2016). Stout (2016) documented roughly 200 *L. diffusus* individuals devastated by the larvae in one population with no evidence of any insects predated on the moth larvae. (USFWS, 2016)

Recovery

Reclassification Criteria:

Not defined. (USFWS, 1999).

Delisting Criteria:

1. Protect sites in Polk and Highlands counties, and establish a disturbance regime to create bare, sunny openings (USFWS, 2007).

2. Conduct demographic monitoring for the foreseeable future. Manage and rehabilitate publicly-owned habitats in Orange County (USFWS, 2007).

3. Manage and rehabilitate publicly-owned habitats in Orange County (USFWS, 2007).

Recovery Actions:

- Determine current distribution of *L. aridum*. This species has an extremely restricted range. In South Florida, it is found only in northern Polk County off the Lake Wales Ridge. This species is found in a fast growing urbanizing area and essentially all of its habitat has been converted from the natural state. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Conduct research on life history characteristics of *L. aridum*. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species more specific biological information is needed. (USFWS, 1999)
- Monitor existing populations of *L. aridum*. S4.1. Develop monitoring protocol to assess population trends for *L. aridum*. Develop a quantitative description of the population structure of *L. aridum*. (USFWS, 1999)
- Provide public information about *L. aridum*. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private land owners be appropriately informed about this species. Care is needed, though, to avoid revealing specific locality information about where *L. aridum* is found. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. The public should be informed that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of *L. aridum* and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- Habitat-level Recovery Actions: Prevent degradation of existing habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

Conservation Measures and Best Management Practices:

- Update and revise the recovery plan to improve and clarify the objective measurable criteria and better address the five factors. (USFWS, 2016).
- Collaboration with conservation land managers to increase habitat suitability of occupied habitat. Actively engage landowners to protect and manage occupied habitat. (USFWS, 2016)
- Continued research on biology and ecology: genetics; seed germination (soil/microbial interactions); out planting techniques to reduce mortality; fungus and bacteria stressors. (USFWS, 2016)
- Conduct research on different habitat management techniques and their effects in regards to maintaining or improving the residual seed bank for populations. (USFWS, 2016)
- Increase existing monitoring efforts. (USFWS, 2016)

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<https://www.fws.gov/verobeach/MSRPPDFs/ScrubLupine.pdf>

SPECIES ACCOUNT: *Lupinus nipomensis* (Nipomo Mesa lupine)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/20/2000; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An annual herb (NatureServe, 2015). The low-spreading individuals can reach 8 inches (20 centimeters) in height (Riggins 1993). Leaves are pinnately compound into five to seven leaflets. Up to 10 pinkish-purple flowers are borne on the ends of the inflorescences (flowering stems). Leaves and stems are succulent, and provide prolonged moisture for seed development (USFWS, 2009).

Taxonomy

Recognized as distinct in Kartesz's 1999 Synthesis (had been questionable synonymized into *Lupinus concinnus* ssp. *concinus* in the 1994 Checklist). Recognized as distinct by Jepson, CNDDDB, and the 1999 Federal Register (NatureServe, 2015). A member of the pea family (Fabaceae) (USFWS, 2009).

Historical Range

Historically and currently, the species is known only from the southwestern corner of San Luis Obispo County, California, scattered over an area of approximately 2 miles wide and 2 miles long (3.2 by 3.2 kilometers (km)) (USFWS, 2009).

Current Range

It is currently extant at Nipomo Mesa, San Luis Obispo County, California (NatureServe, 2015). Colonies are scattered across a 2-mile (3.2-km) stretch of backdune habitat west of Highway 1 and between Black Lake Canyon to the north and Oso Flaco Lake to the south (USFWS, 2009).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: self-pollination, cross-pollination (USFWS, 2009)

Lifespan

Adult: One year (USFWS, 2009)

Breeding Season

Adult: March - May (NatureServe, 2015)

Key Resources Needed for Breeding

Adult: Insect pollinators, based on closely related species (USFWS, 2009)

Reproduction Narrative

Adult: This is an annual species. Potentially, seed production could reach on the order of 1,000 seeds; however, based on 2 years of sampling, observed seed production per plant ranged from 1 to over 200, with most plants producing less than 30 fruits (Walters and Walters 1988). Flowers are self-compatible if manipulated; however, they may require insect visitation for full complements of seeds (Center for Plant Conservation (CPC) 2009). While pollination ecology has not been specifically studied for *L. nipomensis*, other lupine taxa are known to be pollinated by butterflies and a variety of bee taxa, especially from the genera *Bombus*, *Osmia*, *Synhalonia*, and *Anthidium* (Moldenke 1976) (USFWS, 2009). It blooms from March to May (NatureServe, 2015).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Coastal dune scrub (USFWS, 2009)

Dependencies on Specific Environmental Elements

Adult: Natural disturbance (USFWS, 2009)

Geographic or Habitat Restraints or Barriers

Adult: Occurs < 50 m elevation (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits stabilized coastal sand dunes at < 50 m elevation. (NatureServe, 2015). It is restricted to sandy soils associated with the Callender Dune Sheet (Cooper 1967). Habitat for *Lupinus nipomensis* is comprised of stabilized back dunes supporting a central coastal dune scrub community. *Lupinus nipomensis* needs open habitat to persist. Sandy soils along the coast typically undergo a certain amount of natural disturbance from coastal winds and from the activity of wildlife (USFWS, 2009).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Very low (inferred from USFWS, 2009)

Redundancy:

Low (inferred from USFWS, 2009)

Number of Populations:

1 population; 10 occurrences (USFWS, 2009)

Population Size:

Variable; 139 - 771 (USFWS, 2009)

Population Narrative:

Each of the occurrences has only a small number of plants (Skinner and Pavlik 1994) (NatureServe, 2015). The Service considers the entire extent of the species to comprise one population; however, the California Natural Diversity Database (CNDDB) has divided the population into approximately 10 occurrences for tracking purposes. Over the last 4 years, the total number of individuals has fluctuated between approximately 139 and 771, depending on winter and spring climatic conditions (Land Conservancy of San Luis Obispo County (Conservancy) 2009). The current footprint of the populations is on the order of 100 acres (40.5 ha) (USFWS, 2009).

Threats and Stressors

Stressor: Development (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: A Notice of Preparation to expand refinery capabilities at the Conoco-Phillips plant has been received (County of San Luis Obispo 2008). The Service has also recently received a notice regarding a proposal to construct a telecommunications facility less than 0.25 mile (0.4 km) away from EO #7 (C. Mehlberg, Service, in litt. 2009). The project proponent notes that the site was previously developed with agricultural fields; whether above-ground plants or a seed bank of *L. nipomensis* remains is unknown. In addition, it appears that several housing developments have been constructed within a mile of *L. nipomensis* habitat over the past 5 years (Google Earth 2009). The presence of a larger human population in the adjacent area is likely to introduce additional direct and indirect effects (such as trampling from recreational use, spread of invasive horticultural species used in landscaping, and loss of pollinator habitat) on the species as time goes on. Little opportunity for population expansion is available adjacent to the existing populations because habitat has already been converted to other uses, including roads, facilities, agriculture, and housing (USFWS, 2009).

Stressor: Pocket gophers (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: While pocket gophers are known to harvest seeds of many species in general (Martin et al. 1951), it is more likely that they consume the roots, stems, and leaves of *L. nipomensis*, and that seeds die prior to full maturation. However, seed that are able to complete maturation despite being excised from the plant may find suitable germination sites in the vacated gopher mounds the following winter season (Walters and Walters 1988). In addition, the listing rule stated that the presence of veldt grass increases the food source for pocket gophers and thus potentially increases their numbers and their potential harm to *L. nipomensis* (Walters and Walters 1988). Survey results for the 3 years from 2007 through 2009 indicate that from 28 to 31 percent of *L. nipomensis* individuals are consumed by pocket gophers on Conoco-Phillips

property (Conservancy in litt. 2009); therefore, pocket gophers continue to be a threat to the species (USFWS, 2009).

Stressor: Nonnative plants (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: In general, invasion of this habitat by nonnative species (particularly veldt grass (see Bossard et al. 2000)) is a threat to populations of native species because individuals cannot compete well for light, water, and resources (D'Antonio and Vitousek 1992). Veldt grass was described as "rampant" in the area at least 25 years ago (McLeod and Walters 1987); its presence can cause a shift from scrub habitat to grassland habitat (Bossard et al. 2000, California Invasive Plant Council 2009). Since 2000, the Conservancy has been actively removing veldt grass from *Lupinus nipomensis* habitat. While these efforts may have slowed the conversion to a monoculture of veldt grass, it is likely that the habitat will have to be managed in perpetuity to maintain the open patches that is required by *L. nipomensis* (USFWS, 2009).

Stressor: Stochastic events (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The existence of less than 10 occurrences and the small number of individuals in the occurrences place *Lupinus nipomensis* at risk of extinction from stochastic events. The conservation biology literature commonly notes the vulnerability of taxa known from one or very few locations and/or from small and highly variable populations (e.g., Shaffer 1981, 1987; Groom et al. 2006; Primack 2006). In particular, although the plants are apparently self-compatible and capable of self-fertilization, the small size of the population makes it difficult for this species to persist while sustaining the impacts of habitat alteration that favors nonnative plant species and the potential loss of pollinator habitat (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Recently, the potential impacts of climate change on the flora of California were discussed by Loarie et al. (2008). Based on modeling, they predicted that species' distributions will shift in response to climate change, specifically that the species will "move" or disperse to higher elevations and northward, depending on the ability of each species to do so. Species diversity will also shift in response to these changes with a general trend of increasing diversity shifting towards the coast and northwards with these areas becoming de facto future refugia. However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects (USFWS, 2009).

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- Complete a Recovery Outline and Species Action Plan for *Lupinus nipomensis* as a first step in preparing a recovery plan for the species (USFWS, 2009).
- Work with Conoco-Phillips and California Department of Transportation to ensure that management of their lands and rights-of-way is consistent with the long-term persistence of *Lupinus nipomensis* at those sites. In addition, work with the County of San Luis Obispo to ensure that consideration is given to *L. nipomensis* during projects review and implementation (USFWS, 2009).
- In partnership with Santa Barbara Botanic Garden, continue with research on seed characteristics, particularly to determine the extent of the soil seed bank present, and whether there is a difference in seed viability between those produced from self-fertilization and those produced by cross-pollination to determine if lack of pollinators is a concern (USFWS, 2009).
- In partnership with Santa Barbara Botanic Garden and the Conservancy, experiment with establishment of new populations in other coastal dune scrub habitat in coastal San Luis Obispo County (USFWS, 2009).

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SPECIES ACCOUNT: *Lupinus sulphureus* ssp. *kincaidii* (Kincaid's Lupine)

Species Taxonomic and Listing Information

Listing Status: Threatened; 02/24/2000; Pacific Region (R1)

Physical Description

Lupinus sulphureus ssp. *kincaidii* is an herbaceous perennial in the legume family (Fabaceae) that forms a branched crown, usually with numerous unbranched stems 40 to 100 centimeters (16 to 39 inches) tall, with whitish or brownish stiff to silky pubescence. Basal leaves are usually persistent until after flowering, the lowermost petioles 3 to 5 times as long as the blades, the upper cauline leaves with petioles sometimes shorter than the blades. Leaflets usually number from 7 to 12, and are rather narrowly oblanceolate, usually acute, 2.5 to 5 centimeters (1 to 2 inches) long. The flowers are numerous but not crowded on the stem, and range in color from bluish or purple to yellowish or creamy white, fading to orange-brown. The banner is distinctively ruffled and not very reflexed, the upper calyx lip short, bidentate, and not concealed by the reflexed sides of the longclawed banner. The fruit pods are not hairy, are 3 to 4 centimeters (1 to 1.5 inches) long, with 1 to 6 pinkish-brown to black seeds. The species is distinguished from other relatives by its ruffled banner on light-colored flowers, its unbranched flowering stems, and its low growing habit (Hitchcock 1961, Kaye and Kuykendall 1993, Gisler 2004). (USFWS, 2010)

Taxonomy

Lupinus sulphureus ssp. *kincaidii* was first described in 1921 by A.A. Heller as *Lupinus oreganus* from a collection made in Eugene, Oregon (Wilson et al. 2003). In the intervening decades, Phillips (1955) described the plant as a subspecies, *L. sulphureus* ssp. *kincaidii*. Hitchcock (1961) retained the position noted by Phillips (1955), but preferred the combination as a varietal rank, *L. sulphureus* var. *kincaidii*, although this is not accepted under the rules of botanical nomenclature (Wilson et al. 2003). Additional taxonomic work may be needed for this subspecies, and it is possible that the subspecies should be considered a distinct species, *L. oreganus* (Wilson et al. 2003). (USFWS, 2010) This taxonomic change for Kincaid's lupine, from the subspecies *Lupinus sulphureus* ssp. *kincaidii* to the full species *Lupinus oreganus*, has now been recognized by the Oregon Department of Agriculture (Oregon Department of Agriculture, 2019) and by botanical authorities such as the Oregon Flora Project's Vascular Plant Checklist (Iaster et al. 2019) and the Flora of Oregon (S. Meyers pers. comm. 2019). Other authorities, such as the Natural Resources Conservation Service's USDA PLANTS database (USDA PLANTS 2019), the Integrated Taxonomic Information System (ITIS.GOV 2019), the Flora of the Pacific Northwest (Hitchcock and Cronquist 2018), and Washington Department of Natural Resources (Washington Natural Heritage Program 2019, p. 19) now recognize Kincaid's lupine as a variety, *Lupinus oreganus* var. *kincaidii* C.P. Sm. (the other variety being *L. oreganus* var. *oreganus*, formerly *L. biddlei*). Whether a full species or an infraspecies, all authorities now agree that at a minimum, Kincaid's lupine should be recognized under the specific epithet "oreganus" instead of "sulphureus." (USFWS, 2017)

Historical Range

Historically, the species was documented from Vancouver Island, British Columbia, Canada (Dunn and Gillet 1966), but has not been located in that region since the 1920s (Kaye 2000). Before Euro-American settlement of the region, Kincaid's lupine was likely well distributed

throughout the prairies of western Oregon and southwestern Washington; today, habitat fragmentation has resulted in existing populations that are widely separated by expanses of unsuitable habitat (USFWS, 2016).

Current Range

Douglas County, Oregon to Lewis County, Washington, and into southern British Columbia. Considered extirpated in British Columbia. In Oregon, in the Willamette and Umpqua Valleys.

Critical Habitat Designated

Yes; 11/30/2000.

Legal Description

On October 31, 2006, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective November 30, 2006) for *Lupinus sulphureus* ssp. *kincaidii* (Holmgren milk-vetch) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 13 critical habitat units (CHUs) in Oregon and Washington (71 FR 63862-63977).

Critical Habitat Designation

The critical habitat designation for *Lupinus sulphureus* ssp. *kincaidii* includes 13 CHUs in Benton, Lane, Polk, and Yamhill Counties, Oregon, and Lewis County, Washington. This species critical habitat encompasses approximately 585 acres (ac) (237 hectares (ha)). Brief descriptions are presented below; detailed coordinates and maps are included in the Final Rule (71 FR 63862-63977; USFWS, 2006).

Unit KL–1 consists of approximately 4 ac (1.6 ha) of private land in Lewis County, Washington.

Unit KL–2A and 2B encompass approximately 6.25 ac (2.5 ha) and 14.1 ac (5.7 ha) respectively, of private land in northern Yamhill County. KL–2A supports *Lupinus sulphureus* ssp. *kincaidii* patches along both the east and west sides of Oak Creek Road. KL– 2B is located approximately 0.68 miles (1.1 km) south of KL–2A along both the east and west sides of Oak Creek Road, near the junction with Fairdale Road.

Unit KL–3 consists of approximately 51 ac (20.6 ha) of private lands within Yamhill County.

Unit 4 of *Lupinus sulphureus* ssp. *kincaidii* (Unit KL–4A and 4B) Unit KL–4A and 4B consists of approximately 68.6 ac (27.8 ha) of private lands in Yamhill County and is located west of Muddy Valley Road and south of Eagle Point Road.

Unit 5 of *Lupinus sulphureus* ssp. *kincaidii* (Unit KL–5) Unit KL–5 encompasses approximately 1.7 ac (0.7 ha) of ODOT land in southern Yamhill County and is located south of State Highway 18, east of Ballston Road, and approximately 0.6 mi (1 km) south of the Yamhill River.

Unit KL–6 encompasses approximately 3.6 ac (1.5 ha) of primarily ODOT land in northern Polk County. The *Lupinus sulphureus* ssp. *kincaidii* population occurs in two patches scattered along the northeast and southwest sides of Highway 22, near the intersection with Mill Creek Road.

Unit KL–7 consists of approximately 12.3 ac (5 ha) of private lands in central Polk County. This unit is located near the junction of Highway 223 and Oakdale Avenue, and largely falls within the City of Dallas urban-growth boundary.

Unit KL–8 consists of approximately 11.5 ac (4.6 ha) of private and State lands in Benton County. This unit occurs in McDonald Forest located off Oak Creek Road and supports one of the highest quality remaining prairies.

Unit KL–9 encompasses approximately 171.6 ac (69.4 ha) of private lands within Benton County. This unit is located in Wren, Oregon, between Kings Valley Highway, Cardwell Hill Road, and Blakesly Creek Road, approximately 2 mi (3.2 km) southwest of Unit KL–8.

Unit KL–10 consists of approximately 17.9 ac (7.2 ha) of private lands within Benton County and is located north of Philomath, with the habitat occurring primarily to the south of West Hills Road and to the west of 19th Street.

Unit KL–11 encompasses approximately 64.6 ac (26.2 ha) of prairie habitat distributed across Federal and private lands in Lane County. This unit is located in West Eugene, near the Fern Ridge Reservoir, just south of Clearlake Road, and on both the east and west sides of Fir Butte Road. The area included in Units KL–11A, 11B, 11C, 11D, and 11E.

Unit KL–12 encompasses approximately 141.2 ac (57.1 ha) of prairie habitat distributed across Federal and private lands in Lane County. This unit is in west Eugene and located north of Bailey Hill Road and west of Bertelsen Road. This unit primarily occurs on lands owned by TNC and the BLM, with 4 percent occurring on private lands. The area included in KL– 12A, 12B, 12C, 12D, and 12E, collectively represents habitat with the features essential to the conservation of a functioning *Lupinus sulphureus* ssp. *kincaidii* metapopulation.

Unit KL–13 encompasses approximately 16.2 ac (6.6 ha) of private land in Lane County, and is located north of Powell Road and west of Coyote Creek.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Lupinus sulphureus* ssp. *kincaidii* critical habitat consists of two components (71 FR 63862-63977):

- (i) Early seral upland prairie, or oak savanna habitat with a mosaic of lowgrowing grasses and forbs, and spaces to establish seedlings or new vegetative growth; an absence of dense canopy vegetation; and undisturbed subsoils.
- (ii) The presence of insect outcrossing pollinators, such as *Bombus mixtus* and *B. californicus*, with unrestricted movement between existing lupine patches.

Special Management Considerations or Protections

Lupinus sulphureus ssp. *kincaidii* populations respond positively to habitat restoration. Mowing, burning, and mechanical removal of weeds, when done appropriately, have all been shown to benefit Fender's blue populations. At sites managed by The Nature Conservancy (TNC), the Fender's blue butterfly and *L. sulphureus* ssp. *kincaidii* populations increased following removal

of noxious non-native plants such as *Rubus discolor* (Himalayan blackberry) and *Cytisus scoparius* (Scotch broom) (Fitzpatrick 2005, pp. 6, 7, 10, 11, 20). At Baskett Slough National Wildlife Refuge in western Oregon, Wilson and Clark (1997, p. 10, 11) studied the effects of controlled fire and mowing on the Fender's blue butterfly and its native upland prairie. Although fire killed all larvae in treated patches, nearby unburned (untreated) patches provided a source of female Fender's blue butterflies that were able to recolonize the entire burned (treated) area. Wilson and Clark (1997, pp. 10, 23) also found that in the year following mowing and burning treatments, Fender's blue butterfly eggs were 10 to 14 times more abundant in treated plots than in undisturbed control plots. Woody plants were reduced by 45 percent with burning and by 66 percent with mowing. At the Corps' Fern Ridge Reservoir, the Fender's blue population has increased dramatically since fall mowing of *L. sulphureus* ssp. *kincaidii* patches has been implemented. The abundance of Fender's blue butterfly eggs and *L. sulphureus* ssp. *kincaidii* has increased as blackberry bushes have been controlled in several test plots located on BLM lands in Eugene, Oregon (Kaye and Cramer 2003, p. 10). In general, Fender's blue butterfly egg abundance increased substantially at sites treated to control non-native weeds (Schultz et al. 2003, p. 69). (USFWS, 2006)

Lupinus sulphureus ssp. *kincaidii* is at risk of inbreeding depression and site extirpation across their respective ranges because populations are small and isolated from one another. This species will benefit from reestablishing prairie plant patches in proximity to core populations. (USFWS, 2006)

Many remaining populations of *Lupinus sulphureus* ssp. *kincaidii* populations occur in road rights of ways and are adversely affected by maintenance activities such as mowing or spraying of herbicides at the wrong time of year. A few *L. sulphureus* ssp. *kincaidii* populations along roads persist, likely because the routine maintenance provides open, full-sun conditions characteristic of *L. sulphureus* ssp. *kincaidii* habitat.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (USFWS, 2016)

Breeding Season

Adult: Flowering begins in April and extends through June (USFWS 2010). As the summer dry season arrives, Kincaid's lupine becomes dormant, and is completely senescent by mid-August (Wilson et al.2003) (USFWS, 2016).

Reproduction Narrative

Adult: Flowering begins in April and extends through June (USFWS 2010). As the summer dry season arrives, Kincaid's lupine becomes dormant, and is completely senescent by mid-August (Wilson et al.2003). Pollination is largely accomplished by small native bumblebees (*Bombus mixtus* and *B. californicus*), solitary bees (*Osmia lignaria*, *Anthophora furcata*, *Habropoda* sp., *Andrena* spp., *Dialictus* sp.) and occasionally, European honey bees (*Apis mellifera*) (Wilson et al.2003). Insect pollination appears to be critical for successful seed production (Wilson et al.2003). Kincaid's lupine reproduces by seed and vegetative spread. It is able to spread

extensively through underground growth. Individual clones can be several centuries old (Wilson et al.2003), and become quite large with age, producing many flowering stems. As part of a genetic evaluation, collections taken from small populations of Kincaid's lupine at the Baskett Slough National Wildlife Refuge were found to be genetically identical, indicating that the population consists of one or a few large clones (Liston et al.1995). Reproduction by seed is common in large populations where inbreeding depression is minimized and ample numbers of seeds are produced. In small populations, seed production is reduced and this appears to be due, at least in part, to inbreeding depression (Severns 2003). Kincaid's lupine is vulnerable to seed, fruit and flower predation by insects, which may limit the production of seeds. Seed predation by bruchid beetles and weevils and larvae of other insects has been documented, and may result in substantially reduced production of viable seed (Kaye and Kuykendall 1993, Kuykendall and Kaye 1993). Floral and fruit herbivory by larvae of the silvery blue butterfly (*Glaucopsyche lygdamus columbia*) has also been reported (Kuykendall and Kaye 1993). The vegetative structures of Kincaid's lupine support a variety of insect herbivores, including root borers, sap suckers and defoliators (Wilson et al.2003). Kincaid's lupine is the primary larval host plant of the endangered Fender's blue butterfly (Wilson et al.2003). Female Fender's blue butterflies lay their eggs on the underside of Kincaid's lupine leaves in May and June; the larvae hatch several weeks later and feed on the plant for a short time before entering an extended diapause, which lasts until the following spring (Schultz et al.2003). Kincaid's lupine, like other members of the genus *Lupinus*, is unpalatable to vertebrate grazers (USFWS, 2016).

Habitat Type

Adult: Upland prairie (USFWS, 2016)

Habitat Narrative

Adult: In the Willamette Valley and southwestern Washington, Kincaid's lupine is found on upland prairie remnants where the species occurs in small populations at widely scattered sites (USFWS 2010). A number of populations are found in road rights-of-way, between the road shoulder and adjacent fence line, where they have survived because of a lack of agricultural disturbance. Some of the populations in Washington occur in pastures and appear to benefit from light grazing by livestock, which reduces the cover of competing shrubs and grasses (Joe Arnett, Washington Department of Natural Resources, in litt 2008). Common native species typically associated with Kincaid's lupine include: *Festuca idahoensis* ssp. *roemerii*, *Danthonia californica*, *Calochortus tolmiei*, *Eriophyllum lanatum*, and *Fragaria virginiana*. The species appears to prefer heavier, generally well-drained soils and has been found on 48 soil types, typically Ultic Haploxerolls, Ultic Argixerolls, and Xeric Palehumults (Wilson et al.2003). In Douglas County, Oregon, Kincaid's lupine appears to tolerate more shaded conditions, where it occurs at sites with canopy cover of 50 to 80% (Barnes 2004). In contrast to the open prairie habitats of the more northerly populations, in Douglas County, tree and shrub species dominate the sites, including *Pseudotsuga menziesii* (Douglas-fir), *Quercus kelloggii* (California black oak), *Arbutus menziesii* (Pacific madrone), *Pinus ponderosa* (ponderosa pine), *Calocedrus decurrens* (incense cedar), *Arctostaphylos columbiana* (hairy manzanita) and *Toxicodendron diversilobum*. In contrast to historical ecosystem composition, invasive non-native species are a significant component of Kincaid's lupine habitat today (USFWS 2010). Common invasives include: *Arrhenatherum elatius*, *Brachypodium sylvaticum*, *Dactylis glomerata*, *Festuca arundinacea*, *Rubus armeniacus* and *Cytisus scoparius* (Wilson et al.2003). In the absence of fire, some native species, such as *Toxicodendron diversilobum* and *Pteridium aquilinum*, invade prairies and compete with Kincaid's lupine (USFWS, 2016).

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Unknown (USFWS, 2016)

Number of Populations:

21 - 80 (NatureServe, 2015)

Population Narrative:

Kincaid's lupine is found in dry upland prairies from Lewis County, Washington, in the north, south to the foothills of Douglas County, Oregon; however, most of the known and historical populations are found in the Willamette Valley (USFWS 2010). Historically, the species was documented from Vancouver Island, British Columbia, Canada (Dunn and Gillet 1966), but has not been located in that region since the 1920s (Kaye 2000). Before Euro-American settlement of the region, Kincaid's lupine was likely well distributed throughout the prairies of western Oregon and southwestern Washington; today, habitat fragmentation has resulted in existing populations that are widely separated by expanses of unsuitable habitat. Range-wide, Kincaid's lupine is known at about 164 sites, comprising about 608 acres of total coverage (USFWS 2010). In Oregon, the ONHIC (2014) reported Kincaid's lupine over 100 sites. From these locations, at least 43 populations are considered potential populations that could contribute to recovery (USFWS, OFWO, 2014, unpublished data); and 25 of those populations have protection in place for Kincaid's lupine. Until the summer of 2004, Kincaid's lupine was known from just two extant populations in Washington, in the Boistfort Valley in Lewis County, more than 160 km (100 miles) from the nearest population in the Willamette Valley (USFWS 2010). Arnett (2014) reported a total of 5 populations across 9 sites of Kincaid's lupine in 2014. At two sites, Kincaid's lupine covered more than 1,000 m² (1,196 square yards) each (Boistfort and Cowlitz Prairie); only one plant was observed at Drew's Prairie in 2013. Only one location (Lozier Preserve within the Cowlitz Prairie population) has protection for Kincaid's lupine; all other locations are privately owned with no formal protections. Monitoring the size of Kincaid's lupine populations is challenging because its pattern of vegetative growth renders it difficult to distinguish individuals (Wilson et al. 2003). Instead of counting plants, most monitoring for this species relies on counting the number of leaves per unit area, partly because there is a strong correlation between Fender's blue butterfly egg numbers and lupine leaf density (Schultz 1998, Kaye and Thorpe 2006). Leaf counts are time consuming, however, and recent evaluations have shown that lupine cover estimates are highly correlated with leaf counts, much faster to perform, and useful for detecting population trends (Kaye and Benfield 2005) (USFWS, 2016).

Threats and Stressors

Stressor: Plant succession (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: A serious long-term threat to all Willamette Valley prairie species is the change in community structure due to plant succession. The vast majority of Willamette Valley prairies

would likely be forested if left undisturbed. The natural transition of prairie to forest in the absence of disturbance such as fire will lead to the eventual loss of these prairie sites unless they are actively managed (Johannessen et al.1971; Kuykendall and Kaye 1993) (USFWS, 2016).

Stressor: Urbanization (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Urbanization is listed as a threat to this species. Land development and alteration in the prairies of western Oregon and southwestern Washington have been so extensive that the remaining populations are essentially relegated to small, isolated patches of habitat. Habitat loss is likely to continue as private lands are developed; at least 49 of 54 sites occupied by *Lupinus sulphureus* ssp. *kincaidii* in 2000 at the time of listing were on private lands and are at risk of being lost unless conservation actions are implemented (USFWS 2000) (USFWS, 2016).

Stressor: Agriculture (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Agriculture is listed as a threat to this species (USFWS, 2016).

Stressor: Silviculture (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Silviculture practices are listed as threats to this species (USFWS, 2016).

Stressor: Roadside maintenance (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Roadside maintenance is listed as a threat to this species (USFWS, 2016).

Stressor: Habitat fragmentation (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat/loss of genetic variability

Narrative: Habitat fragmentation and isolation of small populations may be causing inbreeding depression in *Lupinus sulphureus* ssp. *kincaidii*. The subspecies was likely wide-spread historically, frequently outcrossing throughout much of its range, until habitat destruction and fragmentation severely isolated the remaining populations (Liston et al.1995). There is some evidence of inbreeding depression, which may result in lower seed set (Severns 2003). Hybridization between *Lupinus sulphureus* ssp. *kincaidii* and *Lupinus arbustus* has been detected at Baskett Slough National Wildlife Refuge (Liston et al.1995)

Recovery

Reclassification Criteria:

Not applicable.

Delisting Criteria:

Delisting will be considered when all of the following conditions have been met: (USFWS, 2010)

1. Distribution and abundance. The distribution of populations should reflect the extent of the species' historical geographic distribution to the extent practicable. See Table IV-5 in the Recovery Plan for distribution and abundance goals for this species. (USFWS, 2010)
2. Population trend and evidence of reproduction. The number of individuals in the population (or area of foliar cover for *Lupinus sulphureus* ssp. *kincaidii* or *Sidalcea nelsoniana*) shall have been stable or increasing over a period of at least 15 years. Stable does not mean that the population size is static over time; over a period of 15 years, the number of individuals in the population may exhibit natural year-to-year variability, but the trend must not be declining. Populations must show evidence of reproduction by seed set or presence of seedlings. (USFWS, 2010)
3. Habitat quality and management. Sites supporting populations of listed plants considered in Criterion 1 above must meet these criteria: (a) Prairie quality. Sites supporting populations of the listed plant species must be managed for high quality prairie habitat. High quality prairie habitat consists of a diversity of native, non-woody plant species, low frequency of aggressive non-native plant species and encroaching woody species, and essential habitat elements (e.g., nest sites and food plants) for native pollinators. See Appendix D of the Recovery Plan for suggested criteria for evaluating prairie quality and diversity. (b) Security of habitat. For each listed species, a substantial portion of the habitat for the populations should either be owned or managed by a government agency or private conservation organization that identifies maintenance of the species and the prairie ecosystem upon which it depends as the primary management objective for the site, or the site must be protected by a permanent or long-term conservation easement or covenant that commits present and future landowners to the conservation of the species. (c) Management, monitoring, and control of threats. Each population must be managed appropriately to ensure the maintenance or restoration of quality prairie habitat for each species and to control threats to the species. Use of herbicides, mowing, burning or livestock grazing in management should be implemented with appropriate methods and timing to avoid impacts to listed plant species. Management should be coordinated with adjacent landowners to minimize effects of pesticide drift, changes in hydrology, timber harvest, or road/utility maintenance. Species that may hybridize with *Sidalcea nelsoniana* or *Lupinus sulphureus* ssp. *kincaidii* should be managed as appropriate to avoid contact with these taxa. Other potential threats relating to scientific research, overcollection, vandalism, recreational impacts, or natural herbivory/parasitism should be successfully managed so as not to significantly impair recovery of the species. (USFWS, 2010)
4. Genetic material is stored in a facility approved by the Center for Plant Conservation. The stored genetic material in the form of seeds must represent the species' geographic distribution and genetic diversity through collections across the full range of the species. Collections from large populations are particularly important as reservoirs of genetic variability within the species. (USFWS, 2010)

5. Post-delisting monitoring plans and agreements to continue post-delisting monitoring are in place and ready for implementation at the time of delisting. Monitoring of populations following delisting will verify the ongoing recovery of the species, provide a basis for determining whether the species should be again placed under the protection of the Endangered Species Act, and provide a means of assessing the continuing effectiveness of management actions. (USFWS, 2010)

Recovery Actions:

- Details of the Recovery Actions are available in the 2010 Recovery Plan. Presented below is the introductory paragraph only. (USFWS, 2010)
- 1. Preserve, restore, and manage populations and habitat for the listed prairie species covered by this plan. The listed prairie species of western Oregon and southwestern Washington addressed by this plan are now found only in small, highly fragmented upland and wet prairie habitat remnants. The first step in the recovery of these species is to identify and protect the remaining populations with the greatest potential for restoration. The next step is to augment and, if necessary, reintroduce populations to restore connectivity between those that are currently isolated from one another to restore gene flow and create a population structure that provides for resiliency in a dynamic natural environment. Recovery for all of these species will depend upon the successful establishment of a network of protected populations in managed, suitable prairie habitats distributed across their historical range. As a large portion of the remnant prairie habitats within the range of these species is in private ownership, recovery will to a large extent depend upon the successful development of partnerships with private landowners and support of their efforts to protect, restore and manage native prairie habitats in the region. (USFWS, 2010)
- 2. Coordinate recovery actions to benefit other listed species and nonlisted prairie species of conservation concern. The extensive loss of both wet and upland prairie habitats throughout the geographic region addressed by this draft recovery plan has resulted in the concurrent declines of many of the native plants and animals associated with these ecosystems. In this plan we have attempted to focus not only on the recovery of the listed prairie species, but to extend these recovery efforts to the ecosystems upon which they depend. The recommended actions for restoring and reconnecting prairie habitats in western Oregon and southwestern Washington are intended to extend benefits beyond the threatened or endangered species addressed in the plan to all of the native prairie species in these regions, including nonlisted prairie species that are recognized as in decline. Proactive efforts to restore prairie systems should contribute to the arrest or reversal of these declines, thereby preventing the need to list these species in the future. Particularly on sites where listed species co-occur with nonlisted species of conservation concern, landowners or managers should be made aware so as to tailor management actions to avoid inadvertent negative impacts on any such species. Coordination with other agencies, private landowners, or other interested parties will help ensure that the recovery actions outlined in this plan benefit the habitat and populations of other native prairie species. (USFWS, 2010)
- 3. Promote protection of listed species and prairie restoration on private lands. More than 90 percent of the land in the Willamette Valley is in private ownership. The restoration of prairie systems and their native plant and animal communities can therefore only be successful with the participation of private landowners. Without active management, populations of both listed and nonlisted species endemic to prairie habitats are almost certain to experience further declines. Working with private landowners and providing

incentives to participate in the recovery effort for these species are critical elements of the recovery strategy. (USFWS, 2010)

- 4. Cultivate partnerships with both public and private agencies and organizations to promote the conservation of prairie ecosystems and listed prairie species. A diverse group of agencies and organizations are involved in recovery activities for the native prairies in western Oregon and southwestern Washington, including, but not limited to, the U.S. Fish and Wildlife Service, the Willamette Valley National Wildlife Refuge Complex, the U.S. Bureau of Land Management, U.S. Army Corps of Engineers, Confederated Tribes of Grand Ronde, Oregon Department of Transportation, City of Eugene, The Nature Conservancy, Oregon State University, Institute for Applied Ecology, Greenbelt Land Trust, McKenzie River Land Trust, Oregon Oak Communities Working Group, Washington Native Plant Society, Oregon Native Plant Society, Heritage Seedlings, and Berry Botanic Garden. Information regarding the recovery efforts for the prairie species should be shared with city and county planning, parks, and natural resource departments throughout the region covered by this recovery plan. City and county governments are the primary agencies that determine future land uses, and their participation is important for the recovery and restoration of the prairies and their associated listed species. Some local agencies are already making significant contributions toward prairie restoration; the West Eugene Wetlands are an excellent example of a significant conservation accomplishment achieved through a partnership of federal and local governments and private landowners/organizations. Plans, data, and information pertinent to the recovery of the prairie species must be synthesized and shared effectively between all agencies, groups, and individuals to leverage collective conservation efforts and achieve recovery. (USFWS, 2010)
- 5. Revise and update recovery plan as needed. Based on the results of the recommended research and monitoring efforts and the evaluation of the relative success or failure of different management techniques, the recovery plan should be revised periodically as needed to reflect this increased knowledge and improve the efficacy of future recovery actions. The scientific validity of the recovery criteria should also be reviewed and refined, if necessary, as more accurate species-specific data become available to assist with refining recovery criteria. (USFWS, 2010)
- 6. Develop post-delisting monitoring plans for each listed species prior to delisting. To ensure the continuing recovery of the listed species and adequacy of management actions to maintain the species at viable levels into the foreseeable future, a post-delisting monitoring plan must be developed and ready for implementation prior to delisting of any threatened or endangered species. Such a monitoring plan must be designed to be continued for a minimum of 5 years following the delisting action. (USFWS, 2010)
- Recommendation for Future Action from 2017 5-Year Review: Site naming conventions remain inconsistent and do not reflect “populations” as functional units. We recommend that a standard procedure for aggregating sites into populations be developed so that the Service and our partners can describe the number of populations in a more meaningful way. (USFWS, 2017)
- Recommendation for Future Action from 2017 5-Year Review: We recommend that the taxonomy of this species be reviewed as multiple names are currently being used for the same species. Naming conventions and genetics issues surrounding Kincaid’s lupine remain unresolved. (USFWS, 2017)
- Recommendation for Future Action from 2017 5-Year Review: Management is imperative for prairie species to survive. Removal of woody species, control of invasive weeds and, in

some cases, reintroduction of the once common native prairie matrix species may be necessary to maintain suitable habitat for Kincaid's lupine. (USFWS, 2017)

- Recommendation for Future Action from 2017 5-Year Review: Recovery of Kincaid's lupine will require voluntary conservation by private landowners. The majority of this species' habitat is privately owned and, due to the regulatory limitations, the Service is not able to prevent privately owned populations from being destroyed. Working with private landowners, conservation organizations, and local governments to conserve and protect Kincaid's lupine is essential to achieving recovery. (USFWS, 2017)
- Recommendation for Future Action from 2017 5-Year Review: We recommend that the issue of hybridization be addressed through genetic analysis or crossing studies of Kincaid's lupine. Current publications are limited to one known instance of hybridization between Kincaid's lupine and spur lupine at Baskett Slough National Wildlife Refuge (Liston et al. 1995). In order to determine the role of hybridization and the risk it poses to this species, additional genetic information is needed for Kincaid's lupine populations throughout its range. (USFWS, 2017)
- Recommendation for Future Action from 2017 5-Year Review: The gaps in data evident in this analysis also indicate the need for accurate and up-to-date population (foliar cover) estimates for a number of sites. We recommend a complete survey effort to assess the status of all presumed extant populations of Kincaid's lupine throughout its range. (USFWS, 2017)

Conservation Measures and Best Management Practices:

- All of the General Plant Conservation Measures (Section 3.13.1) apply for Kincaid's lupine. Additional species-specific measures include: • Broadcast application of grass-specific herbicides may be used in on up to half of an area occupied by Kincaid's lupine between February 15 and April 15. If using a weed wiper to apply a grass-specific herbicide for a particular listed plant during the growing season, the herbicide will be applied to the upper grass stems of targeted non-native plants, thus avoiding the shorter listed plant species. • All other broadcast applications will only occur after August 15 when Kincaid's lupine is dormant. This plant is the primary host plant for Fender's blue butterflies (another listed species); see additional PDC, restrictions, and conservation measures that apply for Fender's blue butterfly (USFWS, 2016).

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Provided to FESTF from Chris Mullens 9/30/2016

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SPECIES ACCOUNT: *Lupinus tidestromii* (Clover lupine)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A creeping, perennial herb, 1-3 dm tall, rhizomatous. Roots bright yellow. Narrow leaves with 3-5 leaflets, arranged in a fan shape. Stems and leaves with short hairs. Inflorescence stems are 4-8 cm long, and whorls of flowers are blue to lavender. Fruits are pods containing 5-8 seeds with blackish spots (Fish and Wildlife Service 1997). (NatureServe, 2015)

Taxonomy

Lupinus tidestromii (Tidestrom's lupine) was described by Edward Greene in 1895 from an 1893 collection made by Ivar Tidestrom on the Monterey Peninsula. In 1938, Alice Eastwood described a similar lupine from Point Reyes (*L. layneae*). Philip Munz (1958) later recognized the Point Reyes plants as a variety of *L. tidestromii*, and called them *L. tidestromii* var. *layneae* to separate them from the Monterey Peninsula plants. The recent treatment by Rhonda Riggins and Teresa Sholars suggested that *L. tidestromii* exists as a single, variable species (Riggins and Sholars 1993) (USFWS, 1998).

Historical Range

See Current

Current Range

This species is found in clustered colonies at 3 sites along the California coastal dunes: the southern most populations are found at various sites from Carmel Beach to Asilomar State Beach (ASB) on the northern tip of the Monterey Peninsula, the central populations are found in their highest numbers and concentration on Point Reyes National Seashore around Abbott's lagoon, and the northern most populations are found at Goat Rock Beach on the Sonoma Coast State Beach (SCSB). (USFWS, 2009)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Flowering occurs from May through June (USFWS, 1998).

Reproduction Narrative

Adult: The life history of *Lupinus tidestromii* is largely unknown or the information is unpublished. Flowering occurs from May through June. *L. tidestromii* is probably pollinated by bees (Moldenke 1976). Within populations, plants exhibit highly congested distributions. Most lupine seeds for all 5 coastal species can be found littered at the plant base. This and large seed size is consistent with localized limited dispersal, and limited long-distance dispersal by abiotic

factors. Seeds of *Lupinus* are generally long lived and probably forms a persistent dormant seed bank. For seeds to germinate under natural conditions, the seed coat probably must be degraded (although not necessarily scarified, as by “sandblasting” by windblown sand). *Lupinus tidestromii* grows in stable to slightly mobile dunes, far from “sandblasting” habitats, so very slow microbial decomposition of seed coats of long-lived seeds is the more likely route to germination. This is not a species of accreting foredunes, and it has very low burial tolerance compared with larger dune plants of the pea family (e.g., *Lupinus chamissonis* and *Lathyrus littoralis*, which grow in highly mobile dunes). As a result, *Lupinus tidestromii* is confined to the vast stable deflation plains next to southern Abbots Lagoon (USFWS, 1998).

Habitat Type

Adult: Coastal dunes (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (Inferred from NatureServe, 2015)

Site Fidelity

Adult: High (Inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species occurs on partially stabilized coastal dunes up to about 8 m high in the mild maritime climate of the central California coast and grows in coastal dune communities in association with Menzies' wallflower, sand gilia, beach sagewort, sand verbena, and mock heather (Fish and Wildlife Service 1997) (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat needs of this species and the limited number of known locations.

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Seeds are generally long lived and probably form a persistent dormant seed bank. Very slow microbial decomposition or long term erosion of the seed coat from sand scarification is the likely route for germination. This species has a very low burial tolerance and does not survive in accreting foredune formations. In addition, Dr. Knight believes that historically, large storms moved extensive areas of sand and brought deeply buried seeds to the surface where they could germinate (USFWS, 2009).

Population Information and Trends**Number of Populations:**

6 - 20 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

The nineteen extant populations consist of 433 individuals (Fish and Wildlife Service 1997).

Known from nineteen extant populations (Fish and Wildlife Service 1997). (NatureServe, 2015)

Threats and Stressors

Stressor: Commercial and residential development (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Commercial and residential development along coastal communities continues to be the primary threat to habitat loss while trampling from hikers and livestock, and dune stabilization from invasive species are also contributing threats. These threats are considered to be current and foreseeable and this factor is still valid (USFWS, 2009).

Stressor: Predation (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Disease is currently not considered a threat to the species; however, predation from small mammals is considered to be a new current and foreseeable threat factor in this analysis. It is recommended that this threat be addressed in the recovery delisting criteria number 3 (Habitat and populations will be free of invasive weeds) as invasive weeds provide shelter for the mammals who prey on the seeds of *L. tidestromii* (USFWS, 2009).

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The Endangered Species Act is the primary Federal law that provides protection for this species since its listing as endangered in 1992. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act. Therefore, we continue to believe other laws and regulations have limited ability to protect the species in absence of the Endangered Species Act (USFWS, 2009).

Stressor: Hybridization (USFWS, 2009)

Exposure:

Response:

Consequence: Extirpation

Narrative: Hybridization from *L. chamissonis* in the Monterey Peninsula is considered to be a new, current and foreseeable threat factor in this analysis. This new threat was not considered in the original listing for *Lupinus tidestromii* and should be considered a new recovery criterion for the Monterey Peninsula populations (USFWS, 2009).

Stressor: Invasive species (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Invasive species continue to be a very significant threat with habitat loss and hybridization. The threat of invasive species is currently being addressed and managed on protected sites; however, unsecured private lands have no protection against such threats (USFWS, 2009)

Stressor: Trampling (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Trampling by both humans and livestock is considered a threat to this species (USFWS, 2009)

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Impacts to the species under predicted future climate change are unclear. Current forecasts of warming are expected to raise mean temperatures and sea levels along of coast of western North America (IPCC 2007). While it appears reasonable to assume that the species may be affected, we have no knowledge of more detailed climate change information or literature specifically for this species. We lack sufficient information to predict with certainty the extent of effect that climate change along the California coast will have on the species. We do not know when or how the changes may occur, the potential changes to the ecosystem, or the level of threat posed by seasonal changes, rising mean temperatures and rising sea levels on the habitat (USFWS, 2009).

Recovery

Reclassification Criteria:

Secure habitat for the species at current known occurrences (USFWS, 2009).

Management measures at the secured habitat locations (USFWS, 2009).

Monitoring of recovery for the secured habitat locations (USFWS, 2009).

Additional restored habitat (USFWS, 2009)

Delisting Criteria:

15 years of monitoring (USFWS, 2009).

Reintroduced populations within historic range through natural means (USFWS, 2009).

Habitat and populations will be free of invasive weeds (USFWS, 2009).

Average of 10,000 individuals and progress toward the eradication of beach grass and iceplant at PORE (USFWS, 2009).

Private land occurrences protected, endowments secured and managed for recovery (USFWS, 2009).

Historic populations at Dillon Beach are restored and occupied (USFWS, 2009).

Recovery Actions:

- **Reclassification criteria:** Is the criterion valid and have they been addressed: Yes, the criterion is still valid and is being addressed. Habitat at PORE, ASB and SCSB has been secured for the species; however, these current protections are not permanent. Point Reyes National Seashore has designated the majority of areas that contain *Lupinus tidestromii* and other federally listed plants as “wilderness” providing protection under the National Parks Service regulations regarding wilderness. This encompasses approximately 33,000 acres and contains greater than 50 percent of the individuals as of the 2008 census (PORE LUTI report 2008). This percentage varies yearly depending on stochastic population fluctuations. Asilomar State Beach has designated 25 acres of dune habitat that contain *L. tidestromii* and other listed species as a Natural Dune Preserve under the California State Parks regulations and is protected by such definition. From a census conducted in 2000 the preserve contains approximately 40 percent of the genetically pure (unhybridized) individuals on ASB (Madison, pers. comm. 2009). A new comprehensive census for *L. tidestromii* is being conducted in 2009 and will include a determination of pure and hybrid populations. Although the “wilderness” and “Dune Preserve” designations provide a higher level of protection for the listed plant and its habitat, these protections can be changed or altered through a policy change or redesignation. Sonoma Coast State Beach currently has no extra protections for the areas that contain the listed plant other than those provided by the California State Parks regulations regarding protected species on State Parks lands. Pebble Beach and Spanish Bay golf courses have protected habitat with a mitigation agreement from the private land owner. The City of Carmel has designated the North Dune an Environmental Sensitive Habitat Area (ESHA). This designation does not provide any physical protections for the plant; however, it does provide limited protection against development unless this designation is removed or changed. Several private land occurrences on the Monterey Peninsula still remain unprotected. This private land protection on the Monterey Peninsula was a criterion in the Recovery Plan; however, this criterion for private land occurrences may not be feasible at this time with the threat of hybridization in the Monterey Peninsula populations. Listing factors addressed: (Factor A) Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range, (Factor E) Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2009). **Delisting Criteria:** Is the criterion valid and have they been addressed: Yes, the criterion is still valid and is being addressed; however, they are not complete. Monitoring efforts at PORE, SCSB and ASB are currently in their 8th year and are planned through 2015. Monitoring on public and private land occurrences are being performed through public city efforts; however no plan has been enacted or planned through a future date. Monitoring has also been done sporadically by California Native Plant Society (CNPS) for the Monterey Peninsula populations on private land when access has been granted. Listing factors addressed: (Factor A) Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range, (Factor D)

Inadequacy of Existing Regulatory Mechanisms, (Factor E) Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2009).

- Reclassification criteria: Is the criterion valid and have they been addressed: Yes, the criterion is still valid and is currently being addressed. Management measures are not permanent and could be altered or withdrawn depending on the status of the protections afforded the species. Management for recovery of the species has been implemented for the secured habitat sites at PORE, SCSB and ASB. Point Reyes National Seashore is under management through National Parks Service and SCSB and ASB are under management through California State Parks. Management plans have been written for all three locations through their respective agency with regards to recovery of the species and include reduction of effects from recreation use of the parks, invasive plants removal, and dune restoration efforts. Pebble Beach and Spanish Bay golf courses in Monterey County also have management plans for the continued conservation and protection of the plant on their respective properties. The City of Carmel North Dune is not considered a secured habitat, but the city has adopted several shoreline management plans and is currently in the process of creating a long term management plan for the North Dune population. Listing factors addressed: (Factor A) Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range, (Factor D) Inadequacy of Existing Regulatory Mechanisms, (Factor E) Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2009). Delisting Criteria: Is the criterion valid and have they been addressed: The criterion is still valid and is being addressed; however, no new occurrences beyond the extent of the populations described from the time of listing and in this review have been identified. The populations at PORE and SCSB have increased in individual numbers since the time of listing, but naturally reintroduced populations on the Monterey Peninsula are generally hybrids and currently being removed. Listing factors addressed: (Factor A) Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range, (Factor E) Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2009).
- Reclassification criteria: Is the criterion valid and have they been addressed: Yes, this criterion has been met and has been addressed. Monitoring for recovery has been implemented at the PORE, SCSB, and ASB secured habitat sites. Research efforts by Dr. Knight and her colleagues include extensive monitoring at PORE. Monitoring for SCSB is being conducted currently by State ecologist Brendan O'Neil. Point Reyes National Seashore monitoring includes individual population counts, observing for invasive plants, small mammal predation, habitat and plant (*L. tidestromii*) condition. Sonoma Coast State Beach populations are being monitored for rough population counts, effects from human recreational use, habitat and plant (*L. tidestromii*) condition. Asilomar State Beach is being monitored for rough population counts, effects from human recreational use, and hybridization effects. Pebble Beach and Spanish Bay golf courses have private monitoring in accordance with the mitigation agreement which includes monitoring for rough population stands. The City of Carmel North Dune is not considered a secured habitat; however, the population has been monitored and the City's ESHA designation has general monitoring incorporated in the program. This monitoring effort is superficial; it is not guaranteed and is not specific for the listed plant. Listing factors addressed: (Factor A) Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range, (Factor D) Inadequacy of Existing Regulatory Mechanisms, (Factor E) Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2009). Delisting Criteria: Is the criterion valid and have they been addressed: Yes, the criterion is still valid and is being addressed. At the time of listing there was no substantial dune restoration or invasive weed removal efforts. Currently,

extensive dune restoration efforts are ongoing at PORE. Sonoma Coast State Beach and ASB are conducting minor dune restoration efforts and continual invasive weed removal. Although these efforts have been enacted, invasive weeds have not been completely removed at any of these locations and will most likely be a continual threat. Listing factors addressed: (Factor A) Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range, (Factor E) Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2009).

- Reclassification criteria: Is the criterion valid and have they been addressed: Yes, additional restored habitat is being created at the PORE and SCSB sites to extend the range of *Lupinus tidestromii* at those sites. Dune restoration efforts are being conducted on several sites along the California coast; however no restoration efforts specifically for *L. tidestromii* are being conducted. The seed life for *L. tidestromii* is considerably long, so these other dune restoration efforts may provide new occurrences for *L. tidestromii* provided there is a viable seed bank. Listing factors addressed: (Factor A) Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range, (Factor D) Inadequacy of Existing Regulatory Mechanisms, (Factor E) Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2009). Delisting Criteria: Is the criterion valid and have they been addressed: Yes, the criterion is still valid and is being addressed. Efforts are currently being conducted and progress towards both criteria has shown positive trends toward meeting recovery. The largest population, located near Abbott's Lagoon is estimated to have over 100,000 individuals, and this number has persisted since 2001. The dunes near Abbott's Lagoon have received a great deal of restoration attention from 2002-2006 (*Ammophila arenaria* removal). The second largest population, located on the dunes west of the Mendoza Ranch, was estimated at 32,528 individuals in 2003 whereas a 2007 census by Dr. Knight et al. estimated 11,668 individuals. The third largest population at PORE, located on the dunes near the Davis residence declined from 982 individuals in 2003 to 159 individuals in 2007, likely due to encroachment of iceplant. Removal of beach grass and iceplant surrounding this population was conducted in July 2008 through the mechanical removal of the beach grass (digging 3m into the ground and overturning this invasive grass) and hand removal of the iceplant. Listing factors addressed: (Factor A) Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range, (Factor E) Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2009).
- Delisting Criteria: Is the criterion valid and have they been addressed: Yes, securing private lands for recovery is still a valid criterion; however, with the current information regarding the hybridization and until the threat of hybridization can be addressed this criterion may become obsolete for the Monterey Peninsula populations unless genetically pure individuals can be reintroduced. No private land occurrences other than Pebble Beach and Spanish Bay golf courses are currently or under process for endowment or managed for recovery at the time of this review. Listing factors addressed: (Factor A) Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range, (Factor D) Inadequacy of Existing Regulatory Mechanisms, (Factor E) Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2009).
- Is the criterion valid and have they been addressed: Yes, the criterion is still valid; however, currently no efforts are being made at Dillon Beach for the reintroduction of *Lupinus tidestromii*. This criterion would be considered vital to the expansion of the species. Dillon Beach provides highly suitable habitat, but is under threat of development and high human usage. More controlled conservation measures would need to be enacted before reintroduction could take place naturally or through manned efforts. Listing factors

addressed: (Factor A) Present or Threatened Destruction, Modification, or Delisting Criteria: Curtailment of Habitat or Range, (Factor D) Inadequacy of Existing Regulatory Mechanisms, (Factor E) Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2009).

Conservation Measures and Best Management Practices:

- Continue Dune restoration and eradication of invasive plants at PORE and SCSB (USFWS, 2009).
- Continue monitoring at PORE, SCSB and ASB. Establish structured monitoring plan for Monterey Peninsula populations on private lands (USFWS, 2009).
- Secure further conservation easements and/or acquire lands for protection of Monterey Peninsula populations (USFWS, 2009).
- Continue research of hybridization and seed predation threats (USFWS, 2009).
- Conduct accurate census of the Monterey private land occurrences (USFWS, 2009).
- Examine and implement dune restoration efforts for repopulation at Dillon Beach (USFWS, 2009).

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SPECIES ACCOUNT: *Lyonia truncata* var. *proctorii* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 4/27/1993; Southeast Region (R4) (USFWS, 2015)

Physical Description

A perennial evergreen shrub which may reach up to 2 meters in height. The leaves are alternate, elliptic to ovate, coriaceous, and from 0.9 to 4.5 centimeters long and 0.4 to 2.3 centimeters wide. The leaf margins may be toothed and the lower surface is sparsely to moderately lepidote and moderately to densely pubescent. The inflorescences are fasciculate with from 2 to 15 flowers. Pedicels are from 2 to 5 millimeters in length and sparsely pubescent. Flowers are small (0.7 to 1.5 millimeters in length), white, and urn-shaped. The fruit is a dry capsule, 3 to 4.5 millimeters in length and 2.5 to 4 millimeters in width, sparsely pubescent, and contains seeds approximately 2.5 millimeters in length (USFWS, 1994).

Taxonomy

In the family Ericaceae, one of 3 varieties (USFWS, 1994).

Historical Range

See current range/distribution.

Current Range

Endemic to Puerto Rico and are known to occur only in the summit area of Cerro Mariquita in the Sierra Bermeja, municipality of Cabo Rojo. Elevations range from 270 to 300 meters (USFWS, 1994). In 2013, two new localities of *L. truncata* var. *proctorii* were reported during surveys at La Tinaja Tract by Morales-Pérez (2013). These localities (lower slopes) were estimated with a total of 280 individuals; about 80 percent of those individuals were recorded within the LCNWR land (La Tinaja), and 20 percent were documented southwest of the property in an adjacent private land known as Lozada Farm (Morales-Pérez 2013). Morales-Pérez (2013) reported a third locality of the species in the upper slope at Cerro Mariquita where the species was originally reported. In 2016, Service biologists visited the northwest section of the Finca Lozada and observed around 49 individuals of *L. truncata* var. *proctorii* (C. Pacheco, Service, unpublished data, 2016). Overall, the population is characterized as old population structure (composed of only mature plants) with no evidence of natural recruitment in the wild (O. Monseguir-Rivera, Service, 2018, pers. comm.). (USFWS, 2019).

Critical Habitat Designated

Yes;

Life History**Food/Nutrient Resources****Breeding Season**

Adult: Flowering in October, April, and May (EPA, 2016)

Key Resources Needed for Breeding

Adult: Insects for pollination (EPA, 2016)

Reproduction Narrative

Adult: Species is insect pollinated, with flowering observed in October, April, and May (EPA, 2016). Little additional information is available about reproductive biology (inferred from USFWS, 2010)

Habitat Type

Adult: Terrestrial (USFWS, 1994)

Habitat Vegetation or Surface Water Classification

Adult: Subtropical dry forest life zone (USFWS, 1994)

Geographic or Habitat Restraints or Barriers

Adult: 270 to 300 meters; extremely steep slopes (USFWS, 1994)

Habitat Narrative

Adult: Habitat is described as subtropical dry forest life zone (USFWS, 2010). Found at 270 to 300 meters elevation, on extremely steep slopes. Soils have been described as Guayama cherty clay loam, 20 to 60 percent slopes, a soil series which covers most of the steep slopes of the Sierra Bermeja. This soil is from 14 to 30 centimeters deep to weathered siliceous rock and is acid in nature (USFWS, 1994).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Little information is available about dispersal mechanisms (inferred from USFWS, 2010)

Population Information and Trends**Population Trends:**

Not available.

Species Trends:

Stable (USFWS, 2010)

Resiliency:

Low (inferred from USFWS, 2010)

Representation:

Low (inferred from USFWS, 2010)

Redundancy:

Low (inferred from USFWS, 2010)

Population Growth Rate:

Slow (inferred from USFWS, 2010)

Number of Populations:

1 (USFWS, 2010)

Population Size:

63 (USFWS 2010)

Population Narrative:

The Service considered the species status as stable. In 1991, Proctor conducted a population survey on the species, estimating 63 individuals in two subpopulations located on the eastern and northwest cliffs of Cerro Mariquita. Breckon and Kolterman (1994) concluded that this population size may be underestimated by 50% due to difficulties to access the population (extremely steep slopes). On January 21, 2008, Service biologists conducted a preliminary survey on the species finding only 13 individuals on the eastern cliffs of Cerro Mariquita. On February 19, 2009, Service biologist visited the northwest subpopulation estimating the population at around 12 individuals. Because the areas where the species is located are very difficult to access and localities reported by Proctor (1991) and Breckon and Kolterman (1994) are unclear, comprehensive surveys with secure rappelling equipment should be conducted to establish the overall status of the species. However, during the last three years changes in land use and habitat conditions have not been documented at the Cerro Mariquita area (USFWS, 2010).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Grazing induced habitat modification, dispersal of invasive grass species, predation of seedlings and saplings, and land clearing pose a serious threat (USFWS, 2010). When *Lyonia truncata* var *proctorii* - was listed in 1993, the Service identified habitat destruction and modification as one of the factors affecting the continued existence of the species. At that time, these three species were found in Sierra Bermeja, a privately owned site subjected to agricultural, rural and tourist development. In addition, the final rule for *pelos del diablo* also identified proposed copper and gold mining as a threat to the species in Cerro Las Mesas. In 1996, DOI acquired La Tinaja Farm (LTF) in the Sierra Bermeja mountain range. The Service incorporated this land to the Cartagena Lagoon National Wildlife Refuge, protecting 50% of the known populations of *Lyonia truncata* var *proctorii*, approximately 80% of the known individuals of *Vernonia proctorii*, and its suitable habitat, and about 50% of the populations of *A. chaseae* and *pelos del diablo*. However, the remaining individuals of these species in Sierra Bermeja are located in the adjacent Cerro Mariquita area, which remains under private ownership. Although the Cerro Mariquita area was classified by the Puerto Rico Planning Board as a District of Conservation Resource 1 (CR1) (the most restrictive for development, precluding tourist and residential development and mining activities), this classification allows agricultural (e.g. cattle grazing) and rural developments (one house in 25 acres of land). In 2006 and 2007, private landowners cut new roads to gain access through their properties to the peak of Cerro Mariquita affecting indeterminate amount of habitat for these species (Pacheco, USFWS 2009, field observations). (USFWS, 2019).

Stressor: Other natural or man-made factors (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: The species is currently threatened by competition from exotic grasses, human-induced fires, and landslides (USFWS, 2010).

Stressor: Limited distribution (USFWS, 2019).

Exposure:**Response:****Consequence:**

Narrative: *Lyonia truncata* var *proctorii* is only found in a limited area on the edge of a precipice of the upper Jurassic chert in Cerro Mariquita. Any seismic event in this area and heavy rain that result in a landslide may affect a significant portion of the population. In September 2009, the Service observed three landslides at the Cerro Mariquita due to the heavy rain. (USFWS, 2019)

Recovery**Reclassification Criteria:**

1. The known populations on privately owned land in Sierra Bermeja are placed under protective status (USFWS, 2010)
2. New populations (the number of which should be determined following the appropriate studies) capable of self-perpetuation have been established within protected areas, such as the Cabo Rojo National Wildlife Refuge (USFWS, 2010)

Delisting Criteria:

Not available.

Recovery Actions:

- Prevent further habitat loss and population decline (USFWS, 1994)
- Gather information on the distribution and abundance in southwestern Puerto Rico (USFWS, 1994).
- Conduct research to define habitat requirements, reproductive biology/ecology, and propagation techniques (USFWS, 1994)
- Establish new populations (USFWS, 1994)
- Better define, and possibly modify, recovery goals as additional information on the biology, ecology, propagation, and management is accumulated (USFWS, 1994).
- Protection of currently known natural populations occurring on privately owned lands by establishing long-term conservation mechanisms such as Habitat Conservation Plans (HCP), conservation easements and conservation agreements with the landowners. (USFWS, 2019).
- Develop conservation and management plans with landowners that includes education on species description and needs and fire management. (USFWS, 2019)
- Establishment of new populations on protected lands within the Sierra Bermeja or other suitable habitats in southwestern Puerto Rico. (USFWS, 2019).

Conservation Measures and Best Management Practices:

- Revise the recovery plans to include new information on the species and the development of measurable criteria for delisting the species (USFWS, 2010).
- Conduct comprehensive surveys at Sierra Bermeja to determine relative abundance and distribution (USFWS, 2010).
- Promote Conservation agreements with private landowners to protect and enhance existing populations (USFWS, 2010).
- Work closely with private landowners in the Sierra Bermeja mountain range and Peñones de Melones to protect individuals on private lands from existing agricultural practices and control exotic grasses (USFWS, 2010).
- Implement fire prevention practices in Sierra Bermeja, CNRWR and Peñones de Melones during dry season (USFWS, 2010).
- Continue to provide technical assistance to Service's Refuge Division for the development of the CCPs for CRNWR and LCNWR and to address current threats within the refuge (USFWS, 2010).
- Conduct comprehensive studies on habitat requirements, phenology, and recruitment success of the species in the wild (USFWS, 2010).
- Determine the number of self-sustainable populations needed to delist the species (USFWS, 2010).
- Additional surveys should be conducted in Puerto Rico (USFWS, 2010).
- Continue protecting existing populations and their habitat (USFWS, 2010).

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SPECIES ACCOUNT: *Lysimachia asperulaefolia* (Rough-leaved loosestrife)

Species Taxonomic and Listing Information

Listing Status: Endangered; 7/13/1987; Southeast Region (R4)

Physical Description

A perennial rhizomatous herb, with erect stems 30 to 60 centimeters (cm) tall. Leaves are sessile in whorls of 3 to 4, are broadest at the base (0.8 to 2 cm wide), and have three prominent veins. The upper surface is deep yellow-green or blue-green and lustrous; the leaf margins are entire and slightly revolute (Figure 1). The yellow bisexual flowers are borne in a loose, cylindrical, terminal raceme, 3 to 10 cm long. The corolla is 1.5 cm across. There are usually five petals that have ragged margins near the apex and that have dots or streaks. The anthers are yellow-orange, and the style tapers to the simple stigma. The fruit is a capsule. Stipitate glands are usually present on most parts of the plant. Flowering is from late May to early June. Seeds are formed by August, but capsules do not dehisce until October. Although the plants are dormant in the winter, they are easy to find in the fall because of the distinctive leaf pattern and the reddish color of the leaves. (USFWS, 1995)

Taxonomy

Lysimachia asperulaefolia was described by Jean Louis Marie Poiret in 1814. Since listing as endangered in 1987, there have been no changes to the nomenclature of the species, however some references now spell the specific epithet as “*asperulifolia*” an orthographic variant of “*asperulaefolia*.” In addition, in the listing documents and the Recovery Plan, the common name is referred to as Rough-leaved Loosestrife; however, some references use the common name Rough-leaf Loosestrife. Ironically, the leaves are actually smooth in texture. The genus *Lysimachia* is now considered to be part of the Myrsinaceae family and not the Primulaceae family (Weakley 2012). (USFWS, 2014)

Historical Range

Southern coastal plain and sandhills of North Carolina and the sandhills of South Carolina. (USFWS, 1995)

Current Range

Southern coastal plain and sandhills of North Carolina and the sandhills of South Carolina. Twelve counties in North Carolina; one county in South Carolina. (USFWS, 2014)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Flowering is from late May to early June (USFWS, 1995).

Reproduction Narrative

Adult: The first spring shoots of *L. asperulaefolia* appear in late March or early April. Flowering begins in late May and extends through mid to late June. *L. asperulaefolia* is an obligate out-crossing species, pollinated by solitary bees: most of the pollinators are in the genus *Dialictus*. Pollinators were found to be scarce and inefficient, perhaps contributing to low natural fruit and seed set. Fruit and seed set were much higher when flowers were artificially pollinated (Frantz 1984). Another possible explanation for low fruit and seed set is that populations are highly clonal, with several shoots arising from one rhizome. Since self-fertilization does not occur, pollinator activity among ramets would not result in seed set. Fruits are visible within 3 weeks of fertilization, but capsules do not dehisce until October. An average of 3.2 capsules are produced by flowering stems, with an average of less than two seeds per capsule. In one germination trial, 85 percent of the seeds germinated (Frantz 1984). While fruit and seed set are low, this is not unusual for a perennial species that apparently has a life strategy based largely on rhizomatous growth and therefore does not depend upon sexual reproduction and seedlings for short-term survival (USFWS, 1995). Flowering is from late May to early June. Seeds are formed by August, but capsules do not dehisce until October (USFWS, 1995).

Spatial Arrangements of the Population

Adult: Clumped (inferred from NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Rough-leaf loosestrife occurs most often in ecotones between longleaf pine uplands and pond pine pocosins in moist, sandy or peaty soils with low vegetation that allows for abundant sunlight to the herb layer (USFWS 1993). Fire is primarily responsible for maintaining low vegetation in these ecotones which have been documented to occur between the following habitat types: longleaf pine savanna and pocosin; longleaf pine flatwood and pocosin; longleaf pine savanna and mixed herb; longleaf pine-pond pine and evergreen shrub; longleaf pine/wiregrass savanna and Carolina bay pocosin; Streamhead Pocosin and Pine/Scrub Oak Sandhill; and Sandhill Seep and Pine/Scrub Oak Sandhill (NCNHP 1993). This species often spreads from the ecotone into the open edges of the bordering habitats, for example into longleaf pine savannas and low shrub communities of Carolina bays. Other habitats and community types in which it has been found include: Low Pocosin, High Pocosin, Wet Pine Flatwoods, Pine Savanna, Streamhead Pocosin, and Sandhill Seep (Schafale and Weakley 1990), as well as creek flood basins, pond and lake margins, boggy seeps and meadows, boggy pools in shrub pocosins, and disturbed areas such as roadside depressions, powerline rights-of-way, firebreaks, and trails. In the NC Sandhills, *Lysimachia asperulifolia* prefers to be in lower parts of the ecotone, well within the shrub zone, even when such ecotones are well-burned. On Fort Bragg, a sizeable occurrence was found in a shrub ecotone/pocosin that had burned within four

months of its discovery; most shrubs there had been 2 meters or more tall prior to burning. Low Pocosins occur in areas with deep peat overlaying wet sands and in Carolina bays. They are nutrient-poor, seasonally saturated, and dominated by a dense shrub layer, kept small by low nutrients and severe fires. *L. asperulifolia* occupies openings in the dense shrub layer (USFWS 1993). Rough-leaf loosestrife is also found in the ecotones between Wet Pine Flatwoods or Pine Savannas and High Pocosins where the water table is near the surface during winter and early spring. If burned, these ecotones remain open with characteristic grasses, herbs, and low shrubs (USFWS 1993) (NatureServe, 2015). Clumped spatial arrangement of the population, high ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: No information available.

Population Information and Trends

Population Trends:

See narrative.

Number of Populations:

148 in NC and 1 in SC (USFWS, 2014)

Population Narrative:

Since 2000, land managers have monitored sub-populations at 62 different sites within nine population centers. Kristopher Voss, a Duke University graduate student, conducted a preliminary PVA using Bayesian State-Space Models on the monitoring data collected from 2000 to 2012. Based on his analysis, it appears that two populations are increasing, two populations are stable, five populations are estimated as declining and the trends at one population are undeterminable with the current amount of monitoring data available. (USFWS, 2014)

Threats and Stressors

Stressor: Development (USFWS, 2014)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Residential and commercial development are listed as threats to this species (USFWS, 2014).

Stressor: Road construction (USFWS, 2014)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Road construction is listed as a threat to this species (USFWS, 2014).

Stressor: Silviculture (USFWS, 2014)

Exposure:**Response:****Consequence:** Loss of habitat**Narrative:** Silviculture (pine plantations) are listed as a threat to this species (USFWS, 2014).**Stressor:** Wetland draining/filling (USFWS, 2014)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** Wetland draining and/or filling are listed as threats to this species (USFWS, 2014).**Stressor:** Herbicide use (USFWS, 2014)**Exposure:****Response:****Consequence:** Loss of individuals**Narrative:** Herbicide use, especially on road shoulders and powerline rights of way has potential to quickly cause negative impacts to this rhizomatous perennial (USFWS, 2014).**Stressor:** Herbivory (USFWS, 2014)**Exposure:****Response:****Consequence:** Loss of individuals**Narrative:** Herbivory (likely by deer) is listed as a threat to this species (USFWS, 2014).**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2014)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** At the time of federal listing, this species was also listed as state endangered by the State of North Carolina under the Plant Protection and Conservation Act of 1979 (North Carolina Code Article 19B, § 106-202.12; NC Act). The NC Act provides limited protection from unauthorized collection and trade of plants listed under that statute. However, the statute does not protect the species or its habitat from destruction in conjunction with development projects or otherwise legal activities (Robinson and Finnegan 2014). The NC Act authorizes the NC Plant Conservation Program to establish nature preserves for protected species and their habitat, but that agency has not yet created any nature preserves for this species (USFWS, 2014).**Stressor:** Fire suppression (USFWS, 2014)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** Fire suppression was also identified as a serious threat. The lack of fire in the habitat where this species occurs allows woody species to grow and compete for sunlight, eventually shading out this low growing species. The exclusion of fire also affects nutrient cycling and insect populations (USFWS, 2014).**Stressor:** Small population size (USFWS, 2014)**Exposure:**

Response:**Consequence:** Loss of populations**Narrative:** Populations that are small in size and number of individual plants are vulnerable to stochastic events (USFWS, 2014).***Recovery*****Reclassification Criteria:**

1. Management plans have been prepared and are being implemented for all publicly owned population centers and those owned by The Nature Conservancy (USFWS, 1995)
2. Populations at these centers have been monitored for at least 5 years and are determined to be stable. (USFWS, 1995)

Delisting Criteria:

1. When the reclassification criteria are met and a binding management agreement for each population center is in place (USFWS, 1998)

Recovery Actions:

- 1. Protect significant sites and adjacent habitat. - Map all sites and mark sites in the field (except where there is ready public access and where signs would increase the threat of collecting): include in the marked area the adjacent habitat and buffer. - Map and search appropriate habitat for new sites within each population center. - Prepare a management plan for each population center. (USFWS, 1995)
- 2. Conduct research to more fully understand habitat conditions, fire frequency effects, seedling recruitment, genetic diversity among and within sites and population centers, population dynamics, and reestablishment techniques. (USFWS, 1995)
- 3. Enforce laws protecting the species and its habitat. Provisions of the Endangered Species Act of 1973, as amended, will be enforced. North Carolina regulations prohibit taking a protected species from private property without the landowner's written permission and a State permit. However, at this time the collection of *L. asperulaefolia* plants ~ not the major threat to the species' continued survival. In meeting their responsibilities under the Endangered Species Act, the military services involved have developed guidance directing certain actions with respect to listed species occurring on their bases. Implementation of these policies and directives should continue. (USFWS, 1995)
- 4. Reintroduce the species into historic habitat. In cooperation with the North Carolina Botanical Garden and the Center for Plant Conservation, plants should be propagated and a program of reintroduction should be initiated. Historic sites, such as the proposed Minnesott Ridge-Prescott Ridge Natural Area in Pamlico County, would be ideal sites for this program. Plants introduced into such an area should derive from the same population center, when possible, or from a nearby population source, unless genetic analyses indicate that inbreeding is a problem within populations. The genetic analysis will assist in determining appropriate reintroduction source material. (USFWS, 1995)
- 5. Negotiate binding management agreements. In order to ensure the survival of this species and proceed with delisting, permanent binding management agreements should be negotiated between the Service and landowners. The North Carolina Plant Conservation Program or North Carolina Natural Heritage Program should assist the Service in monitoring these agreements. (USFWS, 1995)

- 6. Conduct public information and education activities. News releases concerning the status and significance of the species and recovery efforts should be prepared and distributed to newspapers on the coastal plain and in the sandhills area. Cooperation with military bases should be sought: this would be a positive public relations opportunity for them. State agencies managing lands where *L. asperulaefolia* occurs should prepare/distribute brochures and offer educational hikes to sites where this would be appropriate. (USFWS, 1995)
- 7. Annually review the recovery efforts. The Service, North Carolina Plant Conservation Program, North Carolina Natural Heritage Program, and South Carolina Heritage Trust should meet annually with the managers of *L. asperulaefolia* sites to assess progress toward the recovery goals, review new information, assign any new sites to a new or existing population center, evaluate and coordinate programs planned for the coming year, and, if necessary, redirect monitoring or management actions. (USFWS, 1995)

Conservation Measures and Best Management Practices:

- Revisit known populations that have not been visited in the past three years, especially those populations that have been ranked as F (Failed to Find) or H (Historic) in the NCNHP database; monitor the condition of the habitat at each site including threats; discuss conservation options with landowners where appropriate; report the results of these site visits to the appropriate Heritage Program (USFWS, 2014).
- Search for additional populations in appropriate habitat (USFWS, 2014).
- Prioritize known sites for protection and identify recovery populations (USFWS, 2014).
- Protect additional populations (USFWS, 2014).
- Identify those populations that would contribute the most toward recovery (self-sustaining, protected, etc.) as recovery populations (USFWS, 2014).
- Determine which sites have management plans and how they are being implemented (USFWS, 2014).
- Develop and implement management plans for all remaining protected populations (USFWS, 2014).
- Determine the management techniques for sustaining populations, such as fire frequency and seasonality (USFWS, 2014).
- Update monitoring protocols and remind land managers about their commitment to monitoring this species on their property, continue to analyze monitoring data using PVA or other accepted methods (USFWS, 2014).
- Complete a population genetic analysis as suggested by Edwards (2007) (USFWS, 2014).
- Organize a meeting of land managers, researchers and other interested parties to discuss the long-term recovery of this species (USFWS, 2014).
- Work with NC Botanical Garden to conserve germplasm and further develop propagation and transplantation protocols (USFWS, 2014).

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SPECIES ACCOUNT: *Lysimachia daphnoides* (lehua makanoe)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (R1) (USFWS, 2016)

Physical Description

A small shrub forming clumps 2 - 5 dm tall. Leaves are closely spaced. Flowers are solitary in the leaf axils. Corollas are dark purple or dark burgundy (NatureServe, 2015).

Taxonomy

A member of the myrsine family (Myrsinaceae) (USFWS, 2010b). This is a nearly cosmopolitan genus (NatureServe, 2015).

Historical Range

Historically, *L. daphnoides* was known from the more southerly mountains of Kauai, including the Wahiawa drainage and ridges, in what is now the Lihue-Koloa Forest Reserve (HBMP 2007) (USFWS, 2010b).

Current Range

Currently, this species is found in the Alakai Wilderness Preserve and the Na Pali Kona Forest Reserve (Kauai) (USFWS, 2010b).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Lysimachia daphnoides* (lehua makanoe) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Lysimachia daphnoides* includes three CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Montane Wet—Section 1: Montane Wet—Section 1 consists of 13,055 ac (5,257 ha) in the montane wet ecosystem, extending across the Alakai Plateau from Hanakoa to Mount Waialeale, on State (12,628 ac, 5,110 ha) and privately owned (427 ac, 173 ha) land in the Na Pali Coast State Park, the Alakai Wilderness Preserve, the Na PaliKona and Halelea forest reserves, and Hono o Na Pali NAR (Figure 4). It is occupied by the plants *Astelia waialealae*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *K. helenae*, *Labordia helleri*, *L. pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, and *Platydesma rostrata*; by the akekee and akikiki; and by the picture-wing fly. This section also contains unoccupied habitat that is essential to the conservation of these 18 species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the montane wet forest, the moisture regime, and canopy, subcanopy, and understory plant species

identified as PCEs in the montane wet ecosystem (Table 3), and the species-specific PCEs including (1) bogs (identified as PCEs for *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*) (2) bog hummocks (identified as PCEs for *Astelia waialealae* and *Lysimachia daphnoides*); (3) arthropod prey (identified as PCEs for the akekee and the akikiki); and (4) larval-stage host plants, *Cheirodendron* and *Tetraplasandra* sp., (identified as a PCE for the picture-wing fly). Although Montane Wet–Section 1 is not known to be occupied by the plants *Dubautia kalalauensis*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, those portions of the section that overlies previously designated critical habitat fall within two existing Critical Habitat Units of 50 CFR 17.99(a)(1): Unit 10, Map 35a; and Unit 11, Map 64a. The previously undesignated land comprises Unit 23, Map 217f; and Unit 24, Map 217g. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 4–Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 4–Montane Wet).

Kauai—Montane Wet—Section 2: Montane Wet–Section 2 consists of 790 ac (320 ha) in the montane wet ecosystem, extending from Kahuamaa Flat south to the edge of Waimea Canyon, on State-owned land in Kokee State Park (Figure 4, above). The entire section is within previously designated critical habitat, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Dubautia kalalauensis*, *Labordia helleri*, *Melicope puberula*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*, and by the akekee. This section includes montane wet forest, potentially some small-scale boggy areas, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and arthropod prey (identified as a species-specific PCE for the akekee). Although Montane Wet–Section 2 is not known to be occupied by the plants *Astelia waialeale*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialeale*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *Myrsine mezii*, and *Phyllostegia renovans*; by the akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. This area also supports the arthropod prey identified as a PCE for the akikiki, and the larval-stage host plants (*Cheirodendron* and *Tetraplasandra* spp.) identified as a PCE for the picturewing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within previously designated Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 5–Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 5–Montane Wet).

Kauai—Montane Wet—Section 3: Montane Wet–Section 3 consists of 413 ac (167 ha) in the montane wet ecosystem, encompasses the summit of Namolokama, on State (156 ac, 63 ha) and privately owned (257 ac, 104 ha) land in the Halelea Forest Reserve (Figure 4, above). It is entirely within previously designated critical habitat, and is occupied by the plants *Keysseria erici* and *Labordia pumila*. This section includes the montane wet forest, the moisture regime, and the canopy, subcanopy, and understory plant species identified as PCEs in the montane wet

ecosystem (Table 3), and bogs (identified as a species-specific PCE for *K. erici*). Although Montane Wet–Section 3 is not known to be occupied by the plants *Astelia waialeale*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia kalalauensis*, *D. waialeale*, *Geranium kauaiense*, *Keysseria helenae*, *Labordia helleri*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*; by the akekee and akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. It also supports the arthropod prey identified as a PCE for the akekee and akikiki, and the larval-stage host plants (*Cheirodendron* and *Tetraplasandra* spp.) identified as a PCE for the picture-wing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 6–Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 6–Montane Wet).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Lysimachia daphnoides* critical habitat consists of one component (Montane wet). Species-specific PCEs include: Hummocks in bogs (75 FR 18960-19165):

Ecosystem: Montane Wet. Elevation: 3,000–5,243 ft (914-1,598 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within

each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available

Habitat Type

Adult: Wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Montane Metrosideros polymorpha mixed bogs (USFWS, 2010b and NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 3,960 - 4,440 ft. elevation (USFWS, 2010b)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: Montane bogs in wet forests, usually in the cloud zone. The environmental specificity is unknown (NatureServe, 2015). It is found in Metrosideros polymorpha mixed bogs on hummocks, at elevations between 3,960 and 4,440 ft. (1,207 and 1,353 m) in the montane wet ecosystem (Marr and Bohm 1997, p. 265; Wagner et al. 1999, p. 1,080; HBMP 2007; TNCH 2007) (USFWS, 2010b).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Declining (USFWS, 2017)

Species Trends:

Stable (NatureServe, 2015)

Resiliency:

Very low (inferred from USFWS, 2010b; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2010a)

Number of Populations:

1 (USFWS, 2017)

Population Size:

200 (USFWS, 2017)

Population Narrative:

The long term population trend is unknown. Apparently, total plant numbers fluctuated very little between 2001 and 2004 (Marie Bruegmann, pers. comm. to USFWS 2004) (NatureServe, 2015). There are three populations totaling 200 - 300 individuals (USFWS, 2010a). Currently,

Nyberg and Watson (2015) report this species is declining, with seven “subpopulations” (considered by USFWS as populations) totaling 200 individuals. These subpopulations occur in the more northerly portion of the Alakai Wilderness Preserve and possibly into the Hono o Na Pali Natural Area Reserve (NTBG 2010, 2012, 2014ac) (USFWS, 2017).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from non-native plants, pigs, hurricanes, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species.

Stressor: Predation and herbivory (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species present an immediate and significant threat to *Lysimachia daphnoides* throughout its range due to documented browsing and trampling by pigs, goats, and deer (USFWS, 2010).

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor: Ungulate degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Feral pigs (*Sus scrofa*), goats (*Capra hircus*), and black-tailed deer (*Odocoileus hemionus*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil (Loope 1998; van Riper and van Riper 1982). Feral pigs, goats, and black-tailed deer, and evidence of their activities, have been observed at all occurrences of *Lysimachia daphnoides* (HBMP 2010; Nyberg and Watson 2015; NTBG 2010, 2014b-c) (USFWS, 2017).

Stressor: Established ecosystem-altering invasive plant modification and degradation of habitat

Exposure:

Response:

Consequence:

Narrative: —Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community (Cuddihy and Stone 1990). Habitat modification and destruction by invasive introduced plants negatively affects *Lysimachia daphnoides* at all locations. The nonnative plants with the greatest impacts include *Andropogon virginicus* (broomsedge), *Axonopus fissifolius* (narrow-leaved carpetgrass), *Erechtites valerianifolia* (fireweed), *Hedychium gardnerianum* (kahili ginger), *Juncus planifolius* (rush), *Paspalum urvillei* (vasey grass), *Psidium cattleianum* (strawberry guava), *Rubus argutus* (prickly Florida blackberry), *Sacciolepis indica* (glenwood grass), *Setaria parviflora* (yellow foxtail), and *Xyris complanata* (yellow-eyed grass) (HBMP 2010; NTBG 2010, 2014a-c) (USFWS, 2017).

Stressor: Hurricanes—Loss and degradation of habitat

Exposure:

Response:

Consequence:

Narrative: In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013) (USFWS, 2017).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Lysimachia daphnoides* is vulnerable to the impacts of climate change with a vulnerability score of 0.546 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery

Reclassification Criteria:

In addition to achieving 5 to 10 populations with 500 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats (USFWS, 2017).

Delisting Criteria:

In addition to achieving 5 to 10 populations with 500 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis (USFWS, 2017).

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys (USFWS, 2010a).
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units (USFWS, 2010a).
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys (USFWS, 2010a).
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range (USFWS, 2010a).
- Conduct research on control methods for introduced slugs and avian malaria (USFWS, 2010a).

- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction (USFWS, 2010a).
- Identify threats and prioritize which ones to address first for the two birds (USFWS, 2010a).
- Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program (USFWS, 2010a).
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security (USFWS, 2010a).
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems (USFWS, 2010a).
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations (USFWS, 2010a).
- Current Management Actions:
 - Population viability monitoring—USFWS and DOFAW monitor the vegetative cover, vigor, and phenology of *Lysimachia daphnoides* regularly (Bruegmann et al. 2015, in litt.).
 - Ungulate monitoring and control—USFWS coordinated with DOFAW to fence the bogs on State land in which *Lysimachia daphnoides* occurs or occurred previously from pigs and goats (not deer) (Bruegmann 2002).
 - Invasive plant monitoring and control—Weed control is ongoing within the fenced bogs (Bruegmann et al. 2015, in litt.; Caraway 2017, pers. comm.).
 - Captive propagation for genetic storage and reintroduction—*Lysimachia daphnoides* is represented in ex situ collections at Lyon Arboretum (2017; one founder represented in tissue culture and seven founders represented in the seed bank, which includes the founder in tissue culture). NTBG has seed stored in their seed bank from five different collections (approximately 1,500 seeds) from Platanthera Bog, and one collection from Charlie's Bog (approximately 50 seeds), but the number of founders represented is uncertain (NTBG 2014d, 2015).
 - A boardwalk constructed in the 1990s to alleviate impacts from hiking was recently improved by replacing the wooden structure with plastic lumber (DLNR 2016). The boardwalk has been somewhat successful at preventing impacts to plants, although it is still possible that hikers may trespass from the boardwalk and damage individuals of *Lysimachia daphnoides* (Bruegmann 2002) (USFWS, 2017).
- RECOMMENDATIONS FOR FUTURE ACTIONS
 - Surveys and inventories—Survey for populations of *Lysimachia daphnoides* in areas of potentially suitable habitat.
 - Ungulate monitoring and control—Protect all occurrences against disturbance from feral ungulates. Continue to construct and maintain fenced exclosures to protect individuals of *Lysimachia daphnoides*. Control feral ungulates within fenced exclosures.
 - Invasive plant monitoring and control
 - o Control established ecosystem-altering nonnative invasive plant species around all populations.
 - o Control invasive nonnative plant species around all populations that compete with the species.
 - Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock.
 - Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.
 - Human interaction monitoring and control—Develop and implement effective measures to reduce the impacts of hikers.
 - Population viability monitoring and analysis—Continue to monitor populations at Charlie's Bog and Platanthera Bog.
 - Population biology research—Study *Lysimachia*

daphnoides populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms. • Based on the recovery criteria above, consider development of a recovery plan (USFWS, 2017).

Conservation Measures and Best Management Practices:

- USFWS and the Hawaii Division of Forestry and Wildlife have fenced 9 montane bogs in the Alakai Plateau, totaling approximately 40 hectares (100 acres). These fenced bogs contain roughly half of the *Lysimachia daphnoides* individuals (USFWS, 2010a).
- This species is currently in controlled propagation for genetic storage and/or reintroduction efforts (USFWS, 2010a).

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SPECIES ACCOUNT: *Lysimachia filifolia* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 2/25/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

Lysimachia filifolia is a small, short-lived, perennial shrub 0.5 to 1.6 feet tall. The linear leaves are up to 2 inches tall and 0.7 inches wide and are usually alternately arranged. The bell-shaped flowers are reddish purple, small, and borne singly on flower stalks that elongate upon fruiting. Fruits are thick, hard capsules that contain numerous minute, nearly black, irregularly shaped seeds. (USFWS, 1994)

Taxonomy

From 1897 until 1990, the genus was alternately considered *Lysimachia* or *Lysimachiopsis*. (USFWS, 1994)

Historical Range

Historically, *Lysimachia filifolia* was known only from the upper portion of Olokele Valley on Kauai (HHP 1994). (USFWS, 1994)

Current Range

Lysimachia filifolia currently occurs on Kauai and Oahu. On Kauai, it was rediscovered in 2008 at Kamanu Ridge at the headwaters of Waikoko Stream. On Oahu, it occurs in the Koolau mountains in Waianu and Waiahole Valleys and Uwao (Uau) Gulch. (USFWS, 2013)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Lysimachia filifolia* under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Lysimachia filifolia* (77 FR 57648-57862). The critical habitat designation includes 3 critical habitat units, which encompass approximately 4,944 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Lysimachia filifolia* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Lysimachia filifolia* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Lysimachia filifolia* includes 3 critical habitat units, covering one ecosystem type, which encompasses approximately 4,944 acres on the Island of Oahu,

Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Wet Cliff—Units 6, 7, 8.

Oahu—Wet Cliff—Unit 6 [151 ac (61 ha)]. This area consists of 151 ac (61 ha) in the wet cliff ecosystem on State land on the windward side of the Koolau Mountains in Kaipapau Gulch, entirely within the Kaipapau Forest Reserve. Oahu—Wet Cliff—Unit 7 [144 ac (58 ha)]. This area consists of 144 ac (58 ha) in the wet cliff ecosystem in State land on the windward side of the Koolau Mountains in Hauula Gulch, entirely within the Hauula Forest Reserve. Oahu—Wet Cliff—Unit 8 [4,649 ac (1,881 ha)]. This area consists of 1,479 ac (598 ha) of State land, 1,281 ac (519 ha) of City and County of Honolulu land, 5 ac (2 ha) of Federal land, and 1,884 ac (762 ha) of privately owned land, in the wet cliff ecosystem along the summit of the Koolau Mountains, overlapping portions of Sacred Falls State Park, the Waiahole FR (Waiahole and Iolekaa sections), the Kaneohe and Honolulu Watershed FRs, and the Nuuanu Pali State Wayside.

The critical habitat designation for *Lysimachia filifolia* includes one unit totaling 2,458 acres in Kauai County, Hawaii. The unit is Kauai 10—*Lysimachia filifolia*—a.

Kauai 10—*Lysimachia filifolia*—a: This unit is critical habitat for *Lysimachia filifolia* and is 995 ha (2,458 ac) on State (Lihue-Koloa Forest Reserve) and private land. This unit contains Iole, Kalalea, Kamanu, and Palikea Summits. This unit provides habitat for four populations of 300 mature, reproducing individuals of the short-lived perennial *Lysimachia filifolia* and is currently occupied with 20 to 75 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. It provides habitat for the westernmost range of the species. The habitat features contained in this unit that are essential for this species include, but are not limited to, mossy banks at the base of cliff faces within the spray zone of waterfalls or along streams in lowland wet forests. This unit provides for four populations within this multi-island species' historical range on Kauai that are some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Lysimachia filifolia* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Lysimachia filifolia* occurs within the indicated ecosystem in the Koolau Mountain caldera complex:

Oahu—Wet Cliff—Units 6, 7, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: >65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. (F) Understory: *Bryophytes*, *Ferns*, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Within this unit, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Mossy banks at the base of cliff faces within the spray zone of waterfalls or along streams in lowland wet forests and containing one or more of the following associated native plant species: *Antidesma platyphyllum*, *Bidens valida*, *Bobea elatior*, *Chamaesyce remyi* var *kauaiensis*, *Cyanea*

asarifolia, Dubautia plantaginea ssp. magnifolia, Eragrostis variabilis, Machaerina angustifolia, Melicope spp., Metrosideros polymorpha, or Panicum lineale; and

(ii) Elevations between 454 and 1,308 m (1,490 and 4,290 ft).

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for Lysimachia filifolia to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Unknown (USFWS, 2003)

Lifespan

Adult: Unknown (USFWS, 2003)

Dependency on Other Individuals or Species

Adult: Unknown pollinators (USFWS, 2003)

Reproduction Narrative

Adult: Little is known about the life history of *Lysimachia filifolia*. Flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown. (USFWS, 2003)

Habitat Type

Adult: Wet cliff faces (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Wet hardwood forests (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: High humidity (waterfall spray) (USFWS, 2003)

Environmental Specificity

Adult: Very narrow (USFWS, 2003)

Site Fidelity

Adult: High (inferred from USFWS, 2003)

Habitat Narrative

Adult: This species typically grows on mossy banks at the base of cliff faces within the spray zone of waterfalls or along streams in lowland wet forests at an elevation of 800 to 2200 ft. Associated plant taxa include mosses, ferns, liverworts, pili grass, tarweed, and clearweed (HHP 1991; J. Lau, pens. comm., 1991). (USFWS, 1994)

Dispersal/Migration**Dispersal**

Adult: Unknown (USFWS, 2003)

Dispersal/Migration Narrative

Adult: The seed dispersal agents for *Lysimachia filifolia* are unknown (USFWS, 2003)

Population Information and Trends**Population Trends:**

Decreasing (USFWS, 2013)

Resiliency:

Low (inferred from USFWS, 2009)

Representation:

Low (inferred from USFWS, 2009)

Redundancy:

Low (inferred from USFWS, 2009)

Number of Populations:

1 (USFWS, 2017)

Population Size:

~50 individuals (USFWS, 2017)

Adaptability:

Low (inferred from USFWS, 2009)

Population Narrative:

After *L. pendens* was separated from *L. filifolia* in 1997, there were no known *L. filifolia* plants on Kauai until a new population of about 30 plants was discovered in 2008. On Oahu, the Waiahole population has declined from approximately 100 individuals in the last five-year review to 50 individuals. A new population of ten individuals was observed in Uwao (Uau) Gulch (Susan Ching, Plant Extinction Prevention Program, pers. comms. 2012a, b, c). The status of the Waianu population was not reported. (USFWS, 2013). *Lysimachia filifolia* has been found in one new location on Kauai since the time of the last 5-year review in 2013, an occurrence of one individual at the upper north fork of the Wainiha River; however, botanists were unable to relocate it (NTBG 2013a; PEPP 2014; Kishida 2017, in litt.). The second population totaling approximately 30 individuals was destroyed by a landslide (Kishida 2017, in litt.). There are no known remaining individuals on Kauai. Populations on Oahu remain at the same three locations, with one of those locations monitored recently (Uwao, 50 individuals) (PEPP 2015); additional estimates remain as unknown for Waianu and at approximately 50 individuals at Waiahole, as no observations have been made since the last five year review (USFWS, 2017).

Threats and Stressors

Stressor: Non-native invasive plants (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: The major threat to *Lysimachia filifolia* is competition with alien plant taxa. Marsh pennywort, tarweed, and thimbleberry, although not invasive weeds, are present in this near-pristine area of Waialeale and may degrade the native ecosystem. Individuals on Oahu compete for space with alien plants such as marsh pennywort, tarweed, *Ageratina riparia* (Hamakua pamakani), and *Schefflera actinophylla* (octopus tree). (USFWS, 1995)

Stressor: Feral pigs (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: A major threat to *Lysimachia filifolia* is the degradation of its habitat by feral pigs. (USFWS, 2009)

Stressor: Small numbers (USFWS, 1995)

Exposure:**Response:****Consequence:**

Narrative: Because only one population of *Lysimachia filifolia* occurs on each of only two islands, the species is threatened by stochastic extinction. (USFWS, 1995)

Stressor: Landslides (USFWS, 1995)

Exposure:**Response:****Consequence:**

Narrative: Individuals of this species on Kauai are damaged and destroyed by natural rock slides in their habitat, which is near the bottom of steep cliffs. (USFWS, 1995)

Stressor: Climate change (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. (USFWS, 2013)

Stressor: Climate change loss or degradation of habitat

Exposure:**Response:****Consequence:**

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Lysimachia filifolia* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.443 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Stressor: Rodent predation or herbivory

Exposure:**Response:****Consequence:**

Narrative: Rats are noted to be a threat to the occurrence of *Lysimachia filifolia* at Wainiha (Kauai) (NTBG 2013a) (USFWS, 2017).

Stressor: Invertebrate predation or herbivory

Exposure:**Response:****Consequence:**

Narrative: Slugs are noted to be a threat to the occurrence of *L. filifolia* at Wainiha (Kauai) (NTBG 2013a) (USFWS, 2017).

Recovery**Reclassification Criteria:**

A total of five to seven populations should be documented on Kauai and on Oahu. (USFWS, 1995)

Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1995)

Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1995)

Delisting Criteria:

A total of eight to ten populations should be documented on Kauai and Oahu. (USFWS, 1995)

Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1995)

Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1995)

Recovery Actions:

- Protect current populations, control threats and monitor. (USFWS, 1995)
- Expand current populations. (USFWS, 1995)
- Conduct research essential to conservation of the species. (USFWS, 1995)
- Establish new populations as needed to reach recovery objectives. (USFWS, 1995)
- Validate and revise recovery objectives. (USFWS, 1995)
- Devise and implement a public education program. (USFWS, 1995)
- New Management Actions: • Population viability monitoring and analysis—PEPP is surveying for new populations and monitoring known populations on Oahu and Kauai (PEP 2013, 2014, 2015). • Captive propagation for genetic storage and reintroduction—Lyon Arboretum maintained over 500 explants between 1994 and 2016, and currently has 168 containers in micropropagation from two collections from Waiahole (Oahu). Pahole Rare Plant Facility has seven collections totaling 19 plants (Lyon Arboretum 2017) (USFWS, 2017).
- Recommendations for Future Actions: Predation and herbivory by rats and slugs has been identified as a new threat to *Lysimachia filifolia*. No other significant new information regarding the species biological status has come to light since the last 5-year review in 2013. Thus, the following recommendations for future actions are added or reiterated for the 5-year review for 2017. • Surveys and inventories—Continue to survey for populations of *Lysimachia filifolia* in areas of potentially suitable habitat. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative species that compete with the species around all populations. • Predator and herbivore monitoring and control— o Implement effective control methods for rodents. o Determine and implement effective control methods for slugs. • Captive propagation for genetic storage and reintroduction—Continue collection

efforts for maintenance of genetic stock. • Reintroduction and translocation—Reintroduce individuals into protected suitable habitat within historic range. • Population biology research—Study *Lysimachia filifolia* populations to determine viable population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and rock falls (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Captive propagation for genetic storage and reintroduction - Continue collecting material for genetic storage and propagation for reintroduction. Investigate new propagation methods. (USFWS, 2013)
- Invertebrate control research - Investigate insect predation and appropriate control methods. (USFWS, 2013)
- Ungulate exclosures - Fence remaining populations to protect them from the impacts of feral ungulates. (USFWS, 2013)
- Ecosystem-altering invasive plant species control - Remove competing invasive introduced plant species within fenced areas and maintain those areas free of invasive introduced plants. (USFWS, 2013)
- Fire protection – Develop and implement fire prevention plans for vulnerable populations. (USFWS, 2013)
- Population biology research: (1) Continue to implement genetic studies to assess viability of remaining populations, and (2) Investigate causes of reproductive failure and techniques to improve natural recruitment. (USFWS, 2013)
- Surveys / inventories - Survey current and historical locations on all islands to determine current status of the rangewide. (USFWS, 2013)
- Alliance and partnership development - Initiate planning and contribute to implementation of ecosystem level restoration and management to benefit this taxon. (USFWS, 2013)

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SPECIES ACCOUNT: *Lysimachia iniki* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (R1) (USFWS, 2016)

Physical Description

A shrub with pendulous branches 30 - 150 cm long. Leaf blades 37 - 45 mm long and 35 - 38 mm wide. Flowers solitary in leaf axils. Petals with the distal portion white and the proximal portion dark red, oblanceolate, 15 - 16 mm long and 5 mm wide. Capsules are globose, 6 - 7 mm long (NatureServe, 2015).

Taxonomy

A member of the myrsine family (Myrsinaceae) (USFWS, 2010a).

Historical Range

This species was first described in 1997 from material collected in the “Blue Hole” at the headwaters of the Wailua River on Kauai (USFWS, 2010b).

Current Range

Lysimachia iniki is known from only a single occurrence in the headwaters of the Wailua River, Kauai Island, Hawaii (NatureServe, 2015).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Lysimachia iniki* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Lysimachia iniki* includes three CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Wet Cliff—Section 1: Wet Cliff—Section 1 consists of 190 ac (77 ha) in the wet cliff ecosystem, including cliffs along the rim of Kalalau Valley from Alealeau to Pihea, on Stateowned land in the Na Pali Coast State Park and the Hono o Na Pali NAR (Figure 6-A). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70b, and is occupied by the plant *Chamaesyce remyi* var. *remyi*. This section includes the wet cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the wet cliff ecosystem (Table 3). Although Wet Cliff—Section 1 is not known to be occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyanea dolichopoda*, *Cyrtandra oenobarbara*, *C. paliku*, *Dubautia plantaginea* ssp. *magnifolia*, *Lysimachia iniki*, *L. pendens*, *L. venosa*, and *Platydesma rostrata*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical

range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Wet Cliff—Section 2: Wet Cliff—Section 2 consists of 784 ac (317 ha) in the wet cliff ecosystem, and includes the cliffs at the headwaters of the Wailua River or “Blue Hole,” on State (778 ac, 315 ha) and privately owned (6 ac, 3 ha) land in the LihueKoloa Forest Reserve (Figure 6-B). There are 489 ac (198 ha) within previously designated critical habitat and 296 ac (120 ha) of newly designated critical habitat on State-owned land. The portion of the section that is in previously designated critical habitat falls within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36b. The newly designated portion of the section comprises Critical Habitat Unit 18 of 50 CFR 17.99(a)(1), Map 217a. This section is occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyrtandra oenobarba*, *Dubautia plantaginea* ssp. *magnifolia*, *Lysimachia iniki*, *L. pendens*, and *Platydesma rostrata*. The section includes the wet cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the wet cliff ecosystem (Table 3). Although Wet Cliff—Section 2 is not known to be occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyanea dolichopoda*, *Cyrtandra paliku*, and *Lysimachia venosa*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Wet Cliff—Section 3: Wet Cliff—Section 3 consists of 61 ac (24 ha) in the wet cliff ecosystem, including cliffs below Kekoiki, on State (8 ac, 3 ha) and privately owned (53 ac, 22 ha) land in the Halelea, Moloaa and Kealia forest reserves (Figure 6-C). There are 23 ac (9 ha) of newly designated critical habitat on privately owned land within this section. That portion of the section that falls within previously designated critical habitat is within Critical Habitat Unit 4 of 50 CFR 17.99(a)(1), Map 5a. The newly designated portion of the section comprises Critical Habitat Unit 19 of 50 CFR 17.99(a)(1), Map 217b. This section is occupied by the plant *Cyrtandra paliku*, and includes the wet cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the wet cliff ecosystem (Table 3). Although Wet Cliff—Section 3 is not known to be occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Cyanea dolichopoda*, *Cyrtandra oenobarba*, *Dubautia plantaginea* ssp. *magnifolia*, *Lysimachia iniki*, *L. pendens*, *L. venosa*, and *Platydesma rostrata*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Lysimachia iniki* critical habitat consists of one component (Wet cliff) (75 FR 18960-19165):

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. Understory: *Bryophytes*, *Ferns*, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not

adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available

Habitat Type

Adult: Terrestrial (USFWS, 2010b)

Habitat Vegetation or Surface Water Classification

Adult: Wet cliff ecosystem (USFWS, 2010b)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at 2,400 ft. elevation (USFWS, 2010b)

Habitat Narrative

Adult: Occurs on wet, mossy, or rocky cliffs in the wet cliff ecosystem at 2,400 ft. (720 m) (Marr and Bohm 1997, pp. 270–271; TNCH 2007) (USFWS, 2010b).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Very low (inferred from USFWS, 2010a)

Redundancy:

Very low (inferred from USFWS, 2010a)

Number of Populations:

1 (USFWS, 2010a; USFWS, 2017)

Population Size:

40 (USFWS, 2010a; USFWS, 2017))

Population Narrative:

There is one population totaling 40 individuals (USFWS, 2010a). This species was first described in 1997 from material collected at Blue Hole located at the headwaters of the Wailua River on Kauai. In 1992, fallen branches broken by Hurricane Iniki were collected by NTBG (1992). At the time this species was discovered, it was known from about 24 individuals. At the time of listing it was estimated there were 40 individuals (PEPP 2010). Currently, there are 40 individuals from this area (Nyberg and Watson 2015). This species grows on steep slopes and cliffs and obtaining an exact count of individuals is difficult (USFWS, 2017).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from non-native plants, hurricanes, landslides, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Landslides destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities.

Stressor: Small populations (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: *Lysimachia iniki* is known only from a single population with fewer than 50 individuals. Research on *Pittosporum* species suggests that small populations are susceptible to loss of genetic variation through inbreeding and drift (USFWS, 2010).

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor: Ungulate degradation of habitat

Exposure:

Response:**Consequence:**

Narrative: Feral pigs (*Sus scrofa*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil (Loope 1998; van Riper and van Riper 1982). Feral pigs are reported to be a threat to the habitat of the only known occurrence of *Lysimachia iniki* (DLNR 2005) (USFWS, 2017).

Stressor: Landslides and flooding destruction or degradation of habitat

Exposure:**Response:****Consequence:**

Narrative: The only known individuals of *Lysimachia iniki* occur on steep slopes and cliffs. Landslides and erosion due to disturbance by feral ungulates and by natural weathering destabilize substrates, damage and destroy individual plants, and alter hydrological patterns (Nyberg and Watson 2015; PEPP 2013, Stearns 1985) (USFWS, 2017).

Stressor: Climate change loss or degradation of habitat

Exposure:**Response:****Consequence:**

Narrative: Climate change loss or degradation of habitat—Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment was not conducted specifically for *Lysimachia iniki*. However, it was concluded that the Hawaiian *Lysimachia* (with a vulnerability score of 0.497; on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change) is the second most vulnerable genus (for the Hawaiian plants only) to climate change. Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery**Reclassification Criteria:**

In addition to achieving 5 to 10 populations with 1,000 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats (USFWS, 2017).

Delisting Criteria:

In addition to achieving 5 to 10 populations with 1,000 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable,

secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis (USFWS, 2017).

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys (USFWS, 2010a).
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units (USFWS, 2010a).
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys (USFWS, 2010a).
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range (USFWS, 2010a).
- Conduct research on control methods for introduced slugs and avian malaria (USFWS, 2010a).
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction (USFWS, 2010a).
- Identify threats and prioritize which ones to address first for the two birds (USFWS, 2010a).
- Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program (USFWS, 2010a).
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security (USFWS, 2010a).
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems (USFWS, 2010a).
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations (USFWS, 2010a).
- Current Management Actions: • Population viability monitoring—PEPP monitors this occurrence regularly (PEPP 2010, 2011, 2012, 2013, 2014, 2016). • Captive propagation for

- genetic storage and reintroduction—Cuttings and seeds are collected from *Lysimachia iniki* by NTBG and PEPP and sent to propagation facilities at NTBG and Lyon Arboretum for storage and propagation. Three founders are represented at the Lyon seed bank, with one of those also at Lyon tissue culture. Two collections of seeds are at the NTBG seedbank, though it is uncertain which wild plants are represented. There is one plant planted on the NTBG garden grounds and three plants in the nursery (Lyon Arboretum 2017; NTBG 2017b). There are eight plants at the Kokee Rare Plant Facility (DOFAW 2016) (USFWS, 2017).
- **RECOMMENDATIONS FOR FUTURE ACTIONS** • Surveys and inventories—Survey for populations of *Lysimachia iniki* in areas of potentially suitable habitat. • Ungulate monitoring and control—Protect all occurrences against disturbance from feral ungulates to prevent imminent extinction. • Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Human interaction monitoring and control—Develop and implement effective measures to reduce the impacts of hikers. • Population biology research—Study *Lysimachia iniki* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and hurricanes. • Based on the recovery criteria above, consider development of a recovery plan (USFWS, 2017).

Conservation Measures and Best Management Practices:

- This species is currently in controlled propagation for genetic storage and/or reintroduction efforts (USFWS, 2010a).

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SPECIES ACCOUNT: *Lysimachia lydgatei* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/15/1992; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Lysimachia lydgatei is a sprawling shrub in the primrose family (Primulaceae). The stems are 1-1.3 m (3.3-4.3 ft) long and branched, woolly when young, but losing this coating with age. The leathery and roughly oval-shaped (49-70 x 14-22 mm [1.9-2.8x 0.6-0.9 in]) leaves are alternately positioned on the stems on 10-16 mm (0.4-0.6 in) leaf stalks (petioles), the leaf edges smooth and the leaf tips pointed. Both surfaces of the leaf blades are covered with minute rusty-colored hairs, which give the foliage a conspicuous golden-brown pubescent appearance characteristic of the species. Flowers are borne singly at the point of attachment of leaves to the stem on stalks (peduncles) approximately 1-3 cm (0.4-1.2 in) long when in fruit; flower parts are in sixes or sevens. Lance-shaped floral parts below the petals (sepals) are 7-8 mm (0.27-0.31 in) long; the exact nature of other flower parts (petals, etc.) is unknown. The fruits are capsules, probably somewhat flattened spheres; seed characteristics are unknown. (USFWS, 1997)

Taxonomy

Genus cosmopolitan, species endemic to west Maui. Treated as *lysimachiopsis* by heller. (NatureServe, 2015). Hawaiian name for genus is kolokolo-kuahiwi (USFWS, 1997).

Historical Range

Historically, this species is poorly known from only a single, fragmentary collection on Maui (Hillebrand sn. BISH) made before 1871 (USFWS, 1997).

Current Range

Currently known from at least three mountain summits (Lihau, Halepohaku, and Helu) of leeward West Maui (USFWS, 1997).

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Lysimachia lydgatei* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes nine detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Lysimachia lydgatei* includes nine CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Lowland Dry—Unit 5 consists of 3,615 ac (1,463 ha) of State land, and 43 ac (17 ha) of privately owned land, from Panaewa to Manawainui on the western and southern slopes of west Maui. This unit is occupied by the plants *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, *Cenchrus agrimonioides*, *Gouania hillebrandii*, *Kadua coriacea*, *Remya mauiensis*,

Santalum haleakalae var. *lanaiense*, and *Spermolepis hawaiiensis*, and *Tetramolopium capillare*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 5 is not known to be occupied by *Ctenitis squamigera*, *Cyanea obtusa*, *Hesperomannia arbuscula*, *Hibiscus brackenridgei*, *Lysimachia lydgatei*, *Neraudia sericea*, *Schiedea salicaria*, *Sesbania tomentosa*, or *T. remyi*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 6 consists of 3 ac (1 ha) of State land, and 237 ac (96 ha) of privately owned land, from Paleaahu Gulch to Puu Hona on the southern slopes of west Maui. This unit is occupied by the plants *Hibiscus brackenridgei* and *Schiedea salicaria*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 6 is not known to be occupied by *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, *Cenchrus agrimonoides*, *Ctenitis squamigera*, *Cyanea obtusa*, *Gouania hillebrandii*, *Hesperomannia arbuscula*, *Kadua coriacea*, *Lysimachia lydgatei*, *Neraudia sericea*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Spermolepis hawaiiensis*, *Tetramolopium capillare*, or *T. remyi*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 2 (and) *Palmeria dolei*—Unit 19—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 19— Montane Mesic This area consists of 124 ac (50 ha) of State land at Helu and the upper reaches of Puehuhunui on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Lysimachia lydgatei*, *Remya mauiensis*, and *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 2 is not known to be occupied by the plants *Geranium hillebrandii*, *Huperzia mannii*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 3 (and) *Palmeria dolei*—Unit 20—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 20— Montane Mesic This area consists of 174 ac (70 ha) of State land at Lihau on the southwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plant *Geranium hillebrandii*, and contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 3 is not known to be occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Huperzia mannii*, *Lysimachia lydgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 4 (and) *Palmeria dolei*—Unit 21—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 21— Montane Mesic This area consists of 72 ac (29 ha) of State land at Halepohaku on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). Although Maui—Montane Mesic—Unit 4 is not known to be occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Geranium hillebrandii*, *Huperzia mannii*, *Lysimachia lydgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 5 (and) *Palmeria dolei*—Unit 22—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 22— Montane Mesic This area consists of 170 ac (69 ha) of State land at the upper reaches of Manawainui Gulch on the southeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants *Remya mauiensis* and *Santalum haleakalae* var. *lanaiense*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 5 is not known to be occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Geranium hillebrandii*, *Huperzia mannii*, *Lysimachia lydgatei*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations

within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 6 (and) *Palmeria dolei*—Unit 35—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 35— Wet Cliff This area consists of 1,858 ac (752 ha) of State land, and 253 ac (102 ha) of privately owned land, at the summit ridges of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plants *Alectryon macrococcus*, *B. conjuncta*, *Ctenitis squamigera*, *Cyrtandra munroi*, *Remya mauiensis*, and *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 6 is not known to be occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Bonamia menziesii*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyriformis*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, or *Tetramolopium capillare*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 7 (and) *Palmeria dolei*—Unit 36—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 36— Wet Cliff This area consists of 556 ac (225 ha) of State land along Honokowai ridge on the northwestern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units are occupied by the plants *Cyrtandra filipes* and *C. munroi*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 7 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyriformis*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 8 consists of 337 ac (137 ha) of State land along Kahakuloa ridge on the north side of west Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff— Unit 8 is

not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Lysimachia lydgatei* critical habitat consists of three components. Lowland dry (west Maui), Montane mesic (west Maui) and Wet cliff (west Maui) (81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*. Subcanopy: *Chamaesyce*, *Dodonaea*, *Leptecophylla*, *Osteomeles*, *Psydrax*, *Scaevola*, *Wikstroemia*. Understory: *Alyxia*, *Artemisia*, *Bidens*, *Chenopodium*, *Nephrolepis*, *Peperomia*, *Sicyos*.

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: *Acacia*, *Ilex*, *Metrosideros*, *Myrsine*, *Nestegis*, *Nothocestrum*, *Pisonia*, *Pittosporum*, *Psychotria*, *Sophora*, *Zanthoxylum*. Subcanopy: *Alyxia*, *Charpentiera*, *Coprosma*, *Dodonaea*, *Kadua*, *Labordia*, *Leptecophylla*, *Phyllostegia*, *Vaccinium*. Understory: Ferns, *Carex*, *Peperomia*.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. Understory: Bryophytes, Ferns, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia*

var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to

reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Shrubland/chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 825 and 975 meters (2,700 to 3,200 feet) (USFWS, 1997)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1997)

Habitat Narrative

Adult: The habitat of *Lysimachia lydgatei* is stunted native vegetation on the sides of steep ridges and slopes in mesic shrubland at 825-975 meters (2,700-3,200 feet) elevation. Associated native species include *Dodonaea viscosa*, *Vaccinium*, *Styphelia tameiameia*, *Dicranopteris linearis*, *Dubautia linearis*, *Myrsine sandwicensis*, *Sadleria*, *Carex*, *Scaevola chamissoniana*, *Eragrostis variabilis*, *Broussaisia arguta*, *Lobelia grayana*, *Coprosma*, *Dubautia scabra*, *Machaerina*, and *Bidens mauiensis* (HHP reference; R.W. Hobdy, personal communication 1990; USFWS 1992a; HPCC 1994). (USFWS, 1997)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2011)

Redundancy:

Very low (inferred from USFWS, 2011)

Number of Populations:

2 (USFWS, 2011; USFWS, 2018)

Population Size:

50-67 (USFWS, 2018)

Population Narrative:

Currently, there are approximately 35 total individuals known in 2 populations. (USFWS, 2011). The latest review of the species by IUCN in 2016 reported two subpopulations totaling 52 individuals (Keir et al. 2016). Currently, there are approximately 50 to 67 wild individuals of *Lysimachia lydgatei* on west Maui (USFWS, 2018).

Threats and Stressors

Stressor: Fire (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Fire is a major potential threat to *Lysimachia lydgatei* (USFWS 1997). (USFWS, 2011)

Stressor: Landslides (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Landslides are another potential threat to rare plants in this area (National Tropical Botanical Garden 2009). (USFWS, 2011)

Stressor: Invasive plants (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: *Adiantum hispidulum* (rough maidenhair fern), *Ageratina adenophora* (sticky snakeroot), *Buddleia asiatica* (dogtail), *Grevillea robusta* (silk oak), *Psidium guajava* (common guava), *Rubus rosifolius* (thimbleberry), and *Tibouchina herbacea* (glorybush) are invasive introduced plants which have modified the habitat for *Lysimachia lydgatei* (Hawaii Biodiversity and Mapping Program 2009; Perlman 2010; Wood 2010). The introduced invasive plant species

are also a threat to *Lysimachia lydgatei* because they compete with the species for water, light, and nutrients. (USFWS, 2011)

Stressor: Predation by rats, slugs, and insects (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Rats (*Rattus* spp.) and slugs (species unknown) are predators of *Lysimachia lydgatei* (Hawaii Biodiversity and Mapping Program 2009; Perlman 2010; Wood 2010). Insects (species unknown) attack the young seed capsules and no seeds, only frass, are found within (H. Oppenheimer, pers. comm. 2010). (USFWS, 2011)

Stressor: Small population size (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: In addition to all of the other threats, species like *Lysimachia lydgatei* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding, and disease outbreaks. The extent of these natural processes on this single island endemic are exacerbated by anthropogenic threats, such as habitat loss for human development or predation by introduced species (USFWS 1997). (USFWS, 2011)

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai'i using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Lysimachia lydgatei* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.765 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future, such as identifying suitable habitat at micro-sites that may be less susceptible to rapid changes in climate (USFWS, 2018).

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived

perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)

3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1997)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)

2. Each population must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)

3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1997)

Recovery Actions:

- Monitor changes in ungulates. If feral ungulates become established, the area must be fenced and animals excluded. (USFWS, 1997)
- Search for additional populations. To meet recovery goals, a minimum of five additional populations must be found or established, and protected. (USFWS, 1997)
- New Management Actions:
 - Surveys and monitoring—The Plant Extinction Prevention Program (PEPP) surveys for and monitors populations of *Lysimachia lydgatei* on west Maui (PEPP 2012, 2013, 2015, 2016, 2017b).
 - Captive propagation for genetic storage and reintroduction—
 - o In 2017, the PEPP reports for *Lysimachia lydgatei* that five of 45 founders were collected from at Kauaʻula; three of seven founders from Launiupoko were collected from and two of 10 founders from Ukumehame were collected from (PEPP 2017a).
 - o The Lyon Arboretum Micropropagation Laboratory reports 48 containers of propagules from Kauaʻula in storage. The Lyon Arboretum Seed Conservation Laboratory reports seeds in storage from F2 seed from plants at Olinda Rare Plant Facility (ORPF) from Kauaʻula (3,000), from Ukumehame (almost 1,000 representing five individuals), and from Launiupoko (over 1,500 seeds representing five individuals) (Lyon Arboretum 2017).
 - o The ORPF reports five potted plants were sent out to Helu in 2013 (ORPF 2013). In 2018, 25 potted plants were propagated from material collected from plants at Launiupoko, 2 potted plants from an unspecified source, and 1 potted plant from material from Makamakaʻole (ORPF 2018).
 - o The Plant Extinction Prevention Program (PEPP) monitors wild individuals and collects fruit (PEPP 2012, 2013, 2015, 2016, 2017b). In 2012, there were 46 individuals at Kauaʻula and two individuals at Lihau. In 2016 there were six individuals at Launiupoko and four individuals at Helu. In 2017, there were nine individuals at Ukumehame.
 - Stochastic events—Build resiliency and redundancy—PEPP reports reintroduction of plants at Kauaʻula (9), Lihau (5), and Launiupoko (2) (PEPP 2016, 2017b) (USFWS, 2018).
- Recommendations for Future Actions: We are not aware of any new threats or significant new information regarding the species' biological status since the last 5-year review in 2011. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2018.
 - Population viability and monitoring—Continue to survey known localities and suitable habitat areas on west Maui determine the current status of all populations of

Lysimachia lydgatei. Search historical habitat on west Maui for occurrences of this species. • Ungulate monitoring and control—Construct and maintain exclusion fences, or strategic fencing as appropriate, to protect *L. lydgatei* from the impacts of feral ungulates. • Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. • Fire destruction or degradation of habitat—Develop and implement fire prevention management plans. • Captive propagation for genetic storage and reintroduction—

- o Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range.
- o Evaluate genetic resources currently in storage to determine the need to place additional material into long-term storage due to this species' vulnerability to climate change.

• Reintroduction and translocation—Continue to augment current populations and reintroduce individuals into suitable habitat within historical range that is being managed for known threats to this species. • Rodent predation or herbivory—Implement effective methods to control rats at known populations. • Invertebrate predation or herbivory—Determine and implement effective methods to control slugs at known populations. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through suitable habitat to reduce impacts from landslides. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for its recovery. • Alliance and partnership development—Work with the Hawai'i Division of Forestry and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2018).

Conservation Measures and Best Management Practices:

- Survey areas where *Lysimachia lydgatei* have been reported to assess current status of the species. (USFWS, 2011)
- Monitor known populations and collect any available seeds. (USFWS, 2011)
- Fence existing populations to protect from negative impacts of ungulates. (USFWS, 2011)
- Control invasive introduced species around known populations. (USFWS, 2011)
- Develop and implement methods to control rats and slugs. (USFWS, 2011)
- Propagate to augment the existing populations. (USFWS, 2011)
- Establish additional populations within protected suitable habitat. (USFWS, 2011)
- Work with Hawaii Division of Forestry and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2011)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2011)

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

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SPECIES ACCOUNT: *Lysimachia maxima* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Lysimachia maxima, a member of the primrose family (Primulaceae), is a sprawling shrub with reddish brown bark. The leaves, borne in groups of three along the stems, are oval with the broadest portion at the tip of the leaves. The leaves are 3.8 to 8 cm (1.5 to 3 in) long and 1.8 to 5 cm (0.7 to 2 in) wide. The upper surface of the leaves has a few scattered hairs when young, and the lower surface is sparsely covered with long, soft, rusty hairs when young. The corolla is purplish-yellow, bell-shaped, and about 10 to 12 mm (0.4 to 0.5 in) long. This species is differentiated from others in this genus by the leaves borne in groups of three, the broadest portion of the leaf above the middle, and rusty hairs that disappear with maturity (Wagner et al. 1990). (USFWS, 1998)

Taxonomy

Genus nearly cosmopolitan, species endemic to northeast Molokai. In 1905, R. Knuth named Hillebrand's specimen *Lysimachia hillebrandii* var. *maxima* (Pax and Knuth 1905). St. John (1987b) elevated the variety to a species, *Lysimachia ternifolia*. Wagner et al. (1990) called this taxon *Lysimachia maxima*. An ongoing revision of the genus has determined that *Lysimachia ternifolia* is an invalidly published name and concurs that *Lysimachia maxima* is the correct name for this species (USEWS 1996a). (USFWS, 1998)

Historical Range

See Current Range

Current Range

Current range includes the windward side of Molokai. (USFWS, 1998)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Lysimachia maxima* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Lysimachia maxima* includes six CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Molokai—Lowland Wet—Unit 1 (and) Palmeria dolei—Unit 38—Lowland Wet (and) Pseudonestor xanthophrys—Unit 38— Lowland Wet This area consists of 2,195 ac (888 ha) of State land, and 754 ac (305 ha) of privately owned land (partly within The Nature Conservancy's Pelekunu Preserve), from Pelekunu Valley to Wailau Valley, in north-central Molokai. These units

are occupied by the plant *Cyrtandra filipes*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Lowland Wet—Unit 1 is not known to be occupied by *Asplenium dielarectum*, *Bidens wiebkei*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Lysimachia maxima*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 2 (and) *Palmeria dolei*—Unit 39—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 39—Lowland Wet This area consists of 1,356 ac (549 ha) of State land and 594 ac (241 ha) of privately owned land, from Kahanui to Pelekunu Valley, in north-central Molokai. These units are occupied by the plant *Lysimachia maxima*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Lowland Wet—Unit 2 is not known to be occupied by *Asplenium dielarectum*, *Bidens wiebkei*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Cyrtandra filipes*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 3 consists of 94 ac (38 ha) of State land, and 3,125 ac (1,265 ha) of privately owned land, from Waiahookalo gulch to Moaula stream and Puniuohua, on eastern Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Molokai—Lowland Wet—Unit 3 is not known to be occupied by *Asplenium dielarectum*, *Bidens wiebkei*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Cyrtandra filipes*, *Lysimachia maxima*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes,

suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 1 (and) *Palmeria dolei*—Unit 40—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 40— Montane Wet This area consists of 1,545 ac (625 ha) of State land, and 1,851 ac (749 ha) of privately owned land, from the headwaters of Waialeale Stream and above Pelekunu Valley, eastward along the summit area to Mapulehu, in northcentral Molokai. These units are occupied by the plants *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. profuga*, *Phyllostegia hispida*, and *Pteris lidgatei*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Montane Wet—Unit 1 is not known to be occupied by *Adenophorus periens*, *Cyanea procera*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Melicope reflexa*, *Phyllostegia mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 41—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 41— Montane Wet This area consists of 871 ac (353 ha) of State land, and 39 ac (16 ha) of privately owned land, from Honukaupu to Olokui (between Pelekunu and Wailau valleys), in north-central Molokai. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). Although Molokai— Montane Wet—Unit 2 is not known to be occupied by *Adenophorus periens*, *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. procera*, *C. profuga*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Melicope reflexa*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Pteris lidgatei*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 3 consists of 77 ac (31 ha) of State land, and 726 ac (294 ha) of privately owned land, above the east rim of Wailau Valley on eastern Molokai. This unit is occupied by the plant *Melicope reflexa*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Montane Wet—Unit 3 is not known to be occupied by *Adenophorus periens*, *Bidens wiebkei*, *Clermontia*

oblongifolia ssp. brevipes, *Cyanea mannii*, *C. procera*, *C. profuga*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Pteris lidgatei*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Lysimachia maxima* critical habitat consists of two components. Lowland wet (Molokai) and Montane wet (Molokai) (81 FR 17790-18110):

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookii*, which exists

only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*,

Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Flowers, buds and immature fruit of Lysimachia maxima have been observed in late May through July (Hawaii Plant Conservation Center (HPCC) 1991a; USEWS 1996a). (USFWS, 1998)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at an elevation of 975 meters (3,200 feet) (USFWS, 1998)

Environmental Specificity

Adult: Low, with few key requirements (USFWS, 1998)

Habitat Narrative

Adult: This species occurs in ohia-uluhe montane wet forest at an elevation of 975 meters (3,200 feet). Associated species include Psychotria sp. (kopiko), Vaccinium sp. (ohelo), Hedyotis sp. (manono), Duhautia sp. (naenae), and Ilex anomala (kawau) (HPCC 1991a; USEWS 1996a). (USFWS, 1998)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Slight decrease (USFWS, 2014)

Resiliency:

Very low (inferred from USFWS, 2013)

Redundancy:

Very low (inferred from USFWS, 2013)

Number of Populations:

2 (USFWS, 2018)

Population Size:

33-39 wild (USFWS, 2018)

Population Narrative:

In 2010, there were two populations containing seven wild individuals of *L. maxima* (Plant Extinction Prevention Program [PEPP] 2010). In 2013, there were a total of 8 wild individuals of *L. maxima* and 18 reintroduced individuals (PEPP 2013). Overall, the numbers of individuals have decreased from approximately 20 wild individuals reported in the previous 5-year review to approximately 8 wild individuals in 2013 (PEPP 2012, 2013). (USFWS, 2014). New Status Information: • The latest review of the species by IUCN in 2015 reported two subpopulations of one individual each (Chau et al. 2015). In 2017, the Plant Extinction Prevention program (PEPP) reported six plants at Kawela, seven plants at Oloku'i, and 20 plant at 'Ōhi'ālele (PEPP 2017a) (USFWS, 2018).

Threats and Stressors

Stressor: Flooding (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Flooding is a threat to this species (PEPP 2010). (USFWS, 2014)

Stressor: Herbivory by slugs (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Herbivory by slugs has been reported as a threat to this species (PEPP 2010, 2011, 2012, 2013). (USFWS, 2014)

Stressor: Small population size (USFWS, 1998)

Exposure:

Response:

Consequence:

Narrative: Reduced reproductive vigor due to the small number of individuals in the only known population (HPCC 1991a; USEWS 1996a). (USFWS, 1998)

Stressor: Pigs and goats (USFWS, 1998)

Exposure:

Response:

Consequence:

Narrative: Pigs and goats inhabit adjacent areas and pose a potential threat to this species (USFWS 1996a). (USFWS, 1998)

Stressor: Landslides and hurricanes (USFWS, 1998)

Exposure:

Response:

Consequence:

Narrative: Other major threats to *Lysimachia maxima* are landslides and hurricanes. (USFWS, 1998)

Stressor: Climate change loss or degradation of habitat (USFWS, 2018).

Exposure:**Response:****Consequence:**

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai'i using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Lysimachia maxima* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.876 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this species has no overlap between current and future climate envelopes, and is unlikely to tolerate expected changes in climate at its current location. This means that this species must persist within suitable microrefugia, or move to newly available climate-compatible areas to avoid extinction. Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2018).

Recovery**Reclassification Criteria:**

1. A total of five to seven populations of each taxon should be documented on Molokai. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Molokai. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1998)

Recovery Actions:

- In order to prevent this species from going extinct, the current program of propagation and maintenance of *cx situ* genetic stock should be continued and expanded. (USFWS, 1998)

- The remaining wild population should be fenced to provide protection from the potential effects of pigs and goats. If fencing is not feasible due to the local terrain (steep slopes), other means should be employed to control ungulate populations. (USFWS, 1998)
- New Management Actions:
 - Surveys and monitoring—The Plant Extinction Prevention Program (PEPP) surveys for and monitors populations of *Lysimachia maxima* on Molokaʻi (PEPP 2014, 2016, 2017b).
 - Captive propagation for genetic storage and reintroduction—
 - o In 2017, PEPP had collected from four of six founders from Kawela Gulch, three of 20 founders from ʻŌhiʻalele, and two of seven founders from Olokuʻi (PEPP 2017a).
 - o The Lyon Arboretum Micropropagation Laboratory had almost 1,000 containers of propagules of *Lysimachia maxima* between 2001 and 2015. Currently, Lyon reports 66 containers of propagules from two individuals from ʻŌhiʻalele in storage. The Lyon Arboretum Seed Conservation Laboratory reports 57 seeds in storage from one individual from the Puʻukolekole outplanting, but they have not germinated and are suspected to not be viable (Lyon Arboretum 2017).
 - o The Olinda Rare Plant Facility (ORPF) reports 11 cuttings made from five individuals at Kawela Gulch, four potted plants from three individuals at Kawela Gulch, and 19 potted plants from three individuals at ʻŌhiʻalele (ORPF 2014, 2015, 2017).
 - o PEPP monitors wild individuals and collects fruit (PEPP 2014, 2016, 2017b). In 2016, there were seven individuals at ʻŌhiʻalele, and in 2017 there were five individuals at Kawela Gulch (PEPP 2016, 2017b).
 - Stochastic events—Build resiliency and redundancy—PEPP reports reintroduction of plants at Puʻukolekole (ca 50) and Kawela Gulch (30) (PEPP 2014, 2016, 2017b) (USFWS, 2018).
- Recommendations for Future Actions: We are not aware of any new threats or significant new information regarding the species' biological status since the last 5-year review 2014. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2018.
 - Population viability and monitoring—Continue to survey known localities and suitable habitat areas on Molokaʻi to determine the current status of all populations of *Lysimachia maxima*.
 - Ungulate monitoring and control—Construct and maintain exclusion fences, or strategic fencing as appropriate, to protect *L. maxima* from the impacts of feral ungulates.
 - Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations.
 - Captive propagation for genetic storage and reintroduction—
 - o Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range.
 - o Evaluate genetic resources currently in storage to determine the need to place additional material into long-term storage due to this species' vulnerability to climate change.
 - Reintroduction and translocation—Continue to augment current populations and reintroduce individuals into suitable habitat within historical range that is being managed for known threats to this species.
 - Rodent predation or herbivory—Implement effective methods to control rats at known populations.
 - Climate change adaptation strategy—Research the suitability of habitat for reintroducing this species in the future due to impacts of climate change. Develop a strategy for preventing the extinction of this species if no suitable habitat is predicted in the future.
 - Alliance and partnership development—Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2018).

Conservation Measures and Best Management Practices:

- Continue collecting material for genetic storage and propagation for reintroduction. (USFWS, 2014)
- Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change. (USFWS, 2014)

- Continue augmenting current natural populations to increase numbers of individuals. (USFWS, 2014)
- Fence remaining populations to protect them from the impacts of feral ungulates. If fencing is not feasible due to the local terrain (steep slopes), other means should be employed to control ungulate populations. (USFWS, 2014)
- Control invasive introduced plant species within exclosures. (USFWS, 2014)
- Continue to survey the geographical and historical range of *L. maxima* for a current assessment of the species' status. (USFWS, 2014)
- Control rats (*Rattus* spp.) and slugs (unidentified species) within the vicinity of all known *L. maxima* populations. (USFWS, 2014)
- Control rats (*Rattus* spp.) and slugs (unidentified species) within the vicinity of all known *L. maxima* populations. (USFWS, 2014)
- Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2014)

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SPECIES ACCOUNT: *Lysimachia pendens* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (R1) (USFWS, 2016)

Physical Description

A shrub; many-branched, pendulous. Stems are 20 - 60 mm long. Leaf blades narrowly lanceolate, 25 - 30 mm long and 2 - 4 mm wide. Flowers solitary in the leaf axils. Petals red, obovate, 7.5 - 8.5 mm long and 5 - 6 mm wide (NatureServe, 2015).

Taxonomy

A member of the myrsine family (Myrsinaceae) (USFWS, 2016).

Historical Range

See current range/distribution.

Current Range

Known only on Kauai (NatureServe, 2015).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Lysimachia pendens* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Lysimachia pendens* includes three CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Wet Cliff—Section 1: Wet Cliff—Section 1 consists of 190 ac (77 ha) in the wet cliff ecosystem, including cliffs along the rim of Kalalau Valley from Alealeau to Pihea, on Stateowned land in the Na Pali Coast State Park and the Hono o Na Pali NAR (Figure 6-A). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70b, and is occupied by the plant *Chamaesyce remyi* var. *remyi*. This section includes the wet cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the wet cliff ecosystem (Table 3). Although Wet Cliff—Section 1 is not known to be occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyanea dolichopoda*, *Cyrtandra oenobarbara*, *C. paliku*, *Dubautia plantaginea* ssp. *magnifolia*, *Lysimachia iniki*, *L. pendens*, *L. venosa*, and *Platydesma rostrata*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Wet Cliff—Section 2: Wet Cliff—Section 2 consists of 784 ac (317 ha) in the wet cliff ecosystem, and includes the cliffs at the headwaters of the Wailua River or “Blue Hole,” on State (778 ac, 315 ha) and privately owned (6 ac, 3 ha) land in the LihueKoloa Forest Reserve (Figure 6-B). There are 489 ac (198 ha) within previously designated critical habitat and 296 ac (120 ha) of newly designated critical habitat on State-owned land. The portion of the section that is in previously designated critical habitat falls within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36b. The newly designated portion of the section comprises Critical Habitat Unit 18 of 50 CFR 17.99(a)(1), Map 217a. This section is occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyrtandra oenobarba*, *Dubautia plantaginea* ssp. *magnifolia*, *Lysimachia iniki*, *L. pendens*, and *Platydesma rostrata*. The section includes the wet cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the wet cliff ecosystem (Table 3). Although Wet Cliff—Section 2 is not known to be occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyanea dolichopoda*, *Cyrtandra paliku*, and *Lysimachia venosa*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Wet Cliff—Section 3: Wet Cliff—Section 3 consists of 61 ac (24 ha) in the wet cliff ecosystem, including cliffs below Kekoiki, on State (8 ac, 3 ha) and privately owned (53 ac, 22 ha) land in the Halelea, Moloaa and Kealia forest reserves (Figure 6-C). There are 23 ac (9 ha) of newly designated critical habitat on privately owned land within this section. That portion of the section that falls within previously designated critical habitat is within Critical Habitat Unit 4 of 50 CFR 17.99(a)(1), Map 5a. The newly designated portion of the section comprises Critical Habitat Unit 19 of 50 CFR 17.99(a)(1), Map 217b. This section is occupied by the plant *Cyrtandra paliku*, and includes the wet cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the wet cliff ecosystem (Table 3). Although Wet Cliff—Section 3 is not known to be occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Cyanea dolichopoda*, *Cyrtandra oenobarba*, *Dubautia plantaginea* ssp. *magnifolia*, *Lysimachia iniki*, *L. pendens*, *L. venosa*, and *Platydesma rostrata*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Lysimachia pendens* critical habitat consists of one component (Wet cliff) (75 FR 18960-19165):

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. Understory: *Bryophytes*, *Ferns*, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry

Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available

Habitat Type

Adult: Terrestrial (USFWS, 2010b)

Habitat Vegetation or Surface Water Classification

Adult: Wet cliff ecosystem (USFWS, 2010b)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at 2,400 ft. elevation (USFWS, 2010b)

Habitat Narrative

Adult: It is reported from wet, mossy, or rocky cliffs in the wet cliff ecosystem at 2,400 ft. (720 m) (Marr and Bohm 1997, p. 275; TNCH 2007) (USFWS, 2010b).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Majority of plants destroyed 1997 - 2003 (USFWS, 2010b)

Resiliency:

Very low (inferred from USFWS, 2010a)

Redundancy:

Very low (inferred from USFWS, 2010a)

Number of Populations:

1 (USFWS, 2010a; USFWS, 2017)

Population Size:

~25 (USFWS, 2017)

Population Narrative:

There is one population totaling 8 individuals (USFWS, 2010a). Many plants were destroyed by two major landslides that apparently occurred between 1997 and 2003 (previously 100 individuals) (USFWS, 2010b). This species was discovered in the Blue Hole area at the base of Mount Waialeale on Kauai in 1987 from several small populations totaling approximately 100 individuals (Marr and Bohm 1997; DLNR 2005). Based on information taken from field survey reports, many plants were destroyed by two major landslides that apparently occurred between 1997 and 2003. At the time of listing, the species was known from only 8 to 10 individuals (Perlman 2003, in litt.; Perlman and Wood 2007, in litt.). Currently, there is one population totaling approximately 25 individuals (PEPP 2014; Watson and Nyberg 2015) (USFWS, 2017).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from non-native plants, pigs, hurricanes, landslides, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Landslides destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities.

Stressor: Predation and herbivory (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species present an immediate and significant threat to *Lysimachia pendens* throughout its range due to documented browsing and trampling by pigs, goats, and deer (USFWS, 2010).

Stressor: Small populations (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: *Lysimachia pendens* is threatened by the effects of small population size (fewer than 50 wild individuals). Research on *Pittosporum* species suggests that small populations are susceptible to loss of genetic variation through inbreeding and drift (USFWS, 2010).

Stressor: Ungulate degradation of habitat

Exposure:**Response:****Consequence:**

Narrative: Feral pigs (*Sus scrofa*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil (Loope 1998; van Riper and van Riper 1982). Feral pigs are reported to be a threat to the habitat of the only known occurrence of *Lysimachia pendens* (DLNR 2005) (USFWS, 2017).

Stressor: Landslides and flooding destruction or degradation of habitat

Exposure:**Response:****Consequence:**

Narrative: The only known individuals of *Lysimachia pendens* occur on steep slopes and cliffs. Landslides and erosion due to disturbance by feral ungulates and by natural weathering destabilize substrates, damage and destroy individual plants, and alter hydrological patterns (DLNR 2005; Perlman 2003, in litt.; PEPP 2011, 2013, 2014; Stearns 1985; Watson and Nyberg 2015) (USFWS, 2017).

Stressor: Climate change loss or degradation of habitat

Exposure:**Response:****Consequence:**

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment was not conducted specifically for *Lysimachia pendens*. However, it was concluded that the Hawaiian *Lysimachia* (with a vulnerability score of 0.497; on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change) is the second most vulnerable genus to climate change in Hawaii. Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery**Reclassification Criteria:**

In addition to achieving 5 to 10 populations with 1,000 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has

been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats (USFWS, 2017).

Delisting Criteria:

In addition to achieving 5 to 10 populations with 1,000 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis (USFWS, 2017).

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys (USFWS, 2010a).
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units (USFWS, 2010a).
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys (USFWS, 2010a).
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range (USFWS, 2010a).
- Conduct research on control methods for introduced slugs and avian malaria (USFWS, 2010a).
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction (USFWS, 2010a).
- Identify threats and prioritize which ones to address first for the two birds (USFWS, 2010a).
- Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program (USFWS, 2010a).

- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security (USFWS, 2010a).
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems (USFWS, 2010a).
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations (USFWS, 2010a).
- Current Management Actions: • Population viability monitoring—PEPP monitors this occurrence regularly (PEPP 2010, 2011, 2012, 2013, 2014). • Established invasive plant species—Nonnative invasive plants are removed from around the known population (PEPP 2011, 2012, 2014). • Captive propagation for genetic storage and reintroduction—Four cuttings were collected in February 2017 and sent to the NTBG nursery (NTBG 2017) (USFWS, 2017).
- RECOMMENDATIONS FOR FUTURE ACTIONS • Surveys and inventories—Survey for populations of *Lysimachia pendens* in areas of potentially suitable habitat. • Ungulate monitoring and control—Construct small-scale fenced exclosures to exclude feral ungulates from wild populations to prevent imminent extinction. Protect all occurrences against disturbance from feral ungulates to prevent imminent extinction. • Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. • Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and hurricanes. • Based on the recovery criteria above, consider development of a recovery plan (USFWS, 2017).

Conservation Measures and Best Management Practices:

- This species is currently in controlled propagation for genetic storage and/or reintroduction efforts (USFWS, 2010a).

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Determination of Endangered Status for 48 Species on Kauai and Designation of Critical Habitat

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SPECIES ACCOUNT: *Lysimachia scopulensis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (R1) (USFWS, 2016)

Physical Description

A branching shrubs Stems are up to 75 cm long. Leaf blades are oblanceolate, sometimes narrowly obovate, 55 - 65 mm long and 8 - 11 mm wide. Flowers solitary in the leaf axils, bell shaped. Petals are red, obovate, 10 - 11 mm long and 6 - 7 mm wide. Capsules are globose (NatureServe, 2015).

Taxonomy

A member of the myrsine family (Myrsinaceae) (USFWS, 2010b).

Historical Range

It was first discovered in 1991 in Kalalau Valley (USFWS, 2010b).

Current Range

It currently occurs in Kalalau and Puu Kii (Kauai) (USFWS, 2010b).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Lysimachia scopulensis* (Shiny-leaf Island-loosestrife) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Lysimachia scopulensis* includes two CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Dry Cliff—Section 1: Dry Cliff—Section 1 consists of 404 ac (163 ha) in the dry cliff ecosystem, along cliffs from Kalanu to Pihea peak, within the Na Pali Coast State Park (Figure 5). The entire section is within previously designated critical habitat and is State-owned; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 67a. This section is occupied by the plants *Chamaesyce eleanoriae*, *Lysimachia scopulensis*, *Schiedea attenuata*, and *Stenogyne kealiae*. This section includes the dry cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the dry cliff ecosystem (Table 3).

Kauai—Dry Cliff—Section 2: Dry Cliff—Section 2 consists of 309 ac (125 ha) in the dry cliff ecosystem, including cliffs and ridges extending from Kanakou to Keanapuka and along Manono Ridge, surrounding the hanging valley Pohakuao, in the Na Pali Coast State Park (Figure 5, above). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 67a. This section is occupied by the plant *Chamaesyce eleanoriae* and includes the dry cliffs, the moisture regime, and subcanopy and

understory plant species identified as PCEs in the dry cliff ecosystem (Table 3). Although Dry Cliff - Section 3 is not known to be occupied by the plants *Lysimachia scopulensis*, *Schiedea attenuata*, and *Stenogyne kealiae*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range of the species. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Lysimachia scopulensis* critical habitat consists of one component (Dry cliff) (75 FR 18960-19165):

Ecosystem: Dry Cliff. Elevation: unrestricted. Annual precipitation: < 75 in (<190 cm). Substrate: >65 degree slope, rocky talus. Canopy: None. Subcanopy: *Antidesma*, *Chamaesyce*, *Diospyros*, *Dodonaea*. Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Schiedea*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., "sustained yield") in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While

fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available

Habitat Type

Adult: Terrestrial (USFWS, 2010b)

Habitat Vegetation or Surface Water Classification

Adult: Lowland diverse mesic forest (USFWS, 2010b)

Geographic or Habitat Restraints or Barriers

Adult: 2,950 - 3,200 ft. elevation (USFWS, 2010b)

Habitat Narrative

Adult: Found on cliffs in lowland diverse mesic forest pockets at elevations between 2,950 and 3,200 ft. (900 and 975 m) within the dry cliff ecosystem (Wood 2007d; TNCH 2007) (USFWS, 2010b).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Resiliency:

Very low (inferred from USFWS, 2010b)

Redundancy:

Very low (inferred from USFWS, 2010b)

Number of Populations:

2 (USFWS, 2017)

Population Size:

~16 (USFWS, 2017)

Population Narrative:

There are two populations totaling 25 to 30 individuals (USFWS, 2010b). First discovered in 1991 in Kalalau Valley, this species is known from two populations. One population along the Kalalau rim was comprised of approximately 15 individuals and the Puu ki population was comprised of 10 to 15 individuals, totaling 25 to 30 individuals (Marr and Bohm 1997; NTBG 1993, 1994a-d). Current estimates include one individual from the Kalalau population and 15 from the Puu ki population (PEPP 2017) (USFWS, 2017).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from non-native plants, pigs, goats, deer, hurricanes, landslides, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian

terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Landslides destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities.

Stressor: Predation and herbivory (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species present an immediate and significant threat to *Lysimachia scopulensis* throughout its range due to documented browsing and trampling by pigs, goats, and deer (USFWS, 2010).

Stressor: Small populations (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: *Lysimachia scopulensis* is threatened by the effects of small population size (fewer than 50 wild individuals). Research on *Pittosporum* species suggests that small populations are susceptible to loss of genetic variation through inbreeding and drift (USFWS, 2010).

Stressor: Ungulate degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Feral pigs (*Sus scrofa*) and goats (*Capra hircus*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil (Loope 1998; van Riper and van Riper 1982). Feral pigs and goats are reported to be a threat to the habitat of the only known occurrences of *Lysimachia scopulensis* (Watson and Flynn 2015; NTBG 1991, 1992, 1993, 1994a-d, 2016) (USFWS, 2017).

Stressor: Established ecosystem-altering invasive plant modification and degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community (Cuddihy and Stone 1990). Invasive introduced plants with the greatest impacts on *Lysimachia scopulensis* include *Blechnum appendiculatum* (NCN), *Erigeron karvinskianus* (daisy fleabane), *Kalanchoe pinnata* (air plant), *Lantana camara* (lantana), *Plantago lanceolata* (narrow-leaved plantain), *Setaria parviflora* (yellow foxtail), and *Sporobolus indicus* (West Indian dropseed) (NTBG 1994c-d, 1998, 2016) (USFWS, 2017).

Stressor: Landslides and flooding destruction or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: *Lysimachia scopulensis* occurs on steep slopes and cliffs. Landslides and erosion due to disturbance by feral ungulates and by natural weathering destabilize substrates, damage and destroy individual plants, and alter hydrological patterns (Watson and Flynn 2015; NTBG 1991, 1993; Stearns 1985) (USFWS, 2017).

Stressor: Hurricanes—Loss and degradation of habitat

Exposure:

Response:

Consequence:

Narrative: In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013) (USFWS, 2017).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Lysimachia scopulensis* is extremely vulnerable to the impacts of climate change with a vulnerability score of 0.941 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery**Reclassification Criteria:**

In addition to achieving 5 to 10 populations with 1,000 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually)

includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats (USFWS, 2017).

Delisting Criteria:

In addition to achieving 5 to 10 populations with 1,000 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis (USFWS, 2017).

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys (USFWS, 2010a).
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units (USFWS, 2010a).
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys (USFWS, 2010a).
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range (USFWS, 2010a).
- Conduct research on control methods for introduced slugs and avian malaria (USFWS, 2010a).
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction (USFWS, 2010a).
- Identify threats and prioritize which ones to address first for the two birds (USFWS, 2010a).
- Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program (USFWS, 2010a).
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security (USFWS, 2010a).
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems (USFWS, 2010a).

- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations (USFWS, 2010a).
- Current Management Actions: • Population viability monitoring—PEPP monitors this occurrence regularly (PEPP 2010, 2012, 2014, 2016). • Captive propagation for genetic storage and reintroduction—Lyon Arboretum’s Micropropagation Facility maintains explants from a single collection of 12 fruit, collected by NTBG in 1998, from an unknown specified number of plants (Lyon Arboretum 2017). Sixtytwo plants are in the NTBG nursery from two other seed collections from the Kalalau population (NTBG 2017). There is no representation of the Puu ki population in ex situ storage. • Reintroduction and outplanting—Currently there are nine outplants in a fenced exclosure at Kalalau (PEPP 2017) (USFWS, 2017).
- RECOMMENDATIONS FOR FUTURE ACTIONS • Surveys and inventories—Survey for populations of *Lysimachia scopulensis* in areas of potentially suitable habitat. • Ungulate monitoring and control—Protect all occurrences against disturbance from feral ungulates to prevent imminent extinction. • Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. • Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms. • Population biology research—Study *Lysimachia scopulensis* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, hybridization impacts, and threats. • Based on the recovery criteria above, consider development of a recovery plan (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Not available

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U.S. Fish & Wildlife Service. 2010a. Recovery Outline for the Kauai Ecosystem. U.S. Fish and Wildlife Service, Region 1 Pacific Islands Fish and Wildlife Office.

SPECIES ACCOUNT: *Lysimachia venosa* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (R1) (USFWS, 2016)

Physical Description

A shrub 5 - 10 dm tall or perhaps taller. Leaves are well-spaced, alternate, coriaceous, 6 - 11 cm long. Flowers are solitary in the leaf axils. Corolla color is unknown (NatureServe, 2015).

Taxonomy

A member of the myrsine family (Myrsinaceae) (USFWS, 2010b).

Historical Range

Lysimachia venosa was known historically from two collections in the early 1900s from the Waialeale summit region of Kauai (Marr and Bohm 1997, p. 284; Wagner et al. 1999, p. 1,085; HBMP 2007) (USFWS, 2010b).

Current Range

It is known only from the Waialeale area of Kauai, state of Hawaii (NatureServe, 2015). While no plants were found during surveys of the summit area in 2006, there is still additional habitat to be surveyed, and species experts believe *L. venosa* still exists (S. Perlman 2007; Wood 2006, p. 11) (USFWS, 2010b).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Lysimachia venosa* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Lysimachia venosa* includes three CHUs in Kauai County, Hawaii. Note: This species may no longer occur naturally in the wild, therefore there is no known occupied critical habitat for this species. The critical habitat units for this species have been determined to be essential to the conservation of the species because the area provides for the reestablishment of populations within the species' historical range (75 FR 18960-19165).

Kauai—Wet Cliff—Section 1: Wet Cliff—Section 1 consists of 190 ac (77 ha) in the wet cliff ecosystem, including cliffs along the rim of Kalalau Valley from Alealeau to Pihea, on Stateowned land in the Na Pali Coast State Park and the Hono o Na Pali NAR (Figure 6-A). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70b, and is occupied by the plant *Chamaesyce remyi* var. *remyi*. This section includes the wet cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the wet cliff ecosystem (Table 3). Although Wet Cliff—Section 1 is not known to be occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyanea dolichopoda*, *Cyrtandra oenobarbara*, *C. paliku*, *Dubautia plantaginea* ssp. *magnifolia*, *Lysimachia iniki*, *L. pendens*, *L.*

venosa, and *Platydesma rostrata*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Wet Cliff—Section 2: Wet Cliff—Section 2 consists of 784 ac (317 ha) in the wet cliff ecosystem, and includes the cliffs at the headwaters of the Wailua River or “Blue Hole,” on State (778 ac, 315 ha) and privately owned (6 ac, 3 ha) land in the LihueKoloa Forest Reserve (Figure 6-B). There are 489 ac (198 ha) within previously designated critical habitat and 296 ac (120 ha) of newly designated critical habitat on State-owned land. The portion of the section that is in previously designated critical habitat falls within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36b. The newly designated portion of the section comprises Critical Habitat Unit 18 of 50 CFR 17.99(a)(1), Map 217a. This section is occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyrtandra oenobarba*, *Dubautia plantaginea* ssp. *magnifolia*, *Lysimachia iniki*, *L. pendens*, and *Platydesma rostrata*. The section includes the wet cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the wet cliff ecosystem (Table 3). Although Wet Cliff—Section 2 is not known to be occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyanea dolichopoda*, *Cyrtandra paliku*, and *Lysimachia venosa*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Wet Cliff—Section 3: Wet Cliff—Section 3 consists of 61 ac (24 ha) in the wet cliff ecosystem, including cliffs below Kekoiki, on State (8 ac, 3 ha) and privately owned (53 ac, 22 ha) land in the Halelea, Moloaa and Kealia forest reserves (Figure 6-C). There are 23 ac (9 ha) of newly designated critical habitat on privately owned land within this section. That portion of the section that falls within previously designated critical habitat is within Critical Habitat Unit 4 of 50 CFR 17.99(a)(1), Map 5a. The newly designated portion of the section comprises Critical Habitat Unit 19 of 50 CFR 17.99(a)(1), Map 217b. This section is occupied by the plant *Cyrtandra paliku*, and includes the wet cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the wet cliff ecosystem (Table 3). Although Wet Cliff—Section 3 is not known to be occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Cyanea dolichopoda*, *Cyrtandra oenobarba*, *Dubautia plantaginea* ssp. *magnifolia*, *Lysimachia iniki*, *L. pendens*, *L. venosa*, and *Platydesma rostrata*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Lysimachia venosa* critical habitat consists of one component (Wet cliff) (75 FR 18960-19165):

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: Broussaisia, Cheirodendron, Leptecophylla, Metrosideros. Understory: Bryophytes, Ferns, Coprosma, Dubautia, Kadua, Peperomia.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland

Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: *Metrosideros polymorpha* wet forest (USFWS, 2010b)

Geographic or Habitat Restraints or Barriers

Adult: 3,000 - 5,700 ft. elevation (USFWS, 2010b)

Habitat Narrative

Adult: Inhabits wet forest or shrubland (NatureServe, 2015). It occurs in *Metrosideros polymorpha* dominated wet forest areas in the wet cliff ecosystem, at elevations between 3,000 and 5,700 ft. (915 and 1,740 m) (Marr and Bohm 1997, p. 284; Wood 2006, p. 11; TNCH 2007) (USFWS, 2010b).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Species Trends:

122 plants found during 2015 surveys (USFWS, 2017; see current range/distribution)

Resiliency:

Very low (inferred from NatureServe, 2015; see current range/distribution)

Number of Populations:

1 (USFWS, 2017)

Population Size:

122 (USFWS, 2017)

Population Narrative:

The long term population trend is unknown (NatureServe, 2015). No wild extant populations are known (USFWS, 2010a). No plants were found during surveys of the summit area in 2006. During another survey in 2012, about 30 individuals were discovered just below the summit peak of Kawaikini (Wood 2013). As of 2014, there were 45 individuals at Kawaikini (PEPP 2015). In 2015, two new small occurrences totaling nine individuals were found. Currently, Walsh (2015) reports 122 individuals total in the Kawaikini to Iole headwaters area (USFWS, 2017).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from non-native plants, hurricanes, landslides, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Landslides destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities.

Stressor: Small populations (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: *Lysimachia venosa* has not been confirmed to persist in the wild. This species is not in storage or propagation, but individuals familiar with this species believe it may possibly remain extant and that much of its suitable habitat (lowland mesic, lowland wet, and wet cliff) on Kauai remains to be surveyed (USFWS, 2010).

Stressor: Ungulate degradation of habitat

Exposure:

Response:**Consequence:**

Narrative: Feral pigs (*Sus scrofa*) and goats (*Capra hircus*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil (Loope 1998; van Riper and van Riper 1982). Feral pigs and goats are reported to be a threat to the habitat of the only known occurrences of *Lysimachia venosa* (HBMP 2010; NTBG 2012a-b, 2015a; PEPP 2015; Walsh 2015) (USFWS, 2017).

Stressor: Established ecosystem-altering invasive plant modification and degradation of habitat

Exposure:**Response:****Consequence:**

Narrative: Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community (Cuddihy and Stone 1990). Invasive introduced plants with the greatest impacts on *Lysimachia venosa* include *Axonopus fissifolius* (narrow-leaved carpetgrass), *Blechnum appendiculatum* (NCN), *Buddleja asiatica* (dog tail), *Clidemia hirta* (Koster's curse), *Cyperus meyerianus* (NCN), *Erigeron karvinskianus* (daisy fleabane), *Juncus planifolius* (rush), *Melastoma septemnerium* (NCN), *Paspalum conjugatum* (Hilo grass), *Psidium cattleianum* (strawberry guava), *Rhodomyrtus tomentosa* (downy myrtle), *Rubus rosifolius* (thimbleberry), *Sphaeropteris cooperi* (Australian tree fern), and *Sacciolepis indica* (glenwood grass), (NTBG 2012a, 2015a; Wood 2013) (USFWS, 2017).

Stressor: Landslides and flooding destruction or degradation of habitat

Exposure:**Response:****Consequence:**

Narrative: *Lysimachia venosa* occurs on steep slopes and cliffs. Landslides and erosion due to disturbance by feral ungulates and by natural weathering destabilize substrates, damage and destroy individual plants, and alter hydrological patterns (NTBG 2015; Stearns 1985; Walsh 2015) (USFWS, 2017).

Stressor: Climate change loss or degradation of habitat

Exposure:**Response:****Consequence:**

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Lysimachia venosa* is extremely vulnerable to the impacts of climate change with a vulnerability score of 0.926 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery

Reclassification Criteria:

In addition to achieving 5 to 10 populations with 500 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats (USFWS, 2017).

Delisting Criteria:

In addition to achieving 5 to 10 populations with 500 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis (USFWS, 2017).

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys (USFWS, 2010a).
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units (USFWS, 2010a).
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys (USFWS, 2010a).
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range (USFWS, 2010a).
- Conduct research on control methods for introduced slugs and avian malaria (USFWS, 2010a).
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction (USFWS, 2010a).

- Identify threats and prioritize which ones to address first for the two birds (USFWS, 2010a).
- Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program (USFWS, 2010a).
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security (USFWS, 2010a).
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems (USFWS, 2010a).
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations (USFWS, 2010a).
- Current Management Actions: • Population viability monitoring—PEPP monitors this occurrence regularly (PEPP 2012, 2015). • Captive propagation for genetic storage and reintroduction—Seeds from the Kawaikini summit area were collected from *Lysimachia venosa* by NTBG and PEPP in 2014. The seed bank has 260 seeds from one collection. An additional 118 seeds were sown for propagation and currently there are six plants in the NTBG gardens. There are seven plants in the nursery from another collection where 63 seeds were sown. (NTBG 2017) (USFWS, 2017).
- RECOMMENDATIONS FOR FUTURE ACTIONS • Surveys and inventories—Survey for populations of *Lysimachia venosa* in areas of potentially suitable habitat. • Ungulate monitoring and control—Construct fenced exclosures to exclude feral ungulates from wild populations. Protect all occurrences against browsing and disturbances from feral ungulates. • Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations that alter habitat and compete with the species. • Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and hurricanes. • Based on the recovery criteria above, consider development of a recovery plan (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Not available

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SPECIES ACCOUNT: *Macbridea alba* (White birds-in-a-nest)

Species Taxonomic and Listing Information

Listing Status: Threatened; 6/8/1992; Southeast Region (R4)

Physical Description

This perennial herb usually has one stem (often clothed with long, multicellular hairs) which may be branched. The leaves are oblanceolate or spatulate, mostly in 6-8 pairs. White flowers are borne from May through July in compressed thyrses (dense flower cluster in which the main axis is racemose and the branches are cymose). The small clusters of white buds and flowers look like eggs and little bird heads in a nest. Each flower is bisexual, has a green calyx and a white two lipped-corolla about 2.5-3 cm long; the pistil and filaments are white, and the anthers purple basally. Each flower can produce four nutlets (small fruit similar to a nut), which are about 2-2.5 mm long, narrowly obovate in outline, and light brown (Godfrey and Wooten 1981, Godt et al. 2004). (USFWS, 2009)

Taxonomy

The genus *Macbridea*, which belongs to the mint family (Lamiaceae or Labiatae), consists of only two species (Kral 1983, Godfrey and Wooten 1981). *Macbridea alba* Chapman was first collected about 1860 by A. W. Chapman and a friend named Gausman (Roger Sanders, then a graduate student at University of Texas, currently at Bot. Res. Inst. of Texas, in litt. 1977), and it was named by Chapman (1860). (USFWS, 1994).

Historical Range

See current range/distribution.

Current Range

Endemic to the Florida panhandle and is still restricted to the same four counties: Bay, Gulf, Franklin, and Liberty. (USFWS, 2009)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual and vegetative (USFWS, 2009)

Reproduction Narrative

Adult: Dr. Walker surmised that *Macbridea* may require regular recruitment from seed and is a poor competitor with other plants, requiring bare ground to germinate and grow (USFWS, 1994). *Macbridea alba* is a hermaphroditic species capable of both sexual and vegetative (via rhizomes) reproduction (Godt et al. 2004). This species is capable of both outcrossing and selfing. However, selfed seeds exhibit inbreeding depression (Godt et al. 2004). Pitts-Singer et al. (2002) studied the pollinator-plant relationship at two sites located on the ANF. Twenty

inflorescences were observed for 34 hours over five days. The authors observed 70 visits of nine insect and spider species. Since only bumble bees (*Bombus* spp.) were large enough to make contact with the reproductive structures of the flowers, the authors concluded that bumble bees are the potential pollinators of *M. alba*. Thus, bumble bees are probably critical to the long-term persistence of *M. alba* because they provide a mechanism for ensuring seed set, and facilitate gene flow between plants and plant populations (Negrón-Ortiz, pers. interpretation) (USFWS, 2009).

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits grassy vegetation on poorly drained, infertile sandy peat soils of the Florida Gulf coastal lowlands near the mouth of the Apalachicola River. Also in seepage bogs and savannas and, sparingly, on drier sites with longleaf pine and runner oaks. (Based on Ward 1979.) (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species.

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: The authors observed in the field that seeds germinated while in the infructescences (the fruiting stage of the inflorescence), suggesting that the matured ovules lack dormancy, in addition to the possibility of viviparous seedlings. About 87% of dry-stored seeds were viable (or germinable) for six months after dispersal, but viability of dry-stored and of buried seeds was insignificant after one year. They concluded that a persistent seed bank is not present, based on the lack of emergence of seedlings from soil that was field collected prior to seed dispersal. This lack of seed dormancy and seed bank means that if the established individuals are eliminated, a population cannot re-establish itself (USFWS, 2009).

Population Information and Trends**Population Trends:**

Decreasing (NatureServe, 2015)

Resiliency:

Moderate (inferred from NatureServe, 2015)

Representation:

Moderate (inferred from NatureServe, 2015)

Redundancy:

Moderate (inferred from NatureServe, 2015)

Number of Populations:

21 - 80 (NatureServe, 2015)

Population Size:

1000 - 10,000 individuals (NatureServe, 2015)

Population Narrative:

Plant tolerates some disturbance due to forestry operations although actual effects and population numbers unknown. Substantial areas within the small range of this plant have been converted to short rotation pine plantations during the 20th century. Decline of 30-50% Many occurrences have shown fluctuating numbers from year to year (EO data in the NatureServe central database as of April 2012). 33 occurrences verified since 1989, but some of these are sub-occurrences which are clustered into larger occurrences (EO data in the NatureServe central database as of April 2012) (NatureServe, 2015). Moderate redundancy, resiliency and representation are inferred based on the number of known populations and individuals as well as the relatively large geographic distribution of the species.

Threats and Stressors

Stressor: Logging (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The timber industry in North Florida became well established in the 1850s (FNAI 2005). It started in Franklin County in the 1870s and continued to be a prominent industry until the mid-1990s (Howell and Hartsell 1995). The St. Joe Paper Company had close to a million acres in timber in the eastern region of the panhandle. The Company also owned a paper mill in Port St. Joe until it was sold and shut down in 1999; therefore, this industry is no longer considered a primary threat (USFWS, 2009).

Stressor: Urban development (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Urban development continues to threaten white birds-in-a-nest. The St. Joe Company owns extensive areas of land in Northwest Florida, and focuses on commercial and residential development along roadways and near or within business districts in the region. Urbanized land in Florida, statewide, is projected to double by 2060 along with doubling of the population to 36 million (<http://www.1000friendsofflorida.org/PUBS/2060/01-Northwest-Florida>). According to the study, much of the new development will be focused along roadways. Many M. alba's locations are found along US 98 and other state roads. Construction activity may directly kill individual plants or convert habitat to unsuitable space; widening may convert native habitat to managed road side; and culvert modification may change drainage patterns, which may change seasonal hydrology. Therefore, road widening and new roads continue to pose a threat to the species from habitat loss (USFWS, 2009).

Stressor: Fire suppression (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Suppression of fire during the dormant season continues to threaten the pineland and savanna's flora, as fire is an important factor in the maintenance of flatwoods (Abrahamson and Hartnett 1990). Fire influences community structure and composition (Abrahamson and Hartnett 1990), and with insufficient frequency in longleaf pine communities, a woody midstory quickly develops (Glitzenstein et al. 1995), negatively affecting the understory diversity. Thus, fire suppression continues to be a threat to *M. alba*. Lack of fire, and subsequent growth of shrubs (particularly encroachment of *Cyrilla racemiflora* L., commonly known as swamp titi) and saplings in the understory, inhibits this species emergence (Negrón-Ortiz, 2008, pers. observ.; FNAI 2008). Declining fire frequency reduces *M. alba* abundance in areas where it was previously observed in great quantities (FNAI 2008). In recently burned areas, however, plant emergence is prolific within two years of the fire event (F. Winters, 2008, pers. comm.). The ANF utilizes a 3-5 yr interval burn rotation. Several studies have shown that frequent prescribed fire regimes are important for maintenance of flatwoods diversity (Hiers et al. 2007). Therefore, frequent prescribed burnings, i.e., 4-5 yr intervals, are needed to maintain optimal *M. alba* populations (USFWS, 2009).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2009)

Exposure:**Response:**

Consequence: Loss of individual plants/Loss of habitat

Narrative: Section 7(b)(4) and 7(b)(2) of the Act generally do not apply to listed plants species. However, limited protection of listed plants from take is provided to the extent that the Act prohibits the removal and reduction to possession of federally listed threatened and endangered plants or the malicious damage of such plants on areas under federal jurisdiction, or the destruction of endangered plants on nonfederal areas in violation of state law or regulations or in the course of any violation of a state criminal trespass law. Several populations of *M. alba* occur on private timberland and ROWs. While the Act requires Federal agencies to carry out programs for the conservation of endangered and threatened species, no such programs are stipulated for private landowners. Neither section of the Act provides protection for plants on private lands as long as the activity is permissible under state/local laws. The State requires permission of private landowners for collecting of state-listed plants from their property. *Macbridea alba* is protected under Florida State Law, chapter 85-426, which includes preventions of taking, transport, and the sale of the plants listed under the State Law. The rule Chap. 5B-40, Florida Administrative Code, contains the "Regulated Plant Index" (5B-40.0055) and lists endangered, threatened, and commercially exploited plant species for Florida; defines the categories; lists instances where permits may be issued; and describes penalties for violations (<http://www.virtualherbarium.org/EPAC>). Bay County code of ordinance (chapter 19-Environmental Standards), under sections 1907 and 1909, provides restrictions, constraints and requirements to protect and preserve designated habitat conservation areas for rare, threatened, or endangered species, and wetlands (<http://www.municode.com/Resources/gateway.asp?pid=14281&sid=9>). Gulf, Franklin, and Liberty Counties do not have such regulations. Highway ROW maintenance activities are not always reviewed for threatened and endangered species impact. However, if there is an activity (e.g., construction, reconstruction, or maintenance projects) affecting protected species, then the Service can request a consultation with the Florida Department of Transportation under the Act (*M. Mittiga*, 2009, pers. comm.). In the Apalachicola National Forest SR 65 ROW, it should

conform to specifications and coordination between Talquin Electric, FDOT and the Service. Currently, these protections are inadequate; see section IV, action 1 (USFWS, 2009).

Recovery

Reclassification Criteria:

Not relevant. (USFWS, 1994)

Delisting Criteria:

1. When 15 populations are adequately protected and managed throughout its historic range. Existing public land (mainly the Apalachicola National Forest) does not suffice for recovery). (USFWS, 1994)

Recovery Actions:

- Protect population in Apalachicola National Forest and on other public lands: At present, we have about 21 protected locations with an estimated 3,967 to 7,262 plants. (USFWS, 2009)
- Manage rights-of-way: This is an ongoing action. *Macbridea alba* is found scattered under the Apalachicola National Forest Utility ROW of SR 65. Protective measures have been established with Talquin Electric during annual maintenance and the upcoming pole replacement. Management for other *M. alba* elements of occurrences found in ROW outside SR 65 has not been initiated (USFWS, 2009).
- Protect and manage these plants outside Apalachicola National Forest: 3.1. Secure protection, Develop and implement management and monitoring plans for protected sites. (USFWS, 2009)
- Systematics and other studies: Genetic structure of *M. alba*, and Comparison of *M. alba* and *M. carolinensis*. (USFWS, 2009)
- Garden propagation and reintroduction. This recovery action has not been initiated. According to Schulze et al. (2002) study, an ex-situ collection of seeds is not recommended due to the lack of dormancy, and poor viability of dry-stored seeds. Although conserving this species in-situ is the best option, an ex-situ collection of established seedlings and adults is recommended (USFWS, 2009).

Conservation Measures and Best Management Practices:

- 1. Manage ROW (Rights-of-Way). Continue fostering conservation practices for utility and highway ROWs with the Forest Service, Talquin Electric, FDOT, and USFWS; a management plan should be developed and implemented (USFWS, 2009).
- 2. Establish an ex-situ collection of seedlings and adults (USFWS, 2009).
- 3. Conduct population biology studies at ANF a. Compare the demographic performance of *M. alba* in pinelands and road habitats i) Survey for seedling recruitment and survival of tagged individuals (plant height and reproduction) for a period of 3-5 years in roadside populations of SR 65 and pinelands. ii) Perform germination experiments (USFWS, 2009).
- 4. Revisit and conduct inventories (e.g., the total number of individuals, number of flowering vs. non-flowering plants, presence of visitors to the flowers, and whether seedling recruitment is occurring) on all the historical locations (USFWS, 2009).
- 5. Conduct surveys/inventories on potentially new sites. This action can include the use of species distribution modeling methods to initially determine potential sites, with subsequent validation or inspection of the sites for plants (USFWS, 2009).

- 6. Implement monitoring for selected populations in Bay, Gulf, Franklin, and Liberty counties. Note: Bay (Lathrop Bayou) and Gulf (SJBP) have a monitoring program. A similar monitoring protocol should be followed, thus results can be comparable across sites. Monitoring should examine density and abundance of individuals. Observations of flowering and fruiting are important and should be integrated with variables such as plant size and seedling data. Since *M. alba* occurs in fire prone habitats, the effect of this disturbance (including winter vs. growing season prescribed fire, fire frequency, intensity, duration, and timing) on survival and fecundity should be also monitored. Such studies should be conducted on large, protected and managed populations. Plants should be monitored several times during a 12-month cycle (e.g., flowering and fruiting seasons) the first year, then annually or biannually over an extended number of years. The results would help determining the smallest size at which a population can exist without facing extinction, i.e., the minimum viable population size (USFWS, 2009).
- 7. The recovery plan should be updated to define objective measurable criteria and better address the five factors (USFWS, 2009).

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https://ecos.fws.gov/docs/five_year_review/doc23712.pdf

SPECIES ACCOUNT: *Maesa walkeri* (No common name)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/02/2015; Pacific Region (R1) (USFWS, 2016)

Physical Description

A shrub or small tree (USFWS, 2015).

Taxonomy

A member of the primrose family (Primulaceae) (USFWS, 2015).

Historical Range

Historically, *M. walkeri* was known from at least 13 occurrences on Guam and 9 occurrences on Rota (Bishop Museum 2014—Online Herbarium Database) (USFWS, 2015).

Current Range

It occurs on Guam and Rota (Mariana Islands). The cumulative data indicate that *Maesa walkeri* was once relatively abundant on Guam and Rota, and has since declined substantially on Guam (USFWS, 2015).

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available

Habitat Type

Adult: Terrestrial (USFWS, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest (USFWS, 2015)

Habitat Narrative

Adult: It occurs in the forest ecosystem (USFWS, 2015).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

50% decline in range (USFWS, 2015)

Species Trends:

Increasing (USFWS, 2015)

Resiliency:

Low (inferred from USFWS, 2015)

Redundancy:

Low (inferred from USFWS, 2015)

Number of Populations:

5 (USFWS, 2015)

Population Size:

686+ (USFWS, 2015)

Population Narrative:

It has declined across at least 50 percent of its range (i.e., on Guam). Currently, *M. walkeri* is known from 5 occurrences in the forest ecosystem on Guam and Rota, totaling at least 686 individuals. This is a significant increase over numbers of individuals that were known at the time of the proposed rule (estimated at fewer than 60). On Guam, there are two individuals (M and E Pacific, Inc. 1998, pp. 31, 79; Grimm 2013, in litt.); and on Rota, there are at least 684 individuals spread out across the Sabana, with a healthy population structure consisting of seedlings, juveniles, and adults (Harrington et al. 2012, in litt.; Gawel 2013, in litt.; Liske-Clark et al. 2015, in litt.) (USFWS, 2015).

Threats and Stressors

Stressor: Development, military training, and urbanization (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: In their 2015 Final SEIS ([http:// guambuildupeis.us/](http://guambuildupeis.us/)) (see “Historical and Ongoing Human Impacts,” above), the U.S. Department of Navy states that approximately 5,000 Marines will be relocated from Okinawa to Guam, accompanied by approximately 1,300 dependents, with a concurrent introduction of support staff and development of infrastructure, and increased use of resources such as water (Berger et al. 2005, p. 347; JGPO– NavFac, Pacific 2015, p. ES–3). The current preferred alternative sites on Guam for cantonment and live-fire training include the Naval Computer and Telecommunications Station Finegayan and Northwest Field on Andersen AFB, where this species occurs. Further, the Navy is planning jungle training at the Naval Munitions Site (NMS) on Guam, which will require the establishment of foot trails within the southern portion of the NMS due to repeat use during maneuvering training. This species occurs on the Naval Magazine. In November 2007, the people of Rota voted to legalize casino gambling to increase tourism, and two development projects have been proposed. Development around and within forested areas on Rota will also directly impact the forest habitat and individuals of this species (USFWS, 2015).

Stressor: Ungulates (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: In the Hawaiian Islands, pigs have been described as the most pervasive and disruptive nonnative influence on the unique native forests, and are widely recognized as one of the greatest current threats to Hawaii's forest ecosystems (Aplet et al. 1991, p. 56; Anderson and Stone 1993, p. 195). The negative impacts from pig rooting and wallowing described above negatively affects this species and its habitat. Several herds of Asiatic water buffalo or carabao roam southern Guam and the Naval Magazine area, and cause damage to the forest ecosystem that supports this species. Philippine deer have caused extensive damage resulting in changes in the forest structure, including erosion, grazing to the point of clearing the entire herbaceous understory, consumption of seeds and seedlings preventing regeneration of native plants and the spread of invasive plant species, and other physical damage (e.g., trunk rubbing) (Schreiner 1997, pp. 179–180; Wiles et al. 1999, pp. 193–215; Berger et al. 2005, pp. 36, 45–46, 100; CNMI–SWARS 2010, p. 24; JGPO–NavFac, Pacific 2010b, p. 3–33; SWCA 2011, pp. 35, 42; Harrington et al. 2012, in litt.) (USFWS, 2015).

Stressor: Fire (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Fire is a human-exacerbated threat to native species and native ecosystems throughout the Mariana Islands, particularly on the island of Guam. Fire can destroy dormant seeds of native species as well as plants themselves, even in steep or inaccessible areas. Successive fires that burn farther and farther into native habitat destroy native plants and remove habitat for native species by altering microclimate conditions to those favorable to alien plants (USFWS, 2015).

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- In 2012, the Guam Plant Extinction Prevention Program (GPEPP) was formed to address conservation concerns for a select group of native Mariana Islands plant species, including *Maesa walkeri*. GPEPP is a partnership between the University of Guam (UOG), multiple Federal agencies (USFWS, DOD, and USDA), Hawaii State DLNR, and the Hawaii Plant Extinction Prevention Program (Hawaii PEPP). The goal of GPEPP is to prevent the extinction of native Mariana Islands plant species that have fewer than 200 individuals remaining in the wild on the island of Guam (GPEPP 2014, in litt.). The program's main objectives are to monitor, collect, survey, manage, and reintroduce native

plant species in the Mariana Islands. They plan to work with conservation partners to protect wild populations and preserve genetic material (GPEPP 2014, in litt.) (USFWS, 2015).

- A conservation project on Rota, administered through the Water and Environmental Research Institute of the Western Pacific at the University of Guam, is aimed to analyze the island's hydrology, with the ultimate goal of protection of the Sabana Watershed and Talakhaya Springs (Keel et al. 2007, pp. 5, 22–23). Erosion control, revegetation, and water source preservation conducted as part of this project may provide protection to this species (USFWS, 2015).

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Final Rule. 80 Federal Register 190. October 1, 2015. Pages 59423 - 59497.

USFWS. 2015. Endangered and Threatened Wildlife and Plants

SPECIES ACCOUNT: *Malacothamnus clementinus* (San Clemente Island bush-mallow)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015); Proposed Delisting

Physical Description

A short subshrub with shaggy, grayish branches. The leaf blades are 3-5 lobed and are green on the upper surface and white/hairy below. The flowers are pink. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

This plant is only known from San Clemente Island, Los Angeles Co., California. Its range covers about 48 sq miles. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: No information found

Habitat Type

Adult: Coastal scrub (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits valley and foothill grasslands, and rocky canyon walls in coastal scrub. (NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: No information found.

Population Information and Trends

Population Trends:

Not available

Number of Populations:

21 - 80 (NatureServe, 2015)

Population Size:

50 - 2500 individuals (NatureServe, 2015)

Population Narrative:

Only known from a small number of sites on one Channel Island and the population sizes are very small. The long term trend was probably one of major decline due to the island initially being overrun with nonnative herbivores which severely damaged its ecology. Decline of 30-70% The population counts the CNDDDB has are old, and add up to fewer than 50 total plants. However, new data exist that may indicate much larger populations on the island today. 6 total EO's are known, and most are historic in the sense that CNDDDB records are over 20 years old. However, for island plants, this is more or less normal. CNDDDB expects to fully update San Clemente Island plants in Jan 2006. The inference is that there are many more sites now that the feral animals are mostly gone. (NatureServe, 2015)

Threats and Stressors

Stressor: Erosion ((USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: To help ameliorate threats, the Navy is developing an erosion control plan, a fire management plan, and an island-wide nonnative species control program (USFWS 2008, pp. 1–237). However, management actions directed at conservation of *M. clementinus* may not be fully implemented at 4 of the 11 known occurrences (Lower China Canyon, Upper China Canyon, Horse Beach Canyon, and Lemon Tank Canyon) currently closed to natural resource access. Since the 2007 status review, the Navy has increased and intensified military operations through the Military Operations and Fire Management Plan and though the species is expanding and on-going and anticipated conservation efforts contribute to its conservation, significant habitat threats continue to impact the species (USFWS, 2012).

Stressor: Military activities (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: To help ameliorate threats, the Navy is developing an erosion control plan, a fire management plan, and an island-wide nonnative species control program (USFWS 2008, pp. 1–237). However, management actions directed at conservation of *M. clementinus* may not be fully implemented at 4 of the 11 known occurrences (Lower China Canyon, Upper China Canyon, Horse Beach Canyon, and Lemon Tank Canyon) currently closed to natural resource access. Since the 2007 status review, the Navy has increased and intensified military operations through the Military Operations and Fire Management Plan and though the species is expanding and on-going

and anticipated conservation efforts contribute to its conservation, significant habitat threats continue to impact the species (USFWS, 2012).

Stressor: Predation (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Since the removal of feral goats and pigs, the distribution of *Malacothamnus clementinus* has expanded from 3 to 11 occurrences on San Clemente Island. Since we conducted our 2007 status review, there has been a change in intensity of training and habitat impacts associated with the 2008 Military Operations and Fire Management Plan. These changes include the escalation in frequency and intensity of bombardments in Impact Areas I and II and the movement of troops and vehicles through *M. clementinus* habitat. Therefore, based on the increased habitat impacts since the last status review and the ongoing threats discussed above, at this time we conclude this taxon continues to be at risk of extinction throughout all of its range (USFWS, 2012).

Stressor: Nonnative plants (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Competition with non-native plants is listed as a threat to this species (USFWS, 2012).

Stressor: Fire management (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: The Navy is implementing measures through the Integrated Natural Resources Management Plan to help minimize impacts associated with this threat (USFWS, 2012).

Recovery

Delisting Criteria:

Identify present adverse impacts to biological resources and strive to eliminate them (USFWS, 2012).

Protect known resources from further degradation by: (a) removal of feral herbivores, carnivores, and selected exotic plant species; (b) control of erosion in sensitive locations; (c) direct military operations and adverse recreational uses away from biologically sensitive areas (USFWS, 2012).

Restore habitats by revegetation of disturbed areas using native species (USFWS, 2012).

Identify areas of San Clemente Island where habitat restoration and population increase of certain addressed taxa may be achieved through a careful survey of the island and research on habitat requirements of each taxon (USFWS, 2012).

Delist or upgrade the listing status of those taxa that achieve vigorous, self-sustaining population levels as the result of habitat stabilization, restoration, and preventing or minimizing adverse human related impacts (USFWS, 2012).

Monitor effectiveness of recovery efforts by undertaking baseline quantitative studies and subsequent follow-up work (USFWS 1984, pp. 106–107) (USFWS, 2012).

Conservation Measures and Best Management Practices:

- Develop a systematic survey protocol for *Malacothamnus clementinus* on San Clemente Island. These surveys should include confirmation of existing locations at greater regularity to better determine accurate population status and trend for the species. Additionally, these protocols should include the standardization of information collected such as habitat conditions, habitat type, number of plants, date collected, etc (USFWS, 2012).
- Conduct studies to investigate genetic diversity of *Malacothamnus clementinus* to determine how the genetic fitness of the plant affects reproduction and the existence of the plant on island (USFWS, 2012).
- Conduct studies to determine the fire tolerance and preferred fire regime of *Malacothamnus clementinus* (USFWS, 2012).
- Work with the Navy to better estimate fire frequency in areas occupied by *Malacothamnus clementinus* on San Clemente Island (USFWS, 2012).

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SPECIES ACCOUNT: *Malacothamnus fasciculatus* var. *nesioticus* (Santa Cruz Island bush-mallow)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A small shrub, up to 2 m in height. Produces pink flowers, up to 3.75 cm broad, scattered along the ends of the branches. Blooms in June and July. (NatureServe, 2015)

Taxonomy

The 2nd edition of The Jepson Manual (Baldwin et al. 2012) accepts distinct varieties of *Malacothamnus fasciculatus*, including var. *nesioticus*, however, it states "Vars. maybe be untenable, needs study." *M. fasciculatus* var. *nesioticus* is included (along with several other names) in the synonymy of *M. fasciculatus* in Hickman (1993) and in Kartesz (1999). However, genetic studies have shown that var. *nesioticus* may be distinct variety (Swenson et al. in prep, as cited in USFWS 1995). In the summary and table of the July 31, 1997 notice in the Federal Register (in which the USFWS determines this taxon as endangered) this taxon is listed as *M. fasciculatus* SSP. *nesioticus*, although no publication of the name with this rank appears to exist. In the text of the notice it is called *Malacothamnus fasciculatus* VAR. *nesioticus* (NatureServe, 2015)

Current Range

Currently known from only four small populations on Santa Cruz Island. (USFWS, 2012)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Habitat Type

Adult: Scrub (NatureServe, 2015)

Habitat Narrative

Adult: One population is in a coastal scrub community, the other is in the dry interior. (NatureServe, 2015)

Dispersal/Migration

Population Information and Trends

Population Trends:

Not Available.

Threats and Stressors

Stressor: Small population size and limited distribution (USFWS, 2007)

Exposure:

Response:

Consequence: Extinction

Narrative: *Malacothamnus fasciculatus* var. *nesioticus* is threatened by the risk of stochastic extinction due to small population size and limited distribution, which was a threat at the time of listing and continues to be a threat. The conservation biology literature commonly notes the vulnerability of taxa known from one or very few locations and/or from small populations (e.g., Shaffer 1981, 1987; Primack 1998); Groom et al. 2006). In particular, small population size makes it difficult for this species to persist while sustaining the impacts of soil loss, shrub canopy loss, and competition with annual plants

Stressor: Non-native plants (USFWS, 2007)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The disruption of native habitats and displacement of native species by alien plants, particularly sweet fennel (*Foeniculum vulgare*) and nonnative grasses, was considered a major threat at the time of listing (62 FR 40954). Fennel is particularly invasive because its leaves and stems contain chemicals that inhibit the growth of native plants (Schoenherr et al. 1999). Ironically, nonnative grazers seemed to control the spread of fennel by keeping a check on its abundance. Consequently, once the sheep had been removed, a program to manually remove sweet fennel was initiated for fear that it would take over vast areas of the island (Schoenherr et al 1999) (USFWS, 2007).

Recovery**Reclassification Criteria:**

Establish five viable populations on Santa Cruz Island (addresses Listing Factors A, C, and E.) Only four populations are known at this time. Although surveys in historical and other suitable habitat have been conducted, other populations have not been found. In addition, no reintroduced populations have been established. Therefore, this criterion has not been met. We believe this criterion is adequate and appropriate with respect to the recovery of the species (USFWS, 2007).

Maintain populations as stable or increasing with evidence of natural recruitment for a period of 15 years that includes the normal precipitation cycle (addresses Listing Factors A, C, and E). Because the species has not been listed for a minimum of 15 years, this criterion has not been met. We believe this criterion is adequate and appropriate with respect to the recovery of the species (USFWS, 2007).

Delisting Criteria:

Discover or establish five additional populations (addresses Listing Factors A, C, and E). This criterion has not been met (USFWS, 2007).

No decline after downlisting for 10 years (addresses Listing Factors A, C, and E). This criterion has not been met. Although we believe the intent of this criterion is appropriate, we think it should be refined in the future to focus more on long-term trends, rather than a short-term, absolute decline, once additional information about the life history of the species and its response to recovery actions are better understood (USFWS, 2007).

Conservation Measures and Best Management Practices:

- Seek additional funding beyond 2007 to continue field surveys and monitoring, demographic monitoring, population viability analyses, and further investigations into recovery prescriptions (USFWS, 2007).
- Expand the fennel eradication program as soon as feral pigs have been eliminated from Santa Cruz Island (USFWS, 2007).
- Implement exotic vegetation removal, such as nonnative grasses, from Santa Cruz Island (USFWS, 2007).
- Refine the generalized downlisting criteria to take into consideration new information regarding the limited number of genotypes that currently exist. Attaining the recovery objective of securing several populations containing a minimum of 2,000 plants each is unrealistic for this species (USFWS, 2007).
- Refine delisting criteria to emphasize long-term population trends rather than short-term gains or declines (USFWS, 2007).
- Investigate the community-level factors that influence population abundance, distribution, and demographic trends (e.g., slope steepness and aspect, vegetation type, etc.) (USFWS, 2007).

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SPECIES ACCOUNT: *Malacothrix indecora* (Santa Cruz Island malacothrix)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An annual herb with broadly lobed, fleshy leaves. Produces hemispheric heads, 2-6 mm wide, of yellowish-green flowers. The heads are surrounded by long bracts. Blooms April-September. (NatureServe, 2015)

Taxonomy

Malacothrix indecora was first described by Edward Lee Greene (1886), based on specimens collected from “islets close to the northern shore of Santa Cruz Island.” In 1957, Williams published a combination of the species as *Malacothrix foliosa* var. *indecora* (Ferris 1960) and subsequently Munz (1974) later synonymized the taxon with *Malacothrix foliosa*. However, Ferris (1960) and others (Smith 1976, Davis 1980) continued to recognize the taxon as *Malacothrix indecora* and this nomenclature has been retained in the most recent treatments of the genus (Davis 1993, Jepson 2010, Flora of North America (FNA) 2010a). There have been no changes in the taxonomic classification or nomenclature since the time of listing (USFWS, 2010).

Historical Range

See current range/distribution.

Current Range

Known from three of the northern Channel Islands (Santa Cruz Island, San Miguel Island, and Prince Island) in Santa Barbara County, California. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Little is known about the life history of Santa Cruz Island malacothrix. This annual species is poorly to moderately self-compatible (Davis 1998) (USFWS, 2000).

Habitat Type

Adult: Coastal bluffs and flats (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits shallow soils on ocean bluffs and open, coastal rocky flats (NatureServe, 2015). High ecological integrity of the community and site fidelity and low tolerance ranges are inferred based on the species narrow geographic range and specific habitat requirements.

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: No information found

Population Information and Trends**Population Trends:**

Not available

Population Narrative:

The status of both *Malacothrix indecora* and *M. squalida* has not changed substantially since the time of listing in 1997. Currently, there are eight known populations of *M. indecora*, which occur on four of the northern Channel Islands: Anacapa, San Miguel, Santa Rosa, and Santa Cruz. These populations have exhibited some decline in the number of individuals over the last 15 years and we are lacking recent or comprehensive survey data for all of the populations, which makes it difficult to draw any conclusions about the current abundance trend for this species. There are three locations of *M. indecora* that were recently discovered in the spring of 2010 on East Anacapa Island where large patches of iceplant were removed in 2009. These new discoveries appear to indicate that this species might be expanding its range, since it was not historically known from Anacapa Island. There are two known extant populations of *M. squalida*, which occur on two of the northern Channel Islands: Santa Cruz and Anacapa. These populations have exhibited some decline and overall fluctuation in numbers of individuals over the last 15 years, but the number of individuals of this species is already very low and we do not have any recent or comprehensive survey data, which makes it difficult to draw any conclusions about the current abundance trend for this species (USFWS, 2011).

Threats and Stressors

Stressor: Fire and Invasive Species (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: we still believe that non-native plant species and catastrophic fires pose a risk to both the *Malacothrix* species. With the removal of non-native herbivores, we have also seen an increase in vegetation biomass, thus increasing the chance of larger and more frequent fires. Particularly, the vegetative biomass of non-native species has increased, due to the removal of non-native herbivores and continued exposure, thus increasing the amount of competition for

resources for both *Malacothrix* species. There has been some speculation that climate change may further complicate these two issues; however we lack adequate information to draw any conclusions about the specific changes that may occur on the northern Channel Islands as a result of climate change (please see discussion under Climate Change below) (USFWS, 2010).

Stressor: Hybridization (USFWS, 2010)

Exposure:

Response:

Consequence: Extirpation

Narrative: *Malacothrix indecora* and *M. squalida* hybridize both with one another and with several other *Malacothrix* species (McEachern, in litt. 2010). In particular, there is one documented occurrence of *M. indecora* and *M. squalida* hybrids in a north-draining canyon at Potato Harbor on Santa Cruz Island (McEachern, in litt. 2010). There are two other *Malacothrix* species that occur on the same islands as *M. indecora*, but *M. indecora* is the only other *Malacothrix* species that co-occurs with *M. squalida* (Junak et al. 1995). Hybridization was not addressed in the listing rule or the recovery plan and we lack any specific data which would allow us to draw any conclusions about how hybridization may affect either of these species at this time (USFWS, 2010).

Stressor: Stochastic Extinction (USFWS, 2010)

Exposure:

Response:

Consequence: Extirpation

Narrative: At the time of listing, we noted that due to the limited geographic range, and limited number of individuals and populations of both *Malacothrix indecora* and *M. squalida*, these species were at risk of stochastic extinction resulting from loss of genetic diversity, through chance events affecting survival and reproduction, and through naturally occurring catastrophic events, such as fire, drought, disease, or storms (Service 1997). We believe that the existence of only two and eight relatively isolated populations of *M. squalida* and *M. indecora*, respectively, place these species at risk of extinction from stochastic events. Because both species have a relatively limited geographic range and exist as only a few populations, the genetic viability and resilience of both *M. indecora* and *M. squalida* to human-caused or natural disasters may be greatly reduced (Menges 1991, Ellstrand and Elam 1993). Studies on Santa Cruz Island have shown that unexpected, complex interactions sometimes result in substantial declines within endemic species populations that were assumed to be stable (Roemer et al. 2001). The conservation biology literature commonly notes the vulnerability of taxa known from one or very few locations and/or from small and highly variable populations (Shaffer 1981, Groom et al. 2006, Primack 2006). In particular, although the plants are apparently self-compatible, the small size of the populations make it difficult for these species to persist while sustaining the impacts of soil damage (compaction and erosion) and habitat alteration that favors non-native species (USFWS, 2010).

Stressor: Climate Change (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Because all of the populations for both *Malacothrix* species occur on coastal bluffs in close proximity to the ocean, these species are subject to a wide range of climatic conditions,

such as occasional salt spray (Wilken 1996), which may directly affect the soils and plants at low elevation exposed coastal flats. Sea level rise and the continued erosion of the ocean-front cliffs on the exposed bluffs of the northern Channel Islands from high surf and storm events, in addition to climate variability, both from year to year and due to large-scale climate change, pose a threat to the relatively small and exposed *Malacothrix* populations (USFWS, 2010).

Recovery

Reclassification Criteria:

The recovery plan indicates that downlisting for *Malacothrix indecora* can be considered when the following criterion has been achieved: ? Stable populations are maintained on San Miguel, Santa Cruz, and Santa Rosa Islands for a period of 15 years that includes the normal precipitation cycle (USFWS, 2010).

Delisting Criteria:

The recovery plan indicates the delisting of *Malacothrix squalida* can be considered when the following criterion has been achieved: ? There has been no decline of this species for 10 years after downlisting (USFWS, 2010).

Recovery Actions:

- **Reclassification criteria:** This criterion is relevant; however, it should be updated to include a more measurable and threats-based component. Additionally, it may become increasingly difficult to evaluate the population over 15 years that includes the normal precipitation cycle due to the fact that the normal precipitation cycle is already changing and is predicted to continue to fluctuate considerably under the effects of climate change (IPCC 2007). This criterion does not include a clear definition of what constitutes a stable population for this species; therefore, it should be updated to include a more concrete definition of this term. David Keith presents a widely accepted method of evaluation of at-risk plant species that is based on The World Conservation Union (IUCN) Red List Criteria of 1994, consisting of a set of decision rules based on quantitative thresholds of population size, distributional range, rates of decline, and extinction risk (Keith 1997). We recommend that the recovery criteria for *Malacothrix indecora* be updated to include a more well-defined method, such as the one presented by Keith (1997), for assessing when this species can be considered stable and recovered. Despite the three new occurrences of *Malacothrix indecora* that were discovered this year, the most recent surveys of the *M. indecora* populations seem to show that overall, the number of individuals has decreased somewhat since listing (McEachern, in litt. 2010). Additionally, the precipitation cycles during the last 15 years have not been normal (Levine et al. 2009, Levine et al. 2010); therefore, this criterion has not been met (USFWS, 2010). **Delisting criteria:** This criterion is relevant; however it is rather vague. We recommend that this criterion be revised to take into consideration that there may be some fluctuation in the population sizes of these annual plant species; however, delisting may be considered when this species is considered recovered based on the quantitative methods of evaluation presented by Keith (1997) or some other comparable method. This criterion has not yet been met (USFWS, 2010).

Conservation Measures and Best Management Practices:

- Develop and implement monitoring and adaptive management plans for all of the existing populations. Monitoring should occur at intervals of 1 to 2 years and include population abundance

surveys, habitat condition assessment, and documentation of existing and potential threats. 1a. Work closely with agencies such as TNC, USGS, and NPS to continue monitoring efforts for the species and to develop a long-term adaptive management plan for special status species which occur on the northern Channel Islands (USFWS, 2010).

- Develop and implement an integrated non-native plant control program for Santa Cruz, Anacapa, San Miguel, and Santa Rosa Islands, which complements and enhances existing efforts (USFWS, 2010).
- 3. Continue to research the species' life history requirements, especially with regard to the habitat conditions favorable to both species. 3a. Specifically, we recommend a follow-up study to evaluate the response of both *Malacothrix* species to the removal of the non-native mammals from Santa Cruz, Santa Rosa, and San Miguel Islands and whether recovery of the soil health and stability has occurred. Because non-native large herbivores still remain on Santa Rosa Island, some baseline data could be gathered now and compared with the results that are gathered several years after the eventual removal of the remainder of these animals (USFWS, 2010).
- Update the recovery criteria for both *Malacothrix indecora* and *M. squalida* to include a more measurable and threats-based evaluation method, based on the recommendations presented in the discussion of the recovery criteria for both species on pages 16 through 18 of this review (USFWS, 2010).

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SPECIES ACCOUNT: *Malacothrix squalida* (Island malacothrix)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An annual herb, up to 9 cm tall, with narrow, irregularly toothed or lobed leaves. Flowers are pale yellow, borne in hemispheric heads which are 4-10 mm wide. Blooms April-July. (NatureServe, 2015)

Historical Range

This species was historically reported as having four known occurrences on two of the northern Channel Islands: Santa Cruz and Anacapa. One of the historically reported populations on Santa Cruz Island has not been seen since 1886 (CNDDDB 2010b, McEachern, in litt. 2010). Furthermore, based on our definition of a plant population (any occurrences within 0.25 mile of one another), two of the occurrences on Anacapa Island in the California Natural Diversity Database (CNDDDB) are close enough in proximity to be considered a single population; therefore, we consider there to be two known extant populations of this species. (USFWS, 2010)

Current Range

There has been no significant change in the geographic range for *Malacothrix squalida* since listing in 1997; however, several of the known populations appear to have expanded in areal extent in the last few years. There are currently two known extant populations of *Malacothrix squalida*.

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Self-pollinating (USFWS, 2000)

Dependency on Other Individuals or Species

Adult: No such dependencies (inferred from USFWS, 2010)

Reproduction Narrative

Adult: The island malacothrix is self-pollinating; it is inferred to have no dependences on other individuals or species for reproduction (USFWS, 2010).

Habitat Type

Adult: Coastal bluffs and rocky areas of cismontane woodland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Chaparral; cismontane woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Soil derived from igneous and metamorphic rock along coastal dunes, bluffs, and exposed flats (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: Elevation 15-200m (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Occurs on two islands: Santa Cruz Island and Anacapa (USFWS, 2010).

Habitat Narrative

Adult: The species inhabits coastal bluffs and rocky areas of cismontane woodland, and vegetation type is considered chaparral. The island malacothrix is observed at elevations of 15-200m, but the existing literature does not specify whether this is a geographic restraint (NatureServe, 2015). The species relies on soil derived from igneous and metamorphic rock along coastal dunes, bluffs, and exposed flats. It is distributed on two islands: Santa Cruz Island and Anacapa (USFWS, 2010).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: This species' motility/mobility, dispersal, or migration behavior and/or needs have not been determined (inferred from USFWS, 2010).

Population Information and Trends**Population Trends:**

Unknown (USFWS, 2010)

Number of Populations:

2 (USFWS, 2010)

Population Size:

Under 50 (USFWS, 2010)

Population Narrative:

It is not known whether island malacothrix populations are stable or in decline. The plant is considered to have two populations: one on Santa Cruz Island, and one on Anacapa. Population size was last noted to be under fifty individuals (USFWS, 2010).

Threats and Stressors

Stressor: Soil loss (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: This species is exposed to soil loss, habitat alteration, competition with non native plants, sheep grazing and feral pig rooting. Sea bird nesting may have some impacts to the populations on Middle Anacapa Island (Junak 2001). (NatureServe, 2015)

Stressor: Habitat alteration (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: This species is exposed to soil loss, habitat alteration, competition with non native plants, sheep grazing and feral pig rooting. Sea bird nesting may have some impacts to the populations on Middle Anacapa Island (Junak 2001). (NatureServe, 2015)

Stressor: Competition with non native plants (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: This species is exposed to soil loss, habitat alteration, competition with non native plants, sheep grazing and feral pig rooting. Sea bird nesting may have some impacts to the populations on Middle Anacapa Island (Junak 2001). (NatureServe, 2015)

Stressor: Sheep grazing (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: This species is exposed to soil loss, habitat alteration, competition with non native plants, sheep grazing and feral pig rooting. Sea bird nesting may have some impacts to the populations on Middle Anacapa Island (Junak 2001). (NatureServe, 2015)

Stressor: Sea bird nesting (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: This species is exposed to soil loss, habitat alteration, competition with non native plants, sheep grazing and feral pig rooting. Sea bird nesting may have some impacts to the populations on Middle Anacapa Island (Junak 2001). (NatureServe, 2015)

Stressor: Stochastic extinction due to limited distribution

Exposure:

Response:

Consequence:

Narrative: Stochastic extinction is named as a threat to extinction supplemental to those listed above (USFWS, 2010).

Recovery

Reclassification Criteria:

Ten additional populations have been discovered or outplanted on Anacapa and Santa Cruz Islands and stable populations have been maintained for a period of 15 years that includes the normal precipitation cycle (USFWS, 2010)

Not available

Not available

Not available

Delisting Criteria:

There has been no decline of this species for 10 years after downlisting (USFWS, 2010)

Recovery Actions:

- Develop and implement monitoring and adaptive management plans for all of the existing populations. Monitoring should occur at intervals of 1 to 2 years and include population abundance surveys, habitat condition assessment, and documentation of existing and potential threats (USFWS, 2010).
- Develop and implement an integrated non-native plant control program for Santa Cruz, Anacapa, San Miguel, and Santa Rosa Islands, which complements and enhances existing efforts (USFWS, 2010).
- Continue to research the species' life history requirements, especially with regard to the habitat conditions favorable to both species (USFWS, 2010).
- 4. Update the recovery criteria for both *Malacothrix indecora* and *M. squalida* to include a more measurable and threats-based evaluation method, based on the recommendations presented in the discussion of the recovery criteria for both species on pages 16 through 18 of the 2010 5-Year Review document (USFWS, 2010).

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SPECIES ACCOUNT: *Manihot walkerae* (Walker's manioc)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/02/1991; Southwest Region (Region 2) (USFWS, 2016)

Physical Description

A perennial herb, highly branched or few-stemmed, sprawling or erect, up to 1.5 m tall. The stems are smooth, grayish-brown, 3.2 millimeters (0.13 inch) in diameter. The leaves are alternate, deeply incised, and palmately 5-lobed. Flowers are unisexual and occur in racemes with staminate flowers in the raceme opening later than pistillate ones. Staminate flowers are tubular, constricted in the middle; tepals are 1.2 centimeters (0.47 inch) long, light purplish streaked externally, and cleft one-fourth of the way down into 5 lobes; stamens are 6-10, filaments and anthers are cream-colored. Flowers from spring through autumn, probably following rains. Clusters of 2-3 fragrant, white flowers open in late afternoon and last only 1 day. There are separate male and female flowers on the same plant. (USFWS, 1993; NatureServe, 2015)

Taxonomy

Leon Croizat (1942) described Walker's manioc as a distinct species. Rogers and Appan (1973) place it within section *Parvibracteatae* of the genus *Manihot*. Its closest relative may be *M. subspicata*, another rare plant of south Texas and northeast Mexico found on caliche or rocky limestone substrates. Tom Patterson observed that the ranges of these two species overlap in the Loreto sand plain of Tamaulipas (Patterson 2008, pers. com.). (USFWS, 2009)

Historical Range

Walker's manioc is known only from the Lower Rio Grande Valley of Texas (Hidalgo and Starr counties) and northern Tamaulipas, Mexico. One historical location for Walker's manioc was Ringgold Barracks, an old fort located on the eastern outskirts of Rio Grande City, Starr County, Texas. (USFWS, 1993)

Current Range

Walker's manioc is known only from the Lower Rio Grande Valley of Texas (Hidalgo and Starr counties) and northern Tamaulipas, Mexico. (USFWS, 1993). As of 2019: Walker's manioc has been documented from as far north as Duval County in southern Texas (TXNDD 2018, p. 18) to the vicinity of Aldama (Service 2009, p. 11) in the most southern part of the state of Tamaulipas, Mexico; a distance of approximately 532 kilometers (km). (USFWS, 2019).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual and asexual (USFWS, 2009)

Breeding Season

Adult: Spring through fall (USFWS, 2009)

Reproduction Narrative

Adult: The species is self-fertile, and does not appear to require a rare or specialized pollinator (Best 2008). Flowers from spring through autumn, probably following rains. The fruit capsules contain up to three seeds, which are dispersed a distance of several meters by the spontaneous, violent dehiscence (rupturing) of the capsules upon drying, which impedes seed collection (Best 2008). Seeds may remain dormant for a year or more, but germination can be induced by exposure to heat and moisture (Simpson 1995), or gibberellic acid (a naturally occurring plant hormone) (Best 2008). Individual plants have produced up to 20 rounded tubers 2 to 3 inches (5 to 7.5 cm) in diameter, after about 3 years' growth (Best 2008). This demonstrates that the species perenniates in the wild through both seeds and tubers (Best 2008). (USFWS, 2009). Walker's manioc is capable of dormancy due to its underground tubers that remain viable even when unfavorable aboveground conditions (e.g., drought, extended period of high temperatures, freezes) result in leaves and stems dying back. The ability of the species to regenerate, or to spread to new sites, via pieces of tuber has positive implications for propagation and reintroduction recovery actions. Observations at Lower Rio Grande Valley National Wildlife Refuge (LRGV NWR) show that manioc plants can begin tuber production at less than one year of age (Best 2008 in Service 2009, p. 10) and that potted manioc plants can produce numerous, large tubers by 2.5 years. Field observations indicate that javelina (*Pecari tajacu*) dig up and consume tubers, but may also act as agents of dispersal by dropping tuber pieces as they move (Service 2009, p. 18). In Tamaulipas, Mexico, manioc grew from tuber pieces scattered about in a crop field (Best 2008 in Service 2009, p. 16). Tubers appear to help the species survive adverse environmental conditions as well as anthropogenic surface impacts including herbicides, mowing, and perhaps disking or plowing. Manioc has reemerged following herbicide application that killed the aboveground portions of the plants (Best 2008 and Patterson 2008 pers comm. in Service 2009, p. 10). (USFWS, 2019).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Grassland/herbaceous, shrubland/chaparral (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Widely-spaced or small clusters (USFWS, 2009)

Environmental Specificity

Adult: Moderate, with some key requirements (USFWS, 2009)

Habitat Narrative

Adult: The recorded habitat descriptions from collections of the species vary from native brush to grassland. Endemic to the Tamaulipan grassland-thornscrub community of the Lower Rio Grande Valley, where it occurs on sandy-loam soils underlain by caliche. Walker's manioc plants occupy only a small portion of the upland vegetation of the Goliad geological formation, in shallow, calcareous sandy soil overlying indurated caliche. The soil depth is often 12 in (30 cm) or less. Populations may consist of widely-spaced individual plants along bands of shallow soil,

or small clusters of a few dozen individuals. Johnston (1963), Best (1995, 2005), and Poole et al. (2007) have described plant species found in close association with Walker's manioc. These include short native grasses and herbaceous plants, and low shrubs and sub-shrubs. (USFWS, 2009; NatureServe, 2015)

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 2009)

Dispersal/Migration Narrative

Adult: The fruit capsules contain up to three seeds, which are dispersed a distance of several meters by the spontaneous, violent dehiscence (rupturing) of the capsules upon drying, which impedes seed collection (Best 2008). (USFWS, 2009)

Population Information and Trends

Population Trends:

Not available.

Resiliency:

Moderate (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from USFWS, 2009)

Number of Populations:

3 (USFWS, 2009). Update: 11 (USFWS, 2019).

Population Size:

<1,000 individuals (NatureServe, 2015)

Population Narrative:

A regional endemic of southern Texas and northern Mexico, this species was thought to have been extirpated from the U.S. until a single surviving plant was discovered in 1990. Three sites on LRGV NWR, consisting of up to 90 individuals each, may be large enough to be considered viable populations. Five additional sites found in Texas have as many as 30 individuals. There is probably less than 1,000 individuals. (USFWS, 2009; NatureServe, 2015). With the exception of the Duval County population, all known Texas manioc populations occur in western Hidalgo County and southeastern-to-southcentral Starr County with the majority of these populations located within 2.4 km of the Rio Grande. Although the population data show a patchy, scattered distribution, much of the potential habitat between known populations has not been surveyed. The discovery of additional sites in 2009 illustrate the likelihood of finding more populations in unsurveyed suitable habitat on which the land cover has not been mined or otherwise built over. Three of the largest Texas populations occur on protected tracts of the LRGV NWR (TXNDD 2018, pp. 6, 8, and 10; Best 1996 in Service 2009), which implements monitoring and management actions intermittently. All other populations in Texas and Mexico, except for a small site on TXDOT ROW, are on privately-owned land. The TXDOT site in Hidalgo County is

considered highly vulnerable because of its location along a road (D. Price 2007, pers. comm.). (USFWS, 2019).

Threats and Stressors

Stressor: Urban and residential development (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Urban and residential development continues at a rapid pace throughout the border region of south Texas and northern Mexico. The human populations of Starr and Hidalgo Counties are projected to grow 67% and 88%, respectively, between 2000 and 2025 (Texas State Data Center 2008). Habitat loss is likely to continue both through development of sites as well as increased surface mining of caliche for construction of roads and parking lots. (USFWS, 2009)

Stressor: Energy development (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Intensive energy exploration continues throughout the entire range of Walker's manioc in south Texas and northeast Mexico. Under Texas and Mexican law, mineral rights owners take precedence over surface owners. Seismic exploration, pipelines, oil and gas wells, and access roads have proliferated on private lands as well as tracts of LRGV NWR, incrementally augmenting the loss of potential habitat of this and other listed plant and animal species. Habitats and populations at LRGV NWR are potentially vulnerable to impacts from oil and gas exploration, since USFWS does not own the mineral rights pertaining to most of the refuge's tracts. (USFWS, 2009). 2019 update: At the end of 2018, there were no wind turbines, oil and gas well pads, or roads directly impacting known manioc populations. However, the two south central Starr County manioc population sites were within 4.0 km and 4.8 km from existing turbines at large wind farms to the east and north, respectively. A 56–100-turbine wind farm is proposed for construction to the northwest of these populations. In Starr and Hidalgo counties, there are five existing wind farms (USGS 2019, unpaginated) with some of the 380 turbines atop manioc-appropriate soils. Wind energy development does not have a federal nexus and is not required to carry out surveys for listed species, therefore placement of turbine pads and internal roads could impact undiscovered populations, but the level of impacts is unknown. (USFWS, 2019).

Stressor: Habitat loss (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The primary threats to Walker's manioc are habitat loss and competition from invasive grasses. Although the caliche outcrops where the species occurs are not conducive to production of row crops, extensive surface mining of caliche supplies much of the base material for highways, unpaved roads, well-drilling pads, and parking lots throughout the region. Surface mining of caliche is therefore a major threat to species, such as Walker's manioc, that are endemic to exposed caliche outcrops. (USFWS, 2009)

Stressor: Invasive plants (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Many species of Old World grasses have been introduced in the Tamaulipan region of south Texas and northeast Mexico for cattle forage and erosion control, including several that are now highly invasive (Best, in press). The “common variety” of buffelgrass (*Pennisetum ciliare*) was derived from a single apomictic individual from northern Kenya (Holt 1985). Common buffelgrass was introduced in south Texas beginning in 1946 and is now abundant from Texas and Tamaulipas to Arizona and Sonora. Buffelgrass is well adapted to the well-drained calcareous soils where Walker’s manioc occurs. This forage grass is typically established by root-plowing sites with powerful tracked vehicles, then broadcasting the seed in the disturbed soil. A large amount of potentially suitable habitat for Walker’s manioc has been converted to root-plowed buffelgrass pasture. Buffelgrass often increases following soil disturbance, allowing it to spread rapidly along road, powerline, and pipeline rights-of-way. It is present at most Walker’s manioc sites, frequently dominating the herbaceous vegetation and suppressing most native species including Walker’s manioc. In the Loreto sand plain another introduced grass, pitted bluestem (*Bothriochloa pertusa*), may also compete with Walker’s manioc (Best 2005). (USFWS, 2009)

Stressor: Genetic swamping (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: A closely related plant, cassava (*Manihot esculenta*), is an important staple crop throughout the tropics. Walker’s manioc may serve as a source of genetic material for the development of improved cassava cultivars (U.S. Fish and Wildlife Service 1990b, 1993a). The storage life of edible cassava roots is significantly diminished by post-harvest physiological deterioration (PPD). Researchers created an inter-specific hybrid between cassava and propagated specimens of a Mexican collection of *M. walkerae* which is the only known source of resistance to PPD (Centro Internacional de Agricultura Tropical 2005; Cuambe 2007). This research has not directly affected wild populations, since the source material came from cultivated plants. However, if the inter-specific hybrid or cultivars derived from it are able to back-cross with wild plants, this could threaten wild populations through genetic swamping. (USFWS, 2009)

Stressor: Predation (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: In September 2003, Tom Patterson reported an incidence of digging in the exact locations of Walker’s manioc plants on three tracts of LRGV NWR (Patterson 2003, pers. com.). These plants had been precisely mapped with GPS, and had been identified with numbered aluminum tags. A refuge law enforcement officer (who is a skilled tracker) and the plant ecologist investigated these sites. They determined that the digging had not been done by humans and identified numerous tracks of javelina (collared peckary) at these sites. Javelina feed heavily on plant seeds and tubers (Leopold 1972). The refuge staff observed that some partially-eaten tuber fragments had sprouted new roots and shoots (Best 2008). Feral hogs are abundant in the region, and may also constitute a serious threat to Walker’s manioc populations (Patterson 2008, pers.

com.). Patterson also observed rabbits consuming the stems and leaves of Walker's manioc (Patterson 1996, pers. com.). (USFWS, 2009)

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: According to the Intergovernmental Panel on Climate Change (IPCC) (2007) "Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level." Average Northern Hemisphere temperatures during the second half of the 20th century were very likely higher than during any other 50-year period in the last 500 years and likely the highest in at least the past 1300 years (IPCC 2007). It is very likely that over the past 50 years cold days, cold nights and frosts have become less frequent over most land areas, and hot days and hot nights have become more frequent (IPCC 2007). It is likely that heat waves have become more frequent over most land areas, and the frequency of heavy precipitation events has increased over most areas (IPCC 2007, p. 1). Some climate change models also predict increased precipitation along the Gulf Coast, largely due to increased tropical storm activity and severity (Twilley et. al. 2001). Since the species now occurs in some of the most xeric of regional habitats, increasing rainfall could reduce its competitive advantage in those marginal sites. Regardless of how changes in temperature and rainfall amounts and patterns may affect the autecology of Walker's manioc, the altered synecology may be far more significant. For example, higher winter temperatures and increased precipitation could augment competition from buffelgrass or other introduced invasive grasses. Conversely, the same changes could expand the range or increase the pathogenicity of *Pyricularia grisea*, a rust fungus that attacks buffelgrass, thereby reducing its invasiveness. The possible effects of climate change on the synecology of Walker's manioc habitat are infinitely complex. Therefore, the Service will continue to monitor the species and its habitat, and will adapt our recovery and management strategies when necessary to address the changing conditions. (USFWS, 2009)

Stressor: Quarrying/Mining (USFWS, 2019).

Exposure:

Response:

Consequence:

Narrative: Google Earth imagery dated January 2017 shows numerous pits or caliche quarries in the area between the most eastern manioc population in southern Texas and Rio Grande City, Texas. Mining is evident on this imagery to both the north and south of Highway 83 with ongoing activity at a number of the sites as evidenced by on-site vehicles. Expansion of a number of these pits can be confirmed by comparing imagery across years. All of the manioc sites in Hidalgo and Starr counties, including some on refuge tracts, are in relatively close proximity to either active quarries or what appear to be old pits that are now full of water, illustrating that the species occurs within a zone of active caliche or gravel quarrying. On private land, known populations are not currently protected by agreements and any undiscovered populations that may exist remain threatened by caliche mining. (USFWS, 2019).

Stressor: U.S./Mexico Border development (USFWS, 2019).

Exposure:

Response:

Consequence:

Narrative: Walker's manioc's proximity to the Rio Grande and to HWY 83 increases the vulnerability of the species to development which tends to occur along the river and HWY 83. Proximity to the Rio Grande also means more vulnerability to new roads, new border barriers, increased traffic, and other activities related to increased law enforcement and border security. (USFWS, 2019).

Recovery**Reclassification Criteria:**

Maintain or establish 15 self-sustaining populations of Walker's manioc in the United States. Establish management plans (public lands) or management agreements (private lands) to insure the protection of these populations. (USFWS, 1993)

2019 Downlisting Criterion amendment: Within the Hidalgo-Starr Counties, Texas Recovery Unit, establish or maintain 15 distinct, self-sustaining populations of Walker's manioc. Each population should consist of at least 1,000 reproductive individuals. (USFWS, 2019).

Delisting Criteria:

1. Over a 30-year period, maintain at least 15 fully protected, self-sustaining populations containing at least 1,000 reproductive individuals in each, within the known U.S. range. (USFWS, 2019).

Protection and management agreements need to be perpetual to provide a permanent level of protection. (USFWS, 2019).

Recovery Actions:

- Protect the habitat of the existing populations on private lands in the United States and Mexico. (USFWS, 1993)
- Gather biological information necessary for management and develop a monitoring program for populations. (USFWS, 1993)
- Search for new populations in the United States and Mexico. (USFWS, 1993)
- Establish a botanical garden population. (USFWS, 1993)
- Initiate a reintroduction program into suitable habitat on the Lower Rio Grande Valley National Wildlife Refuge, Texas Parks and Wildlife Department lands and other lands made available for use. (USFWS, 1993)
- In 2019, one Recovery Unit was identified: Recovery Unit 1 – Hidalgo-Starr Counties, Texas. (USFWS, 2019).

Conservation Measures and Best Management Practices:

- Criterion 1 calls for establishment or maintenance of at least 15 self-sustaining populations of 100 or more individuals. This criterion should be revised using updated methods to describe what constitutes a viable population, and the number and geographic distribution of populations necessary for recovery. (USFWS, 2009)
- Criterion 2 requires establishment of "agreements for the protection and management of all populations on private lands..." However, USFWS has no authority to require private landowners to protect endangered plants. Furthermore, because the USFWS cannot survey private lands without

the owner's permission, it is not possible to quantify the number of populations requiring protection. The criterion, as currently written, tends to promulgate misinterpretation of the authority of the Endangered Species Act, and might discourage landowners from cooperating with USFWS in the conservation of this species. Finally, successful recovery may be possible without protecting all known sites. This criterion should be revised to establish quantifiable, attainable objectives. (USFWS, 2009)

- The plan should have a recovery criterion that addresses seed banking, establishment of refugium populations and reintroduction efforts, all of which serve as safeguards against the unavoidable loss of populations to development, competition from invasive species, or catastrophic events. (USFWS, 2009)
- Periodic monitoring and surveys of known sites in Texas and Tamaulipas. In particular, a quantitative survey should be conducted at the three sites on LRGV NWR to detect population trends at those sites. (USFWS, 2009)
- Additional surveys of potential habitat in Texas and Tamaulipas, focusing on sites with Goliad-formation caliche outcrops that have not previously been surveyed. (USFWS, 2009)
- Seed collection for propagation and seed banking, establishment of seed increase plots, and pilot reintroduction projects. (USFWS, 2009)
- In-situ investigation of reproductive biology and population dynamics. (USFWS, 2009)
- Investigation of the genetic structure of known populations throughout the species range. (USFWS, 2009)
- Establish cooperative efforts to promote the conservation of Goliad formation caliche outcrops. (USFWS, 2009)
- Promote cooperative efforts with Mexican agencies, scientists, and non-profit conservation organizations to conserve populations in Mexico. (USFWS, 2009)
- Conduct public outreach efforts to encourage conservation of the species and its habitat on private lands. (USFWS, 2009)
- Determine whether inter-specific hybrids of *M. esculenta* and *M. walkerae*, or cultivars derived from those hybrids, are able to create fertile progeny with wild *M. walkerae*. (USFWS, 2009)

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SPECIES ACCOUNT: *Marshallia mohrii* (Mohr's Barbara's buttons)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/7/1988; Southeast Region (R4)

Physical Description

Erect perennial herb, 3 to 7 decimeters (1 to 2.3 feet) tall. The leaves are alternate, 8 to 20 centimeters (cm) (3.2 to 7.8 inches) long, firm-textured, three-nerved, and lanceolate-ovate in shape. Leaves are often clustered near the base and gradually reduce in size upwards. The flowers are typically produced in several heads in a branched arrangement. The heads are approximately 2.5 cm (1 inch) broad and consist of disk flowers (tubular in shape) which are pale pink or white in color. The fruit is an achene (USFWS, 1991).

Taxonomy

In the sunflower family (Asteraceae) (USFWS, 1991). The taxon is currently recognized as valid by the Integrated Taxonomic Information System (ITIS) (ITIS 2015), as well as national and regional floras (e.g., Flora of North America [Watson 2006] and Flora of the Southern and Mid-Atlantic States [Weakley 2015]). While the taxonomic status of this species is not affected, some authors use the alternate common name Coosa Barbara's-buttons (e.g., Noss 2012, Spaulding 2013, Weakley 2015) rather than Mohr's Barbara's buttons used by the Service and others (e.g., Chafin 2007, ITIS 2015, NatureServe 2015). (USFWS, 2016)

Historical Range

Historical records exist for Walker County, Georgia, and Walker and Cullman Counties, Alabama, in addition to the current range (USFWS, 1991).

Current Range

Currently known from Bibb, Cherokee, and Etowah Counties, Alabama, and Floyd County, Georgia (USFWS, 1991)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Abiotic, Insect (EPA, 2016)

Breeding Season

Adult: Flowering in mid-June; fruiting in July to August (EPA, 2016)

Key Resources Needed for Breeding

Adult: Insects for pollination (EPA, 2016)

Reproduction Narrative

Adult: Reproduction is abiotic and by insect. Flowering occurs in mid-June, with fruiting in July to August. As a means of avoiding self-pollination, flowers on a given plant produce pollen before that plant's stigmas become receptive (EPA, 2016)

Habitat Type

Adult: Wetland, Terrestrial (NatureServe, 2015b)

Habitat Vegetation or Surface Water Classification

Adult: Barrens, forest edges, meadows, grasslands (NatureServe, 2015b)

Dependencies on Specific Environmental Elements

Adult: sandy clays, which are alkaline, high in organic matter, and seasonally wet (USFWS, 1991)

Environmental Specificity

Adult: Narrow (NatureServe, 2015b)

Habitat Narrative

Adult: The habitat is moist prairie-like openings in woodlands, along shale-bedded streams, and meadows. The soils are sandy clays, which are alkaline, high in organic matter, and seasonally wet. Most currently known populations occur on soils of the Conasauga-Firestone Association. Plants occur in full sun or partial shade in a grass-sedge community (USFWS, 1991; NatureServe, 2015).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Seeds are probably dispersed by birds and other small mammals (EPA, 2016).

Population Information and Trends**Population Trends:**

Not available.

Number of Populations:

19 extant, 9 historical/extirpated (USFWS, 2016)

Population Size:

Up to 6,740 individuals estimated (USFWS, 2016)

Population Narrative:

Schotz (2014) estimated the total range-wide population to be up to 6,740 individuals. Additional recent survey data from some of these sites and other sites not visited by Schotz in Alabama (e.g., AANG 2015, TVA 2015) suggests that this estimate is low; however, 2015 surveys by Malcolm Hodges (pers. comm. 2015) did not relocate plants at three small sites in Georgia where Schotz had previously found them. Together, this recent survey data suggests that the range-wide Mohr's Barbara's buttons population size may approach 10,000 plants (Schotz 2014, AANG 2015, M. Hodges pers. comm. 2015, TVA 2015). Individual sites may range from fewer than 20 plants to well over 1,000 (Schotz 2014, AANG 2015, TVA 2015); although, most (27

[79%]) of the 34 extant sites surveyed by Schotz support 200 or fewer plants. Furthermore, two-thirds of the plants encountered during Schotz's surveys were found at only seven sites. Additionally, Schotz noted that at a given site, plants may be clustered in areas of approximately 50 square feet or can be scattered across several acres, which is similar to observations made by others (i.e., AANG 2015, TVA 2015). (USFWS, 2016)

Threats and Stressors

Stressor: Destruction and Degradation of Habitat (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Clearing, conversion, and agricultural activities remain persistent threats to various Mohr's Barbara's buttons' occurrences (Schotz 2014). Nearly one-third (11 of 34) of extant sites Schotz (2014) surveyed have been converted to pine plantations and/or had been impacted by recent timber harvests. In addition, logging is thought to have extirpated Etowah County, Alabama's only known population (Schotz 2014, D. Spaulding pers. comm. 2015), while conversion to row crop agricultural field has likely extirpated one population in Cherokee County, Alabama (Schotz 2014). Suitable habitat for Mohr's Barbara's buttons remains vulnerable to loss. As described above, most Coosa Valley prairies are thought to have been lost since the early 1800s with the only known remnants of this habitat currently located in Floyd County, Georgia (Duncan 2013). Similarly, Bibb County, Alabama's Ketona dolomite glades are unique and exceedingly rare habitats and are vulnerable to damage by recreational uses and adjacent logging activities. Schotz (2014) noted damage to two glades by recreational traffic (e.g., ATV use) and logging damage or vulnerability of two others. Construction of a borrow pit is thought to have reduced available habitat for one site in Floyd County, Georgia (Schotz 2014). Furthermore, development and associated habitat destruction are projected to continue for decades to come throughout the southeastern United States (Stein et al. 2010), which could further encroach upon and limit habitat suitable for Mohr's Barbara's buttons. (USFWS, 2016)

Stressor: Inadequate/Incompatible Habitat Management (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: An important threat to Mohr's Barbara's buttons' continued survival is incompatible and inadequate land management. While the species is apparently able to survive certain types of forestry practices (e.g., limited timber harvesting that opens up the canopy), its apparent inability to tolerate heavy shading likely increases its susceptibility to practices that promote vegetation succession and encroachment of invasive species (e.g., fire suppression). Fire may be an important mechanism for maintaining the open character of some of Mohr's Barbara's buttons habitats. Inadequate fire regimes threaten some occurrences by allowing competing vegetation—particularly hardwoods—to grow unchecked, thereby encroaching upon available habitat for Mohr's Barbara's buttons and reducing availability of resources (e.g., light) that the species requires to survive and thrive (Patrick et al. 1995, Schotz 2014). Fire exclusion was noted as a primary threat to 24% of sites surveyed by Schotz (2014), whereas succession was considered a threat to 29%. Highway and utility rights-of-way are currently home to various Mohr's Barbara's buttons sites. The known extent of three extant populations are restricted to a TVA utility right-of-way (in Jefferson County, Alabama), whereas portions of at least six other

populations occur in either utility or road rights-of-way (Allison 1993, Schotz 2014, M. Hodges pers. comm. 2015). As such, these sites are heavily dependent upon compatible management regimes to maintain healthy populations (e.g., Schotz 2014, AANG 2015, TVA 2015). Mohr's Barbara's buttons is particularly vulnerable to herbicides and incompatible mowing regimes within its habitats; however, appropriate mowing regimes may also serve as valuable conservation tools in these areas (Schotz 2014). Schotz (2014) noted that nearly one-third of all sites surveyed were vulnerable to incompatible management regimes within rights-of-way throughout the species' range. Furthermore, at least one site along a road right-of-way in Cherokee County, Alabama is thought to have been extirpated by incompatible management (Schotz 2014). Additional emphasis on reintroducing fire or fire surrogates (e.g., mowing) is needed to promote healthy populations and maintain open conditions that this species requires. (USFWS, 2016)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Mohr's Barbara's buttons is a State threatened plant in Georgia (Patrick et al. 1995) and, therefore, receives State protection from non-permitted collection and sale; however, State law does not provide protection against habitat destruction in Georgia. Collection of this species on public lands without a permit is prohibited in Georgia under the Georgia Wildflower Preservation Act of 1973, O.C.G.A. 12-6-170. No such provisions are afforded to plants found on privately owned lands in the State. The species does not receive any specific legal protections from State laws or regulations in Alabama. (USFWS, 2016)

Stressor: Invasive Species (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: During the most recent range-wide survey, Schotz (2014) noted that invasive species are a potential threat to some Mohr's Barbara's buttons populations. Indeed, Schotz (2014) observed encroachment of exotic invasive plants species at 14 Mohr's Barbara's buttons sites. These species—predominantly Chinese privet (*Ligustrum sinense*)—left unchecked have the potential to degrade habitat quality and out-compete Mohr's Barbara's buttons for resources (e.g., moisture, nutrients, light, and recruitment sites). Currently, threats posed from invasive plants at most sites appears to be minimal (Schotz 2014); however, habitat management (e.g., fire, mechanical or hand thinning, etc.) may be required to control invasive species where they threaten Mohr's Barbara's buttons. (USFWS, 2016)

Stressor: Small Population Size (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Most extant populations of Mohr's Barbara's buttons are comprised of a number of small, fragmented occurrences. While population sizes (i.e., number of plants obtained from counts or estimates) are not available for all sites/populations of Mohr's Barbara's buttons, the most recent range-wide status assessment by Schotz (2014) found that most sites had small local population sizes and that most of the range-wide population was contained in only a few sites

with comparatively large local populations. Indeed, Schotz found that 53% (18 of 34) of extant sites had local populations of ≤ 100 individuals and 79% (27 of 34) of these sites had ≤ 200 individuals. Together, sites with ≤ 200 individuals accounted for about one-third of the total population evaluated by Schotz. By contrast, only three sites evaluated were found to have 500 or more plants, which accounted for nearly half of the entire population evaluated range-wide. Small population sizes increase the vulnerability of individual sites to environmental and anthropogenic perturbations and chance events. In addition, small population sizes increase the risks posed by inbreeding and genetic drift, which may limit the species' adaptive capacity and ability to cope with future stressors (Ellstrand and Elam 1993). (USFWS, 2016)

Stressor: Climate Change (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: The precise magnitude and impacts of climate change on the southeastern United States are uncertain, but models have projected that climate change in the region may include increased temperatures of 2 to 4°C (3.6 to 7.2°F) accompanied by reduced average annual precipitation by the end of the century (Joyce et al. 2011). Specific impacts of climate change on populations of Mohr's Barbara's buttons are poorly understood; however, a variety of impacts are possible. Climate change has the potential to affect distribution and abundance of plants by influencing seasonal weather patterns, frequency and timing of severe weather events, and myriad plant physiological responses (Hawkins et al. 2008). Davenport (2007) suggested that Mohr's Barbara's buttons may be negatively impacted by climate change within Alabama as available habitat becomes constricted. In addition, climate change may disrupt plant-pollinator interactions via phenological shifts in flowering and/or pollinator activity (Memmott et al. 2007, Hawkins et al. 2008), which may thereby reduce sexual reproduction of Mohr's Barbara's buttons. While disease is not currently known to threaten Mohr's Barbara's buttons, climate change has the potential to promote the spread of infectious diseases among plants, particularly if arthropod vectors become more widespread and abundant (Anderson et al. 2004, Garrett et al. 2006, Hawkins et al. 2008). Given the variety and complexity of climate change's potential effects (cf. Hawkins et al. 2008, Walther 2010), more research is needed to assess its potential long-term impacts on Mohr's Barbara's buttons populations and habitats. (USFWS, 2016)

Recovery

Reclassification Criteria:

Not applicable.

Delisting Criteria:

1. There are 15 viable populations and all are protected from present and foreseeable human-related and natural threats (USFWS, 1991)
2. At least three populations each should be located within the two physiographic regions represented by its historic range (Cumberland Plateau, Ridge and Valley) (USFWS, 1991).
3. At least three of the 15 populations should be located within Alabama and three in Georgia. Viability of populations will be assessed through monitoring for a period not less than 15 years (USFWS, 1991).

Recovery Actions:

- Protect existing populations from any present or foreseeable threats, and search for additional populations (USFWS, 1991)
- Determine population size. Conduct demographic studies and gather life history information (USFWS, 1991).
- Determine habitat characteristics. An understanding of this species ecology is an important component to determining what factors limit its distribution (USFWS, 1991).
- Determine parameters of a viable population. The long-term survival of the species will be ensured only if a sufficient number of viable populations are protected. (USFWS, 1991).
- Determine and implement appropriate management. Management of habitat, as well as protection, appears to be essential for ensuring that vigorous populations are maintained (USFWS, 1991).
- Conduct monitoring studies. A general monitoring program should be devised and implemented on sites in order to track population trends and evaluate the effectiveness of recovery efforts (USFWS, 1991).
- Preserve genetic material. Protection of the gene pool should be accomplished through seed bank storage and by maintaining material in cultivation (USFWS, 1991).
- Recommendations for Future Actions from 2016 5-Year Review: •Work with federal and state entities, non-governmental organizations, and private individuals to permanently protect and manage existing habitats and populations, including the development and implementation of management plans, as needed. •Conduct studies to determine the number and distribution of populations required to maintain the species' genetic diversity. •Investigate metapopulation structure and dynamics of the species. •Conduct studies into the species' life history, biology, and ecology. •Investigate efficacy of habitat management techniques (e.g., fire). Update and improve monitoring and habitat management methods. •Update the species' recovery plan to reflect current knowledge (e.g., distribution, habitats) and needs (e.g., data/knowledge deficiencies, management). (USFWS, 2016)

Conservation Measures and Best Management Practices:

- Personnel of the Alabama Highway Department (Department) are aware of the plants on or near the ROWs they maintain and of the importance of protecting them. An informal agreement exists between the U.S. Fish and Wildlife Service (Service) and the Department for protection of the plants on their ROWs (USFWS, 1991).
- One population on private land in Cherokee County is protected through a long-term Cooperative Agreement (USFWS, 1991).

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SPECIES ACCOUNT: *Melanthera (=Lipochaeta) kamolensis* (Nehe)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/15/1992; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Lipochaeta kamolensis is a low perennial herb in the aster family (Asteraceae). The occasionally somewhat woody stems are low-lying or free-climbing, 30 cm to 3 m (1-9.8 feet) long, rooting along their lower surfaces. Leaves are long and narrow or triangular, about 3-6 cm (1.2-2.4 in) long and 1-4 cm (0.4-1.6 in) wide, both surfaces hairy, especially along the veins. The leaves are lobed, sometimes deeply, along the middle vein in a feather-like arrangement (pinnately lobed), and are on leaf stalks (petioles) about 1 to nearly 2 cm (0.8 in) long. Flower heads occur singly or in pairs, each with 6 approximately 4-9 mm (0.2-0.4 in) petal-like ray florets surrounding about 15 small (3 mm [0.1 in]) disk florets. Each head is surrounded by lance shaped leaf-like parts (bracts); old bracts are tan in color. The fruits are small (approximately 1.5-2 x 2 mm (0.06-0.08 x 0.08 in)) and dry (achenes). (USFWS, 1997)

Taxonomy

The 2012 supplement to the Manual of the Flowering Plants of Hawaii (Wagner et al. 2012) accepts the change from the genus *Lipochaeta* to the currently accepted *Melanthera*, and recognizes *Lipochaeta kamolensis* as *Melanthera kamolensis*. The proposed change will recognize *Lipochaeta kamolensis* with the new name of *Melanthera kamolensis*. The range of the species has not changed with this taxonomic revision. Gardner (1979) stated that *L. kamolensis* is most closely related to *L. subcordata* (endemic to Kauai, Lanai, and Hawaii Island), and to a lesser degree to *Lipochaeta venosa* (endemic to Hawaii Island) and *L. bryanii* (endemic to Kahoolawe). The genus *Lipochaeta* comprises 20 species, restricted to the Hawaiian Islands. (USFWS, 1997; USFWS, 2014)

Historical Range

See Current Range (USFWS, 1997).

Current Range

Current range: over about 100 acre area in Kamole and Kepuni gulches of East Maui. (USFWS, 2014)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Lipochaeta kamolensis* (Nehe) (aka *Melanthera kamolensis*) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Lipochaeta kamolensis* includes four CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Lowland Dry—Unit 1 consists of 11,465 ac (4,640 ha) of State land, 2,069 ac (837 ha) of federally owned land, and 3 ac (1 ha) of privately owned land, from Kanaio to Kahualau Gulch on the southern slopes of east Maui. This unit is occupied by the plants *Bonamia menziesii*, *Cenchrus agrimonoides*, *Flueggea neowawraea*, *Melicope adscendens*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 1 is not known to be occupied by *Alectryon macrococcus*, *Bidens micrantha* ssp. *kalealaha*, *Canavalia pubescens*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Sesbania tomentosa*, *Solanum incompletum*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 2 consists of 1,851 ac (749 ha) of State land at Keokea on the southern slopes of east Maui. This unit is occupied by the plants *Bonamia menziesii*, *Canavalia pubescens*, and *Hibiscus brackenridgei*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 2 is not known to be occupied by *Alectryon macrococcus*, *Bidens micrantha* ssp. *kalealaha*, *Cenchrus agrimonoides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 3 consists of 188 ac (76 ha) of privately owned land, at Keauhou on the southern slopes of east Maui. This unit is occupied by the plant *Canavalia pubescens*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 3 is not known to be occupied by *Bidens micrantha* ssp. *kalealaha*, *Bonamia menziesii*, *Cenchrus agrimonoides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of

these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 4 consists of 1,266 ac (512 ha) of State land (including the Department of Land and Natural Resources) at Ahihi-Kinau Natural Area Reserve on the southern slopes of east Maui. This unit includes the mixed hermland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Maui—Lowland Dry—Unit 4 is not currently occupied by *Bidens micrantha* ssp. *kalealaha*, *Bonamia menziesii*, *Canavalia pubescens*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Lipochaeta kamolensis* critical habitat consists of one component. Lowland dry (east Maui) (81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*. Subcanopy: *Chamaesyce*, *Dodonaea*, *Leptecophylla*, *Osteomeles*, *Psydrax*, *Scaevola*, *Wikstroemia*. Understory: *Alyxia*, *Artemisia*, *Bidens*, *Chenopodium*, *Nephrolepis*, *Peperomia*, *Sicyos*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The

125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant

species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Dependency on Other Individuals or Species

Adult: Honeybees (USFWS, 1997)

Reproduction Narrative

Adult: Gardner (1979) noted flowering in December-February. Flowering was observed in April 1994 (A.C. Medeiros, L. Loope, and P.A. Thomas, personal observation 1994). Vegetative growth normally occurs only during the November-April/May wet season. During the dry season, the plants are desiccated and appear to be metabolically inactive. Though native bees (*Nesoprosopis* sp.) were observed nearby on flowers of other native species (e.g., *Argemone glauca*), only alien honeybees (*Apis mellifera*) were observed visiting the flowers of *Lipochaeta kamolensis*. (USFWS, 1997)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Grassland/herbaceous, shrubland/chaparral (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Annual rainfall ranges from 24-30 inches with most rain coming in November through April (USFWS, 1997)

Habitat Narrative

Adult: Degener's type collection made in 1948 notes: "Very rare, among lantana and grass" (Medeiros et al. 1986). Medeiros et al. (1986) reported that the habitat "is highly impacted by cattle" and that "very little native vegetation remains"; at that time *Lipochaeta kamolensis* was found to persist "in small depressions and along cattle trails." Mean annual rainfall for the area is in the neighborhood of 600-750 mm (24-30 in). Rainfall is variable from year to year and highly seasonal, with most rain coming in November-April (Giambelluca et al. 1986). (USFWS, 1997)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2014)

Redundancy:

Very low (inferred from USFWS, 2014)

Number of Populations:

1 (USFWS, 2018)

Population Size:

1 wild (USFWS, 2018)

Population Narrative:

In 2012, there were approximately 30 to 40 individuals of *Lipochaeta kamolensis* on East Maui (USFWS 2012; A. Medeiros, U.S. Geological Survey, pers. comm. 2010). Overall, *Lipochaeta kamolensis* has increased from approximately 25 wild individuals reported in the last 5-year review to approximately 30 to 40 wild individuals (USFWS 2012; A. Medeiros, pers. comm. 2010). (USFWS, 2014). The latest review of the species by IUCN in 2015 reported one subpopulation of four individuals (Chau et al. 2015); however, by 2018, only one wild plant remained (Oppenheimer, 2018, in litt.) (USFWS, 2018).

Threats and Stressors

Stressor: Drought (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Drought may exacerbate the effects of ungulates and has direct adverse impacts on *M. kamolensis* (PEPP 2013). (USFWS, 2014)

Stressor: Landslides and flooding (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Landslides and flooding destruction or degradation of habitat – This species is threatened by landslides and erosion (PEPP 2012). (USFWS, 2014)

Stressor: Ungulate trampling, grazing, and browsing (USFWS, 1997)

Exposure:**Response:****Consequence:**

Narrative: Habitat destruction and predation by feral goats and domestic cattle threaten *Lipochaeta kamolensis* (Medeiros et al. 1986; R.W. Hobdy, personal communication 1994). Ironically, however, heavy grazing of habitat surrounding *L. kamolensis* serves a partially positive role in removing much of the biomass of alien vegetation, which would potentially fuel wildland fires. (USFWS, 1997)

Stressor: Alien plant species (USFWS, 1997)

Exposure:**Response:****Consequence:**

Narrative: The remaining habitat of *Lipochaeta kamolensis* has been much altered by alien plant species. Three species have spread widely within the last decade on leeward East Maui, and though present in the habitat of *Lipochaeta kamolensis* in limited cover, have the potential to dominate the site. These species include a leguminous vine, *Glycine wightii*, and two invasive grasses, *Melinis minutiflora* (molasses grass), and *Panicum maximum* (Guinea grass). (USFWS, 1997)

Stressor: Wildland fire (USFWS, 1997)

Exposure:**Response:****Consequence:**

Narrative: Fire is a major threat to the persistence of *Lipochaeta kamolensis*; a single fire could extirpate either of the only known populations (R.W. Hobdy, personal communication 1994). The fire threat would become much more severe with reduction of grazing/browsing and/or invasion of *Penniselum selaceum* (fountain grass). (USFWS, 1997)

Stressor: Climate change loss or degradation of habitat

Exposure:**Response:****Consequence:**

Narrative: We previously reported that climate change may pose a threat to this species, citing the analysis by Fortini et al. (2013), but we did not include the species' vulnerability rank. The assessment by concluded that *Melanthera kamolensis* is extremely vulnerable to the impacts of climate change, with a vulnerability score of 0.95 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this species is also one of the most vulnerable native Hawaiian plant species that has a projected future climate envelope. Therefore, additional management actions, such as locating suitable locations for recovery in both current and future climate envelopes, are needed to conserve this taxon into the future (USFWS, 2018).

Recovery**Reclassification Criteria:**

1. A total of five to seven populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)

3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1997)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)

2. Each population must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)

3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1997)

Recovery Actions:

- Develop landowner commitment to protect the two known populations of *Lipochaeta kamolensis*. (USFWS, 1997)
- Construct experimental exclosures within known populations to protect some but not all *Lipochoeta kamolensis* individuals.
- Monitor selected invasive weeds within and outside exclosures to determine long-term effects and manage weeds as needed. (USFWS, 1997)
- Develop a fire management action plan with Maui Division of Forestry and Wildlife (DOFAW) for protection of *Lipochaeta kamolensis*. (USFWS, 1997)
- Using seeds from known populations, establish outplantings of *Lipochaeta kamolensis* into protected sites. (USFWS, 1997)
- New Management Actions:
 - Surveys and monitoring—The Plant Extinction Prevention Program (PEPP) surveys for and monitors populations of *Melanthera kamolensis* on east Maui (PEPP 2013, 2014, 2015, 2016, 2017b, 2018).
 - Captive propagation for genetic storage and reintroduction—
 - o In 2017, PEPP reported that 10 founders were represented in collections from Luala'ilua; and that three of 10 founders from a hybrid swarm (with *M. rockii*) in the same area had been collected for molecular analyses to study the hybrid swarm (PEPP 2017a).
 - o The Lyon Arboretum Micropropagation Laboratory reported germination and propagation of *Melanthera kamolensis* from two collections, one in 2001 and another in 2012, though no propagules remain. The Lyon Arboretum Seed Laboratory reports almost 2,000 seeds in storage from 11 individuals collected between 2013 and 2016. There are also pooled collections from eight plants (382 seeds) from another location (Lyon Arboretum 2017).
 - o The Olinda Rare Plant Facility (ORPF) reported 20 cuttings and nine potted plants collected from 10 individuals at an undocumented location and 14 cuttings and three potted plants from four individuals at Kepuni Gulch in 2013. In 2014, ORPF further propagated cuttings into potted plants from five of the same individuals (15 plants) and six potted plants from two new individuals from Luala'ilua. In 2015, 11 potted plants were sent

- out to Kahikinui (in situ). In 2017, almost 70 potted plants were produced, with at least six sent out in situ (Kanaio, Alena) (ORPF 2014, 2015, 2017). • Stochastic events—Build resiliency and redundancy—PEPP establishes and monitors outplanting sites and has reintroduced 28 individuals at two sites at Lua-laʻilua and 35 individuals at three sites in Kanaio NAR (PEPP 2016, 2017b, 2018) (USFWS, 2018).
- Recommendations for Future Actions: We are not aware of any new threats or significant new information regarding the species' biological status since the last 5-year review in 2014. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2018. • Population viability and monitoring—Continue monitoring the wild population of *Melanthera kamolensis*. • Ungulate monitoring and control—Construct and maintain exclusion fences to protect *M. kamolensis* from the impacts of feral ungulates. • Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. • Fire monitoring and control—Develop and implement fire management plans for all wild and reintroduced populations. • Captive propagation for genetic storage and reintroduction—
 - o Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range.
 - o Evaluate genetic resources currently in storage to determine the need to place additional material into long-term storage due to this species' vulnerability to climate change. • Reintroduction and translocation—Continue to augment current populations and reintroduce individuals into suitable habitat within historical range that is being managed for known threats to this species. • Taxonomy research—Conduct research on the hybrid population to confirm hybrid status between *M. kamolensis* and *M. rockii*. • Climate change adaptation strategy—Research the suitability of habitat for reintroducing this species in the future due to impacts of climate change. Develop a strategy for preventing the extinction of this species if no suitable habitat is predicted in the future. • Alliance and partnership development—Initiate planning and work with landowners to contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2018).

Conservation Measures and Best Management Practices:

- Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. (USFWS, 2014)
- Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change. (USFWS, 2014)
- Survey geographical and historical range for a current assessment of the species' status. (USFWS, 2014)
- Fence remaining populations to protect them from the impacts of feral ungulates. (USFWS, 2014)
- Augment current natural populations to increase numbers of individuals. (USFWS, 2014)
- Develop and implement a fire management plan for all populations. (USFWS, 2014)
- Control invasive introduced plant species within enclosures. (USFWS, 2014)
- Continue monitoring wild populations. (USFWS, 2014)
- Conduct research on the taxonomy of the species to confirm if the population at Alena is a hybrid swarm between *M. kamolensis* and *M. rockii*. (USFWS, 2014)
- Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. (USFWS, 2014)
- Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2014)

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SPECIES ACCOUNT: *Melanthera tenuifolia* (Nehe)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

A perennial herb with long trailing stems reaching up to 30 dm or more. The leaves are highly dissected and lacy in appearance. The flowers are yellow and showy. (NatureServe, 2015)

Historical Range

See current range/distribution

Current Range

Melanthera tenuifolia is endemic to the Hawaiian Islands and it historically occurred in the northern Waianae Mountains of Oahu (68 FR 35950) (USFWS, 2016).

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Melanthera tenuifolia* (Nehe) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Melanthera tenuifolia* (77 FR 57648-57862). The critical habitat designation includes 17 critical habitat units, which encompass approximately 7,808 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Melanthera tenuifolia* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Melanthera tenuifolia* includes 17 critical habitat units, covering three ecosystem types, which encompass approximately 7,808 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Dry—Units 1, 2, 8, 9, 10, 11; Oahu— Lowland Mesic—Units 1, 2, 3; , Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8 .

Oahu—Lowland Dry—Unit 1 [102 ac (41 ha)]; This area consists of 49 ac (20 ha) of State land and 53 ac (22 ha) of privately owned land in the Waianae Mountains, extending from Haili Gulch to Kawaipahai. Oahu—Lowland Dry— Unit 2 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland dry ecosystem in the Waianae Mountains, on Federal land within Kaena Point State Park. Oahu—Lowland Dry—Unit 8 [99 ac (40 ha)]. Oahu—This area consists of 96 ac (40 ha) of privately owned land and 3 ac (1 ha) of State land as part of the old railroad right-of-way in the lowland dry ecosystem, at the Kalaeloa Barber's Point Harbor area. Oahu—Lowland Dry—Unit 9 [37 ac (15 ha)]. This area consists of 17 ac (7 ha) of City and County land, 3 ac (1 ha) of privately owned land, 1 ac (0.5 ha) of State land, and 16 ac (6 ha) of Federal (Pearl Harbor NWR) land in

the lowland dry ecosystem at Kalaeloa. Oahu—Lowland Dry— Unit 10 [43 ac (17 ha)]. This area consists of 43 ac (17 ha) of State land (DHHL) in the lowland dry ecosystem at Kalaeloa. Oahu—Lowland Dry—Unit 11 [166 ac (67 ha)]. This area consists of 166 ac (67 ha) of federal land (U.S. Navy) in the lowland dry ecosystem at Kalaeloa.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac (105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Melanthera tenuifolia* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Melanthera tenuifolia* occurs within the Lowland dry, Lowland mesic and Dry cliff ecosystems in the Waianae Mountain caldera complex:

Oahu—Lowland Dry—Units 1, 2, 8, 9, 10, 11. (A) Elevation: <3,300 ft (<1,000 m). (B) Annual Precipitation: <50 in (<130 cm). (C) Substrate: Weathered silty loams to stony clay, rocky ledges, little weathered lava. (D) Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*, *Sapindes*. (E) Subcanopy: *Chamaesyce*, *Dodonaea*, *Leptecophylla*, *Osteomeles*, *Psychrax*, *Scaevola*,

Wikstroemia. (F) Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Plumbago, Sicyos, Sida, Waltheria.

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (F) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. (F) Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Melanthera tenuifolia* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (USFWS, 2016)

Breeding Season

Adult: *Melanthera tenuifolia* flowers for much of the year, mostly in late winter and spring until onset of the summer dry season (USFWS, 2016).

Reproduction Narrative

Adult: *Melanthera tenuifolia* flowers for much of the year, mostly in late winter and spring until onset of the summer dry season. The flowers are probably insect-pollinated, as are many yellow-flowered members of the sunflower family. Because *M. tenuifolia* is an herbaceous species, its longevity probably is similar to that of other small plants that live less than 10 years (i.e., short-lived perennials) (Makua Implementation Team 2003). Other demographic information for *M. tenuifolia* in the wild is unknown, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, pollination and seed dispersal in the wild, and specific environmental requirements (USFWS, 2016).

Habitat Type

Adult: Cliffs/steep ridges (USFWS, 2016)

Habitat Narrative

Adult: *Melanthera tenuifolia* is found in habitats that range from very dry (Ohikilolo Makai subpopulation) to mesic (Mt. Kaala Natural Area Reserve population unit), at elevations of 122 to 914 m (400 to 3,000 ft) (Makua Implementation Team 2003; U.S. Army Garrison 2005b). Most plants occur on north-facing slopes, cliff faces and cliff ledges, and steep rocky ridge sides; or in forest openings vegetated with native shrubs, grasses, and sedges (USFWS, 2016).

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Increasing long-term/decreasing short-term (USFWS, 2016)

Number of Populations:

6 (USFWS, 2016)

Population Size:

3254 individuals (USFWS, 2016)

Population Narrative:

Currently, *M. tenuifolia* occurs in six population units totaling approximately 3,254 individuals (Table SB 25). Survey data of *Melanthera tenuifolia* since it was listed in 1991 indicate significant increases in the total range-wide number of individuals, due in large part to enhanced reproduction and recruitment in managed sites. However, a 25 to 31 percent decrease in overall numbers seems to have occurred since 2003. *Melanthera tenuifolia* reproduces both vegetatively and sexually, and both vegetative clones and seedlings are commonly observed. Vegetative reproduction creates identical adjacent plants, so monitoring results are based on individuals identified as plant material at least 2 m (6.6 ft) apart (U.S. Army 2005b). Plants in the Kahanahaiki, Kaluakauila, Keawaula, and the three Ohikilolo population units are located in zones at risk from training-related wildfire. Thus, *M. tenuifolia* is characterized by six population units, of which five are exceeding minimum numerical criteria for stabilization population, overall increasing trends in numbers since listing and decreasing trends over the short-term since 2003 (USFWS, 2016).

Threats and Stressors**Stressor:****Exposure:****Response:****Consequence:**

Narrative: Threats include alien vegetation and fire (especially in and adjacent to firing ranges). Feral goats are causing severe habitat degradation. Feral pigs also pose a threat. (NatureServe, 2015)

Recovery

Reclassification Criteria:

Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1995a, 1998a) (USFWS, 2016).

Delisting Criteria:

Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1995a, 1998a) (USFWS, 2016).

References

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SPECIES ACCOUNT: *Melicope adscendens* (Alani)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/05/1994; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Melicope adscendens is a vine-like shrub in the rue family (Rutaceae). New growth on the long, slender branches is densely to sparsely covered with yellowish to golden-brown hairs, the hairs becoming grayish and more sparse with age. The papery or leathery leaves, widely spaced, occur in pairs opposite each other on 6-16 mm (0.2-0.6 in) leaf stalks (petioles) and are generally oval-shaped (1.5-6.5 x 1-4 cm [0.6-2.6 x 0.4-1.6 in]). The leaves have about 14 pairs of veins branching from the main vein and are generally smooth, with sparse hairs on the underside when young. Flowers occur on 13-17 mm (0.5-0.7 in) stalks (peduncles) from the point of leaf attachment in groups of one to three flowers, each on an individual shorter stalk (pedicel). Male flowers are small (petals about 5 mm (0.2 in) long) with tiny hairs; characteristics of female flowers are unknown. The fruit is apocarpous (breaking easily into four distinct sections), smooth on the outside, 14-15 mm (0.54-0.59 in) wide, and subtended by persistent petals and other floral parts (sepals). (USFWS, 1997)

Taxonomy

Melicope adscendens is distinguished from other *Melicope* species in its sprawling vine-like habit, long, thin peduncles, and apocarpous fruits. (USFWS, 1997)

Historical Range

See Current Range.

Current Range

Current range includes East Maui. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Melicope adscendens* (Alani) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Melicope adscendens* includes two CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Lowland Dry—Unit 1 consists of 11,465 ac (4,640 ha) of State land, 2,069 ac (837 ha) of federally owned land, and 3 ac (1 ha) of privately owned land, from Kanaio to Kahualau Gulch on the southern slopes of east Maui. This unit is occupied by the plants *Bonamia menziesii*, *Cenchrus agrimonioides*, *Flueggea neowawraea*, *Melicope adscendens*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and includes the mixed herbland and shrubland, the moisture

regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 1 is not known to be occupied by *Alectryon macrococcus*, *Bidens micrantha* ssp. *kalealaha*, *Canavalia pubescens*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Sesbania tomentosa*, *Solanum incompletum*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 1 (and) *Palmeria dolei*—Unit 18—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 18—Montane Mesic This area consists of 6,593 ac (2,668 ha) of State land, 707 ac (286 ha) of privately owned land, and 3,672 ac (1,486 ha) of federally owned land (Haleakala National Park), from Kealahou to Puualae, nearly circumscribing the summit of Haleakala on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Asplenium dielirectum*, *A. peruvianum* var. *insulare*, *Clermontia lindseyana*, *Cyanea horrida*, *C. obtusa*, *Cyrtandra ferripilosa*, *C. oxybapha*, *Diplazium molokaiense*, *Geranium arboreum*, *G. multiflorum*, *Huperzia mannii*, *Melicope adscendens*, and *Neraudia sericea*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 1 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Cyanea glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. mceldowneyi*, *Phyllostegia bracteata*, *P. mannii*, *Santalum haleakalae* var. *lanaiense*, *Wikstroemia villosa*, or *Zanthoxylum hawaiiense*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Melicope adscendens* critical habitat consists of two components. Lowland dry (east Maui) and Montane mesic (east Maui). Species- specific physical or biological features: elevation >3,200 ft (>975 m) (81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*. Subcanopy: *Chamaesyce*, *Dodonaea*, *Leptecophylla*, *Osteomeles*, *Psydrax*, *Scaevola*, *Wikstroemia*. Understory: *Alyxia*, *Artemisia*, *Bidens*, *Chenopodium*, *Nephrolepis*, *Peperomia*, *Sicyos*.

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: *Acacia*, *Ilex*, *Metrosideros*, *Myrsine*, *Nestegis*, *Nothocestrum*, *Pisonia*, *Pittosporum*, *Psychotria*, *Sophora*, *Zanthoxylum*. Subcanopy: *Alyxia*, *Charpentiera*, *Coprosma*, *Dodonaea*, *Kadua*, *Labordia*, *Leptecophylla*, *Phyllostegia*, *Vaccinium*. Understory: Ferns, *Carex*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to

be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Despite its vine habit, the species appears to be relatively long-lived; the first individual of this species rediscovered in 1982 is still extant 12 years later without signs of appreciable growth or decline. In limited diurnal observations, no flower visitors were observed. Fruiting collections have been made in March and July. (USFWS, 1997)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland, old field (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations of 1,000 to 1,220 meters (3,280 to 4,000 feet) (USFWS, 1997)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1997)

Habitat Narrative

Adult: The known individuals of *Melicope adscendens* occur at 1,000-1,220 meters (3,280-4,000 feet) elevation in the extreme western Auwahi district in dryland forest described in some detail by Rock (1913) and Medeiros, Loope, and Holt (1986). In his unpublished field notes (filed in the Bishop Museum library), botanist Charles N. Forbes mentions, of the species' habitat: "Open forest type with *Osmanthus* (= *Neslegis*) dominant, *Dracaena* (*Pleomele*) second at least in the lower part." The four known plants grow tangled and interlocked amidst branches of the native shrubs *Dodonaea viscosa* and *Osteomeles anthyllidifolia*. Other associated native species include *Alectryon macrococcus*, *Alphilonia ponderosa*, *Chamaesyce celastroides* var. *lorifolia*, *Nestegis sandwicensis*, *Osteomeles anthyllidifolia*, *Pouteria sandwicensis*, *Santalum ellipticum*, *Xylosma hawaiiense*, and *Zanthoxylum hawaiiense*. Associated alien species include *Asclepias physocarpa*, *Melinis minutiflora*, and *Pennisetum clandestinum*. (USFWS, 1997)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2014)

Redundancy:

Very low (inferred from USFWS, 2014)

Number of Populations:

1 (USFWS, 2018)

Population Size:

2 (USFWS, 2018)

Population Narrative:

One plant is present as of July 6, 2012, in an outplanting established at Puu Mahoe Arboretum (PEPP 2013). One plant is present on State owned land in Kanaio Natural Area Reserve, Maui (PEPP 2012). Approximately 20 plants are present on private land in Auwahi, Maui (PEPP 2012).

(USFWS, 2014). The review for this species by IUCN in 2015 reported one subpopulation of 26 individuals on east Maui (Weisenberger et al. 2015). Currently, there are only two wild individuals remaining (Oppenheimer 2018, in litt.) (USFWS, 2018).

Threats and Stressors

Stressor: Impacts of feral ungulates (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: Rock (1913) noted the serious degradation of the botanically rich site of Auwahi as a result of browsing of goats and cattle. Pigs are now present in the area as well. (USFWS, 1997)

Stressor: Alien plants (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: Alien plants, particularly, *Penniselum clandestinum* (kikuyu grass) and *Melinis minutiflora* (molasses grass), threaten *Melicope adscendens*. (USFWS, 1997)

Stressor: Seed predation by insects (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: The endemic microlepidopteran *Prays cf. fulvocanella* Walsingham (Yponomeutidae) is known to feed on the buds, flowers and seeds of *Melicope* and *Platydesma*. (USFWS, 1997)

Stressor: Fire (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: Fire is a continuing threat to this dry forest habitat. (USFWS, 1997)

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: We previously reported that climate change may pose a threat to this species, citing the analysis by Fortini et al. (2013), but we did not include the species' vulnerability rank. The assessment by concluded that *Melicope adscendens* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.88 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future, such as locating key microsites that overlap with current and future climate envelopes for outplanting efforts (USFWS, 2018).

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1997)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)
2. Each population must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)
3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1997)

Recovery Actions:

- Initiate an emergency program to save *Melicope adscendens* from extinction. This program needs to involve propagation, outplanting into managed (with weed control) exclosures on protected lands, establishment of “nurse forests” to nurture reestablishment of the taxon in the long run, and emergency assessment of and response to limiting factors. (USFWS, 1997)
- Search for new populations (individuals). The best chance for locating new individuals is between the two known populations, where similar habitat exists. (USFWS, 1997)
- New Management Actions:
 - Surveys and monitoring—The Plant Extinction Prevention Program (PEPP) surveys for and monitors populations of *Melicope adscendens* on east Maui (PEPP 2015, 2016, 2017b, 2018).
 - Captive propagation for genetic storage and reintroduction—
 - o In 2017, PEPP reported that one founder was represented in collections, along with one reintroduced individual (PEPP 2017a). The founder has since died (Oppenheimer 2018, in litt.).
 - o The Lyon Arboretum Micropropagation Laboratory reported 146 containers of propagules of *M. adscendens* between 2005 and 2014. Currently, there are three active containers totaling five individuals from three source plants. The Lyon Arboretum Seed Conservation Laboratory reports 160 seeds in storage collected from one individual in 2006 (Lyon Arboretum 2017).
 - o The Olinda Rare Plant Facility (ORPF) reported one potted plant sent out to Pu‘umāhoe (Fleming Arboretum) in 2013 and four seeds collected from one individual in 2014 (ORPF 2013, 2014). The facility currently stores two plants from the Auwahi population (ORPF 2018).
 - Stochastic events—Build resiliency and redundancy—PEPP establishes and monitors outplanting sites and has reintroduced three individuals at two sites on east Maui (PEPP 2014, 2015, 2016, 2017b, 2018) (USFWS, 2018).
- Recommendations for Future Actions: We are not aware of any new threats or significant new information regarding the species’ biological status since the last 5-year reviews in 2008 and 2014. Thus, the following recommendations for future actions are reiterated for

the 5-year review for 2018. • Population viability and monitoring—Continue monitoring the wild individuals of *Melicope adscendens*. Continue to survey the geographical and historical range of the species for additional populations. • Ungulate monitoring and control—Construct and maintain exclusion fences to protect *M. adscendens* from the impacts of feral ungulates. • Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all individuals. • Fire monitoring and control—Develop and implement fire management plans for all wild and reintroduced populations. • Invertebrate predation or herbivory—Research and implement effective control methods for the black twig borer and for the endemic microlepidopteran, *Prays cf. fulvocanella*. • Rodent predation or herbivory—Implement effective control methods for rodents at the last known location. • Captive propagation for genetic storage and reintroduction— o Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. o Evaluate genetic resources currently in storage to determine the need to place additional material into long-term storage due to this species' vulnerability to climate change. • Reintroduction and translocation—Continue to augment current populations and reintroduce individuals into suitable habitat within historical range that is being managed for known threats to this species. • Climate change adaptation strategy—Research the suitability of habitat for reintroducing this species in the future due to impacts of climate change. Develop a strategy for preventing the extinction of this species if no suitable habitat is predicted in the future. • Alliance and partnership development—Initiate planning and work with landowners to contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2018).

Conservation Measures and Best Management Practices:

- Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species high vulnerability to climate change. (USFWS, 2014)
- Continue seed collection for complete ex situ genetic storage and reintroduction. (USFWS, 2014)
- Augment populations as genetically appropriate individuals become available in nurseries and as habitat is protected. (USFWS, 2014)
- Reintroduce individuals into suitable habitat within the current and historical range in areas where threats are managed. (USFWS, 2014)
- Survey the geographical and historical range of *Melicope adscendens* to assess the status of known populations and possible additional populations. (USFWS, 2014)
- Fence remaining populations to protect them from the impacts of feral ungulates. (USFWS, 2014)
- Eradicate invasive introduced plants and rodents within the vicinity of *Melicope adscendens* populations and maintain *Melicope adscendens* habitat free of invasive introduced plants. (USFWS, 2014)
- Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. (USFWS, 2014)
- Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2014)

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

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SPECIES ACCOUNT: *Melicope balloui* (Alani)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/05/1994; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Melicope balloui is a small tree or shrub in the rue family (Rutaceae). New growth is covered with yellowish-brown hairs and waxy scales, the hairs becoming grayish and they, along with the scales, more sparse with age. The generally oval-shaped leathery leaves (5-10 x 3-7 cm [2-3.9x 1.2-2.8 in]) occur in pairs on 10-26 mm (0.4-1.0 in) leaf stalks (petioles) opposite each other on the stems. The leaves have about 9-14 pairs of veins branching from the main vein connected by another vein near the periphery of the leaf. The leaves are slightly hairy, the underside becoming less hairy except around the main vein. Female flowers are yellowish green, tiny (petals approximately 4 mm (0.2 in) long) and are densely covered with small hairs. They grow in flat clusters of five to nine, each on individual 5 mm (0.2 in) stalks (pedicels), on 3-16 mm (0.1-0.6 in) stalks (peduncles) from the point of leaf attachment. Details of male flowers are unknown. Petals and some other floral parts (sepals) usually persist as the fruit matures; the fruits are about 26 mm (1.02 in) wide, each 12-13 mm (0.47-0.51 in) part containing one or two 7 mm (0.3 in) seeds. (USFWS, 1997)

Taxonomy

Melicope balloui is opposite-leaved, distinguishing it from species in Section *Pelea*, locally *Melicope clusiifolia* and *Melicope haleakalae*. When sterile, *Melicope balloui* is not easy to distinguish from other opposite-leaved members of the genus. Individuals of *Melicope balloui* bearing fruit can be distinguished from the more common and widespread *M. volcanica* and *M. molokiensis* by the distinctive silky-haired fruiting exocarp (capsule exterior) and sparsely haired endocarp (capsule interior). *Melicope balloui* is an East Maui endemic (found nowhere else). A recent review (Hartley and Stone 1989) synonymized the near exclusively Hawaiian genus *Pelea* with *Melicope*, resulting in *Melicope balloui* (Rock) Hartley and Stone. Wagner et al. (1990) state that the correct name of this species may actually be *Melicope mannii*, pending a determination when a type specimen is designated for that taxon. Part of the description of *Pelea mannii* is based on Mann & Brigham 376 ("AC, BISH" per Wagner et al. 1990), which is actually *Melicope balloui*. (USFWS, 1997)

Historical Range

See Current Range (USFWS, 1997)

Current Range

Current range includes East Maui. (USFWS, 1997)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Melicope balloui* (Alani) under the Endangered Species Act of 1973, as amended (Act). The

critical habitat designation includes six detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Melicope balloui* includes six CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Lowland Wet—Unit 1 (and) *Palmeria dolei*—Unit 2—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 2— Lowland Wet This area consists of 6,616 ac (2,677 ha) of State land, 7,425 ac (3,005 ha) of privately owned land, and 2,038 ac (825 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Kipahulu Valley on the northern and eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia samuelii*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *M. ovalis*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 1 is not known to be occupied by the plants *Clermontia oblongifolia* ssp. *mauiensis*, *C. peleana*, *Mucuna sloanei* var. *persericea*, *Phyllostegia haliakalae*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 1 (and) *Palmeria dolei*—Unit 10—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 10— Montane Wet This area consists of 1,313 ac (531 ha) of State land and 798 ac (323 ha) of privately owned land, at Haiku Uka on the northern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Cyanea duvalliorum*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *Phyllostegia pilosa*, and by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 1 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small

numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 11—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 11— Montane Wet This area consists of 4,075 ac (1,649 ha) of State land, 9,633 ac (3,898 ha) of privately owned land, and 875 ac (354 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Puukaukanu and upper Waihoi Valley, on the northern and northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Geranium hanaense*, *G. multiflorum*, and *Wikstroemia villosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 2 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea glabra*, *C. maritae*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, and *Schiedea jacobii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 3 (and) *Palmeria dolei*—Unit 12—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 12— Montane Wet This area consists of 2,228 ac (902 ha) of federally owned land (Haleakala National Park) in Kipahulu Valley, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. maritae*, and *Melicope ovalis*, and by the forest bird, kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 3 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea duvalliorum*, *C. glabra*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest bird, the akohekohe (*Palmeria dolei*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 4 (and) *Palmeria dolei*—Unit 13—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 13— Montane Wet This area consists of 180 ac (73 ha) of State land and 1,653 ac (669 ha) of federally owned land (Haleakala National Park), in Kaapahu Valley on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *Cyrtandra ferripilosa*, and *Huperzia mannii*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 4 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea duvalliorum*, *C. glabra*, *C. mceldowneyi*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 5 (and) *Palmeria dolei*—Unit 14—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 14— Montane Wet This area consists of 222 ac (90 ha) of State land, and 165 ac (67 ha) of federally owned land (Haleakala National Park), near Kaumakani on the eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units area occupied by the plant *Bidens campylotheca* ssp. *pentamera*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 5 is not currently occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Melicope balloui* critical habitat consists of two components. Lowland wet (east Maui) and Montane wet (east Maui) (81 FR 17790-18110):

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire,

drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations from 1,280 to 1,520 meters (4,200-4,990 feet) (USFWS, 1997)

Environmental Specificity

Adult: Low, with few key requirements (USFWS, 1997)

Habitat Narrative

Adult: This species is “known only from wet forest, about 1,280-1,520 meters (4,200-4,990 feet), slopes of Haleakala, Maui, between Olinda and Ukelele (Wagner et al. 1990)” and from similar wet forest in Kipahulu Valley. Associated native species include *Acacia koa*, *Cibotium chamissoi*, *Cibotium glaucum*, *Diplazium sandwichianum*, *Melicope clusiifolia*, *Metrosideros polymorpha*, and *Sadleria pallida*. Associated alien species include *Cyathea cooperi*, *Paspalum conjugatum*, *Psidium cattleianum*, and *Rubus rosifolius*. (USFWS, 1997)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2011)

Redundancy:

Very low (inferred from USFWS, 2011)

Number of Populations:

1-2 (USFWS, 2011)

Population Size:

possibly extinct, maybe 1-50 (USFWS, 2018)

Population Narrative:

It was observed in 1997 in Opana Gulch in Waikamoi, north of Puu o Kaka'e at 1,311 meters (4,300 feet) elevation (Wood 2009). About 50 individuals were seen in 1999 in Kipahulu Valley, along Palikea Stream, Delta Camp Region, at 914 meters (3,000 feet) elevation (Wood 2009). In

2009, it was seen again in the same general area, but at a higher elevation of 1,082 meters (3,550 feet) (Wood 2009). In total, about 50 individuals are estimated to currently exist. (USFWS, 2011). Currently, there is one potential individual of *Melicope balloui* in Waikamoi Preserve, and possibly as many as 50 individuals in Kīpahulu on east Maui, depending upon verification of taxonomy (Robertson 2016, in litt.) (USFS, 2018).

Threats and Stressors

Stressor: Feral pigs (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: Feral pigs are currently being controlled in Haleakala National Park. Constant vigilance is required to keep fences repaired and to remove pigs that get in through breaks in the fence. (USFWS, 1997)

Stressor: Invasive plants (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: If uncontrolled, *Paspalum conjugatum* (Hilo grass), *Clidemia hirta* (Koster's curse), *Psidium cattleianum* (strawberry guava), *Hedychium gardnerianum* (kahili ginger), and *Cyathea cooperi* (Australian tree fern) all potentially represent serious threats to the long-term survival of *Melicope balloui*. Other invasive introduced plant species include *Ageratina adenophora* (sticky snakeroot), *Andropogon virginicus* (broom sedge), *Clidemia hirta* (Koster's curse), *Paspalum conjugatum* (Hilo grass), *P. urvillei* (vasey grass), *Rubus argutus* (blackberry), and *Rubus rosifolius* (thimbleberry) (Wood 2009). (USFWS, 1997; USFWS, 2011)

Stressor: Insect predation (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: The endemic microlepidopteran *Prays cf. fulvocanella* Walsingham (Yponomeutidae) is known to feed on the buds, flowers and seeds of *Melicope* and *Platydesma*. (USFWS, 1997)

Stressor: Predation by rats, moths, unknown insects, and the black twig borer (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Rats (*Rattus* spp.) are noted as a threat to this species because are known to eat plants in the genus *Melicope* (Wood 2009). Unidentified Lepidoptera moths eat the flowers of this species preventing seed production. Similarly, an unknown insect have been noted to bore into the seed capsules of this species limiting seed production. Black twig borer (*Xylosandrus compactus*) is a threat to the species. (USFWS, 2011)

Stressor: Avian dispersal (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Oppenheimer believes the avian dispersal agent has become depleted and is potentially extinct, therefore constricting the dispersal area of this species (H. Oppenheimer, pers. comm. 2010). (USFWS, 2011)

Stressor: Small population size (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: In addition to all of the other threats, species like *Melicope balloui* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding and disease outbreaks. The extent of these natural processes on this single island endemic are exacerbated by anthropogenic threats, such as habitat loss for human development or predation by introduced species (USFWS 1997). (USFWS, 2011)

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: We previously reported that climate change may pose a threat to this species, anticipating an analysis by 2013. The assessment conducted by Fortini et al. (2013) concluded that *Melicope balloui* is vulnerable to the impacts of climate change, with a vulnerability score of 0.418 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions may be needed to conserve this taxon into the future (USFWS, 2018).

Recovery**Reclassification Criteria:**

1. A total of five to seven populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1997)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)
2. Each population must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials

and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)

3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1997)

Recovery Actions:

- Maintain relatively pig-free condition of Kipahulu Valley of Haleakala National Park. (USFWS, 1997)
- Continue alien plant control in Kipahulu Valley of Haleakala National Park, with emphasis on *Clidemia hirta*, *Cyathea cooperi*, *Hedychium gardnerianum*, and *Psidium cattleianum*. (USFWS, 1997)
- Produce an accurate assessment of population numbers and distribution; establish simple baseline monitoring of known individuals. (USFWS, 1997)
- Search for *Melicope balloui* on northwest Haleakala. (USFWS, 1997)
- Conduct/encourage research on limiting factors. (USFWS, 1997)
- New Management Actions: • Surveys and monitoring—The Plant Extinction Prevention Program (PEPP) manages one possible individual of *Melicope balloui* on east Maui (PEPP 2017) (USFWS, 2018).
- Recommendations for Future Actions: We are not aware of any new threats or significant new information regarding the species' biological status since the last 5-year review in 2011. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2018. • Population viability and monitoring—Continue monitoring the wild individuals of *Melicope balloui*. Continue to survey the geographical and historical range of the species for additional populations. • Population biology and taxonomic research—Conduct taxonomic and genetic studies to determine if the currently known individuals are appropriately identified. • Ungulate monitoring and control—Construct and maintain exclusion fences to protect *M. balloui* from the impacts of feral ungulates. • Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all individuals. • Invertebrate predation or herbivory—Research and implement effective control methods for the black twig borer and for Lepidoptera moths. • Rodent predation or herbivory—Implement effective control methods for rodents around all individuals. • Captive propagation for genetic storage and reintroduction—
 - o Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range.
 - o Evaluate genetic resources currently in storage to determine the need to place additional material into long-term storage due to this species' vulnerability to climate change.• Reintroduction and translocation—Augment current population and reintroduce individuals into suitable habitat within historical range that is being managed for known threats to this species. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use this information to determine future landscape needed for its recovery. • Alliance and partnership development—Initiate planning and work with the Division of Forestry and Wildlife and other land managers to contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2018).

Conservation Measures and Best Management Practices:

- Survey areas where *Melicope balloui* has been reported to establish current status of the species. (USFWS, 2011)
- Conduct taxonomic and genetic study to determine if the currently known individuals are appropriately identified as this species. (USFWS, 2011)
- Monitor known populations and collect any available seeds. (USFWS, 2011)
- Maintain the fences around existing populations to provide protection from the negative impacts of feral ungulates. (USFWS, 2011)
- Continue to control invasive introduced species around known populations. (USFWS, 2011)
- Control rats in the vicinity of these populations. (USFWS, 2011)
- Develop and implement methods to control unidentified Lepidoptera moths. (USFWS, 2011)
- Develop and implement methods to control black twig borer. (USFWS, 2011)
- Propagate to augment the existing populations. (USFWS, 2011)
- Establish additional populations within protected suitable habitat. (USFWS, 2011)
- Work with Hawaii Division of Forestry and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2011)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2011)

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

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SPECIES ACCOUNT: *Melicope christophersenii* (Alani)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/18/2012; Pacific Region (R1) (USFWS, 2016)

Physical Description

A shrub or tree, 3 - 6 m tall. Cymes with 3 - 15 flowers. Capsules are 25 - 40 mm wide (NatureServe, 2015).

Taxonomy

A member of the rue family (Rutaceae) (USFWS, 2012). The genus is nearly endemic to Hawaiian Islands, with 2 species in the Marquesas Islands. The species is endemic to the Waianae Mts., Oahu. *Pelea kauaensis* and *P. storeyana* combined with this species by Wagner et al. 1990 (NatureServe, 2015).

Historical Range

Endemic to the Waianae Mountains on the island of Oahu, state of Hawaii (NatureServe, 2015). Historically, *M. christophersenii* was known from a few scattered locations in the Mt. Kaala area of the Waianae Mountains, and as far south as Puu Kaua (HBMP 2008) (USFWS, 2012).

Current Range

Currently, it occurs in the Waianae summit area, with the southernmost occurrence at Puu Hapapa (U.S. Army 2006; HBMP 2008) (USFWS, 2012).

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On September 18, 2012, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Melicope christophersenii* (Alani) under the Endangered Species Act of 1973, as amended (Act) (77 FR 57648-57862). The critical habitat designation includes 6 critical habitat units, which encompass approximately 679 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Melicope christophersenii* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Melicope christophersenii* includes 6 critical habitat units, covering one ecosystem type, which encompasses approximately 679 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Montane Wet—Unit 1; Oahu—Wet Cliff—Units 1, 2, 3, 4, 5.

Oahu—Montane Wet—Unit 1 [370 ac (150 ha)]. This area consists of 18 ac (7 ha) of City and County of Honolulu land, 352 ac (142 ha) of State land, and less than 1 ac (less than one ha) of

privately-owned land in the montane wet ecosystem at the summit of the Waianae Mountains at Kaala, and partially within the Mokuleia Forest Reserve and the Kaala Natural Area Reserve.

Oahu—Wet Cliff—Unit 1 [235 ac (95 ha)]. This area consists of 167 ac (68 ha) of State land, 68 ac (28 ha) of City and County of Honolulu land, and less than 1 ac (less than 1 ha) of privately owned land in the wet cliff ecosystem in the Waianae Mountains, near the summit of Kaala, and partially within the Mokuleia and Waianae Kai FRs and the Kaala Natural Area Reserve. Oahu—Wet Cliff—Unit 2 [3 ac (1 ha)]. This area consists of 3 ac (1 ha) of State land in the wet cliff ecosystem in the Waianae Mountains at Puuhapapa, within a small area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Oahu—Wet Cliff—Unit 3 [16 ac (6 ha)]. This area consists of 16 ac (6 ha) in the wet cliff ecosystem on State land in the Waianae Mountains at Puukanehoa, partially within an area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Oahu—Wet Cliff—Unit 4 [23 ac (9 ha)]. This area consists of 23 ac (9 ha) in the wet cliff ecosystem on State land in the Waianae Mountains at Puukaua, partially overlapping an area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and recently acquired by the State. Oahu—Wet Cliff—Unit 5 [31 ac (13 ha)]. This area consists of 31 ac (13 ha) of State land in the wet cliff ecosystem in the Waianae Mountains, at Palikea and north of Palikea.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Melicope christophersenii* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Melicope christophersenii* occurs within the Montane wet and Wet cliff ecosystems in the Waianae Mountain caldera complex:

Oahu—Montane Wet—Unit 1. (A) Elevation: 3,300–6,600 ft (1,000-2,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Well-developed soils, montane bogs. (D) Canopy: Acacia, Charpentiera, Cheiropodendron, Metrosideros. (E) Subcanopy: Broussaisia, Cibotium, Eurya, Ilex, Myrsine. (F) Understory: Ferns, Carex, Coprosma, Leptecophylla, Oreobolus, Rhynchospora, Vaccinium.

Oahu—Wet Cliff—Units 1, 2, 3, 4, 5. (A) Elevation: unrestricted. (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: >65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: Broussaisia, Cheiropodendron, Leptecophylla, Metrosideros. (F) Understory: Bryophytes, Ferns, Coprosma, Dubautia, Kadua, Peperomia.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Melicope christophersenii* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Montane wet forest and shrubland (USFWS, 2012)

Geographic or Habitat Restraints or Barriers

Adult: 2,400 - 4,000 ft. elevation (USFWS, 2012)

Habitat Narrative

Adult: Inhabits wet forests and shrublands on ridgcrests and gulch slopes, and also on flat to gently sloped terrain on the summit plateau of Kaala (mountain) (NatureServe, 2015). It occurs in wet forest and shrubland in the montane wet and wet cliff ecosystems at elevations between 2,400 and 4,000 ft. (730 and 1,200 m) in the Waianae Mountains (Stone et al. 1999, pp. 1,184–1,185; U.S. Army 2006; TNC 2007; HBMP 2008) (USFWS, 2012).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Resiliency:

Very low (inferred from USFWS, 2012; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2012)

Number of Populations:

3 (USFWS, 2012)

Population Size:

250 (USFWS, 2012)

Population Narrative:

The long term population trend is unknown. An estimated total of 250 plants (U.S. Army 2006; HBMP 2008 cited by USFWS 2011). Total number of EOs are four, of those three are extant

occurrences found only on Oahu. Observation records range from 1999-2000 (HBMP 2007). (NatureServe, 2015). Currently, there are 3 occurrences totaling approximately 250 individuals (USFWS, 2012).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative plants, animals (pigs), hurricanes, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. The projected effects of climate change will likely exacerbate the effects of the other threats to the species (USFWS, 2012).

Stressor: Predation and herbivory (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs) is considered an ongoing threat to *Melicope christophersenii* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2012).

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor:

Exposure:

Response:

Consequence:

Narrative:***Recovery*****Reclassification Criteria:**

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- Not available

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SPECIES ACCOUNT: *Melicope degeneri* (Alani)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (R1) (USFWS, 2016)

Physical Description

A shrub or a tree. Leaves are opposite. Inflorescences have about 3 flowers. Capsules are cuboid (NatureServe, 2015).

Taxonomy

A member of the rue family (Rutaceae) (USFWS, 2010b). This genus is nearly endemic to Hawaii, with 2 species in the Marquesas Islands (NatureServe, 2015).

Historical Range

Endemic to the Northwestern region of Kauai, state of Hawaii (NatureServe, 2015).

Current Range

Range of current occurrences is about 62 square km (NatureServe, 2015). *Melicope degeneri* was thought to be extinct until it was rediscovered in Pohakuao, just beyond the northwest corner of the Hono o Na Pali NAR, in 1993 (Wood 2000, p. 6), and subsequently observed in upper Hanakoa in 1995 and along Koaie Stream in 1999 (NTBG Accession Data 1999). The Pohakuao individual has not been relocated since its discovery (Wood 2000, p. 5). One small mature individual of *M. degeneri* was found growing in Koaie Canyon's upper drainage in 1999, and was last observed there in September of 2006 (K. Wood, pers. comm. 2007b). A new population of 9 individuals was found in Wainiha Valley (USFWS, 2010b).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Melicope degeneri* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Melicope degeneri* includes three CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Montane Wet—Section 1: Montane Wet—Section 1 consists of 13,055 ac (5,257 ha) in the montane wet ecosystem, extending across the Alakai Plateau from Hanakoa to Mount Waialeale, on State (12,628 ac, 5,110 ha) and privately owned (427 ac, 173 ha) land in the Na Pali Coast State Park, the Alakai Wilderness Preserve, the Na PaliKona and Halelea forest reserves, and Hono o Na Pali NAR (Figure 4). It is occupied by the plants *Astelia waialealae*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *K. helenae*, *Labordia helleri*, *L. pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, and *Platydesma rostrata*; by the akekee and akikiki; and by the picture-wing fly. This section also contains unoccupied habitat that

is essential to the conservation of these 18 species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the montane wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and the species-specific PCEs including (1) bogs (identified as PCEs for *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*) (2) bog hummocks (identified as PCEs for *Astelia waialealae* and *Lysimachia daphnoides*); (3) arthropod prey (identified as PCEs for the akekee and the akikiki); and (4) larval-stage host plants, *Cheirodendron* and *Tetraplasandra* sp., (identified as a PCE for the picture-wing fly). Although Montane Wet—Section 1 is not known to be occupied by the plants *Dubautia kalalauensis*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, those portions of the section that overlie previously designated critical habitat fall within two existing Critical Habitat Units of 50 CFR 17.99(a)(1): Unit 10, Map 35a; and Unit 11, Map 64a. The previously undesignated land comprises Unit 23, Map 217f; and Unit 24, Map 217g. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 4—Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 4—Montane Wet).

Kauai—Montane Wet—Section 2: Montane Wet—Section 2 consists of 790 ac (320 ha) in the montane wet ecosystem, extending from Kahuamaa Flat south to the edge of Waimea Canyon, on State-owned land in Kokee State Park (Figure 4, above). The entire section is within previously designated critical habitat, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Dubautia kalalauensis*, *Labordia helleri*, *Melicope puberula*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*, and by the akekee. This section includes montane wet forest, potentially some small-scale boggy areas, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and arthropod prey (identified as a species-specific PCE for the akekee). Although Montane Wet—Section 2 is not known to be occupied by the plants *Astelia waialeale*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialeale*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *Myrsine mezii*, and *Phyllostegia renovans*; by the akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. This area also supports the arthropod prey identified as a PCE for the akikiki, and the larval-stage host plants (*Cheirodendron* and *Tetraplasandra* spp.) identified as a PCE for the picturewing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within previously designated Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 5—Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 5—Montane Wet).

Kauai—Montane Wet—Section 3: Montane Wet—Section 3 consists of 413 ac (167 ha) in the montane wet ecosystem, encompasses the summit of Namolokama, on State (156 ac, 63 ha) and privately owned (257 ac, 104 ha) land in the Halelea Forest Reserve (Figure 4, above). It is entirely

within previously designated critical habitat, and is occupied by the plants *Keysseria erici* and *Labordia pumila*. This section includes the montane wet forest, the moisture regime, and the canopy, subcanopy, and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and bogs (identified as a species-specific PCE for *K. erici*). Although Montane Wet–Section 3 is not known to be occupied by the plants *Astelia waialeale*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia kalalauensis*, *D. waialeale*, *Geranium kauaiense*, *Keysseria helenae*, *Labordia helleri*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*; by the akekee and akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. It also supports the arthropod prey identified as a PCE for the akekee and akikiki, and the larval-stage host plants (*Cheirodendron* and *Tetraplasandra* spp.) identified as a PCE for the picture-wing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 6–Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 6–Montane Wet).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Melicope degeneri* critical habitat consists of one component (Montane wet) (75 FR 18960-19165):

Ecosystem: Montane Wet. Elevation: 3,000–5,243 ft (914-1,598 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: *Ferns*, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species,

competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (inferred from USFWS, 2010b)

Reproduction Narrative

Adult: This species is dioecious (USFWS, 2010b).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Metrosideros-Cheirodendron-Dicranopteris montane wet forest (USFWS, 2010b)

Geographic or Habitat Restraints or Barriers

Adult: 3,000 - 3,800 ft. elevation (USFWS, 2010b)

Environmental Specificity

Adult: Very narrow to moderate (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits wet forests. This species exhibits a very narrow to moderate environmental specificity (NatureServe, 2015). It occurs in the montane wet ecosystem in Metrosideros-Cheirodendron-Dicranopteris wet forest between the elevations of 3,000 and 3,800 ft. (914 and 1,158 m) (Stone et al. 1999, p. 1186; HBMP 2007; TNCH 2007) (USFWS, 2010b).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Species Trends:

Presumed extinct until rediscovery in 1993 (NatureServe, 2015)

Resiliency:

Very low (inferred from NatureServe, 2015; see current range/distribution)

Redundancy:

Very low (inferred from USFWS, 2010a)

Number of Populations:

5 (USFWS, 2017)

Population Size:

<52 (USFWS, 2017)

Population Narrative:

The long term population trend is unknown. This species was thought extinct until it was rediscovered in 1993 (NatureServe, 2015). There are two populations totaling 11 individuals (USFWS, 2010a). At the time of listing in 2010, the total known number of individuals for *M. degeneri* was 22, or possibly 23, known individuals. Currently, resulting from more surveys for the species, there are occurrences at 5 general locations: Mohihi, Hanakoa, Hanakapiai, Wainiha, and Koaie, totaling fewer than 52 individuals (Edmonds and Walsh 2015; NTBG 2013a-f, 2014a-f, 2015a-j, 2016a-c; PEPP 2015, 2016) (USFWS, 2017).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from non-native plants, pigs, goats, hurricanes, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species.

Stressor: Predation and herbivory (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species present an immediate and significant threat to *Melicope degeneri* throughout its range due to documented browsing and trampling by pigs, goats, and deer, and documented mechanical damage by the black twig borer (*Xylosandrus compactus*) (USFWS, 2010).

Stressor: Small populations and lack of reproduction (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: *Melicope degeneri* is threatened by the effects of small population size (fewer than 50 wild individuals). No viable seeds or reproduction have been observed. Research on *Pittosporum* species suggests that small populations are susceptible to loss of genetic variation through inbreeding and drift (USFWS, 2010).

Stressor:

Exposure:

Response:

Consequence:

Narrative:**Stressor:** Ungulate degradation of habitat**Exposure:****Response:****Consequence:**

Narrative: Feral pigs (*Sus scrofa*) and goats (*Capra hircus*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil (Loope 1998; van Riper and van Riper 1982). Feral pigs and goats and evidence of their activities have been observed at Hanakoa, Koaie, Hanakapiai, Mohihi, Wainiha (HBMP 2010; NTBG 2013a-f, 2014a-d, f-g, 2015d-e, i-k, 2016b; PEPP 2015; Wood 2011) (USFWS, 2017).

Stressor: Established ecosystem-altering invasive plant modification and degradation of habitat**Exposure:****Response:****Consequence:**

Narrative: Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community (Cuddihy and Stone 1990). Habitat modification and destruction by invasive introduced plants negatively affects *Melicope degeneri* at all locations. The nonnative plants with the greatest impacts include *Adiantum raddianum* (NCN), *Ageratina riparia* (Hamakua pamakani), *Andropogon glomeratus* (bushy beardgrass), *Axonopus fissifolius* (narrow-leaved carpetgrass), *Buddleia asiatica* (dog tail), *Clidemia hirta* (Koster's curse), *Cyclosorus dentatus* (pauhiha), *Cyperus meyenianus* (NCN), *Erigeron karvinskianus* (daisy fleabane), *Hedychium gardnerianum* (kahili ginger), *Juncus planifolius* (rush), *Kalanchoe pinnata* (air plant), *Lantana camara* (lantana), *Paspalum urvillei* (vasey grass), *Rubus argutus* (prickly Florida blackberry), *Setaria parviflora* (yellow foxtail), and *Sphaeropteris cooperi* (Australian tree fern) (HBMP 2010; NTBG 2013a, 2015j, 2016a-b, d) (USFWS, 2017).

Stressor: Landslides and flooding loss or degradation of habitat**Exposure:****Response:****Consequence:**

Narrative: Floods, including tree falls and erosion associated with them, can have a significant effect on small populations. Landslides and erosion due to natural weathering destabilize substrates, damage and destroy individual plants, and alter hydrological patterns (Stearns 1985). Landslides have been reported to be a threat to an occurrence of *Melicope degeneri* at Hanakoa (PEPP 2011). Flooding is reported to be a threat to an occurrence at Hanakoa and is a likely threat to individuals occurring along a stream at Mohihi (PEPP 2016; Wood 2011) (USFWS, 2017)

Stressor: Hurricanes—Loss and degradation of habitat**Exposure:****Response:****Consequence:**

Narrative: In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013) (USFWS, 2017).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: —Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Melicope degeneri* is highly vulnerable to the impacts of climate change with a vulnerability score of 0.824 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this species has no overlap between current and future climate envelopes, and is unlikely to tolerate expected changes in climate at its current location. This means that this species must persist within suitable microrefugia, or move to newly available climate-compatible areas to avoid extinction. The fewer than 60 individuals of *M. degeneri* occur in only five locations on Kauai, with no alternate habitat available. Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery

Reclassification Criteria:

In addition to achieving 5 to 10 populations with 200 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats (USFWS, 2017).

Delisting Criteria:

In addition to achieving 5 to 10 populations with 200 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure,

naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis (USFWS, 2017).

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys (USFWS, 2010a).
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units (USFWS, 2010a).
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys (USFWS, 2010a).
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range (USFWS, 2010a).
- Conduct research on control methods for introduced slugs and avian malaria (USFWS, 2010a).
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction (USFWS, 2010a).
- Identify threats and prioritize which ones to address first for the two birds (USFWS, 2010a).
- Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program (USFWS, 2010a).
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security (USFWS, 2010a).
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems (USFWS, 2010a).
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations (USFWS, 2010a).
- Current Management Actions: • Population viability monitoring and analysis—PEPP is monitoring individuals at Hanakoa, Koaie, Mohihi, and Wainiha (PEPP 2011, 2012, 2014, 2015, 2016). • Surveys and inventories—Surveys are ongoing to locate additional individuals

- of this species (NTBG 2016b; PEPP 2016). • Invasive plant monitoring and control—Some invasive plant control is ongoing at populations monitored by PEPP (PEPP 2015). • Captive propagation for genetic storage and reintroduction—Seeds and cuttings are collected for storage and propagation. There are currently three plants in the NTBG nursery from one collection at Koaie. There are approximately 100 seeds currently sown in the nursery from five other collections representing three other locations (NTBG 2013a-d, g, 2014b, h, 2015d-f, j, l, 2016a-d, 2017) (USFWS, 2017).
- **RECOMMENDATIONS FOR FUTURE ACTIONS** • Surveys and inventories—Continue to survey for other populations of *Melicope degeneri* in areas of potentially suitable habitat. • Ungulate monitoring and control—Protect all occurrences against browsing and disturbances from feral ungulates to prevent imminent extinction. Construct fenced exclosures to protect against feral ungulates. • Invasive plant monitoring and control o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative plant species around all populations that compete with the species. • Predator and herbivore monitoring and control—Implement effective control methods for rodents around all populations. • Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms. • Population biology research—Study *Melicope degeneri* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats • Based on the recovery criteria above, consider development of a recovery plan (USFWS, 2017).

Conservation Measures and Best Management Practices:

- This species is currently in controlled propagation for genetic storage and/or reintroduction efforts (USFWS, 2010a).
- This species is monitored by the Plant Extinction Prevention program. The Plant Extinction Prevention Program focuses on those plant species with fewer than 50 individuals remaining in the wild. The goal of the program is to achieve the general interim recovery guidelines set by the Hawaii and Pacific Plants Recovery Coordinating Committee (1994), which are: 3 populations of 25 (long-lived species), 50 (short-lived), or 100 (annual) mature, reproducing individuals; all threats to those populations being managed; and all individuals are represented in genetic storage (USFWS, 2010a).

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SPECIES ACCOUNT: *Melicope haupuensis* (Alani)

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/25/1994; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Melicope haupuensis is a tree about 8 m (26 ft) tall. The oval leaves, 5 to 13 cm (2 to 5.1 in) long and 28 to 56 mm (1.1 to 2.2 in) wide, are oppositely arranged. Flowers grow in clusters of five to seven on stalks usually 2 to 7 mm (0.1 to 2.8 in) long, each flower on a stalk 1 to 3 mm (0.04 to 0.12 in) long. Only female flowers are known. The flowers are about 3.5 mm (0.14 in) long, dotted with oil glands, and covered with a dense mat of hairs. Fruits are distinct follicles (a dry fruit that splits open lengthwise), 9 to 11 mm (0.35 to 0.43 in) long, with a hairless exocarp and endocarp (outermost and innermost layers of the fruit wall, respectively). Unlike other taxa of this genus on Kauai, the exocarp and endocarp are hairless and the sepals are covered with dense hairs (St. John 1944, Stone 1969, Stone et al. 1990). (USFWS, 1995)

Taxonomy

A member of the citrus family (Rutaceae) (USFWS, 1995).

Historical Range

Historically known from the north side of Haupu Ridge on Kauai (USFWS, 2003).

Current Range

Known on Kauai, on State-owned land within the Alakai Wilderness Preserve, Na Pali Coast State Park, and Na Pali-Kona Forest Reserve in Kalahu, Awaawapuhi Valley, and Koaie Canyon (USFWS, 2003).

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Melicope haupuensis* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Melicope haupuensis* includes three units totaling 2,950 acres in Kauai County, Hawaii. The units are Kauai 7—*Melicope haupuensis*—a and Kauai 11—*Melicope haupuensis*—b, c.

Kauai 7—*Melicope haupuensis*—a: This unit is critical habitat for *Melicope haupuensis* and is 330 ha (816 ac) on private land. This unit contains Hokulei Peak, Haupu and Naluakeina Summits, and Queen Victoria's Profile. This unit provides habitat for two populations of 100 mature, reproducing individuals of the long-lived perennial *Melicope haupuensis* and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is important to the establishment of additional populations on Kauai in order to reach recovery goals. The habitat features contained in this unit that are essential for this species

include, but are not limited to, moist talus slopes in *Metrosideros polymorpha* dominated lowland mesic forest or *Metrosideros polymorpha*-*Acacia koa* montane mesic forest. This unit is geographically separated from the other two units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Although the Service does not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is at an appropriate distance from the other unit to avoid their destruction by one naturally occurring catastrophic event.

Kauai 11—*Melicope haupuensis*—b: This unit is critical habitat for *Melicope haupuensis* and is 575 ha (1,418 ac) on State land (Kuia NAR, Kokee and Na Pali Coast State Parks). This unit contains portions of Awaawapuhi, Honopu, and Nualolo Trails, Kainamanu and Kalahu Summits. This unit provides habitat for three populations of 100 mature, reproducing individuals of the long-lived perennial *Melicope haupuensis* and is currently occupied with 11 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, moist talus slopes in *Metrosideros polymorpha* dominated lowland mesic forest or *Metrosideros polymorpha*-*Acacia koa* montane mesic forest. This unit is geographically separated from the other two units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Although the Service does not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is at an appropriate distance from the other unit to avoid their destruction by one naturally occurring catastrophic event.

Kauai 11—*Melicope haupuensis*—c: This unit is critical habitat for *Melicope haupuensis* and is 290 ha (716 ac) on State land (Alakai Wilderness Preserve), containing portions of Kipalau Valley. This unit provides habitat for two populations of 100 mature, reproducing individuals of the long-lived perennial *Melicope haupuensis* and is currently occupied with two plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, moist talus slopes in *Metrosideros polymorpha* dominated lowland mesic forest or *Metrosideros polymorpha*-*Acacia koa* montane mesic forest. This unit is geographically separated from the other two units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Although the Service does not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is at an appropriate distance from the other unit to avoid their destruction by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

- (i) Moist talus slopes in *Metrosideros polymorpha*-dominated lowland mesic forests or *Metrosideros polymorpha*-*Acacia koa* montane mesic forest and containing one or more of the following associated native plant species: *Antidesma platyphyllum* var. *hillebrandii*, *Bobea brevipes*, *Cheirodendron trigynum*, *Claoxylon sandwicense*, *Cryptocarya mannii*, *Dianella*

sandwicensis, Diospyros hillebrandii, Diospyros sandwicensis, Dodonaea viscosa, Elaeocarpus bifidus, Hedyotis terminalis, Melicope anisata, Melicope barbigera, Melicope ovata, Pleomele aurea, Pouteria sandwicensis, Pritchardia minor, Psychotria greenwelliae, Psychotria mariniana, Tetraplasandra waimeae, or Zanthoxylum dipetalum; and

(ii) Elevations between 125 and 1,249 m (410 and 4,097 ft).

Special Management Considerations or Protections

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species in paragraph (b) of this section and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 375 to 820 meters (1,230 to 2,690 feet) (USFWS, 1995)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1995)

Habitat Narrative

Adult: These plants grow on moist talus slopes in ohia-dominated lowland mesic forests with such associated taxa as aalii and hame, at elevations between 375 and 820 meters (1,230 and 2,690 feet). This species is found in moist forests in gulch bottoms and on ridgetops. (USFWS, 1995)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2009)

Redundancy:

Very low (inferred from USFWS, 2009)

Number of Populations:

2 (USFWS, 2017)

Population Size:

~40 (USFWS, 2017)

Population Narrative:

Most recently, USFWS (2008) reported three populations totaling 30 individuals, with a population breakdown of one individual at Koaie, about 15 at Awaawapuhi, and 12 at Honopu. (USFWS, 2009). *Melicope haupuensis* occurs at two of the same locations discussed in the 2009 5-year review: Awaawapuhi (ca 30 individuals) and Honopu (ca 10 individuals) (NTBG 2011, 2014, 2015a-e, 2016a-f; USFWS 2009). In 2014, new individuals were found: one individual was reported from Kalepa ridge, downslope of the other Honopu occurrences (PEPP 2014) and another individual was found in Kawaiula Valley (NTBG 2015g). Currently, there are approximately 40 individuals ranging from Kawaiula Valley to Honopu. The individual at Kalalau could not be relocated (PEPP 2011) (USFWS, 2017).

Threats and Stressors

Stressor: Habitat degradation by goats, deer, and rats (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The major threats to this species are habitat degradation by feral goats (*Sus scrofa*), deer (*Odocoileus hemionus*), and rats (*Rattus* spp.). (USFWS, 2009)

Stressor: Invasive introduced plants (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Competition with invasive introduced plant species such as *Lantana camara* (lantana), *Rubus argutus* (thimbleberry), *Hedychium gardnerianum* (kahili ginger), and *Erigeron karvinskianus* (daisy fleabane) are a threat to this species (USFWS, 2009)

Stressor: Black twig borer (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: A potential threat to members of this genus is their known susceptibility to black twig borer (*Xylosandrus compactus*). (USFWS, 2009)

Stressor: Natural disasters (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Naturally occurring events, such as landslides or hurricanes can devastate *Melicope haupuensis*. (USFWS, 2009)

Stressor: Small population size (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Reduced reproductive vigor due to small population size is a threat to *Melicope haupuensis*. (USFWS, 2009)

Stressor: Ungulate degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Feral pigs (*Sus scrofa*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil (Loope 1998; van Riper and van Riper 1982). Feral pigs have been noted to be a threat to the occurrences of *Melicope haupuensis* at Awaawapuhi and Honopu (NTBG 2012a-d, 2013a, 2014, 2015d, f-g; PEPP 2012, 2013, 2014, 2015) (USFWS, 2017).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: —Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Melicope haupuensis* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.772 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Stressor: Fire destruction or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Fire can destroy dormant seeds as well as individual plants. Successive fires burn farther and farther into native habitat and alter microclimate conditions to further alter habitat conditions to favor nonnative plants. Nonnative plants convert native plant communities to nonnative dominated plant communities (D'Antonio and Vitousek 1992; Tunison et al. 2002). Fire is noted to be a threat to *Melicope haupuensis* at Honopu (NTBG 2012a-d. 2013a, 2015d, f-g) (USFWS, 2017).

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Kauai and at least one other island where they now occur or occurred historically. (USFWS, 1995)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1995)
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1995)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Kauai and at least one other island where they now occur or occurred historically. (USFWS, 1995)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1995)
3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1995)

Recovery Actions:

- In order to prevent this taxon from going extinct, propagation efforts and the maintenance of adequate genetic stock ex situ should be undertaken immediately, as well as the protection of remaining wild individuals from feral goats and alien weed threats. (USFWS, 1995)
- Given the degraded nature of the Kauai plant cluster's habitat, their precariously low numbers, and the severity of the threats, the highest priority actions must be aimed at protecting all extant wild individuals and populations, managing habitat to enhance survival and ensuring maintenance of adequate genetic stock ex situ. A monitoring program to track the status of the populations, and to assess the effectiveness of threat management, will also be essential. (USFWS, 1995)
- It is hoped that by eliminating current threats through management, populations of the Kauai cluster taxa will expand naturally. However, in certain special instances, wild populations of the Kauai cluster taxa may need to be augmented. This should be done conservatively and only after careful consideration of all factors involved, particularly the threat of introducing detrimental organisms into the wild populations. Augmentation efforts should always be well-documented as to lineage and methods. (USFWS, 1995)
- Research into various aspects of the life history, habitat, pollinators, reproductive biology, symbionts, optimum requirements for growth, requirements for population viability, and control of threats to each of the Kauai cluster taxa must be carried out to better understand the requirements necessary for perpetuation of these plants. Such additional knowledge would allow more appropriate management and assessment techniques to be developed, and is needed in order to determine meaningful parameters for definition of specific recovery criteria for each taxon. (USFWS, 1995)
- If necessary to meet recovery objectives, populations should be reestablished in areas where they are known to have occurred historically, particularly if genetically uncontaminated, cultivated materials exist which are known to have originated from the historical site. The goal of reintroduction of these taxa is to permanently reestablish viable populations of these taxa in stable and secure conditions. (USFWS, 1995)
- The scientific validity of the recovery objectives should be reviewed as more information becomes available. (USFWS, 1995)
- A public education program is needed to increase awareness of and support for plant recovery efforts in Hawaii. (USFWS, 1995)
- New Management Actions: • Population viability monitoring and analysis—PEPP is surveying for new populations and monitoring known populations of *Melicope haupuensis* (PEPP 2010, 2011, 2012, 2013, 2014, 2015). • Captive propagation for genetic storage and reintroduction—PEPP and NTBG have collected seeds and cuttings for propagation at the NTBG nursery, and there are currently some plants in the nursery (NTBG 2017). Lyon Arboretum Micropropagation Lab reported propagative materials in collection between 2004 and 2012, but not currently (Lyon Arboretum 2017). PEPP is also air-layering for propagation (PEPP 2013, 2015). • Reintroduction and translocation—PEPP is reintroducing individuals into a fenced and monitored enclosure at Nualolo (PEPP 2014, 2015). • Invertebrate predator and herbivore monitoring and control—PEPP is controlling invertebrate predation at Honopu and Awaawapuhi (PEPP 2013) (USFWS, 2017).
- Recommendations for Future Actions: Habitat destruction and modification by feral pigs, and fire destruction or degradation of habitat, have been noted as new threats to *Melicope haupuensis*. No other significant new information regarding the species biological status has come to light since the last 5-year review in 2009. Thus, the following recommendations for

future actions are added and reiterated for the 5-year review for 2017. • Surveys and inventories—Survey geographical and historic range for a thorough current assessment of the species and for additional individuals in potentially suitable habitat. • Ungulate monitoring and control—Construct large-scale fences around all naturally occurring and reintroduced individuals to control feral ungulates. Protect all occurrences against browsing and disturbances from feral ungulates with small-scale fencing to prevent imminent extinction. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative species that compete with the species around all populations. • Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Predator and herbivore monitoring and control— o Implement effective control methods to control rats around all populations. o Study Melicope haupuensis populations to determine level of threat from invertebrate herbivory and any additional recovery actions needed. • Fire monitoring and control—Develop and implement fire-management plans for all wild and reintroduced populations. • Genetic research—Assess genetic variability of the extant populations. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides. • Population biology research—Study Melicope haupuensis populations to determine viable population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Collect fruit from all wild and any reintroduced individuals that set seed to add to the genetic diversity. (USFWS, 2009)
- Construct large-scale fences around all naturally occurring and reintroduced individuals to control feral ungulates. (USFWS, 2009)
- Enhance current natural populations to increase numbers of individuals. (USFWS, 2009)
- Establish populations in protected habitat within historical range. (USFWS, 2009)
- Survey geographical and historical range for a thorough current assessment of the species. (USFWS, 2009)
- Assess genetic variability within extant population. (USFWS, 2009)
- Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2009)
- Study Melicope haupuensis populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. (USFWS, 2009)

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SPECIES ACCOUNT: *Melicope hiiakae* (Alani)

Species Taxonomic and Listing Information

Listing Status: Endangered; 9/18/2012; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

A small tree. Leaves opposite. Inflorescence 1-flowered. Capsules deeply lobed. (NatureServe, 2015)

Taxonomy

Hawaii Heritage Program and USFWS consider *Melicope hiiakae*, discovered in Oahu, Koolau mountains (C. Russell, HIHP, Nov/1994), distinct from *M. wawraeana*. While a previous, unpublished draft of Kartesz's Synthesis did not treat the two taxa as distinct, the 1999 published version does. (NatureServe, 2015)

Historical Range

See Current Range.

Current Range

Endemic to the Koolau Mountains on the island of Oahu, state of Hawaii. The range of the current populations is less than 400 square km. (NatureServe, 2015)

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On September 18, 2012, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Melicope hiiakae* (Alani) under the Endangered Species Act of 1973, as amended (Act) (77 FR 57648-57862). The critical habitat designation includes 11 critical habitat units, which encompass approximately 25,112 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Melicope hiiakae* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Melicope hiiakae* includes 11 critical habitat units, covering one ecosystem type, which encompasses approximately 25,112 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16.

Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Haula Forest Reserves and Sacred Falls State Park,

from Puukainapuaa to Kaluanui (Sacred Falls). Oahu— Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikēkee, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet— Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet— Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu— Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamoa Ridge.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Melicope hiiakae* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Melicope hiiakae* occurs within the indicated ecosystem in the Koolau Mountain caldera complex:

Oahu—Lowland Wet—Units 6, 7, 8, 9,10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (F) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Melicope hiiakae* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland, shrubland/chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 1,300 and 2,260 feet (400 and 700 meters) (USFWS, 2012)

Spatial Arrangements of the Population

Adult: Scattered (USFWS, 2012)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: *Melicope hiiakae* (alani) is a small tree in the rue family (Rutaceae) that occurs in wet forest in the lowland wet ecosystem in the Koolau Mountains, between elevations of 1,300 and 2,260 ft (400 and 700 m) (U.S. Army 2006; NTBG 2007, p. 3; TNC 2007; HBMP 2008). Currently, there are 10 scattered occurrences totaling fewer than 60 individuals from Kawaihoa to Waimalu (NTBG 2007, p. 3; HBMP 2008; Lau 2011, in litt.). (USFWS, 2012)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Resiliency:

Low (inferred from USFWS, 2012)

Redundancy:

Medium (inferred from USFWS, 2012)

Population Growth Rate:

Unknown (NatureServe, 2015)

Number of Populations:

10 (USFWS, 2012)

Population Size:

60 (USFWS, 2012)

Population Narrative:

Currently, there are 10 scattered occurrences totaling fewer than 60 individuals from Kawaihoa to Waimalu (NTBG 2007, p. 3; HBMP 2008; Lau 2011, in litt.).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative plants, animals (pigs), hurricanes, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. The projected effects of climate change will likely exacerbate the effects of the other threats to the species (USFWS, 2012).

Stressor: Predation and herbivory (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs) is considered an ongoing threat to *Melicope hiiakae* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2012).

Stressor: Small populations and trampling by humans (USFWS, 2012)

Exposure:

Response:**Consequence:**

Narrative: Melicope hiiakae faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild) and trampling. M. hiiakae is susceptible to reduced reproductive vigor due to the lack of pollination and seed predation. Field biologists have observed trampling of vegetation near populations of Melicope hiiakae in the Koolau Mountains, suggesting that hikers could be a threat to this species (USFWS, 2012).

Stressor:**Exposure:****Response:****Consequence:****Narrative:****Stressor:****Exposure:****Response:****Consequence:****Narrative:****Stressor:****Exposure:****Response:****Consequence:****Narrative:****Stressor:****Exposure:****Response:****Consequence:****Narrative:*****Recovery*****Reclassification Criteria:**

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

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SPECIES ACCOUNT: *Melicope knudsenii* (Alani)

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/25/1994; Pacific Region (R1) (USFWS, 2016a)

Physical Description

A tree 3 - 10 m tall. Inflorescences are often large, with up to 200 flowers (NatureServe, 2015). It has smooth gray bark and yellowish brown to olive-brown hairs on the tips of the branches. Leaves are variable, ranging from oblong to elliptic, 9 to 25 centimeters (3.5 to 9.8 inches) long, and 4.5 to 10 centimeters (1.8 to 3.9 inches) wide (USFWS, 1995).

Taxonomy

A member of the rue family (Rutaceae) (USFWS, 2016b).

Historical Range

Historically, *Melicope knudsenii* was known only from the southeast slope of Haleakala on Maui and from Olokele Canyon on Kauai (HHP 1994) (USFWS, 1995). At the time critical habitat critical habitat was designated in 2003, there were 10 occurrences on Kauai and 4 occurrences on Maui (68 FR 9116, February 27, 2003; 68 FR 25934, May 14, 2003). (USFWS, 2016b).

Current Range

Current range includes Kauai and East Maui (NatureServe, 2015).

Critical Habitat Designated

Yes; 5/14/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Melicope knudsenii* (Alani) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one detailed critical habitat units (CHU), in Hawaii (81 FR 17790-18110).

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designate critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Melicope knudsenii* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Melicope knudsenii* includes one CHU in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Montane Dry—Unit 1 consists of 2,962 ac (1,199 ha) of State land, and 563 ac (228 ha) of federally owned land (Haleakala National Park), from Kanaio to Naholoku and Kaupo Gap along the southern slopes of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane dry ecosystem (see Table 5). Although Maui—Montane Dry—Unit 1 is not known to be occupied by the plants *Alectryon macrococcus*, *Geranium arboreum*, *Melicope knudsenii*, *M. mucronulata*, *Santalum haleakalae* var. *lanaiense*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation

and recovery of these montane dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat designation for *Melicope knudsenii* includes two units totaling 3,310 acres in Kauai County, Hawaii. The units are Kauai 11—*Melicope knudsenii*—a, b.

Kauai 11—*Melicope knudsenii*—a: This unit is critical habitat for *Melicope knudsenii* and is 967 ha (2,389 ac) on State land (Kuia NAR). This unit contains portions of Awaawapuhi and Nualolo Trails, and Milolii Ridge. This unit provides habitat for three populations of 100 mature, reproducing individuals of the long-lived perennial *Melicope knudsenii* and is currently occupied with four plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. It provides habitat for the westernmost range of the species that is unique to Kauai. The habitat features contained in this unit that are essential for this species include, but are not limited to, forested flats with brown granular soil in lowland dry to montane mesic forests. This unit provides for three populations within this multiisland species' historical range on Kauai that are some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event. Kauai 11—*Melicope knudsenii*—b: This unit is critical habitat for *Melicope knudsenii* and is 373 ha (922 ac) on State land (Alakai Wilderness Preserve). This unit contains portions of Kawaiiki and Kipalau Valleys. This unit provides habitat for two populations of 100 mature, reproducing individuals of the long-lived perennial *Melicope knudsenii* and is currently occupied with six plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. It provides habitat for the westernmost range of the species that is unique to Kauai. The habitat features contained in this unit that are essential for this species include, but are not limited to, forested flats with brown granular soil in lowland dry to montane mesic forests. This unit provides for two populations within this multi-island species' historical range on Kauai that are some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Melicope knudsenii* critical habitat consists of one component. Montane dry (east Maui) (81 FR 17790-18110):

Ecosystem: Montane Dry. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Dry cinder or ash soils, loamy volcanic sands, blocky lava, rock outcroppings. Canopy: *Acacia*, *Metrosideros*, *Myoporum*, *Santalum*, *Sophora*. Subcanopy: *Chamaesyce*, *Coprosma*, *Dodonaea*, *Dubautia*, *Leptecophylla*, *Osteomeles*, *Wikstroemia*. Understory: *Bidens*, *Eragrostis*, *Melanthra*, *Vaccinium*.

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Forested flats with brown granular soil in lowland dry to montane mesic forests and containing one or more of the following associated native plant species: *Alectryon macrococcus*, *Antidesma platyphylla*, *Bobea brevipes*, *Carex meyenii*, *Cryptocarya mannii*, *Diospyros sandwicensis*, *Diplazium sandwichianum*, *Dodonaea viscosa*, *Euphorbia haeleeleana*, *Gahnia beecheyi*, *Hedyotis* spp., *Hibiscus waimeae*, *Isodendron laurifolium*, *Leptecophylla tameiameia*, *Melicope* spp., *Metrosideros polymorpha*, *Myrsine lanaiensis*, *Nestegis sandwicensis*, *Panicum nephelophilum*, *Peucedanum sandwicense*, *Pisonia sandwicensis*, *Pittosporum kauaiensis*, *Pleomele aurea*, *Pouteria sandwicensis*, *Pritchardia minor*, *Psychotria hobbii*, *Psydrax odorata*, *Rauvolfia sandwicensis*, *Remya kauaiensis*, *Scaevola procera*, or *Xylosma hawaiiense*; and

(ii) Elevations between 346 and 1,065 m (1,135 and 3,492 ft).

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's

tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkii*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and

equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Lifespan

Adult: > 10 years (USFWS, 2011)

Reproduction Narrative

Adult: It is a long-lived perennial (USFWS, 2011).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Lowland dry to mesic forest (USFWS, 1995)

Geographic or Habitat Restraints or Barriers

Adult: 1,500 - 3,300 ft. elevation (USFWS, 1995)

Habitat Narrative

Adult: Inhabits moist forests. On Kauai: gentle to steep gulch slopes; on Maui: gently sloped old lava flows (NatureServe, 2015). *Melicope knudsenii* grows on forested flats or talus slopes in lowland dry to mesic forests at an elevation of about 450 to 1,000 meters (1,500 to 3,300 feet) (USFWS, 1995).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Species Trends:

Increasing (USFWS, 2011)

Resiliency:

Low (inferred from NatureServe, 2015; see current range/distribution)

Redundancy:

Very low (inferred from USFWS, 2011)

Population Size:

1 (USFWS, 2018)

Population Narrative:

Overall, the numbers of individuals have increased from approximately four wild mature individuals reported in the previous 5-year review to approximately eight wild mature individuals in 2013 on the islands of Kauai (four individuals) and Maui (four individuals) (PEPP 2012, 2013). Puu Mahoe Arboretum contains a single mature reintroduced individual (PEPP 2012) (USFWS, 2011). Currently, there is only one *Melicope knudsenii* tree on Kaua'i (Kishida 2018, in litt.; NTBG 2016; PEPP 2014, 2015) (USFWS, 2018).

Threats and Stressors

Stressor: Nonnative species (USFWS, 1995)

Exposure:

Response:

Consequence:

Narrative: Competition with alien plant taxa and habitat degradation by feral and domestic animals are the major threats to *Melicope knudsenii*. On Kauai, this species competes with lantana and is affected by feral goats and pigs. On Maui, *Melicope knudsenii* grows in an area currently grazed by domestic cattle, where a continuous mat of Kikuyu grass prevents seedlings from establishing. Although cattle are a threat to this population, they also reduce the density of Kikuyu grass, which appears to be an even greater threat (Robert Hobdy, DOFAW, personal communication 1995). Feral goats and feral pigs are also present in the area of the Maui population, and axis deer, found on the south slope of Haleakala and increasing in numbers, are a potential threat (USFWS, 1995).

Stressor: Stochastic events (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Drought may exacerbate the effects of ungulates and has direct adverse impacts on *M. knudsenii* (PEPP 2011, 2013) (USFWS, 2011). This species is also threatened by fire, stochastic extinction, and/or reduced reproductive vigor due to the small number of existing individuals (USFWS 1994a; 1995).

Stressor: Predation/herbivory (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Damage by black twig borer has been reported at Kanaio NAR (PEPP 2013). – Predation and herbivory by an unknown insect was reported on Kauai (PEPP 2012). The unknown insect damaged the leaves of the wild individual (USFWS, 2011).

Stressor: Habitat loss (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: On Maui, the species' habitat has been converted to pasture (NatureServe, 2015).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: We previously reported that climate change may pose a threat to this species, anticipating an analysis by 2013. The assessment conducted by Fortini et al. (2013) concluded that *Melicope knudsenii* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.722 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are likely needed to conserve this taxon into the future to insure the best locations for recovery are identified (USFWS, 2018).

Recovery

Reclassification Criteria:

1. A total of five to seven populations should be documented on Kauai and at least one other island where they now occur or occurred historically (USFWS, 1995).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population (for long-lived perennials) (USFWS, 1995).
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 1995).

Delisting Criteria:

1. A total of 8 to 10 populations should be documented on Kauai and at least one other island where they now occur or occurred historically (USFWS, 1995).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population (for long-lived perennials) (USFWS, 1995).

3. Each population should persist at this level for a minimum of five consecutive years (USFWS, 1995).

Recovery Actions:

- Protect current populations, control threats and monitor (USFWS, 1995).
- Expand current populations (USFWS, 1995).
- Conduct research essential to conservation of the species (USFWS, 1995).
- Establish new populations as needed to reach recovery objectives (USFWS, 1995).
- Validate and revise recovery objectives (USFWS, 1995).
- Devise and implement a public education program (USFWS, 1995).
- In order to prevent this taxon from going extinct, propagation efforts and the maintenance of adequate genetic stock ex situ should be undertaken immediately, as well as the protection of remaining wild individuals from feral goats and alien weed threats (USFWS, 1995).
- New Management Actions: • Surveys and monitoring—PEPP manages one individual of *Melicope knudsenii* on Kaua'i (PEPP 2014, 2015). • Captive propagation for genetic storage and reintroduction— o Lyon Arboretum reported nine containers in storage representing collections from Miloli'i (Lyon Arboretum 2017). o The National Tropical Botanical Garden (NTBG) reported three cuttings and leaf material collected for genetic studies from an individual at Kawai Iki in 2013. In 2014, 27 cuttings were taken from plants at the Ku'ia enclosure (NTBG 2013, 2014), but they currently have no material of this species (NTBG 2018). o Two of the Maui plants are represented at the Olinda Rare Plant Nursery (ORPF 2018) (USFWS, 2018)
- Recommendations for Future Actions: Drought is observed to be a threat to *Melicope knudsenii* on Kaua'i; however, we are not aware of any significant new information regarding the species' biological status since the last 5-year review in 2014. Thus, the following recommendations for future actions are added or reiterated for the 5-year review for 2018. • Population viability and monitoring—Continue monitoring the wild individual of *Melicope knudsenii*. Continue to survey the geographical and historical range of the species for additional individuals and populations. • Ungulate monitoring and control—Continue to construct and maintain exclusion fences to protect *M. knudsenii* from the impacts of feral ungulates. • Drought destruction and degradation of habitat—Continue to control feral ungulates and nonnative plants at all populations of *M. knudsenii*. Carefully monitor any reintroductions. • Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species around all individuals. • Invertebrate predation or herbivory—Research and implement effective control methods for the black twig borer and other invertebrate pests. • Captive propagation for genetic storage and reintroduction— o Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. o Evaluate genetic resources currently in storage to determine the need to place additional material into long-term storage due to this species' vulnerability to climate change. • Reintroduction and translocation—Continue augmenting current population and reintroduce individuals into suitable habitat within historical range that is being managed for known threats to this species. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use this information to determine future landscape needed for its recovery. • Alliance and partnership development—Initiate planning and contribute to

implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2018).

Conservation Measures and Best Management Practices:

- Captive propagation for genetic storage and reintroduction: Continue collecting material for genetic storage and propagation for reintroduction. Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change (USFWS, 2011).
- Reintroduction / translocation – Continue augmenting current natural populations to increase numbers of individuals (USFWS, 2011).
- Ungulate monitoring and control – Fence remaining populations to protect them from the impacts of feral ungulates (USFWS, 2011).
- Invasive plant monitoring and control – Continue controlling invasive introduced plant species within the vicinity of all known individuals (USFWS, 2011).
- Surveys / inventories – Continue to survey the geographical and historical range of *M. knudsenii* for a current assessment of the species' status (USFWS, 2011).
- Predator / herbivore monitoring and control – Control black twig borer and other invertebrate pests at all infected *M. knudsenii* populations (USFWS, 2011).
- Reintroduced / translocated population management and monitoring – Improve irrigation system at Kanaio NAR to support reintroduced individuals of *M. knudsenii* (USFWS, 2011).
- Climate change adaptation strategy – Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change (USFWS, 2011).
- Alliance and partnership development – Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2011).

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SPECIES ACCOUNT: *Melicope lydgatei* (Alani)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/28/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

Melicope lydgatei is a long-lived perennial in the Rutaceae (citrus family). This species is a small shrub that has leaves arranged oppositely or in groups of three. The leaves are crowded and opposite, elliptic-oblongate, elliptic, or elliptic-ovate, 4 to 10 cm (1.6 to 3.9 in) long, and 2.5 to 6 cm (1.0 to 2.4 in) wide. The 3 to 20 mm (0.1 to 0.8 in) stemmed flowers form axillary cymes of one to five flowers. The flowers are green or red, with petals 10 mm (3.9 in) long and 5 mm (2 in) wide. The berries are white and ovoid shaped, 1 to 2.6 cm (0.4 to 1.0 in) long, and seeds are about 0.5 mm (0.02 in) long. The species' leaf arrangement, the amount of fusion of the fruit sections, and the hairless exocarp (outermost layer of the fruit wall) and endocarp (innermost layer) distinguish it from other species in the genus (Wagner et al. 1999).

Historical Range

See current range/distribution

Current Range

Melicope lydgatei was formerly known throughout the Koolau Mountains of Oahu from Hauula to Kahana, Kipapa Gulch to Waimano, and Kalihi Valley to Wailupe Valley. Currently, two known occurrences containing between 39 and 40 individuals are known in the wild. One occurrence occurs in the Manana area and contains one or two individual plants. The other occurrence with 38 plants is along Opaepaia/lower Peahinaia trail. No seedlings have been observed at these occurrences but juveniles are present (HINHP Database 2001; U.S. Army 2003a; K. Kawelo, U.S. Army, pers. comm. 2003; J. Lau, HINHP, pers. comm. 2003).

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Melicope lydgatei* (Alani) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Melicope lydgatei* (77 FR 57648-57862). The critical habitat designation includes 15 critical habitat units, which encompass approximately 27,051 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Melicope lydgatei* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Melicope lydgatei* includes 15 critical habitat units, covering two ecosystem types, which encompass approximately 27,051 acres on the Island of Oahu,

Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 4, 5, 6, 7; Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16.

Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Hauula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikeekee, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet—Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet—Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu—Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land

Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamoa Ridge.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Melicope lydgatei* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Melicope lydgatei* occurs within the Lowland mesic and Lowland wet ecosystems in the Koolau Mountain caldera complex :

Oahu—Lowland Mesic—Units 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (F) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Melicope lydgatei* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: This species has been observed in flower in May and in fruit from June to July. Little else is known about its flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors (HINHP Database 2001; Service 1998a; U.S. Army 2003a).

Habitat Type

Adult: mesic and wet forests

Habitat Narrative

Adult: Melicope lydgatei typically grows in association with Acacia koa, Bobea elatior, Dicranopteris linearis, Metrosideros polymorpha, Psychotria sp., or Syzygium sandwicensis on ridges in mesic and wet forests at elevations between 349 and 671 m (1,145 and 2,201 ft).

Dispersal/Migration***Population Information and Trends*****Resiliency:**

Fragility unknown. (NatureServe, 2015)

Representation:

Fragility unknown. (NatureServe, 2015)

Redundancy:

Fragility unknown. (NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Adaptability:

Fragility unknown. (NatureServe, 2015)

Population Narrative:

Fragility unknown. Currently, 3-4 plants known. 2 current (between 1982 and 1997) and 13 historical occurrences. (NatureServe, 2015)

Threats and Stressors**Stressor:****Exposure:****Response:****Consequence:**

Narrative: The primary threats to Melicope lydgatei include loss of habitat and degradation of the remaining habitat by non-native plants, insects, and animals. Feral pigs impact this species by consuming fruits and other plant parts and by rooting soil, which degrades the habitat. The black twig borer burrows into the branches and introduces a pathogenic fungus, pruning the host severely and often killing branches or whole plants. Plants typically suffer slight to severe defoliation that leads to reduced vigor due to the infestation of this non-native insect (59 FR 14482). The occurrences located on military land are threatened by fire caused by military activities. The small number of individuals and occurrences with the related limited gene pool

and depressed reproductive vigor make this species extremely vulnerable to inbreeding depression and destruction due to the occurrence of a catastrophic event (59 FR 14482).

Recovery

Conservation Measures and Best Management Practices:

- A State-wide management plan should be developed and implemented for the long-term conservation of all known occurrences of *Melicope lydgatei*. This plan should also include broader landscape actions that are needed for the recovery of this plant throughout its range. The recovery plan for *M. lydgatei* identifies important conservation actions. Where it is topographically feasible, exclosure fences should be constructed around the all known occurrences of *M. lydgatei* to reduce impacts from feral pigs. Pigs should be controlled or removed from these areas and the broader landscape to alleviate impacts on native ecosystems. Control and removal of non-native plants should be carried out in the vicinity of all known occurrences. A number of parasitoids have been introduced to control the black twig borer, though none of them have become established. Further research on biological control of this beetle should be supported. Note that any biocontrol agents should be tested against native Hawaiian scolytids prior to their introduction into the State (Service 1998a). Ongoing Conservation Actions: The Lyon Arboretum has successfully propagated this species (Service 1998a). The Service is currently not aware of any other conservation actions for this species.

References

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SPECIES ACCOUNT: *Melicope makahae* (Alani)

Species Taxonomic and Listing Information

Listing Status: Endangered; 9/18/2012; Pacific Region (R1) (USFWS, 2016)

Physical Description

A shrub or shrubby tree, up to 3 m tall. Inflorescences axillary, with 1-7 flowers. (NatureServe, 2015)

Taxonomy

In the rue family (Rutaceae) (USFWS, 2012).

Historical Range

Historically found in the Waianae Mountains on the west side of Mt. Kaala in Makaha Valley on Oahu (USFWS, 2012).

Current Range

Currently north and west of the summit area of the Waianae Mountains on Oahu (USFWS, 2012).

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On September 18, 2012, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Melicope makahae* (Alani) under the Endangered Species Act of 1973, as amended (Act) (77 FR 57648-57862). The critical habitat designation includes 11 critical habitat units, which encompass approximately 7,332 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Melicope makahae* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Melicope makahae* includes 11 critical habitat units, covering one ecosystem type, which encompasses approximately 7,332 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3; Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the

lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac (105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Melicope makahae* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Melicope makahae* occurs within the indicated ecosystem in the Waianae Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: *Antidesma*, *Chamaesyce*, *Diospyros*, *Dodonaea*. (F) Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Schiedea*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Melicope makahae* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats

will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Potential pollination by insects (EPA, 2016).

Habitat Type

Adult: Terrestrial (USFWS, 2012)

Habitat Vegetation or Surface Water Classification

Adult: Mesic forest and shrubland in the lowland mesic and dry cliff ecosystems (USFWS, 2012)

Geographic or Habitat Restraints or Barriers

Adult: Elevations between 2,200 and 2,900 ft (USFWS, 2012)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: Moist forests on ridgetops and upper gulch slopes. (NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Potential dispersal mechanisms are abiotic and biotic (EPA, 2016).

Population Information and Trends**Population Trends:**

This species has declined precipitously and is extremely threatened (NatureServe, 2015)

Species Trends:

Decline of 10 - 30 % (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

4 (USFWS, 2012)

Population Size:

< 200 individuals (USFWS, 2012)

Population Narrative:

Currently, there are 4 occurrences totaling fewer than 200 individuals north and west of the summit area of the Waianae Mountains (USFWS, 2012).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative plants, animals (pigs and goats), rockfalls, landslides, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Rockfalls and landslides destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. The projected effects of climate change will likely exacerbate the effects of the other threats to the species (USFWS, 2012).

Stressor: Predation and herbivory (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, goats, and the black twig borer) is considered an ongoing threat to *Melicope makahae* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2012).

Stressor: Lack of regeneration (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Lack of regeneration or low levels of regeneration (i.e., reproduction) in the wild has been documented, and represents a threat to *Melicope makahae*. There are four scattered populations of *Melicope makahae* in the Waianae Mountains. Two of these populations are at risk of extirpation because only one adult plant has been observed at one location and one adult plant and a single juvenile plant have been observed at the second location (USFWS, 2012).

Stressor:

Exposure:

Response:
Consequence:
Narrative:

Stressor:
Exposure:
Response:
Consequence:
Narrative:

Stressor:
Exposure:
Response:
Consequence:
Narrative:

Recovery

Reclassification Criteria:
Not available.

Delisting Criteria:
Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

References

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SPECIES ACCOUNT: *Melicope mucronulata* (Alani)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/15/1992; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Melicope mucronulata is a small tree in the rue family (Rutaceae) growing to 4 m (13 ft) tall. New growth is densely hairy. The generally oval-shaped, thin, leathery leaves (8-16 x 3.5-6.5 cm [3.2-6.3 x 1.4-2.5 in]) occur in pairs on 20-35 mm (0.8-1.4 in) leaf stalks (petioles) opposite each other on the stems. The leaves usually have six to eight pairs of veins branching from the main vein, connected by an arched vein from 3-10 mm (0.1-0.4 in) from the periphery of the leaf. The top surface of the leaves is hairless; the underside is densely hairy when young, but less so with age. Flowers occur on 6-15 mm (0.2-0.6 in) stalks (peduncles) from the point of leaf attachment to the stem in groups of three to nine flowers, each on an individual shorter stalk (pedicel), the entire array being somewhat hairy. The fruits are 24-28 mm (0.9-1.1 in) wide with distinct smooth compartments 12-14 mm (0.47-0.55 in) long, each compartment containing one or two 6 mm (0.2 in) seeds. (USFWS, 1997)

Taxonomy

Genus nearly endemic to Hawaiian islands, with 2 species in Marquesas islands. Species endemic to Molokai and east Maui. A recent review has synonymized the near exclusively Hawaiian genus *Pelea* under *Melicope*, resulting in the current name *Melicope mucronulata* (Hartley and Stone 1989). (USFWS, 1997)

Historical Range

See Current Range.

Current Range

Known from only one location each on Maui and Molokai (USFWS, 1997)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Melicope mucronulata* (Alani) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes seven detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Melicope mucronulata* includes seven CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Molokai—Lowland Mesic—Unit 1 (and) *Palmeria dolei*—Unit 37—Lowland Mesic (and) *Pseudonestor xanthophrys*—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Ctenitis*

squamigera, *Cyanea dunbariae*, *C. mannii*, *C. profuga*, *Cyperus fauriei*, *Cyrtandra filipes*, *Gouania hillebrandii*, *Labordia triflora*, *Neraudia sericea*, *Santalum haleakalae* var. *lanaiense*, *Schiedea lydgatei*, *S. sarmentosa*, *Silene alexandri*, *S. lanceolata*, *Spermolepis hawaiiensis*, and *Zanthoxylum hawaiiense*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Lowland Mesic—Unit 1 is not known to be occupied by *Asplenium dielerectum*, *Bonamia menziesii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea procera*, *C. solanacea*, *Diplazium molokaiense*, *Festuca molokaiensis*, *Flueggea neowawraea*, *Isodendron pyriformis*, *Kadua laxiflora*, *Melicope mucronulata*, *M. munroi*, *M. reflexa*, *Phyllostegia haliakalae*, *P. mannii*, *P. pilosa*, *Sesbania tomentosa*, *Stenogyne bifida*, or *Vigna o-wahuensis*, or the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 1 consists of 11,465 ac (4,640 ha) of State land, 2,069 ac (837 ha) of federally owned land, and 3 ac (1 ha) of privately owned land, from Kanaio to Kahualau Gulch on the southern slopes of east Maui. This unit is occupied by the plants *Bonamia menziesii*, *Cenchrus agrimonioides*, *Flueggea neowawraea*, *Melicope adscendens*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 1 is not known to be occupied by *Alectryon macrococcus*, *Bidens micrantha* ssp. *kalealaha*, *Canavalia pubescens*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Sesbania tomentosa*, *Solanum incompletum*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 2 consists of 1,851 ac (749 ha) of State land at Keokea on the southern slopes of east Maui. This unit is occupied by the plants *Bonamia menziesii*, *Canavalia pubescens*, and *Hibiscus brackenridgei*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 2 is not known to be occupied by *Alectryon macrococcus*, *Bidens micrantha* ssp. *kalealaha*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or

Zanthoxylum hawaiiense, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 3 consists of 188 ac (76 ha) of privately owned land, at Keauhou on the southern slopes of east Maui. This unit is occupied by the plant *Canavalia pubescens*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 3 is not known to be occupied by *Bidens micrantha* ssp. *kalealaha*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 4 consists of 1,266 ac (512 ha) of State land (including the Department of Land and Natural Resources) at Ahihi-Kinau Natural Area Reserve on the southern slopes of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Maui—Lowland Dry—Unit 4 is not currently occupied by *Bidens micrantha* ssp. *kalealaha*, *Bonamia menziesii*, *Canavalia pubescens*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Mesic—Unit 1 (and) *Palmeria dolei*—Unit 42—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 42— Montane Mesic This area consists of 257 ac (104 ha) of State land, and 559 ac (226 ha) of privately owned land from Kamiloloa to Makolelau in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Bidens wiebkei*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations.

Although Molokai—Montane Mesic—Unit 1 is not known to be occupied by *Asplenium dielerectum*, *Cyanea dunbariae*, *C. mannii*, *C. procera*, *C. solanacea*, *Cyperus fauriei*, *Kadua laxiflora*, *Melicope mucronulata*, *Neraudia sericea*, *Plantago princeps*, or *Stenogyne bifida*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Dry—Unit 1 consists of 2,962 ac (1,199 ha) of State land, and 563 ac (228 ha) of federally owned land (Haleakala National Park), from Kanaio to Naholoku and Kaupo Gap along the southern slopes of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane dry ecosystem (see Table 5). Although Maui—Montane Dry—Unit 1 is not known to be occupied by the plants *Alectryon macrococcus*, *Geranium arboreum*, *Melicope knudsenii*, *M. mucronulata*, *Santalum haleakalae* var. *lanaiense*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these montane dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Melicope mucronulata* critical habitat consists of four components. Lowland dry (east Maui), Lowland mesic (Molokai), Montane mesic (Molokai) and Montane dry (east Maui) (81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*. Subcanopy: *Chamaesyce*, *Dodonaea*, *Leptecophylla*, *Osteomeles*, *Psydrax*, *Scaevola*, *Wikstroemia*. Understory: *Alyxia*, *Artemisia*, *Bidens*, *Chenopodium*, *Nephrolepis*, *Peperomia*, *Sicyos*.

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: *Acacia*, *Ilex*, *Metrosideros*, *Myrsine*, *Nestegis*, *Nothocestrum*, *Pisonia*, *Pittosporum*, *Psychotria*, *Sophora*, *Zanthoxylum*. Subcanopy: *Alyxia*, *Charpentiera*, *Coprosma*, *Dodonaea*, *Kadua*, *Labordia*, *Leptecophylla*, *Phyllostegia*, *Vaccinium*. Understory: Ferns, *Carex*, *Peperomia*.

Ecosystem: Montane Dry. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Dry cinder or ash soils, loamy volcanic sands, blocky lava, rock outcroppings. Canopy: *Acacia*, *Metrosideros*, *Myoporum*, *Santalum*, *Sophora*. Subcanopy: *Chamaesyce*, *Coprosma*, *Dodonaea*, *Dubautia*, *Leptecophylla*, *Osteomeles*, *Wikstroemia*. Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Vaccinium*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to

be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations of 670-870 meters (2,200-2,850 feet) (USFWS, 1997)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1997)

Habitat Narrative

Adult: On Molokai: intact native moist forest on a gulch slope. On Maui: decadent native moist forests on old lava flows. The habitat of *Melicope mucronulata* is dryland forest on leeward East Maui and Molokai at about 670-870 meters (2,200-2,850feet) elevation. Associated native species include *Dodonaea viscosa*, *Metrosideros polymorpha*, *Styphelia tameiameia*, *Dubautia linearis*, *Chamaesyce celastroides* var. *amplectens*, *Pleomele*, *Myrsine*, *Exocarpus*, and *Wikstroemia* (HPCC 1994; USEWS 1992a). (USFWS, 1997; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2014)

Redundancy:

Very low (inferred from USFWS, 2014)

Number of Populations:

2 (USFWS, 2014)

Population Size:

4 wild and ~ 4 outplanted (USFWS, 2018). Extirpated on Maui only known from Molokai.

Population Narrative:

In 2013, two populations on Molokai contained three mature wild individuals of *Melicope mucronulata* (Plant Extinction Prevention Program [PEPP] 2013). The number of individuals has increased from two individuals since the last 5-year review (USFWS 2008). (USFWS, 2014). Currently, there is one individual of *Melicope mucronulata* at Kūpā'ia Gulch and three individuals at 'Ōnini Gulch on Moloka'i (PEPP 2017a; PEPP 2017b, p. 158). This species has not been observed on east Maui since 1983 (Oppenheimer 2018, in litt.). (USFWS, 2018)

Threats and Stressors

Stressor: Feral ungulates (USFWS, 1997)

Exposure:

Response:**Consequence:**

Narrative: The three remaining individuals of *Melicope mucronulata* on Molokai have been browsed by goats (HHP 1994). Although the plants appeared vigorous when last seen (HHP 1994), continued predation would severely threaten the population (USFWS 1992a). (USFWS, 1997)

Stressor: Alien plants (USFWS, 1997)

Exposure:**Response:****Consequence:**

Narrative: The sole population of *Melicope mucronulata* on Molokai is immediately threatened by molasses grass (HHP reference; Joel Lau, TNCH, personal communication 1990; USFWS 1992a). (USFWS, 1997)

Stressor: Seed predation by native insects (USFWS, 1997)

Exposure:**Response:****Consequence:**

Narrative: The endemic microlepidopteran *Prays cf. fulvocanella* Walsingham (Yponomeutidae) is known to feed on the buds, flowers and seeds of *Melicope* and *Platydesma*. (USFWS, 1997)

Stressor: Small population size (USFWS, 1997)

Exposure:**Response:****Consequence:**

Narrative: The very small remaining number of individuals of *Melicope mucronulata* and the limited distribution of the species are major threats to the continued existence of this species; a single natural or human-caused environmental disturbance could easily cause the species' extinction. In addition, the limited gene pool may depress reproductive vigor (USFWS 1992a). (USFWS, 1997)

Stressor: Climate change loss or degradation of habitat

Exposure:**Response:****Consequence:**

Narrative: We previously reported that climate change may pose a threat to this species. The assessment conducted by Fortini et al. (2013) concluded that *Melicope mucronulata* is extremely vulnerable to the impacts of climate change, with a vulnerability score of 0.913 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions, such as locating microsites of suitable habitat for recovery in current and future climate envelopes, are needed to conserve this taxon into the future (USFWS, 2018).

Recovery**Reclassification Criteria:**

1. A total of five to seven populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)

3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1997)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)

2. Each population must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)

3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1997)

Recovery Actions:

- Protect known individuals. Feral goats and alien plant invasion presently threatening the only known three remaining individuals need to be controlled immediately, via fencing and weed and ungulate removal. (USFWS, 1997)
- Determine numbers of populations and individuals of *Melicope mucronulata* extant. (USFWS, 1997)
- Initiate an emergency program based on Maui and/or Molokai in conjunction with other dryland forest taxa (e.g., *Alecryon macrococcus* var. *auwahiensis*, *Melicope adscendens*, *Sanlalum frecinelianum* var. *lanatense*) to save *Melicope mucronulata* from extinction. (USFWS, 1997)
- New Management Actions:
 - Surveys and monitoring—The Plant Extinction Prevention Program (PEPP) continues to monitor individuals at ‘Ōnini Gulch and Kūpā’ia Gulch on Moloka’i (PEPP 2014, 2015, 2016, 2017a).
 - Invasive plant monitoring and control—PEPP removes invasive plants from areas where *Melicope mucronulata* wild or outplanted individuals are located (PEPP 2014, 2015).
 - Captive propagation for genetic storage and reintroduction—
 - o PEPP collects seeds from wild and outplanted individuals for storage and propagation (PEPP 2014, 2015, 2016, 2017b). One founder from Kūpā’ia Gulch and three founders from ‘Ōnini Gulch have been collected from (PEPP 2017a). PEPP also air-layers individuals for propagation (PEPP 2016).
 - o Lyon Arboretum reports over 200 containers in storage representing collections from one founder each from ‘Ōnini and Kūpā’ia gulches (Lyon Arboretum 2017).
 - o The Olinda Rare Plant Facility has over 70 plants from two founders and sent out four plants of one founder for outplanting in 2018 (ORPF 2018).
 - Stochastic events—Build resiliency and redundancy—PEPP augments and establishes populations in protected areas (PEPP 2016, 2017b). PEPP outplanted four individuals into an enclosure at ‘Ōnini Gulch (PEPP 2017b) (USFWS, 2018).
- Recommendations for Future Actions: We are not aware of any new threats or significant new information regarding the species’ biological status since the last 5-year review in 2014.

Thus, the following recommendations for future actions are reiterated for the 5-year review for 2018. • Surveys and inventories—Continue to survey geographical and historical range for a thorough assessment of the species' status. • Population viability and monitoring—Continue monitoring the wild individuals of *Melicope mucronulata*. • Ungulate monitoring and control—Continue to construct and maintain exclusion fences to protect *M. mucronulata* from the impacts of feral ungulates. • Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species around all individuals. • Fire monitoring and control—Develop and implement a fire management plan for all populations. • Predator and herbivore monitoring and control—Control rodents and nonnative predatory insects within the vicinity of all known populations of *M. mucronulata*. • Captive propagation for genetic storage and reintroduction— o Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. o Evaluate genetic resources currently in storage to determine the need to place additional material into long-term storage due to this species' vulnerability to climate change. o Continue to experiment with propagation methods (air-layering, micropropagation, grafting, cuttings) since seeds are not abundantly produced. • Reintroduction and translocation—Continue augmenting current population and reintroduce individuals into suitable habitat within historical range that is being managed for known threats to this species. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use this information to determine future landscape needed for its recovery. • Alliance and partnership development—Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2018).

Conservation Measures and Best Management Practices:

- Survey geographical and historical range for a thorough current assessment of the species' status. (USFWS, 2014)
- Maintain fencing to exclude browsing by goats, pigs, and deer. (USFWS, 2014)
- Fence remaining populations to protect them from impacts of feral ungulates. (USFWS, 2014)
- Continue control of invasive introduced plant species within the exclosure. (USFWS, 2014)
- Continue collecting material for genetic storage and propagation for reintroduction. (USFWS, 2014)
- Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change. (USFWS, 2014)
- Experiment with various propagation methods (air layers, micropropagation, grafting, and cuttings), since seeds are not abundantly produced. (USFWS, 2014)
- Control rodents and nonnative predatory insects within the vicinity of all known populations of *M. mucronulata*. (USFWS, 2014)
- Develop and implement a fire management plan for all populations. (USFWS, 2014)
- Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. (USFWS, 2014)
- Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2014)

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

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SPECIES ACCOUNT: *Melicope munroi* (Alani)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/03/1999; Pacific Region (R1) (USFWS, 2016)

Physical Description

A sprawling shrub with stems up to 3 m long. Leaves are oppositely arranged. Flowers are borne 1-3 in axillary inflorescences (NatureServe, 2015).

Taxonomy

A member of the citrus family (Rutaceae). The genus *Pelea* has since been submerged into the Pacific genus *Melicope*, creating the combination *M. munroi* (Wagner et al. 1999; USFWS 1999, 2002) (USFWS, 2012).

Historical Range

At the time the species was federally listed in 1999, *Melicope munroi* was known from only a single widely scattered population of about 300 to 500 individuals on Lanai on the Lanaihale summit ridge (USFWS 1999). *Melicope munroi* was last collected on Molokai in 1910 by J.F. Rock, and it is now assumed to be extinct there (USFWS 2003b) (USFWS, 2012).

Current Range

Ken Wood (National Tropical Botanical Garden, pers. comm. 2010) has observed individuals of *M. munroi* from Kunoa, Hauola, and Lopa Gulches, and in the drainage emptying into Waioape Gulch, south of Kahinahina Ridge in Lanai (USFWS, 2012).

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Melicope munroi* (Alani) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one detailed critical habitat unit (CHU), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Melicope munroi* includes one CHU in Maui County, Hawaii with detailed unit information. There are also an unknown number of units on Lanai that contain this species (number of units is unknown because detailed unit descriptions for Lanai are not available) (81 FR 17790-18110).

Molokai—Lowland Mesic—Unit 1 (and) *Palmeria dolei*—Unit 37—Lowland Mesic (and) *Pseudonestor xanthophrys*—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Ctenitis squamigera*, *Cyanea dunbariae*, *C. mannii*, *C. profuga*, *Cyperus fauriei*, *Cyrtandra filipes*, *Gouania hillebrandii*, *Labordia triflora*, *Neraudia sericea*, *Santalum haleakalae* var. *lanaiense*, *Schiedea lydgatei*, *S. sarmentosa*, *Silene alexandri*, *S. lanceolata*, *Spermolepis hawaiiensis*, and

Zanthoxylum hawaiiense, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Mesic—Unit 1 is not known to be occupied by *Asplenium dielerectum*, *Bonamia menziesii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea procera*, *C. solanacea*, *Diplazium molokaiense*, *Festuca molokaiensis*, *Flueggea neowawraea*, *Isodendron pyriformis*, *Kadua laxiflora*, *Melicope mucronulata*, *M. munroi*, *M. reflexa*, *Phyllostegia haliakalae*, *P. mannii*, *P. pilosa*, *Sesbania tomentosa*, *Stenogyne bifida*, or *Vigna o-wahuensis*, or the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Melicope munroi* critical habitat consists of three components. Lowland mesic (Molokai), Montane wet (Lanai) and Wet cliff (Lanai) (81 FR 17790-18110):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Ecosystem: Lowland Wet. Elevation: >75 in (>190 cm). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. Understory: *Bryophytes*, *Ferns*, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we

are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendrion pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire,

creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Lifespan**

Adult: > 10 years (inferred from USFWS, 2012)

Breeding Season

Adult: Unknown (USFWS, 2012)

Key Resources Needed for Breeding

Adult: Unknown (USFWS, 2012)

Reproduction Narrative

Adult: It is a long-lived perennial. Its flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors remain unknown (USFWS 2002, 2003a, 2003b) (USFWS, 2012).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Lowland wet shrublands (USFWS, 2012)

Geographic or Habitat Restraints or Barriers

Adult: 2,299 - 3,385 ft. elevation (USFWS, 2012)

Habitat Narrative

Adult: Inhabits wet shrublands and forests on ridge crests and on gulch slopes (NatureServe, 2015). *Melicope munroi* is typically found on slopes in lowland wet shrublands at 701 to 1,032 meters (2,299 to 3,385 feet) elevation (USFWS, 2012).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Resiliency:

Very low (inferred from USFWS, 0212; see current range/distribution)

Redundancy:

Very low (inferred from USFWS, 2012)

Number of Populations:

1 (USFWS, 2012; USFWS, 2017)

Population Size:

several dozen (USFWS, 2012)

Population Narrative:

Fragility unknown. Currently there are 32 plants known. The latest census estimate for *Melicope munroi* is 300 to 800 individuals within a single population (USFWS 2010; USFWS, 2012). Currently there are a few dozen individuals scattered across Lānaʻi hale on Lānaʻi (Oppenheimer 2018, in litt.). There are no individuals known on Molokaʻi; however, not all historical habitat has been searched (Bakutis 2018, in litt.) (USFWS, 2018).

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Axis deer (*Axis axis*) (USFWS 1999, 2002, 2003a) and ecosystem-altering invasive plant species (USFWS, 2012).

Stressor: Predation (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Axis deer (USFWS 1999, 2002, 2003a); black twig borer – (*Xylosandrus compactus*), which burrows into the twigs of host plants to lay eggs, at the same time introducing pathogens.

Symptoms include branch dieback, and in extreme infestations, tree death. There is a wide array of host plants in Hawaii, including both economic crops and native forest trees (Tenbrink and Hara 2007; USFWS 2010) (USFWS, 2012).

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species (USFWS, 2012).

Stressor: Stochastic events (USFWS, 2002).

Exposure:

Response:

Consequence:

Narrative: Random environmental events also threaten the remaining populations (USFWS, 2002).

Stressor: Collection (USFWS, 2002)

Exposure:

Response:

Consequence:

Narrative: Potential threats include unrestricted collecting or excessive visits by individuals interested in seeing rare plants (U.S. Fish and Wildlife Service 1999b) (USFWS, 2002).

Stressor: Drought loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Drought is noted as a threat to the population of *Melicope munroi* on Lānaʻi (Oppenheimer 2018, in litt.). Over the last 100 years, the Hawaiian Islands have experienced an annual decline in precipitation of over 9 percent, increasing to as much as 15 percent within the last 20 years (US-NSTC 2008; Chu and Chen 2005; Diaz 2005). Drought affects plants directly by desiccation. The increase in drought frequency and intensity leads to a self-perpetuating cycle of increase in cover of nonnative plants, increase in the number of fires, and an increase of erosion (US-GCRP 2009; Warren 2011). Recent episodes of drought have also driven deer farther into urban and forested areas in search of food, increasing their negative impacts to native vegetation from herbivory and trampling (Waring 1996, in litt; Nishibayashi 2001, in litt.) (USFWS, 2018).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: We previously reported that climate change may pose a threat to this species, anticipating an analysis by 2013. The assessment conducted by Fortini et al. (2013) concluded that *Melicope munroi* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.777 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate

change). Therefore, additional management actions are needed to conserve this taxon into the future, such as locating key microsites that overlap with current and future climate envelopes for outplanting efforts (USFWS, 2018).

Recovery

Reclassification Criteria:

1. A total of five to seven populations should be documented on islands where it now occurs or occurred historically (USFWS, 2002).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure with the following minimum numbers of mature individuals per population: 100 for long-lived perennials (USFWS, 2002).
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 2002).

Delisting Criteria:

1. A total of 8 to 10 populations should be documented on islands where it now occurs or occurred historically (USFWS, 2002).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with the following minimum numbers of mature individuals per population: 100 for long-lived perennials (USFWS, 2002).
3. Each population should persist at this level for a minimum of five consecutive years (USFWS, 2002).

Recovery Actions:

- Protect habitat and control threats (USFWS, 2002).
- Expand existing wild populations (USFWS, 2002).
- Conduct essential research (USFWS, 2002).
- Develop and maintain monitoring plans (USFWS, 2002).
- Reestablish wild populations within historic range (USFWS, 2002).
- Validate and revise recovery criteria (USFWS, 2002).
- Construct exclosures to protect populations against axis deer (USFWS, 2002).
- Maintain adequate genetic stock (USFWS, 2002).
- Control competing alien plant species (USFWS, 2002).
- Enhance wild populations and establish new populations (USFWS, 2002).
- New Management Actions: • Surveys and inventories—The Plant Extinction Prevention Program (PEPP) monitors individuals of *Melicope munroi* on Lānaʻi (PEPP 2016). Because the numbers of individuals of this species is declining, PEPP is considering elevating its status to a “POP,” a potential PEP species (those species with 50 or fewer wild individuals). • Captive propagation for genetic storage and reintroduction—In 2017, Lyon Arboretum reported four containers of propagules of *M. munroi* in storage. • Habitat and natural process management and restoration—Pūlama Lānaʻi provides conservation benefits to plant and animal species on Lānaʻi, as demonstrated by the ongoing conservation efforts on the island,

the commitment to develop the Lānaʻi Natural Resources Plan (LNRP), and a memorandum of understanding (MOU) with the Service (USFWS 2015). Currently, Pūlama Lānaʻi has surveyed and inspected the Lānaʻi hale fence (where *M. munroi* occurs) to determine repair needs and vegetation maintenance needs, and has removed 17 axis deer and eight mouflon sheep from within the fenced area (Donoho 2016, in litt.) (USFWS, 2018).

- Recommendations for Future Actions: Drought is reported to be a threat to this species; however, we are not aware of any significant new information regarding the species' biological status since the last 5-year review in 2012. Thus, the following recommendations for future actions are added or reiterated for 5-year review for 2018. • Surveys and inventories—Continue to survey for additional populations of *Melicope munroi* in areas of potentially suitable habitat on Lānaʻi and Molokaʻi. Regularly monitor known populations. • Ungulate monitoring and control—Complete the Lanaihale summit fencing project and remove all feral ungulates from the fenced area to protect *M. munroi* from the impacts of feral ungulates. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative species that compete with the species around all populations, especially focusing on *Clidemia hirta* (Koster's curse), and *Hedychium gardnerianum* (kāhili ginger), *Leptospermum scoparium* (Australian tea tree), *Morella faya* (firetree), *Psidium cattleianum* (strawberry guava), and *Tibouchina herbacea* (glorybush) • Predator and herbivore monitoring and control—Develop and implement effective control methods for the black twig borer. • Captive propagation for genetic storage and reintroduction— o Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. o Explore alternate methods of propagation (e.g., cuttings, air-layering, and tissue culture). • Reintroduction and translocation—Begin reintroduction of individuals into suitable habitat within historic range that is being managed for known threats to this species. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species to determine future landscape needed for recovery of the species. • Alliance and partnership development—Continue to work with land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2018).

Conservation Measures and Best Management Practices:

- Captive propagation for genetic storage and reintroduction: Collect cuttings or seed from tagged individuals, keeping close track of the maternal source for use in ex situ propagation. Collect seeds from all existing populations and send to at least two or three different venues for propagation and storage. Explore alternate methods of propagation (e.g., cuttings, air-layering, and tissue culture) (USFWS, 2012).
- Reintroduction / translocation protocol development – Maximize the genetic variation among individuals at each reintroduction site, based on microsatellite data and detailed information from crossing records (USFWS, 2012).
- Reintroduction / translocation site identification – While surveying for new populations or reintroduced populations, determine which sites are least invaded by invasive introduced plant species and which appear to have the highest likelihood of maintaining new reintroductions (USFWS, 2012).
- Ungulate exclosures – Complete the Lanaihale summit fencing project to protect populations of *M. munroi* (USFWS, 2012).

- Ungulate control – Once the fencing at Lanaihale is completed, control ungulates within the fenced exclosure (USFWS, 2012).
- Ecosystem-altering invasive plant species control – Control invasive introduced plant species around all populations (USFWS, 2012).
- Surveys / inventories – Continue to search for *Melicope munroi* in habitats where it has historically been found on Lanai and Molokai, as well as in other potentially suitable habitats (USFWS, 2012).
- Threats research – Develop and implement effective control methods for black twig borer. Methods to control black twig borer should be developed and implemented if possible (USFWS, 2012).
- Threat monitoring and control – Monitor newly established reintroduced and wild populations for evidence of plant disease and insect predation. If threats are found implement effective control methods (USFWS, 2012).
- Alliance and partnership development – Work with Castle and Cooke and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2012).
- Threats research – Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2012).

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SPECIES ACCOUNT: *Melicope ovalis* (Alani)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/05/1994; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Melicope ovalis is a tree in the rue family (Rutaceae) that attains a height of 5 m (16 ft). New growth is somewhat hairy, the brownish pubescence becoming more sparse with age. The hairless, oval-elliptic leaves (8-16 x 4-10 cm [3.2-6.3 x 1.6-3.9 in]) occur in pairs on stout 30-40 mm (1.2-1.6 in) leaf stalks (petioles) opposite each other on the stems; the leaves become brittle when dry. The leaves have about 10-12 pairs of primary veins branching from the main vein, connected by an arched vein 7-12 mm (0.3-0.5 in) from the periphery of the leaf. Flowers occur on 3-12 mm (0.1-0.5 in) stalks (peduncles) from the point of leaf attachment to the stem in groups of three to seven flowers, each on an individual 10-13 mm (0.4-0.5 in) stalk (pedicel). Floral details are unknown. Fruits are roughly cube-shaped and about 10 mm (0.4 inches) long; each section of the fruit contains one or two 5 mm (0.2 in) seeds. (USFWS, 1997)

Taxonomy

Melicope ovalis is opposite-leaved, distinguishing it from species in Section *Pelea*, locally *Melicope clusifolia* and *Melicope haleakalae*. When sterile, *Melicope ovalis* is not easy to distinguish from other opposite-leaved members of the genus. However, the foliage and fruits of *Melicope ovalis*, especially young, nearly fully expanded leaves, have a strong, sweet, aromatic odor, similar to the fruits of *mokihana* (*Melicope anisala* Mann) of Kauai. Individuals of *Melicope ovalis* bearing fruit can be distinguished by the characteristic rounded-cuboid capsules, often borne abundantly. A recent review has synonymized the nearly exclusively Hawaiian genus *Pelea* under *Melicope*, resulting in the current name *Melicope ovalis* (Hartley and Stone 1989). (USFWS, 1997)

Historical Range

See Current Range.

Current Range

Current range includes East Maui. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Melicope ovalis* (Alani) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes ten detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Melicope ovalis* includes ten CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Lowland Wet—Unit 1 (and) *Palmeria dolei*—Unit 2—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 2— Lowland Wet This area consists of 6,616 ac (2,677 ha) of State land, 7,425 ac (3,005 ha) of privately owned land, and 2,038 ac (825 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Kipahulu Valley on the northern and eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia samuelii*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *M. ovalis*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 1 is not known to be occupied by the plants *Clermontia oblongifolia* ssp. *mauiensis*, *C. peleana*, *Mucuna sloanei* var. *persericea*, *Phyllostegia haliakalae*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 1 (and) *Palmeria dolei*—Unit 10—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 10— Montane Wet This area consists of 1,313 ac (531 ha) of State land and 798 ac (323 ha) of privately owned land, at Haiku Uka on the northern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Cyanea duvalliorum*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *Phyllostegia pilosa*, and by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 1 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 11—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 11— Montane Wet This area consists of 4,075 ac (1,649 ha) of State land, 9,633 ac (3,898 ha) of privately owned land, and 875 ac (354 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Puukaukanu and upper Waihoi Valley, on the northern and northeastern slopes of east Maui. These units include the mixed herbland and

shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Geranium hanaense*, *G. multiflorum*, and *Wikstroemia villosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwiku (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 2 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea glabra*, *C. maritae*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, and *Schiedea jacobii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 3 (and) *Palmeria dolei*—Unit 12—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 12— Montane Wet This area consists of 2,228 ac (902 ha) of federally owned land (Haleakala National Park) in Kipahulu Valley, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. maritae*, and *Melicope ovalis*, and by the forest bird, kiwiku (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 3 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea duvalliorum*, *C. glabra*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest bird, the akohekohe (*Palmeria dolei*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 4 (and) *Palmeria dolei*—Unit 13—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 13— Montane Wet This area consists of 180 ac (73 ha) of State land and 1,653 ac (669 ha) of federally owned land (Haleakala National Park), in Kaapahu Valley on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora*

ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *Cyrtandra ferripilosa*, and *Huperzia mannii*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 4 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea duvalliorum*, *C. glabra*, *C. mceldowneyi*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 5 (and) *Palmeria dolei*—Unit 14—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 14—Montane Wet This area consists of 222 ac (90 ha) of State land, and 165 ac (67 ha) of federally owned land (Haleakala National Park), near Kaumakani on the eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units area occupied by the plant *Bidens campylotheca* ssp. *pentamera*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 5 is not currently occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 1 (and) *Palmeria dolei*—Unit 30—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 30—Wet Cliff This area consists of 290 ac (117 ha) of privately owned land along the wall of Keanae Valley on the northern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff—Unit 1 is not currently occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *Cyanea horrida*, *Melicope ovalis*, *Phyllostegia bracteata*, *P. haliakalae*, or *Plantago princeps*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species

because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 2 (and) *Palmeria dolei*—Unit 31—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 31—Wet Cliff This area consists of 475 ac (192 ha) of State land, 20 ac (8 ha) of privately owned land, and 912 ac (369 ha) of federally owned land (Haleakala National Park), from Kalapawili Ridge along Kipahulu Valley and north to Puuhoolio, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plants *Bidens campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *Melicope ovalis*, *Phyllostegia bracteata*, and *Plantago princeps*. These units also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 2 is not known to be occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Cyanea horrida*, or *Phyllostegia haliakalae*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 3 (and) *Palmeria dolei*—Unit 32—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 32—Wet Cliff This area consists of 5 ac (2 ha) of State land and 433 ac (175 ha) federally owned land (Haleakala National Park) along the south rim of Kipahulu Valley on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff—Unit 3 is not currently occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. horrida*, *Melicope ovalis*, *Phyllostegia bracteata*, *P. haliakalae*, or *Plantago princeps*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 4 (and) *Palmeria dolei*—Unit 33—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 33—Wet Cliff This area consists of 184 ac (75 ha) of State land along the north wall of Waihoi Valley, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plant *Bidens campylotheca* ssp. *pentamera* and *B. campylotheca* ssp. *waihoiensis*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 4 is not known to be occupied by the plants *Cyanea copelandii* ssp.

haleakalaensis, *C. horrida*, *Melicope ovalis*, *Phyllostegia bracteata*, *P. haliakalae*, or *Plantago princeps*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Melicope ovalis* critical habitat consists of three components. Lowland wet (east Maui), Montane wet (east Maui) and Wet cliff (east Maui) (81 FR 17790-18110):

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. Understory: Bryophytes, Ferns, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other

Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C.*

samuelii, Ctenitis squamigera, Cyanea asplenifolia, C. copelandii ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. magnicalyx, C. mannii, C. maritae, C. mceldowneyi, C. profuga, C. solanacea, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Dubautia plantaginea ssp. humilis, Geranium hanaense, G. multiflorum, Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations of 854-1,433 meters (2,800-4,700 ft) (USFWS, 1997)

Environmental Specificity

Adult: Low, with few key requirements (USFWS, 1997)

Habitat Narrative

Adult: Melicope ovalis is found in ohia and koa forest, especially on stable (non-eroding) banks of water courses at 854-1,433 meters (2,800-4,700 ft) in Kipahulu Valley within Haleakala National Park. Associated native species include Acacia koa, Cibotium chamissoi, Cibolium glaucum, Diplazium sandwichtanum, Melicope clustifolia, Melrosideros polymorpha, and Sadleria pallida. Associated alien species include Paspalum conjugatum, Paspalum urvillei, Psidium cattleianum, Psidium guajava, Rhychospora caduca, and Youngia japonica. (USFWS, 1997)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Low (inferred from USFWS, 2011)

Redundancy:

Low (inferred from USFWS, 2011)

Number of Populations:

4 (USFWS, 2011)

Population Size:

possibly 110 (USFWS, 2017)

Population Narrative:

As of 2010, Haleakala National Park has mapped 11 individuals of *Melicope ovalis* near Delta Camp Region around the Palikea and Opae Streams and 88 individuals southwest of Delta Camp (Welton 2010). Another 10 individuals were observed at Koolau Gap in Keanae Valley and a single population on Cable Ridge (unspecified number of individuals) would bring the total number of individuals to over 110 located within 4 populations. (USFWS, 2011). Several populations (previously totaling 110 individuals) of *Melicope ovalis* have not been visited in more than 10 years (Robertson 2016, in litt.). The only reported collections made since 2011 have been at 'Ohe'o and Pi'ina'au- Ke'anae (PEPP 2017) (USFWS, 2018).

Threats and Stressors

Stressor: Seed predation and bark-stripping by alien rodents (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: In comparison with other *Melicope* species in Hawaii, *M. ovalis* appears to be particularly vulnerable to attack of seeds by alien black rats. This vulnerability may be because the relatively large size of the capsules and prolific fruiting of the species makes it more attractive to rodents than other *Melicope* species. (USFWS, 1997)

Stressor: Displacement by alien plants (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant taxa, which crowd out seedlings and alter the habitat of *Melicope ovalis* include *Ageratina adenophora* (sticky snakeroot), *Clidemia hirta* (Koster's curse), *Cortaderia jubata* (Pampas grass), *Hedychium flavescens* (yellow ginger), *H. gardnerianum* (kahili ginger), *Hypochoeris radicata* (hairy cat's ear), *Juncus planifolius* (bog rush), *Paspalum conjugatum* (Hilo grass), *Prunella vulgaris* (selfheal), *Rubus argutus* (blackberry), and *Tibouchina herbacea* (glorybush) (Wood 2010). In Kipahulu Valley, threats to *Melicope ovalis* are invasive introduced plant species including *Ageratina adenophora*, *Andropogon virginicus* (broomsedge), *Clidemia hirta*, *Conyza* sp. (horseweed), *Hedychium gardnerianum*, *Hypochoeris* sp. (cat's ear), *Lythrum maritimum* (loosestrife), *Paspalum conjugatum*, *Paspalum urvillei* (vasey grass), *Psidium cattleianum* (strawberry guava), *Rubus rosifolius* (thimbleberry), *Melinis minutiflora* (molasses grass), and *Youngia japonica* (hawksbeard) (Oppenheimer 2010; Wood 2010). (USFWS, 2011)

Stressor: Seed predation by native insects (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: In comparison with other Melicope species in Hawaii, *M. ovalis* appears to be particularly vulnerable to attack of seeds by native insects. The endemic microlepidopteran *Prays cf. fulvocanella* Walsingham (Yponomeutidae) is known to feed on the buds, flowers and seeds of *Melicope* and *Platydesma*. (USFWS, 1997)

Stressor: Habitat modification by pigs (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Threats that modify habitat at Koolau Gap, in Keanae Valley, include feral pigs (*Sus scrofa*), which disturb the habitat and uproot new seedlings. (USFWS, 2011)

Stressor: Predation by rats, mongoose, black twig borer, and slugs (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Rats (*Rattus* spp.) and small Asian mongoose (*Herpestes javanicus*) are a threat to this species, presumably because they have been noted to consume the leaves and/or seeds of this species (Wood 2010). Black twig borer (*Xylosandrus compactus*) is also a threat to this species. Slugs (unidentified species) may be a factor limiting seedling growth of *Melicope ovalis*, as only mature trees have been observed in the wild (Oppenheimer 2010). (USFWS, 2011)

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: We previously reported that climate change may pose a threat to this species. The assessment conducted by Fortini et al. (2013) concluded that *Melicope ovalis* is vulnerable to the impacts of climate change, with a vulnerability score of 0.568 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions may be needed to conserve this taxon into the future (USFWS, 2018).

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)

3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1997)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)

2. Each population must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)

3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1997)

Recovery Actions:

- Continue alien plant and pig control in Kipahulu Valley of Haleakala National Park, with emphasis on *Clidemia hirta*, *Cyathea cooperi*, *Hedychium gardnerianum*, and *Psidium cattleianum*. (USFWS, 1997)
- Conduct/encourage research on impacts of rodent predation, and remedy any problems noted. If rodents, such as black rats (*Rattus rattus*), are found to be an important limiting factor in the long-term survival of *Melicope ovalis*, some form of seed protection (e.g., gathering and subsequent planting of seeds or trapping and/or poisoning of rats) maybe required. (USFWS, 1997)
- Produce an accurate assessment of population numbers and distribution; establish simple baseline monitoring of known individuals. (USFWS, 1997)
- Search for *Melicope ovalis* elsewhere on windward Haleakala, especially in the area where it was first found. (USFWS, 1997)
- New Management Actions: • Surveys and monitoring—PEPP and NTBG monitored one individual at 'Ohe'o and a second individual at Pi'ina'au -Ke'anae Valley (NTBG 2014; PEPP 2017). • Captive propagation for genetic storage and reintroduction— o PEPP collected seeds from one founder at Pi'ina'au -Ke'anae (PEPP 2017). o Haleakalā National Park reports eight individuals in storage representing one wild individual from 'Ohe'o (Robertson 2016, in litt.). o Olinda Rare Plant Facility (ORPF) reports 25 seeds in storage from Ke'anae Valley (ORPF 2017) but currently has no plants at the nursery (ORPF 2018) (USFWS, 2018).
- Recommendations for Future Actions: We are not aware of any new threats or significant new information regarding the species' biological status has come to light since the last 5-year review in 2011. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2018. • Surveys and inventories—Continue to survey geographical and historical range for a thorough assessment of the species' status. • Population viability and monitoring—Continue monitoring the wild individuals of *Melicope ovalis*. • Ungulate monitoring and control—Continue to construct and maintain exclusion fences to protect *M. ovalis* from the impacts of feral ungulates. • Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species around all individuals. • Predator and herbivore monitoring and control—Control rodents, slugs, and the black twig borer within the vicinity of all known populations of *M. ovalis*. • Captive propagation for genetic storage and reintroduction— o Continue collection of genetic

resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. o Evaluate genetic resources currently in storage to determine the need to place additional material into long-term storage due to this species' vulnerability to climate change. o Research limiting factors to reintroduced populations and find possible solutions to improve survivability. • Reintroduction and translocation—Reintroduce individuals into suitable habitat within historical range that is being managed for known threats to this species. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use this information to determine future landscape needed for its recovery. • Alliance and partnership development—Work with the Hawai'i Division of Forestry and Wildlife and the National Park Service to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2018).

Conservation Measures and Best Management Practices:

- Survey areas where *Melicope ovalis* has been reported to determine the current status of the species. (USFWS, 2011)
- Monitor known populations. (USFWS, 2011)
- Maintain fences around existing populations to provide protection from the negative impacts of feral ungulates. (USFWS, 2011)
- Collect material for genetic storage and propagation for reintroduction from all existing populations. (USFWS, 2011)
- Fence all known populations to provide protection against feral ungulates. (USFWS, 2011)
- Control invasive introduced plant species around all known populations. (USFWS, 2011)
- Control rats in the vicinity of all populations. (USFWS, 2011)
- Develop and implement methods to control slugs. (USFWS, 2011)
- Continue efforts to register an effective control method for black twig borer. (USFWS, 2011)
- Propagate to augment the existing populations. (USFWS, 2011)
- Research limiting factors to reintroduced populations and find possible solutions to improve survivability. (USFWS, 2011)
- Work with Hawaii Division of Forestry and Wildlife, National Park Service, and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2011)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2011)

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SPECIES ACCOUNT: *Melicope pallida* (Alani)

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/25/1994; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Melicope pallida, a member of the citrus family, is a 6- to 10-m (20- to 33-ft) tree with grayish white hairs and black, resinous new growth. The leaves, 6 to 21 cm (2.4 to 8.3 in) long and 2.5 to 8 cm (1 to 3.1 in) wide, are grouped in threes, with each leaf loosely folded. Fifteen to 35 pale yellowish-green flowers are also clustered in groups of 3 along a fuzzy white stalk up to 6 cm (2.4 in) long. The petals are usually lance-shaped and measure 3.5 to 5 mm (0.1 to 0.2 in) long. Fruits contain two shiny black seeds about 3.5 mm (0.1 in) long in each of the usually four distinct carpels. This species differs from *Melicope haupuensis*, *M. knudsenii*, and other members of the genus by the following combination of characteristics: resinous new growth, leaves folded and in clusters of three, and fruits with separate carpels (Degener et al. 1960, Hillebrand 1888, St. John 1944, Stone et al. 1990, Wagner et al. 1990). (USFWS, 1995)

Taxonomy

Following the transfer of the genus *Pelea* to *Melicope* (Hartley and Stone 1989, Wagner et al. 1990), authors of the current treatment of the Hawaiian members of the genus (Stone et al. 1990) now consider *Evodia pallida*, *P. pallida* and *P. leveillei* to be synonyms of *Melicope pallida*. (USFWS, 1995)

Historical Range

Historically known from the Waianae Mountains of Oahu and along the western rim of Kalalau Valley on Kauai. Believed to be extirpated from Oahu (USFWS, 2010).

Current Range

Present in 7 valleys on northwestern Kauai (USFWS, 2010).

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Melicope pallida* (Alani) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Melicope pallida* (77 FR 57648-57862). The critical habitat designation includes 3 critical habitat units, which encompass approximately 5,884 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Melicope pallida* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Melicope pallida* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Melicope pallida* includes 3 critical habitat units, covering one ecosystem type, which encompasses approximately 5,884 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

The critical habitat designation for *Melicope pallida* includes two units totaling 1,118 acres in Kauai county, Hawaii. The units are Kauai 11—*Melicope pallida*—a, b.

Kauai 11—*Melicope pallida*—a: This unit is critical habitat for *Melicope pallida* and is 143 ha (353 ac) on State land (Alakai Wilderness Preserve), containing portions of Kipalau Valley. This unit provides habitat for one population of 100 mature, reproducing individuals of the long-lived perennial *Melicope pallida* and is currently occupied with 10 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. It provides habitat for the westernmost range of the species. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep rock faces in lowland to montane mesic to wet forests or shrubland. This unit provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event. Kauai 11—*Melicope pallida*—b: This unit is critical habitat for *Melicope pallida* and is 310 ha (766 ac) on State land (Na Pali Coast State Park). This unit contains portions of Kaaalahina Ridge and Puu Ki Summit. This unit provides habitat for two populations of 100 mature, reproducing individuals of the long-lived perennial *Melicope pallida* and is currently occupied with 50 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. It provides habitat for the westernmost range of the species. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep rock faces in lowland to montane mesic to wet forests or shrubland. This unit provides for two populations within this multi-island species' historical range on Kauai that are some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Melicope pallida* critical habitat consists of the

following components according to ecosystem type (77 FR 57648-57862). Note: *Melicope pallida* occurs within the indicated ecosystem in the Waianae Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Steep rock faces in lowland to montane mesic to wet forests or shrubland and containing one or more of the following associated native plant species: *Alyxia oliviformis*, *Artemisia australis*, *Boehmeria grandis*, *Carex meyenii*, *Chamaesyce celastroides* var. *hanapeensis*, *Coprosma kauensis*, *Coprosma waimeae*, *Dodonaea viscosa*, *Dryopteris* spp., *Hedyotis terminalis*, *Lepidium serra*, *Melicope* spp., *Metrosideros polymorpha*, *Nototrichium* spp., *Pipturus albidus*, *Pleomele aurea*, *Poa mannii*, *Psychotria mariniana*, *Pritchardia minor*, *Sapindus oahuensis*, *Schiedea membranacea*, *Tetraplasandra waialealae*, or *Xylosma hawaiiense*; and

(ii) Elevations between 418 and 1,081 m (1,371 and 3,546 ft).

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Melicope pallida* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and

augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (NatureServe, 2015)

Reproduction Narrative

Adult: Melicope pallida has a nectary disk and reproduces sexually. (NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland, cliffs, shrublands (USFWS, 2010; NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 490 to 910 meters (1,600 to 3,000 feet) (USFWS, 1995)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 2010)

Habitat Narrative

Adult: Melicope pallida usually grows on steep rock faces in drier regions of lowland mesic forests at an elevation of 490 to 910 meters (1,600 to over 3,000 feet). The habitat in Hanakapiai Valley where Melicope pallida occurs is Diospyros sandwicensis (lama) mesic forest and cliff shrubland. The Honopu sites have Acacia koa – Metrosideros polymorpha montane mesic forest habitat and Metrosideros polymorpha – Dicranopteris linearis montane mesic forest habitat. In Koaie Canyon, in Metrosideros polymorpha – Dicranopteris linearis transitional mesic to wet forest along stream walls in the back of the canyon. Melicope pallida grows on diverse mesic cliff and wet Metrosideros polymorpha – Cheirodendron sp. (olapa) montane forest communities on the northern side of Kalalau Valley, east of Keanapuka Falls, and on the ridge below and west of Pihea. At Pohakua, M. pallida grows in the Metrosideros polymorpha – Diospyros sandwicensis lowland forest and cliff plant communities. Associated plant taxa include Abutilon sandwicense (NCN), Alyxia oliviformis (maile), Dryopteris sp., ohia, Pipturus albidus (mamaki), Sapindus oahuensis (lonomea), Tetraplasandra sp. (ohe), and Xylosma hawaiiense (mana) (USFWS 1994a). (USFWS, 1995; USFWS, 2010)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Resiliency:

Low (inferred from USFWS, 2010)

Redundancy:

Low (inferred from USFWS, 2010)

Number of Populations:

3 (USFWS, 2017)

Population Size:

~40 (USFWS, 2017)

Population Narrative:

Currently, *Melicope pallida* is restricted to 7 valleys on northwestern Kauai with an estimated total of 217 to 296 individuals. Locations include Awaawapuhi Valley (50 to 60 individuals); Hanakapiai Valley (6 individuals); Honopu Valley (50 to 60 individuals); Honopu Ridge above Awaawapuhi Valley (5 individuals); Kalalau Valley (about 100 to 150 individuals); Koaie Canyon (five to ten individuals); Pohakuao (5 to 10 individuals); and Waiahuakua Valley (5 individuals) (Tangalin 2008; Wood 2008). (USFWS, 2010). *Melicope pallida* currently occurs on Kauai at three locations: Awaawapuhi (ca 20 individuals), Honopu (ca seven individuals), and Kalalau rim and cliffs (ca 17 individuals) (NTBG 2011a-b, 2012a-c, 2013a-c, 2014, 2015a-b, 2016a-d, 2017). There have been no updated reports since the last 5-year review regarding occurrences at Koaie, Pohakuao, Hanakapiai, and Limahuli. This species had been known from Oahu, but there are currently no confirmed individuals. In 2009, one individual was found on Oahu; however, its identity was uncertain, and could not be relocated (PEPP 2010). There was also an observation made by the U.S. Army in 2012, but no one has been back to that location to confirm. Lastly, there is one immature *Melicope* in poor health in Makaha that has been monitored by PEPP for several years and is suspected to possibly be *M. pallida* (Ching Harbin 2017, in litt.) (USFWS, 2017)..

Threats and Stressors

Stressor: Invasive plants (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species that threaten *Melicope pallida* by competing for resources and modifying the habitat include *Ageratum conyzoides* (spreading mist flower), *Blechnum appendiculatum* (NCN), *Bryophyllum pinnatum* (airplant), *Erigeron karvinskianus* (daisy fleabane), *Hedychium gardnerianum* (kahili ginger), *Lantana camara* (lantana), *Psidium guajava* (common guava), *Rubus argutus* (blackberry), *Sphaeropteris cooperi* (Australian tree fern), and

Verbena littoralis (vervain) (National Tropical Botanical Garden 2006; Tangalin 2008; Wood 2008). (USFWS, 2010)

Stressor: Habitat modification by feral ungulates (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Feral ungulates, including pigs (*Sus scrofa*), feral goats (*Capra hircus*), and mule deer (*Odocoileus hemionus*), modify the habitat and damage plants (National Tropical Botanical Garden 2006). Pig sign and goats were observed in the Honopu area in 2008 (Tangalin 2008). (USFWS, 2010)

Stressor: Landslides, hurricanes, and human disruption (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Other threats include landslides; hurricanes; and human disruption (National Tropical Botanical Garden 2006). (USFWS, 2010)

Stressor: Herbivory by rats (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Herbivory by rats (*Rattus* spp.) and flower damage by introduced nectar-robbing passerine birds have both been reported (National Tropical Botanical Garden 2006; Wood 2008). (USFWS, 2010)

Stressor: Stochastic events (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: A risk of extinction from stochastic natural events is present, as Kauai has had several hurricanes in the last few decades. Warmer temperatures as a result of global warming could modify the climate at the elevations where this species presently grows (LaPointe 2005; U.S. Environmental Protection Agency 1998). (USFWS, 2010)

Stressor: Small population size (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The loss of reproductive vigor as the result of limited numbers of existing individuals is another concern as numbers of individuals decline and the populations become more isolated. (USFWS, 2010)

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Melicope pallida* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.785 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Stressor: Fire destruction or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Fire can destroy dormant seeds as well as individual plants. Successive fires burn farther and farther into native habitat and alter microclimate conditions to further alter habitat conditions to favor nonnative plants. Nonnative plants convert native plant communities to nonnative dominated plant communities (D'Antonio and Vitousek 1992; Tunison et al. 2002). Fire is noted to be a threat to *Melicope pallida* at Honopu and Kalalau (NTBG 2012a-c, 2013a, 2015a-b, 2016a, d, 2017) (USFWS, 2017).

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Kauai and at least one other island where they now occur or occurred historically. (USFWS, 1995)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1995)
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1995)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Kauai and at least one other island where they now occur or occurred historically. (USFWS, 1995)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1995)
3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1995)

Recovery Actions:

- The plan begins with the protection and management of current habitats of the Kauai cluster taxa. Current threats are addressed through fencing and/or hunting to control ungulates; control of alien plants; protection from fire; control of rodents and slugs; control of insects, pests and disease; protection from human disturbance; collection, storage and maintenance of genetic material; and, a comprehensive monitoring program. (USFWS, 1995)
- A research program is also recommended to study the growth and reproductive viability of each taxon, determine the parameters of viable populations of each taxon, study the reproductive strategy and pollinators of each taxon, study possible pests and diseases, and use the results of such research to improve management practices. (USFWS, 1995)
- A program of augmentation of very small populations and reestablishment of new populations within the historical range of the species is also needed. (USFWS, 1995)
- A public education program is also needed to increase public awareness and support for plant recovery efforts. (USFWS, 1995)
- Finally, the recovery objectives should be refined and revised as new information becomes available. (USFWS, 1995)
- New Management Actions:
 - Population viability monitoring and analysis—PEPP is surveying for new populations and monitoring known populations of *Melicope pallida* (PEPP 2010, 2014, 2015). PEPP recently raised the status of this species on Kauai from “ROI, Rare on Island,” to “POP, Potential PEP” species because of declining numbers (PEPP 2016).
 - Captive propagation for genetic storage and reintroduction—NTBG has collected seeds from Awaawapuhi and there are currently plants in the NTBG nursery from this effort. (NTBG 2017b) (USFWS, 2017).
- Recommendations for Future Actions:
 - Fire destruction or degradation of habitat has been noted as a new threat to *Melicope pallida*. No other significant new information regarding the species biological status has come to light since the last 5-year review in 2010. Thus, the following recommendations for future actions are added and reiterated for the 5-year review for 2017.
 - Surveys and inventories—Survey for populations of *Melicope pallida* in areas of potentially suitable habitat.
 - Ungulate monitoring and control—Construct and maintain fenced exclosures around all populations. Protect all occurrences against browsing and disturbances from feral ungulates.
 - Invasive plant monitoring and control—
 - o Control established ecosystem-altering nonnative invasive plant species around all populations.
 - o Control invasive nonnative species that compete with the species around all populations.
 - Captive propagation protocol development—Determine barriers to seed viability. Research methods of germination and propagation.
 - Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock.
 - Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.
 - Fire monitoring and control—Develop and implement fire-management plans for all wild and reintroduced populations.
 - Predator and herbivore control research—Study *Melicope pallida* populations to determine level of flower damage and impact on seed set by nonnative nectar-robbing passerine birds and any additional recovery actions needed.
 - Predator and herbivore monitoring and control—Implement effective measures to control predation by rats.
 - Human interaction monitoring and management—Develop and implement effective measures to reduce the impacts of hikers and trail maintenance.
 - Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and hurricanes (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Fence to exclude ungulates from wild populations. (USFWS, 2010)
- Weed around existing plants to remove competition from introduced invasive species, and hopefully increase the possibility of in situ regeneration. (USFWS, 2010)
- Collect seed from all populations for genetic storage, research, and propagation. (USFWS, 2010)
- Determine barriers to seed viability. (USFWS, 2010)
- Research methods of germination and propagation. (USFWS, 2010)
- Work with Hawaii Division of Forestry and Wildlife and Hawaii State Parks to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2010)

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SPECIES ACCOUNT: *Melicope paniculata* (Alani)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (R1) (USFWS, 2016)

Physical Description

A small tree. Leaves are opposite. Inflorescence are up to 2.1 dm long with 11 - 50 flowers. Capsules are cuboid (NatureServe, 2015).

Taxonomy

A member of the rue family (Rutaceae) (USFWS, 2010b). This genus indigenous to Hawaiian islands (NatureServe, 2015).

Historical Range

This species was historically reported from central Kauai (HBMP 2007; Stone et al. 1999, p. 1199) (USFWS, 2010b).

Current Range

Currently, *M. paniculata* is known from Limahuli Valley, the north fork of the Wailua River, along Koaie Stream, and on the ridge between Hulua and Kapalaoa (Kauai) (USFWS, 2010b).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Melicope paniculata* (Alani) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Melicope paniculata* includes six CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Lowland Wet—Section 1: Lowland Wet—Section 1 consists of 1,164 ac (471 ha) in the lowland wet ecosystem (117 ac (47.4 ha) on State land; 1,047 ac (424 ha) on private land), including wet forest extending from Kulanalilia into Limahuli Valley to Honoanapali, in the Halelea Forest Reserve (Figure 2-A). The section includes 1,099 ac (445 ha) of State and privately owned land within previously designated critical habitat and 65 ac (26 ha) of newly designated critical habitat on private land. The area that falls within designated critical habitat lies within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and newly designated Critical Habitat Unit 20, Map 217c. This section is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Labordia helleri*, and *Phyllostegia renovans*. This section also contains unoccupied habitat that is essential to the conservation of these four species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—

Section 1 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Cyanea eleeeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Melicope paniculata*, *M. puberula*, *Platydesma rostrata*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 2: Lowland Wet—Section 2 consists of 172 ac (70 ha) in the lowland wet ecosystem, including wet forest extending from Alealau to Pohakea, within the Hono o Na Pali NAR and the Na Pali Coast State Park (Figure 2-A, above). The entire section is Stateowned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plant *Melicope puberula*. This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 2 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope paniculata*, *Phyllostegia renovans*, *Platydesma rostrata*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 3: Lowland Wet—Section 3 consists of 756 ac (306 ha) in the lowland wet ecosystem, including wet forest in upper Wainiha Valley, on privately owned land in the Halelea Forest Reserve (Figure 2-B). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyrtandra oenobarba*, *Melicope puberula*, *Phyllostegia renovans*, and *Stenogyne kealiae*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 3 is not known to be occupied by the species *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope paniculata*, *Platydesma rostrata*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 4: Lowland Wet—Section 4 consists of 591 ac (239 ha) in the lowland wet ecosystem, including wet forest at the head of Lumahai Valley, on State (10 ac, 4.1 ha) and privately owned (581 ac, 235 ha) land in the Halelea Forest Reserve (Figure 2-B, above). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyrtandra oenobarba*, *Melicope paniculata*, *Phyllostegia renovans*, and *Platydesma rostrata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 4 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope puberula*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population numbers of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 5: Lowland Wet—Section 5 consists of 1,541 ac (624 ha) in the lowland wet ecosystem, including wet forest extending from the headwaters of the Wailua River at “Blue Hole” south to Iole, on State (442 ac, 179 ha) and privately owned (1,099 ac, 445 ha) land in the Lihue-Koloa Forest Reserve (Figure 2-C). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36a, and is occupied by the plants *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Melicope paniculata*, *Phyllostegia renovans*, and *Platydesma rostrata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 5 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Labordia helleri*, *Melicope puberula*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 6: Lowland Wet—Section 6 consists of 789 ac (319 ha) in the lowland wet ecosystem, including wet forest extending from Kapalaoa to Kanaele Bog and Lauahihaihai in the Wahiawa Mountains, on State (134 ac, 54 ha) and privately owned (655 ac, 265 ha) land in the Lihue-Koloa Forest Reserve (Figure 2-D). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36a, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Platydesma rostrata*, and *Tetraplasandra bisattenuata*. This section also contains unoccupied habitat that is essential to the conservation of these five

species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet–Section 6 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Labordia helleri*, *Melicope paniculata*, *M. puberula*, *Phyllostegia renovans*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Melicope paniculata* critical habitat consists of one component (Lowland wet) (75 FR 18960-19165):

Ecosystem: Lowland Wet. Elevation: <3,000 ft (<914 m). Annual precipitation: >75 in (>190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepidia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public

hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: *Metrosideros polymorpha* (‘ohi’a) wet forest (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 1,200 - 2,680 ft. elevation (USFWS, 2010b)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: Typical habitat is wet forest dominated by *Metrosideros polymorpha* ('ohi'a) (Russell 2005). The environmental specificity is unknown (NatureServe, 2015). It occurs in the lowland wet ecosystem in forests dominated by *Metrosideros polymorpha*, at elevations between 1,200 and 2,680 ft. (365 and 815 m) (Stone et al. 1999, p. 1199; HBMP 2007; TNCH 2007) (USFWS, 2010b).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Species Trends:

Presumed extinct until rediscovery in 1997, declining (NatureServe, 2015)

Resiliency:

Very low (inferred from USFWS, 2010b; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2010a)

Number of Populations:

1 (USFWS, 2017)

Population Size:

~125 (USFWS, 2017)

Population Narrative:

The long term population trend is unknown. It was thought to be extinct until rediscovered in 1997; more than 200 plants are now known (Joel Lau, pers. comm. 2006). It is known to be declining due to numerous threats, although the exact percentage is unknown (HBMP 2007) (NatureServe, 2015). There are six populations totaling 200 individuals (USFWS, 2010a). Currently, *Melicope paniculata* is known from one larger population in Lumahai of approximately 100 individuals (HBMP 2010). Other locations only have a few individuals each and include Wainiha, Wailua River (and Blue Hole), Laau, Limahuli, and Wahiawa, though some of these observations are over fifteen years old. Best current total estimates include 125

individuals (Wood 1998; Stone et al. 1999; Wagner and Herbst 2003; Bender 2006; HBMP 2010; NTBG 1991, 1997, 1998a-e, 1999a-d, 2000a-c, 2001a-b, 2003a-b, 2005a-b, 2006, 2009a-f, 2013a-b) (USFWS, 2017).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from non-native plants, pigs, goats, hurricanes, landslides, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Landslides destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities.

Stressor: Predation and herbivory (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species present an immediate and significant threat to *Melicope paniculata* throughout its range due to documented browsing and trampling by pigs, goats, and deer, and documented mechanical damage by the black twig borer (*Xylosandrus compactus*) (USFWS, 2010).

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor: Ungulate degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Feral pigs (*Sus scrofa*) and goats (*Capra hircus*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil. Feral pigs and goats are noted to be a threat to individuals of *Melicope paniculata* that occur at Wainiha, Wailua, Laau, Limahuli, Lumahai, and Wahiawa

(Bruegmann 1997; HBMP 2010; NTBG 1998a-b, 1999a-d, 2000b-d, 2001a, 2003a, 2005a-b, 2006, 2009b, e-f, 2013a-b, 2015a-b) (USFWS, 2017).

Stressor: Established ecosystem-altering invasive plant modification and degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community. Invasive introduced plants with the greatest impacts on *Melicope paniculata* are: *Adiantum raddianum* (NCN), *Aleurites moluccana* (kukui), *Andropogon glomeratus* (bushy beardgrass), *Blechnum appendiculatum* (NCN), *Buddleja asiatica* (dog tail), *Clidemia hirta* (Koster's curse), *Cyclosorus dentatus* (pauhiha), *Cyperus meyenianus* (NCN), *Erechtites valerianifolia* (fireweed), *Erigeron karvinskianus* (daisy fleabane), *Hedychium gardnerianum* (kahili ginger), *Juncus planifolius* (bog rush), *Lantana camara* (lantana), *Melastoma septemnerium* (NCN), *Paspalum* spp., *Phaius tankervilleae* (Chinese ground orchid), *Pluchea carolinensis* (sourbush), *Psidium cattleianum* (strawberry guava), *P. guajava* (common guava), *Rubus rosifolius* (thimbleberry), *Setaria parviflora* (yellow foxtail), *Spathodea campanulata* (African tulip tree), *Sphaeropteris cooperi* (Australian tree fern), and *Zingiber zerumbet* (awapuhi) (HBMP 2010; NTBG 1998a, e, 1999b, 2000b, 2006, 2009b, e-f, 2013a-b) (USFWS, 2017).

Stressor: Landslides and flooding loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Landslides have been reported to be a threat to occurrences of *Melicope paniculata* at Lumahai and Limahuli valleys (HBMP 2010; NTBG 1998b, 1999a-b, 2000b, d, 2005a, 2006) (USFWS, 2017).

Stressor: Hurricanes—Loss and degradation of habitat

Exposure:

Response:

Consequence:

Narrative: In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013) (USFWS, 2017).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Melicope paniculata* is highly vulnerable to the impacts of climate change, with a vulnerability rating of 0.609 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery

Reclassification Criteria:

In addition to achieving 5 to 10 populations with 200 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats (USFWS, 2017).

Delisting Criteria:

In addition to achieving 5 to 10 populations with 200 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis (USFWS, 2017)

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys (USFWS, 2010a).

- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units (USFWS, 2010a).
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys (USFWS, 2010a).
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range (USFWS, 2010a).
- Conduct research on control methods for introduced slugs and avian malaria (USFWS, 2010a).
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction (USFWS, 2010a).
- Identify threats and prioritize which ones to address first for the two birds (USFWS, 2010a).
- Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program (USFWS, 2010a).
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security (USFWS, 2010a).
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems (USFWS, 2010a).
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations (USFWS, 2010a).
- Current Management Actions:
 - Ungulate monitoring and control—NTBG manages Upper Limahuli Preserve (366 ac) by installation of strategic fencing to exclude ungulates (Bender 2006; NTBG 2008).
 - Captive propagation for genetic storage and reintroduction—Lyon Arboretum Micropropagation Facility has 138 explants from two founders from Lumahai collected in 1998 (Lyon Arboretum 2017). There are plants from five founders from the Upper Limahuli Preserve population represented in the NTBG gardens (NTBG 2017).
 - Invasive plant monitoring and control—Weed control of nonnative species including *Sphaeropteris cooperi* and *Clidemia hirta* has been funded by USFWS (2002) and conducted by TNC since 2003 in Lumahai Valley (TNC 2003, 2008). Beginning in 2004, TNC, in partnership with The Waipa Foundation and the Sea Grant Program of the University of Hawaii, initiated management of the lowland forest in Lumahai Valley, and actions include invasive plant control (USFWS 2002). NTBG manages the Upper Limahuli Preserve by removing nonnative plants (Bender 2006; NTBG 2008) (USFWS, 2017).
- RECOMMENDATIONS FOR FUTURE ACTIONS
 - Surveys and inventories—Survey for populations of *Melicope paniculata* in areas of potentially suitable habitat.
 - Ungulate monitoring and control—Protect all occurrences against browsing and disturbances from feral ungulates. Construct fence exclosures around all known populations.
 - Invasive plant monitoring and control
 - o Control established ecosystem-altering nonnative invasive plant species around all populations.
 - o Control invasive nonnative plant species around all populations that compete with the species.
 - Predator and herbivore control research—

Research effective methods to control slugs and the black twig borer. Implement effective measures to control rodents around populations. • Captive propagation for genetic storage and reintroduction—Implement propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms. • Population biology research—Study *Melicope paniculata* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. • Based on the recovery criteria above, consider development of a recovery plan (USFWS, 2017).

Conservation Measures and Best Management Practices:

- This species is currently in controlled propagation for genetic storage and/or reintroduction efforts (USFWS, 2010a).
- The Hawaii Division of Forestry and Wildlife has established over 20 small-scale exclosures, largely in lowland and montane mesic ecosystems, and continues to control invasive introduced plants within them. While these fenced areas are extremely small, they have allowed for small-scale protection of remaining wild populations and reintroductions of several species included in this recovery plan, preventing their extinction (Hawaii Division of Forestry and Wildlife 2005, The National Tropical Botanical Garden 2007) (USFWS, 2010a).

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SPECIES ACCOUNT: *Melicope puberula* (Alani)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (R1) (USFWS, 2016)

Physical Description

A shrub or tree, 3 - 10 m tall. Cymes are axillary, with about 5 flowers. Capsules are dark red (NatureServe, 2015).

Taxonomy

A member of the rue family (Rutaceae) (USFWS, 2010b). This genus nearly endemic to Hawaiian Islands, with 2 species in the Marquesas Islands. This species is endemic to Northwest Kauai (NatureServe, 2015).

Historical Range

Historically, *M. puberula* was known from the Alakai Swamp on the island of Kauai (St. John 1944b, p. 266) (USFWS, 2010b).

Current Range

Currently, this species is known from the south rim of Kalalau east to the Alakai-Kilohana plateau area, and north into Hono o Na Pali NAR (HBMP 2007) (USFWS, 2010b).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Melicope puberula* (Alani) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes nine critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Melicope puberula* includes nine CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Lowland Wet—Section 1: Lowland Wet—Section 1 consists of 1,164 ac (471 ha) in the lowland wet ecosystem (117 ac (47.4 ha) on State land; 1,047 ac (424 ha) on private land), including wet forest extending from Kulanalilia into Limahuli Valley to Honoonapali, in the Halelea Forest Reserve (Figure 2-A). The section includes 1,099 ac (445 ha) of State and privately owned land within previously designated critical habitat and 65 ac (26 ha) of newly designated critical habitat on private land. The area that falls within designated critical habitat lies within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and newly designated Critical Habitat Unit 20, Map 217c. This section is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Labordia helleri*, and *Phyllostegia renovans*. This section also contains unoccupied habitat that is essential to the conservation of these four species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory

plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet–Section 1 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Melicope paniculata*, *M. puberula*, *Platydesma rostrata*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 2: Lowland Wet–Section 2 consists of 172 ac (70 ha) in the lowland wet ecosystem, including wet forest extending from Alealau to Pohakea, within the Hono o Na Pali NAR and the Na Pali Coast State Park (Figure 2-A, above). The entire section is Stateowned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plant *Melicope puberula*. This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet–Section 2 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope paniculata*, *Phyllostegia renovans*, *Platydesma rostrata*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 3: Lowland Wet–Section 3 consists of 756 ac (306 ha) in the lowland wet ecosystem, including wet forest in upper Wainiha Valley, on privately owned land in the Halelea Forest Reserve (Figure 2-B). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyrtandra oenobarba*, *Melicope puberula*, *Phyllostegia renovans*, and *Stenogyne kealiae*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet–Section 3 is not known to be occupied by the species *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope paniculata*, *Platydesma rostrata*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 4: Lowland Wet—Section 4 consists of 591 ac (239 ha) in the lowland wet ecosystem, including wet forest at the head of Lumahai Valley, on State (10 ac, 4.1 ha) and privately owned (581 ac, 235 ha) land in the Halelea Forest Reserve (Figure 2-B, above). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyrtandra oenobarba*, *Melicope paniculata*, *Phyllostegia renovans*, and *Platydesma rostrata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 4 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope puberula*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population numbers of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 5: Lowland Wet—Section 5 consists of 1,541 ac (624 ha) in the lowland wet ecosystem, including wet forest extending from the headwaters of the Wailua River at “Blue Hole” south to Iole, on State (442 ac, 179 ha) and privately owned (1,099 ac, 445 ha) land in the Lihue-Koloa Forest Reserve (Figure 2-C). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36a, and is occupied by the plants *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Melicope paniculata*, *Phyllostegia renovans*, and *Platydesma rostrata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 5 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Labordia helleri*, *Melicope puberula*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 6: Lowland Wet—Section 6 consists of 789 ac (319 ha) in the lowland wet ecosystem, including wet forest extending from Kapalaoa to Kanaele Bog and Lauahihaihai in the Wahiawa Mountains, on State (134 ac, 54 ha) and privately owned (655 ac, 265 ha) land in the Lihue-Koloa Forest Reserve (Figure 2-D). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36a, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Platydesma rostrata*, and *Tetraplasandra bisattenuata*. This section also contains unoccupied habitat that is essential to the conservation of these five

species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 6 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Labordia helleri*, *Melicope paniculata*, *M. puberula*, *Phyllostegia renovans*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Montane Wet—Section 1: Montane Wet—Section 1 consists of 13,055 ac (5,257 ha) in the montane wet ecosystem, extending across the Alakai Plateau from Hanakoa to Mount Waialeale, on State (12,628 ac, 5,110 ha) and privately owned (427 ac, 173 ha) land in the Na Pali Coast State Park, the Alakai Wilderness Preserve, the Na PaliKona and Halelea forest reserves, and Hono o Na Pali NAR (Figure 4). It is occupied by the plants *Astelia waialealae*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *K. helenae*, *Labordia helleri*, *L. pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, and *Platydesma rostrata*; by the akekee and akikiki; and by the picture-wing fly. This section also contains unoccupied habitat that is essential to the conservation of these 18 species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the montane wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and the species-specific PCEs including (1) bogs (identified as PCEs for *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*) (2) bog hummocks (identified as PCEs for *Astelia waialealae* and *Lysimachia daphnoides*); (3) arthropod prey (identified as PCEs for the akekee and the akikiki); and (4) larval-stage host plants, *Cheirodendron* and *Tetraplasandra* sp., (identified as a PCE for the picture-wing fly). Although Montane Wet—Section 1 is not known to be occupied by the plants *Dubautia kalalauensis*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, those portions of the section that overlie previously designated critical habitat fall within two existing Critical Habitat Units of 50 CFR 17.99(a)(1): Unit 10, Map 35a; and Unit 11, Map 64a. The previously undesignated land comprises Unit 23, Map 217f; and Unit 24, Map 217g. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 4—Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 4—Montane Wet).

Kauai—Montane Wet—Section 2: Montane Wet—Section 2 consists of 790 ac (320 ha) in the montane wet ecosystem, extending from Kahuamaa Flat south to the edge of Waimea Canyon, on State-owned land in Kokee State Park (Figure 4, above). The entire section is within previously designated critical habitat, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Dubautia kalalauensis*, *Labordia helleri*, *Melicope puberula*, *Platydesma rostrata*, *Psychotria grandiflora*,

and *Tetraplasandra flynnii*, and by the akekee. This section includes montane wet forest, potentially some small-scale boggy areas, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and arthropod prey (identified as a species-specific PCE for the akekee). Although Montane Wet–Section 2 is not known to be occupied by the plants *Astelia waialeale*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialeale*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *Myrsine mezii*, and *Phyllostegia renovans*; by the akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. This area also supports the arthropod prey identified as a PCE for the akikiki, and the larval-stage host plants (*Cheirodendron* and *Tetraplasandra* spp.) identified as a PCE for the picturewing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within previously designated Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 5–Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 5– Montane Wet).

Kauai—Montane Wet—Section 3: Montane Wet–Section 3 consists of 413 ac (167 ha) in the montane wet ecosystem, encompasses the summit of Namolokama, on State (156 ac, 63 ha) and privately owned (257 ac, 104 ha) land in the Halelea Forest Reserve (Figure 4, above). It is entirely within previously designated critical habitat, and is occupied by the plants *Keysseria erici* and *Labordia pumila*. This section includes the montane wet forest, the moisture regime, and the canopy, subcanopy, and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and bogs (identified as a species-specific PCE for *K. erici*). Although Montane Wet–Section 3 is not known to be occupied by the plants *Astelia waialeale*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia kalalauensis*, *D. waialeale*, *Geranium kauaiense*, *Keysseria helenae*, *Labordia helleri*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*; by the akekee and akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. It also supports the arthropod prey identified as a PCE for the akekee and akikiki, and the larval-stage host plants (*Cheirodendron* and *Tetraplasandra* spp.) identified as a PCE for the picture-wing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 6–Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 6–Montane Wet).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Melicope puberula* critical habitat consists of two components (Lowland wet and Montane wet) (75 FR 18960-19165):

Ecosystem: Lowland Wet. Elevation: <3,000 ft (<914 m). Annual precipitation: >75 in (>190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

Ecosystem: Montane Wet. Elevation: 3,000–5,243 ft (914–1,598 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: Acacia, Charpentiera, Cheirodendron, Metrosideros. Subcanopy: Broussaisia, Cibotium, Eurya, Ilex, Myrsine. Understory: Ferns, Carex, Coprosma, Leptecophylla, Oreobolus, Rhynchospora, Vaccinium.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular

attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Lowland and montane wet forests and bogs (USFWS, 2010b)

Geographic or Habitat Restraints or Barriers

Adult: 2,080 - 4,100 ft. elevation (USFWS, 2010b)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits wet forests and bogs in the cloud zone. On gently sloped plateau lands, as well as steeper slopes. The environmental specificity is unknown (NatureServe, 2015). It occurs in the lowland wet and montane wet ecosystems in wet forest and bogs at elevations ranging between 2,080 and 4,100 ft. (634 and 1,250 m) (Stone et al. 1999, p. 1202; HBMP 2007; TNCH 2007) (USFWS, 2010b).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Species Trends:

Declining (NatureServe, 2015)

Resiliency:

Very low (inferred from USFWS, 2010b; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2010a)

Number of Populations:

4 (USFWS, 2017)

Population Size:

100-150 (USFWS, 2017)

Population Narrative:

The long term population trend is unknown. It is known to be declining due to numerous threats, but the exact percentage is unknown (HBMP 2007) (NatureServe, 2015). There are three populations totaling 900 individuals (USFWS, 2010a). Currently, at least 50 individuals are reported ranging from Puu o Kila-Hanakoa, Pihea, Hanakapiai, to Kawaikoi. In addition, with more recent surveys, individuals have been found at Kawaikini (10 to 50), Halehaha-Sincock Bogs (36), and Koaie (5) totaling at least 100 to 150 individuals (NTBG 2009, 2010a-c, 2012a-e, 2013a, 2014a-e, 2015a-b, 2016) (USFWS, 2017).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from non-native plants, pigs, goats, hurricanes, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds, and through the spread of seeds in feces; and creation of open, disturbed areas conducive

to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species.

Stressor: Predation and herbivory (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species present an immediate and significant threat to *Melicope puberula* throughout its range due to documented browsing and trampling by pigs, goats, and deer, and documented mechanical damage by the black twig borer (*Xylosandrus compactus*) (USFWS, 2010).

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor: Ungulate degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Feral pigs (*Sus scrofa*), goats (*Capra hircus*), and black-tailed deer (*Odocoileus hemionus*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil (Loope 1998; van Riper and van Riper 1982). These ungulates and evidence of their activities have been observed at all occurrences of *Melicope puberula* (HBMP 2010; NTBG 2009, 2010a-b, 2012a-e, 2013, 2014 a-e, 2015a-b) (USFWS, 2017).

Stressor: Established ecosystem-altering invasive plant modification and degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species modify habitat occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community (Cuddihy and Stone 1990). Habitat modification and destruction by invasive introduced plants negatively affects *Melicope puberula* at all locations. The nonnative plants with the greatest impacts include *Adiantum raddianum* (NCN), *Andropogon glomeratus* (bushy beardgrass), *Axonopus fissifolius* (narrowleaved carpetgrass), *Blechnum appendiculatum* (NCN), *Buddleja asiatica* (dog tail), *Clidemia hirta* (Koster's curse), *Cyperus meyenianus* (NCN), *Erigeron karvinskianus* (daisy fleabane), *Hedychium gardnerianum* (kahili ginger), *Juncus planifolius* (rush), *Melastoma septemneruvium* (NCN), *Paspalum conjugatum* (Hilo grass), *P. urvillei* (vasey grass), *Psidium cattleianum* (strawberry guava), *Rhodomyrtus tomentosa* (downy myrtle), *Rubus argutus* (prickly Florida blackberry), *R. rosifolius* (thimbleberry), *Sacciolepis indica* (glenwood grass), *Setaria*

parviflora (yellow foxtail), and *Sphaeropteris cooperi* (Australian tree fern) (HBMP 2010; NTBG 2014a-b, d, 2015a) (USFWS, 2017).

Stressor: Landslides and flooding loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Floods, including tree falls and erosion associated with them, can have a significant effect on small populations. Landslides and erosion due to natural weathering destabilize substrates, damage and destroy individual plants, and alter hydrological patterns (Stearns 1985). Landslides and flooding have been reported to be a threat to an occurrence of *Melicope puberula* at Kawaikini (NTBG 2015a) (USFWS, 2017).

Stressor: Hurricanes—Loss and degradation of habitat

Exposure:

Response:

Consequence:

Narrative: —In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois, 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013) (USFWS, 2017).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Climate change loss or degradation of habitat—Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Melicope puberula* is vulnerable to the impacts of climate change with a vulnerability score of 0.452 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery

Reclassification Criteria:

In addition to achieving 5 to 10 populations with 200 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats (USFWS, 2017).

Delisting Criteria:

In addition to achieving 5 to 10 populations with 200 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis (USFWS, 2017).

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys (USFWS, 2010a).
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units (USFWS, 2010a).
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys (USFWS, 2010a).
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range (USFWS, 2010a).
- Conduct research on control methods for introduced slugs and avian malaria (USFWS, 2010a).
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction (USFWS, 2010a).
- Identify threats and prioritize which ones to address first for the two birds (USFWS, 2010a).

- Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program (USFWS, 2010a).
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security (USFWS, 2010a).
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems (USFWS, 2010a).
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations (USFWS, 2010a).
- Current Management Actions: • Surveys and inventories—Recent surveys were conducted and found additional individuals of this species (NTBG 2010a-b, 2012a-d, 2013, 2014a-d, 2015a-b). • Captive propagation for genetic storage and reintroduction—Seeds are collected but there is currently no ex situ storage (NTBG 2013b, 2014f, 2015c) (USFWS, 2017).
- RECOMMENDATIONS FOR FUTURE ACTIONS • Surveys and inventories—Continue to survey for populations of *Melicope puberula* in areas of potentially suitable habitat. • Ungulate monitoring and control—Construct fenced exclosures to protect populations from feral ungulates. Protect all occurrences against browsing and disturbances from feral ungulates. • Invasive plant monitoring and control o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative plant species around all populations that compete with the species. • Predator and herbivore monitoring and control—Implement effective control methods for rodents around all populations. • Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides, flooding and storms. • Population biology research—Study *Melicope puberula* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. • Based on the recovery criteria above, consider development of a recovery plan (USFWS, 2017).

Conservation Measures and Best Management Practices:

- USFWS and the Hawaii Division of Forestry and Wildlife have fenced 9 montane bogs in the Alakai Plateau, totaling approximately 40 hectares (100 acres). These fenced bogs contain some scattered individuals of *M. puberula* (Bruegmann 2002; Perlman and Wood 1995). Weed control and monitoring is ongoing within the fences (Bruegmann 2002; Bruegmann 2008) (USFWS, 2010a).
- This species is currently in controlled propagation for genetic storage and/or reintroduction efforts (USFWS, 2010a).

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SPECIES ACCOUNT: *Melicope quadrangularis* (Alani)

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/25/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

A shrub or small tree. Young branches are generally covered with fine yellow fuzz but become hairless with age. This species differs from others in the genus in having the following combination of characters: oppositely arranged leaves, only one or two flowers per cluster, cube-shaped capsules with fused lobes, and a deep central depression at the top of the fruit (USFWS, 2003).

Taxonomy

A member of the rue family (Rutaceae) (USFWS, 2003).

Historical Range

The species was discovered by C.N. Forbes in the vicinity of Wahiawa Bog on the island of Kauai in 1909 (USFWS, 2010).

Current Range

Currently known from the type locality in the Wahiawa Bog region of Kauai (USFWS, 2003).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Lifespan

Adult: > 10 years (USFWS, 2010)

Breeding Season

Adult: Unknown (USFWS, 2003)

Key Resources Needed for Breeding

Adult: Unknown (USFWS, 2003)

Reproduction Narrative

Adult: It is a long-lived perennial (USFWS, 2010). Flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown (Service 1995) (USFWS, 2003).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Lowland wet ohia forest (USFWS, 2003)

Geographic or Habitat Restraints or Barriers

Adult: 1,995 - 5,228 ft. elevation (USFWS, 2003)

Habitat Narrative

Adult: Inhabits wet forests (NatureServe, 2015). *Melicope quadrangularis* grows in *Metrosideros polymorpha* diverse lowland wet forest that ranges from mesic to wet conditions at elevations between 608 and 1,593 m (1,995 and 5,228 ft.) (USFWS, 2003).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

No living individuals known (USFWS, 2010)

Number of Populations:

3 (USFWS, 2017)

Population Size:

14 (USFWS, 2017)

Population Narrative:

Melicope quadrangularis populations have declined so that currently no living individuals are known. This species has been rediscovered at least once in the last 82 years and suitable habitat still exists within historical range, indicating that *Melicope quadrangularis* may still exist (USFWS, 2010). In addition to those populations cited in the previous 5-year review, new observations include the following: • At the time of the last 5-year review in 2010 botanists were unable to relocate the last known occurrence of *Melicope quadrangularis* because of the destruction caused by Hurricane Iniki. By 2013, four individuals were found at Waiahi (NTBG 2013b-d). Now there are only two founders remaining at this site (PEPP 2017). In 2014, one individual was found in upper Limahuli and six individuals were found at Wahiawa-Kapalaoa (NTBG 2014a; PEPP 2014). Currently, the Limahuli location has six trees (PEPP 2017) (USFWS, 2017).

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Introduced species which threaten the habitat in Wahiawa include the following (in their order of greater to lesser threat): pigs (*Sus scrofa*) and invasive introduced plants *Psidium cattleianum* (strawberry guava), *Clidemia hirta* (Koster's curse), *Melastoma septemnerium* (Asian melastome), *Rhodomyrtus tomentosa* (rat berry), *Rubus rosifolius* (thimbleberry),

Axonopus fissifolius (narrow-leaved carpetgrass), Cyperus meyenianus (no common name [NCN]), Pterolepis glomerata (NCN), Stachytarpheta australis (porterweed), Oplismenus hirtellus (basketgrass), Sacciolepis indica (Glenwood grass), and Setaria parviflora (yellow foxtail) (Wood 2009). Hurricanes (USFWS, 2010).

Stressor: Predation (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Rats (*Rattus rattus*) and slugs (undetermined species) threaten this Melicope species (Wood 2009) (USFWS, 2010).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: —Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Melicope pallida* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.785 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this species has no overlap between current and future climate envelopes, and is unlikely to tolerate expected changes in climate at its current locations. This means that this species must persist within suitable microrefugia, or move to newly available climate-compatible areas to avoid extinction. Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery

Reclassification Criteria:

1. A total of five to seven populations should be documented on Kauai and at least one other island where they now occur or occurred historically (USFWS, 1995).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population (for long-lived perennials) (USFWS, 1995).
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 1995).

Delisting Criteria:

1. A total of 8 to 10 populations should be documented on Kauai and at least one other island where they now occur or occurred historically (USFWS, 1995).

2. ne other island where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population (for long-lived perennials) (USFWS, 1995).

3. Each population should persist at this level for a minimum of five consecutive years (USFWS, 1995).

Recovery Actions:

- Protect current populations, control threats and monitor (USFWS, 1995).
- Expand current populations (USFWS, 1995).
- Conduct research essential to conservation of the species (USFWS, 1995).
- Establish new populations as needed to reach recovery objectives (USFWS, 1995).
- Validate and revise recovery objectives (USFWS, 1995).
- Devise and implement a public education program (USFWS, 1995).
- In order to prevent this taxon from going extinct, propagation efforts and the maintenance of adequate genetic stock ex situ should be undertaken immediately, as well as the protection of remaining wild individuals from alien weed threats (USFWS, 1995).
- New Management Actions: • Population viability monitoring and analysis—PEPP is surveying for new populations and monitoring known populations of *Melicope quadrangularis* (PEPP 2010, 2014). • Captive propagation for genetic storage and reintroduction—There is currently one plant from the Waiahi population at the NTBG nursery. Collection and propagation efforts continue (NTBG 2017) (USFWS, 2017).
- Recommendations for Future Actions: No new threats and no other significant new information regarding the species' biological status have come to light since the last 5-year review in 2010. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2017. • Surveys and inventories—Continue to survey for populations of *Melicope quadrangularis* within suitable habitat. • Ungulate monitoring and control—Fence suitable habitat within historic range to protect the species from further incursions by feral ungulates. Construct small-scale fences to prevent imminent extinction. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative species that compete with the species around all populations. • Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Predator and herbivore control research—Study *Melicope quadrangularis* populations to determine level of threat from slugs and any additional recovery actions needed. • Predator and herbivore monitoring and control—Implement effective measures to control predation by rats. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from hurricanes (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Conduct surveys within suitable habitat (USFWS, 2010).
- Fence suitable habitat within historical range to protect it from further incursions by pigs (USFWS, 2010).
- Remove introduced invasive plants from the fenced areas (USFWS, 2010).

- Work with Hawaii Division of Forestry and Wildlife and other landowners to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2010).

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SPECIES ACCOUNT: *Melicope reflexa* (Alani)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/08/1992; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Melicope reflexa, a member of the citrus family (Rutaceae), is a sprawling shrub 1 to 3 m (3.3 to 10 ft) tall with short, yellowish-brown, short-lived hairs on new growth. The opposite, thin, and leathery leaves are elliptical and measure 8 to 14 cm (3.1 to 5.5 in) long and 4 to 7 cm (1.6 to 2.8 in) wide. Flowers arise singly or in clusters of two or three from the leaf axil. The flower cluster has a stalk 3 to 15 mm (0.1 to 0.6 in) long, and each flower is on a stalk 15 to 20 mm (0.6 to 0.8 in) long. Male flowers have not been seen, but female flowers are made up of four overlapping sepals about 3 to 4 mm (0.1 in) long; four petals about 4.8 mm (0.2 in) long; an eight-lobed nectary disk; eight reduced, nonfunctional stamens; and a style about 4 mm (0.2 in) long. The capsules are 20 to 33 mm (0.8 to 1.3 in) wide with four sections 10 to 17 mm (0.4 to 0.7 in) long which are fused to each other along about one-fourth of their length. One or two glossy black seeds, about 7 to 8 mm (0.3 in) long, are found in each section of the capsule. (USFWS, 1996)

Taxonomy

Genus nearly endemic to Hawaiian Islands, with 2 species in Marquise's islands. Species endemic to eastern Molokai. Species probably represents a minor form of *Pelea pseudoanisata*, needs further study (Wagner et al.). After further study of the genus, Thomas G. Hartley and Benjamin C. Stone (1989) placed *Pelea* into synonymy with *Melicope*, resulting in the new combination *Melicope reflexa* (USFWS 1992). (USFWS, 1996; NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Endemic to Eastern Molokai (NatureServe, 2015).

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Melicope reflexa* (Alani) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes seven detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Melicope reflexa* includes seven CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Molokai—Lowland Mesic—Unit 1 (and) *Palmeria dolei*—Unit 37—Lowland Mesic (and) *Pseudonestor xanthophrys*—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in

central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Ctenitis squamigera*, *Cyanea dunbariae*, *C. mannii*, *C. profuga*, *Cyperus fauriei*, *Cyrtandra filipes*, *Gouania hillebrandii*, *Labordia triflora*, *Neraudia sericea*, *Santalum haleakalae* var. *lanaiense*, *Schiedea lydgatei*, *S. sarmentosa*, *Silene alexandri*, *S. lanceolata*, *Spermolepis hawaiiensis*, and *Zanthoxylum hawaiiense*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Lowland Mesic—Unit 1 is not known to be occupied by *Asplenium dielirectum*, *Bonamia menziesii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea procera*, *C. solanacea*, *Diplazium molokaiense*, *Festuca molokaiensis*, *Flueggea neowawraea*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Melicope mucronulata*, *M. munroi*, *M. reflexa*, *Phyllostegia haliakalae*, *P. mannii*, *P. pilosa*, *Sesbania tomentosa*, *Stenogyne bifida*, or *Vigna o-wahuensis*, or the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 1 (and) *Palmeria dolei*—Unit 38—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 38—Lowland Wet This area consists of 2,195 ac (888 ha) of State land, and 754 ac (305 ha) of privately owned land (partly within The Nature Conservancy's Pelekunu Preserve), from Pelekunu Valley to Wailau Valley, in north-central Molokai. These units are occupied by the plant *Cyrtandra filipes*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Lowland Wet—Unit 1 is not known to be occupied by *Asplenium dielirectum*, *Bidens wiebkei*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Lysimachia maxima*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 2 (and) *Palmeria dolei*—Unit 39—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 39—Lowland Wet This area consists of 1,356 ac (549 ha) of State land and 594 ac (241 ha) of privately owned land, from Kahanui to Pelekunu Valley, in north-central Molokai. These units are occupied by the plant *Lysimachia maxima*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations.

Although Molokai—Lowland Wet—Unit 2 is not known to be occupied by *Asplenium dielirectum*, *Bidens wiebkei*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Cyrtandra filipes*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 3 consists of 94 ac (38 ha) of State land, and 3,125 ac (1,265 ha) of privately owned land, from Waiahookalo gulch to Moaula stream and Puniuohua, on eastern Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Molokai—Lowland Wet—Unit 3 is not known to be occupied by *Asplenium dielirectum*, *Bidens wiebkei*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Cyrtandra filipes*, *Lysimachia maxima*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 1 (and) *Palmeria dolei*—Unit 40—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 40—Montane Wet This area consists of 1,545 ac (625 ha) of State land, and 1,851 ac (749 ha) of privately owned land, from the headwaters of Waialelia Stream and above Pelekunu Valley, eastward along the summit area to Mapulehu, in northcentral Molokai. These units are occupied by the plants *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. profuga*, *Phyllostegia hispida*, and *Pteris lidgatei*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Montane Wet—Unit 1 is not known to be occupied by *Adenophorus periens*, *Cyanea procera*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Melicope reflexa*, *Phyllostegia mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 41—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 41—Montane Wet This area consists of 871 ac (353 ha) of

State land, and 39 ac (16 ha) of privately owned land, from Honukaupu to Olokui (between Pelekunu and Wailau valleys), in north-central Molokai. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). Although Molokai—Montane Wet—Unit 2 is not known to be occupied by *Adenophorus periens*, *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. procera*, *C. profuga*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Melicope reflexa*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Pteris lidgatei*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 3 consists of 77 ac (31 ha) of State land, and 726 ac (294 ha) of privately owned land, above the east rim of Wailau Valley on eastern Molokai. This unit is occupied by the plant *Melicope reflexa*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Montane Wet—Unit 3 is not known to be occupied by *Adenophorus periens*, *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. procera*, *C. profuga*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Pteris lidgatei*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Melicope reflexa* critical habitat consists of three components. Lowland mesic (Molokai), Lowland wet (Molokai) and Montane wet (Molokai) (81 FR 17790-18110):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: *Ferns*, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to

be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at 760 to 1,190 meters (2,490 to 3,900 feet) (USFWS, 1996)

Environmental Specificity

Adult: Low (inferred from USFWS, 1996)

Habitat Narrative

Adult: Melicope reflexa typically grows in wet ohia-dominated forests with native trees such as olapa at elevations between 760 and 1,190 meters (2,490 and 3,900 feet) (USFWS 1992). The habitats on East Molokai where Melicope reflexa occurs are Metrosideros polymorpha (ohia) – Dicranopteris linearis (uluhe) lowland or montane wet forests. (USFWS, 1996; USFWS, 2011)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2011)

Redundancy:

Very low (inferred from USFWS, 2011)

Number of Populations:

2 (USFWS, 2011)

Population Size:

<6 plants (USFWS, 2011)

Population Narrative:

Currently, there are at least two populations of Melicope reflexa totaling fewer than six individuals. (USFWS, 2011)

Threats and Stressors

Stressor: Habitat modification by feral goats, pigs, and deer (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Threats that modify habitat include feral goats (Capra hircus), pigs, and deer that disturb the ground where Melicope reflexa occurs, and degrade the habitat by uprooting seedlings of native plants and creating conditions that may cause landslides and erosion. Pig activity is severe in Puu Ohelo (Oppenheimer 2010). (USFWS, 2011)

Stressor: Non-native invasive plants (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species including *Ageratina adenophora* (sticky snakeroot), *Clidemia hirta* (Koster's curse), *Psidium cattleianum* (strawberry guava), and *Tibouchina herbacea* (glory bush) compete with and inhibit regeneration around existing plants (Oppenheimer 2010; National Tropical Botanical Garden 2009a; Wood 2009). The introduced invasive plant species are also a threat to *Melicope reflexa* because they compete with the species for water, light, and nutrients. (USFWS, 2011)

Stressor: Predation by goats, rats, deer, and black twig borer (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: *Melicope reflexa* is threatened by predation by goats, rats, (*Rattus* sp.) and deer (Hawaii Biodiversity and Mapping Program 2009; National Tropical Botanical Garden 2009a). Black twig borer (*Xylosandrus compactus*) is probably also a threat to this species (Oppenheimer 2010). (USFWS, 2011)

Stressor: Small population size (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: In addition to all of the other threats, species like *Melicope reflexa* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding, and disease outbreaks. The extent of these natural processes on this single island endemic are exacerbated by anthropogenic threats, such as habitat loss for human development or predation by introduced species (USFWS 1996). (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2011)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Molokai and at least one other island where they now occur or occurred historically. (USFWS, 1996)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1996)

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1996)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Molokai and at least 1 other island where they now occur or occurred historically. (USFWS, 1996)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1996)

3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1996)

Recovery Actions:

- Given the altered nature of the Molokai Recovery Plan taxa's habitat, their low numbers, and the severity of the threats acting upon them, the highest priority recovery actions must be aimed at protecting those individuals and populations that currently exist, and managing their habitat to control the threats affecting their survival. Surveys should begin immediately for taxa that have not been observed for several years. If the species cannot be found, they may be considered for delisting due to extinction. A monitoring program is essential to track the status of the populations of all of the taxa covered in this plan, and to assess the effectiveness of threat management. (USFWS, 1996)
- The Molokai cluster taxa may expand naturally following the elimination of current threats through management. However, in certain instances, wild populations may need to be augmented in order to reach down/delisting criteria. Suitable sites for population augmentation should be selected after careful evaluation of the threat of introducing detrimental organisms into the wild populations. Augmentation efforts should always be well-documented as to lineage and methods. (USFWS, 1996)
- Research into various aspects of the life history, habitat, pollinators, reproductive biology, symbionts, optimum requirements for growth, requirements for population viability, and control of threats for each of the Molokai Recovery Plan taxa is needed in order to better understand the requirements necessary for perpetuation of these plants. Additional knowledge would allow more appropriate management and assessment techniques to be developed, and is needed in order to determine meaningful parameters for definition of specific recovery criteria for each taxon. (USFWS, 1996)
- All populations of the Molokai Recovery Plan taxa should be monitored to ensure that current information is available for each. A detailed monitoring plan should be designed and implemented for each taxon. Permanent plots should be set up for each population, and individuals mapped by size class, in order to establish baseline information regarding population size, local distribution patterns and threats. As new populations are discovered

or established, they should be added to the monitoring program. Individual plants may also be carefully tagged as appropriate for monitoring purposes. Data collection should include quantities and locations of all extant plants as well as any other relevant observations regarding phenology, habitat or threats. Plots should be set up to allow point-and/or line-intercept monitoring methods as appropriate for each situation. Information such as changes in numbers of plants by size class, changes in vigor of individual plants, and changes or disturbances to the environment should be noted as appropriate and that data recorded. (USFWS, 1996)

- If necessary to meet recovery objectives, populations should be reestablished in areas where they are known or believed to have occurred historically, particularly if genetically uncontaminated, cultivated materials exist that are known to have originated from the historical site. The goal of reintroduction is to permanently re-establish viable populations of these taxa in stable and secure conditions. (USFWS, 1996)
- The scientific validity of the recovery criteria should be reviewed and revised as appropriate as more information becomes available. (USFWS, 1996)

Conservation Measures and Best Management Practices:

- Survey areas where *Melicope reflexa* was reported to determine the current status of the species. (USFWS, 2011)
- Monitor known populations and collect seeds for genetic storage and reintroduction. (USFWS, 2011)
- Fence existing populations to protect them from the negative impacts of feral ungulates. (USFWS, 2011)
- Control invasive introduced plant species around known populations. (USFWS, 2011)
- Research taxonomy and genetic relationships to clarify the *M. volcanica*/*M. reflexa*/*M. pseudoanisata* species complex. (USFWS, 2011)
- Control rats in the vicinity of these populations. (USFWS, 2011)
- Develop and implement methods to control black twig borer. (USFWS, 2011)
- Propagate to augment the existing populations. (USFWS, 2011)
- Establish additional populations within protected suitable habitat. (USFWS, 2011)
- Work with Hawaii Division of Forestry and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2011)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2011)

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

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SPECIES ACCOUNT: *Melicope saint-johnii* (Alani)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

A tree, 3 to 6 m tall. Flowers are 3-11 per inflorescence. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

The species is endemic to Oahu (NatureServe, 2015).

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Melicope saint-johnii* (Alani) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Melicope saint-johnii* (77 FR 57648-57862). The critical habitat designation includes 15 critical habitat units, which encompass approximately 9,271 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Melicope saint-johnii* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Melicope saint-johnii* includes 15 critical habitat units, covering two ecosystem types, which encompass approximately 9,271 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7; Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve.

Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac (105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Melicope saint-johnii* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Melicope saint-johnii* occurs within the Lowland mesic and Dry cliff ecosystems in the Waianae Mountain caldera complex and was known historically (last observed > 20 yrs ago) from indicated the Lowland mesic ecosystem in the Koolau Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy:

Antidesma, Chamaesyce, Diospyros, Dodonaea. (F) Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Melicope saint-johnii* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliff, forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 500 and 853 meters (1,640 to 2,800 feet) (USFWS, 1998)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1998)

Habitat Narrative

Adult: This species typically grows on mesic forested ridges and cliff ledges from 500 to 853 meters (1,640 to 2,800 feet) elevation. Associated native plants include mamaki, ohia, *Coprosma longifolia* (pilo), *Hedyotis schlechtendahlana* (kopa), *Labordia kaalae* (kamakahala), and *Psychotria hathewayi* (kopiko) (USFWS 1996b; Takeuchi 1992, Takeuchi and Paquin (s.n.) 1985). (USFWS, 1998; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Low (inferred from USFWS, 2011)

Redundancy:

Low (inferred from USFWS, 2011)

Number of Populations:

4 (USFWS, 2011)

Population Size:

200 (USFWS, 2011)

Population Narrative:

Currently, less than 200 individuals of *Melicope saint-johnii* are estimated to occur in four populations on Oahu. (USFWS, 2011)

Threats and Stressors

Stressor: Habitat degradation by feral goats and pigs (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Habitat where *Melicope saint-johnii* is found is typically degraded by feral goats (*Capra hircus*) and pigs (*Sus scrofa*). (USFWS, 2011)

Stressor: Non-native invasive plants (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Competition with invasive introduced plants is a threat and include *Ageratina adenophora* (sticky snakeroot), *Ageratina riparia* (spreading mist flower), *Clidemia hirta* (Koster's curse), *Erigeron karvinskianus* (daisy fleabane), *Grevillea robusta* (silk oak), *Lantana camara* (lantana), *Melinis minutiflora* (molasses grass), *Morella faya* (firetree), *Passiflora suberosa* (corky stem passionflower), *Psidium cattleianum* (strawberry guava), *Rubus rosifolius* (thimbleberry), and *Schinus terebinthifolius* (Wood 2009). (USFWS, 2011)

Stressor: Fire (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: There is a high fire threat for populations located at Ekahanui, where fires have occurred nearby (U.S. Army Garrison 2008). (USFWS, 2011)

Stressor: Predation by black twig borer (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Predation by the black twig borer (*Xylosandrus compactus*) has been a problem for various *Melicope* species (USFWS 1998). (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2011)

Stressor: Small population size (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: In addition to all of the other threats, species like *Melicope saint-johnii* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding, and disease outbreaks. (USFWS, 2011)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1998)

Recovery Actions:

- Construct enclosures to protect populations against feral ungulates. (USFWS, 1998)
- Control competing alien plant species within enclosures. Populations that have only a few remaining individuals (North Palawai Gulch, South Ekahanui Gulch, and Lualualei, Halona subdistrict) should immediately be weeded and protected, if feasible. (USFWS, 1998)
- Maintain adequate genetic stock. Propagation material should be collected immediately from populations that have only a few individuals (North Palawai Gulch, South Ekahanui Gulch, and Lualualei, Halona subdistrict). (USFWS, 1998)

Conservation Measures and Best Management Practices:

- Survey to determine current status of all wild populations. (USFWS, 2011)
- Collect material for genetic storage and propagation for reintroduction. (USFWS, 2011)
- Propagate for reintroduction and augmentation. (USFWS, 2011)
- Develop a plan for conserving the species' genetic diversity in ex situ collections and in reintroduced populations. (USFWS, 2011)
- Control invasive introduced plant species around all populations. (USFWS, 2011)
- Fence all populations to provide protection from the negative impacts of feral ungulates. (USFWS, 2011)
- Develop and implement methods to control black twig borer. (USFWS, 2011)
- Develop and implement wildfire management plans for each population. (USFWS, 2011)
- Work with the U.S. Army Garrison, the U.S. Navy, Hawaii Division of Forestry and Wildlife, and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2011)

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SPECIES ACCOUNT: *Melicope zahlbruckneri* (Alani)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

A medium-sized tree 10 to 12 meters (33 to 40 feet) tall. New growth is covered with yellowish brown, fine, short, curly hairs. The opposite, stalked, elliptically oblong leaves are 6 to 24 cm (2.4 to 9.5 inches) long and 4 to 12.5 cm (1.6 to 4.9 inches) wide, with well defined lateral veins. Clusters of two to five flowers have main flowering stalks 15 to 20 cm (5.9 to 7.9 inches) long and each flower has a stalk about 0.4 cm (0.2 inch) long. Female flowers consist of four sepals about 1.5 mm (0.05 inch) long, four petals about 3 mm (0.1 inch) long, an eight-lobed nectary disk, eight reduced and nonfunctional stamens, and a hairless four-celled ovary. Male flowers consist of four sepals 3.5 mm (0.1 inch) long, four petals about 6 mm (0.2 inch) long, and eight functional stamens in two whorls equal to or longer than the petals. The fruit is squarish, 12 to 14 mm (0.4 to 0.5 inch) long, and up to 30 mm (1.2 inch) wide (USFWS, 1998).

Taxonomy

A member of the citrus family (Rutaceae) (USFWS, 2015).

Historical Range

Historically, *Melicope zahlbruckneri* was known from near Glenwood, Kipuka Puaulu, and Moaula in Kau (USFWS 1998) (USFWS, 2015).

Current Range

Current range includes the Island of Hawaii (NatureServe, 2015). It occurs in Kipuka Puaulu, Kipuka Ki (Big Island Plant Extinction Program 2006), and the Laupahoehoe Natural Area Reserve (USFWS, 2008). Individuals have been reintroduced into Boundary Kipuka Ahi (Hawaii Volcanoes National Park 2012) (USFWS, 2015).

Critical Habitat Designated

Yes; 7/2/2003.

Legal Description

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Melicope zahlbruckneri* on the island of Hawaii (68 FR 39623 - 39722).

Critical Habitat Designation

The critical habitat designation for *Melicope zahlbruckneri* includes two units totaling 2,296 acres in Hawaii County, Hawaii. The units are Hawaii 24—*Melicope zahlbruckneri*—a and Hawaii 26—*Melicope zahlbruckneri*—b. Although the Service does not believe enough habitat currently exists to reach the recovery goal of 8 to 10 populations for this island-endemic species, the two designated units identify habitat for recovery populations that is geographically separated to reduce the likelihood of all recovery populations being destroyed by one naturally occurring catastrophic event. The two critical habitat units designated for this species provide habitat for a total of three populations, each with 100 mature, reproducing individuals of *M. zahlbruckneri*.

Hawaii 24—*Melicope zahlbruckneri*— a [434 ha (1,072 ac)]: This unit is just north of Uwewale gulch, it is completely within the Pahala watershed, and is within the Kau Forest Reserve; provides habitat for 1 population of 100 individuals of *M. zahlbruckneri*; and is currently unoccupied. This unit is essential to the conservation of the species because it supports habitat that is necessary for the establishment of additional populations in order to reach recovery goals.

Hawaii 26—*Melicope zahlbruckneri*—b [495 ha (1,224 ac)]: This unit contains portions of Kipuka Puaulu and Kipuka Ki and lies completely within the Kapapala watershed and within HVNP. The unit provides habitat for 2 populations of 100 individuals of *M. zahlbruckneri* and is currently occupied by 31 to 36 individuals. This unit is essential to the conservation of *M. zahlbruckneri* because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable.

Primary Constituent Elements/Physical or Biological Features

Habitat features that are essential for this species include, but are not limited to, *Acacia koa*-*Metrosideros polymorpha* dominated montane mesic forest.

Special Management Considerations or Protections

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for this species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (inferred from USFWS, 2015)

Lifespan

Adult: > 10 years (USFWS, 2015)

Reproduction Narrative

Adult: *Melicope zahlbruckneri* is a long-lived perennial. Very few seeds are produced by *M. zahlbruckneri* and germination is extremely low (Hawaii Volcanoes National Park 2010) (USFWS, 2015).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Koa-ohia montane mesic forest (USFWS, 1998)

Geographic or Habitat Restraints or Barriers

Adult: 3,920 - 4,265 ft. elevation (USFWS, 1998)

Habitat Narrative

Adult: Inhabits moist and wet forests on old volcanic ash deposits and lava flows (NatureServe, 2015). This species is found in koa- and ohia-dominated montane mesic forest at elevations between 1,195 and 1,300 meters (3,920 and 4,265 feet) (HHP 1991c2; HPCC 1991d; Stone et al. 1990) (USFWS, 1998).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Decreasing (USFWS, 2015)

Resiliency:

Low (inferred from USFWS, 2008)

Redundancy:

Low (inferred from USFWS, 2015)

Number of Populations:

3 (inferred from USFWS, 2015)

Population Size:

25 wild, 38 reintroduced (USFWS, 2015)

Population Narrative:

Overall, the numbers of individuals have decreased from the 35 wild individuals reported in the previous 5-year review to approximately 25 wild individuals in 2015. There are two reintroduced populations containing approximately 38 individuals (USFWS, 2015).

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: This species is threatened by volcanic activity (NatureServe, 2015). Current threats include competition from invasive introduced plant species, including *Ehrharta stipoides* (meadow ricegrass), *Paspalum conjugatum* (Hilo grass), *Paspalum dilatatum* (dallis grass), *Psidium cattleianum* (strawberry guava), and *Hedychium* sp. (ginger) (USFWS, 2008).

Stressor: Predation (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Native Lepidoptera caterpillars (*Prays* spp.) have been found to destroy the few seeds that are produced by *M. zahlbruckneri* (Hawaii Volcanoes National Park 2010) (USFWS, 2015). Rats (*Rattus rattus*) strip the bark, eat seeds, and chew holes in the flowers for nectar. Japanese white-eye birds (*Zosterops japonicus*) rob nectar. *Melicope zahlbruckneri* is also threatened by two-spotted leafhoppers and slugs (USFWS, 2008).

Stressor: Fire (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Not available

Stressor: Small population size (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Species like *Melicope zahlbruckneri* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes and volcanic activity (USFWS, 2008).

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Not available

Recovery**Reclassification Criteria:**

1. A total of five to seven populations should be documented on the Big Island (USFWS, 1998).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population (for long-lived perennials) (USFWS, 1998).

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1998).

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on the Big Island (USFWS, 1998).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population (for long-lived perennials) (USFWS, 1998).

3. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1998).

Recovery Actions:

- Protect current populations and manage threats (USFWS, 1998).
- Conduct essential research (USFWS, 1998).
- Expand existing wild populations, as necessary (USFWS, 1998).
- Create new populations within historical range, as necessary (USFWS, 1998).
- Evaluate and validate recovery objectives (USFWS, 1998).
- Survey and construct protective fencing around the new population at Laupahoehoe (USFWS, 1998).
- Control of insect damage (USFWS, 1998).
- Reduce threats from rodent predation (USFWS, 1998).
- Outplant new populations in areas of reduced threat (USFWS, 1998).

Conservation Measures and Best Management Practices:

- Surveys / inventories – Survey geographical and historical range for a current assessment of the species' status (USFWS, 2015).
- Captive propagation for genetic storage and reintroduction – Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range (USFWS, 2015).
- Ungulate monitoring and control – Maintain existing fences and fence remaining populations to protect them from the impacts of feral ungulates (USFWS, 2015).
- Invasive plant monitoring and control – Eradicate invasive introduced plants within ungulate exclosures and maintain exclosures free of invasive plants (USFWS, 2015).
- Population viability monitoring and analysis – Continue monitoring wild and reintroduced individuals (USFWS, 2015).
- Alliance and partnership development – Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2015).

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SPECIES ACCOUNT: *Mentzelia leucophylla* (Ash Meadows blazingstar)

Species Taxonomic and Listing Information

Listing Status: Threatened; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A biennial herb, up to 5 dm high. The leaves are densely covered with soft white hairs. Bright yellow flowers bloom from late May into September. Flowers open only for brief periods in late afternoon. (NatureServe, 2015)

Taxonomy

Possibly a variant of *M. oreophila* per Jim Morefield, NVHP. (NatureServe, 2015)

Current Range

Western slope and bajadas of mountain range in Ash Meadows, south Nye County, Nevada. (NatureServe, 2015)

Critical Habitat Designated

Yes; 5/20/1985.

Legal Description

On May 20, 1985, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Mentzelia leucophylla* (Ash Meadows blazingstar) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Nevada (50 FR 20777-20794).

Critical Habitat Designation

The critical habitat designation for *Mentzelia leucophylla* includes one CHU in Nye County, Nevada (50 FR 20777-20794).

Nevada, Nye County, Ash Meadows.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Mentzelia leucophylla* critical habitat consists of one component (50 FR 20777-20794):

Known primary constituent elements include sandy or saline clay soils along canyon washes and near springs and seeps.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 1990)

Breeding Season

Adult: Flowering continues from June to September (USFWS, 1990)

Other Reproductive Information

Adult: Flowering is exhibited by bright yellow flowers arranged in open, broad inflorescences (USFWS, 1990)

Reproduction Narrative

Adult: The Ash Meadows Blazingstar is inferred to reproduce sexually. Its flowering season occurs from June to September. Flowers are bright yellow, arranged in open and broad inflorescences (USFWS, 1990).

Habitat Type

Adult: Desert wetland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Springs and seeps that are fed by an extensive groundwater system; light-colored, fine-grained soils with a high salt content (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Local distribution of small populations (USFWS 1990)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS 1990)

Habitat Narrative

Adult: This species inhabits desert wetland, near springs and along canyon washes maintained by springs and seeps that are fed by an extensive groundwater system. Found in light-colored, fine-grained soils with a high salt content, often growing with 2 other narrowly endemic plants: the Ash Meadows milk-vetch (*Astragalus phoenix*) and the Ash Meadows sunray (*Enceliopsis nudicaulis* var. *corrugata*) (NatureServe, 2015). The species is distributed locally in small populations. Tolerance ranges are inferred to be low (USFWS, 1990).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Little or no information exists on seed dispersal, seed germination, or seedling establishment in the wild. Additional dispersal/migration information is also lacking (inferred from USFWS, 1990).

Population Information and Trends**Number of Populations:**

1 - 5 (NatureServe, 2015)

Population Narrative:

There is little information about population level and species level trends. In 1997 there were 8 known populations, but the current population number estimate has been reduced to 1-5 populations (NatureServe, 2015).

Threats and Stressors

Stressor: Habitat disruption (USFWS 1990)

Exposure:

Response:

Consequence:

Narrative: Approximately 65 miles of gravel and unimproved roads now exist within the essential habitat, directly affecting this species (USFWS, 1990)

Stressor: Agricultural use (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: Agricultural use presents a general threat to this species (NatureServe, 2015)

Stressor: Trampling by horses, cattle, and sheep (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: Destruction by horses presents a general threat to this species (NatureServe, 2015)

Stressor: Proposed MX missile system (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: The proposed MX missile system is considered to be a possible threat to this species (NatureServe, 2015)

Recovery

Reclassification Criteria:

None listed

Not available

Not available

Not available

Not available

Not available

Not available

Delisting Criteria:

1. All non-native animals and plant species must be eradicated from essential habitat. These non-native species currently include sailfin mollies, mosquitofish, largemouth bass, black

bullheads, bullfrogs, crayfish, turban snails, wild horses, salt cedar and Russian olive (USFWS, 1990).

2. Secure and protect the Ash Meadows aquifer so that all spring flows return to historic discharge rates, and the water level in Devils Hole is maintained at a minimum level of 1.4 feet below the copper washer (USFWS, 1990).

3. Reestablish water to historic springbrook channels, which are free of barriers that eliminate genetic exchange between populations by preventing movement of native fishes throughout their historic range (USFWS, 1990).

4. The essential habitat must be secure from detrimental human disturbance including mining, OHVs, and the introduction of non-native species (USFWS, 1990).

5. Secure, protect, and maintain in natural vegetation, corridors, and adjacent buffer areas for gene flow and dispersal of listed plant species within the essential habitat (USFWS, 1990).

6. Native plant communities and aquatic communities have been reestablished to historic structure and composition within all essential habitats (USFWS, 1990).

7. All of the listed plant species and the candidate plant species are present in all the sites that they have historically occupied as identified in Appendix A Table XV of the Recovery Plan. Within each critical habitat unit, the listed plant has a frequency value equal to or greater than the frequency value determined by Task 644 needed as an indicator of a self-sustaining plant population (USFWS, 1990).

Recovery Actions:

- Secure habitat and water sources for the Ash Meadows ecosystem (USFWS, 1990)
- Conduct research on the biology of the species (USFWS, 1990)
- Conduct management activities within essential habitat (USFWS, 1990)
- Reestablish populations/monitor new & existing populations (USFWS, 1990)
- Determine/verify recovery objectives (USFWS, 1990)

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SPECIES ACCOUNT: *Mezoneuron (=Caesalpinia) kavaense* (Uhi uhi)

Species Taxonomic and Listing Information

Listing Status: Endangered; 07/08/1986; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Caesalpinia kavalensis is a medium-sized tree up to 10 meters (35 feet) tall with rough, dark bark and a spreading crown. The leaves are twice compound, made up of 1 to 5 pinnae with 4 to 8 pairs of leaflets. Each leaflet is about 4 cm (1.5 in) in length. The flowers are borne in terminal racemes and are pink to red in color. The pink seed pods are short (9 to 13 cm or 3.5 to 5.1 in) and broad (4.5 to 6 cm or 1.8 to 2.4 in) and winged on one side. These pink pods, the bright flowers and bright green lacy foliage combine to make this an attractive tree (Rock 1913 and Wagner et al. 1990). (USFWS, 1994)

Taxonomy

Mezoneuron kavaense is a synonym, referring to the totality of the taxon *Caesalpinia kavaense*. The change of the name back to *Caesalpinia kavajensis* does not indicate any ambiguity of identification of this Hawaiian species, as it is distinctly different from other *Caesalpinia* in Hawaii. The name change follows the opinion of Hattink (1974) that all members of the genus *Mezoneuron* properly belong within *Caesalpinia*. The most widely used common name for *Caesalpinia kavajensis* is the Hawaiian, uhiuhi. On Maui it is also known as kea. Wagner et al. (1990) and Lamoureux (1982) also list kalamona as a native name, but Rock (1913) says that this is the common name for an introduced *Cassia* species, not *Caesalpinia kavajensis*. (USFWS, 1994)

Historical Range

Caesalpinia kavaense occurs or has occurred on dry leeward portions of five of the main Hawaiian Islands which includes Hawaii, Maui, Oahu, Kauai, and Lanai. (USFWS, 1994)

Current Range

Endemic to Hawaiian Islands. Its current range includes Kauai, Waianae Mountains of Oahu, and Hawaii. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Some isolated trees produce viable seed, showing that the species is capable of self-pollination, e.g. the single living wild tree on Kauai. Some wild trees and some cultivated trees regularly produce a good quantity of viable seeds. Seeds germinate in nature and can be germinated in nurseries. However, some isolated trees that flower apparently do not produce viable seed. The tree growing in the Botany Department Courtyard, University of Hawaii at Manoa, has been found to produce normal pollen, but has never set seed. It is not known what

kinds of barriers to self-pollination, if any, may be responsible for this failure (Lamoureux 1982). (USFWS, 1994)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland, shrubland/chaparral (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Occurs between 14 and 18 degrees Celsius (USFWS, 1996)

Habitat Narrative

Adult: *Caesalpinia kawaiiensis* occurs in dry and moist forests and shrublands on gulch slopes and, on Hawaii, on old lava flows. Historically, *Caesalpinia kawaiiensis* has occurred between about 60 meters (200 ft) and approximately 900 meters (3000 ft) elevation. The general slope is 5 to 10 degrees. The substrate is mostly rough a'a lava covered by a thin and discontinuous layer of organic soil (Sato et al. 1973, Lamoureux 1981). The steep slope and rugged volcanic features of the landscape impede passage on the ground. The rainfall in this area is about 75 to 100 cm (30 to 40 in) a year, with no pronounced wet and dry seasons (Blumenstock and Price 1961). Air temperature also fluctuates little during the year, with mean monthly temperatures varying between 14 and 18 degrees Celsius (Lamoureux 1982). The moderate rainfall and high insolation in combination with the shallow, excessively drained, soil provides a dry habitat where moisture is probably frequently limiting. (USFWS, 1994; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: The broad, winged pod suggests that the seeds are dispersed by a combination of gravity and wind. Seeds may also be dispersed by ingestion by birds (Lamoureux 1982) or introduced mammals. (USFWS, 1994)

Population Information and Trends**Population Trends:**

Short-term trends indicate slight increases (USFWS, 2015)

Resiliency:

Low (inferred from USFWS, 2015)

Redundancy:

Low (inferred from USFWS, 2015)

Population Growth Rate:

Slight increase (USFWS, 2015)

Number of Populations:

11 (USFWS, 2015)

Population Size:

99 wild, 535 reintroduced (USFWS, 2015)

Population Narrative:

There are approximately 11 occurrences containing 99 wild individuals (77 mature and 22 immature) and 535 reintroduced individuals (6 mature and 529 immature) of *Mezoneuron kavaense* on Kauai, Oahu, Lanai, and Hawaii. Overall, the numbers of individuals have increased from the approximately 70 to 80 individuals reported in the previous 5-year review to approximately 99 mature wild individuals in 2015. The numbers of reintroduced individuals have also increased from the approximately 149 individuals reported in the previous 5-year review to approximately 535 individuals in 2015. (USFWS, 2015)

Threats and Stressors

Stressor: Grazing and browsing by ungulates (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Rock (1913), Degener (1946) and others recognized that the rapid disappearance from North Kona of *Caesalpinia kavaensis* and *Kokia drynarioides* was mostly due to forest destruction and community disintegration as a result of cattle ranching in the dry forest. Nearly all of the habitat on the island of Hawaii is or has until recently been managed for commercial cattle production. Seedlings and saplings of both species are highly palatable to cattle. Feral goats and sheep also live in this habitat. On Oahu, Maui and Kauai, feral goats have unrestricted access to the *Caesalpinia kavaensis* habitat (Lamoureux 1982) and the Lanai individual may also be subject to browsing by Axis deer (*Axis axis*) and Mouflon sheep (*Ovis musimon*). It is unlikely that either species can recover while subjected to such grazing. (USFWS, 1994)

Stressor: Fountain grass invasion and enhanced fire danger (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Today the most devastating factor within the dry forest habitat of these two species on the island of Hawaii is the invasion by fountain grass that has occurred during this century, resulting in its complete domination of the groundcover in the dry forest habitat of North Kona. Fountain grass has two major negative impacts on the community: the promotion of fire and usurpation of native plant habitat. Fountain grass is a fire-adapted bunch grass that enhances fuel-loading and promotes fire (Tunison in press). Unlike most other alien grasses, fountain grass can invade barren lava flows that were not formerly subject to wildfire. Major fires burned through Puuwaawaa Ranch in 1986 and 1988. Trees of both species, as well as other native dry forest species, were completely eliminated from the burned areas in these fires. Wildfire also burned a major portion of the boundary kipuka section of the *Kokia drynarioides* critical habitat in May, 1993, killing an estimated 80% of the *Kokia drynarioides* and *Caesalpinia kavaensis* found there (L. Mehrhoff, personal communication 1993). The establishment of a closed layer of fountain grass completely alters the structure of the vegetation at these formerly bare-lava sites. The competitive interactions of fountain grass with native tree seedlings have not been scientifically studied, but it is believed that the fountain grass has an adverse effect on seedlings

of *Caesalpinia kavalensis* and *Kokia drynarioides* as well as other native woody plants in these communities (Lamoureux 1981, 1982). Upon the removal of fountain grass from protected exclosures on Bishop Estate land, numerous *Kokia drynarioides* seedlings have been observed next to a fallen adult tree (Steve Bergfeld, Division of Forestry and Wildlife, personal communication 1991), and five *Caesalpinia kavalensis* seedlings survive where fountain grass was removed from under an adult tree inside a DOFAW exclosure. (USFWS, 1994)

Stressor: Other alien plants (USFWS, 1994; USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Many other alien plants are naturalized in the North Kona habitat. Two that are widespread and disruptive are lantana (*Lantana camara*) and silk oak (*Grevillea robusta*). Two cultivated plants that have become established locally on the cinder cone of Puuwaawaa itself are the custard apple (*Annona cherimola*) and *Pittosporum viridiflorum* (Takeuchi 1990). Takeuchi cautions that if fountain grass is controlled in the future, these or other alien plants may increase in cover and become serious pests. The subpopulation at Puupane, Oahu, is being shaded and crowded by Australian red cedar (*Toona ciliata*) (J. Obata, personal communication 1992) and both the Makaleha and Puupane populations are surrounded by stands of Christmasberry and Strawberry guava (*Psidium cattleianum*). The Makaleha population is also bordered on one side by *Lantana camara*. The reintroduced population on Lanai is threatened by *Ageratina adenophora* (Maui pamakani), *Ageratina riparia* (Hamakua pamakani), *Buddleja asiatica* (dog tail), *Cinnamomum burmannii* (Padang cassia), *Leptospermum scoparium* (New Zealand tea tree), *Morella faya* (fire tree), and *Rubus rosifolius* (Plant Extinction Prevention Program [PEPP] 2013, 2015a, b). (USFWS, 1994; USFWS, 2015)

Stressor: Land ownership/land use classification (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: The critical habitat of *Kokia drynarioides* and the surrounding areas of Kaupulehu and Puuwaawaa ahupuaa that contain several *Caesalpinia kavalensis* trees do not have protective state or county zoning. All or nearly all of the land has a State Land Use Classification (LUC) of Agriculture, and much of it is actively managed for commercial ranching. This lack of protective zoning is somewhat alleviated by the Hawaii endangered species law which gives jurisdiction to the Department of Forestry and Wildlife (DOFAW) to manage endangered plant populations. (USFWS, 1994)

Stressor: Insect damage (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: The alien black coffee twig borer (*Xylosandrus compactus*) attacks and may kill *Caesalpinia kavalensis* seedlings (Lamoureux 1982). *Xylosandrus* attacks on outplanted seedlings in North Kona have been observed but no deaths have been attributed to them (S. Bergfeld personal communication 1991). Damage from *Xylosandrus* may be far more serious on Oahu. Based on observations over a 20 year period, J. Obata (personal communication 1992) attributes the marked decline of this previously “widespread” species on Oahu to a combination of the twig

borer and drought. DOFAW staff report (C. Corn, personal communication 1993) that ants farming aphids are one of the biggest threat to the survival of outplanted *C. kavaensis* seedlings in North Kona. No insect predators of *Kokia drynarioides* are reported (Lamoureux 1981), but *Xylosandrus* is known to kill other species, apparently through the introduction of a fungus (L. Wong, personal communication 1993), and may be a threat to *Kokia drynarioides*. (USFWS, 1994)

Stressor: Seed predation (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Predation of seeds of both species by introduced rats, mice and unspecified game birds and invertebrates is well known. Rats eat the seeds of both species while they are still on the tree (Lamoureux 1981, 1982). The large, hard, bean-like seeds of *Caesalpinia kavaensis* have been found in rat burrows (Lamoureux 1982) as have the seed coats of *Kokia drynarioides* (Derral Herbst, U.S. Fish and Wildlife Service, personal communication 1992). The importance of seed predation has not been scientifically assessed. (USFWS, 1994)

Stressor: Genetic problems (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Since the numbers of individuals of both of these two species are very low, it is possible that each species' viability may be reduced due to problems with in-breeding and the depleted gene pool. At this time, it appears that both species produce viable seeds that grow normally when protected. If *Kokia drynarioides* are grown in botanical gardens near other *Kokia* species from other islands, it is possible that cross-pollination leading to hybridization may take place. Such mixing of the gene pools should be avoided by keeping careful records of provenance. It is unlikely that *Caesalpinia kavaensis* will inadvertently hybridize with any available species. (USFWS, 1994)

Stressor: Destruction by volcanic eruption (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: The North Kona populations of these two species occur in a relatively restricted area on the side of a dormant volcano that last erupted about 1800 AD. A future eruption could threaten these wild populations. (USFWS, 1994)

Stressor: Illegal harvests of *Caesalpinia kavaensis* (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: The dark, dense wood of *Caesalpinia kavaensis* is prized by a few knowledgeable craftsmen (Lamoureux 1982). The few remaining wild trees are considered at some risk to illegal harvesting (Herbst 1986). (USFWS, 1994)

Stressor: Drought (USFWS, 1994)

Exposure:

Response:**Consequence:**

Narrative: The North Kona area has experienced drought conditions for several years, and if these two species reproduce only in widely spaced times of favorable climactic conditions, the prolonged drought could be a factor in their recent decline. It is also possible that the drought conditions have exacerbated the insect infestation problems because dry vegetation is more susceptible to such invasion (C. Corn, personal communication 1993). (USFWS, 1994)

Stressor: Instability of substrate (USFWS, 1994)

Exposure:**Response:****Consequence:**

Narrative: Because of past habitat destruction, current *Caesalpinia kavalensis* populations on Oahu are now limited to steep, inaccessible terrain which is subject to frequent rock slides which damage the trees. Feral goats in these areas add to the landslide problem by dislodging rock and soil, and by browsing on stabilizing ground cover (C. Corn, personal communication 1993). (USFWS, 1994)

Stressor: Landslides and flooding (USFWS, 2015)

Exposure:**Response:****Consequence:**

Narrative: Landslides and flooding loss or degradation of habitat – Erosion is a threat to this species on Oahu (PEPP 2010), Kauai (PEPP 2013), and Lanai (PEPP 2015b). (USFWS, 2015)

Stressor: Slug herbivory (USFWS, 2015)

Exposure:**Response:****Consequence:**

Narrative: On Lanai, herbivory by slugs were reported as a threat (PEPP 2015b). (USFWS, 2015)

Stressor: Invertebrate predation or herbivory (USFWS, 2015)

Exposure:**Response:****Consequence:**

Narrative: The white fly (unknown species) and cottony cushion scale (*Icerya purchasi*) are a threat to this species in North Kona and may lead to the death of young plants if not controlled (J. Wagner, Future Forests Nursery, pers. comm. 2015). (USFWS, 2015)

Recovery**Reclassification Criteria:**

1. There are a minimum of 100 naturally reproducing individuals in each of 3 secure populations of each species in North Kona. (USFWS, 1994)
2. When there are three *Caesalpinia kavaensis* populations, each with a minimum of 100 naturally reproducing individuals, on each of Oahu, Lanai, Kauai and Maui. (USFWS, 1994)

Delisting Criteria:

Delisting criteria are not available.

Recovery Actions:

- Current habitat of *Caesalpinia kavaensis* and *Kokia drynarioides* should be protected through cooperative agreements with landowners, and threats to current populations should be controlled. (USFWS, 1994)
- Implementing the management plan will require further research to identify and characterize the environmental threats that are preventing natural regeneration of these two species and to develop management techniques. It is suggested that all dry forest endangered species research be coordinated and contracted through a single office in order to maximize information sharing among researchers and to avoid duplication of efforts. (USFWS, 1994)
- The increase in numbers of these two species should be enhanced by special care and treatment of seeds and seedlings within the management sites. When possible, the present practice of outplanting nursery-raised seedlings should be de-emphasized for two reasons: 1) increasing numbers by outplanting will not reduce the environmental factors that are responsible for endangerment; and 2) nursery-raised stock may carry insects or pathogens into the natural population. Recruitment from seeds collected on the site or from nearby trees should be promoted by management techniques developed through research. Techniques might include barriers to discourage seed predation, drip irrigation systems, placement of seeds in select microhabitats, and shelters or other features to reduce evapotranspiration. Augmentation through transplant of nursery raised stock may be necessary in areas where only a few or no mature individuals remain. (USFWS, 1994)
- Establish new populations. In order to reach the delisting goals of 3 populations of each species on Hawaii island and 3 populations of *Caesalpinia kavaensis* on Oahu, Lanai, Kauai and Maui, new populations of *Caesalpinia kavaensis* will have to be established on Lanai, Kauai and Maui within the historical range of the species. (USFWS, 1994)
- An important role for research is to verify the scientific validity of the stated recovery objectives in this plan. (USFWS, 1994)

Conservation Measures and Best Management Practices:

- Survey geographical and historical range for a current assessment of the species' status. (USFWS, 2015)
- Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change. (USFWS, 2015)
- Maintain existing exclosures and monitor for potential incursions. (USFWS, 2015)
- Eradicate invasive introduced plants within ungulate exclosures and maintain exclosures free of invasive plants. (USFWS, 2015)
- Continue monitoring wild and reintroduced individuals. (USFWS, 2015)
- Develop and implement a fire management plan for all existing exclosures. (USFWS, 2015)
- Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. (USFWS, 2015)
- Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2015)

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SPECIES ACCOUNT: *Mimulus michiganensis* (Michigan monkey-flower)

Species Taxonomic and Listing Information

Listing Status: Endangered; Great Lakes-Big Rivers Region (R3) (USFWS, 2015)

Physical Description

The Michigan monkey-flower is a member of the Scrophulariaceae (snapdragon) family and is an aquatic to semi-aquatic glabrous perennial herb with lax stems averaging 36 cm (14 in) in length. It roots at its lower stem nodes to produce clones of up to several hundred stems. The broadly ovate to roundish, opposite leaves are inconspicuously to coarsely sharp-toothed and evenly distributed along the stem. Bright yellow, snapdragon-like, tubular flowers, ranging from 16 to 27 mm (0.6 to 1.1 in) in length, are produced from the upper leaf axil and are borne on slender pedicels that may be longer than the leaves. The flowers have two upper lips and three-lobed lower lips, with the lower lip and tube irregularly spotted.

Taxonomy

Direct final rule (revised the scientific name from *Mimulus glabratus* var. *michiganensis* to *Mimulus michiganensis*) effective December 13, 2010. (USFWS, 2018).

Current Range

There are 19 element occurrences, including two historical occurrences (MNFI 2012) of MMF, ranging from Benzie and Leelanau counties to Mackinac County (Figure 3 and Appendix A). However, the majority of occurrences are clustered within the Mackinac Straits region. The newest colony was discovered in 2008 (MNFI 2012). Overall, the entire population is stable, although MMF colonies at a few sites are in decline (MNFI 2012). However, this information was obtained from records in which most have not been updated in more than 10 years (MNFI 2012). A systematic survey would provide a more accurate description of MMF abundance and population trends.

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Breeding Season

Adult: bloom from approximately mid-June to mid-August, extending occasionally into October.

Reproduction Narrative

Adult: Michigan monkey-flowers bloom from approximately mid-June to mid-August, extending occasionally into October. The fruit, which is seldom produced, consists of an oblong, pointed capsule around 8–10 mm (0.3–0.4 in) long, containing numerous oval seeds with longitudinal striations. Michigan monkey-flower essentially has no pollen viability and is nearly totally dependent on vegetative propagation via rhizomes (Bliss 1983, Bliss 1986). The Maple River population is the only population that has viable pollen and is capable of self-pollination (Posto and Prather 2000, Posto 2001). The taxon as a whole is also highly unlikely to produce seed

asexually (Posto and Prather 2000). Because MMF depends primarily on vegetative propagation for reproduction, dispersal is greatly limited and likely occurs only locally through the fragmentation of clonal colonies.

Habitat Type

Adult: Alkaline spring seepages and streams

Habitat Narrative

Adult: Michigan monkey-flower is a very rare Michigan endemic that is restricted to cold, alkaline spring seepages and streams, usually in association with northern white cedar (*Thuja occidentalis*) swamps found along current or post-glacial Great Lakes shorelines. It frequently occurs in cedar swamps formed in drainages found at the base of relatively steep, moraine slopes and bluffs. Colonies of MMF have been found in muck-covered sand in cold, flowing water that ranged in temperature from 8.7° to 16.6°C (47.6° - 61.9°F), and with a pH of 7.66 to 8.21. However, research (Posto 2001) has shown that MMF seeds germinate best in light at approximately 23°C, suggesting that seed germination is probably highest along the water margins in the sun, rather than under water. Optimal habitat conditions for this plant are comprised of a combination of moderate to high light availability, cool substrate, and high nutrient availability within a narrow pH range, demonstrating its relatively specialized habitat requirements.

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Increasing (USFWS, 2018).

Number of Populations:

19. As of 2018: Currently, there are 23 known extant populations and less than half of the populations are high-ranking and protected. (USFWS, 2018).

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

There are 19 element occurrences, including two historical occurrences (MNFI 2012) of MMF, ranging from Benzie and Leelanau counties to Mackinac County (Figure 3 and Appendix A). However, the majority of occurrences are clustered within the Mackinac Straits region. The newest colony was discovered in 2008 (MNFI 2012). Overall, the entire population is stable, although MMF colonies at a few sites are in decline (MNFI 2012). However, this information was obtained from records in which most have not been updated in more than 10 years (MNFI 2012). A systematic survey would provide a more accurate description of MMF abundance and population trends. Occurrences of Michigan monkey-flower are often localized, sometimes consisting of small but dense patches restricted to small seeps, springs, and depressions, whereas others are comprised of numerous patches of plants widely dispersed along small streams and spring-fed seeps within northern white cedar swamps (Penskar and Higman 2001). Large to moderately-sized populations include occurrences on Glen Lake, Burt Lake, and

portions of the Mackinac County shoreline within the Manitou Payment Highbanks formation in the Brevort to Epoufette region (Penskar and Higman 2001). Relatively little population monitoring has been conducted for MMF, and thus the demography of its populations cannot be characterized. However, observations of colonies of the taxon through summer and winter seasons indicate that in fall colonies die back and become more or less dormant in streams and springs where water flow and temperature stay relatively constant, with colonies re-initiating growth in spring. Occurrences of Michigan monkey-flower are often localized, sometimes consisting of small but dense patches restricted to small seeps, springs, and depressions, whereas others are comprised of numerous patches of plants widely dispersed along small streams and spring-fed seeps within northern white cedar swamps (Penskar and Higman 2001). Large to moderately-sized populations include occurrences on Glen Lake, Burt Lake, and portions of the Mackinac County shoreline within the Manitou Payment Highbanks formation in the Brevort to Epoufette region (Penskar and Higman 2001).

Threats and Stressors

Stressor:

Exposure:

Response:

Consequence:

Narrative: The greatest threat to MMF is direct destruction and modification of its habitat. Michigan monkey-flower's habitat has been developed for recreational and residential purposes, which has led to severe impacts to and, in some cases, extirpation of historical populations. Hydrological disruptions also constitute a serious threat, as water diversion, warming of water sources, and other groundwater alterations lead to less than optimal habitat conditions. Consequently, this species may be inadvertently impacted by offsite activities. Populations of MMF are particularly vulnerable to extirpation due to low numbers and limited capability for sexual reproduction. Additionally, periodic high water levels of the Great Lakes and strong winter storms impact MMF habitat that occurs near the Great Lakes shoreline by redirecting seepage streams and opening the overstory by felling cedars. However, opening of the overstory may also benefit MMF by allowing for colonization. Invasive species, such as coltsfoot (*Tussilago farfara*) and reed canary grass (*Phalaris arundinacea*), represent an additional threat. Coltsfoot (Figure 2) is a very aggressive invasive plant growing within several MMF patches in the Glen Lake area (Jody Marquis, Mama Bear Restorations, Inc., pers. comm. 2010). It spreads rapidly via vegetative reproduction by rhizomes and windborne distribution of dandelion-like seed heads. The Glen Lake area provides habitat to several high-ranking MMF colonies and without intervention and control of coltsfoot, localized extirpations are likely. Reed canary grass, although not a current threat to MMF colonies, is present in the vicinity. Control of reed canary grass when it is not yet considered a threat, is most successful at this stage, and minimizes its chances of negatively impacting MMF in the Glen Lake area. (USFWS, 2016). Additional invasive plant threats posed by marsh thistle (*Cirsium palustre*) and Canada thistle (*Cirsium arvense*). (USFWS, 2018).

Stressor: Climate change

Exposure:

Response:

Consequence:

Narrative: Our analyses under the Endangered Species Act include consideration of ongoing and projected changes in climate. The terms "climate" and "climate change" are defined by the

Intergovernmental Panel on Climate Change (IPCC). “Climate” refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007). The term “climate change” thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007). Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative and they may change over time, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables (e.g., habitat fragmentation) (IPCC 2007). In our analyses, we use our expert judgment to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change. Climate change models predict the climate of the Great Lakes region will grow warmer and drier over the next century, with precipitation increasing in winter and decreasing in summer (AMEC 2006; Anton Reznicek, University of Michigan, pers. comm. 2004; Kling et al. 2003). Average temperatures in the Great Lakes region could increase by 3 to 7°C in winter and 3 to 11°C in summer by the year 2100. While average annual precipitation could increase by 10–20 percent, significant changes in the seasonal precipitation cycle are likely, with winter and spring rain increasing and summer rain decreasing by up to 50 percent (Kling et al. 2003). A warmer, drier summer will affect surface and groundwater levels, as well as soil moisture, which is projected to decrease by 30 percent in summer (Kling et al. 2003). Earlier models had indicated that increased precipitation, higher air temperatures, and reduced ice cover would increase evaporation in the Great Lakes, resulting in lake level drops of 1.5 feet to as much as 8 feet (Sousounis and Glick 2000, AMEC 2006, Kling et al. 2003). However, more recent models show a more variable response in lake levels. A majority of the model simulations run by Angel and Kunkel (2010) resulted in reductions in lake levels, yet also showed a high degree of uncertainty in possible future lake levels, depending on future emissions. Furthermore, Hayhoe et al. (2010) suggested that the competing effects of shifting precipitation and warmer temperatures will result in little change in Great Lakes levels until the end of the century, when net decreases in lake levels are expected under higher emission scenarios. A warmer climate will also likely cause an increase in water temperatures that may facilitate the invasion of warm water-adapted species or exotic species (MacIsaac et al. 2002; AMEC 2006). Increased water temperatures will also result in decreased ice cover and, when combined with an expected intensity of winter storms, will leave coastal areas more vulnerable to the effects of winter storms and flooding (Fang and Stefan 2000, AMEC 2006). Additionally, AMEC (2006) predicts that increased precipitation will increase the flow rates of some rivers and streams, resulting in increased scouring, deposition of sediment, nutrients and pesticides, bank erosion, channel widening, and siltation of gravel beds and estuaries. Thus, climate change could significantly alter the natural stream morphology and likely make the habitat unsuitable for this Michigan endemic.

Stressor: Predation (USFWS, 2018).

Exposure:

Response:

Consequence:

Narrative: The NPS at Sleeping Bear Dunes National Lakeshore (Jennifer Chaffin, NPS pers. commun. 2011) observed evidence of deer browse in the past and, more recently, evidence of insect browse on Michigan monkey-flower plants in the vicinity of their Orr Restoration Site. The average insect browse in 2011 was three percent for the whole Michigan monkey-flower

population within the restoration site while deer browse prior to 2011 was observed to be as much as 25 percent (Chaffin, pers. commun. 2011). (USFWS, 2018).

Recovery

Recovery Actions:

- The Michigan Monkey-flower Recovery Plan was approved on September 17, 1997 (USFWS 1997). The objective of the recovery plan is to secure long-term protection for all occurrences of MMF, thereby allowing reclassification, and ultimately, removal from the Federal List of Endangered and Threatened Wildlife and Plants. Michigan monkey-flower may be considered for reclassification from endangered to threatened status when protection is secured for all eight occurrences ranked “A - excellent” or “B - good” and delisted when all occurrences are sufficiently protected. The recovery goals listed in the recovery plan are: (1) long-term protection for all known existing occurrences, with primary emphasis on the preservation of essential habitat; (2) field surveys for new occurrences and to determine the specific status of recently discovered and historical sites; (3) biosystematics research to determine the most appropriate taxonomic classification, and; (4) demographic, physiological, breeding system, and genetic studies to understand population biology, specific habitat requirements, floral biology, and genetic variability, and long-term post-delisting viability monitoring.
- New in 2018 - 1: Develop a plan for conducting regular surveys, assessments, and monitoring at all known extant and historical Michigan monkey-flower locations. Continue exploration for new occurrences in the Lower Peninsula and eastern Upper Peninsula, and provide detail mapping of all occurrences. Document habitat and status conditions and population trends during these assessments. Recovery plan action numbers: 2-21, 2-22, 2-23, 2-45 ☐ Penskar (2012) was not able to access the Manitou Payment Highbanks occurrence due to a lack of permission from the landowner, and the historical Mullet Lake-West Shore occurrence was not accessed due to insufficient time and resources. Both of these sites should be considered priorities for future surveys. (USFWS, 2018).
- 2018 - 2: Research is needed to understand the genetic diversity within and between patches or populations. Recovery plan action number: 2-44 (USFWS, 2018).
- 2018 - 3: Research is needed to understand the genetic diversity within and between patches or populations. Recovery plan action number: 2-44 (USFWS, 2018).
- 2018 - 4: Work with public and private landowners, site managers, and other stakeholders to protect the species and its stream/seep habitat upstream, if possible. Acquire land containing occupied or suitable Michigan monkey-flower habitat. Recovery plan action numbers: 2-13, 2-15. (USFWS, 2018).
- 2018 - 5: Provide education and outreach to stakeholders and the public. Recovery plan action number: 1-121 (USFWS, 2018).
- 2018 - 6: Monitor approach of non-native species and control as appropriate. Recovery plan action number: N/A (USFWS, 2018).
- 2018 - 7: Evaluate if the fundamental recovery objective in terms of the number of previously known and newly discovered occurrences requiring long-term protection warrants revision. (USFWS, 2018).

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SPECIES ACCOUNT: *Mirabilis macfarlanei* (MacFarlane's four-o'clock)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/29/1979; Pacific Region (R1)

Physical Description

A herbaceous perennial with a deep-seated, thickened root. This species typically blooms from May through June. The bright pink flowers are conspicuous, up to 25 millimeters (1 inch) long by 25 millimeters (1 inch) wide. The flowers occur in inflorescences, which consist of a group of three to seven flowers subtended by a five-lobed involucre (saucer-shaped bract). The flowers are funnel-shaped with a widely expanding limb. Leaves are opposite, somewhat succulent, and broadly lanceolate to ovate. (USFWS, 2000)

Taxonomy

Mirabilis macfarlanei is a member of the four-o'clock family (Nyctaginaceae). It was first described in 1936 (Constance and Rollins 1936) from specimens collected along the Snake River Canyon. *Mirabilis macfarlanei* is morphologically similar to *Mirabilis greenei*, found in the Klamath region of California and Oregon. In contrast to *M. greenei*, *M. macfarlanei* has broader leaves and shorter, nearly round bracts (Constance and Rollins 1936). At least two other species of *Mirabilis* occur in the Pacific Northwest (*M. linearis* and *M. bigelovii* var. *retrorsa*), but these species do not overlap in distribution with *M. macfarlanei* (Hitchcock and Cronquist 1973). (USFWS, 2000)

Historical Range

M. macfarlanei was known from only three populations along the Snake River Canyon in Oregon (Hell's Canyon National Recreation Area) and the Salmon River Canyon in Idaho. (USFWS, 2000)

Current Range

Portions of the Snake, Salmon, and Imnaha river canyons in Wallowa County in northeastern Oregon, and adjacent Idaho County in Idaho. (USFWS, 2000)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual (USFWS, 2016); Sexual (USFWS, 2000)

Lifespan

Adult: > 20 years (based on observations of individual plants) (USFWS, 2000)

Breeding Season

Adult: Seeds are typically dispersed in June and July, and seed germination probably occurs in early spring. (USFWS, 2000)

Other Reproductive Information

Adult: Specific conditions required for germination and seedling survival are unknown (USFWS, 2000)

Reproduction Narrative

Adult: *Mirabilis macfarlanei* reproduces by seed, as demonstrated by the presence of seedlings with cotyledons and the documented survival of some of these seedlings in population monitoring studies (Kaye 1992). Vegetative reproduction by off-shoots beneath the soil surface also occurs. *M. macfarlanei* is primarily an outcrosser, but is able to produce a small proportion of one-seeded fruits through autogamy (self-pollination). Inflorescences bagged to exclude pollinators produced fewer fruits than open-pollinated inflorescences. Seed dispersal has not been studied, but apparently seeds fall to the ground and are transported by gravity and rain (Kaye 1992). Seed viability is low.; *Mirabilis macfarlanei* is a taprooted perennial that reproduces by seed, but also colonizes via long spreading rhizomes. Individual plants tend to produce a few to several hundred stems in clusters ranging up to about nine square meters in size (Callihan 1988). The species has been able to persist in areas historically grazed by livestock since the 1870's, and presently in poor ecological condition. Preliminary data suggests grazing may have a negative effect on plant height, but additional research is needed (Kaye 1995). The most serious consequences of livestock grazing are likely indirect, most notably habitat degradation. At one site in Idaho, the number of *M. macfarlanei* plants appears to be stable several years after a range fire. An increase in *Bromus tectorum*, however, suggests that habitat degradation is an ongoing problem. The underground stems of *M. macfarlanei* would survive most natural fires, especially since they would likely occur later in the summer, when the plant is dormant. Genetic studies (Barnes 1994; 1995; Wolf et al. 1994) have shown that measures of genetic diversity in *M. macfarlanei* were lower than for plants with a similar life history. The greatest level of gene flow occurred between populations that were 0.5 km apart. Levels of gene flow decreased as distances between populations increased.; ASEXUAL; Perfect; Predominantly outcrossing (NatureServe, 2015).

Habitat Type

Adult: River canyon slopes (USFWS, 2016)

Habitat Narrative

Adult: Gentle to very steep, open river canyon slopes. Aspects vary, but are usually southeast to west. Soils are often sandy and underlain by talus. *Mirabilis macfarlanei* occurs in river canyon habitats characterized by regionally warm and dry conditions. Precipitation occurs mostly as rain during the winter and spring. Sites are dry and open, or with scattered shrubs. Plants can be found on all aspects, but most often on southeast to western exposures. Slopes are often steep, but range to nearly flat. Plants can occur along any slope position. Soils vary from sandy to rocky. Talus rock often underlies the soil substrate and several sites are relatively unstable and prone to erosion. The associated vegetation is usually in early to mid-seral condition, and the grasslands are typically grazing modified versions of *Agropyron spicatum* communities. In a habitat analysis study conducted at a site in Oregon, the vegetation associated with a population of *M. macfarlanei* appeared to be influenced by aspect, soil development and topographic position, at least on a local scale (Kaye 1992). Nearby sites without *M. macfarlanei* had a higher number of weedy annual species, and more gentle slopes with deeper, more stable soils (USFWS, 2016).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Seeds apparently fall near the parent plant and are transported by gravity and rain water. It is possible that *M. macfarlanei* seeds may be dispersed by birds or mammals, but seed dispersal has not been studied for this species. No information exists on whether *M. macfarlanei* maintains a soil seed bank (USFWS, 2000)

Population Information and Trends**Population Trends:**

Stable (USFWS, 2016)

Number of Populations:

13 (USFWS, 2016)

Population Narrative:

Mirabilis macfarlanei occurs within the geographic area identified in the 2000 Recovery Plan: the Salmon, Snake, and Imnaha river canyons in Idaho and Oregon. The species occurs in 13 Element Occurrences (EOs), 9 in Idaho and 4 in Oregon. Land ownership is comprised of BLM, Forest Service, and private lands. Of the 13 EOs, 5 are located on BLM land, 1 is located on both BLM and private land, 4 are located on Forest Service land, 1 is located on both Forest Service and private land, and 2 are located solely on private land. Both the BLM and the Forest Service continue to conduct surveys for *Mirabilis macfarlanei*. The Forest Service conducted surveys in the Hells Canyon National Recreation Area, Wallowa-Whitman National Forest annually from 2007 through 2014. Approximately 4,700 acres of suitable habitat were surveyed over the 8 year period, with an average of nearly 600 acres per year. The BLM surveyed an average of approximately 1,000 acres of suitable habitat on BLM lands annually from 2010 through 2015. Despite these survey efforts, no new *M. macfarlanei* populations have been discovered since the last 5-year review in 2009. The BLM has established a new population of *Mirabilis macfarlanei* at the Lower Otto Creek Conservation area located on BLM land. The BLM worked cooperatively with a local private landowner to transplant approximately 25 rhizomes from private property to the Lower Otto Creek Conservation area in April 2015 (in accord with the FWS Section 7 Biological Opinion (dated July 22, 2011) prepared for the Shroyer Trail and Lower Otto Creek Conservation Area project). This population has not yet been counted as a new EO. Future monitoring will document the success of this transplanting. Monitoring data show an overall stable population trend for *Mirabilis macfarlanei*. In 2000, one of the action items identified in the *M. macfarlanei* Recovery Plan was to monitor population trends (U.S. Fish and Wildlife Service 2000). In 2007, the Service funded a project to synthesize and analyze monitoring data collected by the BLM between 1981 and 2004, and the Wallowa-Whitman NF from 2001 to 2006, and to provide a general review of the respective monitoring programs (Mancuso and Shepherd 2008). Among its results, analysis found no significant change in *M. macfarlanei* ramet abundance over the years at most monitored occurrences. *Mirabilis macfarlanei* forms colonies from an extensive lateral root system that can extend up to 10 meters (33 feet; Yates 2007). Clonal shoots emanating from the same root system are referred to as ramets. Collectively, these genetically identical ramets comprise a genet (or the individual plant). While this review acknowledged the impressive monitoring datasets, which included over 20 years of data

collection, it also included a set of recommendations to improve the efficiency and value of the BLM and Forest Service monitoring efforts. One of these recommendations was the development and implementation of a rangewide monitoring strategy (U.S. Fish and Wildlife Service 2007; U.S. Fish and Wildlife Service 2009). In response, a collaborative effort to develop and implement a new, standardized, rangewide monitoring program for *M. macfarlanei* was initiated in 2010. Development of the new monitoring program was guided by management objectives identified by the Service, the BLM, and the Forest Service. The overall purpose of the new monitoring plan is to provide more comprehensive documentation and a better understanding of the rangewide conservation status of *M. macfarlanei*. The monitoring program is designed to collect quantitative information on *M. macfarlanei* and its habitat. A full description of the monitoring protocol is provided in Mancuso 2011. Ten *Mirabilis macfarlanei* transects were sampled in 2010 to test the proposed new monitoring protocols. Transect locations represented eight suboccurrences within six *M. macfarlanei* EOs. Monitoring results comparing 2010 results to pre-2010 datasets indicated that overall, *M. macfarlanei* percent frequency values for 2010 were similar to pre-2010 mean values and analysis found no significant difference ($p < 0.05$) in 2010 frequency compared to pre-2010 mean values for any of the monitoring plots sampled in 2010 (Mancuso 2011, p. 13). These data support the 2008 findings by Mancuso and Shepard (2008) that suggest the *Mirabilis macfarlanei* “population size” is stable rangewide (Mancuso 2011, p. 13). Monitoring data has not been reanalyzed since 2005 because the new monitoring protocol has not yet been established at all *Mirabilis macfarlanei* EOs. In addition, monitoring sites that have been established are monitored on a rotation. Annual monitoring is not conducted due to concerns regarding excessive researcher disturbance that can result from trampling of the fragile soils on steep slopes where these plants occur (USFWS, 2016).

Threats and Stressors

Stressor: Grazing by livestock and wildlife

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Although it is uncertain whether most or all *M. macfarlanei* populations have been grazed by domestic livestock in the past, livestock grazing still occurs at some sites. Livestock impact this species directly by trampling or consuming plants, and can result in reduced reproduction (i.e., seed set) for *M. macfarlanei* plants. Native and introduced ungulate species, including Rocky Mountain bighorn sheep (*Ovis canadensis*), Rocky Mountain elk (*Cervus elaphus*), and mountain goats (*Oreamnos americanus*), are found in the vicinity of *M. macfarlanei* habitat in Hell’s Canyon National Recreation Area and the Salmon River Canyon. Although evidence of herbivory by rabbits and deer has been observed, native wildlife species do not appear to significantly threaten this species. However, the potential introduction of additional Rocky Mountain bighorn sheep or mountain goats by State or Federal agencies could threaten *M. macfarlanei* habitat. Mountain goats and other ungulate species can impact rare plant habitat by trampling or consuming plants and by exposing mineral soil. (USFWS, 2000)

Stressor: Invasive nonnative plant species

Exposure:

Response:

Consequence:

Narrative: Exotic (non-native) plant species pose a serious threat to *M. macfarlanei* and other native plants since they compete with native species for space, light, water, and nutrients. Two of the most serious exotic species are *Bromus tectorum* (cheatgrass) and *Centaurea solstitialis* (yellow star-thistle). *Centaurea solstitialis* infestations have increased significantly in the Snake River Canyon over the past decade. Efforts to control *Centaurea solstitialis* have been initiated at a few sites containing *M. macfarlanei* (USFWS, 2000). This threat was listed as a primary threat in the 2015 5-year review (USFWS, 2015).

Stressor: Wildfire or Fire History

Exposure:

Response:

Consequence:

Narrative: Specific effects of historic and current fire regimes on *M. macfarlanei* are unknown. Fire suppression activities and rehabilitation efforts, including seeding with native species, are a potential threat to this species. It is possible that *M. macfarlanei* habitat has burned less frequently in the past 100 years due to fire suppression. Sites where fire has been excluded are vulnerable to accelerated succession, e.g., the invasion of shrubs or trees into grassland or meadow communities. However, the invasion of cheatgrass alters natural community dynamics by producing greater fine fuel levels, which may result in frequent, large-scale range fires. In areas where cheatgrass has invaded sagebrush-grass communities, altered fire dynamics have converted formerly productive, perennial communities to annual-dominated communities with increased fire management problems. Wildfires that occur during summer and fall months when *M. macfarlanei* plants are dormant may have minimal direct effects on this species since the underground rhizomes will be largely insulated from fire. However, fires may result in adverse changes in the ecological condition of sites and lead to the subsequent invasion of exotic species. Burning may also result in concentrations of ungulates grazing within the burned areas, which might cause increased trampling of *M. macfarlanei* plants. The primary concern from wildfires appears to be during the active growing period (typically April through June) when the aboveground plants would be susceptible to fire kill or injury (USFWS, 2000). This threat was stated to be a primary threat in the 2015 5-year review (USFWS, 2015).

Stressor: Herbicide and pesticide spraying

Exposure:

Response:

Consequence:

Narrative: Spraying vegetation in areas where *M. macfarlanei* occurs could potentially have an adverse effect on this species if weed control activities are not carefully implemented and monitored. (USFWS, 2000)

Stressor: Landslides and flood damage

Exposure:

Response:

Consequence:

Narrative: Activities associated with flood damage repair, including maintaining roads, trails, and facilities damaged by landslides or flooding, should be considered as a potential threat to *M. macfarlanei* habitat. (USFWS, 2000)

Stressor: Insect damage and disease

Exposure:**Response:****Consequence:**

Narrative: Some *M. macfarlanei* plants have been damaged by insects, including lepidopterans and spittle bugs. A type of fungal disease was also previously noted from *M. macfarlanei* plants. Because of connections between ramets, diseases may spread rapidly through clonal plant populations. Although damage from insects and disease do not currently appear to be significant in *M. macfarlanei* populations, these threats should be monitored. (USFWS, 2000)

Stressor: Trampling, off-road vehicle use, road maintenance/construction

Exposure:**Response:****Consequence:**

Narrative: Off-road vehicles: Several *M. macfarlanei* colonies are found within 0.5 kilometer (1/4 mile) of existing roads or highways in Idaho and Oregon. In addition, many *M. macfarlanei* colonies are on steep slopes that are particularly vulnerable to erosion. Uncontrolled off-road vehicle use is a potential threat to this species on both public and private lands. -- Road and trail construction and maintenance: Some *M. macfarlanei* populations in Idaho and Oregon are located near existing roads and trails, and could be adversely impacted by road or trail maintenance activities. The construction of new roads or trails is also a threat to this species. (USFWS, 2000)

Stressor: Collection

Exposure:**Response:****Consequence:**

Narrative: *Mirabilis macfarlanei* is an attractive plant that could be sought by amateur or professional botanists for scientific or horticultural purposes. Because some colonies are readily accessible, collection of *M. macfarlanei* should be considered a potential threat to this species. (USFWS, 2000)

Stressor: Mining

Exposure:**Response:****Consequence:**

Narrative: Although no populations are currently known to be impacted by mining, one *M. macfarlanei* population is located near an existing gravel mining operation along the Salmon River in Idaho County, Idaho. In addition, road construction is often associated with mining activity. The Hell's Canyon National Recreation Area is closed to any new mining claims. However, expansion of existing mining operations and development of future mining operations (e.g., borrow pits) should be considered a potential threat to *M. macfarlanei*. (USFWS, 2000)

Stressor: Competition for pollinators

Exposure:**Response:****Consequence:**

Narrative: Preliminary observations have shown that successful pollination of *M. macfarlanei* may be hindered by competition from adjacent plant species. For example, researchers have noted the presence of mixed pollen loads on solitary bees, which are considered to be potential pollinators of *M. macfarlanei*. No data currently exists on the natural history (e.g., biotic and abiotic requirements) of the primary pollinators of *M. macfarlanei*. It is unknown whether pollinator populations are adequate for the successful reproduction of *M. macfarlanei* at all sites, although one study found that seed set in *M. macfarlanei* does not appear to be pollen limited. (USFWS, 2000)

Stressor: Inbreeding depression.

Exposure:

Response:

Consequence:

Narrative: Some observers have noted that seedling recruitment is apparently rare in populations of *M. macfarlanei*. This could be influenced by extrinsic factors such as competition, inadequate pollination, nutrient levels, or annual precipitation. Inbreeding depression could result in poor seed viability, reduced germination success, or poor seedling survivorship. If new individuals are not successfully added to the population, the population viability of *M. macfarlanei* may decrease over time. (USFWS, 2000)

Recovery

Delisting Criteria:

A minimum of 11 populations are secure from threats and naturally reproducing with stable or increasing population trends for at least 15 consecutive years. (USFWS, 2015)

Population sizes are above the minimum necessary to maintain the viability of the species. (USFWS, 2015)

Populations of this species occur throughout its current range in each of three geographic areas (i.e., Imnaha, Snake, and Salmon River areas). (USFWS, 2015)

Management practices reduce and control threats. On Federal land, habitat management plans are in place and monitoring is used to ensure implementation and effectiveness of conservation management practices. On non-Federal lands, *M. macfarlanei* populations are managed and conserved. (USFWS, 2015)

A post-delisting monitoring program for the species is developed and implemented. This program will be developed through coordination with the BLM, Forest Service, FWS, and other interested parties. (USFWS, 2015)

Recovery Actions:

- Task 1: Protect essential habitat and control threats: Protect essential (occupied and potentially suitable) habitat and implement actions that may be necessary to eliminate or control threats. Manage habitat to maintain or enhance viable populations of *M. macfarlanei*. Habitat should be managed to allow for the maintenance of natural ecosystem functions and processes and contribute to the long-term preservation of this species.

Because *M. macfarlanei* populations are genetically distinct), all populations should be protected in order to maintain the genetic variability of this species. (USFWS, 2000)

- Task 2: Monitor population trends and habitat conditions: Achieving recovery will require monitoring of both *M. macfarlanei* individuals and habitat throughout its range in Idaho and Oregon. Monitoring will provide information on threats to *M. macfarlanei* habitat, and will also provide feedback on the effectiveness of management and conservation activities. (USFWS, 2000)
- Task 3: Conduct research essential to the conservation of the species: Additional research on the reproductive biology and life history of *M. macfarlanei* needs to be conducted to ascertain whether these recovery objectives are valid. Information on life history, population characteristics, and habitat requirements should be obtained to allow specification of management and population goals. Partnerships with other State, Federal, or private agencies and individuals should be developed where possible in order to meet these objectives. The Fish and Wildlife Service will work with appropriate agencies to ensure that adequate funding can be obtained to conduct essential research on *M. macfarlanei*. (USFWS, 2000)
- Task 4: Conduct surveys in potential habitat areas. Manage and protect any newly discovered *M. macfarlanei* populations.: Intensive field work should be conducted to locate additional populations of this species in each of the three geographic areas in which it is currently known (i.e., along the Imnaha, Salmon, and Snake River corridors in Idaho and Oregon). The habitat of any newly discovered populations should be protected and managed as necessary and appropriate following the protocol given in Task 1.
- Task 5: Establish propagule banks, including a long-term seed storage facility for *M. macfarlanei*. Seeds of *M. macfarlanei* should be collected according to currently accepted protocol, and stored at a long-term seed storage facility such as the Berry Botanic Garden (Portland, Oregon). Seeds from many *M. macfarlanei* sites are currently being stored at the Berry Botanic Garden. Additional seeds will be collected to capture as much of the species' genetic variability as possible. Berry Botanic Garden staff will also be conducting germination and propagation studies for *M. macfarlanei*. The Fish and Wildlife Service will assist with securing permits for activities as appropriate. (USFWS, 2000)
- Task 6. If warranted. establish and maintain new populations. If *M. macfarlanei* is extirpated from formerly occupied areas, or if population viability analyses suggest that additional populations are needed for full recovery, new populations of *M. macfarlanei* may be established as necessary and appropriate. (USFWS, 2000)
- Task 7. Validate and revise recovery objectives, as needed. The recovery plan should be modified to incorporate any new information as it becomes available. In particular, the results of any population viability analyses conducted for *M. macfarlanei* will be considered in future recovery plan revisions. The recovery plan should be reviewed every 5 years. and updated if necessary. (USFWS, 2000)

Conservation Measures and Best Management Practices:

- Continue working as an interagency technical team to collaborate on recovery actions for this species. (USFWS, 2015)
- Continue control efforts of invasive nonnative plant species and noxious weeds. The Service suggests developing site-specific management plans and monitoring schedules for individual EOs. (USFWS, 2015)

- Develop and implement studies to assess general life history and ecological needs, including studies addressing soil chemistry and moisture regimes. (USFWS, 2015)
- Continue to pursue opportunities to work with landowners towards conservation of this species on private lands. (USFWS, 2015)
- Continue the rangewide monitoring program and conduct and a 10-year analysis of the data set. (USFWS, 2015)
- Continue survey efforts to locate potential new populations. (USFWS, 2015)

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SPECIES ACCOUNT: *Mitracarpus maxwelliae* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 9/9/1994

Physical Description

A low, densely-branching, mound like shrub which may reach approximately 20 centimeters in height. The somewhat woody branches are striate and sharply 4-angled. The leaves are opposite, sessile, linear or linear-lanceolate, densely scabrous, and from 1 to 3 centimeters long and 2 to 5 millimeters wide. The flower heads are terminal, dense, sub-globose, and from .8 to 1.3 centimeters in diameter. The corolla is white, narrowly funnelform, minutely glandular-papillose, and 5 to 6 millimeters long. The capsule is about 1.5 millimeters in diameter, opening by a transverse circular split at about the middle. The seeds are ellipsoid, brownish-black, and 1.2 millimeters long and .8 millimeter wide (Proctor 1991a). (USFWS, 1998). Can be misidentified or confused in the field as *Spermacoce glabra* (USFWS, 2018).

Historical Range

See current range/distribution.

Current Range

Known from only one locality in the Guanica Commonwealth Forest, Guanica, Puerto Rico (USFWS, 1998). As of 2018: Species has been Monte de la Brea in GCF and has expanded to Monte Las Pargas. (USFWS, 2018). Both locations are at La Montalva Ward in the municipality of Guanica. The population at Monte de la Brea is within the boundaries of the Guanica Commonwealth Forest (GCF), whereas the population at Monte Las Pargas occurs in a public land slated for development. (USFWS, 2019).

Critical Habitat Designated

Yes;

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Little information is available on the reproductive biology of either *Mitracarpus maxwelliae* or *M. polycladus*. The Center for Plant Conservation (1992) indicates that little seed set of *M. polycladus* occurred in cultivation. Studies of the reproductive biology of these species are currently underway (USFWS, 1998).

Habitat Type

Adult: Scrub or Dwarf Coastal Forest (USFWS, 1998)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 1998)

Tolerance Ranges/Thresholds

Adult: Low (Inferred from USFWS, 1998)

Site Fidelity

Adult: High (Inferred from USFWS, 1998)

Habitat Narrative

Adult: Both *Mitracarpus maxwelliae* and *M. polycladus* are found in the vegetation type which has been described as coastal scrub forest over exposed limestone rock or coastal dwarf forest. Here the species grow in crevices and soil pockets of coastal rocks. The vegetation in the area is dwarfed in stature due to the salt spray and lack of soil and consists of species such as *Bucida buceras*, *Bursera simaruba*, *Exostema caribaeum*, *Coccoloba microstachya*, *Plumeria alba*, and *Pilosocereus royenii* (USFWS, 1998). High site fidelity and ecological integrity of the community as well as low tolerance ranges are inferred based on the specific habitat requirements of the species as well as the low number of known populations and individuals.

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Increasing (USFWS, 2011)

Resiliency:

Low (inferred from USFWS, 2011)

Representation:

Low (inferred from USFWS, 2011)

Redundancy:

Low (inferred from USFWS, 2011)

Number of Populations:

Four (USFWS, 2011)

Population Size:

1,443 - 1,882 plants (USFWS, 2011). As of 2018: Based on rapid assessment (not comprehensive survey), number of adults plants estimated at 2169, number of seedlings estimated at 1431. (USFWS, 2018).

Additional Population-level Information:

By 2011, *M. maxwelliae* was only known from Monte de la Brea in the GCF, the type locality for the species (where the species was originally described) (Service 2011). New information on the species confirms that the species also occurs in Monte Las Pargas, a Commonwealth land located at 1.63 kilometers (km) (1.01 miles) northeast from Monte de la Brea. In February 2015, Omar Monsegur, a Service biologist, found *M. maxwelliae* in four sites at Monte Las Pargas while he was searching for endangered plant species in this area (O. Monsegur, Service, unpublished data, 2015). Later in 2016, J. Chabert and E. Ventosa (both Environmental Consultants for ebp Design Group Consulting Engineers, P.S.C.) found the species in three

additional sites at Monte Las Pargas (Charbert and Ventosa, 2017). They estimated that the species occupies an area of approximate 0.818 acre (ac) (0.331 hectare (ha)) in each location. On October 16, 2017, Carlos Pacheco, Service recovery lead biologist for this species, visited the *M. maxwelliae* populations in Monte Las Pargas to validate these new records. He confirmed that the species occurs in seven locations scattered throughout the Monte Las Pargas area (Figure 1; C. Pacheco, Service biologist, unpublished data, 2018). (USFWS, 2018).

Population Narrative:

Mitracarpus maxwelliae is only known from one area (Monte de la Brea) in the Guánica Commonwealth Forest and population estimates have remained stable (between 1443 to 1882 adult plants) since 1991. However, the area occupied by the species has decreased by about 50 percent in ten years. This information needs to be verified in the field with newer surveys and site visits. *Mitracarpus polycladus* is currently known from Puerto Rico and the islands of Saba and Anegada in the British Virgin Islands. Based on the new information we have gathered during this review, the species has expanded its current distribution. At the time of listing, we were not aware of the two localities reported in the Anegada Island and only one locality was reported in the Guánica Forest. No population estimates were available for the species. Currently, the species is known from approximately 1,400 adult individuals in seven localities in Puerto Rico; six localities in the Guánica Commonwealth Forest and another in a private property adjacent to the forest. Based on the new information, we believe that the current status of *M. polycladus* is increasing or improving (USFWS, 2011). Low resiliency, redundancy and representation are inferred based on the number of known populations and individuals.

Threats and Stressors

Stressor: Roadway maintenance (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: *M. maxwelliae* occurs at both sides of the only roadway access to Manglillo Grande beach and Punta Brea area. These areas are used by local residents and tourists throughout the year. Although, this unpaved roadway is within the GCF and is managed for conservation, any mechanized maintenance, improvement, widening or increase in traffic on this roadway would affect severely the habitat suitability for the species and would result in loss of significant portion of the known populations. Because the highest concentration of *M. maxwelliae* plants are found on the access road to areas frequently utilized by visitors and subjected to maintenance, this factor should be considered as a moderate threat. However, since this locality is within a public forest managed for conservation the imminence of this threat should be considered non imminent (USFWS, 2011).

Stressor: Competition with native and exotic grasses (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The rapid growth of native and exotic grass on areas where these species occur can represent an increase in fuel that may further the impact of fire (USFWS, 2011).

Stressor: Human induced fire (USFWS, 2011)

Exposure:**Response:**

Consequence: Loss of habitat/Loss of individuals

Narrative: Because *M. maxwelliae* and *M. polycladus* are known to occur in a limited area subjected to human uses and susceptible to human-induced fire, this factor should be considered as a moderate threat. However, since the species is within a public forest managed for conservation the imminence of this threat should be considered non imminent (USFWS, 2011).

Stressor: Tourist development (USFWS, 2018; USFWS, 2019).

Exposure:**Response:**

Consequence:

Narrative: A tourist development is planned at Montes Las Pargas. (USFWS, 2018; USFWS, 2019).

Stressor: Climate change, severe drought (USFWS, 2019).

Exposure:**Response:**

Consequence:

Narrative: Severe droughts and sea level rise resulting from climate change is believed to impact these species as *M. maxwelliae* and *M. polycladus* are found growing on sandy and rocky soil near sea level. Also, germination and seedling survival depends on the length of the rainy season as highest mortality of seedlings has been observed during the driest period (Buitrago-Soto 2002). (USFWS, 2019).

Recovery**Delisting Criteria:**

1. A management plan that considers the protection and recovery of the species has been prepared and implemented for the Guánica Commonwealth Forest (USFWS, 2011).
2. New populations (the number of which should be determined following the appropriate studies) capable of self perpetuation have been established within protected areas, such as other coastal areas in the Guánica Commonwealth Forest (USFWS, 2011).

Amended delisting criterion 1. Threat reduction and management activities have been implemented to a degree that the species will remain viable into the foreseeable future (addresses Factor A and Factor E). (USFWS, 2019).

Amended delisting criterion 2: Existing natural populations of *M. maxwelliae* (2 populations), *M. polycladus* (6 populations) and *E. woodburyana* (6 populations) show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factor E). (USFWS, 2019).

Amended delisting criterion 3. Within the historic range, establish at least three (3) new populations of *M. maxwelliae* and *M. polycladus*, and *E. woodburyana* on lands protected by a conservation mechanism that show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factor A and E). (USFWS, 2019).

Recovery Actions:

- The first criterion has been met partially. A Cooperative Agreement between the Service and the Puerto Rico Department of Natural and Environmental Resources (DNER) is in place since 1983 to establish and implement a vigorous endangered species program within the Commonwealth of Puerto Rico. In addition, the Guánica Commonwealth Forest is managed by the DNER for conservation of fish and wildlife resources, including federally-listed species (DNER, 1976). The DNER also implements a fire-prevention and management program during dry season to protect fish and wildlife resources. However, the existing Guánica Commonwealth Forest management plan does not mention the specific management activities or the number of individuals needed to ensure the species recovery (USFWS, 2011).
- It is difficult to determine if the second criterion has been met because the number of new populations established was not specified. Service biologists conducted surveys on *M. polycladus* in 2007, 2009 and 2010, finding five additional localities in the Guánica Commonwealth Forest. Approximately, 2925 individuals (doubled from previously known individuals) were observed in five localities within the forest. In October 2008 (FY 2009), Service biologist Carlos Pacheco found a new population with 12 individuals at the Ballenas property. Additionally, the species is found in two localities in the Lesser Antilles (Saba Island and Anegada Island). New information of the species reflects that the species is more widely-distributed than previously thought. *M. maxwelliae* is still restricted to only one known population in the Guánica Commonwealth Forest (USFWS, 2011).
- Initiate propagation program for these species to enhance existing population in the GCF and establish new populations in protected areas in southern Puerto Rico. (USFWS, 2018).
- Conduct comprehensive studies on habitat requirements, phenology, and recruitment success of both species in the wild. (USFWS, 2018).
- Determine the number of self-sustainable population needed to delist each species. (USFWS, 2018).
- Work closely with the PRDNER and landowners to ensure the protection of the species and its habitat in private lands. (USFWS, 2018).
- Continue implementing fire prevention practices in the GCF during dry season. (USFWS, 2018).
- Develop and implement a comprehensive exotic/invasive grass control in areas where the species occurs to avoid competition. (USFWS, 2018).
- Added in 2019: Genetic material from all populations is preserved through long-term seed storage and/or propagation efforts. This recovery action should be added as new Task in the recovery plan (USFWS, 2019).

Conservation Measures and Best Management Practices:

- Revise the recovery plan to include new information on the biology of the species and the development of measurable criteria for delisting the species. (USFWS, 2011).
- Initiate propagation program for these species to enhance existing population in the Guánica Commonwealth Forest and establish new populations in protected areas in southwestern Puerto Rico (USFWS, 2011).
- Conduct comprehensive studies on habitat requirements, phenology, and recruitment success of both species in the wild (USFWS, 2011).
- Determine the number of self-sustainable populations needed to delist each species (USFWS, 2011).
- Additional surveys should be conducted for both species in Puerto Rico (USFWS, 2011).

- Conduct additional studies on the biology and ecology of the *M. maxwelliae* and *M. polycladus* (USFWS, 2011).
- Work closely with the Guánica Commonwealth Forest to address current threats within the forest (USFWS, 2011).
- Continue protecting existing populations and their habitat (USFWS, 2011).
- Identify possible threats of *M. polycladus* in private properties adjacent to the Guanica Forest (USFWS, 2011).
- Work closely with International Affairs to obtain information from *M. polycladus* on the Virgin Islands (USFWS, 2011).

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SPECIES ACCOUNT: *Mitracarpus polycladus* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 9/9/1994

Physical Description

A suffrutescent perennial. It is branched near the base, and the erect or spreading stems may reach up to 45 centimeters in height. The branches are 4-angled and glabrous. Leaves are opposite, linear to linear-lanceolate, 2 to 4.5 centimeters long, .3 to .5 centimeters wide, glabrous and often with an inrolled margin and decurrent base. The inflorescence is terminal and capitate, 8 to 13 millimeters in diameter, many flowered and subtended by 3 bract-like leaves. The corolla is white, about 5 millimeters long, with ovate leaves. The seed capsule is 1.5 millimeter in diameter, (USFWS, 1998). Can be misidentified or confused in the field as *Spermacoce glabra* (USFWS, 2018).

Historical Range

See current range/distribution.

Current Range

Known from only one location in Puerto Rico, in the Guanica Commonwealth Forest in the municipality of Guayanilla, Puerto Rico, where it grows in crevices and soil pockets of coastal rocks in arid areas (Figure 1). Exact numbers of individuals have been difficult to estimate due to extreme drought conditions in recent years. It is also known from the island of Saba in the Lesser Antilles (Proctor 199 ib). (USFWS, 1998). The species is now found in the Guanica, Yauco and Guayanilla municipalities of Puerto Rico, as well as the Guanica Commonwealth Forest (GCF) and San Francisco Wind Farm. (USFWS, 2018).

Critical Habitat Designated

Yes;

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Little information is available on the reproductive biology of either *Mitracarpus maxwelliae* or *M. polycladus*. The Center for Plant Conservation (1992) indicates that little seed set of *M. polycladus* occurred in cultivation. Studies of the reproductive biology of these species are currently underway (USFWS, 1998).

Habitat Type

Adult: Scrub or Dwarf Coastal Forest (USFWS, 1998)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 1998)

Tolerance Ranges/Thresholds

Adult: Low (Inferred from USFWS, 1998)

Site Fidelity

Adult: High (Inferred from USFWS, 1998)

Habitat Narrative

Adult: Both *Mitracarpus maxwelliae* and *M. polycladus* are found in the vegetation type which has been described as coastal scrub forest over exposed limestone rock or coastal dwarf forest. Here the species grow in crevices and soil pockets of coastal rocks. The vegetation in the area is dwarfed in stature due to the salt spray and lack of soil and consists of species such as *Bucida buceras*, *Bursera simaruba*, *Exostema caribaeum*, *Coccoloba microstachya*, *Plumeria alba*, and *Pilosocereus royenii* (USFWS, 1998). High site fidelity and ecological integrity of the community as well as low tolerance ranges are inferred based on the specific habitat requirements of the species as well as the low number of known populations and individuals.

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Increasing (USFWS, 2011)

Resiliency:

Low (inferred from USFWS, 2011)

Representation:

Low (inferred from USFWS, 2011)

Redundancy:

Low (inferred from USFWS, 2011)

Number of Populations:

Four (USFWS, 2011)

Population Size:

1,400 mature plants and 1,500 seedlings (USFWS, 2011). As of 2018: Although the entire population was not surveyed, the Service biologist counted 12,472 adult plants (adults with flowers = 4,308; adults without flowers = 8,164) and 11,456 seedlings within an area of 1.02 ac (0.42 ha) in the GCF (Table 2; C. Pacheco, Service biologist, unpublished data, 2018). Service biologist had estimated that the population in Monte Ventana consists of over 3,000 individuals (C. Pacheco, Service, personal observation, 2018). (USFWS, 2018).

Population Narrative:

At the time of listing, *M. polycladus* was known from one locality at the Guánica Commonwealth Forest, but number of individuals was not estimated due to extreme drought conditions (Proctor 1991b). In 2007, Service biologist Carlos Pacheco found three additional localities and conducted a rapid assessment on the species estimating its abundance in 1,400 mature plants and 1,500 seedlings in four localities within the Guánica Commonwealth Forest (USFWS 2007, unpublished

data). According to our field observations, we believe that the population trend of *M. polycladus* should be considered improving (Table 1) (USFWS, 2011). Low resiliency, redundancy and representation are inferred based on the number of known populations and individuals. By 2011, *M. polycladus* was known from the southern karst region of Puerto Rico, among the municipalities of Guánica, Yauco and Guayanilla. Within its range, the species was known from seven localities: six within the GCF, and one on a parcel of private land at Ballenas Sector in the Municipality of Yauco (Service 2011). New information on the *M. polycladus* reveals that the species occurs in three additional sites in the southern karst region of Puerto Rico (Figure 2). While Service biologists were searching for endangered plant species on the San Francisco Wind Farm in 2012, they found *M. polycladus* (Service 2013). Further searches for the species along the southern section of the GCF revealed that *M. polycladus* also occurs in the Hoya Onda area, in other sites along the state road PR 333, and is widely dispersed along the Mesetas area and in Monte Ventana (C. Pacheco, Service, unpublished data, 2018). (USFWS, 2018).

Threats and Stressors

Stressor: Roadway maintenance (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: *M. polycladus* occurs on exposed limestone rocks along the Mesetas trails and Brunos trails in the Guánica Commonwealth Forest. Currently, Mesetas trails and Brunos trails are managed by DNER as scenic trails and natural areas, avoiding any mechanized maintenance or widening of these trails. However, although these trails are off-limit for vehicle traffic, these trails are frequently used by hikers (locals and tourists) and mountain bikers throughout the year. Because the highest concentration of *M. polycladus* plants are found on trails frequently utilized by visitors but subjected to minimum maintenance, this factor should be considered as a low threat. Since the species is within a public forest managed for conservation the imminence of this threat should be considered non imminent (USFWS, 2011).

Stressor: Competition with native and exotic grasses (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The rapid growth of native and exotic grass on areas where these species occur can represent an increase in fuel that may further the impact of fire (USFWS, 2011).

Stressor: Human induced fire (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat/Loss of individuals

Narrative: Because *M. maxwelliae* and *M. polycladus* are known to occur in a limited area subjected to human uses and susceptible to human-induced fire, this factor should be considered as a moderate threat. However, since the species is within a public forest managed for conservation the imminence of this threat should be considered non imminent (USFWS, 2011).

Stressor: Wind Farm Construction (USFWS, 2019).

Exposure:

Response:**Consequence:**

Narrative: San Francisco Wind Farm poses threat from construction of wind turbines and associated facilities (USFWS, 2019).

Stressor: Climate change, severe drought (USFWS, 2019).

Exposure:**Response:****Consequence:**

Narrative: Severe droughts and sea level rise resulting from climate change is believed to impact these species as *M. maxwelliae* and *M. polycladus* are found growing on sandy and rocky soil near sea level. Also, germination and seedling survival depends on the length of the rainy season as highest mortality of seedlings has been observed during the driest period (Buitrago-Soto 2002). (USFWS, 2019).

Recovery**Delisting Criteria:**

1. A management plan that considers the protection and recovery of the species has been prepared and implemented for the Guánica Commonwealth Forest (USFWS, 2011).
2. New populations (the number of which should be determined following the appropriate studies) capable of self perpetuation have been established within protected areas, such as other coastal areas in the Guánica Commonwealth Forest (USFWS, 2011).

Amended delisting criterion 1. Threat reduction and management activities have been implemented to a degree that the species will remain viable into the foreseeable future (addresses Factor A and Factor E). (USFWS, 2019).

Amended delisting criterion 2: Existing natural populations of *M. maxwelliae* (2 populations), *M. polycladus* (6 populations) and *E. woodburyana* (6 populations) show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factor E). (USFWS, 2019).

Amended delisting criterion 3. Within the historic range, establish at least three (3) new populations of *M. maxwelliae* and *M. polycladus*, and *E. woodburyana* on lands protected by a conservation mechanism that show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factor A and E). (USFWS, 2019).

Recovery Actions:

- The first criterion has been met partially. A Cooperative Agreement between the Service and the Puerto Rico Department of Natural and Environmental Resources (DNER) is in place since 1983 to establish and implement a vigorous endangered species program within the Commonwealth of Puerto Rico. In addition, the Guánica Commonwealth Forest is managed by the DNER for conservation of fish and wildlife resources, including federally-listed species (DNER, 1976). The DNER also implements a fire-prevention and management program during dry season to protect fish and wildlife resources. However, the existing Guánica Commonwealth Forest management plan does not mention the specific management

activities or the number of individuals needed to ensure the species recovery (USFWS, 2011).

- It is difficult to determine if the second criterion has been met because the number of new populations established was not specified. Service biologists conducted surveys on *M. polycladus* in 2007, 2009 and 2010, finding five additional localities in the Guánica Commonwealth Forest. Approximately, 2925 individuals (doubled from previously known individuals) were observed in five localities within the forest. In October 2008 (FY 2009), Service biologist Carlos Pacheco found a new population with 12 individuals at the Ballenas property. Additionally, the species is found in two localities in the Lesser Antilles (Saba Island and Anegada Island). New information of the species reflects that the species is more widely-distributed than previously thought. *M. maxwelliae* is still restricted to only one known population in the Guánica Commonwealth Forest (USFWS, 2011).
- Initiate propagation program for these species to enhance existing population in the GCF and establish new populations in protected areas in southern Puerto Rico. (USFWS, 2018).
- Conduct comprehensive studies on habitat requirements, phenology, and recruitment success of both species in the wild. (USFWS, 2018).
- Determine the number of self-sustainable population needed to delist each species. (USFWS, 2018).
- Work closely with the PRDNER and landowners to ensure the protection of the species and its habitat in private lands. (USFWS, 2018).
- Continue implementing fire prevention practices in the GCF during dry season. (USFWS, 2018).
- Develop and implement a comprehensive exotic/invasive grass control in areas where the species occurs to avoid competition. (USFWS, 2018).
- Added in 2019: Genetic material from all populations is preserved through long-term seed storage and/or propagation efforts. This recovery action should be added as new Task in the recovery plan (USFWS, 2019).

Conservation Measures and Best Management Practices:

- Revise the recovery plan to include new information on the biology of the species and the development of measurable criteria for delisting the species. (USFWS, 2011).
- Initiate propagation program for these species to enhance existing population in the Guánica Commonwealth Forest and establish new populations in protected areas in southwestern Puerto Rico (USFWS, 2011).
- Conduct comprehensive studies on habitat requirements, phenology, and recruitment success of both species in the wild (USFWS, 2011).
- Determine the number of self-sustainable populations needed to delist each species (USFWS, 2011).
- Additional surveys should be conducted for both species in Puerto Rico (USFWS, 2011).
- Conduct additional studies on the biology and ecology of the *M. maxwelliae* and *M. polycladus* (USFWS, 2011).
- Work closely with the Guánica Commonwealth Forest to address current threats within the forest (USFWS, 2011).
- Continue protecting existing populations and their habitat (USFWS, 2011).
- Identify possible threats of *M. polycladus* in private properties adjacent to the Guanica Forest (USFWS, 2011).
- Work closely with International Affairs to obtain information from *M. polycladus* on the Virgin Islands (USFWS, 2011).

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SPECIES ACCOUNT: *Monardella viminea* (Willow monardella)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial herb or subshrub in the Lamiaceae (mint family) with a woody base and aromatic foliage. (USFWS, 2012)

Taxonomy

In this sense, *Monardella viminea* excludes plants named *Monardella stoneana* by Elvin and Sanders (2003) that were included in *M. linoides* ssp. *viminea*. (NatureServe, 2015)

Current Range

Occurs in coastal sage scrub and riparian scrub in sandy bottoms and on banks of ephemeral washes in canyons where surface water flows for usually less than 48 hours after a rain event (Scheid 1985, p. 3; Elvin and Sanders 2003, p. 430; Kelly and Burrascano 2006, p. 51).

Monardella viminea is a geographically narrow endemic species restricted to three watersheds north of Kearny Mesa in San Diego County, California 2012 5-year Review for *Monardella viminea* 3 (Elvin and Sanders 2003, p. 431). Within these watersheds, *M. viminea* occurs on land owned by the Department of Defense at Marine Corps Air Station (MCAS) Miramar, the City of San Diego, the County of San Diego, and private parties. (USFWS, 2012)

Critical Habitat Designated

Yes; 3/6/2012.

Legal Description

On March 6, 2012, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Monardella viminea* (Willow monardella) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in California (77 FR 13394-13447).

Critical Habitat Designation

The critical habitat designation for *Monardella viminea* includes two CHUs in San Diego County, California. This species critical habitat encompasses approximately 122 acres (ac) (50 hectares (ha)) (77 FR 13394-13447).

Unit 1: Sycamore Canyon: Unit 1 consists of 118 ac (48 ha), and is located in Sycamore Canyon at the northeastern boundary of MCAS Miramar, north of Santee Lakes in San Diego County, California. These acres fall within the boundaries of the City of Santee, which has no approved MSCP. This canyon is the only place where *Monardella viminea* is found in oak woodland habitat, and is one of the few areas in the range of *M. viminea* with mature riparian habitat (Rebman and Dossey 2006, p. 23). Sycamore Canyon is essential to the recovery of the species because it supports over 350 individual plants, or approximately 18 percent of the species' total population (City of San Diego 2010a, p. 257; Tierra Data 2011, p. 12), meaning this is an important unit that supports genotypes and diversity not found among the more impoverished occurrences. Additionally, this canyon is one of few that contains seedlings and juveniles (Tierra Data 2011, pp.

16–17), demonstrating that reproduction is occurring and the habitat in this unit is currently suitable to support all lifehistory phases of this declining species. The habitat in this unit provides redundancy and resiliency for *M. viminea* and, since there are areas of suitable habitat within the canyon where plants are not currently growing, the unit provides space for the growth and expansion of the species. This unit contains the physical or biological features essential to the conservation of *M. viminea*, including riparian channels with a natural hydrological regime, ephemeral drainages made up of rocky or sandy alluvium, sandy soil with sediment and cobble deposits, and surrounding vegetation that provides semi-open foliar cover. The PCE may require special management considerations or protection to address threats from nonnative plant species and erosion of the canyon (City of San Diego 2005, p. 68; 2006, p. 10; 2009, p. 2). Please see the Special Management Considerations or Protection section of this final rule for a discussion of the threats to *M. viminea* habitat and potential management considerations.

Unit 2: West Sycamore Canyon: Unit 2 consists of 4 ac (2 ha) of land owned by water districts, and is located in West Sycamore Canyon adjacent to the eastern section of MCAS Miramar, in San Diego County, California. The northernmost point of the unit is just outside the boundary of MCAS Miramar. West Sycamore Canyon, in which Unit 2 is found, is essential to the recovery of *Monardella viminea* because it contains the largest number of *M. viminea* individuals of any canyon in the species' range and over 25 percent of the species' total population (Tierra Data 2011, p. 12), meaning this is an important unit that supports genotypes and diversity not found among the more impoverished occurrences. Additionally, this canyon is one of few that contains seedlings and juveniles (Tierra Data 2011, pp. 16–17), demonstrating that reproduction is occurring and the habitat in this unit is currently suitable to support all lifehistory phases of this declining species. The plants in this canyon were recently observed to be in good health with little to no pressure from herbivores, in contrast to many other areas such as San Clemente or Carroll Canyon, where individuals are declining or are in poor health (Tierra Data 2011, p. 25; Ince 2010, Table 3). The habitat in this unit provides redundancy and resiliency for *M. viminea*, and because there are areas of suitable habitat within the canyon where plants are not currently growing, the unit provides space for the growth and expansion of the species. Unit 2, which contains critical habitat for *M. viminea* in that portion of West Sycamore Canyon located outside of MCAS Miramar, includes the physical or biological features essential to the conservation of *M. viminea*, including riparian channels with a natural hydrological regime, ephemeral drainages made up of rocky or sandy alluvium, sandy soil with sediment and cobble deposits, and surrounding vegetation that provides semi-open foliar cover. The PCE in this unit may require special management considerations or protection to address threats associated with erosion from heavy rainfall events. Please see the Special Management Considerations or Protection section of this final rule for a discussion of the threats to *M. viminea* habitat and potential management considerations.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Monardella viminea* critical habitat consists of four components (77 FR 13394-13447):

- (i) With a natural hydrological regime, in which: (A) Water flows only after peak seasonal rainstorms; (B) High runoff events periodically scour riparian vegetation and redistribute alluvial material to create new stream channels, benches, and sandbars; and (C) Water flows for usually less than 48 hours after a rain event, without long-term standing water;

(ii) With surrounding vegetation that provides semi-open, foliar cover with: (A) Little or no herbaceous understory; (B) Little to no canopy cover; (C) Open ground cover, less than half of which is herbaceous vegetation cover; (D) Some shrub cover; and (E) An association of other plants, including *Eriogonum fasciculatum* (California buckwheat) and *Baccharis sarothroides* (broom baccharis);

(iii) That contain ephemeral drainages that: (B) Are made up of coarse, rocky, or sandy alluvium; and (C) Contain terraced floodplains, terraced secondary benches, stabilized sandbars, channel banks, or sandy washes; and

(iv) That have soil with high sand content, typically characterized by sediment and cobble deposits, and further characterized by a high content of coarse, sandy grains and low content of silt and clay.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the physical or biological features within the geographical area occupied by the species at the time of listing that are essential to the conservation of the species may require special management considerations or protection. The areas designated as critical habitat will require some level of management or protection to address the current and future threats to the physical or biological features. In all units, special management considerations or protection may be required to provide for the sustained function of the ephemeral washes on which *Monardella viminea* depends. The features essential to the conservation of *Monardella viminea* may require special management considerations or protection to reduce the following threats, among others: Cover by nonnative plant species that crowds, shades, or competes for resources; habitat alteration due to altered hydrology from urbanization and associated infrastructure; and any actions that alter the natural channel structure or course, particularly increased water flow that could erode soils inhabited by *M. viminea* or cover them with sediment deposits. Special management considerations or protection are required within critical habitat areas to address these threats. Management activities that could ameliorate these threats include, but are not limited to: Removal of nonnative vegetation by weeding, planting of native species along stream courses in canyons to help control erosion, use of silt fences to control erosion, restriction of development that alters natural hydrological characteristics of stream courses in canyons, and implementation of prescribed burns. Additionally, specialized dams and smaller barriers could be installed in canyons to help address floodwater runoff that results from upstream development (which can cause erosion and loss of clumps of *Monardella viminea*), although these dams must be of adequate size and strength to withstand increased storm flow caused by urbanization.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Vegetative (USFWS, 2008); Sexual (USFWS, 2012)

Dependency on Other Individuals or Species

Adult: Bees and butterflies (USFWS, 2012)

Reproduction Narrative

Adult: The willowy monardella is a perennial species that reproduces at least in part vegetatively (USFWS, 2008). It also reproduces sexually. Monardella viminea is visited by numerous bees and butterflies, and is likely pollinated by a diverse array of insects. Specific species which pollinate M. viminea have not been identified (USFWS, 2012).

Habitat Type

Adult: Sandy washes and floodplains (USFWS, 2008)

Dependencies on Specific Environmental Elements

Adult: Perennial streams; ecosystem culture, function, and integrity; coarse, rocky, and sandy alluvium on terraced floodplains; semi-open canopies of coastal sage and riparian scrub with limited herbaceous understory (USFWS, 2008)

Habitat Narrative

Adult: The willowy monardella inhabits sandy washes and floodplains. The species is dependent on several environmental elements: perennial streams; ecosystem culture, function, and integrity; coarse, rocky, and sandy alluvium on terraced floodplains; semi-open canopies of coastal sage and riparian scrub with limited herbaceous understory (USFWS, 2008)

Dispersal/Migration**Dispersal**

Adult: Low (inferred from USFWS, 2008)

Dispersal/Migration Narrative

Adult: The species is inferred to have low dispersal ability based on a limited historic range and its proximity and vulnerability to urban development (inferred from USFWS, 2008)

Population Information and Trends**Population Trends:**

Declining (USFWS, 2008)

Resiliency:

Low (inferred from USFWS, 2008)

Representation:

Low (inferred from USFWS, 2008)

Redundancy:

Low (inferred from USFWS, 2008)

Number of Populations:

8 (USFWS, 2008)

Population Size:

Up to 6,000 total individuals, as many as six populations of fewer than 15 individuals (USFWS, 2008)

Population Narrative:

The willowy monardella is in decline at the population level. There are 8 extant occurrences (USFWS 2012) and at least 10 documented extirpated occurrences. The overall population is 6,000 individuals, but as many as six populations have fewer than 15 individuals. Species resiliency, representation, and redundancy are inferred to be low based on its vulnerability to stochastic events (USFWS, 2008)

Threats and Stressors

Stressor: Grazing/trampling; urban and residential development; recreational activities; altered hydrological regimes; road construction; soil removal; sand and gravel mining; trash dumping; erosion; wildfires; invasive plants (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: The species is threatened by several anthropogenic activities including grazing/trampling, urban and residential development, recreational activities, altered hydrological regimes, road construction, soil removal, sand and gravel mining, trash dumping, and erosion. Wildfires have also had an adverse effect on the species. Invasive plants such as bulrush and willow can take over otherwise suitable habitat for willowy monardella, a process likely exacerbated by fires (USFWS, 2008). Trampling of *M. viminea* occurs via human travel through the species' habitat. Nonnative plants threaten the species as they frequently out-compete native species for limited resources and grow more quickly, can smother seedling and mature *M. viminea* and prevent natural growth (Rebman and Dossey 2006, p. 12). Nonnative plants also have the potential to lower water tables and alter rates of sedimentation and erosion by altering soil chemistry, nutrient levels, and the physical structure of soil (USFWS, 2012).

Recovery

Reclassification Criteria:

None listed

Conservation Measures and Best Management Practices:

- The Cities of San Diego and Santee have purchased private property as reserve land for *Monardella viminea* (USFWS, 2012)

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SPECIES ACCOUNT: *Monolopia (=Lembertia) congdonii* (San Joaquin woolly-threads)

Species Taxonomic and Listing Information

Listing Status: Endangered; 07/19/2000; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

The common name “woolly-threads” is derived from the many long (up to 45 cm; 18 in), trailing stems covered with tangled hairs. However, San Joaquin woolly-threads plants also can be tiny (< 7 cm (3 in)) and erect with a single stem (Cypher 1994a). The tiny, yellow flower heads are clustered at the tips of the stems and branches. Each flower head is approximately 6 mm (0.25 in) long and contains two types of florets (the tiny flowers characteristic of the aster family); the four to seven outer florets differ in shape from the numerous inner florets. The two types of florets produce achenes (tiny, one-seeded fruits) that also differ in shape (Johnson 1993, Taylor 1989). (USFWS, 1998)

Taxonomy

In 1883, Gray named San Joaquin woolly-threads as *Eatonella congdonii*. The type specimen had been collected by Congdon near Deer Creek (Tulare County) in that same year. The current name, *Leinbertia congdonii*, was published by Greene in 1897, who determined that San Joaquin woolly-threads should be separated from snowy eatonella (*Eatonella nivea*). Subsequent taxonomists have upheld Greene’s taxonomy (Johnson 1993, Taylor 1989). San Joaquin woolly-threads is the sole species in the genus *Lembertia*, which is in the aster family (Asteraceae). (USFWS, 1998)

Historical Range

The historical range of San Joaquin woolly-threads is based on 47 herbarium specimens and literature reports dating from 1883 to 1983; 30 of the occurrences were from the floor of the San Joaquin Valley, four were from the Cuyama Valley, and the remainder were in the hills west of the San Joaquin Valley. These occurrences were concentrated in eight areas (in descending order of abundance): (1) the plains between Avenal and Mendota in Kings and Fresno Counties, (2) from Bakersfield to Shafter in Kern County, (3) the inner Coast Ranges of western Fresno and eastern San Benito Counties, (4) from north of Lokern to Lost Hills in Kern County, (5) the Carrizo and Elkhorn Plains in San Luis Obispo County, (6) the Cuyama Valley in Santa Barbara County, (7) east of Edison in Kern County, and (8) the type locality. However, 33 of the historical occurrences had been eliminated by 1989 (Taylor 1989). (USFWS, 1998)

Current Range

The Service states that *Monolopia congdonii* occur in Fresno, Kings, Kern, San Benito, San Luis Obispo, and Santa Barbara Counties. Nineteen populations of *Monolopia congdonii* were extant (55 FR 29361). Twelve populations remained in the San Joaquin Valley and adjoining foothills from the vicinity of Panoche Pass (San Benito County) southeasterly to Caliente Creek east of Bakersfield (Kern County). Another seven populations occurred to the southwest in the Cuyama Valley (San Luis Obispo and Santa Barbara Counties) and Carrizo Plain (San Luis Obispo County). Thirty-three of 52 historical populations had been lost (55 FR 29361), including a population from Tulare County (Taylor 1989). (USFWS, 2010)

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Breeding Season**

Adult: February to April (USFWS, 2010)

Reproduction Narrative

Adult: San Joaquin woolly-threads is an annual herb, and its phenology varies with weather and site conditions. *Monolopia congdonii* typically flowers between late February and early April (B. Delgado pers. comm. from Service 1998). Each plant may have from 1 to more than 400 flower heads. Seed production depends on plant size and the number of flower heads but can range from 10 to 2,500 seeds per individual (Mazer and Hendrickson 1993; Cypher 1994; E. Cypher unpublished data from Service 1998). (USFWS, 2010)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Chenopod scrub, valley and foothill grassland; sand dunes (Skinner, 1997). (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Prefers less than 10% shrub cover; found at elevations between 200 to 850 feet on the San Joaquin Valley and from 2,000 to 2,600 feet in San Luis Obispo and Santa Barbara counties (USFWS, 2010)

Spatial Arrangements of the Population

Adult: Scattered (USFWS, 2010)

Environmental Specificity

Adult: Narrow/specialist

Habitat Narrative

Adult: *Monolopia congdonii* occurs scattered in Nonnative Grassland, Valley Saltbush Scrub, Interior Coast Range Saltbush Scrub, and Upper Sonoran Subshrub Scrub communities (Service 1998). Plants that often occur with *Monolopia congdonii* include *Bromus rubens* (red brome), *Erodium cicutarium* (red-stemmed filaree), *Schismus* spp. (Arabian grass), *Lasthenia* spp. (goldfields), and *Vulpia myuros* (mouse tail fescue). *Monolopia congdonii* typically occupies microhabitats with less than 10 percent shrub cover, although herbaceous cover may be either sparse or dense, and cryptogamic crust (a layer of moss, lichen, and algae on the soil surface) may or may not be present. *Monolopia congdonii* occurs on neutral to sub-alkaline soils that were deposited in geologic times by flowing water. On the San Joaquin Valley floor, this species typically is found on sandy or sandy loam soils, particularly those of the Kimberlina series,

whereas on the Carrizo Plain, it occurs on silt rich soils. *Monolopia congdonii* frequently occurs on sand dunes and sandy ridges as well as along the high-water line of washes and on adjacent terraces. Occurrences have been reported at elevations ranging from approximately 200 to 850 feet on the San Joaquin Valley floor and surrounding hills, and from 2,000 to 2,600 feet in San Luis Obispo and Santa Barbara Counties (Service 1998). (USFWS, 2010)

Dispersal/Migration

Dependency on Other Individuals or Species for Dispersal

Adult: Possibly wind, water and animals (USFWS, 2010)

Dispersal/Migration Narrative

Adult: Seed dispersal agents are unknown, but possible candidates include wind, water, and animals. Insect pollinators are not known to be required for seed-set in *M. congdonii* (Mazer and Hendrickson 1993); however, animals may be important to this plant species in other ways. (USFWS, 2010)

Population Information and Trends

Population Trends:

Decline of >30% (NatureServe, 2015)

Number of Populations:

66 (USFWS, 2010)

Population Narrative:

Currently, 66 occurrences of *Monolopia congdonii* are presumed extant scattered in Fresno, Kings, Kern, San Benito, San Luis Obispo, and Santa Barbara Counties. Short-term trends suggest declines of greater than 30%. (USFWS, 2010)

Threats and Stressors

Stressor: Agricultural conversion and urbanization (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The loss and modification of habitat due to agricultural conversion and urban development remain the largest threats to *Monolopia congdonii*. As discussed in the final listing rule (55 FR 29361), 96 percent of the native habitats of the valley floor had been lost primarily to urbanization and agricultural land conversion by 1987. The Central Valley Project (CVP) is the largest surface water storage and delivery system in California, with a geographic scope covering 35 of the State's 58 counties. Agricultural conversions and related operations either directly or indirectly facilitated by the Central Valley Project include: conversion of native habitats to agricultural fields; conversion of land use to more water intensive purposes; disposal of agricultural drainwater; application of pesticides; and other mowing and harvesting operations. Agricultural conversion and related operations have contributed to the loss and degradation of several habitat types, including grasslands and alkali scrub associated with declines of multiple listed species (Service 1998). Currently, fewer than 150,000 acres on the San Joaquin Valley

floor remain uncultivated; most of the remaining undeveloped land is located near, or in, the foothills at the valley perimeter. Significant portions of these lands not cultivated for agriculture or urbanized have been developed for petroleum extraction, strip-mined for gypsum and clay, or occupied by roads, canals, airstrips, oil-storage facilities, pipelines, and evaporation and percolation basins. In addition, natural communities have been permanently altered by the introduction and proliferation of nonnative plants, which now dominate many remaining natural habitats (USFWS 1998). Residual natural communities are typically comprised of marginal and highly fragmented habitats. Habitat conditions are so marginal in many of these residual communities that the elimination of listed species is likely, if catastrophic events such as drought or floods were to occur (Service 1998). The California Department of Conservation (CDC) estimates that the conversion of farming or grazing land to residential or industrial uses between 2002 and 2004 in the San Joaquin Valley occurred at a rate of 26 acres per day (CDC 2007). The projected rate of development is anticipated to increase (American Farmland Trust 2007). As urbanization encroaches into valley floor agricultural areas, *Monolopia congdonii* habitats of the foothills are increasingly converted to perennial cropland. Other effects due to agriculture include soil salinization resulting from irrigation; a pattern that has been observed throughout history (Jacobsen and Adams 1958) where agriculture land use dominates arid regions. Soil salinization due to agriculture is common in California's San Joaquin Valley (Schoups et al. 2005; T. Maurer, Service, pers. comm. 2010) and may result in impairment to soil that would make restoration of habitat unlikely. In Fresno County, where *Monolopia congdonii* occurs, human population growth and urbanization have steadily increased. For the period between 1990 and 2000, population growth in Fresno County increased 16.5 percent (California Department of Finance 2007). (USFWS, 2010)

Stressor: Oil and gas extraction and conveyance (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Oil and gas extraction and conveyance continue to threaten *Monolopia congdonii*. Adverse effects of oil and gas development on *M. congdonii* include the loss of habitat, change in habitat quality, destruction of individuals or populations and their seedbank, habitat fragmentation, and increased competition from nonnative plant species due to habitat degradation. On the BLM lands where *Monolopia congdonii* occurs, oil and gas exploration is also a threat to the species' survival and recovery. (USFWS, 2010)

Stressor: Habitat threats from solar power developments (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Solar power development projects pose potential threats to and may impact large amounts of habitat. These projects can destroy, fragment, or impact *Monolopia congdonii* habitat by: altering landscape topography, vegetation, and drainage patterns; and reducing habitat quality through interception of solar energy normally reaching the ground surface, affecting ambient air temperatures through habitat shading, and altering soil moisture regimes (Smith 1984; Smith et al. 1987 as cited in J.R. Single, CDFG. in litt. 2010). Moreover, recently proposed solar projects tend to be large contiguous blocks of disturbance in undeveloped habitat lands, ranging from hundreds to several thousand acres. (USFWS, 2010)

Stressor: Off road vehicle use

Exposure:

Response:

Consequence:

Narrative: Off road vehicle use for recreational purposes is among the threats to *Monolopia congdonii* recorded in the CNNDDB since 1990. The Kettleman Hills BLM population is reportedly under increasing threat from off road vehicle trespass (O'Dell in litt. 2007). Off road vehicle recreational use on Federal lands is often difficult to control due to limited staffing and area remoteness such as in the Kettleman Hills (O'Dell in litt. 2007). As of 2010, off road vehicle use continues to be a threat at Kettleman North Dome where BLM land is "checker-boarded" with Chevron oil fields. Chevron is making efforts to exclude off road vehicles by improving their fences and patrolling the area. There is also some existing threat of off road vehicle activity impact to the species and its habitat on Monocline Ridge, although this threat is lower than at the much more accessible Kettleman North Dome (O'Dell in litt. 2010). Off road vehicle use has been reported as a minor threat on the Carrizo Plain National Monument (BLM 2009). The threat of off road vehicle recreation use on private lands where *Monolopia congdonii* persists is unknown. (USFWS, 2010)

Stressor: Conservation measures (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The California Wildlife Conservation Board purchased 3,000 acres from TNC in December 1988 and 2,500 acres in 1989 to be managed by CDFG. Currently, the Carrizo Plain National Monument (formerly the Carrizo Plain Natural Area) contains over 200,000 acres of natural habitat. The Monument is jointly managed by the BLM, CDFG and The Nature Conservancy (TNC) (California Resources Agency 2008). Although, as discussed above, 130,000 acres within the Monument are open to potential oil and gas development. (USFWS, 2010)

Stressor: Grazing (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: In the final rule (55 FR 29361) we listed overgrazing (by domestic livestock) as a threat. Currently, we think that either the complete removal of grazing, uncontrolled grazing, or grazing that continues during the flowering time of *Monolopia congdonii* are threats to *M. congdonii*. Cattle grazing exclusion in one of BLM's populations in Jacalitos Canyon appears to have resulted in extirpation of that population, coincident with heavy accumulation of annual grass biomass (O'Dell in litt. 2010). The Bakersfield BLM office has noted the same effect of livestock exclusion resulting in plant number declines on part of population at Kettleman Middle Dome (O'Dell in litt. 2010). In contrast, cattle grazing on one of BLM's populations at Kettleman North Dome has maintained grass biomass low to the ground, which has greatly benefitted *Monolopia*, resulting in a population numbering in the thousands that is continuing to increase in size (O'Dell in litt. 2010). Grazing may be detrimental if it continues into the flowering period of *M. congdonii* (Cypher 1996). (USFWS, 2010)

Stressor: Herbivory (USFWS, 2010)

Exposure:

Response:**Consequence:**

Narrative: Herbivory by giant kangaroo rats has been shown to reduce the reproductive capacity of individual *Monolopia congdonii* plants by up to 30 percent. The intensity of the damage to individual plants is correlated with distance from a burrow (Mazer and Hendrickson 1993). *Monolopia congdonii* growing on kangaroo rat precincts has been noted and attributed to the suggestion that the species is a poor competitor with introduced annual grasses (Taylor 1989). On the Carrizo Plain, greater *M. congdonii* plant size and flower head production has been associated with giant kangaroo rat activity (Mazer and Hendrickson 1993) as have been earlier seed germination and maturation (Cypher 1994). (USFWS, 2010)

Stressor: Competition from non-native grasses (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: The southern San Joaquin Valley of California, as with much of western North America, has been invaded by nonnative plant species during the past 100 to 200 years. These include the following species: *Bromus rubens* (red brome), *Vulpia myuros* (mouse tail fescue), *Schismus arabicus* (Arabian grass), *Hordeum murinum* ssp. *glaucum* (known locally as foxtail and elsewhere as smooth barley), *Bromus diandrus* (ripgut brome), and *Bromus hordeaceus* (soft chess) (Biswell 1956; Heady 1977; Germano et al. 2001). These introduced grasses often germinate with the first October rains (J. Jones, Live Oak Associates, pers. comm. 2007) and become established before *Monolopia congdonii* seeds germinate. This allows nonnative plants to out-compete native plant species for water, nutrients, and sun light and places *M. congdonii* at a reproductive disadvantage. An overabundance of residual thatch from the previous year's nonnative grass production can have similar adverse effects by shading out or obstructing *M. congdonii* seedlings. Competition from nonnative grasses affects *Monolopia congdonii* on both private and public lands including the Carrizo Plain National Monument. (USFWS, 2010)

Stressor: Nitrogen deposition/landscape nitrification (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: Elevated atmospheric nitrogen (N) deposition is particularly harmful to N-limited ecosystems such as *Monolopia congdonii* habitat in the arid southern San Joaquin Valley where it leads to increases in nonnative annual grasses which outcompete the native flora (Fenn et al. 2003). Dry nitrogen deposition estimates for Bakersfield, Kern County near a CNDDB *Monolopia congdonii* occurrence, are 10 to 20 kilograms of N per hectare per year (22 to 44 pounds of N per 2.5 acres per year) (Blanchard et al. 1996). Nitrogen limited ecosystems of the western United States, such as the arid/semi-arid San Joaquin Valley, are adversely affected by N deposition as low as 3 to 8 kilograms of N per hectare per year (7 to 18 pounds of N per 2.5 acres per year) (Fenn et al. 2003). (USFWS, 2010)

Stressor: Trampling by livestock and soil compaction (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: Trampling by livestock reduces survival of *Monolopia congdonii* in areas where livestock congregate, such as around water troughs. Trampling from livestock is a threat when it reduces or eliminates the reproductive ability of the plant by, for example, damaging blossoms or seeds. Soil compaction resulting from domestic livestock may be less of an effect in habitat areas where soils have a low clay fraction than in soils with a high clay fraction. In some areas, such as the valley floor, *M. congdonii* is typically found on sandy or sandy loam soils (Service 1998). The Kimberlina soil series, which the plant is known to occupy, consists of very deep, well drained soils on flood plains and recent alluvial fans (Natural Resources Conservation Service 2003). In other types of soil, compaction is likely a threat to individual *Monolopia congdonii*. (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The change in global climate presents a threat to *Monolopia congdonii*. Climate models predict for California an overall warming of 1.7 degrees to 5.8 degrees Celsius (3.0 degrees Fahrenheit to 10.4 degrees Fahrenheit) by 2100 (Cayan et al. 2006) but vary in their predictions for precipitation. VanRheenen et al. (2004), however, predicts a decrease in precipitation in the southern San Joaquin Valley. Any significant changes in temperature or precipitation could have drastic effects on *M. congdonii* populations. Climate change will likely result in changes in the vegetative communities of *M. congdonii* habitat and potentially increase nonnative species. However, there is insufficient data available at this time to predict the specific effects of climate change on *M. congdonii*. (USFWS, 2010)

Recovery

Reclassification Criteria:

1. 95 percent of occupied habitat on public land is secured and protected from incompatible uses. (USFWS, 2010)
2. A management plan is approved and implemented for recovery areas that include survival of the species as an objective. (USFWS, 2010)
3. Population monitoring in specified recovery areas shows stable or increasing numbers in all protected areas through one precipitation cycle. (USFWS, 2010)

Delisting Criteria:

1. 640 acres (260 hectares) or more of occupied habitat in the Lost Hills (Kern County) and one or more other sites on the San Joaquin Valley floor of 640 acres or more has been secured and protected from incompatible uses. (USFWS, 2010)
- 2) Population monitoring in specified recovery areas shows no decline after downlisting, if declining, determine cause and reverse trend. (USFWS, 2010)
- 3) Though not explicitly stated, the delisting criteria include meeting all of the downlisting criteria (Service 1998). (USFWS, 2010)

Recovery Actions:

- Develop and implement a regional cooperative program and participation plan. (USFWS, 1998)
- Protect and secure existing populations. (USFWS, 1998)
- Determine distributions and population statuses of featured species. (USFWS, 1998)
- Conduct important research and monitoring. (USFWS, 1998)
- Maintain and establish linkages in existing natural lands and between islands of habitat on the Valley floor and natural lands around the fringe of the Valley. (USFWS, 1998)
- Apply adaptive management to protected areas (Priority 3). (USFWS, 1998)
- If necessary, reintroduce selected featured species to appropriate habitat within their historic range. (USFWS, 1998)
- Periodically review the status of candidates and species of concern to determine if listing as endangered or threatened is necessary. (USFWS, 1998)

Conservation Measures and Best Management Practices:

- Protect existing habitat in the San Joaquin Valley for *Monolopia congdonii*. (USFWS, 2010)
- Conduct surveys to determine trends in the range-wide status of the species and population abundance. (USFWS, 2010)
- Collect seeds from multiple populations adhering to the Center for Plant Conservation Guidelines (1991). Store seeds in facilities certified by the Center for Plant Conservation. (USFWS, 2010)
- When BLM revises the ACEC management plan, address invasive species, wildlife habitat improvements, and the protection/enhancement of special status species throughout the Panoche-Coalinga ACEC. Ensure that habitat can be protected in blocks of at least 160 acres and buffer zones of 500 feet or more are protected beyond the occurrence margins of *Monolopia congdonii* to reduce external influences and to allow for plant population expansion. (USFWS, 2010)
- Conduct research to determine the degree or intensity of threat from livestock grazing to the plant and its habitat. Include the variables of cattle stocking rate, relative weight or size of animals, numbers, and cattle sheltering or shade selection behavior. (USFWS, 2010)

References

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USFWS. 2010. *Monolopia* (=Lembertia) *congdonii* (San Joaquin woolly-threads). 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Sacramento Fish and Wildlife Office Sacramento, California

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SPECIES ACCOUNT: *Mucuna sloanei* var. *persericea* (sea bean)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

A short-lived perennial vine in the pea family (Fabaceae). (NatureServe, 2015)

Taxonomy

Mucuna sloanei var. *persericea* was published in the Kew Bulletin, Vol. 45(1):27, 1990. Neither Kartesz's 1994 checklist nor his 1999 synthesis address the variety (even in synonymy or in excluded names). The Hawaii Heritage Program tracks it as a Hawaiian endemic. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Endemic to East Maui from Makawao to Wailua Iki (Wagner et al. 2012). (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Mucuna sloanei* *persericea* (sea bean) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one detailed critical habitat unit (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Mucuna sloanei* *persericea* includes one CHU in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Lowland Wet—Unit 1 (and) *Palmeria dolei*—Unit 2—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 2— Lowland Wet This area consists of 6,616 ac (2,677 ha) of State land, 7,425 ac (3,005 ha) of privately owned land, and 2,038 ac (825 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Kipahulu Valley on the northern and eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia samuelii*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *M. ovalis*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 1 is not known to be occupied by the plants *Clermontia oblongifolia* ssp. *mauiensis*, *C. peleana*, *Mucuna sloanei* var. *persericea*, *Phyllostegia haliakalae*, or *Wikstroemia villosa*, or by

the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Mucuna sloanei persericea* critical habitat consists of one component. Lowland wet (east Maui) (81 FR 17790-18110):

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their

conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylothea* ssp. *pentamera*, *B. campylothea* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkii*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources**Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest-hardwood, forest/woodland (NatureServe, 2015)

Habitat Narrative

Adult: *M. sloanei* var. *persericea* ranged from Makawao to Wailua Iki, on the windward slopes of the east Maui mountains (Wagner et al. 2005a—Flora of the Hawaiian Islands database).

Currently, there are possibly a few hundred individuals in the lowland wet ecosystem on east Maui (Duvall 2010, in litt.; Hobdy 2010, in litt.). (USFWS, 2016)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Low (inferred from USFWS, 2016)

Redundancy:

Low (inferred from USFWS, 2016)

Number of Populations:

5 (USFWS, 2016)

Population Size:

~200 (USFWS, 2016)

Population Narrative:

Currently, there are possibly a few hundred individuals in five occurrences: Ulalena Hill, north of Kawaipapa Gulch, lower Nahiku, Koki Beach, and Piinau Road, all in the lowland wet ecosystem on east Maui (Duvall 2010, in litt.; Hobdy 2010, in litt.). (USFWS, 2016)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:**Consequence:**

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs and cattle), nonnative plants, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: Predation and herbivory by nonnative animal species (pigs, cattle, and rats) is considered an ongoing threat to *Mucuna sloanei persericea* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor:**Exposure:****Response:****Consequence:****Narrative:*****Recovery*****Reclassification Criteria:**

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

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USFWS. 2013. Determination of Endangered Status for 38 Species on Molokai, Lanai, and Maui

Final Rule. 78 Federal Register 102, May 28, 2013. Pages 32014 - 32065.

SPECIES ACCOUNT: *Myrcia paganii* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 2/18/1994; Southeast Region (R4) (USFWS, 2015)

Physical Description

An evergreen tree which may reach 9 meters and 13 centimeters in diameter. The bark is mottled and flaky, and the inner bark is orange-brown. Young twigs are flattened and have numerous soft brownish hairs. The leaves are opposite, simple, entire, coriaceous, aromatic, and glandular punctate below. The leaf blade is elliptic to elliptic-oblong, villous when young but glabrescent, 10 to 16 centimeters long, and 4 to 9 centimeters wide. The leaf base is acute, the apex obtuse, and the midvein is clearly impressed above. Petioles are 4 to 5 millimeters long. The flowers and fruit have not been described (USFWS, 1996). New in 2016: May reach 20 m in height (Little et al. 1974, Liogier 1994). (USFWS, 2016).

Taxonomy

In the Myrtaceae family (USFWS, 1996).

Historical Range

First collected south of the city of Arecibo, located in northern Puerto Rico. (USFWS, 1996)

Current Range

Currently known from 3 locations in the limestone hill region of the northwestern part of Puerto Rico (USFWS, 1996).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Biotic (EPA, 2016)

Key Resources Needed for Breeding

Adult: Insects for pollination (EPA, 2016).

Reproduction Narrative

Adult: Little is known about the reproductive biology of *Myrcia paganii*. The plant has not been collected in flower or fruit and seedlings have not been observed (USFWS, 1996). Pollination occurs via insects (EPA, 2016).

Habitat Type

Adult: Terrestrial (USFWS, 1996)

Habitat Vegetation or Surface Water Classification

Adult: Seasonal evergreen or semi-evergreen forest (USFWS, 1996)

Dependencies on Specific Environmental Elements

Adult: shallow, well-drained, alkaline soils (USFWS, 1996)

Habitat Narrative

Adult: Habitat is seasonal evergreen or semi-evergreen forest types of the subtropical moist forest life zone in the limestone region of north and northwestern Puerto Rico (Ewel and Whitmore 1973). This area receives from 175 to 200 centimeters of rainfall per year, with the dry season extending from January to March and the wet season from May through November (Vivaldi and Woodbury 1981). Species is found in soils that are shallow, well-drained, alkaline and interspersed between outcrops of hard limestone. The limestone outcrops may cover up to 75 percent of the surface (USFWS, 1996). Grows at elevations of 150 to 250 m (492-820 ft) on steep hills and top of hills (USFWS 1997, Axelrod 2011, Trejo-Torres et al. 2011). The recent record of the species within the Toro Negro Commonwealth Forest (subtropical wet forest; Ewel and Whitmore 1973).... represents the first record of the species occurring on volcanic derived soils. (USFWS, 2016).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: No information is available about the dispersal of *Myrcia paganii*. The plant has not been collected in flower or fruit and seedlings have not been observed (USFWS, 1996). Potential fruit type is berry/loculicidal capsule (EPA, 2016).

Additional Life History Information

Adult: berry/globulicidal capsule

Population Information and Trends**Population Trends:**

Not available.

Redundancy:

Low (inferred from USFWS, 1996)

Number of Populations:

3 (USFWS, 1996)

Population Size:

8 individuals total (USFWS, 1996)

Population Narrative:

Little is known concerning the population structure of *Myrcia paganii*. Six individuals are known from a privately owned site, with one individual at each of two additional locations (USFWS, 1996). New in 2016: According to Trejo-Torres et al. (2011), in 2001 Pedro Acevedo (U.S. National Herbarium, Smithsonian National Museum of Natural History) and Danilo Chinaa (UPRM) found a population of 10 individuals in the Biáfara sector in Arecibo. In 2005, during a

flora and fauna study for the Senderos de Miraflores project in the Biáfara sector, Ruiz-Lebrón and Puente-Rolón also reported two populations of *M. paganii* comprised of 12-20 individuals (Departamento de la Vivienda de Puerto Rico 2009). In work conducted during 2002-2006, Trejo-Torres et al. (2011) found a total of 103 individuals of *M. paganii*. Ninety four of these individuals were found in four different areas within the northern karst region of Puerto Rico: Guajataca Commonwealth Forest (50 individuals, some were seedlings, number not specified), the private natural reserves of Mata de Plátano and El Tallonal (22 individuals), Biáfara sector, Arecibo (18 individuals; same population found by Acevedo and China in 2001), and Piedra Gorda Ward, Plazuela sector in Camuy (4 individuals). Nine other individuals were found in 2006 by M. Caraballo (UPRRP) in the Toro Negro Commonwealth Forest (Trejo-Torres et al. 2011). In addition, J. Sustache (PRDNER, pers comm. 2015) provided information to the Service regarding the location of *M. paganii* in Quebradillas (1 sterile individual found at one of the proposed routes for highway PR-22), and El Tallonal (19 individuals, including adults and juveniles). According to J. Sustache, he does not have the specific location of the individuals at El Tallonal, thus we are not certain these are the same individuals reported by Trejo-Torres et al. (2011). (USFWS, 2016).

Threats and Stressors

Stressor: Habitat modification or destruction (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Two populations of *Myrcia paganii* are found on privately owned land currently subject to intense pressure for agricultural, rural and tourist development. Adjacent land is being cleared for grazing by cattle and goats. One individual has been reported from the Guajataca Commonwealth Forest, where it may be affected by forest management practices (USFWS, 1994).

Stressor: Vandalism and collection (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: The number of individuals of *C. thomasi* and *M. paganii* is so small that vandalism and collection could seriously affect the survival of these species (USFWS, 1994).

Stressor: Natural factors (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Because so few individuals are known to occur in a limited area, the risk of extinction is extremely high. Hurricane Hugo in 1989 dramatically affected the Monte Pirata area of Vieques, felling large trees and creating numerous canopy gaps (USFWS, 1994).

Stressor: Climate change (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Vulnerability to climate change impacts is a function of sensitivity and exposure to those changes, and the adaptive capacity of the species (Glick et al. 2011). Under this scenario, the populations of *M. paganii* may be displaced or outcompeted by native or exotic species with wider environmental plasticity. Climate change may also compromise natural recruitment by affecting seed germination and/or the survival of seedlings. (USFWS, 2016).

Stressor: Genetic variation (USFWS, 2016).

Exposure:

Response:

Consequence:

Narrative: Given the very small numbers of individuals reported in wild populations of *M. paganii*, it is highly likely that its genetic variability is very low. This would result in a loss of alleles by random genetic drift (Honnay and Jacquemyn 2007), which would limit the species' ability to respond to a changing environment (Booy et al. 2000). Also, there may be genetic differences among populations. (USFWS, 2016).

Stressor: Phenology and Breeding system (USFWS, 2016).

Exposure:

Response:

Consequence:

Narrative: The reproductive biology of *M. paganii* is unknown, and we believe that the small and isolated populations may be affected by lack of natural recruitment. Many Myrtaceae flower sporadically and for very short periods of time. If the species is self-incompatible (not able to self-pollinate), its sexual reproduction would be severely limited. Thus, we consider the reproductive biology of the species and the small size of populations as threats to the species. (USFWS, 2016).

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

1. Populations on privately owned land are placed under protective status (USFWS, 1996).
2. New populations (the number of which should be determined following the appropriate studies) capable of self perpetuation have been established in protected areas such Commonwealth Forests of the limestone hill region (USFWS, 1996).

Recovery Actions:

- Protect the existing populations known from privately owned land (USFWS, 1996).
- Develop management plans for known populations (USFWS, 1996).
- Monitor known populations (USFWS, 1996).
- Enforce existing Commonwealth and Federal endangered species regulations (USFWS, 1996).
- Educate the public on conservation values and regulations (USFWS, 1996).

- Conduct research on the life history of the species and evaluate propagation techniques (USFWS, 1996).
- Conduct propagation and enhance existing populations or establish new ones on protected lands (USFWS, 1996).
- 2016 recommended actions (some overlap with prior actions) - 1: The recovery of *M. paganii* should focus on the protection of known populations and their habitat. (USFWS, 2016).
- 2016 - 2: Conduct studies to determine the current status of wild populations. Additional visits should be made after hurricanes or other major disturbances. (USFWS, 2016).
- 2016 - 3: Conduct studies on the species' phenology and reproductive biology, including its breeding system. (USFWS, 2016).
- 2016 - 4: Conduct studies to determine the genetic variation in order to develop a plan to preserve the species' germplasm. (USFWS, 2016).
- 2016 - 5: Currently known populations should be enhanced using seeds if available or vegetative propagation (e.g., air layering, tissue culture, etc.) if necessary. Ideally, the species' patterns of genetic variation should be known first. (USFWS, 2016).

Conservation Measures and Best Management Practices:

- Not available.

References

USFWS. 2015. Environmental Conservation Online System (ECOS) – Species Profile. <http://ecos.fws.gov/speciesProfile/>. Accessed April 2016

U.S. Fish and Wildlife Service. 1996. *Myrcia paganii* and *Auerodendron pauciflorum* Recovery Plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 17 pp.

USFWS. 2016. *Myrcia paganii* 5-Year Review: Summary and Evaluation. USFWS, Southeast Region, Boqueron, Puerto Rico. 13 pp.

EPA 2016. Chapter 1: Draft Chlorpyrifos Problem Formulation for ESA Assessment. Attachments 1-11, 1-12, 1-13, 1-14, 1-15, 1-20 and 1-21. <https://www.epa.gov/endangered-species/biological-evaluation-chapters-chlorpyrifos-esa-assessment#chapter 1>

USFWS. 1994. Determination of Endangered Status for *Myrcia paganii* and *Calyptanthus thomasi*

Final Rule. 59 Federal Register 34. February 18, 1994. Pages 8138 - 8142.

USFWS. 2016. *Myrcia paganii* 5-Year Review: Summary and Evaluation. USFWS, Southeast Region, Boqueron, Puerto Rico. 13 pp.

SPECIES ACCOUNT: *Myrsine fosbergii* (Kolea)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2017)

Physical Description

Myrsine fosbergii is a branched shrub or small tree 6.7 to 13 feet (ft) (2 to 4 meters (m)) tall. Branches are dark reddish brown and glabrous. Leaves are dark green, dark purple at the base, clustered at the tips of the branches, narrowly elliptic, and glabrous. Flowers are perfect or possibly unisexual (dioecious), arising on short woody knobs among the leaves. Drupes are purplish black, globose, and 0.2 to 3.5 inches (in) (6 to 9 millimeters (mm)) in diameter (Wagner et al. 1999, p. 940).

Taxonomy

Kingdom: Plantae; Phylum: Anthophyta; Class: Dicotyledoneae; Order: Primulales; Family: Myrsinaceae (Collic wood). *Myrsine fosbergii* was described by Hosaka (1940, pp. 46-47). This species is recognized as a distinct taxon in Wagner et al. (1999, p. 40) and Wagner and Herbst (2003, p. 940), the most recently accepted Hawaiian plant taxonomy. There is some question regarding the taxonomy of the individuals of *M. fosbergii* found on Kauai, and without those collections, the species would be endemic to Oahu with fewer than 50 individuals (Lau 2012, pers. comm. in Conry, in litt. 2012).

Historical Range

Historically known from the Koolau Mountains of Oahu at the Puu Lanihuli and Kuliouou summit ridges (HBMP 2008). It was never observed or collected on Kauai before 1987, but it is assumed to have been there historically.

Current Range

Currently known from widely scattered populations along the Koolau summit ridge on Oahu from Schofield to Puu Kahuaui. On Kauai, this species is known from the Wahiawa Mountains and Wahiawa Drainage Basin, Kawaiula Valley, Limahuli Valley, Namolokama, Kalalau, Hanakapiai, and Mt. Haupu (HBMP 2008; Wood, in litt. 2005; 2007).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Habitat Type

Adult: Wet shrublands and forests on windswept ridges and slopes, usually in the cloud zone. Also in moist forests (Kauai).

Habitat Vegetation or Surface Water Classification

Adult: Forest - Hardwood; Forest/Woodland, Shrubland/Chaparral

Environmental Specificity

Adult: Unknown

Habitat Narrative

Adult: Typical habitat on Kauai is *Metrosideros-Diospyros* (ohia-lama) lowland mesic forest and *Metrosideros-Cheirodendron montane* (ohia-olapa) wet forest, often on watercourses or stream banks, between 900 and 4,300 ft (274 to 1,311 m) elevation (Hawaii Biodiversity and Mapping Program (HBMP 2008). Typical habitat on Oahu is *Metrosideros*-mixed native, wet shrubland between 2,200 and 2,800 ft (671 and 853 m) elevation (HBMP 2008).

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Declining

Species Trends:

Unknown

Number of Populations:

14 on Kauai (9) and Oahu (5)

Population Size:

Oahu: < 30; Kauai: 55 (USFWS, 2016)

Population Narrative:

This species is currently known from 14 populations, totaling a little more than 100 individuals observed during surveys conducted as recently as 2010. We are unaware of additional surveys conducted to date. Nine populations totaling approximately 55 individuals are on Kauai at Wahiawa Drainage Basin (47 individuals), east Kalalau (1 individual), upper Limahuli Valley (1 individual), Namolokama (1 individual), Hanakapiai (1 individual), the Iole headwaters (1 individual), east of Sincok bogs (1 individual), Waialeale summit bogs (1 individual), and at Mt. Haupu (1 individual); and five populations totaling 48 individuals in the Koolau mountains of Oahu at the Moanalua summit (21 individuals), Halawa summit (4 individuals), along the summit crest between Eleao and Waimano trail (6 individuals), Punaluu summit (2 individuals), and the Kaipapau-Puu Kainapuaa summit (15 individuals) (U.S. Army 2006; HBMP 2008; Kawelo, in litt. 2010; Kawelo, in litt. 2011). There is some question regarding the taxonomy of the individuals of *Myrsine fosbergii* on Kauai, and without these individuals, *M. fosbergii* would be endemic to Oahu with fewer than 50 individuals (Lau 2012, pers. comm. in Conry, in litt. 2012). Currently, on Oahu, there are fewer than 30 individuals in the Koolau Mountains (lowland mesic and lowland wet ecosystems) (HBMP 2010; OTFM 2014, in litt.; Reynolds 2015, in litt.; Sailer 2015, in litt.). Propagation attempts of the Oahu plants have been unsuccessful (Ching Harbin 2015, in litt.). On Kauai, this species was once widely scattered in the northwest and central areas, but is currently known from only 55 remaining individuals (Wood 2005e and 2007c, in litt.; HBMP 2010) (USFWS, 2016).

Threats and Stressors

Stressor: Feral pigs and goats

Exposure: Habitat degradation and destruction

Response:

Consequence:

Narrative: *Myrsine fosbergii* is threatened by feral pigs (*Sus scrofa*) and goats (*Capra hircus*) that degrade and destroy habitat (HBMP 2008). On Kauai, evidence of the activities of feral pigs has been reported at the Wahiawa, Sincok Bogs, Mt. Haupu, and Iole headwaters populations (HBMP 2008; Wood, in litt. 2005 and 2007), and evidence of the activities of feral goats has been reported at the Kalalau (east) and Iole headwaters populations (HBMP 2008). On Oahu, evidence of the activities of feral pigs has been reported at the Puu Kainapuaa and Eleao to Waimano Trail summit populations (HBMP 2008).

Stressor: Feral pigs and goats

Exposure: Predation

Response:

Consequence:

Narrative: Predation by feral pigs and goats is a likely threat to *Myrsine fosbergii* (HBMP 2008; Wood, in litt. 2005 and 2007). In a study conducted in the 1980s, feral pigs were observed browsing on young shoots, leaves and fronds of a wide variety of plants, of which over 85 percent were endemic species (Diong 1982, p. 138). A stomach content analysis in this study showed that the pigs' food sources consisted of native plants, 60 percent of which were *Cibotium* spp. (tree ferns), alternating with *Psidium cattleianum* when it was available. Pigs were observed felling and removing the bark of *Clermontia*, *Cibotium*, *Coprosma*, *Psychotria*, and *Hedyotis* species (herbaceous and woody plants), and causing enough damage to kill larger trees over a few months of repeated feeding (Diong 1982, pp. 138, 144). Goats browse on introduced grasses and native plants, and are able to reach more remote and inaccessible areas than other ungulates. They thrive on a variety of food plants, and are instrumental in the decline of native vegetation in many areas (Cuddihy and Stone 1990, pp. 40, 61, 63-64).

Stressor: Nonnative plants

Exposure: Degradation of habitat and competition

Response:

Consequence:

Narrative: *Myrsine fosbergii* is threatened by alien weeds that compete with it and degrade habitat (HBMP 2008). Several studies (Cuddihy and Stone 1990, p. 74; Wood and Perlman 1997, p. 18; Robichaux et al. 1998, p. 4) indicate nonnative plant species may outcompete native plants similar to *M. fosbergii*. Competition may be for space, light, water, or nutrients, or there may be a chemical produced that inhibits growth of other plants. In addition, nonnative pest plants found in habitat similar to that of this species have been shown to make the habitat less suitable for native species (Smith 1985, pp. 240-241; Loope and Medeiros 1992, pp. 7-8; Medeiros et al. 1992, p. 30; Ellshoff et al. 1995, pp. ii, 3-4; Meyer and Florence 1996, p. 778; Medeiros et al. 1997, pp. 23-24; Loope et al. 2004, p. 1,472). In particular, alien pest plant species degrade habitat by modifying availability of light, altering soil-water regimes, modifying nutrient cycling, or altering fire characteristics of native plant communities (Smith 1985, pp. 227-230; Cuddihy and Stone 1990, p. 74; Vitousek et al. 1997, pp. 6-10). Because of demonstrated habitat modification and resource competition by nonnative plant species in habitat similar to the wet forest habitat of *M. fosbergii*, the FWS believes nonnative plant species are a threat to this species.

Stressor: Hybridization (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Hybridization is a threat to this species, as *M. fosbergii* hybridizes with other *Myrsine* species, and the number of non-hybrid individuals may actually be lower than estimated (Ching Harbin 2015, in litt.) (USFWS, 2016).

Stressor: Climate change (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013, p. 82) found that, as environmental conditions are altered by climate change, *M. fosbergii* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions (USFWS, 2016).

Recovery

Recovery Actions:

- Survey for populations of *Myrsine fosbergii* in areas of potentially suitable habitat.
- Verify taxonomic status of individuals on Kauai.
- Control feral pigs and goats by removing these species from areas where *M. fosbergii* populations exist
- Prevent reinvasion of feral pigs and goats through the use of exclosures.
- Control alien plants through physical, mechanical, and biological control methods, as well as herbicides when necessary.
- Conduct research into potential biocontrol species.
- Continue propagation efforts for maintenance of genetic stock.

Conservation Measures and Best Management Practices:

- Control feral pigs and goats by removing these species from areas where *M. fosbergii* populations exist
- Prevent reinvasion of feral pigs and goats through the use of exclosures.
- Control alien plants through physical, mechanical, and biological control methods, as well as herbicides when necessary.
- Continue to conduct propagation efforts for maintenance of genetic stock.

References

USFWS. 2014. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for *Myrsine fosbergii* (kolea), Pacific Region, 16 p.

USFWS. 2017. Environmental Conservation Online System (ECOS) – Species Profile.
<http://ecos.fws.gov/ecp0/>. Accessed March 2017.

USFWS 2014. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for *Myrsine fosbergii* (kolea), Pacific Region, 16 p.

USFWS. 2016. Endangered and Threatened Wildlife and Plants

Endangered Status for 49 Species From the Hawaiian Islands. Final rule. 81 FR 67786 - 67860 (September 30, 2016).

SPECIES ACCOUNT: *Myrsine juddii* (Kolea)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

Myrsine juddii is a short-lived perennial in the Myrsinaceae (myrsine family). This species is a many branched shrub ranging from 1 to 2 m (3.5 to 6.6 ft) tall with leathery, lanceshaped to elliptic, narrowly inverse leaves 4 to 12 cm (1.6 to 4.7 in.) long and 1.5 to 3.2 cm (0.6 to 1.3 in.) wide. The leaf base is broadly wedge-shaped to heart-shaped, and the margins are smooth and curl under. The upper leaf surface is hairless, whereas the lower surface is sparsely to moderately covered with short, coarse, stiff, whitish or brownish hairs toward the base and along the midrib. The midrib is prominent and lateral veins are moderately conspicuous. The flowers are unisexual (dioecious with male and female flowers are on separate plants) and occur in groups of four to eight in tight clusters surrounded by small bracts. The yellowish green petals are narrowly inverse lance-shaped, 2.8 to 3.2 mm (0.1 in.) long and with short hairs, becoming smooth. The fleshy, round drupe contains a single seed. This species is distinguished from others in the genus by the hairiness of the lower leaf surface and the shape of the leaf base (Service 1998a; Wagner et al. 1999).

Historical Range

See current range/distribution

Current Range

Myrsine juddii has been reported from only three occurrences in the central Koolau Mountains: the north Kaukonahua-Kahana summit divide, Peahinaia trail, and Puu Kainapuaa to Poamoho trail. Currently, one occurrence of approximately 3,000 M. *juddii* are known in the wild. It is located between Puu Kainapuaa and north Kaukonahua in the Koolau Mountains (U.S. Army 2003a; J. Lau, HINHP, pers. comm. 2003; K. Kawelo, U.S. Army, pers. comm. 2003).

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Myrsine juddii* (Kolea) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Myrsine juddii* (77 FR 57648-57862). The critical habitat designation includes 11 critical habitat units, which encompass approximately 25,112 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Myrsine juddii* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Myrsine juddii* includes 11 critical habitat units, covering one ecosystem type, which encompasses approximately 25,112 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16.

Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Haula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikēē, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet—Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet—Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu—Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 ac (246 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamo Ridge.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Myrsine juddii* critical habitat consists of the

following components according to ecosystem type (77 FR 57648-57862). Note: *Myrsine juddii* occurs within the indicated ecosystem in the Koolau Mountain caldera complex:

Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (F) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Myrsine juddii* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: This plant species has unisexual flowers, but very little is known about the life history requirements of this species (U.S. Army 2003a; HINHP Database 2001; Service 1998a; 61 FR 53089).

Habitat Type

Adult: Wet forests and shrublands

Habitat Narrative

Adult: *Myrsine juddii* typically grows on ridge crests and gulch slopes in wet forests and shrublands dominated by *Metrosideros polymorpha* or a mixture of *M. polymorpha* and *Dicranopteris linearis* at elevations between 384 and 867 m (1,260 and 2,844 ft). Associated native plant species include *Cheirodendron platyphyllum*, *Cheirodendron trigynum*, *Machaerina* sp., *Melicope clusiifolia*, *Psychotria mariniana*, and *Syzygium sandwicensis*.

Dispersal/Migration

Population Information and Trends

Resiliency:

Fragility unknown. (NatureServe, 2015)

Representation:

Fragility unknown. (NatureServe, 2015)

Redundancy:

Fragility unknown. (NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Adaptability:

Fragility unknown. (NatureServe, 2015)

Population Narrative:

Fragility unknown. The total number of plants known is hundreds or a few thousand. The total number of plants is believed to be less than 3,000. 2 current (between 1982 and 1997) and 1 historical occurrence. (NatureServe, 2015)

Threats and Stressors**Stressor:****Exposure:****Response:****Consequence:**

Narrative: The primary threats to the species are feral pigs and alien plants. (NatureServe, 2015)

Recovery**References**

USFWS 2016. Status of the Species and Critical Habitat: *Myrsine juddii* (Kolea). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016.

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

U.S. Fish and Wildlife Service. 2012. Endangered and Threatened Wildlife and Plants

Endangered Status for 23 Species on Oahu and Designation of Critical Habitat for 124 Species. Final Rule. 77 FR 57648-57862 (September 18, 2012)

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A."

SPECIES ACCOUNT: *Myrsine knudsenii* (Kolea)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (R1) (USFWS, 2016)

Physical Description

A tree or shrub, 1.5 - 4.5 m tall. Flowers are borne in clusters along the stems (NatureServe, 2015).

Taxonomy

A member of the myrsine family (Myrsinaceae) (USFWS, 2010b). The genus is found throughout tropical and subtropical regions of the world; this species is endemic to Kauai (NatureServe, 2015).

Historical Range

Historically, *M. knudsenii* was found in Hanapepe Valley in southcentral Kauai; Kawaiula Trail in western Kauai; and Awaawapuhi, Kumuwela, Honopu, and Nualolo in the Kokee region of the island of Kauai (Wagner et al. 1999, p. 941) (USFWS, 2010b).

Current Range

Currently, the species is known from Honopu, Awaawapuhi, and Nualolo (Kauai) (S. Perlman 2007; Wood et al. 2001, p. 10; Wood et al. 2002, p. 15; HBMP 2007; Wood 4907 (BISH)) (USFWS, 2010b).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Myrsine knudsenii* (Kolea) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Myrsine knudsenii* includes three CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Montane Mesic—Section 1: Montane Mesic—Section 1 consists of 2,423 ac (980 ha) in the montane mesic ecosystem, including the area above Honopu Valley to Mahanaloa Valley, on State owned land in Kokee State Park, the Na Pali-Kona Forest Reserve, and Kuia NAR (Figure 3-A). The entire section is within previously designated critical habitat for the plant species, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70c, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Labordia helleri*, *Myrsine knudsenii*, *Platydesma rostrata*, *Psychotria grandiflora*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*. This section is also occupied by the akekee and the picture-wing fly; maps of critical habitat for these species can be found at 50 CFR 17.95(b) for the akekee and akikiki (Unit 1—Montane Mesic), and at 50 CFR 17.95(i) for the picture-wing fly (Unit 1—Montane Mesic). This section also contains unoccupied habitat that is

essential to the conservation of these nine species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the montane mesic forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane mesic ecosystem (Table 3), as well as species-specific PCEs for the akekee and akikiki (arthropod prey) and picture-wing fly (the larval-stage host plants, *Cheirodendron* sp. and *Tetraplasandra* sp.). Although Montane Mesic–Section 1 is not known to be occupied by the species *Diellia mannii*, *Myrsine mezii*, and the akikiki, we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Montane Mesic—Section 2: Montane Mesic–Section 2 consists of 376 ac (152 ha) in the montane mesic ecosystem and includes a portion of the area surrounding a tributary of Nawaimaka Stream east to Kumuwela Ridge (Figure 3-A, above). The entire section is State-owned within Kokee State Park, and includes 8 ac (3 ha) of newly designated critical habitat. This section is occupied by *Diellia mannii* and the picture-wing fly *Drosophila sharpi*, and includes the montane mesic forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane mesic ecosystem (Table 3), as well as the larval-stage host plants (*Cheirodendron* sp. and *Tetraplasandra* sp.) associated with the picture-wing fly. This section also contains unoccupied habitat that is essential to the conservation of these two species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Montane Mesic–Section 2 is not known to be occupied by the plants *Chamaesyce remyi* var. *remyi*, *Labordia helleri*, *Myrsine knudsenii*, *Myrsine mezii*, *Platydesma rostrata*, *Psychotria grandiflora*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*, or by the birds the akekee and akikiki, we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range, as well as species-specific PCEs for the akekee and akikiki (arthropod prey). Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, that portion of the section that overlies previously designated critical habitat falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70c. The previously undesignated land comprises Critical Habitat Unit 21 of 50 CFR 17.99(a)(1), Map 217d. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 2–Montane Mesic), and for the picture-wing fly at 50 CFR 17.95(i) (Unit 2–Montane Mesic).

Kauai—Montane Mesic—Section 3: Montane Mesic–Section 3 consists of 139 ac (56 ha) in the montane mesic ecosystem, including the upper portion of the Nawaimaka Valley up to Kapukapaia Ridge, on State-owned land in the Na Pali-Kona Forest Reserve (Figure 3-B). This section is not in previously designated critical habitat and includes the only montane mesic forest occupied by the plant *Myrsine mezii*, and the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. Although Montane Mesic–Section 3 is not known to be occupied by the plants *Chamaesyce remyi* var. *remyi*, *Labordia helleri*, *Myrsine knudsenii*, *Myrsine mezii*, *Platydesma*

rostrata, *Psychotria grandiflora*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*; by the birds the akekee and akikiki; or by the picturewing fly *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. It also provides for the species-specific PCEs for the akekee and akikiki (arthropod prey) and the larval-stage host plants (*Cheirodendron* sp. and *Tetraplasandra* sp.) associated with *D. sharpi*. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, this section comprises Critical Habitat Unit 22 of 50 CFR 17.99(a)(1), Map 217e. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 3– Montane Mesic), and for the picturewing fly at 50 CFR 17.95(i) (Unit 3– Montane Mesic).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Myrsine knudsenii* critical habitat consists of one component (Montane mesic) (75 FR 18960-19165):

Ecosystem: Montane Mesic. Elevation: 3,300–5,243 ft (914–1,598 m). Annual precipitation: 50–75 in (127–190 cm). Substrate: weathered aa lava, rocky mucks, thin silty loams, deep volcanic ash soils. Canopy: *Acacia*, *Metrosideros*, *Psychotria*, *Tetraplasandra*, *Zanthoxylum*. Subcanopy: *Cheirodendron*, *Coprosma*, *Kadua*, *Ilex*, *Myoporum*, *Myrsine*. Understory: *Bidens*, *Dryopteris*, *Leptecophylla*, *Poa*, *Scaevola*, *Sophora*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs

and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Acacia koa-Metrosideros polymorpha-Dicranopteris linearis mesic forest (USFWS, 2010b)

Geographic or Habitat Restraints or Barriers

Adult: 3,200 - 3,900 ft. elevation (USFWS, 2010b)

Habitat Narrative

Adult: Inhabits moist forests on ridges and on gulch slopes. (NatureServe, 2015). Historically, the species may have been found in lowland mesic and lowland wet ecosystems, but currently it is only known from Acacia koa-Metrosideros polymorpha-Dicranopteris linearis mesic forest at elevations between 3,200 and 3,900 ft. (975 and 1,200 m) in the montane mesic ecosystem (Wagner et al. 1999, p. 941; Wood et al. 2002, p. 15; HBMP 2007; TNCH 2007) (USFWS, 2010b).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Very low (inferred from USFWS, 2010b; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2010a)

Number of Populations:

9 (USFWS, 2017)

Population Size:

40 (USFWS, 2017)

Population Narrative:

There are three populations totaling 30 individuals (USFWS, 2010a). Currently, there are nine occurrences totaling 40 individuals at Nualolo (four sites totaling 10 individuals), Awaawapuhi (two sites totaling 24 individuals), Honopu (two sites totaling three individuals), and Kalalau Rim (three individuals; HBMP 2010; PEPP 2017) (USFWS, 2017).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from non-native plants, pigs, goats, deer, hurricanes, and climate change. The effects of nonnative plants on

native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species.

Stressor: Predation and herbivory (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species present an immediate and significant threat to *Myrsine knudsenii* throughout its range due to documented browsing and trampling by pigs, goats, and deer, and documented mechanical damage by rats (USFWS, 2010).

Stressor: Small populations (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: *Myrsine knudsenii* is threatened by the effects of small population size (fewer than 50 wild individuals). Research on *Pittosporum* species suggests that small populations are susceptible to loss of genetic variation through inbreeding and drift (USFWS, 2010).

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor: Ungulate degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Feral pigs (*Sus scrofa*), goats (*Capra hircus*), and black-tailed deer (*Odocoileus hemionus*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil. Feral pigs, goats, and black-tailed deer are noted to be a threat to individuals of *Myrsine knudsenii* that occur at Honopu, Awaawapuhi, Berry Flats, and Nualolo (HBMP 2010; NTBG 1996a-d, 1998, 2001a-c, 2003a-c, 2004b-d, 2005, 2006, 2007, 2008a-b, 2010, 2013, 2015a-b; PEPP 2010, 2011, 2012, 2013, 2014, 2015) (USFWS, 2017).

Stressor: Established ecosystem-altering invasive plant modification and degradation of habitat

Exposure:

Response:

Consequence:

Narrative: —Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community. Invasive introduced plants with the greatest impacts on *Myrsine knudsenii* are: *Corynocarpus laevigatus* (karakanut), *Ehrharta stipoides* (meadow ricegrass), *Erigeron karvinskianus* (daisy fleabane), *Hedychium gardnerianum* (kahili ginger), *Kalanchoe pinnata* (air plant), *Lantana camara* (lantana), *Morella faya* (firetree), *Passiflora tarminiana* (banana poka), *Psidium cattleianum* (strawberry guava), *Rubus argutus* (prickly Florida blackberry), and *R. rosifolius* (thimbleberry) (BISH 2003a-b; HBMP 2010; NTBG 1996a-d, 1998, 2001a-c, 2004a, 2006, 2007, 2008a, 2015a-b) (USFWS, 2017).

Stressor: Hurricanes—Loss and degradation of habitat

Exposure:

Response:

Consequence:

Narrative: —In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013) (USFWS, 2017).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: —Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Myrsine knudsenii* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.981 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). *Myrsine knudsenii* is also classified as a “wink-out” species. “Wink-out” species are those species with no future climate envelope (i.e., no projected suitable climate areas exist for the species to persist in the future). The known individuals of *M. knudsenii* occur in a narrow range between Awaawapuhi and Honopu on Kauai, with no alternate habitat available. Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery

Reclassification Criteria:

In addition to achieving 5 to 10 populations with 500 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats (USFWS, 2017).

Delisting Criteria:

In addition to achieving 5 to 10 populations with 500 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis (USFWS, 2017).

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys (USFWS, 2010a).
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units (USFWS, 2010a).
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys (USFWS, 2010a).
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range (USFWS, 2010a).
- Conduct research on control methods for introduced slugs and avian malaria (USFWS, 2010a).
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction (USFWS, 2010a).
- Identify threats and prioritize which ones to address first for the two birds (USFWS, 2010a).

- Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program (USFWS, 2010a).
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security (USFWS, 2010a).
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems (USFWS, 2010a).
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations (USFWS, 2010a).
- Current Management Actions:
 - Captive propagation for genetic storage and reintroduction—Seed collections and cuttings of *Myrsine knudsenii* have been made and there are 20 plants in propagation from Awaawapuhi at the Kokee DOFAW nursery (DOFAW 2016). Lyon Arboretum Micropropagation Facility has representation from seven wild plants total from two populations (Lyon Arboretum 2017). There are a few dozen seeds each from Awaawapuhi and Honopu stored at the NTBG seed bank, plus over 100 seeds currently being sown at the NTBG nursery (NTBG 2017).
 - PEPP monitors and conducts nonnative plant control at known occurrences of *M. knudsenii*.
 - PEPP has reintroduced one plant into protected habitat in the Kalalau area.
 - Population viability monitoring and analysis is ongoing (PEPP 2011, 2015) (USFWS, 2017).
- RECOMMENDATIONS FOR FUTURE ACTIONS
 - Surveys and inventories—Survey for populations of *Myrsine knudsenii* in areas of potentially suitable habitat.
 - Ungulate monitoring and control—Protect all occurrences against browsing and disturbances from feral ungulates. Construct fence exclosures around all known populations.
 - Invasive plant monitoring and control
 - o Control established ecosystem-altering nonnative invasive plant species around all populations.
 - o Control invasive nonnative plant species around all populations that compete with the species.
 - Rodent predation or herbivory control—Implement effective measures to control rodents around all populations.
 - Captive propagation for genetic storage and reintroduction—Implement propagation efforts for maintenance of genetic stock.
 - Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.
 - Population biology research—Study *Myrsine knudsenii* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats.
 - Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms.
 - Based on the recovery criteria above, consider development of a recovery plan (USFWS, 2017).

Conservation Measures and Best Management Practices:

- This species is monitored by the Plant Extinction Prevention Program. The Plant Extinction Prevention Program focuses on those plant species with fewer than 50 individuals remaining in the wild. The goal of the program is to achieve the general interim recovery guidelines set by the Hawaii and Pacific Plants Recovery Coordinating Committee (1994), which are: 3 populations of 25 (long-lived species), 50 (short-lived), or 100 (annual) mature, reproducing individuals; all threats to those populations being managed; and all individuals are represented in genetic storage (USFWS, 2010a).

- This species is currently in controlled propagation for genetic storage and/or reintroduction efforts (USFWS, 2010a).
- The Hawaii Division of Forestry and Wildlife has established over 20 small-scale exclosures, largely in lowland and montane mesic ecosystems, and continues to control invasive introduced plants within them. While these fenced areas are extremely small, they have allowed for small-scale protection of remaining wild populations and reintroductions of *M. knudsenii*, preventing its extinction (Hawaii Division of Forestry and Wildlife 2005, The National Tropical Botanical Garden 2007) (USFWS, 2010a).

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SPECIES ACCOUNT: *Myrsine linearifolia* (Kolea)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

A branched shrub, 2.5 to 8 meters (8.2 to 26.2 feet) tall. The slightly fleshy, linear leaves are 5 to 9 centimeters (1.7 to 3 inches) long, 0.25 to 0.4 centimeter (0.09 to 0.14 inch) wide, often yellowish purple toward the base, and tend to be clustered toward the upper branches. The margins of the leaves are smooth and roll slightly toward the underside of the leaf. One to three apparently perfect (containing male and female parts) flowers, on stalks 1 to 4.2 millimeters (0.04 to 0.17 inch) long, occur in clusters among the leaves. The greenish petals are inversely lance-shaped, about 2.2 to 2.5 millimeters (0.09 to 0.1 inch) long, and also have margins fringed with hairs. At maturity, the fruits are black elliptic-shaped drupes, about 6 millimeters (0.2 inch) long. This species is distinguished from others of the genus by the shape, length, and width of the leaves, length of the petals, and number of flowers per cluster (USFWS, 1998).

Taxonomy

A member of the myrsine family (Myrsinaceae) (USFWS, 1998).

Historical Range

Historically, *Myrsine linearifolia* was known from 11 scattered locations on Kauai: Kaala (last seen in 1917), Olokele Valley (last seen in 1912), Kaluaalea (last seen in 1939), Kalalau Valley and Kahuamāa Flat, Limahuli-Hanakapiai Ridge, Koaie Stream, Pohakuao, the Namolokama summit plateau, Haupu (last seen in 1992), Lihue-Koloa Forest Reserve, along a ridge east-southeast of Puu Kolo to the summit (last seen in 1987), and Kokee State Park along Highway 550 near mile marker 19 (Hawaii Biodiversity and Mapping Program 2008; National Tropical Botanical Garden 2008a) (USFWS, 2010).

Current Range

Myrsine linearifolia grows in the Wahiawa Mountains, near Kapalaoa summit, south of a peak off the ridge between Hanapepe valley and Wahiawa drainage (USFWS, 2010).

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Myrsine linearifolia* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

Critical habitat for *Myrsine linearifolia* is designated in six units totaling 4,491 acres in Kauai County, Hawaii. The units are Kauai 7—*Myrsine linearifolia*—a, Kauai 10—*Myrsine linearifolia*—b, and Kauai 11—*Myrsine linearifolia*—c, d, e, f.

Kauai 7—*Myrsine linearifolia*—a: This unit is critical habitat for *Myrsine linearifolia* and is 334 ha (825 ac) on private land. This unit contains Hokulei Peak, Haupu and Naluakeina Summits, and Queen Victoria's Profile. This unit provides habitat for one population of 100 mature, reproducing individuals of the long-lived perennial *Myrsine linearifolia* and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is important to the establishment of additional populations on Kauai in order to reach recovery goals. The habitat features contained in this unit that are essential for this species include, but are not limited to, diverse mesic or wet lowland or montane *Metrosideros polymorpha* forest with *Cheirodendron* spp. or *Dicranopteris linearis* as co-dominant species. This unit is geographically separated from the other five units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 10—*Myrsine linearifolia*—b: This unit is critical habitat for *Myrsine linearifolia* and is 167 ha (412 ac) on private and State land (LihueKoloa Forest Reserve). This unit contains Hulua, Kahili, and Kapalaoa Summits. This unit provides habitat for one population of 100 mature, reproducing individuals of the long-lived perennial *Myrsine linearifolia* and is currently occupied with 47 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, diverse mesic or wet lowland or montane *Metrosideros polymorpha* forest with *Cheirodendron* spp. or *Dicranopteris linearis* as co-dominant species. This unit is geographically separated from the other five units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 11—*Myrsine linearifolia*—c: This unit is critical habitat for *Myrsine linearifolia* and is 685 ha (1,692 ac) on State land (Alakai Wilderness Preserve), containing portions of Kipalau Valley. This unit provides habitat for three populations of 100 mature, reproducing individuals of the long-lived perennial *Myrsine linearifolia* and is currently occupied with 34 to 44 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, diverse mesic or wet lowland or montane *Metrosideros polymorpha* forest with *Cheirodendron* spp. or *Dicranopteris linearis* as codominant species. This unit is geographically separated from the other five units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Myrsine linearifolia*—d: This unit is critical habitat for *Myrsine linearifolia* and is 286 ha (707 ac) on State (Halelea Forest Reserve, Hono o Na Pali NAR, and Na Pali Coast State Park) and private land. This unit contains Hono o Na Pali and Pali Eleele Summits, and Limahuli Falls. This unit provides habitat for one population of 100 mature, reproducing individuals of the long-lived perennial *Myrsine linearifolia* and is currently occupied with 23 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, diverse mesic or wet lowland or montane *Metrosideros polymorpha* forest with *Cheirodendron* spp. or *Dicranopteris linearis* as codominant species. This unit is geographically separated from

the other five units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Myrsine linearifolia*—e: This unit is critical habitat for *Myrsine linearifolia* and is 345 ha (854 ac) on State land (Hono o Na Pali NAR, Kokee and Na Pali Coast State Parks). This unit contains Alealau, Pihea, and Puu o Kila Summits. This unit provides habitat for two populations of 100 mature, reproducing individuals of the long-lived perennial *Myrsine linearifolia* and is currently occupied with 366 to 420 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species. The habitat features contained in this unit that are essential for this species include, but are not limited to, diverse mesic or wet lowland or montane *Metrosideros polymorpha* forest with *Cheirodendron* spp. or *Dicranopteris linearis* as co-dominant species. This unit is geographically separated from the other five units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Myrsine linearifolia*—f: This unit is critical habitat for *Myrsine linearifolia* and is 135 ha (334 ac) on State (Halelea Forest Reserve) and private land, containing Kaliko Summit. This unit provides habitat for one population of 100 mature, reproducing individuals of the long-lived perennial *Myrsine linearifolia* and is currently occupied with 20 to 30 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, diverse mesic or wet lowland or montane *Metrosideros polymorpha* forest with *Cheirodendron* spp. or *Dicranopteris linearis* as co-dominant species. This unit is geographically separated from the other five units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

- (i) Diverse mesic or wet lowland or montane *Metrosideros polymorpha* forest with *Cheirodendron* spp. or *Dicranopteris linearis* as co-dominant species, and containing one or more of the following associated native plant species: *Bobea brevipes*, *Cryptocarya mannii*, *Dubautia* spp., *Eurya sandwicensis*, *Freycinetia arborea*, *Hedyotis terminalis*, *Lysimachia glutinosa*, *Machaerina angustifolia*, *Melicope* spp., *Myrsine* spp., *Nothocestrum* spp., *Psychotria* spp., *Sadleria pallida*, or *Syzygium sandwicensis*; and
- (ii) Elevations between 129 and 1,345 m (424 and 4,411 ft).

Special Management Considerations or Protections

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and

other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species in paragraph (b) of this section and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Lifespan**

Adult: > 10 years (USFWS, 2010)

Reproduction Narrative

Adult: It is a long-lived perennial (USFWS, 2010).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Moist and wet forest (NatureServe, 2015); ohia-uluhe forest (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: 1,920 - 4,200 ft. elevation (USFWS, 1998)

Habitat Narrative

Adult: Inhabits moist and wet forests on ridges and in gulches (NatureServe, 2015). It grows in *Metrosideros polymorpha* (ohia) - *Dicranopteris linearis* (uluhe) low wet forest with wind swept ridge and riparian vegetation (USFWS, 2010). *Myrsine linearifolia* typically grows in mesic to wet ohia forests that are sometimes co-dominant with olapa or uluhe from 585 to 1,280 meters (1,920 to 4,200 feet) elevation (USFWS 1996; 1998).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Species Trends:

Declining (USFWS, 2010)

Resiliency:

Very low (inferred from USFWS, 2010; see current range/distribution)

Redundancy:

Moderate (inferred from USFWS, 2010)

Number of Populations:

12 (USFWS, 2010)

Population Size:

164 - 197 wild, 17 outplants (USFWS, 2010)

Population Narrative:

There are 164 - 197 wild individuals in 12 populations and 17 outplanted individuals. The numbers of populations and individuals have declined since the species was listed as threatened, but an accurate current status is not available (USFWS, 2010).

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Threats which alter the habitat for *Myrsine linearifolia* include pigs (*Sus scrofa*), goats (*Capra hircus*), and mule deer (*Odocoileus hemionus*). Invasive introduced plant species which impact the habitat and compete with *Myrsine linearifolia* are *Erigeron karvinskianus* (daisy fleabane), *Bryophyllum pinnatum* (airplant), *Axonopus fissifolius* (narrow-leaved carpetgrass), *Cyperus meyerianus* (NCN), *Holcus lanatus* (common velvet grass), *Melastoma septemnerium* (NCN), *Rhodomyrtus tomentosa* (rose myrtle), *Psidium cattleianum* (strawberry guava), *Pterolepis glomerata* (NCN), *Rubus argutus* (blackberry), *Rubus rosifolius* (thimbleberry), and *Stachytarpheta cayennensis* (Brazilian tea) (Hawaii Biodiversity and Mapping Program 2008; National Tropical Botanical Garden 2008a, b; Perlman 2008; N. Tangalin, pers. comm. 2008; USFWS 1995) (USFWS, 2010).

Stressor: Herbivory (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Goats, rats (*Rattus rattus*), and mule deer are believed to eat *Myrsine linearifolia* (Hawaii Biodiversity and Mapping Program 2008; National Tropical Botanical Garden 2008a, b; Perlman 2008; N. Tangalin, pers. comm. 2008; USFWS 1995) (USFWS, 2010).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Myrsine linearifolia* is vulnerable to the impacts of climate change, with a vulnerability score of 0.467 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Stressor: Fire destruction or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Fire can destroy dormant seeds as well as individual plants. Successive fires burn farther and farther into native habitat and alter microclimate conditions to further alter habitat conditions to favor nonnative plants. Nonnative plants convert native plant communities to nonnative dominated plant communities D'Antonio and Vitousek 1992; Tunison et al. 2002). Fire is reported as a threat to *Myrsine linearifolia* at Puu o Kila, Koaie, and Wahiawa drainage-Kahili (NTBG 2012d-f, 2013b-c, 2014c-d, 2016a-b) (USFWS, 2017).

Stressor: Hurricanes—Loss and degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Hurricanes were omitted in the last five year review. In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event, and 70 percent of all listed plant species on Kauai are only found on Kauai. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013) (USFWS, 2017).

Recovery

Reclassification Criteria:

1. A total of five to seven populations should be documented on the Big Island (USFWS, 1998).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population (for long-lived perennials) (USFWS, 1998).

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1998).

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on the Big Island (USFWS, 1998).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population (for long-lived perennials) (USFWS, 1998).

3. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1998).

Recovery Actions:

- Protect current populations, control threats and monitor (USFWS, 1998).
- Expand current populations (USFWS, 1998).
- Conduct research essential to conservation of the species (USFWS, 1998).
- Establish new populations as needed to reach recovery objectives (USFWS, 1998).
- Validate and revise recovery criteria.
- Devise and implement a public education program.
- Maintenance of adequate genetic stock (USFWS, 1998).
- Development of management plans to control alien plant species (USFWS, 1998).
- New Management Actions: • Captive propagation for genetic storage and reintroduction—NTBG is currently germinating seeds and have plants in their nursery from Kalalau, Hono o Na Pali NAR and Upper Limahuli Preserve (NTBG 2017). This species has been difficult to determine if it is appropriate for long term seed storage and research is ongoing for other congeners (Keir and Weisenberger 2014, OANRP 2016; Lyon Arboretum 2017) (USFWS, 2017).
- Recommendations for Future Actions: Fire is reported as a new threat to *Myrsine linearifolia* at the Puu o Kila, Koaie, and Kahili (Wahiawa drainage) populations. No other significant new information regarding the species' biological status has been reported since the last 5-year review in 2010. Thus, the following recommendations for future actions are added or reiterated for the 5-year review for 2017. • Surveys and inventories—Survey to determine the current status of the species and whether change in status from threatened to endangered is warranted. • Ungulate monitoring and control—Construct fenced exclosures to protect all populations against feral ungulates. Protect all occurrences against browsing and disturbances from feral ungulates. • Invasive plant monitoring and control—o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative species that compete with the species around all populations. • Fire monitoring and control – Develop and implement fire prevention management plans. • Captive propagation for genetic storage and reintroduction—Continue propagation efforts

for maintenance of genetic stock. • Reintroduction and translocation—Augment existing populations and create new populations in suitable protected habitat. • Predator and herbivore monitoring and control—Implement effective measures to control predation by ungulates and rats. • Population biology research—Study *Myrsine linearifolia* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Continue to collect seeds for adequate genetic storage (USFWS, 2010).
- Protect all populations against trampling, browsing and disturbances from feral ungulates (USFWS, 2010).
- Develop and implement methods of rat control for all populations (USFWS, 2010).
- Reintroduce to augment existing populations and create new populations in suitable protected habitat (USFWS, 2010).
- Work with Hawaii Division of Forestry and Wildlife and other landowners to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2010).
- Survey to determine the current status of the species and whether change in status from threatened to endangered is warranted (USFWS, 2010).

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SPECIES ACCOUNT: *Myrsine mezii* (Kolea)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (R1) (USFWS, 2016)

Physical Description

A small, many-branched tree. Flowers are borne in clusters below the leafy portions of the stems (NatureServe, 2015).

Taxonomy

A member of the myrsine family (Myrsinaceae) (USFWS, 2010b). This genus is pantropical and subtropical, 150 - 200 species. Species may be intermediate between *Myrsine kauaiensis* and *M. wawraea* (NatureServe, 2015).

Historical Range

See current range/distribution.

Current Range

It is known from the Koaie Canyon area of western Kauai (N. Tangalin 2007b) (USFWS, 2010b).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Myrsine mezii* (Kolea) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Myrsine mezii* includes six CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Montane Mesic—Section 1: Montane Mesic—Section 1 consists of 2,423 ac (980 ha) in the montane mesic ecosystem, including the area above Honopu Valley to Mahanaloa Valley, on State owned land in Kokee State Park, the Na Pali-Kona Forest Reserve, and Kuia NAR (Figure 3-A). The entire section is within previously designated critical habitat for the plant species, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70c, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Labordia helleri*, *Myrsine knudsenii*, *Platydesma rostrata*, *Psychotria grandiflora*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*. This section is also occupied by the akekee and the picture-wing fly; maps of critical habitat for these species can be found at 50 CFR 17.95(b) for the akekee and akikiki (Unit 1—Montane Mesic), and at 50 CFR 17.95(i) for the picture-wing fly (Unit 1—Montane Mesic). This section also contains unoccupied habitat that is essential to the conservation of these nine species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the montane mesic forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane mesic ecosystem (Table 3), as well as species-specific PCEs for the akekee and akikiki (arthropod prey) and picture-wing fly (the larval-stage host

plants, *Cheirodendron* sp. and *Tetraplasandra* sp.). Although Montane Mesic—Section 1 is not known to be occupied by the species *Diellia mannii*, *Myrsine mezii*, and the akikiki, we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Montane Mesic—Section 2: Montane Mesic—Section 2 consists of 376 ac (152 ha) in the montane mesic ecosystem and includes a portion of the area surrounding a tributary of Nawaimaka Stream east to Kumuwela Ridge (Figure 3-A, above). The entire section is State-owned within Kokee State Park, and includes 8 ac (3 ha) of newly designated critical habitat. This section is occupied by *Diellia mannii* and the picture-wing fly *Drosophila sharpi*, and includes the montane mesic forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane mesic ecosystem (Table 3), as well as the larval-stage host plants (*Cheirodendron* sp. and *Tetraplasandra* sp.) associated with the picture-wing fly. This section also contains unoccupied habitat that is essential to the conservation of these two species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Montane Mesic—Section 2 is not known to be occupied by the plants *Chamaesyce remyi* var. *remyi*, *Labordia helleri*, *Myrsine knudsenii*, *Myrsine mezii*, *Platydesma rostrata*, *Psychotria grandiflora*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*, or by the birds the akekee and akikiki, we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range, as well as species-specific PCEs for the akekee and akikiki (arthropod prey). Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, that portion of the section that overlies previously designated critical habitat falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70c. The previously undesignated land comprises Critical Habitat Unit 21 of 50 CFR 17.99(a)(1), Map 217d. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 2—Montane Mesic), and for the picture-wing fly at 50 CFR 17.95(i) (Unit 2—Montane Mesic).

Kauai—Montane Mesic—Section 3: Montane Mesic—Section 3 consists of 139 ac (56 ha) in the montane mesic ecosystem, including the upper portion of the Nawaimaka Valley up to Kapukapaia Ridge, on State-owned land in the Na Pali-Kona Forest Reserve (Figure 3-B). This section is not in previously designated critical habitat and includes the only montane mesic forest occupied by the plant *Myrsine mezii*, and the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. Although Montane Mesic—Section 3 is not known to be occupied by the plants *Chamaesyce remyi* var. *remyi*, *Labordia helleri*, *Myrsine knudsenii*, *Myrsine mezii*, *Platydesma rostrata*, *Psychotria grandiflora*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*; by the birds the akekee and akikiki; or by the picturewing fly *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. It also provides for the species-specific PCEs for the

akekee and akikiki (arthropod prey) and the larval-stage host plants (*Cheirodendron* sp. and *Tetraplasandra* sp.) associated with *D. sharpi*. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, this section comprises Critical Habitat Unit 22 of 50 CFR 17.99(a)(1), Map 217e. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 3– Montane Mesic), and for the picturewing fly at 50 CFR 17.95(i) (Unit 3– Montane Mesic).

Kauai—Montane Wet—Section 1: Montane Wet—Section 1 consists of 13,055 ac (5,257 ha) in the montane wet ecosystem, extending across the Alakai Plateau from Hanakoa to Mount Waialeale, on State (12,628 ac, 5,110 ha) and privately owned (427 ac, 173 ha) land in the Na Pali Coast State Park, the Alakai Wilderness Preserve, the Na PaliKona and Halelea forest reserves, and Hono o Na Pali NAR (Figure 4). It is occupied by the plants *Astelia waialealae*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *K. helenae*, *Labordia helleri*, *L. pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, and *Platydesma rostrata*; by the akekee and akikiki; and by the picture-wing fly. This section also contains unoccupied habitat that is essential to the conservation of these 18 species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the montane wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and the species-specific PCEs including (1) bogs (identified as PCEs for *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*) (2) bog hummocks (identified as PCEs for *Astelia waialealae* and *Lysimachia daphnoides*); (3) arthropod prey (identified as PCEs for the akekee and the akikiki); and (4) larval-stage host plants, *Cheirodendron* and *Tetraplasandra* sp., (identified as a PCE for the picture-wing fly). Although Montane Wet—Section 1 is not known to be occupied by the plants *Dubautia kalalauensis*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, those portions of the section that overlies previously designated critical habitat fall within two existing Critical Habitat Units of 50 CFR 17.99(a)(1): Unit 10, Map 35a; and Unit 11, Map 64a. The previously undesignated land comprises Unit 23, Map 217f; and Unit 24, Map 217g. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 4–Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 4–Montane Wet).

Kauai—Montane Wet—Section 2: Montane Wet—Section 2 consists of 790 ac (320 ha) in the montane wet ecosystem, extending from Kahuamaa Flat south to the edge of Waimea Canyon, on State-owned land in Kokee State Park (Figure 4, above). The entire section is within previously designated critical habitat, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Dubautia kalalauensis*, *Labordia helleri*, *Melicope puberula*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*, and by the akekee. This section includes montane wet forest, potentially some small-scale boggy areas, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and arthropod prey (identified as a species-specific PCE for the akekee). Although Montane Wet—Section 2 is not known to be occupied by the plants *Astelia waialeale*, *Dryopteris crinalis* var.

podosorus, *Dubautia waialeale*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *Myrsine mezii*, and *Phyllostegia renovans*; by the akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. This area also supports the arthropod prey identified as a PCE for the akikiki, and the larval-stage host plants (*Cheirodendron* and *Tetraplasandra* spp.) identified as a PCE for the picturewing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within previously designated Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 5–Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 5– Montane Wet).

Kauai—Montane Wet—Section 3: Montane Wet—Section 3 consists of 413 ac (167 ha) in the montane wet ecosystem, encompasses the summit of Namolokama, on State (156 ac, 63 ha) and privately owned (257 ac, 104 ha) land in the Halelea Forest Reserve (Figure 4, above). It is entirely within previously designated critical habitat, and is occupied by the plants *Keysseria erici* and *Labordia pumila*. This section includes the montane wet forest, the moisture regime, and the canopy, subcanopy, and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and bogs (identified as a species-specific PCE for *K. erici*). Although Montane Wet—Section 3 is not known to be occupied by the plants *Astelia waialeale*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia kalalauensis*, *D. waialeale*, *Geranium kauaiense*, *Keysseria helenae*, *Labordia helleri*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*; by the akekee and akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. It also supports the arthropod prey identified as a PCE for the akekee and akikiki, and the larval-stage host plants (*Cheirodendron* and *Tetraplasandra* spp.) identified as a PCE for the picture-wing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 6–Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 6–Montane Wet).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Myrsine mezii* critical habitat consists of two components (Montane mesic and Montane wet) (75 FR 18960-19165):

Ecosystem: Montane Wet. Elevation: 3,000–5,243 ft (914-1,598 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Ecosystem: Montane Mesic. Elevation: 3,300–5,243 ft (914–1,598 m). Annual precipitation: 50–75 in (127–190 cm). Substrate: weathered aa lava, rocky mucks, thin silty loams, deep volcanic ash soils. Canopy: Acacia, Metrosideros, Psychotria, Tetraplasandra, Zanthoxylum. Subcanopy: Cheirodendron, Coprosma, Kadua, Ilex, Myoporum, Myrsine. Understory: Bidens, Dryopteris, Leptecophylla, Poa, Scaevola, Sophora.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to

address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual: cross-pollination (inferred from USFWS, 2010b)

Reproduction Narrative

Adult: This species is dioecious (USFWS, 2010b).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Montane mesic and montane wet Acacia-Metrosideros forest (USFWS, 2010b)

Geographic or Habitat Restraints or Barriers

Adult: 3,380 - 3,480 ft. elevation (USFWS, 2010b)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits moist forests. The environmental specificity is unknown (NatureServe, 2015). Found in Acacia-Metrosideros forest in the montane mesic and montane wet ecosystems at elevations between 3,380 and 3,480 ft. (1,030 and 1,060 m) (Wagner et al. 1999, p. 943; HBMP 2007; NTBG Accession Data 9888, 2002; TNCH 2007) (USFWS, 2010b).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Resiliency:

Very low (inferred from USFWS, 2010b; see current range/distribution)

Redundancy:

Very low (inferred from USFWS, 2010a)

Number of Populations:

3 (USFWS, 2017)

Population Size:

7 (USFWS, 2017)

Population Narrative:

The long term population trend is unknown (NatureServe, 2015). There are two populations totaling 5 individuals (USFWS, 2010a). There are currently only seven individuals of *Myrsine mezii* in three locations (USFWS, 2017).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from non-native plants, pigs, goats, hurricanes, landslides, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Landslides destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities.

Stressor: Predation and herbivory (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species present an immediate and significant threat to *Myrsine mezii* throughout its range due to documented browsing and trampling by pigs, goats, and deer (USFWS, 2010).

Stressor: Small populations (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Only five individuals of *Myrsine mezii* are known, and this number has not changed over 10 years. Research on *Pittosporum* species suggests that small populations are susceptible to loss of genetic variation through inbreeding and drift (USFWS, 2010).

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor: Ungulate degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Feral pigs (*Sus scrofa*) and goats (*Capra hircus*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil. Habitat destruction and erosion caused by feral pigs and goats are noted to be a threat to all occurrences of *Myrsine mezii* (HBMP 2010; PEPP 2010, 2011, 2012, 2013, 2014, 2015) (USFWS, 2017).

Stressor: Established ecosystem-altering invasive plant modification and degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species modify habitat occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community. Invasive introduced plants with the greatest impacts on *Myrsine mezii* are: *Clidemia hirta* (Koster's curse), *Grevillea robusta* (silk oak), *Lantana camara* (lantana), *Psidium cattleianum* (strawberry guava), *Rubus argutus* (prickly Florida blackberry), and *Sphaeropteris cooperi* (Australian tree fern) (NTBG 2013a-b, 2014, 2015a) (USFWS, 2017).

Stressor: Landslides and flooding loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: —Landslides and erosion due to natural weathering destabilize substrates, damage and destroy individual plants, and alter hydrological patterns (Stearns 1985). Landslides are a

threat to the occurrence of *Myrsine mezii* at Nawaimaka (HBMP 2010; NTBG 1998; PEPP 2013) (USFWS, 2017).

Stressor: Hurricanes—Loss and degradation of habitat—

Exposure:

Response:

Consequence:

Narrative: In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013) (USFWS, 2017).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: —Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Myrsine mezii* is highly vulnerable to the impacts of climate change with a vulnerability score of 0.987 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this species has no overlap between current and future climate envelopes, and is unlikely to tolerate expected changes in climate at its current locations. This means that this species must persist within suitable microrefugia, or move to newly available climate-compatible areas to avoid extinction. Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery

Reclassification Criteria:

In addition to achieving 5 to 10 populations with 500 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually)

includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats (USFWS, 2017).

Delisting Criteria:

In addition to achieving 5 to 10 populations with 500 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis (USFWS, 2017).

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys (USFWS, 2010a).
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units (USFWS, 2010a).
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys (USFWS, 2010a).
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range (USFWS, 2010a).
- Conduct research on control methods for introduced slugs and avian malaria (USFWS, 2010a).
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction (USFWS, 2010a).
- Identify threats and prioritize which ones to address first for the two birds (USFWS, 2010a).
- Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program (USFWS, 2010a).
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security (USFWS, 2010a).
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems (USFWS, 2010a).
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these

- species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations (USFWS, 2010a).
- Current Management Actions: • Predator and herbivore monitoring and control—All occurrences have been treated with pesticides for control of insect damage (PEPP 2011, 2012, 2013, 2014). • Surveys and inventories—Kauai PEPP and NTBG have been monitoring all populations and surveying for new individuals (PEPP 2010, 2011, 2012, 2013, 2014, 2015; Tangalin 2007). • Captive propagation for genetic storage and reintroduction—Pollen collections and cuttings of *Myrsine mezii* have been made and are stored and propagated at the Kauai DOFAW nursery (PEPP 2014), however, there are currently no plants of this taxon at the facility (DOFAW 2016). Cuttings have been taken for greenhouse propagation efforts at NTBG but it is uncertain the fate of those propagules (NTBG 2017). Lyon Arboretum is currently attempting to germinate seeds from an individual tree (Lyon Arboretum 2017) (USFWS, 2017).
 - RECOMMENDATIONS FOR FUTURE ACTIONS • Surveys and inventories—Continue to survey for populations of *Myrsine mezii* in areas of potentially suitable habitat. • Ungulate monitoring and control—Protect all occurrences against browsing and disturbances from feral ungulates. Construct small-scale fence enclosures around existing populations to prevent imminent extinction. • Invasive plant monitoring and control—
 - o Control established ecosystem-altering nonnative invasive plant species around all populations.
 - o Control invasive nonnative plant species around all populations that compete with the species.
 • Rodent predation or herbivory control—Implement effective measures to control rodents around all populations. Determine level of threat from invertebrate herbivory and any additional needed recovery actions. • Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Population biology research—Study *Myrsine mezii* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered throughout historic range to reduce impacts from landslides and storms. • Based on the recovery criteria above, consider development of a recovery plan (USFWS, 2017).

Conservation Measures and Best Management Practices:

- This species is currently in controlled propagation for genetic storage and/or reintroduction efforts (USFWS, 2010a).

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SPECIES ACCOUNT: *Myrsine vaccinioides* (Kolea)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Branched shrubs 0.3-1 m tall. Lower leaf surfaces usually with conspicuous long, raised, usually reddish purple secretory lines. Flowers 1-2 in fascicles among or just below the leaves. (NatureServe, 2015)

Taxonomy

Genus pantropical & subtropical. Species new, endemic to West Maui. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Endemic to the island of Maui (West Maui only), state of Hawaii. Total range is about 6 square km (NatureServe, 2015).

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Myrsine vaccinioides* (Kolea) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Myrsine vaccinioides* includes two CHUs in Maui County, Hawaii. Approximately 1,479 ac (599 ha) of federal, private and state land on the Island of Maui (west Maui) are being designated as critical habitat for *Myrsine vaccinioides*. (81 FR 17790-18110).

Maui—Montane Wet—Unit 6 (and) *Palmeria dolei*—Unit 15—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 15— Montane Wet This area consists of 1,113 ac (451 ha) of State land, and 286 ac (116 ha) of privately owned land, at the summit and surrounding areas on west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta*, *Calamagrostis hillebrandii*, *Cyanea kunthiana*, *Geranium hillebrandii*, *Myrsine vaccinioides*, and *Sanicula purpurea*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 6 is not known to be occupied by the plants *Acaena exigua*, *Cyrtandra oxybapha*, *Huperzia mannii*, *Phyllostegia bracteata*, or *Platanthera holochila*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu

(*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 7 (and) *Palmeria dolei*—Unit 16—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 16— Montane Wet This area consists of 80 ac (32 ha) of State land near Hanaula and Pohakea Gulch on the southeastern slopes of west Maui. These units include the mixed hermland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). They are occupied by the plants *Cyrtandra oxybapha* and *Platanthera holochila*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 7 is not known to be occupied by the plants *Acaena exigua*, *Bidens conjuncta*, *Calamagrostis hillebrandii*, *Cyanea kunthiana*, *Geranium hillebrandii*, *Huperzia mannii*, *Myrsine vaccinioides*, *Phyllostegia bracteata*, or *Sanicula purpurea*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Myrsine vaccinioides* critical habitat consists of one component (81 FR 17790-18110):

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*. Species- specific physical or biological features: Bogs.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia*

var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to

reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial and palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Bog/fen, forest- hardwood, forest/woodland

Spatial Arrangements of the Population

Adult: Scattered (USFWS, 2016)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: Currently, there are estimated to be several hundred, but fewer than 1,000, individuals scattered in the summit area of the west Maui mountains at Eke Crater, Puu Kukui, Honokowai-Honolua, and Kahoolawe, in the montane wet ecosystem (Oppenheimer 2010i, in litt.). This species is found in montane bogs in wet cloud forests. (NatureServe, 2015; USFWS, 2016)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Long-term trends indicate declines of greater than 10%, whereas short-term trends suggest declines of 10-70% (NatureServe, 2015)

Resiliency:

Low (inferred from USFWS, 2016)

Redundancy:

Low (inferred from USFWS, 2016)

Number of Populations:

4 (USFWS, 2016)

Population Size:

<1,000

Population Narrative:

Long-term population trends indicate declines of greater than 10%, whereas short-term trends suggest declines of 10-70%. Currently, there are estimated to be several hundred, but fewer than 1,000, individuals scattered in the summit area of the west Maui mountains at Eke Crater, Puu Kukui, Honokowai-Honolua, and Kahoolawe, in the montane wet ecosystem (Oppenheimer 2010i, in litt.). (NatureServe, 2015; USFWS, 2016)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs), nonnative plants, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Introduced ungulates (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Introduced ungulates threaten the following 35 plant species in this proposal by grazing and browsing individual plants including *Myrsine vaccinioides* (pigs). (USFWS, 2012)

Stressor:
Exposure:
Response:
Consequence:
Narrative:

Stressor:
Exposure:
Response:
Consequence:
Narrative:

Recovery

Reclassification Criteria:
Not available.

Delisting Criteria:
Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

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SPECIES ACCOUNT: *Navarretia fossalis* (Spreading navarretia)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/13/1998; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

Navarretia fossalis (spreading navarretia), a member of the Polemoniaceae (phlox family), is a low, mostly spreading or ascending annual plant, 4 to 6 in (10 to 15 cm) tall. The leaves are 0.4 to 2 in (1 to 5 cm) long and finely divided into slender spine-tipped lobes. The lower portions of stems are mostly hairless (glabrous). The flowers are arranged in flat-topped, compact, leafy heads. The white to lavender-white petals (corolla) are joined at their bases to form a tube, although the tips (lobes) are free. The fruit is an ovoid, two-chambered capsule. Each seed is covered by a layer that becomes sticky and viscous when the capsule is moistened. (USFWS, 2010)

Taxonomy

The range of *N. fossalis* overlaps with two other species in the genus *Navarretia*: *N. intertexta* (needle-leaved navarretia) and *N. prostrata* (prostrate navarretia). *Navarretia fossalis* is distinguished from the other two species by its linear corolla lobes, spreading or ascending habit, flat topped inflorescences, calyx size and shape (sepals collectively), and the position of the corolla relative to the calyx (Day 1993, p. 846). (USFWS, 2010)

Historical Range

See current range/distribution.

Current Range

Known from southern California and adjacent Mexico, from northwestern Los Angeles County and western Riverside County south through coastal San Diego County to San Quentin in northwestern Baja California (USFWS 1998, 2005). A population was reported from San Luis Obispo County, California, but the identification of that population is believed to be in error (Spencer 2004 cited in USFWS 2005). (NatureServe, 2015).

Critical Habitat Designated

Yes; 10/7/2010.

Legal Description

On October 7, 2010, the U.S. Fish and Wildlife Service (Service), designated final revised critical habitat for *Navarretia fossalis* (spreading navarretia) under the Endangered Species Act of 1973, as amended (75 FR 62192 - 62255). In total, approximately 6,720 acres (ac) (2,720 hectares (ha)) of habitat in Los Angeles, Riverside, and San Diego Counties, California, fall within the boundaries of the critical habitat designation. This final rule constitutes an overall increase of approximately 6,068 ac (2,456 ha) from the 2005 critical habitat designation for *N. fossalis*.

Critical Habitat Designation

The revised critical habitat designation for *Navarretia fossalis* includes six units totaling 6,720 acres in in Los Angeles, Riverside, and San Diego Counties, California. The units are Unit 1: Los Angeles Basin-Orange Management Area, Unit 2: San Diego: Northern Coastal Mesa

Management Area, Unit 3: San Diego: Central Coastal Mesa Management Area, Unit 4: San Diego: Inland Management Area, Unit 5: San Diego: Southern Coastal Mesa Management Area, and Unit 6: Riverside Management Area.

Unit 1: Los Angeles Basin—Orange Management Area. Unit 1 is located in northwestern Los Angeles County and consists of two subunits totaling 176 ac (71 ha) of private land. Subunit 1A: Cruzan Mesa. Subunit 1A is located near the City of Santa Clarita in Los Angeles County. This subunit is on Cruzan Mesa, northwest of Forest Park and the Sierra Highway and southwest of Vasquez Canyon Road. Subunit 1A consists of 156 ac (63 ha) of private land and meets the selection criteria as satellite habitat. Cruzan Mesa is one of the only areas in Los Angeles County that supports mesatop vernal pools. As satellite habitat, this subunit supports a stable occurrence of *Navarretia fossalis*, provides potential connectivity with Subunit 1B, and likely supports a genetically distinct occurrence because of the separation of these two northern occurrences from other occurrences of *N. fossalis*. This subunit and Subunit 1B (described below) represent the most northern occurrences of this species. Subunit 1A contains the physical and biological features that are essential to the conservation of *N. fossalis*, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as mowing or grading) that occur in the vernal pool basins. Subunit 1B: Plum Canyon. Subunit 1B is located near the City of Santa Clarita in Los Angeles County. This subunit is in Plum Canyon, west of Forest Park and the Sierra Highway and north of Plum Canyon Road. Subunit 1B consists of 20 ac (8 ha) of private land and meets the selection criteria as satellite habitat. As satellite habitat, this subunit supports a stable occurrence of *Navarretia fossalis*, provides potential connectivity with Subunit 1A, and likely supports a genetically distinct occurrence because of the separation of these two northern occurrences from other occurrences of *N. fossalis*. The Plum Canyon vernal pool habitat occurs on a flat area down-slope from the vernal pools on Cruzan Mesa. The vernal pools on Cruzan Mesa (Subunit 1A) and Plum Canyon represent the only habitat for *N. fossalis* in Los Angeles County and the most northern occurrences of this species. Subunit 1B contains the physical or biological features essential to the conservation of *N. fossalis*, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species within this subunit.

Unit 2: San Diego—Northern Coastal Mesa Management Area. Poinsettia Lane Commuter Station. Unit 2 is located in the City of Carlsbad in San Diego County and contains 6 ac (3 ha) of land owned by the North County Transit District and 3 ac (1 ha) of private land. This unit is loosely bounded by Avenida Encinas on the north, a housing development on the east, Poinsettia Lane on the south, and train tracks on the west. Unit 2 meets the selection criteria as satellite habitat because it supports a stable occurrence of *Navarretia fossalis* and provides potential connectivity between occurrences on MCB Camp Pendleton and Subunits 4C1, 4C2, and 4D. The Poinsettia Lane vernal pool complex consists of a series of vernal pools that run parallel to a berm created by the train tracks. Unit 2 contains the physical and biological features that are essential to the conservation of *N. fossalis*, including ephemeral wetland habitat (PCE 1),

intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats from nonnative plant species and activities (such as unauthorized recreational use) that occur in the vernal pool basins.

Unit 3: San Diego—Central Coastal Mesa Management Area. Unit 3 is located in central coastal San Diego County and consists of three subunits totaling 103 ac (42 ha). This unit contains 102 ac (42 ha) owned by State and local governments, and approximately 1 ac (less than 1 ha) of private land. Subunit 3B: Carroll Canyon. Subunit 3B is located in the City of San Diego in San Diego County. This subunit is located to the southwest of the intersection of Parkdale Avenue and Osgood Way, and is loosely bounded by residential development on the north, open space to the east, and a quarry to the south and west. Subunit 3B consists of approximately 18 ac (7 ha) that includes 17 ac (7 ha) of land owned by State or local governments and 1 ac (less than 1 ha) of private land. Subunit 3B meets the selection criteria as satellite habitat because it supports a stable occurrence of *Navarretia fossalis* and provides potential connectivity between occurrences in Subunits 3A and 3C. The Carroll Canyon vernal pool complex consists of a group of vernal pools on the edge of a mesa north of Carroll Canyon. Historically, there may have been more habitat for this species; however, the majority of vernal pool habitat in the vicinity of this subunit has been developed. Subunit 3B contains the physical and biological features that are essential to the conservation of *N. fossalis*, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as trespass or illegal trash dumping) that occur in the vernal pool basins. Subunit 3C: Nobel Drive. Subunit 3C is located in the City of San Diego in San Diego County. This subunit is loosely bounded by the 805 interstate on the northeast, train tracks on the south, and Nobel Drive on the northwest. Subunit 3C consists of 37 ac (15 ha) of land owned by local government and meets the selection criteria as satellite habitat because it supports a stable occurrence of *Navarretia fossalis* and provides potential connectivity between occurrences in Subunits 3B and 3D. The Nobel Drive vernal pool complex consists of a group of vernal pools on a mesa-top north of Rose Canyon. Subunit 3C contains the physical and biological features that are essential to the conservation of *N. fossalis*, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as unauthorized recreational use) that occur in the vernal pool basins. Subunit 3D: Montgomery Field. Subunit 3D is located in the City of San Diego in San Diego County. This subunit is located at Montgomery Field (airport) to the northeast of the runway area. Subunit 3D consists of 48 ac (20 ha) of land owned by the City of San Diego and meets the selection criteria as satellite habitat. As satellite habitat, this subunit supports a stable occurrence of *Navarretia fossalis* and provides potential connectivity with the occurrence in Subunit 3C. The Montgomery Field vernal pool complex consists of a large group of vernal pools east of the runway area at Montgomery Field, although only the northeastern portion of this vernal pool complex is being designated as critical habitat because the southeastern portion of this vernal pool complex has been hydrologically disconnected from other vernal pools by past development, is now isolated, and does not meet

the definition of essential habitat. *Navarretia fossalis* has not been documented in the southeastern portion of this vernal pool complex. Subunit 3D contains the physical and biological features that are essential to the conservation of *N. fossalis*, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species that occur in the vernal pool basins.

Unit 4: San Diego—Inland Management Area. Unit 4 is located within inland San Diego County and consists of four subunits totaling 206 ac (83 ha). This unit contains 18 ac (7 ha) owned by State and local governments, and 188 ac (76 ha) of private land. Subunits 4C1, 4C2, and 4D: San Marcos. Subunits 4C1, 4C2, and 4D are located in the City of San Marcos in San Diego County. These three subunits consist of three separate vernal pool complexes. The first (Subunit 4C1) is loosely bounded by La Mirada Drive on the northeast, Las Posas Road on the southeast, Linda Vista Drive on the southwest, and South Pacific Street on the northwest. The second (Subunit 4C2) is loosely bounded by Linda Vista Drive on the northeast, Las Posas Road on the east, West San Marcos Boulevard on the south, and South Pacific Street on the west. The third (Subunit 4D) is loosely bounded by South Bent Avenue on the northeast, commercial development on the southeast and southwest, and Linda Vista Drive on the northwest. Subunit 4C1 consists of 34 ac (14 ha) of private land, Subunit 4C2 consists of 15 ac (6 ha) of land owned by local government and 17 ac (7 ha) of private land, and Subunit 4D consists of 5 ac (2 ha) of private land. These three subunits meet the selection criteria as satellite habitat areas because they support stable occurrences of *Navarretia fossalis* and provide potential connectivity between occurrences in Unit 2 and Subunit 4E. The Service grouped these vernal pool complexes because of the clustered nature of these occurrences. These subunits have separate subunit numbers to be consistent with the numbering identified in the 2005 critical habitat designation. Subunits 4C1, 4C2, and 4D contain the physical and biological features that are essential to the conservation of *N. fossalis*, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in these subunits may require special management considerations or protection to address threats from nonnative plant species and activities (such as commercial development, trespass, or OHV use) that occur in the vernal pool basins. Subunit 4E: Ramona. Subunit 4E is located in the unincorporated community of Ramona. This subunit is loosely bounded by the Ramona Airport and Ramona Airport Road on the north, Sawday Road on the east, Santa Maria Creek on the south, and a series of rock outcrops on the west. Subunit 4E consists of approximately 135 ac (55 ha) that includes 3 ac (1 ha) of land owned by State or local governments and 132 ac (53 ha) of private land. Subunit 4E meets the selection criteria as satellite habitat because it supports a stable occurrence of *Navarretia fossalis* and provides potential connectivity with occurrences in Subunits 4C1, 4C2, and 4D. The vernal pools in this subunit occur in gently sloping grassland habitat and are at the highest elevation where *N. fossalis* is known to occur. Subunit 4E contains the physical and biological features that are essential to the conservation of *N. fossalis*, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant

species and activities (such as agricultural activities or recreational use) that occur in the vernal pool basins.

Unit 5: San Diego—Southern Coastal Mesa Management Area. Unit 5 is located in southern San Diego County and consists of six subunits totaling 748 ac (303 ha). This unit contains 28 ac (11 ha) of federally owned land, 330 ac (134 ha) of land owned by State and local governments, and 390 ac (158 ha) of private land. Subunit 5A: Sweetwater Vernal Pools. Subunit 5A is located southwest of the Sweetwater Reservoir. This subunit is loosely bounded by the Sweetwater Reservoir on the north, steeply sloping topography on the east, State Route 125 on the south, and an unnamed drainage on the west. Subunit 5A consists of approximately 95 ac (38 ha) and includes 23 ac (9 ha) of Federal land that is part of the San Diego National Wildlife Refuge Complex, 1 ac (less than 1ha) of land owned by the State, and 71 ac (29 ha) of land owned by local government. This subunit meets our selection criteria as satellite habitat. This satellite habitat subunit supports a stable occurrence of *Navarretia fossalis* and provides potential connectivity between occurrences in Subunits 5B and 5F. Some of the area occupied by *N. fossalis* was lost during the construction of State Route 125. The soil from that area was salvaged and is being used to restore other vernal pools in this subunit. Subunit 5A contains the physical and biological features that are essential to the conservation of *N. fossalis*, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as unauthorized recreational use) that occur in the vernal pool basins. Subunit 5B: Otay River Valley. Subunit 5B is located in the City of Chula Vista and unincorporated San Diego County. This subunit is loosely bounded by Olympic Parkway on the north, a housing development on the east, and a landfill to the southwest. Subunit 5B consists of 24 ac (10 ha) of private land and meets the selection criteria as satellite habitat because it supports a stable occurrence of *Navarretia fossalis* and provides potential connectivity between occurrences of *N. fossalis* in Subunits 5A and 5H. Subunit 5B contains the physical and biological features that are essential to the conservation of *N. fossalis*, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as unauthorized recreational use) that occur in the vernal pool basins. Subunit 5C: Otay Mesa. Subunit 5C is located on the eastern portion of Otay Mesa, directly northwest of and adjacent to the George F. Bailey Detention Facility at the terminus of Alta Road. Subunit 5C consists of 26 ac (11 ha) of State and local governmentowned land, and 16 ac (7 ha) of private land, and it meets the selection criteria as satellite habitat because it supports a stable occurrence of *Navarretia fossalis* and provides potential connectivity between occurrences of *N. fossalis* in Subunits 5G and 5I. Subunit 5C contains the physical and biological features that are essential to the conservation of *N. fossalis*, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as unauthorized recreational use) that occur in the vernal pool basins. Subunit 5F: Proctor Valley. Subunit 5F is located between the unincorporated communities of

Eastlake and Jamul in San Diego County. This subunit is located along Proctor Valley Road in Proctor Valley. Subunit 5F consists of approximately 88 ac (36 ha) and includes 51 ac (21 ha) of land owned by the City of San Diego and 37 ac (15 ha) of private land. Subunit 5F meets the selection criteria as satellite habitat because it supports a stable occurrence of *Navarretia fossalis* and provides potential connectivity between occurrences of *N. fossalis* in Subunits 5A and 5G. The vernal pools in this subunit occur in Proctor Valley on a flat area that is slightly elevated from the stream channel that runs through this valley. The vernal pools in this subunit to the west of Proctor Valley Road are severely impacted by OHV use, but the vernal pools to the east of Proctor Valley road remain relatively intact. Subunit 5F contains the physical and biological features that are essential to the conservation of *N. fossalis*, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as unauthorized recreational use or OHV use) that occur in the vernal pool basins.

Subunit 5G: Otay Lakes. Subunit 5G is located east of the City of Chula Vista in San Diego County. This subunit is loosely bounded by Lower Otay Reservoir to the north and west and by the slopes of Otay Mountain to the southeast. Subunit 5G consists of 140 ac (57 ha) of land owned by State or local governments and meets the selection criteria as satellite habitat because this location supports a stable occurrence of *Navarretia fossalis* and provides potential connectivity between occurrences of *N. fossalis* in Subunits 5F and 5I. The vernal pool complexes in this subunit are located on the flat areas to the south of Lower Otay Reservoir. Subunit 5G contains the physical and biological features that are essential to the conservation of *N. fossalis*, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as unauthorized recreational use) that occur in the vernal pool basins.

Subunit 5H: Western Otay Mesa vernal pool complexes. Subunit 5H is located within the Otay Mesa Community planning area of the City of San Diego. Subunit 5H consists of approximately 139 ac (56 ha) that includes 41 ac (17 ha) of land owned by local governments and 98 ac (40 ha) of private land. Subunit 5H and Subunit 5I encompass the core habitat on Otay Mesa. As core habitat, this subunit contains a large area of habitat that supports sizable occurrences of *Navarretia fossalis* and provides potential connectivity between occurrences in Subunits 5G and 5I. This subunit contains several mesa-top vernal pool complexes on western Otay Mesa (Bauder vernal pool complexes J 2N, J 2S, J 2W, J 4, J 13N, J 13S, J 14, J 33, J 34 as in Appendix D of City of San Diego, 2004). Subunit 5H contains the physical and biological features that are essential to the conservation of *N. fossalis*, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as unauthorized recreational use or residential and commercial development) that occur in the vernal pool basins.

Subunit 5I: Eastern Otay Mesa vernal pool complexes. Subunit 5I is located in the City of San Diego. This subunit contains several mesa top vernal pool complexes on eastern Otay Mesa. Subunit 5I consists of 221 ac (89 ha) of private land. Subunit 5I and Subunit 5H encompass the core habitat on Otay Mesa. As core habitat, Subunit 5I contains a large area of habitat that supports sizable occurrences of *Navarretia fossalis*

and provides potential connectivity between occurrences in Subunits 5B and 5H. This subunit contains several mesa-top vernal pool complexes on eastern Otay Mesa (Bauder vernal pool complexes J 22, J 29, J 30, J 31N, J 31S as in Appendix D of City of San Diego, 2004 and Service GIS). Subunit 5I contains the physical and biological features that are essential to the conservation of *N. fossalis*, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as unauthorized recreational use or residential and commercial development) that occur in the vernal pool basins.

Unit 6: Riverside Management Area. Unit 6 is located in western Riverside County and consists of three subunits totaling 5,477 ac (2,217 ha). This unit contains 1,504 ac (609 ha) of land owned by the State of California's Department of Fish and Game and 3,973 ac (1,608 ha) of private land.

Subunit 6A: San Jacinto River. Subunit 6A is generally located along the San Jacinto River near the cities of Hemet and Perris in Riverside County. This subunit is loosely bounded by Mystic Lake on the northeast and by the Perris Airport on the southwest. Subunit 6A consists of approximately 4,312 ac (1,745 ha), including 1,504 ac (609 ha) of land owned by State or local governments and 2,808 ac (1,136 ha) of private land. Subunit 6A encompasses core habitat along the San Jacinto River. As core habitat, this subunit contains a large area of habitat that supports sizable occurrences of *Navarretia fossalis* and provides potential connectivity between occurrences in Subunits 6B and 6C. This subunit consists of seasonally flooded alkali vernal plains that occur along the San Jacinto River. Subunit 6A contains the physical and biological features that are essential to the conservation of *N. fossalis*, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as manure dumping or flood control) that occur in the vernal pool basins and associated watershed area.

Subunit 6B: Salt Creek Seasonally Flooded Alkali Plain. Subunit 6B is located near the City of Hemet and west of the Hemet-Ryan Airport in Riverside County. This subunit is loosely bounded by Devonshire Avenue on the north, the boundary for the City of Hemet on the east, train tracks on the south, and lowlying hills on the west. Subunit 6B consists of 930 ac (376 ha) of private land that encompasses the core habitat along the Upper Salt Creek drainage west of the City of Hemet. As core habitat, this subunit contains a large area of habitat that supports sizable occurrences of *Navarretia fossalis* and provides potential connectivity between occurrences in Subunits 6A and 6C. This subunit consists of seasonally flooded alkali vernal plains not subject to U.S. Army Corps of Engineer jurisdiction. Subunit 6B contains the physical and biological features that are essential to the conservation of *N. fossalis*, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as manure dumping, grazing, flood control, or disking for vegetation control) that occur in the vernal pool basins and associated watershed area.

Subunit 6C: Wickerd and Scott Road Pools. Subunit 6C is located in the City of Menifee in Riverside County, California. This subunit is loosely bounded by low lying

hills north of Garbani Road on the north, Briggs Road on the east, Scott Road on the south, and Menifee Road on the west. Subunit 6C consists of 235 ac (95 ha) of private land. This subunit meets the selection criteria as satellite habitat because this location supports a stable occurrence of *Navarretia fossalis* and provides potential connectivity among occurrences of *N. fossalis* in Subunits 6A, 6B, and with Subunit 6D that the Service is excluding under section 4(b)(2) of the Act (see Application Section 4(b)(2) of the Action section). This subunit consists of two large vernal pools. Subunit 6C contains the physical and biological features that are essential to the conservation of *N. fossalis*, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as manure dumping, residential or agricultural development, discing for vegetation control, or maintenance of existing pipelines) that occur in the vernal pool basins and associated watershed area.

Primary Constituent Elements/Physical or Biological Features

Within these areas, the primary constituent elements (PCEs) for *Navarretia fossalis* consist of three components:

- (i) PCE 1—Ephemeral wetland habitat. Vernal pools (up to 10 ac (4 ha)) and seasonally flooded alkali vernal plains that become inundated by winter rains and hold water or have saturated soils for 2 weeks to 6 months during a year with average rainfall (i.e., years where average rainfall amounts for a particular area are reached during the rainy season (between October and May)). This period of inundation is long enough to promote germination, flowering, and seed production for *Navarretia fossalis* and other native species typical of vernal pool and seasonally flooded alkali vernal plain habitat, but not so long that true wetland species inhabit the areas.
- (ii) PCE 2—Intermixed wetland and upland habitats that act as the local watershed. Areas characterized by mounds, swales, and depressions within a matrix of upland habitat that result in intermittently flowing surface and subsurface water in swales, drainages, and pools described in PCE 1.
- (iii) PCE 3—Soils that support ponding during winter and spring. Soils found in areas characterized in PCEs 1 and 2 that have a clay component or other property that creates an impermeable surface or subsurface layer. These soil types include, but are not limited to: Cienega-Pismo-Caperton soils in Los Angeles County; Domino, Traver, Waukena, Chino, and Willows soils in Riverside County; and Huerhuero, Placentia, Olivenhain, Stockpen, and Redding soils in San Diego County.

Special Management Considerations or Protections

Critical habitat does not include manmade structures existing on the effective date of this rule and not containing one of more of the primary constituent elements, such as buildings, aqueducts, airports, and roads, and the land on which such structures are located.

Special management considerations or protection are required within critical habitat areas to address threats. Management activities that could ameliorate these threats include (but are not limited to) fencing *Navarretia fossalis* occurrences to prevent soil compaction and providing

signage to discourage encroachment by hikers, cattle, sheep, and OHV activity; control of nonnative plants using methods shown to be effective; guiding the design of development projects to avoid impacts to *N. fossalis* habitat; enacting local ordinances to prohibit manure dumping; and restoring and maintaining natural hydrology and floodplain dynamics of watersheds associated with *N. fossalis* occurrences where feasible. These management activities will protect the PCEs for the species by reducing soil compaction to help maintain an impermeable surface (PCE 3) that supports ephemeral wetland habitat (PCE 1), which is needed to promote germination, flowering, and seed production for *N. fossalis*. Additionally, management of critical habitat lands will help maintain both the wetland and upland habitat that acts as the local watershed and provides intermittent flowing water on the surface and subsurface (PCEs 2 and 3).

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (NatureServe, 2010)

Lifespan

Adult: 1 year (USFWS, 2010)

Breeding Season

Adult: May to June (USFWS, 2010)

Reproduction Narrative

Adult: *Navarretia fossalis* (spreading navarretia), a member of the Polemoniaceae (phlox family), is a low, mostly spreading or ascending annual plant. Plants usually flower in May and June because vernal pools must be devoid of standing water before plants begin to flower. *Navarretia fossalis* has a low pollen to ovule ratio, suggesting there is frequent self-pollination (Spenser et al. 1998, p. 81; D. Boose, Gonzaga University, pers. comm. 2008). Outcrossing, rather than self-pollination, could be advantageous for many vernal pool specialists because it provides a way to better adapt and evolve to the changing conditions of vernal pool habitat through the recombination of beneficial genes (Spenser et al. 1998, p. 81). (USFWS, 2010)

Habitat Type

Adult: Palustrine and terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Grassland/herbaceous, playa/salt flat, vernal pools (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Dependent on the ephemeral inundation cycle found in vernal pool habitat and playa; temperature and moisture likely affect timing of germination; fruit absorbs water and expand to break open the fruit after rain (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: Requires areas that are ephemerally wet in winter and spring but dry in summer and fall; vernal pools range in size from 10 to 164 feet wide (USFWS, 2010)

Habitat Narrative

Adult: *Navarretia fossalis* is typically found in vernal pool (seasonal depression wetlands) habitat, particularly in Los Angeles and San Diego Counties. In western Riverside County, however, *N. fossalis* is associated with seasonally flooded alkali vernal plain habitat that includes alkali playa (highly alkaline, poorly drained), alkali scrub, alkali vernal pool, and alkali annual grassland components. Vernal pools form in swales, shallow drainages, and depressions that are part of an undulating landscape where soil mounds are interspersed with basins, all above water-impervious soil layers. The hydrologic regime in western Riverside County, however, is unique. *Navarretia fossalis* here is associated with alkali soils series (Bramlet 1993, p. 1; USFWS 1994, p. 64812), which facilitate a hydrologic regime for this habitat involving sporadic flooding in combination with slow drainage on the alkaline soils. The listing rule states that *Navarretia fossalis* can also occur in ditches and other artificial depressions often associated with degraded vernal pool habitat (USFWS 1998b, p. 54978; Moran 1977, p. 155). Pools range in size from 10 to 164 feet (3 to 50 meters) across (Zedler 1987, p. 1). *Navarretia fossalis* abundance also varies from year to year depending on precipitation and the inundation/drying time of the vernal pool. *Navarretia fossalis* is dependent on the ephemeral inundation cycle found in vernal pool habitat and playas, but may also occur in man-made depressions and ditches that have the same hydrological dynamics. For many vernal pool plant species, temperature and moisture affect the timing of plant germination (Myers 1975, p. 67). Although not proven, it is likely that *N. fossalis* uses these same cues for germination. Most *Navarretia* species have indehiscent fruit, or fruit with fibers that absorb water and expand to break open the fruit after a substantial rain (Spenser et al. 1998, p. 82). The timing of germination is important so that the plant germinates under favorable conditions in the spring rather than the summer, autumn, or winter. *Navarretia fossalis* abundance also varies from year to year depending on precipitation and the inundation/drying time of the vernal pool. (USFWS, 2010)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: We have minimal information on the dispersal of *Navarretia fossalis* seeds. However, we know the seed has a layer that becomes viscous and sticky when wet. The seed could stick to an animal or bird passing through the vernal pool, providing a method of dispersal. On the other hand, theories also suggest the layer helps secure the seed during seed establishment (Sorenson 1986, p. 444). (USFWS, 2010)

Population Information and Trends

Population Trends:

Long-term trends suggest a decline of >90%, while short-term trends indicate a decline of 50-70% (NatureServe, 2015)

Representation:

Low (inferred from USFWS, 2010)

Number of Populations:

48 occurrences (USFWS, 2010)

Population Narrative:

Currently, there are 48 extant occurrences of *N. fossalis*. It is estimated that greater than 90 percent of the vernal pool habitat in southern California has been lost due to human activities (Bauder and McMillan 1998, Keeler-Wolf et al. 1998 cited in USFWS 2005). Long-term population trends suggest a decline of >90%, while short-term trends indicate a decline of 50-70%. Individual plants numbering 375,000 were estimated at one California occurrence in 1991-1992 and 100,000 individuals at another in 1998; these occurrences, both in Riverside County, are the largest known for the species (USFWS 2005). Other occurrence counts have indicated a range of sizes from 20 to 50,000+ individuals, but overall most occurrences outside the two largest are believed to be relatively small (< 1,000) (USFWS 2005). The total California population might be around 500,000-600,000 individuals in a wet year, but given that this species is an annual and that single sites are known to vary greatly in population size due to year-to-year variations in precipitation and temperature (USFWS 2005), estimates of plant numbers based on short-term data should be used very cautiously. (USFWS, 2010; NatureServe, 2015)

Threats and Stressors

Stressor: Urbanization (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The threat of development has lessened since listing due to a limited amount of permanent protection and some conservation measures now in place, although urbanization is still a predominant threat to *N. fossalis*. Components of urbanization include the direct loss of habitat from development, alteration of hydrology, transportation and flood control projects, grading, pipeline construction, and OHV use. The population of Riverside County is predicted to grow 46.3 percent from 2000 to 2020 while Los Angeles and San Diego Counties are predicted to grow 20.2 and 14.6 percent, respectively (California Department of Finance 2007, Table 2). These predictions suggest urbanization pressures will continue to rise within the range of *Navarretia fossalis*, posing an increasing threat to remaining populations near growing cities in southern California. (USFWS, 2010)

Stressor: Direct habitat loss to development (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Since listing, three (possibly four) *Navarretia fossalis* occurrences were extirpated by development (S. Brown, U. S. Fish and Wildlife Service, pers. obs. 2008). Wickerd Pool in Riverside County was affected by the installation of a water pipeline across the occurrence (USFWS 2001a, p.1). Also, 9 of the 48 occurrences are proposed for development (San Jacinto River, Stetson-Warren/Hemet, Menifee, Scott Pool, Date Street, Los Caballos, Pacific Street, Montgomery Field, J 29-30). Development plays a role in the fragmentation and habitat isolation of *Navarretia fossalis*. Habitat fragmentation within *Navarretia fossalis* occurrences or groups of nearby occurrences may also disrupt hydrological systems and create barriers to dispersal. The Service encourages project proponents to develop projects that avoid isolating vernal pools or

dividing occurrences into ecologically separate fragments, and to configure preserved or restored sites adjacent to and continuous with existing preserve areas. Whenever vernal pools in a complex are impacted by development, some degree of fragmentation occurs within and among complexes. Fragmentation and associated impacts to hydrology and dispersal continue to threaten *N. fossalis* throughout its range. Since listing, many *Navarretia fossalis* occurrences impacted by development have been restored or partially restored. These restorations help offset impacts from development of vernal pool habitat. The threat to *N. fossalis* habitat from urbanization has decreased since listing, although habitat loss from development is an ongoing predominant threat. (USFWS, 2010)

Stressor: Agricultural Conversion (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Conversion of land for the purposes of grazing or farming was cited in the listing rule as a threat to *Navarretia fossalis*, especially in Riverside County (USFWS 1998b, p. 54985). These factors continue to threaten the San Jacinto River and flood plain in Riverside County, but are not threats in San Diego or Los Angeles Counties (Table 2). Five occurrences in Riverside County are documented as affected by agricultural practices (San Jacinto River, Stowe Pool, Meniffee Pool, Wickerd Pool, and Johnson Ranch). (USFWS, 2010)

Stressor: Discing (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Discing for weed abatement, fire suppression, and dry-land farming were listed as threats to *Navarretia fossalis* in the final listing rule (USFWS 1998, 63 FR 54984). Discing turns up the soil and inhibits *N. fossalis* from germinating. It can destroy vernal pools and affect the long-term viability of *N. fossalis*. Vernal pools are frequently selected as sites to implement fire prevention measures, such as discing, because they are in open areas near development and often support a considerable cover of highly flammable, nonnative grass. Since listing, discing along roads and around development for weed abatement or fuel modification has continued. Discing for agricultural conversion is most abundant in Riverside County, where often such land is considered historically agricultural and therefore is exempt from many of the conservation measures in the Western Riverside County Multiple Species HCP (Western Riverside County MSHCP). *Navarretia fossalis* habitat was observed to be disced at Stowe Pool, historically one of the most abundant occurrences of the species (Brown, pers. obs. 2006a). Discing continues to be a threat to *N. fossalis*. (USFWS, 2010)

Stressor: Manure dumping (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Although not identified at the time of listing, manure dumping has become a threat to the longterm viability of *Navarretia fossalis* in some areas of western Riverside County. This threat is especially evident along the San Jacinto River, which harbors the most extensive occurrences of *N. fossalis* (Roberts 2005, p. 4 and Attachment A; Brown, pers. obs. 2006b; F. Roberts, USFWS, pers. comm. 2008; A. Braswell, pers. obs. 2008; E. Kashac, Santa Ana Regional

Water Quality Control Board, pers. comm. 2008). The Wickerd Pool occurrence has also been affected by manure dumping. When manure or water that leaches through it washes into the flood plain and river, it changes the pH and the soil composition. This inhibits germination of *N. fossalis* and increases nutrients, which promotes the growth of invasive nonnative plant species such as *Chenopodium* spp. (goosefoot), *Brassica nigra* (black mustard), and *Salsola tragus* (Russian thistle) (Roberts 2004, p. 7). (USFWS, 2010)

Stressor: Alteration of hydrology (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Increased urban runoff and channelized drainage of lands can change the inundation of a pool (USFWS 1998b, pp. 54984-54985). At listing, alteration of hydrology was considered a predominant threat to *Navarretia fossalis*. Instances of wetlands drainage for purposes of agriculture or development in Riverside County resulted in the loss of *N. fossalis* populations (USFWS 1998b, p. 54985). The Service considered the remaining wetlands available to *N. fossalis* as smaller and more vulnerable to the effects of surrounding development than they were earlier in the century. Since listing, there have been five accounts (San Jacinto River, Scott Pool, Mesa de Burro, Pacific Street, and Sweetwater High School) of direct alteration of hydrology to vernal pools or complexes that support *Navarretia fossalis*. Development can alter the timing, frequency, and duration of vernal pool inundation as well as water temperature. Modifications to the uplands surrounding a vernal pool can negatively affect the pool's hydrology, even if such modifications occur outside the pool's surface watershed. For example, grading cuts near pools can accelerate the flow of water out of the subsoil (Bauder 1986b, p. 210). As such, graded slope-cuts adjacent to the watersheds of depressional features may result in "leakage" of water out of the watersheds. Such grading of the watershed was observed at the Mesa de Burro occurrence when a road adjacent to the vernal pool was graded in 2003 without authorization (D. Stadlander, U. S. Fish and Wildlife Service, pers. obs. 2003). Disturbance may also allow invasive plants or non-vernal pool species to occupy the pools and compete with vernal pool plant species (Bauder 1986a, pp. 21-22), or may also alter the composition of native species of a vernal pool. As an obligate wetland species, *Navarretia fossalis* depends on compatible, seasonal inundation. *Navarretia fossalis* is vulnerable to changes in water levels and periods of inundation. Although some watersheds have been conserved and instances of runoff avoided through section 7 consultations, alteration of hydrology remains a predominant threat to many *N. fossalis* occurrences. (USFWS, 2010)

Stressor: Transportation and flood control projects (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The listing rule identified SR 125 construction on Otay Mesa as a project that could impact *Navarretia fossalis* habitat. This transportation project is completed and directly impacted the occurrences at Sweetwater Reservoir and J 29-30 vernal pool complexes. State Route 11 is planned southeast of SR 125 on Otay Mesa. Though habitat is present, *N. fossalis* was not detected and Caltrans anticipates future potential indirect impacts in the form of edge effects to occurrences if they are discovered in the area (USDOT and Caltrans 2008, pp. 3.20-11-3.20-15). Scott Road in Riverside County was also widened, threatening but not destroying the Scott Pool occurrence (Terra Nova 2007, Exhibit 6). The San Jacinto River Improvement Project is

an ongoing proposal identified at the time of listing that is not yet complete. The proposed project will affect some sections of *N. fossalis* habitat along the San Jacinto River, and preserve other sections (Dudek and Associates 2003, pp. 7-59). State Route 79 was proposed to run through the Upper Salt Creek occurrence in Hemet prior to the listing of *N. fossalis*, but now an alternate route is being proposed. Through mitigation and avoidance measures, the Service believes that transportation and flood control projects are not a predominant threat to *N. fossalis* at this time. (USFWS, 2010)

Stressor: Grading (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The grading of vernal pool habitat was identified as a threat to *Navarretia fossalis* in the listing rule (USFWS 1998b, p. 57984). Grading can change vernal pool hydrology, turn up the soil, and destroy the habitat and vegetation. Since listing, Service files indicate that three occurrences have been graded: 1) the Cruzan Mesa occurrence; 2) the Arjons area, which is along the east edge of the Carroll Canyon Preserve occurrence; and 3) the aforementioned grading at the Mesa de Burro occurrence (Table 2). Since grading continues to occur, we still consider it a threat to *N. fossalis*. (USFWS, 2010)

Stressor: Pipeline construction (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: A pipeline project was identified as a threat to *Navarretia fossalis* in the listing rule (USFWS 1998b, p. 54984). Since that time, there have been two cases of pipeline construction through a vernal pool (Table 2). First, a pipeline was run directly through Wickerd Pool in Riverside County with no mitigation for the effects of the project (USFWS 2001b, p.1). Second, a proposed storage pond and pipeline for a recycled water storage system would destroy 200 acres (81 hectares) of land on the San Jacinto River Wildlife Area (USFWS 2008, p.1). Since listing, pipeline construction has affected the habitat of *N. fossalis* without mitigation or avoidance of vernal pools and we still consider pipeline construction a threat. (USFWS, 2010)

Stressor: Off-highway vehicles (OHV) (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: At the time of listing, OHV use was described as an ongoing threat to *Navarretia fossalis* in Riverside and San Diego Counties (USFWS 1998b, p. 54984). This type of activity may alter the hydrology, degrade habitat, and compromise the existence of *N. fossalis* within vernal pools (e.g., crush plants). Currently, OHV impacts fall into three categories: recreational (often illegal) on private or public property, Border Patrol activities, and emergency response actions. Since listing, OHV activity has impacted the majority of pools in the Otay Mesa region, and is documented in 12 pools in San Diego County and 1 pool in Los Angeles County (Table 2). Most of these accounts are from recreational vehicles trespassing on protected property, despite efforts of landowners to deter illegal trespass. However, vernal pools at Otay Mesa are threatened by OHV use associated with Border Patrol activities (City of San Diego 2006, pp. 136-140). These roads are often used and expanded by recreational OHV users. Despite attempts to deter this

activity using fencing and signage, off-highway vehicle activity remains a threat to *N. fossalis*. To a lesser degree, OHV use for emergency response (e.g., fire suppression and aviation emergencies) and law enforcement actions may impact *Navarretia fossalis* habitat. Many vernal pools occur within areas that are prone to fire, such as the vernal pools at Otay Lakes that burned in the 2003 Otay Fire. Fire suppression activities may impact vernal pools and *N. fossalis* due to vehicle and people/equipment movement through pools or creation of firebreaks. Additionally, aviation emergency response may occur at vernal pools near the Ramona, Montgomery Field, and Marine Corps Air Station (MCAS) Miramar airports. Today, OHV use remains a threat to *Navarretia fossalis*, especially from Border Patrol and recreational activities near vernal pools on Otay Mesa. Installation and maintenance of fencing and signage are needed to help protect *N. fossalis* habitat from the impact of OHV users. (USFWS, 2010)

Stressor: Grazing (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Sheep herbivory and cattle grazing were reported at listing as threats to *Navarretia fossalis* under Factor A, but are treated under Factor C in this 5-year review. There has been only one reported incident of grazing affecting *N. fossalis* since listing. Sheep grazed on Stowe Pool and reportedly ate the flowering heads of *N. fossalis* and trampled the pool (Roberts, pers. comm. 2005). Disease and predation are not considered wide spread or rangewide threats for *N. fossalis*. (USFWS, 2010)

Stressor: Competition with invasive non-native plants (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The listing rule stated that nonnative species of grasses and forbs invade many plant communities often as an indirect result of habitat disturbance (USFWS 1998b, p. 54988). At listing, many vernal pools on Otay Mesa or in the City of San Marcos were dominated by the nonnative *Lolium perenne* (perennial ryegrass). The ryegrass displaced *Navarretia fossalis* in many vernal pools because ryegrass is more tolerant of inundation. The listing rule cited another nonnative grass, *Cyperus diandra* (swamp pricklegum), as replacing *N. fossalis* in the San Jacinto River Wildlife Area in Riverside County (USFWS 1998b, pp. 54988-54989). Approximately 60 percent (29 of 48) of the existing *N. fossalis* occurrences are threatened by invasive nonnative plants. Invasive nonnative plants that may impact *Navarretia fossalis* are divided into three groups: (1) upland species with less tolerance for inundation, (2) plants with inundation tolerance comparable to native vernal pool species, and (3) marsh or wetland species that require a long inundation period (Bauder 1996, p. 2). Altered hydrology can change the inundation period of an area and indirectly affects species that are less or more water tolerant than native vernal pool species, resulting in elimination from or invasion into vernal pool habitat (Bauder 1986b, p. 210). Alternatively, if natural hydrology persists, the number of nonnatives able to invade may be limited by the inundation period (Bauder 1996, p. 2). Development and OHV use (both discussed under Factor A), human access, and disturbance effects (see below) typically alter the hydrology of vernal pools. Additionally, manure dumping can change soil chemistry and facilitate invasives in normally unfavorable areas. These alterations lead to a higher disturbance level and therefore a greater likelihood of invasion by nonnative species (Bauder 2005, p. 2134). Depending upon conditions, certain invasive nonnative plants, such as

the grasses discussed above, may replace *Navarretia fossalis*. Therefore, we consider invasive nonnative plants to be a continuing threat to *N. fossalis*. (USFWS, 2010)

Stressor: Human access and disturbance effects (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Separation of *Navarretia fossalis* occurrences through habitat loss and fragmentation is often accompanied by the introduction or exacerbation of indirect effects associated with human access, or disturbance associated with adjacent development. Examples include trash dumping, trampling, and nonnative plant invasions. In the listing rule for *N. fossalis*, trash dumping, trampling, and invasive nonnative plant species were cited as threats to the species (USFWS 1998b, p. 54988). All known occurrences of *Navarretia fossalis* may potentially be affected by human access and disturbance impacts from surrounding development (Table 2). Since listing, impacts associated with adjacent development have been documented to occur at 35 (71 percent) of the *N. fossalis* occurrences (Table 2). For example, asphalt was dumped at the Upham occurrence in San Marcos during road repairs in 2001 (J. Upham, owner, pers. comm. 2001). This small property is completely surrounded by development and is highly impacted by human-related disturbance. Pedestrians can introduce invasive nonnative plants that result in altered hydrology and competition with native plants. Protective fencing is used in many conserved occurrences to protect vernal pool complexes. Though implementing this protective measure has lessened the impacts of human access and disturbance, such effects still pose a predominant threat to *N. fossalis*. (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The listing rule stated that drier conditions and drought are threats to *Navarretia fossalis*, which relies on seasonal rainfall and the pooling of water. Drier conditions physiologically stress the species and reduce its germination and survival rates (USFWS 1998b, p. 54989). Additionally, other threats may have an increased impact when combined with impacts from climate change. Data from 1986 to 1992 indicate drought was related to a decrease in the abundance of *N. fossalis* (USFWS 1998b, p. 54989; Table 1). However, there is no evidence to suggest that this was caused by climate change rather than normal climatic cycles. Currently, drier conditions and drought remain a threat to all occurrences of *Navarretia fossalis*. Predictions for California indicate prolonged drought and other climate-related changes will continue in the future (e.g., Field et al. 1999, pp. 8–10; Lenihien et al. 2003, p. 1667; Hayhoe et al. 2004, p.12422; Breshears et al. 2005, p. 15144; Seager et al. 2007, p. 1181; IPCC 2007, p. 9). In habitat such as vernal pools that is isolated and dependent on certain hydrological regimes, these climatic changes are expected to become even more dramatic and intense (Graham 1997). It is expected that climate change will alter the hydrology of the region, and therefore threaten the existence of vernal pool habitat and associated species such as *Navarretia fossalis* (Bauder 2005, pp. 2133-2134). While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to particular species (including *N. fossalis*) or sites at this time. However, it is possible that drying could be expected to adversely affect the long-term viability of *N. fossalis* in its habitat. (USFWS, 2010)

Recovery**Delisting Criteria:**

1. All the existing vernal pools and their watersheds should be secured from further loss and degradation in a configuration that maintains habitat function and viability (as determined by prescribed research tasks). (USFWS, 1998)
2. Secured vernal pools must be enhanced or restored such that population levels of existing species are stabilized or increased. (USFWS, 1998)
3. Population trends must be shown to be stable or increasing for a minimum of 10 consecutive years prior to consideration for reclassification. (USFWS, 1998)

Recovery Actions:

- Design and establish a vernal pool habitat preserve system within each Management Area that will maximize the ecological distribution for each listed and proposed species, minimize risk of habitat loss, retain genetic differentiation, and provide the opportunity for expansion of populations. (USFWS, 1998)
- Within each Management Area, reestablish vernal pool habitat to historic structure and composition to increase genetic diversity and population stability. (USFWS, 1998)
- Within each Management Area, rehabilitate and enhance secured vernal pool habitats and their constituent species. (USFWS, 1998)
- Manage protected habitat. (USFWS, 1998)
- Monitor protected habitat and listed species. (USFWS, 1998)

Conservation Measures and Best Management Practices:

- Coordinate with Riverside County and city governments to enact ordinances banning manure dumping in areas containing sensitive species, such as the San Jacinto River flood plain. Such a measure could reduce threats and meets Criteria 1 and 2 for the Recovery Plan. (USFWS, 2010)
- Determine the breeding system, distribution of genetic diversity of *Navarretia fossalis*, and best management practices to maintain genetic diversity within the species. This would allow a better understanding of the methodology needed to meet Criterion 4. (USFWS, 2010)
- Consider revising the Recovery Plan by incorporating new information and addressing issues discussed in Recovery Criteria section of this review. Consider revising recovery criteria to be threats-based and to include quantifiable thresholds to down list and delist. Additionally, areas of high value to the species should be identified and preserved. (USFWS, 2010)
- In order to analyze trends in abundance, standardize methods for sampling abundance of *Navarretia fossalis*. Use quantitative indices in data collection protocol. Any empirical approach in methodology will prove a more reliable method to analyze population data required in Criteria 3 and 4. (USFWS, 2010)
- Work with partners to help conserve *Navarretia fossalis*, by conducting surveys of all occurrences within the next 5 years to have more information (abundance, spatial distribution, and threats) about the status of the species. Recovery Plan Criteria 3 and 4 require that populations are monitored and stabilized. (USFWS, 2010)

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USFWS. 1998. Vernal Pools of Southern California Recovery Plan. U.S. Fish and Wildlife Service, Portland, Oregon

SPECIES ACCOUNT: *Navarretia leucocephala* ssp. *pauciflora* (=N. *pauciflora*) (Few-flowered navarretia)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A much-branched, spreading annual herb, about 1-4 dm tall, with linear, or linear-lobed, leaves. The inflorescence is a cluster of 2-15 blue or white flowers, subtended by long, spiny, leaf-like bracts. Blooms May-June. (NatureServe, 2015)

Current Range

Volcanic ash vernal pools in Lake County, California. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Habitat Type**

Adult: Vernal Pools (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Vernal Pools (NatureServe, 2015)

Habitat Narrative

Adult: Vernal pools with a volcanic ash substrate in chaparral, grassland, or mixed coniferous forest communities. (NatureServe, 2015)

Dispersal/Migration***Population Information and Trends*****Resiliency:**

Volcanic ash substrate very vulnerable to erosion. (NatureServe, 2015)

Representation:

Volcanic ash substrate very vulnerable to erosion. (NatureServe, 2015)

Redundancy:

Volcanic ash substrate very vulnerable to erosion. (NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1000 - 2500 individuals (NatureServe, 2015)

Adaptability:

Volcanic ash substrate very vulnerable to erosion. (NatureServe, 2015)

Population Narrative:

Volcanic ash substrate very vulnerable to erosion. (NatureServe, 2015)

Threats and Stressors

Stressor: Climate change (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: It is unknown at this time if climate change in California will result in a localized, relatively small cooling and drying trend, or a warmer trend with higher precipitation events. However, it is possible that either scenario would result in negative effects to vernal pool species. Cooling and drying trends could adversely affect fewflowered navarretia through decreased inundation periods that do not allow the species sufficient time to complete its life cycle. In contrast, warmer conditions with higher precipitation could increase the area of vernal pools, which would not necessarily be a negative effect because increased vernal pool area could increase available habitat for few-flowered navarretia. There could also be increased competition from nonnative plants. Monitoring of vernal pool ecosystems to determine effects from climate change is necessary to determine what adaptive land management practices would be the most appropriate to ensure the sustainability of vernal pool species, including few-flowered navarretia (USFWS, 2008).

Stressor: Habitat destruction and modification (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Threats to the habitat of few-flowered navarretia include alteration of hydrology, effects from road maintenance activities, agriculture land conversion, construction of a stock pond, off-road vehicle use, inappropriate grazing regimes, and competition from invasive weedy plant species (USFWS, 2008).

Stressor: Nonnative plants (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Competition from invasive plant species continues to pose a threat to this species. The localities at Hesse Flat and Manning Flat have been reported to be threatened by invasive plant species such as yellow star thistle (*Centaurea solstitialis*). Although specific information regarding adverse effects from invasive plant species is not available for all sites, it is likely that many of the localities of few-flowered navarretia are currently threatened by invasive plants to some degree.

Further research and monitoring are necessary to determine the degree that this species is threatened by non-native invasive plant species (USFWS, 2008).

Stressor: Stochastic events (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Small numbers of localities makes it difficult for this species to persist while sustaining the impacts from competition from nonnative plant species, intensive grazing, changes in hydrology, adjacent development, drought, or other unknown factors. Such populations may be highly susceptible to extirpation due to chance environmental disturbances. If a locality of fewflowered navarretia has several consecutive years of poor rainfall, intensive grazing, changes in hydrology from adjacent development, or intense competition from other plant species, it is possible that the locality will become extirpated. Populations that decline to zero may not always be capable of rebounding from the soil seed bank and the population is likely to become extirpated (USFWS, 2008).

Recovery

References

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USFWS. 2008. Few-flowered Navarretia (*Navarretia leucocephala* ssp. *pauciflora*)

5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California. 24 pp.

SPECIES ACCOUNT: *Navarretia leucocephala* ssp. *plieantha* (Many-flowered navarretia)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/18/1997; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

Navarretia leucocephala ssp. *plieantha* forms mats 5 to 20 cm (2.0 to 7.9 in) across and 1 to 3 cm (0.4 to 1.2 in) high. The stems have a peeling, white surface and are highly branched. Stem thickness is 0.8 to 1.4 mm (0.03 to 0.06 in) and is more or less uniform throughout its length. The leaves are 3 to 4 cm (1.2 to 1.6 in) long and are either entire or have a few thread-like lobes. Flower heads are 1.5 to 2 cm (0.6 to 0.8 in) across and contain between 10 and 60 pale blue flowers. Each flower in the head is 5 to 6 mm (0.20 to 0.24 in) long. The capsule and seeds are similar to those of *N. leucocephala* ssp. *pauciflora*; each fruit may contain as many as three seeds (Mason 1946, Day 1993b). (USFWS, 2005)

Taxonomy

The name first assigned to many-flowered navarretia was *Navarretia plieantha*. The type locality for the species is Boggs Lake, in Lake County (Mason 1946). Day (1993a) later reduced many-flowered navarretia to the rank of subspecies, under the name *Navarretia leucocephala* ssp. *plieantha*. As explained in the species account for *Navarretia leucocephala* ssp. *pauciflora*, some populations of *Navarretia* consist of individuals intermediate in characteristics between two subspecies. Dr. Day (in litt. 1997) has distinguished two types of intermediate specimens, which others have identified as *N. leucocephala* ssp. *plieantha*. One group is intermediate between *N. leucocephala* ssp. *pauciflora* and *N. leucocephala* ssp. *plieantha*, and the other is intermediate between *N. leucocephala* ssp. *plieantha* and *N. leucocephala* ssp. *bakeri* (Baker's navarretia). (USFWS, 2005)

Historical Range

Typical *Navarretia leucocephala* ssp. *plieantha* was known historically only from Boggs Lake (A. Day in litt. 1993, 1997). The other reported occurrences include six sites with plants that are intermediate between *N. leucocephala* ssp. *plieantha* and other subspecies, and two sites where Dr. Alva Day does not have access to specimens to confirm the identity of the plants (A. Day in litt. 1993, 1997). Three historical occurrences in Lake County (Loch Lomond, Mount Hannah Lodge, and Siegler Springs Road) have plants intermediate between *N. leucocephala* ssp. *pauciflora* and *N. leucocephala* ssp. *plieantha*. At least three occurrences in the Santa Rosa area, in Sonoma County, consist of plants intermediate between *N. leucocephala* ssp. *plieantha* and *N. leucocephala* ssp. *bakeri* (A. Day in litt. 1993, 1997). (USFWS, 2005)

Current Range

The five occurrences reported as extant in the final rule (U.S. Fish and Wildlife Service 1997b) were Boggs Lake, Loch Lomond, Mount Hannah Lodge, Siegler Springs Road, and Stienhart Lake, which are in the Lake-Napa Vernal Pool Region (Keeler-Wolf et al. 1998). These occurrences are still believed to be extant, although only three populations have been revisited since 1989 (California Natural Diversity Data Base 2005). (USFWS, 2005)

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Lifespan**

Adult: 1 year (USFWS, 2009)

Breeding Season

Adult: May to June (NatureServe, 2015)

Reproduction Narrative

Adult: Navarretias are an annual herb of the phlox family that bloom from May to June. Each fruit may contain as many as three seeds (Mason 1946; Day 1993b). (USFWS, 2009; NatureServe, 2015)

Habitat Type

Adult: Palustrine and terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest/Woodland, temporary pools (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Requires temporary pools or wet ground in forest openings (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist

Habitat Narrative

Adult: Navarrieta leucocephala ssp. plieantha are found in margins of vernal pools and lakes with a volcanic ash substrate, and wet ground in forest openings. This species is found only on substrates of volcanic origin and is dependent on vernal pools, vernal lakes, and swales for survival. (USFWS, 2009; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Low (inferred from USFWS, 2009)

Representation:

Low (inferred from USFWS, 2009)

Redundancy:

Low (inferred from USFWS, 2009)

Number of Populations:

5 (USFWS, 2005)

Population Narrative:

The five occurrences reported as extant in the final rule (U.S. Fish and Wildlife Service 1997b) were Boggs Lake, Loch Lomond, Mount Hannah Lodge, Siegler Springs Road, and Stienhart Lake, which are in the Lake-Napa Vernal Pool Region (Keeler-Wolf et al. 1998). These occurrences are still believed to be extant, although only three populations have been revisited since 1989 (California Natural Diversity Data Base 2005). The typical population of *Navarretia leucocephala* ssp. *plieantha* at Boggs Lake has not declined (Baldwin and Baldwin 1991, California Natural Diversity Data Base 2005). (USFWS, 2005)

Threats and Stressors

Stressor: Invasive species (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The primary threat to *Navarretia leucocephala* ssp. *plieantha* at Boggs Lake is infestation by invasive species including *Cirsium* spp. (thistle), *Centaurea* spp. (knapweed), and *Typha* spp. (cattail) (CNDDDB 2007). Competition from invasive plant species continues to pose a threat to this species. The localities at Mt. Hannah Lodge and Boggs Lake have been reported to be threatened by invasive plant species (CNDDDB 2007) including infestation by invasive *Centaurea solstitialis* (star thistle) and *Taeniatherum caput-medusae* (medusahead). Although site specific information regarding adverse effects from invasive plant species is not available, we believe it is likely that many of the localities of *Navarretia leucocephala* ssp. *plieantha* are currently threatened by invasive plants to some degree. (USFWS, 2009)

Stressor: Off-highway vehicles (OHVs) (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The primary threat to *Navarretia leucocephala* ssp. *plieantha* at this site is offhighway vehicles (OHV's) and California Department of Transportation activities next to the preserve (CNDDDB 2007). The occurrence is adjacent to State Route 175, where road maintenance activities could still result in the loss of plants. Occasional fence vandalism and vehicle trespass still occur at Loch Lomond (S. Zalusky, Northwest Biosurvey, pers. comm. 2008). (USFWS, 2009)

Stressor: Urban lane use (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Plants at Seiglers Springs are threatened by urban land use (CNDDB 2007). (USFWS, 2009)

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Pyke 2005). However, climatic conditions for smaller sub-regions such as California remain uncertain (Pyke 2005). It is unknown at this time if climate change in California will result in a localized, relatively small cooling and drying trend, or a warmer trend with higher precipitation events (Pyke 2005). However, it is possible that either scenario would result in negative effects to vernal pool species (Pyke 2004; Pyke and Marty 2005). Cooling and drying trends could adversely affect *Navarretia leucocephala* ssp. *plieantha* through decreased inundation periods that do not allow the species sufficient time to complete its life cycle. In contrast, warmer conditions with higher precipitation could increase the area of vernal pools, which would not necessarily be a negative effect because increased vernal pool area could increase available habitat for *N. leucocephala* ssp. *plieantha*. There could also be increased competition from nonnative plants. Monitoring of vernal pool ecosystems to determine effects from climate change is necessary to determine what adaptive land management practices would be the most appropriate to ensure the sustainability of vernal pool species (Pyke and Marty 2005), including *N. leucocephala* ssp. *plieantha*. (USFWS, 2009)

Stressor: Small numbers of localities/stochastic extinction (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The conservation biology literature commonly notes the vulnerability of taxa known from one or very few locations (e.g., Shaffer 1981, 1987; Primack 1998; Groom et al. 2006). In particular, small numbers of localities makes it difficult for this species to persist while sustaining the impacts from competition from nonnative plant species, intensive grazing, changes in hydrology, adjacent development, drought, or other unknown factors. Such populations may be highly susceptible to extirpation due to chance events or additional environmental disturbance (Goodman 1987; Gilpin and Soule 1988). If a locality of *Navarretia leucocephala* ssp. *plieantha* has several consecutive years of poor rainfall, intensive grazing, changes in hydrology from adjacent development, or intense competition from other plant species, it is possible that the locality will become extirpated. (USFWS, 2009)

Stressor: Cattle grazing (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Threats to the Saunders Road locality include cattle grazing, wastewater irrigation, and potential urban development. Additionally, grazing has eliminated many native species (CNDDB 2007). Threats to Shiloh Ranch include grazing, trampling, and urban development (CNDDB 2007). (USFWS, 2009)

Recovery

Reclassification Criteria:

1. Habitat protection: Accomplish habitat protection that promotes vernal pool ecosystem function sufficient to contribute to population viability of the covered species. Suitable vernal pool habitat within each prioritized core area for the species is protected. Species localities distributed across the species geographic range and genetic range are protected. Protection of extreme edges of populations protects the genetic differences that occur there. Reintroduction and introductions must be carried out and meet success criteria. Additional localities that are detected (and determined essential to recovery goals) are permanently protected. Habitat protection results in protection of hydrology essential to vernal pool ecosystem function, and monitoring indicates that hydrology that contributes to population viability has been maintained through at least one multi-year period that includes above average, average, and below average local rainfall as defined above, a multi-year drought, and a minimum of 5 years of post-drought monitoring. (USFWS, 2009)

2. Habitat management and monitoring plans that facilitate maintenance of vernal pool ecosystem function and population viability have been developed and implemented for all habitat protected. Mechanisms are in place to provide for management in perpetuity and long-term monitoring. Monitoring indicates that ecosystem function has been maintained in the areas protected under 1A-D for at least one multi-year period that includes above average, average, and below average local rainfall, a multi-year drought, and a minimum of 5 years of post-drought monitoring. Seed banking actions have been completed for species that would require it as insurance against risk of stochastic extirpations or that will require reintroductions or introductions to contribute to meeting recovery criteria. (USFWS, 2009)

3. Status surveys, 5-year status reviews, and population monitoring show populations within each vernal pool region where the species occur are viable (e.g., evidence of reproduction and recruitment) and have been maintained (stable or increasing) for at least one multi-year period that includes above average, average, and below average local rainfall, a multi-year drought, and a minimum of 5 years of post-drought monitoring. Status surveys, status reviews, and habitat monitoring show that threats identified during and since the listing process have been ameliorated or eliminated. Site-specific threats identified through standardized site assessments and habitat management planning also must be ameliorated or eliminated. (USFWS, 2009)

4. Research actions necessary for recovery and conservation of the covered species have been identified (these are research actions that have not been specifically identified in the recovery actions but for which a process to develop them has been identified). Research actions (both specifically identified in the recovery actions and determined through the process) on species biology and ecology, habitat management and restoration, and methods to eliminate or ameliorate threats have been completed and incorporated into habitat protection, habitat management and monitoring, and species monitoring plans, and refinement of recovery criteria and actions. Research on genetic structure has been completed (for species where necessary – for reintroduction and introduction, seed banking) and results incorporated into habitat protection plans to ensure that within and among population genetic variation is fully representative by populations protected. Research necessary to determine appropriate

parameters to measure population viability for each species have been completed. (USFWS, 2009)

5. Recovery Implementation Team is established and functioning to oversee rangewide recovery efforts. Vernal pool regional working groups are established and functioning to oversee regional recovery efforts. Participation plans for each vernal pool region have been completed and implemented. Vernal pool region working groups have developed and implemented outreach and incentive programs that develop partnerships contributing to achieving recovery criteria 14. (USFWS, 2009)

Delisting Criteria:

Same as reclassification criteria.

Recovery Actions:

- Recovery actions are not available.

Conservation Measures and Best Management Practices:

- The majority of known localities of this species are on private land and not protected. Preservation of Zone 1 core areas should be pursued to preserve known localities that are currently not protected. (USFWS, 2009)
- Conduct research at as many of the extant localities as possible to incorporate research recommendations outlined in the 2005 Recovery Plan. The following research should be prioritized over the next five years: a. Develop a standardized monitoring method to monitor species status and population trends at all known locations. This will better our understanding of potential threats to the species, and will aid in the development of methods to ameliorate these threats. b. Conduct research on the genetic structure of the species to determine the taxonomic status of the *Navarretia leucocephala* group. (USFWS, 2009)
- Once additional sites are protected, management plans should be prepared. Results from standardized monitoring discussed in item 3, below, should be included in the management plans for these protected sites. Grazing management and invasive weed control should be primary components of these management plans. (USFWS, 2009)
- Regional vernal pool working groups should be created in regions where *Navarretia leucocephala* ssp. *pliantha* is known to occur to aid with monitoring and management efforts. (USFWS, 2009)
- Potential habitat should be surveyed for new populations and if located, those populations should be protected. (USFWS, 2009)

References

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USFWS. 2009. *Navarretia leucocephala* ssp. *plieantha* (Many-flowered Navarretia). 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Sacramento Fish and Wildlife Office Sacramento, California

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SPECIES ACCOUNT: *Neraudia angulata* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

Neraudia angulata is a short-lived shrub in the Urticaceae (nettle family). It is an upright shrub up to 3 m (9.8 ft) tall with alternately arranged leaves 7 to 15 cm (2.7 to 5.9 in) long. The undersides of the leaves are usually covered with hairs, and the leaf margins are sometimes toothed. The flowers are borne in axillary clusters, and the species is dioecious (with male and female flowers on separate plants). Many cultivated plants, however, have both male and female flowers (Makua Implementation Team 2003). The mature fruit is small and seed-like, and is enclosed in a red, fleshy calyx (Wagner et al 1999) (USFWS, 2016).

Historical Range

The genus *Neraudia* is endemic to the Hawaiian Islands. Historic data indicate *Neraudia angulata* occurred throughout the Waianae Mountains of Oahu (56 FR 55770) (USFWS, 2016).

Current Range

Endemic to Waianae Mountains, Oahu.

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Neraudia angulata* under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Neraudia angulata* (77 FR 57648-57862). The critical habitat designation includes 17 critical habitat units, which encompass approximately 7,808 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Neraudia angulata* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Neraudia angulata* includes 17 critical habitat units, covering three ecosystem types, which encompass approximately 7,808 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Dry—Units 1, 2, 8, 9, 10, 11; Oahu—Lowland Mesic—Units 1, 2, 3; , Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8

Oahu—Lowland Dry—Unit 1 [102 ac (41 ha)]; This area consists of 49 ac (20 ha) of State land and 53 ac (22 ha) of privately owned land in the Waianae Mountains, extending from Haili Gulch to Kawaipahai. Oahu—Lowland Dry—Unit 2 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland dry ecosystem in the Waianae Mountains, on Federal land within Kaena Point State Park.

Oahu—Lowland Dry—Unit 8 [99 ac (40 ha)]. Oahu—This area consists of 96 ac (40 ha) of privately owned land and 3 ac (1 ha) of State land as part of the old railroad right-of-way in the lowland dry ecosystem, at the Kalaeloa Barber's Point Harbor area. Oahu—Lowland Dry—Unit 9 [37 ac (15 ha)]. This area consists of 17 ac (7 ha) of City and County land, 3 ac (1 ha) of privately owned land, 1 ac (0.5 ha) of State land, and 16 ac (6 ha) of Federal (Pearl Harbor NWR) land in the lowland dry ecosystem at Kalaeloa. Oahu—Lowland Dry—Unit 10 [43 ac (17 ha)]. This area consists of 43 ac (17 ha) of State land (DHHL) in the lowland dry ecosystem at Kalaeloa. Oahu—Lowland Dry—Unit 11 [166 ac (67 ha)]. This area consists of 166 ac (67 ha) of federal land (U.S. Navy) in the lowland dry ecosystem at Kalaeloa.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac (105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawana, and partially within the Nanakuli Forest Reserve.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Neraudia angulata* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Neraudia angulata* occurs within the Lowland dry, Lowland mesic and Dry cliff ecosystems in the Waianae Mountain caldera complex:

Oahu—Lowland Dry—Units 1, 2, 8, 9, 10, 11. (A) Elevation: <3,300 ft (<1,000 m). (B) Annual Precipitation: <50 in (<130 cm). (C) Substrate: Weathered silty loams to stony clay, rocky ledges, little weathered lava. (D) Canopy: Diospyros, Myoporum, Pleomele, Santalum, Sapindes. (E) Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. (F) Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Plumbago, Sicyos, Sida, Waltheria.

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (F) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. (F) Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Neraudia angulata* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Wind-pollinated (USFWS, 2016)

Lifespan

Adult: <10 years (USFWS, 2016)

Key Resources Needed for Breeding

Adult: Flowers year-round (USFWS, 2016)

Reproduction Narrative

Adult: *Neraudia* species are wind-pollinated (Wagner et al 1999), and flowering and fruiting occur throughout the year. The red, fleshy calyx surrounding the mature fruit suggests that fruit-eating birds may disperse the seeds. The longevity of *N. angulata* is probably similar to that of other small shrubs that live less than 10 years (i.e., short-lived perennials) (Makua Implementation Team 2003). This dioecious species is subject to large declines or fluctuations in

population size. Other demographic information for *N. angulata* in the wild is unknown, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, seed dispersal, vegetative reproduction and specific environmental requirements (USFWS, 2016).

Habitat Type

Adult: Dry forest and shrubland (USFWS, 2016)

Habitat Narrative

Adult: Diverse mesic forest, on slopes or in gulches, in open or broken understory. (NatureServe, 2015). *Neraudia angulata* is found in dry forests and shrublands, and occasionally in mesic forests and shrublands, at elevations of 189 to 978 m (620 to 3,208 ft) (Makua Implementation Team 2003; 68 FR 35950). Plants occur on gulch slopes, on steep to nearly vertical cliffs and cliff ledges, in the forest understory, and among shrubs and grasses in exposed areas (Makua Implementation Team 2003). Plants may lose all their leaves during the dry summer months (U.S. Army Garrison 2005b) (USFWS, 2016).

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Increasing (USFWS, 2016)

Number of Populations:

9 (USFWS, 2016)

Population Size:

380 individuals (USFWS, 2016)

Population Narrative:

When the species was listed in 1991, only five occurrences totaling 15 individuals were known. Since then, more occurrences have been discovered, but the number of sites was still thought to be diminishing in 2003 (Makua Implementation Team 2003). With the initiation of intensive population unit and habitat management in 2003, numbers of individuals have increased. Currently, *N. angulata* occurs in nine population units totaling approximately 380 individuals (Table SB 26). These population units are found on Federal, State, city/county, and private lands (68 FR 35950). None of the existing population units has met minimum numerical criteria for stabilization (defined for this species as at least 100 mature, reproducing individuals) (USFWS, 2016).

Threats and Stressors

Stressor:

Exposure:

Response:

Consequence:

Narrative: Threats from serious erosion due to action of feral animals, fires, military activity, and aggressive alien plants. (NatureServe, 2015)

Stressor: Fire (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: This species is particularly threatened by fire (USFWS, 2016).

Stressor: Landslides (USFWS, 2016)

Exposure:

Response:

Consequence: Extinction

Narrative: In addition, occurrences of *N. angulata* are vulnerable to extirpation from naturally occurring events such as landslides and/or reduced reproductive vigor due to small population size and limited distribution (56 FR 55770; 68 FR 35950; Service 1995a; Service 1998a).

Recovery

Reclassification Criteria:

Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1995a, 1998). At least 50 mature, reproducing individuals are needed per population unit to attain stability for short-lived perennials. However, species subject to common, large fluctuations in numbers may require a stabilization target of at least 100 mature individuals for each population unit. The minimum population size was increased for this species also because fertilization and seed set of dioecious plants require more reproducing individuals of both male and female plants within pollination range that are flowering at the same time (Makua Implementation Team 2003) (USFWS, 2016).

References

USFWS 2016. Status of the Species and Critical Habitat: *Neraudia angulata* (No Common Name).

U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016

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Endangered Status for 23 Species on Oahu and Designation of Critical Habitat for 124 Species. Final Rule. 77 FR 57648-57862 (September 18, 2012)

USFWS. 2016. Status of the Species and Critical Habitat: *Neraudia angulata* (No Common Name).

U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016

USFWS 2016. Status of the Species and Critical Habitat: *Neraudia angulata* (No Common Name).
U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF
from Chris Mullens 9/30/2016.

SPECIES ACCOUNT: *Neraudia ovata* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

It is a sprawling, rarely erect, shrub with 1 to 3 meters (3.3 to 10 feet) long stems or it can develop into a small tree. The leaves are grayish to greenish on the lower surface, thin, ovate to elliptic-ovate or elliptic. They are 4 to 12 centimeters (1.6 to 4.7 inches) long and 2.0 to 6.4 centimeters (0.8 to 2.5 inches) wide. This species is mostly dioecious, male and female flowers occurring on separate plants. Male flowers are short with a densely haired calyx and female flowers are sessile, are also densely haired, and have a boat-shaped calyx. The fruit is an achene. The lack of a conspicuous tuft of hairs at the base of the leaves, the distribution of the hairs on the lower surface, and the shape of the female flower are diagnostic characteristics for the *N. ovata* (U.S. Army 2003a).

Taxonomy

Neraudia ovata is in the Urticaceae, or nettle family.

Historical Range

See current range/distribution

Current Range

Neraudia ovata is known currently and historically only from the island of Hawaii. The species is found on the Kona coast from North Kona to Kau. There are only 13 individuals persisting on the island of Hawaii. There is one individual in Kaloko, North Kona; one individual in the Manuka Natural Area Reserve; 10 individuals in three locations at PTA, and one individual on State land outside of PTA (U.S. Army 2003a).

Critical Habitat Designated

Yes; 7/2/2003.

Legal Description

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Neraudia ovata* on the island of Hawaii (68 FR 39623 - 39722).

Critical Habitat Designation

The critical habitat designation for *Neraudia ovata* includes two units totaling 7,294 acres in Hawaii County, Hawaii. The units are Hawaii 10—*Neraudia ovata*—a and Hawaii 18—*Neraudia ovata*—d. One of the units, Hawaii 18—*Neraudia ovata*—d, currently is occupied. This unit is essential to the conservation of *N. ovata* because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The remaining unoccupied unit is essential to the conservation of the species because it supports habitat that is necessary for the establishment of additional populations in order to reach recovery goals. Each unit is geographically separated from other critical habitat for this island-endemic species within its historical range in order to reduce the

likelihood of all recovery populations being destroyed by one naturally occurring catastrophic event. The two units for this species that we are designating on the island of Hawaii provide for habitat for a total of four populations, each with 300 mature, reproducing individuals of the *N. ovata*.

Hawaii 10—*Neraudia ovata*—a [1,859 ha (4,493 ac)]: This unit contains no named natural features and lies completely within the Kiholo watershed. This unit, plus the excluded Kamehameha Schools land, provides habitat for 2 populations of 300 mature, reproducing individuals of the *N. ovata* and is currently unoccupied. This unit provides the northernmost critical habitat within the species' historical range.

Hawaii 18—*Neraudia ovata*—d [1,134 ha (2,801 ac)]: This unit contains no named natural features and is completely within the Kauna watershed. This unit provides habitat for 2 populations of 300 individuals of *N. ovata* and is currently occupied by one individual. The unit provides the southernmost critical habitat within the species' historical range.

Primary Constituent Elements/Physical or Biological Features

Habitat features that are essential for this species include, but are not limited to, open *Metrosideros polymorpha*-*Sophora chrysophylla* dominated lowlands, montane dry forests, and *Metrosideros*-shrub woodland.

Special Management Considerations or Protections

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for this species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Plants have been observed in vegetative form during fall and winter, and in flower and fruit during spring and summer. Limited observations suggest plants are not truly dioecious, but facultatively monoecious, bearing male and female flowers at different times on the same plant (U.S. Army 2003a).

Habitat Type

Adult: Dry, subalpine forest

Habitat Narrative

Adult: *Neraudia ovata* occurs in dry forests, on open lava flows, and in subalpine forests on the leeward side of the island of Hawaii at elevations from 115 to 1,520 meters (377 to 4,987 feet). At PTA, the species grows in Open *Metrosideros* Treelands with a sparse shrub understory and in *Myoporum* Shrublands. Most plants are found on Mauna Loa aa flows that are approximately 4,000 years old (U.S. Army 2003a).

Dispersal/Migration***Population Information and Trends*****Number of Populations:**

5 (USFWS, 2015)

Population Size:

90 wild individuals (USFWs, 2015)

Population Narrative:

Fragility unknown. Currently 11-12 plants observed. 2 current (between 1982 and 1997) and 9 historical occurrences. (NatureServe, 2015). During the 2003 to 2007 surveys 11 wild individuals of *Neraudia ovata* were found at Puu Anahulu on State owned lands (State of Hawaii Department of Land and Natural Resources [DLNR] 2015a). These individuals are protected within individual fences 2 and will be enclosed by a larger fence in the future. In 2014, 6 of the 10 individuals were relocated and monitored (Plant Extinction Prevention Program [PEPP 2014]).
□ In fiscal year 2009, there were 116 individuals of *Neraudia ovata* at Pohakuloa Training Area (PTA) (U.S. Army Garrison Pohakuloa [US Army] 2010). In fiscal year 2010, 90 individuals remained. The loss of 26 individuals in Area of Species Recovery 24 between monitoring cycles represents 22 percent of the known population. Within the large-scale fence units are Areas of Species Recovery (ASRs), which are defined as 100-meter (328-foot) buffers around known federally-listed plant population where management is focused (US Army 2014). The primary factors in the decline of this species are dry conditions due to drought combined with increased ungulate pressure (US Army 2010). In fiscal year 2013, there were approximately 75 individuals (32 mature and 43 immature) (US Army 2014). At least 11 of the 75 individuals are female and seed collections have been from 10 of these plants (US Army 2014). Since 2004, there are 25 male and female individuals in the PTA greenhouse representing 15 founders from the wild population (USFWS, 2015).

Threats and Stressors**Stressor:****Exposure:****Response:****Consequence:**

Narrative: The threats to *Neraudia ovata* are heavy browsing and the resulting habitat modification by feral sheep and goats; competition from non-native species such as *Pennisetum*

setaceum, *Leucaena leucocephala*, and *Schinus terebinthifolius*; insect damage (e.g., from *Aleurodicus dispersus*; spiraling whitefly); reduced reproductive vigor; residential development; fire; and due to the very limited distribution of this species, a single natural or human-caused environmental disturbance could be catastrophic (U.S. Army 2003a).

Stressor: Climate change destruction or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Neraudia ovata* is minimally vulnerable to the impacts of climate change (USFWS, 2015).

Stressor: Stochastic events

Exposure:

Response:

Consequence:

Narrative: Drought mortality or reduced viability – Drought may exacerbate the effects of ungulates and has direct adverse impacts on *N. ovata* (PEPP 2010; J. Wagner, pers. comm. 2015; US Army 2014) (USFWS, 2015)

Stressor: Collecting impacts

Exposure:

Response:

Consequence:

Narrative: Illegal collection for scientific, horticultural or other purposes threatens the populations of *N. ovata*, as well as possible excessive visitation. For instance, on two occasions in 2013, five reintroduced individuals of *N. ovata* were uprooted in the Mauna Kea area and those five plants were stolen along with other common and federally listed plants (P. Peshut and S. Evans, US Army, pers. comm. 2013) (USFWS, 2015).

Recovery

Recovery Actions:

- New management actions:
 - Surveys / inventories – A survey was conducted for new individuals of *N. ovata* in Kau (PEPP 2014). At least two mature individuals were discovered and fruits were collected from those plants (PEPP 2014).
 - Ungulate monitoring and control – In 2009, four exclosures were constructed for *N. ovata* at Puu Anahulu (PEPP 2009). Each exclosure was 9 meters by 9 meters (30 feet by 30 feet) in size. In 2014, the fenced exclosure was maintained and inspected for any damages (PEPP 2014).
 - Invasive plant monitoring and control – Annual weed control is ongoing in North Kona on private property (J. Wagner, pers. comm. 2015) and at Pohakuloa Training Area (US Army 2014).
 - Population viability monitoring and analysis o Monitoring of the 11 wild individuals at Puu Anahulu revealed that severe drought was affecting the plants as noted by wilting (PEPP 2010). In 2014, the plants were revisited and monitored (PEPP 2014).
 - o The wild individual on private

- land in North Kona was monitored (PEPP 2012). ☐ Captive propagation for genetic storage and reintroduction o The Volcano Rare Plant Facility (2013) has 36 plants propagated in their nursery representing five locations. The Facility propagated 20 plants for reintroductions next year. Meanwhile, eight individuals were reintroduced on private property in Kona. In 2014, the Volcano Rare Plant Facility (2014) had the same number of plants propagated in their nursery representing five locations. The Facility propagated 17 plants for reintroductions next year and a single individual was reintroduced at Puu Waawaa. o The Lyon Arboretum's Seed Conservation Lab (2014) has 10 seeds in genetic storage. o The Hawaii Volcanoes National Park (2014) has 12 cuttings and 30 plants in their nursery. o Pohakuloa Training Area has 97 seeds from two founders in genetic storage (US Army 2014). In total more than 286,000 seeds, representing 122 accessions from 38 founders, have been collected and are in storage at Pohakuloa Training Area (US Army 2014). Pohakuloa Training Area also provided the following plants for reintroduction efforts: 30 plants to Hawaii Volcanoes National Park, 10 plants and 29 cuttings to Jill Wagner, 320 cuttings to the US Forest Service's Environmental Security Technology Certification Program, and 2 plants to the State Department of Forestry and Wildlife (US Army 2014). o Propagation of *N. ovata* by cuttings is 50 percent successful but highly dependent on the founder (US Army 2014). However, propagation of *N. ovata* by seeds has been less successful with low germination rates observed after 10 years of being sown. o Fruits were collected from 3 of the 10 wild individuals at Puu Anahulu (PEPP 2014). The fruits were given to the Volcano Rare Plant Facility for propagation. o In Kau, fruits from two wild individuals were collected and given to the Volcano Rare Plant Facility for propagation (PEPP 2014). ☐ Reintroduction / translocation o Two individuals of *N. ovata* were reintroduced in a Natural Area Reserve System on Hawaii Island (DLNR 2014). o The Hawaii Volcanoes National Park (2014) reintroduced 30 individuals in the Park. o At Puu Waawaa, 270 individuals was reintroduced in 2014 (DLNR 2015b) o During 2002 to 2004, four individuals were reintroduced at Pohakuloa Training Area (US Army 2014). An additional 46 individuals was reintroduced in 2014. There were 48 individuals remaining in 2014 with a natural recruitment of 20 seedlings of *N. ovata* (US Army 2014). o Near Saddle Road, there are 63 reintroduced individuals (US Army 2014). o On State owned lands in North Kona, there are two reintroduced populations containing a total of 50 mature and 13 immature individuals. At the first population between 2004 and 2009, 42 individuals were reintroduced. In 2014, none of those reintroductions survived but two mature naturally recruited individuals were observed (US Army 2014). The second reintroduced population contained 111 individuals in 2005 to 2012. In 2014, 21 individuals were reintroduced. There are 48 individuals remaining at the site with a natural recruitment of 13 immature individuals (US Army 2014). o On County lands in North Kona, there are 28 reintroduced individuals with a natural recruitment of 11 mature and 86 immature individuals (US Army 2014) (USFWS, 2015).
- Recommendations for Future Actions: ☐ Surveys / inventories – Survey geographical and historical range for a current assessment of the species' status. ☐ Captive propagation for genetic storage and reintroduction – Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. ☐ Ungulate monitoring and control – Maintain existing exclosures and monitor for potential incursions. ☐ Invasive plant monitoring and control – Eradicate invasive introduced plants within ungulate exclosures and maintain exclosures free of invasive plants. ☐ Population viability monitoring and analysis – Continue monitoring wild and outplanted individuals. ☐ Fire monitoring and control – Develop and implement a fire management plan at the existing exclosure. ☐ Climate change adaptation strategy – Research the suitability of habitat

for reintroducing this species in the future due to the impacts of climate change. 2 Alliance and partnership development – Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2015).

Conservation Measures and Best Management Practices:

- Important conservation actions needed for *Neraudia ovata* include the following: protective fences to be constructed around the known occurrences of *N. ovata*, and removal of feral ungulates and non-native plants from habitat. A commitment from all landowners on whose land this species grows should be developed for long-term stewardship and conservation of these areas once they have been enclosed. Insect damage must be controlled, such as that caused by the spiraling whitefly. In addition, the following conservation actions are needed: propagation and maintenance of genetic stock ex situ; augmentation of extant occurrences and establishment of new occurrences within the species' historical range; control or eradication of non-native plants; protection from fire and human disturbance; implementation of a comprehensive monitoring program; surveys to identify individuals and/or occurrences that may exist in former habitats, or that may be present in areas that have not been surveyed recently (Service 1998b). A State-wide management plan that identifies areas and landscapes for the long-term conservation of all known occurrences of *N. ovata* is needed. As part of this management plan, landowners and managers should delineate management units to conserve this species and other native species through threat control and habitat restoration. Ongoing Conservation Actions: The Volcano Rare Plant Facility has three plants in cultivation from the Manuka population and eight plants from the Kona population. Fifteen plants grown at the facility were outplanted at Manuka in 2002. The Hawaii Department of Agriculture has conducted a very successful biocontrol program for the spiraling whitefly which has significantly reduced damage caused by this insect. The spiraling whitefly remains a problem on certain preferred host plants, particularly in the summer, or on windy coastal areas where biocontrol efforts are not effective (Service 1998b).

References

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SPECIES ACCOUNT: *Neraudia sericea* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/10/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

A shrub 3-5 m tall. Leaf undersides densely covered with silky hairs. Male and female flowers are borne on separate plants (NatureServe, 2015).

Taxonomy

A member of the nettle family (Urticaceae) (USFWS 2003a-c). In a taxonomic revision of the genus *Neraudia*, Richard Cowan (1949) restored *N. sericea* to full species status and surmised that *N. kahoolawensis*, for which the type (and only) material was no longer available, was likely a Kahoolawe representative of *N. sericea*, based on its written description. Wagner et al. (1999) accepted *N. sericea* as a full species and synonymized *N. kahoolawensis* as a Kahoolawe population of *N. sericea* (USFWS, 2012).

Historical Range

Historically, *Neraudia sericea* was known from Kamalo and near Waianu on Molokai; Kaiholena on central Lanai; Olowalu Valley on West Maui (portions of which have been surveyed on several occasions without success [Hank Oppenheimer, pers. comm. 2010]) and the southern slopes of Haleakala on East Maui; and from an unspecified site on Kahoolawe (USFWS 1994) (USFWS, 2012).

Current Range

Currently occurs on Molokai, Lanai, and Maui (USFWS, 2012).

Critical Habitat Designated

Yes; 5/14/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Neraudia sericea* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 14 detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Neraudia sericea* includes 14 CHUs in Maui County, Hawaii with detailed unit information. There are also an unknown number of units on Lanai that contain this species (number of units is unknown because detailed unit descriptions for Lanai are not available) (81 FR 17790-18110).

Kahoolawe—Lowland Dry—Unit 1 consists of 1,220 ac (494 ha) of State land, north of Waihonu Gulch on west Kahoolawe. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Kahoolawe—Lowland Dry—Unit 1 is not known to be occupied by *Gouania hillebrandii*, *Hibiscus brackenridgei*, *Kanaloa*

kahoolawensis, *Neraudia sericea*, *Sesbania tomentosa*, or *Vigna owahuensis*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Kahoolawe—Lowland Dry—Unit 2 consists of 3,205 ac (1,297 ha) of State land from Lua o Kealialuna to Puu o Moaulaiki and Luamakika on the eastern side of Kahoolawe. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Kahoolawe—Lowland Dry— Unit 2 is not known to be occupied by *Gouania hillebrandii*, *Hibiscus brackenridgei*, *Kanaloa kahoolawensis*, *Neraudia sericea*, *Sesbania tomentosa*, or *Vigna o-wahuensis*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Mesic—Unit 1 (and) *Palmeria dolei*—Unit 37—Lowland Mesic (and) *Pseudonestor xanthophrys*—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Ctenitis squamigera*, *Cyanea dunbariae*, *C. mannii*, *C. profuga*, *Cyperus fauriei*, *Cyrtandra filipes*, *Gouania hillebrandii*, *Labordia triflora*, *Neraudia sericea*, *Santalum haleakalae* var. *lanaiense*, *Schiedea lydgatei*, *S. sarmentosa*, *Silene alexandri*, *S. lanceolata*, *Spermolepis hawaiiensis*, and *Zanthoxylum hawaiiense*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Mesic—Unit 1 is not known to be occupied by *Asplenium dielirectum*, *Bonamia menziesii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea procera*, *C. solanacea*, *Diplazium molokaiense*, *Festuca molokaiensis*, *Flueggea neowawraea*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Melicope mucronulata*, *M. munroi*, *M. reflexa*, *Phyllostegia haliakalae*, *P. mannii*, *P. pilosa*, *Sesbania tomentosa*, *Stenogyne bifida*, or *Vigna o-wahuensis*, or the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 1 consists of 11,465 ac (4,640 ha) of State land, 2,069 ac (837 ha) of federally owned land, and 3 ac (1 ha) of privately owned land, from Kanaio to Kahualau Gulch on the southern slopes of east Maui. This unit is occupied by the plants *Bonamia menziesii*, *Cenchrus agrimonoides*, *Flueggea neowawraea*, *Melicope adscendens*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or

biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 1 is not known to be occupied by *Alectryon macrococcus*, *Bidens micrantha* ssp. *kalealaha*, *Canavalia pubescens*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Sesbania tomentosa*, *Solanum incompletum*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 2 consists of 1,851 ac (749 ha) of State land at Keokea on the southern slopes of east Maui. This unit is occupied by the plants *Bonamia menziesii*, *Canavalia pubescens*, and *Hibiscus brackenridgei*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 2 is not known to be occupied by *Alectryon macrococcus*, *Bidens micrantha* ssp. *kalealaha*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 3 consists of 188 ac (76 ha) of privately owned land, at Keauhou on the southern slopes of east Maui. This unit is occupied by the plant *Canavalia pubescens*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 3 is not known to be occupied by *Bidens micrantha* ssp. *kalealaha*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 4 consists of 1,266 ac (512 ha) of State land (including the Department of Land and Natural Resources) at Ahihi-Kinohiwa Natural Area Reserve on the southern slopes of

east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Maui—Lowland Dry—Unit 4 is not currently occupied by *Bidens micrantha* ssp. *kalealaha*, *Bonamia menziesii*, *Canavalia pubescens*, *Cenchrus agrimonoides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 5 consists of 3,615 ac (1,463 ha) of State land, and 43 ac (17 ha) of privately owned land, from Panaewa to Manawainui on the western and southern slopes of west Maui. This unit is occupied by the plants *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, *Cenchrus agrimonoides*, *Gouania hillebrandii*, *Kadua coriacea*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and *Tetramolopium capillare*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 5 is not known to be occupied by *Ctenitis squamigera*, *Cyanea obtusa*, *Hesperomannia arbuscula*, *Hibiscus brackenridgei*, *Lysimachia lydgatei*, *Neraudia sericea*, *Schiedea salicaria*, *Sesbania tomentosa*, or *T. remyi*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 6 consists of 3 ac (1 ha) of State land, and 237 ac (96 ha) of privately owned land, from Paleaahu Gulch to Puu Hona on the southern slopes of west Maui. This unit is occupied by the plants *Hibiscus brackenridgei* and *Schiedea salicaria*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 6 is not known to be occupied by *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, *Cenchrus agrimonoides*, *Ctenitis squamigera*, *Cyanea obtusa*, *Gouania hillebrandii*, *Hesperomannia arbuscula*, *Kadua coriacea*, *Lysimachia lydgatei*, *Neraudia sericea*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Spermolepis hawaiiensis*, *Tetramolopium capillare*, or *T. remyi*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Mesic—Unit 1 (and) *Palmeria dolei*—Unit 42—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 42— Montane Mesic This area consists of 257 ac (104 ha) of State land, and 559 ac (226 ha) of privately owned land from Kamiloloa to Makolelau in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Bidens wiebkei*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Montane Mesic—Unit 1 is not known to be occupied by *Asplenium dielerectum*, *Cyanea dunbariae*, *C. mannii*, *C. procera*, *C. solanacea*, *Cyperus fauriei*, *Kadua laxiflora*, *Melicope mucronulata*, *Neraudia sericea*, *Plantago princeps*, or *Stenogyne bifida*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 1 (and) *Palmeria dolei*—Unit 2—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 2— Lowland Wet This area consists of 6,616 ac (2,677 ha) of State land, 7,425 ac (3,005 ha) of privately owned land, and 2,038 ac (825 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Kipahulu Valley on the northern and eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia samuelii*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. maritae*, *C. mcelandowneyi*, *Huperzia mannii*, *Melicope balloui*, and *M. ovalis*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 1 is not known to be occupied by the plants *Clermontia oblongifolia* ssp. *mauiensis*, *C. peleana*, *Mucuna sloanei* var. *persericea*, *Phyllostegia haliakalae*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 1 (and) *Palmeria dolei*—Unit 18—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 18— Montane Mesic This area consists of 6,593 ac (2,668 ha) of State land, 707 ac (286 ha) of privately owned land, and 3,672 ac (1,486 ha) of federally owned land (Haleakala National Park), from Kealahou to Puualae, nearly circumscribing the summit of Haleakala on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the

plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Asplenium dielirectum*, *A. peruvianum* var. *insulare*, *Clermontia lindseyana*, *Cyanea horrida*, *C. obtusa*, *Cyrtandra ferripilosa*, *C. oxybapha*, *Diplazium molokaiense*, *Geranium arboreum*, *G. multiflorum*, *Huperzia mannii*, *Melicope adscendens*, and *Neraudia sericea*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 1 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Cyanea glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. mceldowneyi*, *Phyllostegia bracteata*, *P. mannii*, *Santalum haleakalae* var. *lanaiense*, *Wikstroemia villosa*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 5 (and) *Palmeria dolei*—Unit 29—Dry Cliff (and) *Pseudonestor xanthophrys*—Unit 29— Dry Cliff This area consists of 1,298 ac (525 ha) of State land, from Helu and across Olowalu to Ukumehame Gulch, on west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). They are occupied by the plant *Tetramolopium capillare*, and contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Dry Cliff—Unit 5 is not currently occupied by the plants *Bonamia menziesii*, *Diplazium molokaiense*, *Hesperomannia arbuscula*, *Isodendron pyrifolium*, *Kadua laxiflora*, or *Neraudia sericea*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 6 consists of 279 ac (113 ha) of State land along the east wall of Ukumehame Gulch on west Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). Although Maui—Dry Cliff— Unit 6 is not currently occupied by the plants *Bonamia menziesii*, *Diplazium molokaiense*, *Hesperomannia arbuscula*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Neraudia sericea*, or *Tetramolopium capillare*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Neraudia sericea* critical habitat consists of four components. (Lowland dry (east Maui, west Maui, Lanai and Kahoolawe), Lowland mesic

(Molokai), Montane mesic (east Maui and Molokai) and (Dry cliff (west Maui and Lanai) (81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: Diospyros, Myoporum, Pleomele, Santalum. Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Sicyos.

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: Acacia, Ilex, Metrosideros, Myrsine, Nestegis, Nothocestrum, Pisonia, Pittosporum, Psychotria, Sophora, Zanthoxylum. Subcanopy: Alyxia, Charpentiera, Coprosma, Dodonaea, Kadua, Labordia, Leptecophylla, Phyllostegia, Vaccinium. Understory: Ferns, Carex, Peperomia.

Ecosystem: Dry Cliff. Elevation: unrestricted. Annual precipitation: <75 in (<190 cm). Substrate: >65 degree slope, rocky talus. Canopy: None. Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*,

Schiedea jacobii, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkii*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*,

Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Lifespan**

Adult: < 10 years (USFWS, 2012)

Breeding Season

Adult: Unknown (USFWS, 2012)

Key Resources Needed for Breeding

Adult: Unknown (USFWS, 2012)

Reproduction Narrative

Adult: It is a short-lived perennial (fewer than 10 years). Its flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors remain unknown (USFWS 2003a, 2003b, 2003c) (USFWS, 2012).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Lowland dry to mesic ohia-aalii-pukiawe shrubland or forest, koa forest (USFWS, 2012)

Geographic or Habitat Restraints or Barriers

Adult: 650 - 5,439 ft. elevation (USFWS, 2012)

Habitat Narrative

Adult: Inhabits dry and moist forests in gulches (NatureServe, 2015). On Molokai, the general habitat of Neraudia sericea is described as gulch slopes and gulch bottoms in lowland dry to mesic Metrosideros polymorpha (ohia)-Dodonaea viscosa (aalii)-Leptecophylla tameiameiae (pukiawe) shrubland or forest between 691 and 1,043 meters (2,266 and 3,421 feet) elevation. On Maui, the habitat is described as dry to mesic Metrosideros polymorpha-Dodonaea viscosa-Leptecophylla tameiameiae shrubland or forest or Acacia koa (koa) forest between 198 and 1,658 meters (650 and 5,439 feet) elevation (USFWS, 2012).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Species Trends:

Declining (USFWS, 2012)

Resiliency:

Low to moderate (inferred from USFWS, 2012; see current range/distribution)

Redundancy:

Low to moderate (inferred from USFWS, 2012)

Number of Populations:

7 (USFWS, 2017)

Population Size:

~30 (USFWS, 2017)

Population Narrative:

As of 2009, the population status of *Neraudia sericea* was reported as nine populations containing approximately 27 individuals, but acknowledges that the population trend is downward, and the species may be close to extinction (USFWS 2010; USFWS, 2012). A new population was discovered on west Maui at Launiupoko (PEPP 2014). Currently there are about five populations totaling 14 individuals on east and west Maui (Keir et al. 2016; PEPP 2013, 2014, 2015, 2016, 2017). There are two populations totaling about 16 individuals on Moloka'i (Keir et al. 2016; PEPP 2013, 2014, 2015, 2016, 2017a) (USFWS, 2018).

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Wood and Perlman (2002) reported that the Makolelau region where the *Neraudia sericea* population lives had been severely impacted by a large feral goat population and that the status of the species was uncertain. Pigs, axis, deer, and cattle activity are also impacting habitat. Ecosystem-altering invasive plant species are also degrading habitat (USFWS, 2012).

Stressor: Stochastic events (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Landslides and flooding; On Maui a large fire in July 2010 burned 2,510 hectares (6,200 acres) in the Pohakea area, but Oppenheimer (pers. comm. 2010) is unsure whether the known *Neraudia sericea* population site was involved (USFWS, 2012).

Stressor: Predation (USFWS, 2012).

Exposure:**Response:****Consequence:**

Narrative: Ferla goats, axis deer, and rats (USFWS, 2012).

Stressor: Drought loss or degradation of habitat

Exposure:**Response:****Consequence:**

Narrative: Drought is noted as a threat to populations of *Neraudia sericea* on west Maui (PEPP 2014, 2015). Over the last 100 years, the Hawaiian Islands have experienced an annual decline in precipitation of over 9 percent, increasing to as much as 15 percent within the last 20 years (US-NSTC 2008; Chu and Chen 2005; Diaz 2005). Drought affects plants directly by desiccation. The increase in drought frequency and intensity leads to a self-perpetuating cycle of increase in cover of nonnative plants, increase in the number of fires, and an increase of erosion (US-GCRP 2009; Warren 2011). Recent episodes of drought have also driven deer farther into urban and forested areas in search of food, increasing their negative impacts to native vegetation from herbivory and trampling (Waring 1996, in litt; Nishibayashi 2001, in litt.) (USFWS, 2018).

Stressor: Climate change loss or degradation of habitat

Exposure:**Response:****Consequence:**

Narrative: We previously reported that climate change may pose a threat to this species, anticipating an analysis by 2013. The assessment conducted by Fortini et al. (2013) concluded that *Neraudia sericea* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.751 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions may be needed to conserve this taxon into the future (USFWS, 2018).

Recovery**Reclassification Criteria:**

1. A total of five to seven populations should be documented on islands where it now occurs or occurred historically (USFWS, 1999).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 1999).
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1999).

Delisting Criteria:

1. A total of 8 to 10 populations should be documented on islands where it now occurs or occurred historically (USFWS, 1999).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 1999).

3. Each population should persist at this level for a minimum of five consecutive years (USFWS, 1999).

Recovery Actions:

- Protect habitat and control threats (USFWS, 1999).
- Expand existing wild populations (USFWS, 1999).
- Conduct essential research (USFWS, 1999).
- Develop and maintain monitoring plans (USFWS, 1999).
- Reestablish wild populations within the historic range (USFWS, 1999).
- Validate and revise recovery criteria (USFWS, 1999).
- Construct exclosures to protect populations against feral ungulates (USFWS, 1999).
- Control competing alien plant species (USFWS, 1999).
- Protect endangered plants from fire (USFWS, 1999).
- Maintain adequate genetic stock (USFWS, 1999).
- Enhance wild populations and establish new populations (USFWS, 1999).
- New Management Actions:
 - Surveys and inventories—The Plant Extinction Prevention Program (PEPP) surveys for and monitors individuals of *Neraudia sericea* on Maui and Moloka'i (PEPP 2013, 2014, 2015, 2016, 2017a).
 - Invasive plant monitoring and control—PEPP monitors all known populations on Maui and Moloka'i and removes invasive nonnative plants.
 - Captive propagation for genetic storage and reintroduction—
 - o In 2017, Lyon Arboretum reported 15 containers of propagules of *N. sericea* from populations at Launiupoko (west Maui) and Mākolelau (Moloka'i) in storage. The Lyon Seed Conservation Laboratory reports 58 seeds in storage from the same populations (Lyon Arboretum 2017).
 - o The Plant Extinction Prevention Program (PEPP) has collected from one founder at Kala'e (Moloka'i), six founders from one subpopulation at Mākolelau (Moloka'i) and from four founders at a second subpopulation at Mākolelau (PEPP 2017b).
 - o PEPP collects seeds, cuttings, and vouchers from all known populations (PEPP 2013, 2014, 2015, 2016, 2017a).
 - o The National Tropical Botanical Garden (NTBG) continues to store over 1,000 seeds collected from individuals on Moloka'i in 2002 (NTBG 2017). The viability of these collections is uncertain.
 - o Olinda Rare Plant Facility (ORPF) reports propagation of plants from cuttings and fruit taken from individuals on west Maui at Lihau, Manawainui Gulch, Launiupoko, and ʻĪao Valley; from east Maui at Manawainui Gulch; and from Moloka'i at Mākolelau (ORPF 2013, 2014, 2015, 2017).
 - Stochastic events—Build resiliency and redundancy—
 - o PEPP has augmented populations or created new sites for reintroduction of *N. sericea* and reintroduced nearly 100 individuals. Of those outplanted, the current survivors on west Maui are at Launiupoko (six individuals), Kaua'ula (eight individuals), ʻĪao Valley (10 individuals), and Olowalu (six individuals); and on east Maui at five sites at Wai'ōpai Gulch (12 individuals) (PEPP 2016, 2017a). On Moloka'i, PEPP has reintroduced one individual at Kalae, five individuals at east Kawela, and 14 individuals at Mākolelau (PEPP 2016, 2017a).
 - o ORPF has distributed at least 23 propagated plants for reintroduction into Olowalu Valley, ʻĪao Valley, Kaua'ula, and west Mākolelau (ORPF 2013, 2014, 2015, 2017).
 - Habitat and natural process management and restoration—Pūlama Lāna'i provides conservation benefits to plant and animal species on Lāna'i, as demonstrated by the ongoing

conservation efforts on the island, the commitment to develop the Lānaʻi Natural Resources Plan (LNRP), and a memorandum of understanding (MOU) with the Service (USFWS 2015). The fenced area at Lānaʻihale may provide suitable habitat for reintroduction of *N. sericea* to Lānaʻi once fence repairs are made, ungulates are removed, and nonnative plant control is conducted (USFWS, 2018).

- Recommendations for Future Actions: Habitat destruction by drought and herbivory by slugs are reported to be threats to this species; however, we are not aware of any significant new information regarding the species' biological status since the last 5-year review in 2012. Thus, the following recommendations for future actions are added or reiterated for 5-year review for 2018.
 - Surveys and inventories—Continue to survey for additional populations of *Neraudia sericea* in areas of potentially suitable habitat on Lānaʻi and Molokaʻi. Regularly monitor known populations.
 - Ungulate monitoring and control—Complete the Lānaʻihale summit fencing project and remove all feral ungulates from the fenced area to protect *N. sericea* from the impacts of feral ungulates.
 - Invasive plant monitoring and control—
 - o Control established ecosystem-altering nonnative invasive plant species around all populations.
 - o Control invasive nonnative species that compete with the species around all populations, especially focusing on *Clidemia hirta* (Koster's curse), *Hedychium gardnerianum* (kāhili ginger), *Leptospermum scoparium* (Australian tea tree), *Morella faya* (firetree), *Psidium cattleianum* (strawberry guava), and *Tibouchina herbacea* (glorybush).
 - Predator and herbivore monitoring and control—Develop and implement effective control methods for the black twig borer and slugs.
 - Captive propagation for genetic storage and reintroduction—
 - o Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range.
 - o Explore alternate methods of propagation (e.g., cuttings, air-layering, and tissue culture).
 - Reintroduction and translocation—Continue reintroduction of individuals into suitable habitat within historic range that is being managed for known threats to this species.
 - Climate change adaptation strategy—Assess the modeled effects of climate change on this species to determine future landscape needed for recovery of the species.
 - Alliance and partnership development—Continue to work with land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2018).

Conservation Measures and Best Management Practices:

- Captive propagation for genetic storage and reintroduction: Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation and storage. A portion of the seeds stored at National Tropical Botanical Garden should be used for germination trial (USFWS, 2012).
- Reintroduction / translocation protocol development – Maximize the genetic variation among individuals at each reintroduction site (USFWS, 2012).
- Reintroduction / translocation site identification – While surveying for new populations or reintroduced populations, determine which sites are least invaded by invasive introduced plant species and which appear to have the highest likelihood of maintaining new reintroductions (USFWS, 2012).
- Ungulate control: Now that the East Molokai fence line is complete, control feral ungulates inside the fence. Once the Lanaihale fencing project is complete, remove feral ungulates from inside the fence (USFWS, 2012).

- Ungulate exclosure: Continue to construct ungulate-proof fenced exclosures around each population. Complete the Lanaihale fencing project. Monitor all fences for any signs of breaching (USFWS, 2012).
- Ecosystem-altering invasive plant species control – Control invasive introduced plant species around all populations (USFWS, 2012).
- Predator / herbivore control – Implement effective control methods for rodents (USFWS, 2012).
- Surveys / inventories: Continue to search for *Neraudia sericea* in habitats where it has historically been found on Molokai and Maui. On Molokai, also investigate mesic gulches east of Kamalo, from Wawaia to East Ohia Gulches. Survey for remaining individuals of *N. sericea* within the fenced exclosure at East Molokai (USFWS, 2012).
- Competitive invasive plant species control – Control invasive introduced plant species in the immediate vicinity of *Neraudia sericea* populations (USFWS, 2012).
- Threats monitoring – Investigate the status of the Pohakea, Maui, population, following the July 2010 fire (USFWS, 2012).
- Site / area / habitat protection – Implement erosion control measures to prevent landslides (USFWS, 2012).
- Fire protection – Develop and implement fire management plans for all wild and reintroduced populations (USFWS, 2012).
- Population biology research: Study *Neraudia sericea* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors. Research the life history of *Neraudia sericea* in reference to designating the taxon from a short-lived perennial to long-lived perennial (USFWS, 2012).
- Alliance and partnership development – Work with the Hawaii Division of Forestry and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2012).
- Threats research – Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2012).

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SPECIES ACCOUNT: *Nesogenes rotensis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 04/08/2004; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Nesogenes rotensis is a low-growing herbaceous (non-woody) plant with small, opposite, broadly lanceolate (lance-shaped), coarsely toothed leaves. Flowers are axillary (located on a stem in the area between the stem and the petiole) and tubular in shape, with five white petals and male and female components (Figure 2). Often a flowering branch grows upright, which might aid in pollination or seed dispersal (Raulerson and Rinehart 1997). Plants typically branch near the base at about five to seven nodes, and stature may range from not quite flat-growing (subprostrate) to upward-growing (ascending), scrambling over flattened (appressed) shrubs, with whole plants up to almost 1 meter (3 feet) in diameter (Fosberg and Herbst 1983). (USFWS, 2007)

Taxonomy

The familial placement of *Nesogenes* has shifted between Verbenaceae, Chloanthaceae (Dicrastylidaceae, an illegitimate name), Nesogenaceae, and Orobanchaceae (Marais 1980; Fosberg and Herbst 1983; USFWS 2004a; Bennett and Matthews 2006). (USFWS, 2012)

Historical Range

See current range/distribution. New in 2017: In addition to the two above-described locations where the species has been confirmed since the 2004 listing, in the late 1970s or early 1980s *Nesogenes* was also observed at two other locations along the east coast of the island. These locations (Puntan As Fani and Puntan Haiña) were reported to be similar to Poña Point and Puntan Fina Atkos, in terms of similar coastal vegetation on exposed limestone karst (Estanislao Taisacan, pers. comm. 2016). (USFWS, 2017).

Current Range

Known from a single collection at Haaniya Point (Poña Point Fishing Cliff), Palie area, Rota, Mariana Islands (USFWS, 2012). Also known to occur at Puntan Fina Atkos at the island's northeast tip. (USFWS, 2017); USFWS. 2017. 5-Year Review Short Form Summary, *Nesogenes rotensis* (no common name). USFWS, Region 1, Honolulu, Hawai'i. 9 pp.

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Includes the months of March, April, May, and November (USFWS, 2012)

Reproduction Narrative

Adult: Based on information from collections and observations, *N. rotensis* flowers in March, April, May, and November (Raulerson and Rinehart 1997; G. Koob, in litt. 2005; L. Williams, CNMI Division of Fish and Wildlife, pers. comm. 2005). It has been observed in fruit in January, March, and November (Raulerson and Rinehart 1997; G. Hughes, in litt. 1998; G. Koob, in litt. 2005). All of the available information and recent observations suggest that these plants are perennials, but their above-ground parts die back annually. (USFWS, 2012)

Habitat Type

Adult: Terrestrial (USFWS, 2007)

Habitat Vegetation or Surface Water Classification

Adult: Limestone flat above seaside cliff (USFWS, 2007)

Environmental Specificity

Adult: High, with several key requirements (USFWS, 2007)

Habitat Narrative

Adult: This species has been found in two locations, Poña Point on Rota's southern coast and Puntan Fina Atkos on Rota's eastern coast. At both locations a small population exists on an exposed, raised limestone flat above a 7.6- to 30.5 meter (25- to 100-foot) seaside cliff. Although these flats are up to 30.5 meters (100 feet) above the sea, they are subject to scouring winds during severe storms. *Nesogenes rotensis* grows in association with *Scaevola taccada*, *Terminalia samoensis*, *Hedyotis strigulosa*, *Pogonatherum paniceum*, and *Bikkia tetrandra* (Resources Northwest 1997). (USFWS, 2007)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2012)

Redundancy:

Very low (inferred from USFWS, 2012)

Number of Populations:

2 (USFWS, 2012)

Population Size:

30-40 (USFWS, 2012). As of 2017: 341 individuals, 126 of which are mature plants. (USFWS, 2017).

Additional Population-level Information:

Population counts vary over time, and are subject to repeated typhoon disturbance. (USFWS, 2017). • Field surveys conducted at Poña Point by DLNR and CNMI-DFW staff documented in excess of 100 individual *Nesogenes* plants in February 2016 (Lainie Berry, CNMI Department of Lands and Natural Resources, pers. comm. 2016). That fieldwork was focused on distribution and was not a complete census. (USFWS, 2017). • In August 2016, two groupings of *Nesogenes* plants were observed at Poña Point. Each cluster included at least 7-13 individuals, with the first group being located at the east end of the point, in the public park area most immediately accessible to the public, while the second group was located 325 m to the WSW of the first group. This was not a complete census. Both this and the previous February 2016 survey confirm that the current distribution of *Nesogenes* population(s) at Poña Point spans over 400m (Lainie Berry and Bethany Chagnon, CNMI Department of Lands and Natural Resources and Division of Fish and Wildlife, pers. comm. 2016; and McBride field notes and GPS points, August 26, 2016). (USFWS, 2017). • In January 2017, the *Nesogenes* at Poña Point were surveyed by CNMI DLNR. A total of 403 individuals were recorded, distributed in three discrete patches; among these, 152 individuals were observed to be flowering and/or fruiting. (Lainie Berry, CNMI Department of Lands and Natural Resources, pers. comm. 2017). (USFWS, 2017).

Population Narrative:

There are only two populations of *Nesogenes rotensis* known to exist, with a current total population size estimated to be 30 to 40 individuals. (USFWS, 2012)

Threats and Stressors

Stressor: Land use practices (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Native vegetation, including open coastal scrubland habitat for *Nesogenes rotensis* on Rota, has undergone extreme alteration due to past and present land use practices, including ranching, deliberate and unintentional nonnative animal and plant introductions, agriculture, and military activities during World War II (Falanruw et al. 1989). (USFWS, 2007)

Stressor: Human activities (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Coastal habitat for *Nesogenes rotensis* is under increased pressure of development and is threatened by fragmentation and degradation associated with human use, development, and recreational activities. The species occurs in an area adjacent to a trail that is increasingly subject to bonfires, collecting, and trampling by fishermen and tourists, all human-caused threats to its habitat. (USFWS, 2007)

Stressor: Typhoons (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Rota has a long history of disturbances by tropical typhoons (Weir 1991). While native species are adapted to these events, these typhoons, in combination with human-caused disturbances and the relatively new presence of invasive species, threaten the continued existence of *Nesogenes rotensis*. Within the past decade, frequent typhoons have made landfall on Rota, severely affecting the island. Most recently, in 2003 supertyphoon Pongsona affected the Mariana Islands, particularly Guam and Rota, with winds of up to 296 kilometers (184 miles) per hour. (USFWS, 2007)

Stressor: Small population size (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: *Nesogenes rotensis* is particularly susceptible to extirpation or extinction from a natural disaster because of its limited distribution and small numbers of individuals. (USFWS, 2007)

Stressor: Invasive plants (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: *Nesogenes rotensis* is also threatened by *Casuarina equisetifolia* (gagu or ironwood), which is becoming established in the coastal scrubland habitat at Poña Point Fishing Cliff. This tree is known to spread by root suckers and, as observed in other areas with similar habitat, may change the coastal scrubland into a monotypic gagu forest. *Casuarina equisetifolia* forest habitat is characterized by an absence of understory vegetation due to the restriction of available sunlight and soil nutrients, and possibly the release of a chemical agent that prevents other plants from growing beneath the trees (Smith 1985; L. Williams, pers. comm. 2004). Additionally, the native parasitic vine *Cassytha filiformis* (agasi) has been reported to parasitize individuals of *N. rotensis*, but deleterious effects have not been documented (L. Williams, pers. comm. 2005). (USFWS, 2007)

Stressor: Human activities (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: One population of *Nesogenes rotensis* is located in a public park (Poña Point). Human activities not only threaten the habitat for the species at this location, but the plants may also experience direct mortality and lower reproductive success due to trampling from foot traffic and bonfires set by tourists and fishermen. The small population size and extremely limited distribution of this species makes it particularly vulnerable to extinction from reduced reproductive vigor. With only 2 populations of 15 to 20 individuals each, a decline of successful reproduction in *N. rotensis* could lead to the extinction of the species (USFWS 2004). (USFWS, 2007)

Recovery

Reclassification Criteria:

1. A total of two populations of *Nesogenes rotensis* are naturally reproducing and stable, or increasing in numbers. Each population of *N. rotensis* must consist of at least 300 mature, reproducing individuals. A total of two populations of *Osmoxylon mariannense* are naturally reproducing and stable, or increasing in numbers. Each population of *O. mariannense* must consist of at least 100 mature, reproducing individuals. A stable or increasing population is defined as having a finite rate of increase (known as λ or lambda) greater than or equal to 1 over the requisite 10-year time period. (USFWS, 2007)
2. Sufficient habitat is protected and managed to achieve criterion 1 above. (USFWS, 2007)
3. Management and control of nonnative species by local, regional, Commonwealth, and Federal authorities are demonstrated to be successful and sufficient to achieve criterion 1 above. (USFWS, 2007)

Delisting Criteria:

1. A total of four populations of *Nesogenes rotensis* are naturally reproducing and stable, or increasing in numbers. Each population of *N. rotensis* must consist of at least 300 mature, reproducing individuals. A total of four populations of *Osmoxylon mariannense* are naturally reproducing and stable, or increasing in numbers. Each population of *O. mariannense* must consist of at least 100 mature, reproducing individuals. A stable or increasing population is defined as having a finite rate of increase (known as λ or lambda) greater than or equal to 1 over the requisite 10-year time period. (USFWS, 2007)
2. Sufficient habitat is protected and managed to achieve criterion 1 above. (USFWS, 2007)
3. Management and control of nonnative species by local, regional, Commonwealth, and Federal authorities are demonstrated to be successful and sufficient to achieve criterion 1 above. (USFWS, 2007)

Recovery Actions:

- Coordinate and monitor recovery efforts. (USFWS, 2007)
- Address factors affecting viability of the wild populations. (USFWS, 2007)
- Monitor the extant *Nesogenes rotensis* and *Osmoxylon mariannense* populations, establish new populations, and augment existing populations. (USFWS, 2007)
- Provide educational and informational opportunities to build public support for conservation. (USFWS, 2007)
- 2017 recommended action 1: Survey protocol development: Given the recognized seasonal die-back exhibited by this species, and consequent variation in detectability through the calendar year, develop guidance defining season(s) when the species can be more reliably observed, and consistently counted. (USFWS, 2017).
- 2017 - 2: Resurvey and reconfirm the population at Puntan Fina Atkos, including its current condition, numbers, and distribution. (USFWS, 2017).
- 2017 - 3: Population monitoring – Monitor annually the number of individuals in the Poña Point Fishing Cliff and Puntan Fina Atkos populations. (USFWS, 2017).
- 2017 - 4: Survey for additional populations of *Nesogenes* in other areas of similar habitat, including the exposed limestone karst coastal cliffs that are common along the eastern

shore of Rota. Revisit and reconfirm the two historical occurrences of *Nesogenes* at Puntan Haiña and Puntan As Fani. (USFWS, 2017).

- 2017 - 5: Habitat requirements research – Conduct research on *Nesogenes rotensis* habitat requirements, with emphases on identifying key suitability parameters in order to a) inform effective management of the existing populations at the two confirmed (and any additionally-found) sites, and b) recognize appropriate sites for successful re-/establishment of the species. (USFWS, 2017).
- 2017 - 6: Conduct studies to clarify whether *Nesogenes* functions hemi-parasitically, and if so, which host species may be essential for its survival. (USFWS, 2017).
- 2017 - 7: Conduct studies to determine if parasitic or pioneering plant species such as *Cassytha filiformis* or *Casuarina equisetifolia* are negatively affecting populations of *Nesogenes*, either directly or via impacts to potential host plant species. (USFWS, 2017).
- 2017 - 8: Monitor to determine whether other invasive plant species in the vicinity of either population may be negatively affecting *Nesogenes*. Particular attention should be given to species not previously documented at those sites, or those species whose numbers appear to be increasing. (USFWS, 2017).
- 2017 - 9: In the event that plant interactions such as those described above are found to negatively affect *Nesogenes*, develop and implement control techniques to limit or eliminate such affects. (USFWS, 2017).
- 2017 - 10: Disturbance ecology: Consider the roles of typhoon events for this species. The known distribution of *Nesogenes rotensis* is in sites highly subject to the periodic major disturbance events of typhoons, and its recovery from such events has been documented. Beyond a degree of typhoon-resilience, might *N. rotensis* be somewhat typhoon-dependent? (i.e., Does it need periodic re-establishment of early-seral conditions to compete with other plants and persist on a site?) If some type(s) of disturbance is found to be important to the species' persistence on a site that perspective could indirectly inform decisions about managing other forms of disturbance. (USFWS, 2017).
- 2017 - 11: Captive propagation for genetic storage and reintroduction: o Collect cuttings or seed from tagged individuals, keeping close track of the maternal source for use in ex situ propagation. o Collect seeds from all existing populations and send to at least two or three different venues for propagation and storage. (USFWS, 2017).
- 2017 - 12: Captive propagation protocol development – Conduct studies to determine how to propagate the species and maintain the species in nurseries. (USFWS, 2017).
- 2017 - 13: Reintroduction / translocation protocol development – Maximize the genetic variation among individuals at each reintroduction site, maintain detailed provenance information. (USFWS, 2017).
- 2017 - 14: Reintroduction / translocation site identification – While surveying for new populations, determine which sites are least invaded by invasive plant species and which appear to have the highest likelihood of maintaining new reintroductions. (USFWS, 2017).
- 2017 - 15: If *Nesogenes* host species are identified, then seed areas of suitable habitat where the host species is present, but where *Nesogenes rotensis* is lacking. (USFWS, 2017).
- 2017 - 16: Threats research – Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2017).
- 2017 - 17: Site / area / habitat protection – Develop and implement effective measures to reduce the impact of urban development, typhoons, and human disturbance if and where these are found to be detrimental to the species. (USFWS, 2017).

- 2017 - 18: Alliance and partnership development – Work with the CNMI Department of Lands and Natural Resources, Division of Forestry, Division of Fish and Wildlife, and other land managers to coordinate planning and support implementation of ecosystem level restoration and management to benefit this species. (USFWS, 2017).
- 2017 - 19: Conduct systematic inventories of multiple Nesogenes populations to measure progress toward recovery goals and determine if and when downlisting criteria have been met. (USFWS, 2017).
- 2017 - 20: Regulatory protections – Work with CNMI authorities to ensure that federal and local regulations provide the necessary protections to support the recovery of Nesogenes rotensis, whether by adding the species to the CNMI Threatened and Endangered Species list, or by other means. (USFWS, 2017).
- 2017 - 21: Review the recovery plan (USFWS 2007) to determine if any new information suggests any need to update the plan to more effectively attain recovery goals (e.g., if Cassytha is determined to be a substantial issue for recovery, then Recovery Criteria 3 may need to address parasitic and/or pioneering as well as non-native species.) (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Continue to collect cuttings or seed from tagged individuals, keeping close track of the maternal source for use in ex situ propagation. (USFWS, 2007)
- Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation and storage. (USFWS, 2007)
- Conduct studies to determine how to propagate the species and maintain the species in nurseries. (USFWS, 2007)
- Maximize the genetic variation among individuals at each reintroduction site, based on microsatellite data and detailed information from crossing records. (USFWS, 2007)
- While surveying for new populations, determine which sites are least invaded by invasive introduced plant species and which appear to have the highest likelihood of maintaining new reintroductions. (USFWS, 2007)
- Conduct research on the possible hemiparasitic nature of the species and determine its host species. (USFWS, 2007)
- If the host species is determined, then reseed areas of suitable habitat where the host species is present, but where Nesogenes rotensis is lacking. (USFWS, 2007)
- Conduct intensive surveys for Nesogenes rotensis in potentially suitable habitat on Rota to determine if additional populations exist. (USFWS, 2007)
- Monitor annually the number of individuals in the Poña Point Fishing Cliff and Puntan Fina Atkos populations. (USFWS, 2007)
- Monitor and control invasive nonnative plant species in the vicinity of both populations, paying particular attention to species not previously documented or those whose numbers appear to be increasing. (USFWS, 2007)
- Conduct research on Nesogenes rotensis habitat requirements. (USFWS, 2007)
- Develop and implement effective measures to reduce the impact of urban development, typhoons, and human disturbance. (USFWS, 2007)
- Revise the hunting regulations of CNMIs Division of Fish and Wildlife to add Nesogenes rotensis to the list of protected wildlife and plant species. (USFWS, 2007)
- Revise recovery plan and recovery criteria with any updated information. (USFWS, 2007)

- Work with Commonwealth of the Northern Mariana Islands Division of Fish and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem level restoration and management to benefit this species. (USFWS, 2007)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2007)

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SPECIES ACCOUNT: *Nitrophila mohavensis* (Amargosa niterwort)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial herb. Leaves ovate, small, bright green. Flowers small, inconspicuous, pink, becoming white. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Known only from the Amargosa River drainage in extreme southeastern Inyo County, California (Reveal, 1989) and from Nye county in bordering Nevada. (NatureServe, 2015)

Critical Habitat Designated

Yes; 5/20/1985.

Legal Description

On May 20, 1985, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Nitrophila mohavensis* (Amargosa niterwort) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in California (50 FR 20777-20794).

Critical Habitat Designation

The critical habitat designation for *Nitrophila mohavensis* includes one CHU in Inyo County, California (50 FR 20777-20794).

California, Inyo County, Ash Meadows: W ½ sec. 5. E ½ sec. 6, NE ¼ and E ½NW ¼ sec. 7, NW ¼ sec. 8, T25N, R6E.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Nitrophila mohavensis* critical habitat consists of one component (50 FR 20777-20794):

Known primary constituent elements include salt-encrusted alkaline flats.

Life History

Food/Nutrient Resources

Breeding Season

Adult: Flowering occurs in the late spring (USFWS, 1990).

Reproduction Narrative

Adult: Flowering occurs in the late spring; flowers are small, apetalous, and axial (Munz and Roos 1955, Reveal 1978c) (USFWS, 1990).

Habitat Type

Adult: Alkaline flats (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (inferred from NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits playas (clay, mesic) (Skinner, 1997). Alkaline flats associated with *Distichlis spicata* var. *stricta*, *Cordylanthus tecopensis*, and *Cleomella brevipes* (Reveal, 1989). (NatureServe, 2015). High ecological integrity of the population and site fidelity and low tolerance ranges are inferred based on the restricted geography this species inhabits along with the specific habitat requirements of this species.

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Decreasing (USFWS, 2007)

Resiliency:

Low (inferred from NatureServe, 2015)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1000 - 2500 individuals (NatureServe, 2015)

Population Narrative:

Wetland habitat (Bittman 1998). Populations described as containing thousands of plants (Bittman 1998). Known from two occurrences in California (Bittman 1998), and three in Nevada. (NatureServe, 2015). Low resiliency, representation and redundancy are inferred based on the low number of known populations and restricted geographic range.

Threats and Stressors

Stressor: Threats from Groundwater Development (USFWS, 2007)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Given our current understanding of Amargosa niterwort demographic and hydrologic trends at the Lower Carson Slough population, coupled with the rate of groundwater extraction in the Amargosa Valley, the relative magnitude and imminence of groundwater development are considered high (USFWS, 2007).

Stressor: Threats of Habitat Loss or Degradation from Surface Mining (USFWS, 2007)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Given the importance of the Lower Carson Slough and Crystal Reservoir populations and the threat posed by mineral claims on roughly 25 percent of the critical habitat, we conclude the magnitude of this threat is high. Currently, the economic viability of mineral extraction is unknown; therefore, we consider the imminence of this threat to be unknown (USFWS, 2007).

Stressor: Threat of Habitat Degradation from Ash Meadows Road (USFWS, 2007)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: At the time of listing, Ash Meadow Road did not pose a threat to the Amargosa niterwort. In late 1999 and early 2000, the California Department of Transportation (Caltrans) improved Ash Meadows Road where it crosses the Lower Carson Slough and Amargosa niterwort habitat. Caltrans imported fill and raised the roadbed where it crosses the Lower Carson Slough and in doing so, impacted individual Amargosa niterwort plants. The raised roadbed now poses an indirect threat to the Amargosa niterwort population by altering sedimentation patterns in the Carson Slough during thunderstorms or rare high flow events. Several low-water crossings with drainage pipes are present under the highway; however, during unusually high-volume flows the pipes may be filled with sediment, causing the roadbed itself to act as a dam that retains sediment that could bury a portion of the Lower Carson Slough population (Service 1999). Given the importance of the Lower Carson Slough population, the magnitude of this threat is high. However, given the relative infrequency of flash floods, the overall magnitude and imminence of this threat is low (USFWS, 2007).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2007)

Exposure:

Response:**Consequence:** Loss of habitat

Narrative: The 1985 final rule recognized establishment of the Refuge did not provide any protection for the Amargosa niterwort (50 FR 20777-20794) because the only known population for the Amargosa niterwort was located in California. Presently, with the discovery of the Crystal Reservoir population, a small portion, roughly 5 percent, is now protected on the Refuge and within the adjacent BLM Area of Critical Environmental Concern. Protection under the Act continues to be the most important regulatory mechanism for protecting the Amargosa niterwort because it is the only regulatory mechanism that spans both California and Nevada state jurisdictions and it is the only mechanism that is able to protect Amargosa niterwort habitat from mining and groundwater pumping in certain situations. For this reason we conclude the magnitude of the threat posed by inadequate regulatory mechanisms is high. We consider this threat to be imminent because groundwater pumping is now at 200 percent above sustainable levels (USFWS, 2007).

Stressor: Trampling by wild horses and OHV activity (USFWS, 2007)**Exposure:****Response:****Consequence:** Loss of individuals

Narrative: Amargosa niterwort populations on the Refuge are relatively well protected; however, the Crystal Reservoir population was impacted by illegal OHV activity in the early 2000s. The effects of OHV activity on this population were scattered over a 0.5 acre area, but were less than 0.01 acre in total. The Tecopa population appears to be at the highest risk to damage from OHV activity. The area is unfenced and tire tracks have been observed going through the small Amargosa niterwort population (Edwards 2006). Given the fencing that has been installed to protect the lower Carson Slough population and the Refuge, which together compose roughly 98 percent of the known distribution, we consider the magnitude and threat posed by trampling by wild horses and OHV activity to be low and non-imminent (USFWS, 2007).

Stressor: Invasive Species and Fire (USFWS, 2007)**Exposure:****Response:****Consequence:** Loss of habitat/loss of individuals

Narrative: Invasive species were described as a threat in the rule to list the species in 1985. Amargosa niterwort habitat consists of barren, salt-encrusted mudflats with little to no vegetation. With the exception of salt cedar (*Tamarix* sp.), most invasive species present at Ash Meadows lack the special adaptations needed to survive in Amargosa niterwort habitat. Salt cedar is known to be a significant threat to wetlands in the vicinity (Service 2006a). However, salt cedar does not currently appear to be establishing in Amargosa niterwort habitat in either the Lower Carson Slough or below Crystal Reservoir (Service 2006a). Neither the Refuge nor BLM has an active program to remove salt cedar in or near occupied habitat. Fire has recently been identified as a threat to other Ash Meadows endemic plant species due to the increase in non-native species that would carry a fire (e.g., Ash meadows gumplant 5-year review, Service 2007); however, given the sparse cover and open structure of Amargosa niterwort habitat, fire is not expected to pose a significant threat. Given the available information, we conclude the threats posed by non-native species and fire are low and non-imminent (USFWS, 2007).

Stressor: Failure of Crystal Spring Dam (USFWS, 2007)

Exposure:**Response:****Consequence:** Loss of individuals/Loss of habitat

Narrative: A breach of the reservoir would affect the area immediately below the dam, Lower Crystal Marsh, as well as the Lower Carson Slough at Ash Meadows Road (Service 2005). Given the severity of a potential impact, the magnitude of this threat is considered high. However, given the infrequent nature of catastrophic flash flooding and earthquakes in the vicinity that could cause the failure of Crystal Spring Dam, and the absence of human habitation or structures, we consider the imminence of this threat to be low. Nonetheless, Amargosa niterwort habitat occurs in low-lying areas susceptible to flooding. The Amargosa niterwort population in the Lower Carson Slough has likely survived previous flash floods. However, because the Lower Carson Slough population is now smaller than it was in the 1950s and 1960s, when it was described as extensive, it is less protected against stochastic events such as flash flooding. Further compounding potential impacts from a flash flood event are the hydrologic modifications at Ash Meadows Road (see discussion under Factor A). Given the severity of a potential impact, the magnitude of this threat is considered high. However, given the infrequent nature of catastrophic flash flooding in the vicinity, the imminence of this threat is low (USFWS, 2007).

Recovery**Reclassification Criteria:**

All non-native animals and plant species must be eradicated from essential habitat (USFWS, 2007).

Secure and protect the Ash Meadows aquifer so that all spring flows return to historic discharge rates and the water level in Devils Hole is maintained at a minimum level of 1.4 feet below the copper washer (USFWS, 2007).

Essential habitat must be secure from detrimental human disturbance including mining, off-road vehicles, and introduction of non-native species (USFWS, 2007).

Amargosa niterwort is present in all localities that it has occupied historically as identified in Appendix A, Table XV, of the Recovery Plan (USFWS, 2007).

Delisting Criteria:

Criteria shown above for downlisting from endangered to threatened (USFWS, 2007).

Secure, protect, and maintain in natural vegetation, corridors, and adjacent buffer areas for gene flow and dispersal of listed plant species within the essential habitat (USFWS, 2007).

Native plant communities and aquatic communities have been reestablished to historic structure and composition within all essential habitat (USFWS, 2007).

All of the listed plant species are present in all the sites that they have historically occupied as identified in Appendix A, Table XV, of the Recovery Plan, and within each critical habitat unit, the listed plant has a frequency value equal to or greater than the frequency value determined by Recovery Plan Task number 644 needed as an indicator of a self-sustaining plant species. Task number 644 requires that for each listed plant species, frequency data must be gathered from

examples of vegetation that is unaltered, to quantify recovery objectives. Sampling method must be determined, including the size/shape of sampling units and the number of units needed to accurately estimate frequency values (USFWS, 2007).

Recovery Actions:

- Downlisting criterion #1, the removal of all non-native animals and plant species from essential habitat, has been partially achieved (Factor E). While non native species are not currently a direct threat to the Amargosa niterwort, salt cedar (*Tamarix ramosissima*) is generally a problem in the Carson Slough and wetlands on the Refuge. The Refuge has recently prepared an Integrated Pest Management Plan (Service 2006a). This plan provides a framework for managing invasive species, including salt cedar. In addition, the Refuge recently secured funding for salt cedar removal activities. These activities have only recently been implemented and have not yet produced on-the-ground results. The Bureau of Land Management (BLM) Las Vegas District has recently completed an Interagency Agreement with the Lake Mead National Recreation Area Exotic Plant Management Team for spot removal of non-native species within the Upper Carson Slough watershed. This work is ongoing (USFWS, 2007). Delisting is contingent on completion of the downlisting criteria described above. Delisting criterion #1, successful completion of the downlisting criteria, has not been completed. Criteria #2, 3 and 6 which address establishing corridors and re-establishing historical plant community structure are beginning to be addressed but have not been completed. The Refuge recently completed a Geomorphic and Biological Assessment for the Refuge (Service 2006b) which describes targets states for hydrologic and biologic functioning. The Refuge also recently completed an Integrated Pest Management Plan which outlines a strategy for managing weeds on the Refuge (Service 2006a). These efforts are just beginning and no tangible on-the-ground results have been achieved (USFWS, 2007).
- Downlisting criterion #2, secure and protect the Ash Meadows aquifer so that all spring flows return to historic discharge rates and the water level in Devils Hole is maintained at a minimum level of 1.4 feet below the copper washer, has only partially been achieved (Factor A). See discussion in section II.C.2.a. Protecting a minimum water level in Devils Hole will protect Amargosa niterwort occurrences on the Refuge; however, it may not protect critical habitat and the Lower Carson Slough occurrence which depend in part on subsurface flows from the Amargosa Valley (USFWS, 2007).
- Downlisting criterion #4, securing essential habitat from detrimental human disturbance including mining, off-road vehicles, and introduction of non-native species, has been partially achieved (Factor A). See discussion under section II.C.2.a. Occurrences on the Refuge receive protection from off-road vehicles and surface mining on lands where the Service owns mineral rights. The Lower Carson Slough population receives limited protection from fencing installed on both sides of Ash Meadows Road. Active mining claims are present adjacent to the Lower Carson Slough population; this population could be indirectly affected by dewatering or other mining activities. Public minerals are available and minerals claims can be made on the Crystal Reservoir population; the economic incentive for these claims is unknown (USFWS, 2007).
- Downlisting criterion #6 has not been completed. Amargosa niterwort is not present in all localities that it has occupied historically as identified in Appendix A, Table XV (USFWS, 2007).

Conservation Measures and Best Management Practices:

- For the Amargosa niterwort, implementing population monitoring and investigating the factors that affect recovery are crucial (as described in tasks 4 and 6 in the Recovery Plan). Determining population trends for this species as described in the Recovery Plan is imperative and should be the first priority and should be performed over the next five years. Groundwater pumping will likely continue to increase in the Amargosa Valley. Documenting population trends will be paramount to identify any changes associated with such pumping. Before monitoring surveys are implemented, a long-term population monitoring plan for the Amargosa niterwort should be prepared to ensure that the necessary statistical rigor is included. Permanent plot markers were placed as part of the mapping and sampling plots set up during a demographic study by San Diego State University (SERG 2004). These plots offer a unique opportunity to gather quantitative population trend data for the species. This study should be incorporated into the longterm population monitoring plan (USFWS, 2007).
- Additional research into the hydrology of the Central and Lower Carson Slough as it relates to the Ash Meadows and Alkali Flat/Furnace Creek hydrologic subbasins is needed. This should be the second priority for this species. Additional groundwater monitoring wells should be installed in the Central and Lower Carson Slough as part of the research (USFWS, 2007).
- Limiting potential flash flood or failure of Crystal Spring Dam impacts to the Lower Carson Slough population is critical. To accomplish this, modifications to Ash Meadows Road should be pursued to restore the natural hydrology that supports the Amargosa niterwort. Additionally, the repair, modification or removal of Crystal Spring Dam should be studied and implemented. These actions should be the third priority for this species (USFWS, 2007).

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SPECIES ACCOUNT: *Nothocestrum breviflorum* (ʻAiea)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/04/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

A tree, 10 - 12 m tall. Flowers are numerous on short axillary spurs, and are greenish yellow (NatureServe, 2015).

Taxonomy

A member of the nightshade family (Solanaceae) (USFWS, 2012).

Historical Range

The known historical range of *Nothocestrum breviflorum* was from Hawaii Island in the southern part of the Kohala Mountains, the northern slope of Hualalai, and all but the northern slopes of Mauna Kea (USFWS 1994, 1996) (USFWS, 2012).

Current Range

Current range includes the Island of Hawaii (NatureServe, 2015).

Critical Habitat Designated

Yes; 7/2/2003.

Legal Description

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Nothocestrum breviflorum* on the island of Hawaii (68 FR 39623 - 39722).

Critical Habitat Designation

The critical habitat designation for *Nothocestrum breviflorum* includes three units totaling 12,708 acres in Hawaii County, Hawaii. The units are Hawaii 5—*Nothocestrum breviflorum*—a, Hawaii 6—*Nothocestrum breviflorum*—b, and Hawaii 10—*Nothocestrum breviflorum*—c. Two of the units are currently occupied. Each unit is geographically separated from other critical habitat for this island-endemic species within its historical range in order to reduce the likelihood of all recovery populations being destroyed by one naturally occurring catastrophic event. The three units designated for this species on the island of Hawaii provide habitat to support a total of nine populations of *N. breviflorum*, each with 100 mature, reproducing individuals.

Hawaii 5—*Nothocestrum breviflorum*—a [403 ha (995 ac)]: This unit is the ridge adjacent to Laupahoehoe Iki Cape between Waimanu Valley and Kaimu Stream, bordered on the west by Kamu watershed, on the east by Waimanu watershed, with the Pae watershed in between. The unit lies in the Kohala Forest Reserve in the west and the Waimanu Estuarine Research Reserve in the east. This unit provides habitat for 3 populations of 100 individuals of *N. breviflorum* and is currently unoccupied. This unit is essential to the conservation of the species because it supports habitat that is necessary for the establishment of additional populations in order to reach recovery goals. This unit provides the easternmost critical habitat within the species' historical range.

Hawaii 6—*Nothocestrum breviflorum*—b [1,113 ha (2,749 ac)]: This unit contains portions of Kalaikaula, Kamoloumi, Kolealiilii, Nakookoo, Ohiahuea, Oniu, and Waiapuka streams, and Paohia Gulch. It is bordered by the Honokea watershed in the west, the Waikaloa watershed in the east. It contains portions of the Honopue, Kalikaula, Kolealiilii, Nakookoo, Ohiahuea, and Waiapuka watersheds. The unit lies completely within the Kohala Forest Reserve; provides habitat for 1 population of 100 individuals of *N. breviflorum*; and is currently occupied by 6 individuals. This unit is essential to the conservation of *N. breviflorum* because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. This unit provides the northernmost critical habitat within the species' historical range.

Hawaii 10—*Nothocestrum breviflorum*—c [3,627 ha (8,964 ac)]: This unit contains Poohohoo summit and is completely within the Kiholo watershed. This unit provides habitat for 5 populations of 100 individuals of *N. breviflorum* and is currently occupied by more than 165 individuals. This unit is essential to the conservation of *N. breviflorum* because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population. The unit provides the southwesternmost critical habitat within the species' historical range.

Primary Constituent Elements/Physical or Biological Features

Habitat features that are essential for this species include, but are not limited to, lowland and montane dry forest, and montane mesic forest dominated by *Metrosideros polymorpha*, *Acacia koa*, and/or *Diospyros sandwicensis* on aa lava substrates.

Special Management Considerations or Protections

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for this species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Lifespan

Adult: > 10 years (USFWS, 2012)

Breeding Season

Adult: January - February (USFWS, 2012)

Reproduction Narrative

Adult: It is a long-lived perennial that produces seed infrequently. Flowering occurs in January and February, and fruiting has been confirmed from December through August (Rock 1913; USFWS 1996, 2002; Bishop Museum 2011; National Tropical Botanical Garden 2011) (USFWS, 2012).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Dry to moist ohia, koa, and lama forest (NatureServe, 2015; USFWS, 2012)

Geographic or Habitat Restraints or Barriers

Adult: 500 - 6,390 ft. elevation (USFWS, 2012)

Habitat Narrative

Adult: Inhabits dry or, occasionally, moist forests, often on old lava flows (NatureServe, 2015). The species is often found in dry to occasionally mesic forests (Wagner et al. 1999) from 146 to 1,948 meters (500 to 6,390 feet) elevation on aa lava substrates, including dry cinder cones (USFWS 1996, 2002). The forests typically are dominated by *Metrosideros polymorpha* (ohia), *Acacia koa* (koa), or *Diospyros sandwicensis* (lama) (USFWS 1994). The soil groups on which *Nothocestrum breviflorum* is known to occur include histic plaquepts, lithic tropofolists, typic tropofolists, typic eutrandepts, and eutrandept-tropofolist associations (Hawaii Biodiversity and Mapping Program 2010) (USFWS, 2012).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Low (inferred from NatureServe, 2015; see current range/distribution)

Redundancy:

Low to moderate (inferred from USFWS, 2012)

Number of Populations:

10 (USFWS, 2012)

Population Size:

< 150 wild, 79 outplants (USFWS, 2012)

Population Narrative:

In 2010, there were an estimated 10 wild populations of *Nothocestrum breviflorum* containing less than 150 total individuals (USFWS 2010). There are 79 outplanted individuals (USFWS, 2012).

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Ungulates; invasive plants: *Lantana camara* (lantana), *Leucaena leucocephala* (koa haole), *Pennisetum setaceum* (fountain grass), *Schinus terebinthifolius* (Christmas berry); development for housing and commercial activities; fire; recreation (USFWS, 2012).

Stressor: Herbivory (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: *Nothocestrum breviflorum* is reportedly a host species for a cerambycid (long-horned) beetle, *Plagithmysus simplicicollis* (Giffin 2009). The foliage is also a host for the sphingid moth, *Manduca blackburni* (Blackburn's hawk moth) (Giffin 2009). Ungulates: cattle (*Bos taurus*), feral sheep (*Ovis aries*); rodents: rats (*Rattus* spp.), mice (*Mus* spp.) (USFWS, 2012).

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species (USFWS, 2012).

Recovery**Reclassification Criteria:**

1. A total of five to seven populations should be documented on the Big Island (USFWS, 1996).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population (for long-lived perennials) (USFWS, 1996).
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1996).

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on the Big Island (USFWS, 1996).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population (for long-lived perennials) (USFWS, 1996).
3. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1996).

Recovery Actions:

- Protect current populations and manage threats (USFWS, 1996).
- Conduct essential research (USFWS, 1996).
- Expand existing wild populations, as necessary (USFWS, 1996).
- Create new populations within historical range, as necessary (USFWS, 1996).
- Evaluate and validate recovery objectives (USFWS, 1996).
- Propagation and maintenance of ex situ genetic stock is necessary (USFWS, 1996).
- Populations should be protected from cattle via fencing or other means, and competing alien plant taxa, specifically *Schinus terebinthifolius*, lantana and fountain grass, should be controlled (USFWS, 1996).
- Habitat of this species should be protected from residential and recreational development in sufficient area to allow for full recovery of the species (USFWS, 1996).

Conservation Measures and Best Management Practices:

- Captive propagation for genetic storage and reintroduction: Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation and genetic storage. Collect cuttings or seed from tagged individuals, keeping close track of the maternal source for use in ex situ propagation (USFWS, 2012).
- Reintroduction / translocation site identification – Determine areas within the species native range that are most suitable for reintroduction (USFWS, 2012).
- Reintroduction / translocation implementation – Continue to reintroduce the species back into its known historical range (USFWS, 2012).
- Ungulate exclosures: Monitor fenced exclosures twice a year for evidence of breaching by feral ungulates. Continue to construct fenced exclosure around all known populations (USFWS, 2012).
- Ungulate control – Protect all populations against disturbances from feral ungulates (USFWS, 2012).
- Ecosystem-altering invasive plant species control – Continue to control invasive introduced plant species around all populations (USFWS, 2012).
- Fire protection: Continue to control invasive introduced plant species around all populations, especially since a buildup of biomass of some species is enough to carry destructive fires. Develop and implement fire management plans for all wild and reintroduced populations (USFWS, 2012).
- Surveys / inventories – Resurvey the historical geographical range of the species for previously unknown populations or individuals, particularly given that nine or more of its historical locations are not now known to harbor the species (USFWS, 2012).
- Predator / herbivore control – Implement effective control methods for rodents (USFWS, 2012).
- Population biology research – Consider carrying out hand pollination on individuals in the wild to enhance reproductive success (USFWS, 2012).

- Threat monitoring and control – Monitor newly established reintroduced and wild populations for evidence of plant disease and insect predation. If threats are found implement effective control methods (USFWS, 2012).
- Site / area / habitat protection – Develop and implement effective measures to reduce the impact of urban development and hikers and trail maintenance (USFWS, 2012).
- Alliance and partnership development – Work with Hawaii Division of Forestry and Wildlife, National Park Service, and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2012).
- Threats research – Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2012).

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SPECIES ACCOUNT: *Nothocestrum latifolium* (`aiea, broadleaf `aiea)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2017)

Physical Description

Nothocestrum latifolium is a small tree up to 33 feet (ft) (10 meters (m)) tall, with a gnarled trunk, rigid ascending branches, and young parts with yellowish-brown pubescence. The thick, pubescent leaves, usually clustered toward the ends of the branches, are seasonally deciduous. Flowers occur in clusters on short spurs and have a greenish yellow corolla in which the tube is about twice as long as the calyx. Berries are yellowish orange, succulent, and depressed-globose (Symon 1999, p. 1,263).

Taxonomy

Kingdom: Plantae; Phylum: Anthophyta; Class: Dicotyledoneae; Order: Solanales; Family: Solanceae (potatoes). *Nothocestrum latifolium* was described by Gray (1862). This species is recognized as a distinct taxon in Wagner et al. (1999, p. 1,263.)

Historical Range

Historically, *Nothocestrum latifolium* was known from Koele, Kaohai, and Maunalei Valleys on Lanai; the southwest rift zone of Haleakala on Maui; the Kawela and Kapaakea gulches on Molokai; and Waieli, Kaumokuni, and Kupehau gulches, and Makua in the Waianae Mountains of Oahu (HBMP 2008). It was never observed or collected on Kauai before 1987 but is assumed to have been there historically.

Current Range

Currently, *Nothocestrum latifolium* is known from Kalalau on Kauai, Kanepuu on Lanai, Kapunakea Preserve in the west Maui Mountains, Auwahi to Puu Mahoe in the east Maui Mountains, Puu Kolehale and Makolelau on Molokai, and several gulches in the Waianae Mountains of Oahu (HBMP 2008).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Habitat Type

Adult: Dry and moist forests. On Oahu, Molokai, and West Maui: ridges and gulches. On East Maui: old lava flows. On Lanai: mostly on plateau lands with deep soil (NatureServe 2015).

Habitat Vegetation or Surface Water Classification

Adult: Terrestrial: Forest - Hardwood, Forest/Woodland

Dependencies on Specific Environmental Elements

Adult: Dry cliff, lowland dry, lowland mesic ecosystems (USFWS, 2016)

Environmental Specificity

Adult: Unknown

Habitat Narrative

Adult: The species is typically found in dry and moist forests. On Oahu, Molokai and West Maui: ridges and gulches. On East Maui: old lava flows. On Lanai: mostly on plateau lands with deep soil. (NatureServe 2015). Typical habitat for this species is dry to mesic forest in the dry cliff (Kauai, Oahu, Lanai, and Maui), lowland dry (Oahu, Lanai, and Maui), and lowland mesic (Oahu, Molokai, Lanai, and Maui) ecosystems (TNCH 2007; HBMP 2010) (USFWS, 2016).

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Unknown, but likely declining

Species Trends:

Unknown, but likely declining; very little recruitment observed.

Number of Populations:

18 on the islands of Kauai, Lanai, Maui, Molokai, Oahu

Population Size:

~1,600 individuals

Population Narrative:

Nothocestrum latifolium is known from 18 populations totaling approximately 1,600 individuals observed during surveys conducted as recently as 2012. We are unaware of additional surveys conducted to date. One population on east Maui is the largest, with an estimated 1,200 to 1,500 individuals in 1999 (HBMP 2008). The remaining populations consist of very few individuals each. There is one population of one individual on Kauai; three populations of seven individuals on Lanai; one population with a total 31 individuals on west Maui; two populations totaling 43 to 48 individuals on Molokai; and 10 populations totaling 15 individuals on Oahu (Moses, in litt. 2006; Starr, in litt. 2006; Oppenheimer 2006, pers. comm.; HBMP 2008; Welton, in litt. 2010; Perlman, in litt. 2010; Kawakami, in litt. 2010; Kawelo, in litt. 2010; Oppenheimer, in litt. 2011). While the species has not been extirpated from any island, its range on each island has decreased dramatically and very little recruitment has been observed (Oppenheimer 2006, pers. comm.; HBMP 2008; Kawelo, in litt. 2005 and 2010). For example, on Lanai, Duvall (in litt. 2011) has no knowledge of any trees surviving. Oppenheimer (in litt. 2011) could not find any individuals from the population near the State Cooperative Game Management Area at Kanepuu, Lanai, and will re-survey the three other population units (Kahue, Paomai, and Upper Paomai) near Kanepuu, Lanai. According to the PEP program (in litt. 2013), no individuals were found within Lanai islands Kanepuu Preserve (Kahue Unit) during surveys in 2012, although there are plans to continue surveying the area and other suitable habitat. Additionally, on the island of Oahu, Manuwai Gulch contains one individual which is currently threatened by ungulates although a fence enclosure is planned for this site. Also on Oahu, the one individual at

Kaluaa could not be relocated and the three individuals located at west Makaleha have died (PEP Program, in litt. 2013).

Threats and Stressors

Stressor: Feral pigs, goats, and deer

Exposure:

Response:

Consequence: Degradation and loss of habitat

Narrative: *Nothocestrum latifolium* is threatened by feral pigs (*Sus scrofa*), goats (*Capra hircus*), and axis deer (*Axis axis*) that degrade and destroy habitat (HBMP 2008). Rooting by feral pigs is observed to be related to the search for earthworms, with rooting depths averaging 8 in (20 cm), greatly disrupting the leaf litter and topsoil layers, contributing to erosion and changes in ground topography (Diong 1982, pp. 143-150). The feeding habits of pigs created seed beds, enabling the establishment and spread of weedy species such as *Psidium cattleianum* (strawberry guava) (Diong 1982, pp. 164-165). All aspects of the food habits of pigs are damaging to the structure and function of the Hawaiian forest ecosystem (Diong 1982, pp. 166-167). The effects on mesic and wet forest habitat by foraging of feral pigs have also been reported in fencing studies. In a fencing study conducted in the montane bogs of Haleakala, it was found that when feral pigs were fenced out of an area the cover of native plant species increased from 6 percent to 95 percent within 6 years of protection (Loope et al. 1991, pp. i, 13). Currently, populations exist on Kauai, Oahu, Maui, Molokai, and Hawaii. Goats browse on introduced grasses and native plants, trample roots and seedlings, cause erosion, and promote the invasion of alien plants. Goats are able to forage in extremely rugged terrain and have a high reproductive capacity (Clarke and Cuddihy 1980, p. C20; van Riper and van Riper 1982, pp. 34-35; Scott et al. 1986, pp. 352-358; Tomich 1986, pp. 150-156; Culliney 1988, pp. 336-337; Cuddihy and Stone 1990, p. 64). Evidence of the activities of axis deer has been reported at the Kanepuu populations on Lanai (HBMP 2008). Axis deer were introduced to Lanai in 1920 (Hobdy 1993, p. 207). After goats were eradicated from Lanai, the deer began to occupy slopes and cliffs previously thought to be too steep for them (Hobdy 1993, p. 207). On Lanai, as of 2007, axis deer number approximately 6,000 to 8,000, and damage to the landscape has increased dramatically (Leone, in litt. 2001; The Insider 2007; WCities 2007).

Stressor: Feral pigs, goats, and deer

Exposure:

Response:

Consequence: Predation

Narrative: Because Hawaii's native plants evolved without any browsing or grazing mammals present, many lost natural defenses to such impacts (Carlquist 1980, pp. 173). Browsing by ungulates has been observed on many other native species, including common and rare or endangered species (Cuddihy and Stone 1990, pp. 63-64; Loope et al. 1991, p. 3). Therefore, even though we have no evidence of browsing for this species, it is likely that pigs, goats, and deer impact this species directly as well as the surrounding habitat.

Stressor: Nonnative plants

Exposure:

Response:

Consequence: Displacement and degradation of habitat

Narrative: The original native flora of Hawaii consisted of about 1,400 species, nearly 90 percent of which were endemic. Of the current total native and naturalized Hawaiian flora of 1,817 taxa, 47 percent are introduced species, and nearly 100 species of those are considered pests (Smith 1985, p. 180; Wagner et al. 1999, p. 45). Several studies (Cuddihy and Stone 1990, p. 74; Wood and Perlman 1997, p. 18; Robichaux et al. 1998, p. 4) indicate nonnative plant species may outcompete native plants similar to *N. latifolium*. Competition may be for space, light, water, or nutrients, or there may be a chemical produced that inhibits growth of other plants (Smith 1985, pp. 227-230; Cuddihy and Stone 1990, p. 74). In addition, nonnative pest plants found in habitat similar to that of this species have been shown to make the habitat less suitable for native species (Smith 1985, pp. 240-241; Loope and Medeiros 1992, pp. 7-8; Medeiros et al. 1992, p. 30; Ellshoff et al. 1995, pp. ii, 3-4; Meyer and Florence 1996, p. 778; Medeiros et al. 1997, pp. 23-24, Loope et al. 2004, p. 1,472). In particular, alien pest plant species degrade habitat by modifying availability of light, altering soil-water regimes, modifying nutrient cycling, or altering fire characteristics of native plant communities (Smith 1985, pp. 227-230; Cuddihy and Stone 1990, p. 74; Vitousek et al. 1997, pp. 6-10). Because of demonstrated habitat modification and resource competition by nonnative plant species in habitat similar to the dry to mesic forest habitat of *N. latifolium*, the FWS believes nonnative plant species are a threat to this species. The nonnative plants reported to be the greatest threats to all of the populations of *Nothocestrum latifolium* are: *Fraxinus uhdei* (tropical ash), *Lantana camara* (lantana), *Melinis minutiflora* (molasses grass), *Psidium cattleianum*, *Schinus terebinthifolius* (Christmas berry), and *Syzygium cumini* (java plum) (HBMP 2008).

Stressor: Fire (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Wildfire, and fire caused by military training activities, is a threat to this species and its habitat (Sailer 2015, in litt.) (USFWS, 2016).

Stressor: Small population size (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Low numbers of individuals limits this species' ability to adapt to environmental change (USFWS, 2016).

Stressor: Black twig borer (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Infestation by the black twig borer is a threat to *N. latifolium* (Ching Harbin 2015, in litt.) (USFWS, 2016).

Stressor: Low reproduction (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: This species continues to decline, and, for unknown reasons, there is an observed lack of regeneration in *N. latifolium* in the wild (HBMP 2010; Duvall 2015, in litt.) (USFWS, 2016).

Stressor: Climate change (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013, p. 83) found that, as environmental conditions are altered by climate change, *N. latifolium* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions (USFWS, 2016).

Recovery

Recovery Actions:

- Survey for populations of *Nothocestrum latifolium* in areas of potentially suitable habitat.
- Control feral pigs, goats, and deer by removing these species from areas where *N. latifolium* populations exist and preventing reinvasion through the use of exclosures
- Control alien plants through physical, mechanical, and biological control methods, as well as herbicides when necessary.
- Conduct research into potential biocontrol species.
- Conduct research into lack of regeneration in the wild.
- Conduct propagation efforts for maintenance of genetic stock.
- Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.
- Conduct research into the pollinator species, *Manduca blackburni*, and consider potential reintroductions where extirpated.

Conservation Measures and Best Management Practices:

- Control feral pigs, goats, and deer by removing these species from areas where *N. latifolium* populations exist and preventing reinvasion through the use of exclosures
- Control alien plants through physical, mechanical, and biological control methods, as well as herbicides when necessary.
- Conduct propagation efforts for maintenance of genetic stock.
- Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.

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SPECIES ACCOUNT: *Nothocestrum peltatum* (`Aiea)

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/25/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

A tree up to 5 m tall. Flowers are greenish yellow (NatureServe, 2015). A small tree with ash-brown bark and woolly stems. The usually peltate (leaf stem attached to the center) leaves and shorter leaf stalks separate this species from others in the genus (Symon 1999) (USFWS, 2003).

Taxonomy

This genus of 4 species is endemic to the Hawaiian islands (NatureServe, 2015). A member of the nightshade family (Solanaceae) (USFWS, 2003).

Historical Range

Historically, *N. peltatum* was known from Kauai at Kumuwela, Kaholuamanu, and Nualolo (USFWS, 2009).

Current Range

It currently occurs in upper Nualolo, Awaawapuhi, and northwestern Kauai (USFWS, 2009).

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Nothocestrum peltatum* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Nothocestrum peltatum* includes four units totaling 5,271 acres in Kauai County, Hawaii. The units are Kauai 11—*Nothocestrum peltatum*—a, b, c, and Kauai 12—*Nothocestrum peltatum*—d.

Kauai 11—*Nothocestrum peltatum*—a: This unit is critical habitat for *Nothocestrum peltatum* and is 427 ha (1,056 ac) on State land (Kokee State Park). This unit contains portions of Kumuwela Ridge and Trail. This unit provides habitat for two populations of 100 mature, reproducing individuals of the long-lived perennial *Nothocestrum peltatum* and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is important to the establishment of additional populations on Kauai in order to reach recovery goals. The habitat features contained in this unit that are essential for this species include, but are not limited to, rich soil on steep slopes in mesic or wet forest dominated by *Acacia koa* or a mixture of *Acacia koa* and *Metrosideros polymorpha*. This unit is geographically separated from the other three units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Nothocestrum peltatum*—b: This unit is critical habitat for *Nothocestrum peltatum* and is 1,465 ha (3,619 ac) on State land (Kuaia NAR, Kokee, Waimea

Canyon, and Na Pali Coast State Parks). This unit contains portions of Awaawapuhi, Honopu, and Nualolo Trails, Kainamanu and Kalahu Summits, and Mahanaloa Valley. This unit provides habitat for four populations of 100 mature, reproducing individuals of the long-lived perennial *Nothocestrum peltatum* and is currently occupied with 12 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, rich soil on steep slopes in mesic or wet forest dominated by *Acacia koa* or a mixture of *Acacia koa* and *Metrosideros polymorpha*. This unit is geographically separated from the other three units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 11—*Nothocestrum peltatum*—c: This unit is critical habitat for *Nothocestrum peltatum* and is 80 ha (198 ac) on State land (Kokee and Na Pali Coast State Parks). This unit contains Kahuamaa Flat and Puu o Kila Summit. This unit provides habitat for one population of 100 mature, reproducing individuals of the long-lived perennial *Nothocestrum peltatum* and is currently occupied with five plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, rich soil on steep slopes in mesic or wet forest dominated by *Acacia koa* or a mixture of *Acacia koa* and *Metrosideros polymorpha*. This unit is geographically separated from the other three units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 12—*Nothocestrum peltatum*—d: This unit is critical habitat for *Nothocestrum peltatum* and is 161 ha (400 ac) on State land (Waimea Canyon State Park and Puu Ka Pele Forest Reserve). This unit contains Puu Lua Summit. This unit provides habitat for two populations of 100 mature, reproducing individuals of the long-lived perennial *Nothocestrum peltatum* and is currently occupied with three plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, rich soil on steep slopes in mesic or wet forest dominated by *Acacia koa* or a mixture of *Acacia koa* and *Metrosideros polymorpha*. This unit is geographically separated from the other three units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Rich soil on steep slopes in mesic or wet forest dominated by *Acacia koa* or a mixture of *Acacia koa* and *Metrosideros polymorpha* and containing one or more of the following associated native plant species: *Alphitonia ponderosa*, *Antidesma* spp., *Bobea brevipes*, *Broussaisia arguta*, *Cheirodendron trigynum*, *Claoxylon sandwicense*, *Coprosma* spp., *Cryptocarya mannii*, *Dianella sandwicensis*, *Dicranopteris linearis*, *Diplazium sandwichianum*, *Dodonaea viscosa*, *Elaeocarpus bifidus*, *Hedyotis terminalis*, *Ilex anomala*, *Melicope anisata*, *Melicope barbigera*, *Melicope*

haupuensis, Perrottetia sandwicensis, Pleomele aurea, Pouteria sandwicensis, Psychotria mariniana, Psychotria greenwelliae, Tetraplasandra kawaiensis, or Xylosma spp.; and

(ii) Elevations between 581 and 1,290 m (1,906 and 4,232 ft).

Special Management Considerations or Protections

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species in paragraph (b) of this section and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Lifespan

Adult: > 10 years (USFWS, 2009)

Breeding Season

Adult: February - March, July - November (USFWS, 2009)

Reproduction Narrative

Adult: Herbarium vouchers at Bernice Pauahi Bishop Museum (C. Imada, Bernice Pauahi Bishop Museum, pers. comm. 2008) and data from the National Tropical Botanical Garden (2008) and the Hawaii Natural Heritage Program (2007) revealed flowering in February, March, and July through November; fruiting specimens were noted from February, March, and August through November. It is a long-lived perennial (USFWS, 2009). Although plants of this long-lived perennial species have been observed flowering, they rarely set fruit. This could be the result of a loss of pollinators, reduced genetic variability, or an inability to fertilize itself (USFWS, 2003).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Mesic to wet koa or ohia forest (USFWS, 2003)

Geographic or Habitat Restraints or Barriers

Adult: 1,906 - 4,232 ft. elevation (USFWS, 2003)

Habitat Narrative

Adult: Inhabits moist forests in gulches and on ridges (NatureServe, 2015). This species generally grows in rich soil on steep slopes in mesic or wet forest dominated by Acacia koa or a mixture of A. koa and Metrosideros polymorpha, at elevations between 581 and 1,290 m (1,906 and 4,232 ft.) (USFWS, 2003).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Very low (inferred from USFWS, 2009; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2009)

Number of Populations:

8-11 (USFWS, 2017)

Population Size:

32-41 (USFWS, 2017)

Population Narrative:

A recent estimate lists seven populations totaling 23 individuals (Perlman 2006; USFWS 2008) (USFWS, 2009). At the time of the last 5-year review in 2009 there were seven populations totaling 23 individuals. Currently, individuals are reported from the same areas at Nualolo, Awaawapuhi, Makaha, and Waimea Canyon rim (NTBG 2012c-d, 2013a-b, 2015a-d, 2016a-c). New occurrences have been found at Kopakapaka (two individuals), Honopu (two to five individuals), Waiakoali stream (two individuals), and Nawaimaka stream (one individual) (NTBG 2009a-c, 2010a, 2012a-b, 2014, 2016c-d). These 8 to 11 populations total between 32 and 41 individuals (USFWS, 2017).

Threats and Stressors

Stressor: Invasive plants (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The major threats to this species include competition with invasive introduced plants such as *Passiflora tarminiana* (banana poka), *P. edulis* (passion fruit), *Erigeron karvinskianus* (daisy fleabane), *Lantana camara* (lantana), *Rubus argutus* (blackberry), *R. rosifolius* (thimbleberry), *Hedychium gardnerianum* (kahili ginger), *Psidium cattleianum* (strawberry guava), *Corynocarpus laevigatus* (karakanut), and *Bryophyllum pinnatum* (air plant) (USFWS, 2009).

Stressor: Fire (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Not available

Stressor: Stochastic events (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: This species is at risk of extinction from naturally occurring events such as storms, hurricanes, or landslides; and reduced reproductive vigor due to the small number of existing individuals (USFWS, 2009).

Stressor: Ungulate degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Feral pigs (*Sus scrofa*), goats (*Capra hircus*), and black-tailed (mule) deer (*Odocoileus hemionus*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil (Loope 1998, van Riper and van Riper 1982). Feral pigs, goats, and black-tailed deer and evidence of their activities have been reported at all populations of *Nothoctrum peltatum* (NTBG 2009a-c, 2010a, 2012a-d, 2013a-b, 2014, 2015a-d, 2016a-b; PEPP 2010, 2011, 2012, 2013, 2014, 2015) (USFWS, 2017).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Nothoctrum peltatum* is highly

vulnerable to the impacts of climate change, with a vulnerability score of 0.917 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Stressor: Rodent predation or herbivory

Exposure:

Response:

Consequence:

Narrative: Herbivory by rats is noted to be a threat to *Nothocestrum peltatum* at the Waiakoali, Honopu, Nawaimaka, and Waimea Canyon rim populations (NTBG 2009a, 2010a, 2012a-d, 2013a-b, 2014, 2015a-d, 2016a-d). Rats eat virtually every part of plants and at every stage: fleshy fruits, seeds, flowers, stems, leaves, shoot, seedlings, and roots (Russell 1980; Cuddihy and Stone 1990). The effects on plants range from reduced vigor and decreased reproduction to mortality of individuals and complete lack of recruitment (USFWS, 2017).

Recovery

Reclassification Criteria:

1. A total of five to seven populations should be documented on Kauai and at least one other island where they now occur or occurred historically (USFWS, 1995).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials (USFWS, 1995).
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 1995).

Delisting Criteria:

1. A total of eight to ten populations should be documented on Kauai and at least one other island where they now occur or occurred historically (USFWS, 1995).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials (USFWS, 1995).
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 1995).

Recovery Actions:

- Protect current populations, control threats and monitor (USFWS, 1995).
- Expand current populations (USFWS, 1995).
- Conduct research essential to conservation of the species (USFWS, 1995).
- Establish new populations as needed to reach recovery objectives (USFWS, 1995).
- Validate and revise recovery objectives (USFWS, 1995).
- Devise and implement a public education program (USFWS, 1995).

- In order to prevent this taxon from going extinct, propagation efforts and the maintenance of adequate genetic stock ex situ should be undertaken immediately, as well as the protection of remaining wild individuals from feral goats, feral pigs, mule deer, red jungle fowl and alien weed threats (USFWS, 1995).
- New Management Actions:
 - Captive propagation for genetic storage and reintroduction—
 - o NTBG has collected and attempted to propagate hundreds of seeds from several different collections from Kopakaka, Makaha, and Nawaimaka, but the seeds would not germinate, and probably not viable. The NTBG nursery has also received air layers from one plant along Nualolo trail in 2017 (NTBG 2017). Lyon Arboretum Seed Bank has received six collections, but of the two collections in which they tried to germinate a subsample, no seeds, out of the 325 seeds sown, germinated (Lyon Arboretum 2017). The Lyon Arboretum Micropropagation Lab has been maintaining representation from two trees by subculturing seedlings from a 2001 fruit collection. This collection, from Puu Kapele, is the only collection where germination has been documented. Ten seeds from a collection of 250 seeds of varying sizes germinated from one tree, and 27 seeds from a collection of 50 seeds of uniform size germinated. This low viability and variation in seed size may indicate that this species produces a high percentage of unfilled (no embryo) seeds. There have been observations of flowers of *Nothocestrum peltatum* that suggest that this species is in fact dioecious (Perlman 2017, pers. obs.), and similar observations have been made on *Nothocestrum longifolium* on Oahu (Keir 2014, pers. obs.). This may be a possible explanation for reduced seed viability in these small remnant populations. PEPP has collected seeds, cuttings, and airlayers for NTBG, KRPF, DOFAW, and Lyon Arboretum (PEPP 2010, 2011, 2012, 2013, 2014, 2015).
 - o An individual outplanted within a fenced enclosure at Waimea Canyon rim in 2010 has died (PEPP 2011) (USFWS, 2017).
- Recommendations for Future Actions:
 - Habitat destruction and herbivory by feral pigs, goats, and black-tailed (mule) deer is reported as a new threat to all populations of *Nothocestrum peltatum*. In addition, predation or herbivory by rats is reported to be a new threat at the Waiakoali, Honopu, Nawaimaka, and Waimea canyon rim populations. Botanists have observed little to no germination of collected seeds. No other significant new information regarding the species' biological status has been reported since the last 5-year review in 2009. Therefore, the following recommendations for future actions are added or reiterated for the 5-year review for 2017.
 - Surveys and inventories—Survey for populations of *Nothocestrum peltatum* in areas of potentially suitable habitat.
 - Ungulate monitoring and control—Construct large-scale fences around all naturally occurring and reintroduced individuals to control feral ungulates. Protect all occurrences against browsing and disturbances from feral ungulates.
 - Invasive plant monitoring and control—
 - o Control established ecosystem-altering nonnative invasive plant species around all populations.
 - o Control invasive nonnative species that compete with the species around all populations.
 - Fire monitoring and control—Develop and implement fire management plans for all wild and reintroduced populations.
 - Predator and herbivore monitoring and control—Implement effective control methods for rodents.
 - Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock.
 - Genetic research—Assess genetic variability within extant populations.
 - Population biology research—Research the lack of regeneration in the wild and ex situ.
 - Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.
 - Population biology research—Study *Nothocestrum peltatum* populations to determine viable population size and structure,

geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Collect fruit from all wild individuals that set seed (USFWS, 2009).
- Control introduced invasive plant species around wild and outplanted plants (USFWS, 2009).
- Construct large-scale fences around all naturally occurring and reintroduced individuals to control feral ungulates (USFWS, 2009).
- Enhance current natural populations to increase numbers of individuals (USFWS, 2009).
- Reintroduce individuals into protected suitable habitat within historical range (USFWS, 2009).
- Work with the Kauai Watershed Alliance and the Hawaii Division of Forestry and Wildlife to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2009).
- Investigate techniques to improve natural recruitment (USFWS, 2009).
- Assess genetic variability within extant population (USFWS, 2009).
- Study *Nothocestrum peltatum* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2009).

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SPECIES ACCOUNT: *Nototrichium humile* (Kulu`i)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

Nototrichium humile is a long-lived perennial shrub in the Amaranthaceae (amaranth) family. It is a basal-branching shrub 1 to 2 m (3.3 to 6.6 ft) tall, with upright or arching branches. The green, ovate to oblong leaves are 3 to 9 cm (1.2 to 3.5 in) long, and lack the silvery hairs characteristic of the other two *Nototrichium* species. The flowers are borne in slender, terminal spikes 3 to 14 cm (1.2 to 5.5 in) long. The perfect flowers (with both male and female reproductive parts) are small and inconspicuous, and the dry fruits are not much larger (Wagner et al 1999; Makua Implementation Team 2003) (USFWS, 2016).

Historical Range

Historically it occurred throughout the Waianae Mountains of Oahu and on East Maui (56 FR 55770, 68 FR 25934) (USFWS, 2016).

Current Range

Current range: Waianae Mountains of Oahu; also known historically from Lualailua Hills on Maui (NatureServe, 2015). The status of *N. humile* on Maui is uncertain as no reports have been documented since 1979 (68 FR 25934). When the species was listed in 1991, 11 occurrences were estimated to contain up to 3,000 individuals on Oahu. Since then, 16 population units have been identified with a total of about 1,296 individuals. These population units are found on Federal, State, and city/county lands (68 FR 35950). No information is available on the current existence or numbers of *N. humile* on Maui (USFWS, 2016).

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Nototrichium humile* (Kulu`i) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Nototrichium humile* (Kulu`i) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Nototrichium humile* (77 FR 57648-57862). The critical habitat designation includes 17 critical habitat units, which encompass approximately 7,808 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Nototrichium humile* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Nototrichium humile* includes four CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Lowland Dry—Unit 1 consists of 11,465 ac (4,640 ha) of State land, 2,069 ac (837 ha) of federally owned land, and 3 ac (1 ha) of privately owned land, from Kanaio to Kahualau Gulch on the southern slopes of east Maui. This unit is occupied by the plants *Bonamia menziesii*, *Cenchrus agrimonioides*, *Flueggea neowawraea*, *Melicope adscendens*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 1 is not known to be occupied by *Alectryon macrococcus*, *Bidens micrantha* ssp. *kalealaha*, *Canavalia pubescens*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Sesbania tomentosa*, *Solanum incompletum*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 2 consists of 1,851 ac (749 ha) of State land at Keokea on the southern slopes of east Maui. This unit is occupied by the plants *Bonamia menziesii*, *Canavalia pubescens*, and *Hibiscus brackenridgei*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 2 is not known to be occupied by *Alectryon macrococcus*, *Bidens micrantha* ssp. *kalealaha*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 3 consists of 188 ac (76 ha) of privately owned land, at Keauhou on the southern slopes of east Maui. This unit is occupied by the plant *Canavalia pubescens*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 3 is not known to be occupied by *Bidens micrantha* ssp. *kalealaha*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var.

lanaiense, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 4 consists of 1,266 ac (512 ha) of State land (including the Department of Land and Natural Resources) at Ahihi-Kinohiwa Natural Area Reserve on the southern slopes of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Maui—Lowland Dry—Unit 4 is not currently occupied by *Bidens micrantha* ssp. *kalealaha*, *Bonamia menziesii*, *Canavalia pubescens*, *Cenchrus agrimonoides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat designation for *Nototrichium humile* includes 17 critical habitat units, covering one ecosystem type, which encompasses approximately 7,808 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Dry—Units 1, 2, 8, 9, 10, 11; Oahu—Lowland Mesic—Units 1, 2, 3; Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Lowland Dry—Unit 1 [102 ac (41 ha)]; This area consists of 49 ac (20 ha) of State land and 53 ac (22 ha) of privately owned land in the Waianae Mountains, extending from Haili Gulch to Kawaipahai. Oahu—Lowland Dry—Unit 2 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland dry ecosystem in the Waianae Mountains, on Federal land within Kaena Point State Park. Oahu—Lowland Dry—Unit 8 [99 ac (40 ha)]. Oahu—This area consists of 96 ac (40 ha) of privately owned land and 3 ac (1 ha) of State land as part of the old railroad right-of-way in the lowland dry ecosystem, at the Kalaeloa Barber's Point Harbor area. Oahu—Lowland Dry—Unit 9 [37 ac (15 ha)]. This area consists of 17 ac (7 ha) of City and County land, 3 ac (1 ha) of privately owned land, 1 ac (0.5 ha) of State land, and 16 ac (6 ha) of Federal (Pearl Harbor NWR) land in the lowland dry ecosystem at Kalaeloa. Oahu—Lowland Dry—Unit 10 [43 ac (17 ha)]. This area consists of 43 ac (17 ha) of State land (DHHL) in the lowland dry ecosystem at Kalaeloa. Oahu—Lowland Dry—Unit 11 [166 ac (67 ha)]. This area consists of 166 ac (67 ha) of federal land (U.S. Navy) in the lowland dry ecosystem at Kalaeloa.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland

Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac (105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Nototrichium humile* critical habitat consists of one component. Lowland dry (east Maui) (81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*. Subcanopy: *Chamaesyce*, *Dodonaea*, *Leptecophylla*, *Osteomeles*, *Psydrax*, *Scaevola*, *Wikstroemia*. Understory: *Alyxia*, *Artemisia*, *Bidens*, *Chenopodium*, *Nephrolepis*, *Peperomia*, *Sicyos*.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Nototrichium humile* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Nototrichium humile* occurs within the Lowland dry, Lowland mesic and Dry cliff ecosystems in the Waianae Mountain caldera complex:

Oahu—Lowland Dry—Units 1, 2, 8, 9, 10, 11. (A) Elevation: <3,300 ft (<1,000 m). (B) Annual Precipitation: <50 in (<130 cm). (C) Substrate: Weathered silty loams to stony clay, rocky ledges, little weathered lava. (D) Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*, *Sapindes*. (E) Subcanopy: *Chamaesyce*, *Dodonaea*, *Leptecophylla*, *Osteomeles*, *Psydrax*, *Scaevola*,

Wikstroemia. (F) Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Plumbago, Sicyos, Sida, Waltheria.

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (F) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. (F) Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire,

drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkii*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Nototrichium humile* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes,

landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Breeding Season

Adult: Flowering in *N. humile* is generally heaviest in the spring and summer, and the fruits mature a few weeks after flowering (USFWS, 2016).

Reproduction Narrative

Adult: Flowering in *N. humile* is generally heaviest in the spring and summer, and the fruits mature a few weeks after flowering. Pollination vectors for this species are not known, nor is it known if the plants are self-compatible. Based on observations of particular individuals, the plants live for at least one or two decades (Makua Implementation Team 2003). Other demographic information for *N. humile* in the wild is unknown, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, seed dispersal, vegetative reproduction and specific environmental requirements (USFWS, 2016).

Habitat Type

Adult: Dry forest gulch (USFWS, 2016)

Habitat Narrative

Adult: Open, remnant dry or mesic forest, on cliff faces, in gulches, or on steep slopes. (NatureServe, 2015). *Nototrichium humile* is found on gulch slopes and gulch bottoms in the understory of dry forests dominated by *Diospyros sandwicensis* or *Sapindus oahuensis*, dry shrublands near ridge tops, and open dry cliffs and cliff ledges sparsely vegetated with shrubs and grasses. Small groups or isolated plants sometimes occur in mesic habitats. On cliffs, *N. humile* is somewhat protected from feral ungulates, invasive alien weeds, and fire. This species usually is found on north-facing slopes at elevations of 60 to 700 m (197 to 2,298 ft) (Makua Implementation Team 2003) (USFWS, 2016).

Dispersal/Migration

Population Information and Trends

Population Trends:

Increasing (USFWS, 2016)

Number of Populations:

16 (USFWS, 2016)

Population Size:

1500-3000 (USFWS, 2016)

Population Narrative:

Trends in numbers indicate declines of *Nototrichium humile* since 1991, when consistent monitoring was initiated (Table SB 27), followed by an increase in 2004. All but two of the 16 population units have decreased or remained about the same, though the increases in two of the population units are sizable. Overall, numbers have decreased by about 20 percent, but current numbers have increased to roughly the 2003 levels. Seven of the population units have exceeded minimum numerical criterion for stabilization population units (defined as at least 25 mature, reproducing individuals for long-lived perennials). Plants in the Kahanahaiki, Kaluakauila, Keaau, Keawaula, Punapohaku, and the two Makua population units are located in zones at risk from training-related wildfire. Thus, *N. humile* is characterized by 16 population units, of which seven have exceeded minimum numerical criteria for stabilization population units; overall trends in numbers have increased since 2004 after initially falling in 1991 (USFWS, 2016).

Threats and Stressors

Stressor: Fire (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Threats include fires (USFWS, 2016)

Recovery**Reclassification Criteria:**

Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1995a, 1998a) (USFWS, 2016).

Delisting Criteria:

Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1995a, 1998a) (USFWS, 2016).

References

USFWS. 2016. Status of the Species and Critical Habitat: *Nototrichium humile* (Kulu i). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

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USFWS. 2016. Status of the Species and Critical Habitat: *Notrichium humile* (Kulu i). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016.

SPECIES ACCOUNT: *Ochrosia haleakalae* (Holei)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2017)

Physical Description

Ochrosia haleakalae is a tree 6.7 to 26.3 feet (ft) (2 to 8 meters (m)) tall. The elliptic leaves are clustered three or four per node. Tubular flowers occur in relatively open inflorescences.

Robust, ovoid drupes are yellow or plum-colored, streaked with brown and often have irregular ridges at maturity due to differential thickening of the exocarp (Wagner et al. 1999, p. 218).

Taxonomy

Kingdom: Plantae; Phylum: Anthophyta; Class: Dicotyledoneae; Order: Gentianales; Family: Apocynaceae (Dogbane); Genus: *Ochrosia*. *Ochrosia haleakalae* was described by St. John (1978). This species is recognized as a distinct taxon in Wagner et al. (1999, p. 218), the most recently accepted Hawaiian plant taxonomy. Also known as St. John Holei (NatureServe 2015).

Historical Range

Historically, *Ochrosia haleakalae* was known from two islands, Maui and Hawaii. On Maui the species was known to occur from the Koolau and Makawao Forest Reserves (FRs), the northern slope of Haleakala, and from Auwahi and Kanaio on the southern slopes of Haleakala volcano (Hawaii Biodiversity and Mapping Program (HBMP) 2008). On the island of Hawaii the species was known from valleys in the Kohala Mountains (Pololu, Honopue, and Waipio) and from Kalopa gulch on the eastern (Hamakua) slope of Mauna Kea volcano (HBMP 2008).

Current Range

Ochrosia haleakalae is currently known from Makawao FR and Auwahi/Kanaio on the island of Maui, and from Kohala FR (Honopue gulch), Waipio, Hilo FR (Laupahoehoe section), Hamakua FR (Kalopa gulch), and at Hawaii Volcanoes National Park on the island of Hawaii (Pratt 2005, in litt.; Agorastos 2007, pers. comm.; Medeiros 2007, in litt.; HBMP 2008; Oppenheimer 2008, in litt.).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Habitat Type

Adult: Dry to mesic, and sometimes wet, forest, often on lava at elevations between 2,300 and 4,000 ft.

Habitat Vegetation or Surface Water Classification

Adult: Forest - Hardwood, Forest/Woodland

Dependencies on Specific Environmental Elements

Adult: Dry cliff, lowland mesic, and montane mesic ecosystems (USFWS, 2016)

Habitat Narrative

Adult: Typical *Ochrosia haleakalae* habitat is dry to mesic, and sometimes wet, forest, often on lava, at elevations between 2,300 and 4,000 ft (700 and 1,200 m) (The Nature Conservancy (TNC) 2006; Wagner et al. 1999, p.218). On east Maui, the species occurs in diverse mesic and wet forest (Medeiros et al. 1986; TNC 2006; Medeiros 2007, in litt.). On the island of Hawaii, *O. haleakalae* is known from gulches and valleys in the Hamakua district and from degraded *Metrosideros polymorpha*-*Pisonia sandwicensis* (ohia-papala kepa) mesic and forest in the Kohala Mountains (Perlman and Wood 1996; Wagner et al. 1999, p. 218; TNC 2006). Occurs in the dry cliff (Maui), lowland mesic (Maui and Hawaii Island), and montane mesic (Maui) ecosystems (Medeiros et al. 1986, pp. 27–28; Wagner et al. 1999, p. 218; TNCH 2007; HBMP 2010) (USFWS, 2016).

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Not available

Resiliency:

Low (inferred from USFWS, 2016)

Redundancy:

Low (inferred from USFWS, 2016)

Number of Populations:

Maui: 4, Hawaii: 3 (USFWS, 2016)

Population Size:

Maui: 15, Hawaii: 151 wild, 150 outplanted (USFWS, 2016)

Population Narrative:

Currently, *O. haleakalae* is known from 4 occurrences totaling about 15 individuals on the island of Maui (Medeiros 2007, in litt.; Oppenheimer 2008, in litt.; HBMP 2010; Oppenheimer 2015, in litt.). On Hawaii Island, there are two occurrences totaling at least 150 individuals in Hawaii Volcanoes National Park, with 150 outplanted in nearby kipuka (vegetated areas surrounded by lava flows), and one individual in the Laupahoehoe section of Hilo Forest Reserve (Pratt 2005, in litt.; Bio 2008a, in litt.; HBMP 2010; Pratt 2011, in litt.; Conry 2012, in litt.; Orlando 2015, in litt.; Perry 2015, in litt.) (USFWS, 2016).

Threats and Stressors

Stressor: Feral pigs, goats, and cattle

Exposure:

Response: Habitat loss and degradation

Consequence:

Narrative: *Ochrosia haleakalae* is highly and imminently threatened by feral pigs (*Sus scrofa*) on both islands, and by goats (*Capra hircus*) and cattle (*Bos taurus*) on Maui (Oppenheimer 2004, in litt.; HBMP 2008). Evidence of the activities of feral pigs, goats and cattle has been reported in areas where *O. haleakalae* is known to occur (Medeiros 1995, in litt.; Oppenheimer 2004, in litt.; Agorastos 2007, pers. comm.). Hawaiian ecosystems, having evolved without hoofed mammals, are susceptible to large-scale disturbance by pigs, goats, and other introduced ungulates (Loope et al. 1991, p. 3). Because of demonstrated habitat modifications by feral pigs, goats, and cattle, such as destruction of native plants, disruption of topsoil leading to erosion, and establishment and spread of nonnative plants, the U.S. Fish and Wildlife Service (FWS) believes they are potential threats to *O. haleakalae*.

Stressor: Feral pigs, goats, and cattle

Exposure:

Response: Predation

Consequence:

Narrative: *Ochrosia haleakalae* is potentially threatened by feral pigs on both islands, and by goats and cattle on Maui at all but three locations (Medeiros 1995, in litt.; Oppenheimer 2004, in litt.; Pratt 2005, in litt.; USGS-BRD 2006; Agorastos 2007, pers. comm.). Browsing by ungulates has been observed on many native plant species, including common and rare or endangered species (Cuddihy and Stone 1990, pp. 40, 61, 63-64; Loope et al. 1991, p. 3). Because Hawaii's native plants evolved without any browsing or grazing mammals present, many lost natural defenses to such impacts (Carlquist 1980, p. 173; Lamoureux 1994, pp. 55-57).

Stressor: Fire

Exposure:

Response: Habitat loss and degradation; burning

Consequence:

Narrative: Fire is a major threat to *Ochrosia haleakalae* and is exacerbated by the presence of introduced plant species such as *Pennisetum clandestinum* (kikuyu grass) (HBMP 2008). Because Hawaiian plants were only subjected to fire during their evolution in areas of volcanic activity or from occasional lightning strikes, they are not adapted to recurring fire regimes and do not quickly recover following a fire. Alien plants are often better adapted to fire than native plant species, and some fire-adapted grasses such as *P. clandestinum* have become widespread where *O. haleakalae* occurs (DAntonio and Vitousek 1992, p. 73; Friefelder et al. 1998, pp. 296-297; HBMP 2008). The presence of such species in Hawaiian ecosystems greatly increases the intensity, extent, and frequency of fire, especially during the drier months or periods of drought. Fire can destroy dormant seeds as well as plants, even in steep or inaccessible areas. Fires may result from natural causes, or they may be accidentally or intentionally started by humans (Cuddihy and Stone 1990, p. 74; DAntonio and Vitousek 1992, p. 73; Friefelder et al. 1998, pp. 296-297).

Stressor: Nonnative plants

Exposure:

Response: Competition, displacement

Consequence:

Narrative: The original native flora of Hawaii consisted of about 1,400 species, nearly 90 percent of which were endemic. Of the total current native and naturalized Hawaiian flora of 1,817 taxa, 47 percent are introduced species, and nearly 100 of those species are considered pests (Smith

1985, p. 180; Wagner et al. 1999). Confirmed personal observations (HBMP 2008) and several studies (Cuddihy and Stone 1990, p. 74; Wood and Perlman 1997, p. 18; Robichaux et al. 1998, p. 4) indicate nonnative plant species may outcompete native plants similar to *O. haleakalae*. Competition may be for space, light, water, or nutrients, or they may produce a chemical that inhibits the growth of other plants (Smith 1985; Cuddihy and Stone 1990). In addition, nonnative pest plants found in habitat similar to that of this species have been shown to make the habitat less suitable for native species (Smith 1985, pp. 240-241; Loope and Medeiros 1992, pp. 7-8; Medeiros et al. 1992, p. 30; Ellshoff et al. 1995, pp. ii, 3-4; Meyer and Florence 1996, p. 778; Medeiros et al. 1997, pp. 23-24, Loope et al. 2004, p. 1,472). In particular, alien pest plant species degrade habitat by modifying availability of light, altering soil-water regimes, modifying nutrient cycling, or altering fire characteristics of native plant communities (Smith 1985, pp. 227-230; Cuddihy and Stone 1990, p. 74; Vitousek et al. 1997, p. 73). Because of demonstrated habitat modification and resource competition by nonnative plant species in habitat similar to that of *O. haleakalae*, the FWS believes nonnative plant species are a threat to this species.

Stressor: Herbivory and seed predation (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Herbivory and seed predation by slugs and rats is a threat to this species (Oppenheimer 2015, in litt.) (USFWS, 2016).

Stressor: Low reproduction (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: There is low to no reproduction observed in the wild, and this reduced reproductive vigor is due to reduced levels of genetic variability resulting from low numbers of individuals. This decreases the species' capacity to adapt to environmental changes, and thereby lessens the probability of its long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361; Duvall 2015, in litt.) (USFWS, 2016).

Stressor: Climate change (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013, p. 83) found that, as environmental conditions are altered by climate change, *O. haleakalae* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions (USFWS, 2016).

Recovery

Recovery Actions:

- Remove feral pigs, goats, and cattle from areas where *O. haleakalae* populations exist and prevent reinvasion through the use of exclosures.
- Control alien plants through physical, mechanical, and biological control methods, as well as herbicides when necessary.

- Conduct research into potential biocontrol species.
- Control fire through removal of nonnative grasses.
- Conduct field surveys for additional populations in suitable *O. haleakalae* habitat.
- Reintroduce *O. haleakalae* individuals into suitable habitat within historic range that is being managed for known threats to this species.
- Propagate and maintain genetic stock of *O. haleakalae*.

Conservation Measures and Best Management Practices:

- Remove feral pigs, goats, and cattle from areas where *O. haleakalae* populations exist and prevent reinvasion through the use of exclosures.
- Control alien plants through physical, mechanical, and biological control methods, as well as herbicides when necessary.
- Control fire through removal of nonnative grasses.
- Reintroduce *O. haleakalae* individuals into suitable habitat within historic range that is being managed for known threats to this species.
- Propagate and maintain genetic stock of *O. haleakalae*.

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17 p.

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SPECIES ACCOUNT: *Ochrosia kilaueaensis* (Holei)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/04/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

A tree with milky sap that grows to about 49-59 ft (15-18 m) tall (Wagner et al. 1990). Oblance-shaped to ob-elliptic leafblades, 2.4-7.5 in (6-19 cm) long and 0.9-2.6 in (2.2-6.5 cm) wide, are arranged three to four at a node. Conspicuous secondary veins are almost perpendicular to the midvein. Numerous flowers are arranged in clusters and subtended by main flower cluster stalks divided into two sections: primary stalks (peduncles), 1.8-2.5 in (4.5-6.3 cm) long; and secondary branch stalks, 0.4-1 in (1.1-2.5 cm) long. Each flower has a flower stalk (pedicel) 0.2-0.3 in (5-7 mm) long. The calyx is deeply 5-lobed and about 0.4 in (1 cm) long. The green-white, trumpet-shaped flowers have five lobes 0.5-0.6 in (12-15 mm) long fused at the base into a cylindric tube 0.3-0.4 in (7-11 mm) long. Lance-shaped fruits, 1.8-1.9 in (4.5-4.9 cm) long and 0.9-1.1 in (2.4-2.5 cm) wide, have a fleshy inner layer, a stony single seed, and may be yellow-brown when mature (USFWS, 1996).

Taxonomy

A member of the dogbane family (Apocynaceae) (USFWS, 2012).

Historical Range

Historically known on Hawaii island (USFWS, 1996).

Current Range

There are currently no known individuals in the wild (USFWS, 2012).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: > 10 years (USFWS, 2012)

Reproduction Narrative

Adult: It is a long-lived perennial (USFWS, 2012).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Moist forest (NatureServe, 2015); montane mesic koa, ohia, or lama forest (USFWS, 2012)

Geographic or Habitat Restraints or Barriers

Adult: 2,200 - 4,000 ft. elevation (USFWS, 2012)

Habitat Narrative

Adult: Inhabits moist forests on old volcanic ash or old lava flows (NatureServe, 2015). The typical habitat of *Ochrosia kilaueaensis* is described as *Acacia koa* (koa) and *Metrosideros polymorpha* (ohia) or *Diospyros sandwicensis* (lama) dominated montane mesic forest between 670 and 1,220 meters (2,200 and 4,000 feet) in elevation (USFWS 1994, 1996) (USFWS, 2012).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

This species has not been observed in the wild since at least the 1940s (USFWS, 2012)

Species Trends:

Possibly extinct (USFWS, 2012)

Number of Populations:

None known (NatureServe, 2015)

Population Size:

None known (NatureServe, 2015)

Population Narrative:

It was last collected in 1927. There are no current occurrences (NatureServe, 2015). Additional surveys are needed to confirm whether the species is extinct (USFWS, 2012).

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Feral goats (*Capra hircus*), disturb the substrate and understory, thus providing ample sites for weedy adventives (USFWS 1994, 1996). *Pennisetum setaceum* (fountain grass) (USFWS 1994, 1996); fire (USFWS, 2012).

Stressor: Collection (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: This species was most likely threatened by human impacts such as unrestricted collecting for scientific or horticultural purposes in the past (USFWS 1994, 1996) (USFWS, 2012).

Stressor: Predation (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: This species, if still extant, is threatened by fruit herbivory by rats (*Rattus* spp.) (USFWS 1994, 1996) (USFWS, 2012).

Stressor: Small population size (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Low numbers, inbreeding depression (USFWS, 2012).

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species (USFWS, 2012).

Recovery

Reclassification Criteria:

1. A total of five to seven populations should be documented on the Big Island (USFWS, 1996).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population (for long-lived perennials) (USFWS, 1996).
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1996).

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on the Big Island (USFWS, 1996).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population (for long-lived perennials) (USFWS, 1996).
3. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1996).

Recovery Actions:

- Protect current populations and manage threats (USFWS, 1996).
- Conduct essential research (USFWS, 1996).
- Expand existing wild populations, as necessary (USFWS, 1996).

- Create new populations within historical range, as necessary (USFWS, 1996).
- Evaluate and validate recovery objectives (USFWS, 1996).
- A thorough survey of the area where the last known *Ochrosia kilaueaensis* occurred is necessary (USFWS, 1996).
- If the species is found, genetic material for maintenance of ex situ stock should be collected, the existing population protected, and eventual outplanting of propagated material in protected areas within its historic range pursued (USFWS, 1996).

Conservation Measures and Best Management Practices:

- Surveys / inventories – A thorough survey of Kipuka Puaulu and Puuwaawaa where *Ochrosia kilaueaensis* was last observed should be undertaken to determine the status of the species (USFWS, 2012).
- Captive propagation for genetic storage and reintroduction – If the species is rediscovered, genetic material for ex situ storage should be collected (USFWS, 2012).
- Ungulate exclosures – If the species is rediscovered, construct fenced exclosures to protect the population from feral goats (USFWS, 2012).

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USFWS. 2012. *Ochrosia kilaueaensis* (Holei) 5-Year Review Summary and Evaluation. U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii.

SPECIES ACCOUNT: *Oenothera deltoides* ssp. *howellii* (Antioch Dunes evening-primrose)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A biennial herb that forms tufts of coarse, heavily-branched, drooping stems. Lower leaves grayish, pubescent, form basal rosette. Flowers bell-shaped, acquiring a blush of pink with age (Smithsonian Institution 1980). (NatureServe, 2015)

Taxonomy

Oenothera deltoides subsp. *howellii* is a short-lived perennial in the primrose family (Onagraceae) (USFWS, 2019).

Historical Range

See current range/distribution.

Current Range

Endemic to the Antioch Dunes, known from Contra Costa County and introduced in Sacramento County, California (Skinner 1997). (NatureServe, 2015)

Critical Habitat Designated

Yes; 8/31/1978.

Legal Description

On August 31, 1978, the U.S. Fish and Wildlife Service, designated critical habitat for *Oenothera deltoides* ssp. *howellii* (Antioch Dunes evening-primrose) under the authority of the Endangered Species Act of 1973 (43 FR 39042 - 39044). Critical habitat was designated for one unit in California.

Critical Habitat Designation

One critical habitat unit is designated in California, described as: An area of land, water, and airspace in Contra Costa County with the following components: T. 2 N. R. 2 E. SW 1/4 section 17, E 2/3 of S 1/3 of section 18 (43 FR 39042 - 39044).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements are not described (43 FR 39042 - 39044).

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Self-incompatible, requiring cross-pollination for viable seed, insect pollinated (USFWS, 1984; 2019)

Reproduction Narrative

Adult: The Antioch Dunes evening-primrose is vespertine; the flowers open in early evening and close by mid-morning. In the garden, the plant flowers from “March to May and briefly in September” (Roof 1969). This *Oenothera* is self-incompatible (Klein 1970) and thus requires cross-pollination for sound seed. Arnold (pers. Comm. 1982) believes that bees are the primary pollinating agent at Antioch. Although hawkmoths were not known on the dunes until 1983, they have been reported as pollinators of other *Oenothera* species (Gregory 1963). Their role as pollinators of Antioch Dunes evening-primrose has not been documented. Studies are needed to determine the phenology, pollinators and seed dispersal mechanisms of this subspecies (USFWS, 1984).

Habitat Type

Adult: Interior dunes on the "Antioch Dunes" along the shore of the San Joaquin River in Contra Costa County, California, occurring in nearly pure and shifting sand (USFWS, 2019).

Spatial Arrangements of the Population

Adult: Clumped (inferred from NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits inland dunes; this species will not mature where adult plants have previously grown unless fresh sand is deposited (Smithsonian Institution 1980 and Skinner 1997 in NatureServe, 2015). O.d. subsp. *howellii* is considered almost entirely restricted to the remaining Antioch Dunes habitat at the Antioch Dunes Natural Wildlife Refuge, which encompasses 67 acres (the 41-acre Stamm Unit, owned by the Service and the 26-acre Sardis Unit, of which 14 acres are owned by the Service and 12 acres are owned by Pacific Gas and Electric)(USFWS, 2019).

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Declining (USFWS, 2019)

Number of Populations:

4 (Stamm Unit, Sardis Unit, transplanted location on Browns Island, and Brannan Island)(USFWS, 2019).

Population Size:

2,368 (as of 2017)(USFWS, 2019)

Population Narrative:

According to the CNDDDB (2018a), *Oenothera deltoides* subsp. *howellii* is known from 10 EOs, nine of which are presumed extant and one of which is considered likely extirpated (Table 2). Of

the nine presumed extant EOs, six are considered natural occurrences and three are considered transplanted outside of native habitat and/or range. The total population in 2017 was estimated at 2,368 individuals, with 2,334 plants counted at the ADNWR (2,008 at the Stamm Unit and 326 at the Sardis Unit) and 34 plants at one of the transplanted locations at Browns Island (Table 2). Population numbers have shown some improvement since the 2008 Five-Year Review, as illustrated by plant count numbers from ADNWR (Figure 5; Service 2018a, Service No Date). However, despite the improvement, the overall population is still not considered stable or self-sustaining due to the overall low population numbers, low redundancy of populations, and continuing and increasing threats (USFWS, 2019).

Threats and Stressors

Stressor: Habitat destruction from sand mining, industrial and urban/suburban development, and/or conversion to agriculture

Exposure:

Response:

Consequence:

Narrative: Habitat for the Lange's metalmark, O.d. subsp. howellii, E.c. var. angustatum, and pollinators, and area available for habitat restoration is threatened by destruction and conversion to other uses. This threat is largely ameliorated on the ADNWR and other properties with protection/management agreements in place, but not on properties without such agreements (USFWS, 2019).

Stressor: Habitat degradation due to loss of natural disturbance regime

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: The reduction in sand deposition in Antioch Dunes habitat as a result of water management/use (dams, levees, etc.) in the Sacramento/San Joaquin River Delta system and reduced effectiveness of wind-driven dispersal of sand and disturbance of dunes has and continues to reduce overall size and connectedness of the dune natural community (USFWS, 2019).

Stressor: Habitat degradation due to non-native and native invasive vegetation

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Invasive vegetation colonizes open sand habitat, reducing available suitable Lange's metalmark, O.d. subsp. howellii, E.c. var. angustatum, and pollinator, habitat. Invasive plants out-compete native species, including Lange's metalmark host and food plants, and O.d. subsp. howellii and E.c. var. angustatum, for sunlight, space, nutrients, and moisture. They also stabilize the sand/soil, eliminating the natural disturbance regime and may cause soils to become more eutrophic (Thomson 2005a, Thomson 2005b, Chin 2012, McNally 2014). The 2008 Five-Year Review notes that the proliferation of non-native invasive plants has been increasing rapidly since 1998 (Service 2008) and these conditions continue (Chin 2012, McNally 2014, Service 2018a, Service 2018b, Service 2018c, Service 2018d). The use of herbicides to control non-native and native invasive vegetation may also present potential threat to Lange's metalmark host and food plants, O.d. subsp. howellii, and E.c. var. angustatum occurring in the same vicinity. Applying

herbicides selected for the target species and using appropriate rates and technique should minimize effects to non-target Lange's metalmark host and food plants, *O.d. subsp. howellii*, and *E.c. var. angustatum*. These practices have been instituted at the ADNWR, so this threat is considered largely ameliorated there (Service 2008), but it may pose a risk to current and future occurrences of these listed species elsewhere. Additionally, some herbicides may pose threat directly to Lange's metalmark. In a study of Behr's metalmark, a close relative of Lange's metalmark butterfly, the herbicides triclopyr, sethoxydim, and imazapyr were found to reduce the number of adults that emerged from pupation by 24-36% after exposure to typical field application rates (Stark et al 2012 in Richmond et al 2015) (USFWS, 2019).

Stressor: Habitat degradation due to gypsum dust deposition from neighboring plant (facility)

Exposure:

Response:

Consequence:

Narrative: The 2008 Five-Year Review reported that gypsum dust building up on plants may reduce exposure to sunlight and decrease photosynthesis. It may also alter soil chemistry due to introduction of calcium and sulphates, which may affect the growth of Lange's metalmark host and food plants, *O.d. subsp. howellii* and *E.c. var. angustatum* and promote colonization by invasive species. Deposition is noted as affecting mostly the Sardis Unit. The ADNWR staff have met with Georgia-Pacific (G-P) about concerns over the dust and G-P increased efforts to reduce airborne gypsum (beyond the standards for air pollution control) by keeping it wetted down when possible during production activities. At the time of the 2008 Five-Year Review, staff noted a reduction in dust from G-P efforts. The review noted that there was no evidence that gypsum dust was adversely affecting any of the three species (Service 2008). However, it also cited a study that demonstrated that dusts may adversely increase transpiration through the cuticle of insect larvae and cause desiccation and abrasion of the cuticle (Wigglesworth 1945 in Service 2008), which may affect Lange's metalmark and pollinators of *O.d. subsp. howellii* or *E.c. var. angustatum*. The ADNWR staff reported an increase in gypsum dust deposition at ADNWR in 2017-2018 (Susan Euing pers. comm. December 12, 2018). In 2018, staff noted that gypsum was being deposited on the refuge at concentrations that coats plants, leading to cancellation of surveys for the Lange's metalmark in some parts of the refuge (Susan Euing pers. comm. August 17, 2018). In 2019, after several weeks into the Lange's metalmark survey season, ADNWR staff confirmed that no surveys had been canceled due to concerns about gypsum dust deposition (Louis Terrazas pers. comm. September 10, 2019). The magnitude of this potential stressor requires further investigation and Service partnership with G-P is ongoing (USFWS, 2019).

Stressor: Habitat degradation due to rogue hiking/trails

Exposure:

Response:

Consequence:

Narrative: This activity may cause direct injury or mortality to the Lange's metalmark, to its host and food plants, and to *O.d. subsp. howellii* and *E.c. var. angustatum* from trampling while also increasing potential for accidental introduction of wildfire from hikers. These threats and stressors were significantly reduced when ADNWR was fenced in 1986 and the 2008 Five-Year Review (Service 2008) no longer considered recreational and pedestrian traffic to be a significant threat. However, ADNWR staff note that incidence of trespassing and human encampments at ADNWR has increased in the past several years (Susan Euing pers. comm. December 12, 2018) (USFWS, 2019).

Stressor: Overutilization for commercial, recreational, scientific, or educational purposes

Exposure:

Response:

Consequence: Extirpation

Narrative: These activities represent a threat to the Antioch Dunes species from direct mortality of any individual(s) collected and a reduction in annual recruitment by killing or injuring reproductive individuals (USFWS, 2019).

Stressor: Disease or predation

Exposure:

Response:

Consequence:

Narrative: Evidence exists of *O.d. subsp. howellii* infestation by beetles (possibly family Chrysomelidae), which feed on petals, pollen, and seed pods. Also, in the early 1980s up to 50% of *O.d. subsp. howellii* was infested with small mirid bugs (family Miridae of the insect order Hemiptera) that prey upon *O.d. subsp. howellii*, and these insect predators remained an identified threat in 2008 (Service 2008). The magnitude of this stressor requires further investigation (USFWS, 2019).

Stressor: Wildfire

Exposure:

Response:

Consequence:

Narrative: Wildfire may cause direct mortality of *O.d. subsp. howellii* and *E.c. var. angustatum* plants during vulnerable life stages. These stages include the period from germination during the beginning of the wet season in December through the deposition of seeds in mid-summer. However, historical evidence indicates that the native plants may recover rather quickly from a wildfire (Service 2008). Any mortality would also result in reduced annual recruitment by killing or injuring reproductive individuals. The threat extends to pollinators and other pollinator plant species (USFWS, 2019).

Stressor: Fuelbreak discing

Exposure:

Response:

Consequence:

Narrative: Fuelbreak discing may cause direct injury or mortality to Lange's metalmark, its host and food plants, and to *O.d. subsp. howellii*, and *E.c. var. angustatum*. However, it also creates open, disturbed, sand/soil that may be suitable for colonization by *O.d. subsp. howellii* and *E.c. var. angustatum*, as well as invasive vegetation. The net impact of this activity to listed plant resilience is unquantified (USFWS, 2019).

Stressor: Loss of pollinators

Exposure:

Response:

Consequence:

Narrative: Lange's metalmark is addressed as a pollinator for this discussion of the potential threat posed by possible insecticide drift from mosquito abatement spraying on neighboring

properties (Richmond et al 2015). The Mosquito Abatement District allows for spraying of insecticides to reduce the incidence of West Nile Virus at a wetland adjacent to the Stamm Unit of the ADNWR. The spray could drift on to the refuge and affect pollinators, such as Lange's metalmark and those that pollinate *O.d. subsp. howellii* or *E.c. var. angustatum*. While ADNWR staff have worked with county mosquito control staff to minimize effects from this potential threat, the magnitude of this stressor requires further investigation. As of the 2008 Five-Year Review, there was no evidence that lack or loss of pollinators has negatively impacted *O.d. subsp. howellii* or *E.c. var. angustatum* (Service 2008), but both species require cross-pollination, so an adequate pollinator population is necessary. Bees are suspected pollinators for both species and hawkmoths may also be pollinators for the primrose; however, actual pollinator taxa are unknown. This potential threat requires investigation (USFWS, 2019).

Stressor: Low population numbers

Exposure:

Response:

Consequence:

Narrative: *Oenothera deltoides* subsp. *howellii* and *E.c. var. angustatum* are threatened by few and small populations that are limited to a small and localized distribution, which increases the risk of extirpation and extinction due to: (1) Reduced resiliency (the ability of a species to withstand stochastic disturbance; resiliency is positively related to population size and growth rate and may be influenced by connectivity among populations); (2) Low redundancy (spreading risk among multiple populations or a large area to minimize the potential loss of the species from catastrophic events); and (3) Low representation (the breadth of genetic and environmental diversity within and among populations that influences the ability of a species to adapt to changing environmental conditions over time) (USFWS, 2019).

Stressor: Climate change

Exposure:

Response:

Consequence:

Narrative: *Oenothera deltoides* subsp. *howellii* and *E.c. var. angustatum* are threatened by multiple environmental effects anticipated with climate change, which may result in loss of habitat, altered temperature and moisture regimes causing direct mortality and/or impaired reproduction, and altered temperature and moisture regimes causing indirect mortality and/or impaired reproduction via phenological mismatches with pollinators and between pollinators and their host and/or other nectar plants (Richmond et al 2015) (USFWS, 2019).

Recovery

Reclassification Criteria:

There are at least five separate self-sustaining (all plants are naturally recruiting*) populations, including: at least three populations, each with a 15-year moving median of at least 4,800 flowering plants; and at least two populations, each with a 15-year moving median of at least 1,500 flowering plants (USFWS, 2019).

A distance of at least 1,500 feet and a natural and/or man-made firebreak separates individual populations (USFWS, 2019).

Populations should be protected and have in place a long-term management plan for the conservation of *O.d. subsp. howellii* and commitment for implementation of the plan (USFWS, 2019).

Delisting Criteria:

There are at least seven separate self-sustaining (all plants are naturally recruiting (*Any flowering individuals counted as naturally recruiting would have to be \geq two flowering seasons post-outplanting. This would indicate the individual has completed the life cycle in situ.)) populations including: at least five populations, each with a 15-year moving median of at least 4,800 flowering plants; and at least two populations, each with a 15-year moving median of at least 1,500 flowering plants. OR, population viability analysis determines that *O.d. subsp. howellii* has a range-wide 95% probability of persistence over a 100-year period. a. A distance of at least 1,500 feet and a natural and/or man-made firebreak separates individual populations. b. Populations should be protected and have in place a long-term management plan for the conservation of the *O.d. subsp. howellii* and commitment for implementation of the plan. (USFWS, 2019)

A post-delisting monitoring plan for the species has been developed (USFWS, 2019).

Recovery Actions:

- The final supporting actions for Primary Action 1 include identification of other essential habitat and developing an MOU with the landowner to develop protective alternatives and actions. Since listing, the only new habitat identified for conservation is the property owned by the Pioneer Companies, Inc., and currently occupied by the McCulloch-Kemwater North American Company. All three of the Antioch Dunes species have been surveyed on this property (USFWS 2005). Currently, this property is for sale and the Service is considering alternatives that include purchasing this valuable habitat (USFWS, 2008).
- The initial supporting actions for Primary Action 2 are essentially the same for all three endangered Antioch Dunes species, and include conducting annual census of population and habitat; captive breeding (Lange's metalmark butterfly) or propagation and outplanting (Antioch Dunes evening-primrose, Contra Costa wallflower); developing and implementing a habitat restoration plan; and conducting studies of the biology of the species which include life history (Lange's metalmark butterfly), autecological studies (Antioch Dunes evening-primrose, Contra Costa wallflower), habitat requirements (Lange's metalmark butterfly), population biology (Lange's metalmark butterfly), and reproductive studies (Antioch Dunes evening-primrose, Contra Costa wallflower). Out-planting buckwheat host plants is also needed for Lange's metalmark butterfly. All of these actions have been ongoing and are discussed below in section IIC. Another group of supporting actions includes rebuilding the natural dune substrate and topography to the degree feasible by negotiating with the Army Corps of Engineers (Corps) and the Port of Stockton for sandy dredged material, preparing the sites for deposition of dredged material, and surveying the sites for candidate and listed species in order to ameliorate any negative effects. Several sources of sand were used in restoration efforts since listing the three species. Dredged material was found to contain a substantial amount of fine non-silica sediment which proved to stabilize too quickly for use as a substitute for the original dune sand (C. Smith in litt. 2007). Antioch Dunes NWR staff recently located several sources of local high-silica content sand that should prove useful in the restoration; however, although funding sources are being sought for purchasing and delivering the sand, current plans tentatively include testing the composition of the

imported sand prior to using it to supplement the refuge. (C. Smith in litt 2007; L. Terrazas, USFWS, pers. comm. 2008). Other actions include removal of a vineyard and removal of other non-native invasive vegetation throughout the Antioch Dunes NWR. The vineyard was removed in 1983 and removal of non-native invasive vegetation has been an ongoing effort (see section IIC for updated status on the restoration) (USFWS, 2008).

- Supporting actions for this include erecting interpretive signs, printing and distribution of leaflets describing the Antioch Dunes NWR's unique dune ecosystem and the need for restoration, and the development of an environmental education program. These actions were completed in the early 1980s; however, the public awareness effort is a dynamic and ongoing process (USFWS, 2008).

Conservation Measures and Best Management Practices:

- Continue restoration of riverine dune habitat at Antioch Dunes NWR (USFWS, 2008)
- Conduct controlled propagation of the Lange's metalmark butterfly until natural populations at Antioch Dunes NWR are at a self-sustainable level (USFWS, 2008)
- Continue research into life history, habitat requirements, and population studies, including annual population monitoring surveys (USFWS, 2008)
- Acquire the McCulloch/Kemwater property abutting the eastern boundary of the Sardis Unit of the Antioch Dunes NWR (USFWS, 2008)
- Consider revising the Recovery Plan for the three endangered species endemic to Antioch Dunes, California (USFWS, 2008)

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capitatum var. angustatum) 5-Year Review: Summary and Evaluation. Sacramento Fish and Wildlife Field Office U.S. Fish and Wildlife Service Sacramento, California.

SPECIES ACCOUNT: *Opuntia treleasei* (Bakersfield cactus)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A flat-padded (beavertail) opuntia cactus, with the eye-spots (which are not sunken) having spines as well as bristles. Typically flowers in May. (NatureServe, 2015)

Taxonomy

USFWS treats as *Opuntia treleasei* (8/93). (NatureServe, 2015)

Historical Range

The distribution of Bakersfield cactus was not estimated historically. Based on written descriptions (Twisselmann 1967), historical photographs (Britton and Rose 1920; Benson 1982), topography, and deductions from plant morphology, the populations were likely more or less continuous east of Bakersfield (Service 1998). According to Twisselman (1967), Bakersfield cactus "once grew in dense almost impenetrable colonies on the mesas east of Bakersfield." Densely-spaced clumps of Bakersfield cactus once covered about two square miles from the Caliente Creek floodplain onto Sand Ridge. (USFWS, 2011)

Current Range

California: San Joaquin Valley (central Kern County). Other reports are no longer considered to be this taxon (cf. Munz 1974; Benson 1982; Brown and Cypher 1997).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated/Vegetative reproduction (USFWS, 1998)

Lifespan

Adult: at least 48 years (USFWS, 1998)

Breeding Season

Adult: Bakersfield cactus typically flowers in May (Munz and Keck 1959) (USFWS, 1998).

Reproduction Narrative

Adult: Bakersfield cactus is a perennial. The life span of wild plants has not been determined, but clumps in cultivation at the Rancho Santa Ana Botanic Garden in Claremont, California, survived for 48 years, until extremely wet winter weather caused the pads to rot (R. van de Hoek pers. comm.). Bakersfield cactus typically flowers in May (Munz and Keck 1959). Reproductive biology of this taxon has not been studied, but certain other *Opuntia* species

require cross-pollination for seed-set and many are pollinated by bees (Benson 1982, Spears 1987, Osborn et al. 1988). One potential pollinator of Bakersfield cactus is the native solitary bee *Diadasia australis* ssp. *california*, which is known to occur in Kern County and which specializes in collecting pollen from *Opuntia* species (Thorp in litt. 1998). Vegetative reproduction, which is the production of new plants from sources other than seed, is typical in Bakersfield cactus and several related species (Benson 1982). Fallen pads root easily if sufficient water is available (Twisselmann 1967, Benson 1982, Mitchell 1988), but Bakersfield cactus does not survive prolonged inundation (ESA Planning and Environmental Services 1986a). Bakersfield cactus produces seeds infrequently. Van de Hoek (pers. comm.) noted that the frequency of seed set in extant populations is similar to the proportion of seeds he observed in herbarium specimens. Cactus seeds require warm, wet conditions to germinate, a combination which is extremely rare in the Bakersfield area (Benson 1982). Pads may be dispersed by flood waters (ESA Planning and Environmental Services 1986a), but seed dispersal agents are unknown (USFWS, 1998).

Habitat Type

Adult: Grasslands (USFWS, 1998)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits sandy soils or sand flats and low hills mostly in grassland at 120-550 m (Benson 1982; Brown and Cypher 1997). Characteristic in Sierra-Tehachapi Saltbush Scrub community, but also in Blue Oak Woodland and a riparian woodland. (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on its specific habitat needs and low number of known populations.

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Pads may be dispersed by flood waters (ESA Planning and Environmental Services 1986), but seed dispersal agents are unknown (USFWS, 2011).

Population Information and Trends**Population Trends:**

Not available

Number of Populations:

6 - 20 (NatureServe, 2015)

Population Narrative:

Twenty-nine occurrences are presumed extant; about half have not been surveyed for over 20 years (USFWS 2011; CNDDDB 2012). (NatureServe, 2015)

Threats and Stressors

Stressor: Agricultural Conversion and Urbanization (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The primary threats to Bakersfield cactus over its entire habitat range continue to be residential development and conversion to agriculture. Continuing threats to localized populations that were identified in the listing rule include urbanization events such as; road expansion and maintenance (Oildale Area (within the MBNKR Recovery Site), Wheeler Ridge, and Sand Ridge), expansion of the Kern River Power Plant (Kern Canyon), the county airport (MBNKR), and the Bena landfill (Caliente-Bena Hills); as well as oil and gas development (Oildale Area (within the MBNKR) and Wheeler Ridge), Off road vehicle use (MBNKR and Cottonwood Creek), sand and gravel mining (Sand Ridge) and California Aqueduct right-of-way maintenance (Wheeler Ridge) (Cypher pers comm. 2010). All of these activities continue to threaten Bakersfield cactus by the modification of its habitat, the removal of Bakersfield cactus clumps, and the further fragmentation of existing populations. Table 2 summarizes land ownership and protected status (USFWS, 2011).

Stressor: Oil and Gas Extraction and Conveyance (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Oil and gas extraction and conveyance continue to threaten Bakersfield cactus. Adverse effects of oil and gas development on Bakersfield cactus include the loss of habitat, change in habitat quality, destruction of individuals or populations and their seedbank, habitat fragmentation, and increased competition from nonnative plant species due to habitat degradation. According to our HCP database (Service 2010), there is one HCP that covers oil and gas production that includes Bakersfield cactus as a covered species. The Nuevo Energy Company and Torch Operating Company (Nuevo/Torch) HCP was permitted in 1999 for a 30-year permit term. The project size is 21,800 acres with 1,700 acres impacted. The mitigation includes 800 acres to be created, enhanced, or restored, and 840 acres to be protected. Approximately 1,328 acres of the total 21,900 acres in the Nuevo/Torch Plan Area may be suitable for Bakersfield cactus (Nuevo/Torch 1999). Only those Nuevo/Torch lands east of Highway 99 overlap with reported occurrences of Bakersfield cactus. Bakersfield cactus has a limited range and is only found in western Kern County. Therefore Nuevo/Torch proposed avoidance and minimization measures are particularly important for this species. Oil and gas development is often limited and linear in nature in terms of well pads and pipeline construction but where oil and gas fields are developed into production sites, the cumulative impact can be large. Three of the five largest U.S. oil fields are in Kern County and span more than one million acres (USFWS, 2011).

Stressor: Conservation Efforts (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Approximately 1068.40 acres (74.6 percent) of occupied presumed extant Bakersfield cactus habitat is on private land that is not protected from agricultural conversion, urbanization, oil and gas development, and off road vehicle use. About 144.35 acres (10.1 percent) of occupied

presumed extant Bakersfield habitat is on private land that is protected. About 115.03 acres (8 percent) of presumed extant Bakersfield cactus habitat is on public land that is not protected from oil and gas development, off road vehicle use, and utility operation and maintenance; 104.37 acres (7.3 percent) is on protected public lands (USFWS, 2011).

Stressor: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: At the time of listing we stated that many cacti are collected and cultivated by plant collectors, or offered for sale or trade by cactus growers. Although there have been no reports of such trade in Bakersfield cactus, the species may still be collected and cultivated (Service 1990). Currently, we have no evidence whether this has occurred. Currently, the lack of monitoring means that we probably would not detect collection or vandalism, especially on private land (USFWS, 2011).

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: In summary, the Endangered Species Act is the primary Federal law that provides protection for this species since its listing as endangered in 1990. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act. Therefore, we continue to believe other laws and regulations have limited ability to protect the species in absence of the Endangered Species Act (USFWS, 2011).

Stressor: Nonnative annual grasses and increased fire frequency (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Nonnative annual grasses directly threaten the survival of mature cactus plants and hinder the establishment of new plants (ESA Planning and Environmental Services 1986; Mitchell 1988). In 2002-2004, mortality of Bakersfield cactus clumps and low rates of vegetative and sexual reproduction at Sand Ridge Preserve were attributed to competition with nonnative annual grasses for water during years with below-average precipitation (Cypher and Fiehler 2006; Cypher pers. comm. 2006). Nonnative annual grasses also indirectly affect Bakersfield cactus in three ways. First, indirect effects from nonnative annual grasses include increased fire frequency (Service 1998; Brooks 1999; Brooks and Pyke 2001; Brooks 2003), damage from insects (Burger and Louda 1994), and rot of cactus pads during wet years (Service 1998). Fire suppression has allowed the extensive growth of nonnative grasses in some areas to the detriment of Bakersfield cactus (Moe 1989). Also, nonnative annual grasses, which are adapted to fire, increase the fuel load in fire-intolerant saltbush (*Atriplex* sp.) habitat, where Bakersfield cactus is found, resulting in an increase in fire frequency (Brooks 1999; Brooks and Pyke 2001; Brooks 2003). Although the effect of repeated fires on Bakersfield cactus has not been determined, the survival of Bakersfield cactus plants was monitored following single fire events at Sand Ridge (R. Hewett, Sand Ridge Preserve Manager, in litt. 1987) and near the Rio Bravo Hydroelectric Power Plant in Kern Canyon

(Lawrence 1987; George Lawrence and Associates 1988). All of the Bakersfield cactus clumps survived the fires at both sites, despite wilting and browning of the pads. During the following spring, Bakersfield cactus plants that were subjected to low-intensity flames flowered; however, those subjected to moderate-intensity flames produced only vegetative growth. Second, dense grass also may harbor insects that damage cactus, as was observed with related species of *Opuntia* in Nebraska grasslands (Burger and Louda 1994), but not yet studied in Bakersfield cactus. Third, the dense grass cover creates a moist microclimate which may promote the growth of decay organisms and cause cactus pads to rot more in years of above-average precipitation (Service 1998) (USFWS, 2011).

Stressor: Loss of genetic diversity (USFWS, 2011)

Exposure:

Response:

Consequence: Extirpation

Narrative: The destruction of Bakersfield cactus habitat by agriculture and urban sprawl has left the remaining populations highly fragmented and small. The small size of many of the populations (Moe 1989; CNDDDB 2010), presumed lack of gene flow between populations, and infrequent sexual reproduction (Menges 1986) may result in a lack of genetic diversity (Service 1998) although this has not been tested in Bakersfield cactus. Populations that are low in genetic variation are more vulnerable to diseases and parasites (Burdon and Marshall 1981) and to chance events, including environmental fluctuations, catastrophes, and genetic drift (Menges 1991). Several of the occurrences have few individuals (CNDDDB 2010) and could be subject to loss of genetic diversity (USFWS, 2011).

Stressor: Flooding (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Bakersfield cactus populations located in floodplains are threatened by flooding. Bakersfield cactus plants cannot survive long periods of inundation (ESA Planning and Environmental Services 1986; Service 1998). Populations within the Caliente Creek floodplain have been extirpated due to flooding, and flooding continues to be a threat for the Caliente - Bena Hills populations (Service 1998; CNDDDB 2010). Populations of Bakersfield cactus within the California Aqueduct right-of-way are also potentially threatened by flooding. Kern County identified earthquakes as highly significant hazard to all regions of Kern County. Large earthquakes can cause secondary hazards including landslides, fire, and flooding. The California Aqueduct crosses the White Wolf Fault at Wheeler Ridge and parallels the San Andreas Fault within 25 miles for most of its length in Kern County (Kern County Fire Department Office of Emergency Services 2005). The largest concentration of clumps in the Wheeler Ridge population is located adjacent to an overflow drain for the Aqueduct, which could lead to flooding if an earthquake occurred anywhere along its length (Service 1998) (USFWS, 2011).

Stressor: Air pollution (USFWS, 2011)

Exposure:

Response:

Consequence: Reduced reproduction

Narrative: The Recovery Plan cites Messick (1987) as stating that air pollution is suspected to have contributed to the decline of Bakersfield cactus. Messick noted that populations of

Bakersfield cactus appeared to be reproducing less and losing vigor and that soft tissues may be adversely affected by acid deposition or ozone. He suggested that study of possible air pollution effects was needed (USFWS, 2011).

Stressor: Reproductive threats (USFWS, 2011)

Exposure:

Response:

Consequence: Reduced reproductive success

Narrative: Reproduction of Bakersfield cactus may be threatened by the loss of pollinators. The reproductive biology of Bakersfield cactus has not been studied, but other *Opuntia* species are known to require cross-pollination for seed-set and many are pollinated by bees (Benson 1982; Spears 1987; Osborn et al. 1988; Thorp in litt. 1998). Pollinators are threatened by the use of both regulated (e.g., malathion) and unregulated pesticides (e.g., pyrethroids) (Service 2000; DPR 2006; Keith 2006). Malathion, a broad spectrum insecticide, has been used to control the beet leaf-hopper (*Circulifer tenellus*) in rangeland habitat, fallow fields, oil fields, and cultivated areas on both public (BLM) and private lands in the San Joaquin Valley, and in adjacent valleys and foothills. Increasingly, malathion is used to kill agricultural pests and mosquitoes, which are documented as vectors of the West Nile Virus. Its application therefore, is not limited to agricultural areas but includes residential and commercial zones thereby increasing the regional areas in which it is used. Hymenopterans (ants, wasps, bees, etc.) are particularly susceptible to malathion exposure (Dobroski and Lambert 1984) (USFWS, 2011).

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Climate models predict for California an overall warming of 1.7 degrees to 5.8 degrees Celsius (3.0 degrees Fahrenheit to 10.4 degrees Fahrenheit) by 2100 (Cayan et al. 2006), but they vary in their predictions for precipitation. VanRheenen et al. (2004) predict a decrease in precipitation in the southern San Joaquin Valley. Bakersfield cactus seeds require warm, wet conditions to germinate (Benson 1982). Therefore, a sufficient decrease in precipitation could hinder Bakersfield cactus growth by sexual reproduction. Additionally, studies at Sand Ridge Preserve revealed increases in Bakersfield cactus mortality and lowered rates of vegetative and sexual reproduction in years of below-average precipitation due to competition for water with nonnative annual grasses (Cypher and Fiebler 2006; Cypher pers. comm. 2006). Conversely, increases in annual precipitation would possibly promote the growth of decay organisms resulting in the rot of cactus pads (Service 1998). Bakersfield cactus cannot tolerate prolonged periods of inundation as observed in the Caliente Creek floodplain (ESA Planning and Environmental Services 1986; Service 1998; CNDDDB 2010). The effect of such changes in climate on nonnative species and parasites is unknown, but could accelerate their establishment in Bakersfield cactus habitat. If such changes in climate occur, and the resulting changes in precipitation occur, Bakersfield cactus could be extirpated with no available refugia (USFWS, 2011).

Recovery

Reclassification Criteria:

1) Secure and protect specified areas from incompatible uses A) 95 percent of occupied habitat on public lands; 75 percent of Bakersfield cactus clumps and 75 percent of occupied habitat in the Caliente-Bena Hills, Comanche Point, Kern Bluff, Sand Ridge, and Wheeler Ridge areas (addresses Listing Factor A) (USFWS, 2011);

2) A management plan has been approved and implemented for the recovery areas that includes survival of the species as an objective (addresses Listing Factors C and E) (USFWS, 2011);

3) Population monitoring in specified recovery areas shows: stable or increasing populations at all protected sites for a 5-year period (addresses Listing Factor E) (USFWS, 2011).

Delisting Criteria:

1) 90 percent of existing clumps and occupied habitat in the areas specified in the downlisting criteria (i.e. Caliente-Bena Hills, Comanche Point, Kern Bluffs, Sand Ridge, and Wheeler Ridge areas) and in the Fuller Acres, Cottonwood Creek, Granite Station, and Kern Canyon populations are protected (as defined in the downlisting criteria) (USFWS, 2011);

2) 100 or more clumps each in other populations north and south of the Kern River are protected (USFWS, 2011);

3) A management plan exists for all protected areas identified as important to the continued survival of the species; and (USFWS, 2011)

4) All protected populations show evidence of reproduction (USFWS, 2011)

Conservation Measures and Best Management Practices:

- 1. Protect populations within Bakersfield City limits in the Kern Bluff area and south of highway 178 (USFWS, 2011).
- 2. Work with willing land owners to establish a conservation easement or fee title to the property at the mouth of Kern Canyon (USFWS, 2011).
- 3. Complete the draft Department of Water Resources Habitat Conservation Plan (USFWS, 2011).
- 4. Conduct census of known populations and monitor the reproductive status of known populations (USFWS, 2011).
- 5. Determine suitable management methods for reducing nonnative annual grasses and increasing native perennials, including Bakersfield cactus, and communicate the benefits of such management to rangeland landowners (USFWS, 2011).

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SPECIES ACCOUNT: *Osmoxylon mariannense* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 04/08/2004; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Osmoxylon mariannense is a spindly, soft-wooded tree in the ginseng family (Araliaceae), which can reach 10 m (33 feet) in height. It has several upward-growing (ascending), gray-barked branches that bear conspicuous leaf scars. Leaves vary in size; mature leaves are palmately lobed (hand-shaped) and about 30 cm (1 foot) long and 50 cm (1.7 feet) wide. The seven to nine lobes are coarsely toothed, and each lobe has a conspicuous, depressed mid-vein. The leaves are alternate or whorled and grow only at the branch tips. The petioles are 35 to 40 cm (1 to 1.5 feet) long and based in distinctive, conspicuous green multiple “sockets” (Raulerson and Rinehart 1991). The flowers are yellow and have both male and female components. They are borne in many-branched, compact terminal cymes or umbels. The fruits are round and maroon in color when ripe (Raulerson and Rinehart 1991). (USFWS, 2007)

Taxonomy

The species *Osmoxylon mariannense* (Kanehira) Fosberg and Sachet was first described as *Boerlagiodendron mariannense* by Kanehira. Fosberg and Sachet (1980) made the generic transfer to *Osmoxylon*. (USFWS, 2012)

Historical Range

See current range/distribution.

Current Range

Endemic to Rota in the Mariana Islands (USFWS 2004b).

Critical Habitat Designated

Yes;

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: The species is dioecious, with male and female flowers being produced on separate trees. Trees have been observed flowering in February, March, and October and fruiting in November, December, January, February, and March (Raulerson and Rinehart 1997; G. Hughes, in litt. 1998; G. Koob, in litt. 2005). The seeds of *O. mariannense* are difficult to germinate and this may be due to production of “false seeds” (structures that appear to be seeds but aren’t) or low viability rates (J. Manglona, CNMI, pers. comm. 2005; L. Raulerson, pers. comm. 2005). (USFWS, 2007)

Habitat Type

Adult: Terrestrial (USFWS, 2007)

Habitat Vegetation or Surface Water Classification

Adult: Limestone forests, forest edges, cliffs (USFWS, 2012)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations of approximately 425 meters (1,400 feet) and higher; prefers partial shade and forest edges (USFWS, 2012)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 2007; USFWS, 2012)

Habitat Narrative

Adult: *Osmoxylon mariannense* prefers partial shade or grows on the edges of forests, including areas near cliffs (Manglona no date [n.d.]). *Osmoxylon mariannense* is found in limestone forests at approximately 425 meters (1,400 feet) elevation and higher, where moisture and humidity levels are high (Koob 2005; Manglona n.d.). These forests occur in patches in the formerly mined Sabana and are dominated by *Hernandia labyrinthica* and *Elaeocarpus joga* (yoga) interspersed with *Pandanus* (kafu) thickets. Mixed with the *Elaeocarpus* and *Hernandia* are a few *Ficus* spp., *Artocarpus* spp., and *Hibiscus tiliaceus* (pago). Understory species include *Macaranga thompsonii* (pengua) and *Pipturus argenteus* (amahadyan). Epiphytes are abundant and include *Freycinetia reineckeii* (no common name), *Asplenium nidus* (galak), *Davalia solida* (pugua-machena), and other ferns; *Coelogyne guamensis* (no common name) and other orchids; and mosses (Falunruw et al. 1989). (USFWS, 2007; USFWS, 2012)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: The fruit may provide food for birds and bats, which may also be the dispersal agents, though this is not confirmed (Raulerson and Rinehart 1991; Resources Northwest 1997; J. Manglona, pers. comm. 2005). (USFWS, 2007)

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2007)

Redundancy:

Very low (inferred from USFWS, 2007)

Number of Populations:

1 (USFWS, 2007)

Population Size:

10 (8 wild) (USFWS, 2007)

Additional Population-level Information:

There have been no systematic surveys for *Osmoxylon*, and very few field visits to known wild plant locations for several years (Estanislao Taisacan, pers. comm. 2016). During July-August of 2016, one wild *Osmoxylon* tree was observed alive along the north rim of the Mount Sabana plateau (James Manglona, pers. comm. 2016), and a second one further east along the rim was observed alive and bearing fruit (McBride, personal observation). Another *Osmoxylon* was found in the Assoro area on the south part of the Sabana plateau “five or six years ago” (Robert Ulloa, pers. comm. 2016). Two other trees, in As Mundo and Fanlagon areas, were alive when last seen sometime between 2005 and 2010 (Estanislao Taisacan, pers. comm. 2016). Impediments to recruitment: wild reproduction has been limited or prevented by vegetative competition, as well as herbivory by Cuban slugs, which are pervasive throughout forested areas. Also, trampling and browsing by Philippine deer are now the principal ungulate issues for this species as hunters have suppressed or eliminated feral goat and pig populations (James Manglona, pers. comm. 2016). (USFWS 2017)

Population Narrative:

An unknown number of trees currently exist in cultivation, and 2 trees that were outplanted in 2002 adjacent to wild individuals of *Osmoxylon mariannense* continue to survive, bringing the total number of currently known individuals in the wild to 10. (USFWS, 2007)

Threats and Stressors

Stressor: Land-use activities (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Native vegetation, including Sabana limestone forest habitat for *Osmoxylon mariannense*, has undergone extreme alteration due to past and present land use practices, including ranching, deliberate and unintentional nonnative animal and plant introductions, agriculture, and military activities during World War II (Falanruw et al. 1989). Rota was subject to extensive agricultural development (particularly the cultivation of sugar cane in the lowland areas) by the Japanese prior to World War II. Currently, Rota retains less than 60 percent of its historical native forest (Falanruw et al. 1989). Continued loss of native forest is attributable to application of the Agricultural Homestead Act of 1990, which allows for the distribution of 1-hectare (2.5-acre) parcels of public land to eligible participants. (USFWS, 2007)

Stressor: Introduced ungulates (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Throughout the Mariana Islands, introduced goats (*Capra hircus*), pigs (*Sus scrofa*), cattle (*Bos taurus*), and Philippine deer (*Cervus mariannus*) have severely damaged forest vegetation by browsing on plants, causing habitat degradation and erosion (Kessler 1997; Wiles et. al. 1999, 2005; Worthington et. al. 2001) that then retards forest growth and regeneration (Lemke 1992). Of these nonnative ungulates, deer and feral pigs are degrading the forests of the Sabana (L. Williams, pers. comm. 2005, G. Wiles in litt. 2006). These animals may also directly browse on young individuals of *Osmoxylon mariannense*. (USFWS, 2007)

Stressor: Unidentified pests (USFWS, 2007)

Exposure:**Response:****Consequence:**

Narrative: Defoliation (due to the poor health of the leaves), the lack of seedlings and juveniles of *O. mariannense*, and the death of several previously mapped older individual plants are suspected to be caused by unidentified invertebrate pests, mice (*Mus musculus*), rats (*Rattus* spp.), or disease (D. Grout, pers. comm. 1997). (USFWS, 2007)

Stressor: Deer browsing (USFWS, 2007; USFWS, 2012)

Exposure:**Response:****Consequence:**

Narrative: Deer are reported to browse on seedlings of *Osmoxylon mariannense* (USFWS 2004; L. Williams, pers. comm. 2004). The bark of *Osmoxylon mariannense* may be subject to stripping by deer before reaching reproductive age (Hess and Pratt 2006). Cooperative efforts between the U.S. Fish and Wildlife Service and the Rota Division of Fish and Wildlife have resulted in the construction of fenced exclosures around two individuals in the wild. The remaining eight individuals are not currently fenced (USFWS 2004). (USFWS, 2007; USFWS, 2012)

Stressor: Natural disasters (USFWS, 2007)

Exposure:**Response:****Consequence:**

Narrative: While *O. mariannense* is expected to have adapted to high winds and typhoons, its distribution and numbers have been reduced significantly due to human activities, making the few remaining individuals particularly susceptible to extirpation or extinction from a natural disaster. Destruction of the Sabana forest canopy by typhoons has adversely affected *O. mariannense*, altering sub-canopy vegetation conditions over the long term by opening up and drying out older, closed forest habitat (E. Taisacan, pers. comm. 1998; L. Williams, pers. comm. 2004). As discussed above for *Nesogenes rotensis*, all evidence points to the increasing frequency and intensity of the threat from typhoons in this region. (USFWS, 2007)

Stressor: Non-native plants (USFWS, 2007)

Exposure:**Response:****Consequence:**

Narrative: *Osmoxylon mariannense* is threatened by competition from invasive, nonnative plant species including *Momordica charantia* (bitter melon), *Mikania scandens* (climbing hempvine), and *Passiflora suberosa* (corky-stem passionflower). In opened forest areas, these opportunistic, weedy vines cover the ground (Fosberg 1960; G. Hughes, pers. comm. 1998) and may alter the conditions necessary for seed germination and seedling growth provided in closed-canopy, high-stature forests covered with mosses and various epiphytic species. (USFWS, 2007)

Stressor: Small population size (USFWS, 2007)

Exposure:**Response:****Consequence:**

Narrative: Small population size and limited distribution make this species particularly vulnerable to extinction from reduced reproductive vigor or random environmental events. There are currently only 10 known individuals of *Osmoxylon mariannense* remaining in the wild, 2 of which were outplanted from past controlled propagation efforts. A single adverse environmental event or a decline of successful reproduction in *O. mariannense* could lead to the extirpation of this species. (USFWS, 2007)

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2007)

Recovery

Reclassification Criteria:

1. A total of two populations of *Nesogenes rotensis* are naturally reproducing and stable, or increasing in numbers. Each population of *N. rotensis* must consist of at least 300 mature, reproducing individuals. A total of two populations of *Osmoxylon mariannense* are naturally reproducing and stable, or increasing in numbers. Each population of *O. mariannense* must consist of at least 100 mature, reproducing individuals. A stable or increasing population is defined as having a finite rate of increase (known as λ or lambda) greater than or equal to 1 over the requisite 10-year time period. (USFWS, 2007)
2. Sufficient habitat is protected and managed to achieve criterion 1 above. (USFWS, 2007)
3. Management and control of nonnative species by local, regional, Commonwealth, and Federal authorities are demonstrated to be successful and sufficient to achieve criterion 1 above. (USFWS, 2007)

Delisting Criteria:

1. A total of four populations of *Nesogenes rotensis* are naturally reproducing and stable, or increasing in numbers. Each population of *N. rotensis* must consist of at least 300 mature, reproducing individuals. A total of four populations of *Osmoxylon mariannense* are naturally reproducing and stable, or increasing in numbers. Each population of *O. mariannense* must consist of at least 100 mature, reproducing individuals. A stable or increasing population is defined as having a finite rate of increase (known as λ or lambda) greater than or equal to 1 over the requisite 10-year time period. (USFWS, 2007)
2. Sufficient habitat is protected and managed to achieve criterion 1 above. (USFWS, 2007)
3. Management and control of nonnative species by local, regional, Commonwealth, and Federal authorities are demonstrated to be successful and sufficient to achieve criterion 1 above. (USFWS, 2007)

Recovery Actions:

- Coordinate and monitor recovery efforts. (USFWS, 2007)
- Address factors affecting viability of the wild populations. (USFWS, 2007)
- Monitor the extant *Nesogenes rotensis* and *Osmoxylon mariannense* populations, establish new populations, and augment existing populations. (USFWS, 2007)
- Provide educational and informational opportunities to build public support for conservation. (USFWS, 2007)
- Propagation and outplanting programs: through the Rota Rare Plants project (Partners Grant No. F14AC00510) from June 2015 through August 2016, 118 young *Osmoxylon* have been outplanted at locations on and around the Sabana; these plants are currently 1-2 years old, and are protected by fencing enclosures (Manglona 2016). Note also, that there are 35-40 older *Osmoxylon* (12-15 years old) that were outplanted in multiple locations (James Manglona, pers. comm. 2016). (USFWS 2017).
- Also in 2016, Lainie Berry of CNMI Department of Lands and Natural Resources began work on surveys and propagation of *Osmoxylon*, under a USFWS Section 6 grant (F16AP00687). In addition to surveys for previously unknown individuals as well as all previously-known natural and outplanted trees, efforts to propagate the species will also be undertaken. Anticipated propagation activities include seed collection, propagation via established techniques, outplanting in conservation areas, and initial monitoring. Existing fencing will be restored as needed, new fencing and signage established, and invasive plants hand-cleared where necessary to protect individual trees. This work is scheduled to conclude in 2018. Ongoing fence maintenance will be carried out by Rota Forestry, as well as longer-term monitoring if additional federal funding is secured (USFWS 2016). (USFWS 2017)
- Ungulate exclosure – Continue to construct and maintain ungulate-proof fenced exclosures around the remaining individuals or populations (USFWS 2017).
- Other currently-recognized herbivory concerns: develop and implement control programs for slugs and rodents (rats), at least within localized areas around established wild or outplanted trees (USFWS 2017).
- Threats research:
 - o Conduct research to determine the impact of invertebrates on *Osmoxylon mariannense* populations.
 - o Conduct research on methods to control invertebrates, if necessary.
 - o Develop and implement an invertebrate control and /or eradication program, if necessary. (USFWS 2017).
- Established invasive plant species control – Control invasive plant species around all populations (USFWS 2017).
- Mitigation of risks from potential disturbance factors:
 - o Evaluate whether there is evidence of typhoons being a significant risk factor for this species, at least in the current state of very limited population. If this is judged to be the case, develop and implement effective measures to mitigate the impact of typhoons, such as establishing multiple and relatively widelydistributed populations, to improve resiliency at the species level.
 - o Maintain fencing around individuals on the Sabana, as well as those that might be harmed by highway maintenance.
 - o Work with local DPW to ensure that road construction and maintenance activities do not harm existing individuals. (USFWS 2017)
- Population biology research: Identify the pollination mechanisms for the species, including flowering periods, specific pollinators, and other factors (USFWS 2017).

- General outreach: o Develop public outreach programs to inform residents of Rota of the importance of native species and their habitat. o Work with private landowners to help them conserve this species on their property. (USFWS 2017)
- Alliance and partnership development – Work with the CNMI Department of Lands and Natural Resources, Division of Forestry, Division of Fish and Wildlife, and other land managers to coordinate planning and support implementation of ecosystem level restoration and management to benefit *Osmoxylon* (USFWS 2017).
- Assess the modeled effects of climate change on this species, for which records of historic distribution suggest a very restricted elevational—and thus, areal—range on Rota. Consider trends suggested by available climate models when evaluating future landscape needs for the recovery of the species (USFWS 2017).
- Regulatory protections – Work with CNMI authorities to ensure that federal and local regulations provide the necessary protections to support the recovery of *Osmoxylon mariannense*, whether by adding the species to the CNMI Threatened and Endangered Species list, or by other means (USFWS 2017).
- Review the recovery plan (USFWS 2007) to determine if any new information suggests a need to update the plan to more effectively attain recovery goals (USFWS 2017).

Conservation Measures and Best Management Practices:

- Continue to collect cuttings or seed from tagged individuals, keeping close track of the maternal source for use in ex situ propagation. (USFWS, 2012)
- Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation and storage. (USFWS, 2012)
- Determine where populations could be reintroduced on Rota. (USFWS, 2012)
- Continue to reintroduce the species back into its known historical range. (USFWS, 2012)
- Conduct surveys for *Osmoxylon mariannense* in potentially suitable habitat on Rota that may have been overlooked previously. (USFWS, 2012)
- Survey all remaining individuals (native and reintroduced) to gain a better sense of the ratio of male to female trees. (USFWS, 2012)
- Continue to construct ungulate-proof fenced exclosures around the remaining population and monitor the fences for any signs of breaching. (USFWS, 2012)
- Protect all populations against disturbances from feral ungulates. (USFWS, 2012)
- Implement effective control methods for rodents. (USFWS, 2012)
- Develop and implement a slug control program, if necessary. (USFWS, 2012)
- Conduct research to determine the impact of invertebrates on *Osmoxylon mariannense* populations. (USFWS, 2012)
- Conduct research on methods to control invertebrates, if necessary. (USFWS, 2012)
- Develop and implement an invertebrate control and /or eradication program, if necessary. (USFWS, 2012)
- As individual wild trees begin the process of senescence they should be closely watched to determine what factors may be contributing to their demise. (USFWS, 2012)
- Control invasive introduced plant species around all populations. (USFWS, 2012)
- Develop and implement effective measures to reduce the impact of typhoons. (USFWS, 2012)
- Maintain fencing around individuals near Sabana and those that might be harmed by highway maintenance. (USFWS, 2012)
- Prevent the widening of the undeveloped roads that occur near individuals. (USFWS, 2012)

- If fruit set begins to decline overall, then monitor the exact flowering times of each tree to determine whether there is a decrease in the overlap of flowering times between male and female trees. (USFWS, 2012)
- Identify the pollination mechanisms and pollinators for the species. (USFWS, 2012)
- Develop public outreach programs to inform residents of Rota of the importance of native species and their habitat. (USFWS, 2012)
- Work with private landowners to help them conserve this species on their property. (USFWS, 2012)
- Work with private landowners, Mariana Public Lands Authority, the Division of Fish and Wildlife, and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2012)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2012)

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SPECIES ACCOUNT: *Ottoschulzia rhodoxylon* (Palo de rosa)

Species Taxonomic and Listing Information

Listing Status: Endangered; 4/10/1990; Southeast Region (R4) (USFWS, 2015); Proposed Reclassification to Threatened

Physical Description

A small evergreen tree which has been reported to reach 15 meters in height and 41 centimeters in diameter. The average height of 178 trees measured was 6.21 meters and the average diameter was 8.94 centimeters. The leaves are alternate, glabrous, and elliptic to ovate, from 5 to 9 centimeters long, from 3 to 6 centimeters wide, rounded or blunt at the apex and the base, entire, thick and leathery. Flowers in this genus are bisexual, solitary or in clusters at the leaf bases, and composed of a cup-shaped corolla tube with five lobes. The fruit is a one-seeded drupe with a thin pericarp; the heartwood is reddish (USFWS, 1994).

Taxonomy

Member of the Icacinaceae or the Icacinaceae family. This genus includes only three species (*O. rhodoxylon*, *O. domingensis* in Hispaniola, and *O. cubensis* in Cuba) (USFWS, 1994).

Historical Range

In Puerto Rico, first collected near Mayaguez, Puerto Rico, in 1876; when listed in 1990, known on the north coast near Bayamon; in several sites in the Guanica Commonwealth Forest, and in the Maricao Commonwealth Forest (USFWS, 1990).

Current Range

In Puerto Rico, known in the following areas of western Puerto Rico: Guaynabo; Quebradillas/Isabela; Cambalache Commonwealth Forest; Guanica Commonwealth Forest; Maricao Commonwealth Forest; Susua Commonwealth Forest; and the Sierra Bermeja in Cabo Rojo (USFWS, 1994).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Key Resources Needed for Breeding

Adult: Insects for pollination (EPA, 2016)

Reproduction Narrative

Adult: Pollination is by insects (EPA, 2016). It has not been possible to describe any pattern of flowering or fruiting for the species. Preliminary information suggests that seeds may remain viable for at least a year and a half on the forest floor (USFWS, 1994).

Habitat Type

Adult: Terrestrial (USFWS, 1994)

Habitat Vegetation or Surface Water Classification

Adult: Found in humid canyon bottoms (in Guanica) or on drier upper slopes and summits (in Quebradillas/Isabela) (USFWS, 1994)

Dependencies on Specific Environmental Elements

Adult: Well-drained, alkaline, rocky soils (USFWS, 1994)

Geographic or Habitat Restraints or Barriers

Adult: At elevations ranging from 10 to ~625 meters (USFWS, 1994).

Environmental Specificity

Adult: Narrow range of moisture tolerance (USFWS, 1994)

Habitat Narrative

Adult: Trees are limited to well-drained, alkaline, rocky soils derived from limestone or serpentine, as are trees of the other two members of the genus in Cuba and Hispaniola. In both Guanica and the Sierra Bermeja, palo de rosa is restricted to the bottom of canyons, where conditions are more mesic than might be expected given the extremely low annual precipitation. In SusLia, with greater rainfall than Guanica, the populations are restricted to the lower slopes of the mesic ravines. In the limestone hills of the north coast, receiving more precipitation than Guanica or Susua, palo de rosa occurs on the upper slopes and near the summits, where more xeric conditions prevail. Trees, therefore, are found in drier habitats (upper slopes and summits of hills) in the more mesic northern limestone hills and more mesic habitats (canyon bottoms) in the dry forests of Guanica and the Sierra Bermeja, an indication of a narrow range of moisture tolerance. Trees are located elevations ranging from 10 to ~625 meters (USFWS, 1994).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: May be bat dispersed (based on dispersal of similarly sized/shaped fruits in other species) (EPA, 2016).

Population Information and Trends**Population Trends:**

Not available.

Species Trends:

Not available.

Representation:

Low (inferred from USFWS 1994)

Redundancy:

Low (inferred from USFWS 1994)

Population Growth Rate:

Low (inferred from USFWS 1994)

Number of Populations:

The total number of localities (populations) of palo de rosa in Puerto Rico is at least 54 (USFWS 2017).

Population Size:

The estimated number of adult individuals is at least 963 (USFWS 2017).

Additional Population-level Information:

As of the date of the publication of this 5-year review, we believe the status of *O. rhodoxylon* is improving. The species is currently known from the Guanica, Susua, Guajataca, Cambalache and the Rio Abajo Commonwealth Forests, and several areas managed for conservation along the northern coast (i.e., Hacienda Esperanza and Fort Buchanan). The species is widely distributed along the northern karst region of Puerto Rico, and despite previous impacts to the populations due to deforestation for agriculture and urban development, some localities show clear evidence of recruitment. However, since palo de rosa is considered a late successional species with a slow growth rate, the populations that lie on private lands remain vulnerable to habitat modification (i.e., deforestation, habitat intrusion by exotics, habitat fragmentation, etc.). (USFWS 2017)

Population Narrative:

Approximately 200 individual trees are known from 16 populations in 10 areas in western Puerto Rico (USFWS, 1994).

Threats and Stressors

Stressor: Habitat modification or destruction (USFWS, 1990)

Exposure:

Response:

Consequence:

Narrative: Much of the island of Puerto Rico has been deforested, and today all of the known sites for *Ottoschulzia rhodoxylon* are found in areas of secondary forests. The north coast site lies just to the west of the San Juan metropolitan area, an area which is being rapidly developed. Undiscovered individuals in this area are likely to be destroyed before being discovered. Remaining individuals on the southwestern coast are found within the Guanica Commonwealth Forest, but they are found in sites such as dry stream beds and roadsides, which may be vulnerable to forest management practices that do not take the species into consideration (USFWS, 1990).

Stressor: Hurricanes and Climate Change (USFWS 2017)

Exposure:

Response:

Consequence:

Narrative: Due to the low number of populations and individuals, flashfloods were identified as a threat to palo de rosa on its listing rule. As an endemic to the Caribbean, this species should be

well adapted to tropical storms, and associated disturbances such as flashfloods. However, the low number of populations and individuals known at the time of listing posed a threat to the species by making it more susceptible to stochastic events such as hurricanes. Current information indicates that at least 22 (40%) of the known sites for the species harbor 5 or less individuals, and these sites basically show no natural recruitment, making them susceptible to extirpation by stochastic events such as storms and flashfloods. The Service has evidence of uprooted adult trees of palo de rosa within the natural populations at Hacienda La Esperanza and Higuillar "Sabanera" (both in northern Puerto Rico), suggesting damage caused by hurricane winds (Monsecur, USFWS, personal observations 2009 and Ilianet Morales, UPRM, 2006). Moreover, impacts to seedlings due to flashfloods occur on the populations located in drainages and canyons along the southern coast (i.e., Hoya Honda, Las Trichilias, CORCO and Yauco Landfill) of Puerto Rico (Monsecur, USFWS, personal observations 2006-2016). Climate change is predicted to increase the frequency and strength of tropical storms, but also cause severe droughts (Hopkinson et al. 2008). The vulnerability of species to climate change is a function of sensitivity to changes and exposure to those changes, and the adaptive capacity of the species (Glick et al. 2011). It is unlikely that small populations with little or no recruitment withstand the anticipated impacts of climate change and the shift in vegetation communities. Climate change may also compromise natural recruitment by affecting the establishment and survival of seedlings (USFWS 2017).

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

1. populations known to occur on privately owned land are placed under protective status (USFWS, 1994).
2. an agreement between the Service and the U.S. Army concerning the protection of the species on their land (Fort Buchanan) has been prepared and implemented (USFWS, 1994).
3. mechanisms for protection of palo de rosa have been incorporated into management plans (currently not existing for all forests) for the Maricao, Guanica, Susua, and Cambalache Commonwealth Forests. Given the recent discovery of additional populations, priority should be given to the enhancement and protection of existing populations in protected areas and the protection of privately owned sites (USFWS, 1994).

Recovery Actions:

- Protect habitat, through acquisition or conservation easements, for existing privately owned populations, and through the development of management plans for the species where it occurs on Federal or Commonwealth land (USFWS, 1994).
- Monitor known populations and continue to search for additional ones (USFWS, 1994).
- Continue to conduct research on the life history of the species and evaluate the necessity and feasibility of propagation (USFWS, 1994).
- If determined to be necessary and feasible, conduct propagation and enhance existing populations or establish new ones (USFWS, 1994).

- The recovery of palo de rosa should focus on the protection of known key populations that show evidence of natural recruitment. Protections may include the development of conservation easements with private landowners (USFWS 2017).
- Develop a refined GIS model is needed to identify remnants of pristine forest or old secondary forest areas along the northern karst belt that may harbor the species. Surveying those areas may result in the finding of additional populations of palo de rosa, and may also be used to identify areas for the reintroduction of the species (USFWS 2017).
- The populations that are actively reproducing need to be monitored for seed collection for propagation purposes. A species-specific seed collection protocol should be developed to avoid altering its natural recruitment, and to ensure that any propagation effort addresses the populations genetic variability and the species recovery (USFWS 2017).
- Since palo de rosa seems to require a long period for the establishment of seedlings and developing into an adult tree, it is recommended that all planted individuals are pennanently tagged and monitored for their survival (USFWS 2017).

Conservation Measures and Best Management Practices:

- Cooperative Agreements (USFWS, 1994)

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SPECIES ACCOUNT: *Oxypolis canbyi* (Canby's dropwort)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 2/25/1986

Physical Description

A perennial herb with strong, fleshy rhizomes. Plants have slender stems, often more than 1 m tall. Leaves are thin and quill-like. Herbage smells slightly of dill. From mid-August to October the plants bear compound clusters of small white flowers (sometimes tinged with red) (NatureServe, 2015).

Taxonomy

Molecular and morphological studies have shown evidence that the genus *Oxypolis* as currently circumscribed, including compound-leaved and rachis-leaved species, is not monophyletic: the rachis-leaved species of *Oxypolis* (which include *O. canbyi*) are transferred to their own genus, *Tiedemannia* (Feist and Downie 2008 and Feist et al. 2012) (NatureServe, 2015).

Historical Range

See Current

Current Range

Native to the coastal plain, from southwestern Georgia through South Carolina to southeastern North Carolina (mostly in the middle and inner Coastal Plain), and from eastern MD to (historically) Delaware (Weakley 2008). (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Existing populations of *Oxypolis canbyi* are maintained mainly through asexual reproduction. This species is strongly clonal, reproducing vegetatively by means of stoloniferous rhizomes. Stems also become decumbent and root at the nodes, especially in drier sites where there is little or no water to support the stems. The flowers can be either unisexual or bisexual. Bisexual flowers may facilitate some self-pollination; however, the flowers are protandrous, which is indicative of some degree of outcrossing.; Existing populations of *O. canbyi* are maintained mainly through asexual reproduction. This species is strongly "clonalizing," reproducing vegetatively by means of stoloniferous rhizomes. Stems also become decumbent and root at the nodes, especially in drier sites where there is little or no water to support the stems. Perfect (bisexual) flowers are produced which may result in some self-pollination; however, the flowers are protandrous which may ensure some degree of outcrossing. The potential for outcrossing may be higher in those umbels which produce inner male flowers and outer female flowers. Outcrossing results in increased recombination and heterozygosity, thereby ensuring increased evolutionary potential. Sexual reproduction theoretically should act

as a sort of evolutionary buffer enabling the species to survive environmental changes. This may not be the case in *O. canbyi* due to a possible high selfing rate and/or the isolation of small populations. Predation by the caterpillar of the black swallowtail butterfly (*Papilio polyxenes asterius*) may be a factor in reducing the sexual reproductive potential of *O. canbyi*. This caterpillar chews through the stems just below the inflorescence (NatureServe, 2015).

Habitat Type

Adult: Coastal Plains (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from NatureServe, 2015)

Site Fidelity

Adult: Moderate (inferred from NatureServe, 2015)

Habitat Narrative

Adult: *O. canbyi* has been found in a variety of Coastal Plain habitats prone to long periods of inundation, including pond cypress ponds, grass-sedge dominated Carolina bays, wet pine savannahs, shallow pineland ponds and cypress-pine swamps or sloughs. The largest and most vigorous populations reported occur in open bays or ponds which are flooded throughout most of the year and which have little or no canopy cover. Many sites are on a sandy loam or loam soil which is underlain by a clay layer. Based on county soil surveys, known soil types which support populations of *O. canbyi* include Rembert loam, Portsmouth loam, McColl loam, Grady loam, Coxville fine sandy loam, and Rains sandy loam. These soil types are similar in that they have a medium to high organic content, high water table, and are deep, poorly drained, and acidic. Historically, fire was a key element maintaining the open nature of the habitat at many *O. canbyi* sites. The following species are frequently found associated with *O. canbyi*: *Ilex myrtifolia*, *Nyssa biflora*, *Taxodium ascendens*, *Pinus serotina*, *Stillingia aquatica*, *Rhynchospora tracyi*, *R. inundata*, *Manisuris rugosa*, *Rhexia aristosa*, *Polygala cymosa*, *Pluchea rosea*, *Lobelia boykinii* and *Hypericum denticulatum* (NatureServe, 2015). Moderate ecological integrity of the community, tolerance ranges and site fidelity are inferred based on the variety of habitat in which the species can be found.

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: The vectors of seed dispersal are not well understood, but at least some seed dispersal is by wind (USFWS, 1990).

Population Information and Trends**Population Trends:**

Decreasing (NatureServe, 2015)

Resiliency:

Moderate (inferred from NatureServe, 2015)

Representation:

Moderate (inferred from NatureServe, 2015)

Redundancy:

Moderate (inferred from NatureServe, 2015)

Number of Populations:

21 - 80 (NatureServe, 2015)

Population Size:

10,000 - 100,000 total individuals (NatureServe, 2015)

Population Narrative:

Specific habitat requirements; vulnerable to succession if hydrology and/or fire regime changes. Habitat for this species has declined significantly from historical levels. For example, in South Carolina over 90% of Carolina Bays over 1.2 ha in size are believed to have been ditched or destroyed (Glitzenstein no date). The few known extirpated populations are presumed or known to have been destroyed by habitat loss or modification (USFWS no date); for example, at least one Georgia occurrence was destroyed by urbanization, and another was likely destroyed by agricultural development. In Georgia, at least three occurrences have "thousands" of plants, and at least four more have several hundred to a thousand; others are smaller (25-250) or of unknown size. In South Carolina, one occurrence is described as "extremely large", three others as "very large", and one additional as "fairly large"; remaining occurrences are described as "good size", "fair size", or "small", or are of unknown size. The Maryland occurrence fluctuated between 14 and 82 plants over nine years of detailed monitoring. The North Carolina occurrence has had very few plants (e.g., 2 individuals) observed in recent years, although it was larger in the past. Approximately 40 occurrences are believed extant, mostly in South Carolina and Georgia (North Carolina and Maryland have 1 occurrence each). An additional 16 occurrences are ranked "failed to find," "historical," or "unknown." (NatureServe, 2015). NatureServe (2015) also notes that the short-term trend is a decline of 10-50%. Moderate redundancy, resiliency and representation are inferred based on the number of populations and individuals as well as the relatively wide geographical region that populations of this species occur.

Threats and Stressors

Stressor: Wetland draining (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The most significant threat to Canby' dropwort is the direct loss or alteration of its rare wetland habitat. Ditching and draining of wetland areas, primarily for agriculture and silviculture, have reduced the frequency, depth and duration of surface water, lowered the groundwater table, and changed the vegetative composition in many areas of the mid-Atlantic coastal plain where the species historically occurred. Reducing surface water, changing soil moisture levels and lowering of the water table enables other plants to become established, modifies vegetative succession, and makes sites less conducive overall to the plant's growth and reproduction (Murdock and Rayner 1990). As a result, many sites have been invaded by shrubs

and some sites have been planted in pine. Other sites have been dredged thus breaking the clay hardpan and draining the wetland (Murdock and Rayner 1990, Gaddy 2006) (USFWS, 2015).

Stressor: Fire suppression (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: On sites that are not actively disturbed by logging, ditching or dredging, habitat management is often needed to prevent encroachment of shrubs or trees that increase evapotranspiration, lower the water table and shade out Canby's dropwort. Periodic fires probably limited this encroachment under natural conditions but many sites are no longer surrounded by pine forest subject to regular fires and few sites are managed with prescribed burning. An example is the Big Cypress Meadow which is owned by The Nature Conservancy and is the only site in North Carolina. Young trees, shrubs and maidencane have invaded much of the meadow and the number of Canby's dropwort has declined from as many as 10,000 plants in 1986 to only a few plants in recent years and none in 2006 (Gaddy 2006) (USFWS, 2015).

Stressor: Predation (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of plants

Narrative: Black swallowtail butterfly, grasshoppers, rabbits and rodents have all been known to damage/eat these plants (USFWS, 2015).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: There is currently little regulatory protection of Canby's dropwort habitat. The U.S. Army Corps of Engineers (Corps) generally does not regulate dredge and fill activities in isolated wetlands because of a 2001 U.S. Supreme Court opinion. The 2001 opinion was issued in the Solid Waste Agency of Northern Cook County (SWANCC) v. the U.S. Army Corps of Engineers et al. and ruled in favor of SWANCC. The Corps' requirement for a Clean Water Act Section 404 permit to fill isolated wetlands to construct a landfill was overturned. The Corps had asserted jurisdiction on the isolated intrastate waters based solely on use by migratory birds (Findlaw 2007). Since that ruling isolated wetlands are generally not considered jurisdictional by the Corps. Therefore, there is no Federal nexus and consultation under section 7 of the Endangered Species Act is not required. Because Canby's dropwort grows only in isolated wetlands, there is currently no Federal regulatory control of actions that would affect its habitat. In South Carolina and Georgia, where almost all Canby's dropwort populations occur, there are no State laws that protect the isolated wetlands that provide Canby's dropwort habitat. Maryland and North Carolina, with one Canby's dropwort population each, do regulate isolated wetlands and therefore offer some protection to the habitat (Maryland Department of the Environment 2010, North Carolina Department of Environment and Natural Resources 2010). The Endangered Species Act prohibits the taking of endangered plants from Federal lands without a permit and regulates trade of listed plants. In addition, the Endangered Species Act prohibits the malicious damage or destruction of plants on Federal lands; and, their removal, cutting, digging, damaging, or destroying in knowing violation of any state law or regulation, including criminal trespass law.

The State of Maryland prohibits taking of the species from private property without the landowner's permission and from State property without a permit and regulates trade in the species (Code of Maryland regulations 08.03.08). The State of North Carolina prohibits taking of the plant without a permit and the landowner's permission and regulates trade (North Carolina General Statute 19-B, 202.12-202.19). The State of Georgia prohibits digging, removal, or sale of State listed plants from public lands without the approval of the State management authority, and regulates sale or transport of State listed plants from private property (Georgia Wildflower Preservation Act of 1973). The State of South Carolina does not have any regulations that protect endangered plants on private land. However, regulations prohibit the unauthorized taking of plants from South Carolina Heritage Preserves and State Parks (South Carolina Code of Laws: Sections 50-11-2200, 50-11-2210, and 51-3-140) (USFWS, 2015).

Recovery

Delisting Criteria:

Canby's dropwort (*Oxypolis canbyi*) will be considered for delisting when there are at least 19 self-sustaining populations in existence that are protected to such a degree that the species no longer qualifies for protection under the Endangered Species Act (see criteria below). A self-sustaining population is a reproducing population that is large enough to maintain sufficient genetic variation to enable it to survive and respond to natural habitat changes. The number of individuals necessary and the quantity and quality of habitat needed to meet this criterion will be determined as one of the recovery tasks. The populations should be distributed throughout the species' historic range. This recovery objective is considered an interim goal because of the lack of data on biology and management requirements of the species. As new information is acquired, the estimate of self-sustaining populations required for the species' survival may be readjusted. The recovery objective for *O. canbyi* will be reassessed at least annually in light of any new information that becomes available (USFWS, 1990).

Conservation Measures and Best Management Practices:

- Conduct surveys and habitat assessments at all surveyed sites by Gaddy (2006) that are not routinely monitored to determine the species presence and to assess habitat quality (USFWS, 2015).
- Protect known Canby's dropwort populations on private lands with conservation easements or Wetland Reserve Program easements (USFWS, 2015).
- Assess moribund and extirpated sites as well as other isolated wetlands for suitable habitat and resource availability (USFWS, 2015).
- Improve our understanding of the relationship between precipitation (and other parameters) and Canby's dropwort population viability (USFWS, 2015).
- Determine objective, quantitative criteria for self-sustaining populations (USFWS, 2015).
- For populations confined within roadside or powerline right-of-ways, promote management actions that shift Canby's dropwort populations away from right-of-ways and towards the interior of adjacent wetlands (USFWS, 2015).
- Conduct demographic studies that further examine genetic variability, population structures, reproduction, and indeterminate growth factors (USFWS, 2015).

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SPECIES ACCOUNT: *Oxytheca parishii* var. *goodmaniana* (Cushenbury oxytheca)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An annual herb with a small basal rosette of leaves and leafless, wiry stems, mostly 0.5-3 dm tall. Flowers (May-September) are white, pink, or greenish, borne in clusters of 3-12, with each cluster subtended by a funnel-shaped, long-awned involucre. (NatureServe, 2015)

Taxonomy

At the time of listing, Cushenbury oxytheca was recognized as *Oxytheca parishii* var. *goodmaniana* first described by Ertter (1980, p. 90). Ertter recognized *O. parishii* as so distinct as to warrant its own section of the genus, *Acanthoscyphus*. An analysis of molecular as well as morphological data have shown that the sections recognized by Ertter (1980, pp. 70–102) are distinct from each other and in fact are more closely related to other taxa in the *Eriogonoideae* subfamily of the *Polygonaceae* (buckwheat family) than to each other (Pant 2000, pp. 1–94). In reviewing the taxonomic and nomenclatural status of the *Eriogonoideae*, Reveal (2004, p. 144) published names for the taxa found to be distinct from *Oxytheca* by Pant (2000, pp. 1–94). This systematic treatment was followed by Reveal (2005, p. 438) in his contribution to the *Flora of North America* and will be followed in the upcoming revision of the *Jepson Manual Higher Plants of California*. The name now recognized for Cushenbury oxytheca is *Acanthoscyphus parishii* (Parry) Small var. *goodmaniana* (Ertter) Reveal. The name change in no way changes the description or range of the taxon. The common name for the taxon will likewise remain the same. Based on Service convention and the need for continuity with the history of this taxon, 50 CFR 17.12 will be revised to read as follows “*Acanthoscyphus* (*Oxytheca*) *parishii* var. *goodmaniana*” (USFWS, 2009).

Historical Range

See Current

Current Range

Restricted to a carbonate belt in the northeastern San Bernardino Mountains extending from White Mountain in the west to at least Terrace Springs in the east; from Terrace Springs to Rattlesnake Canyon, var. *goodmaniana* occurs with var. *cienengensis* and some morphological intermediates (potential hybrids) between the two (USFWS 2002). Distribution includes occurrences near Cushenbury Spring; Cushenbury, Marble, Arctic, Wild Rose, and Furnace Canyons; Blackhawk, Mineral, and Tip Top Mountains; Terrace Springs; Rose Mine and Green Lead gold mine (USFWS 2002). Range occurs in and adjacent to San Bernardino National Forest; San Bernardino County, California; using GIS tools, range extent was calculated to be approximately 165 square km. (NatureServe, 2015)

Critical Habitat Designated

Yes; 12/24/2002.

Legal Description

On December 24, 2002, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Oxytheca parishii* var. *goodmaniana* (Cushenbury oxytheca) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in California (67 FR 78570-78610).

Critical Habitat Designation

The critical habitat designation for *Oxytheca parishii* var. *goodmaniana* includes one CHU (29 subunits) in San Bernardino County, California (67 FR 78570-78610).

Northeastern Slope Unit, San Bernardino County, California. (i) From USGS 1:24,000 quadrangle maps Butler Peak, Fawnskin, Big Bear City, Rattlesnake Canyon, and Onyx Peak, California.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Oxytheca parishii* var. *goodmaniana* critical habitat consists of three components (67 FR 78570-78610):

(i) Soils derived primarily from upslope limestone, a mixture of limestone and dolomite, or limestone talus substrates with parent materials that include Bird Spring Formation, Bonanza King Formation, middle and lower members of the Monte Cristo Limestone, and the Crystal Pass member of the Sultan Limestone Formation at elevations between 1,440 and 2,372 m (4,724 and 7,782 ft);

(ii) Soils with intact, natural surfaces that have not been substantially altered by land use activities (e.g., graded, excavated, recontoured, or otherwise altered by grounddisturbing equipment); and

(iii) Associated plant communities that have areas with a moderately open canopy cover (generally between 25 and 53 percent (Neel 2000)).

Special Management Considerations or Protections

The SBNF is planning a revision of their Resource Management Plan in the near future that, among other functions, would provide conservation benefits to the two carbonate plant species and their habitat in this unit. These lands, however, currently do not have approved management provisions for the carbonate plants and their habitat, and habitat degradation may still be occurring due to ongoing activities identified in the final listing rule for these species (see USFWS 2001b). Therefore, the subject lands continue to require special management and protection to ensure the conservation of these species and their habitat. The core occurrences of the two carbonate plants in this unit are important as potential sources for the colonization events (e.g., seed dispersal) necessary to maintain the natural population dynamics of the species. Every carbonate plant occurrence in this unit is important as a seed source to colonize unoccupied sites and therefore maintain an equilibrium between local colonization and extirpation events. Every carbonate plant occurrence in this unit potentially provides important genetic material through pollen and seed dispersal which may help maintain genetic diversity and reduce the likelihood of regional extirpation events.

Life History

Food/Nutrient Resources**Breeding Season**

Adult: May through June is the flowering season (USFWS, 1997).

Reproduction Narrative

Adult: May through June is the flowering season (USFWS, 1997).

Habitat Type

Adult: Talus slopes (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species occurs on gentle talus slopes (approximately 10-25 degrees) with no apparent aspect preference. Typically found on soils derived from limestone, dolomite, or a mixture of limestone and dolomite; occupied habitat is mostly correlated with the Bird Springs Formation, Bonanza King Formation, Monte Cristo Limestone, and Sultan Limestone, and Crystal Pass substrate. Plant communities include singleleaf pinyon- Utah juniper woodland, singleleaf pinyon-mountain juniper woodland, singleleaf pinyon woodland, and canyon live oak woodland. Associated species include *Cercocarpus ledifolius* (Curl-Leaf Mountain-Mahogany), *Arctostaphylos glauca* (Big-Berry Manzanita), *Chrysothamnus viscidiflorus* (Green Rabbitbrush), and *Achnatherum coronatum* (Giant Rice Grass). 1440 - 2370 m. (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the species unique habitat requirements and low number of known populations.

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Seed dispersal mechanisms need to be studied (USFWS, 2009).

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Low (inferred from NatureServe, 2015)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

6 - 20 (NatureServe, 2015)

Population Size:

2500 - 100,000 individuals (NatureServe, 2015)

Population Narrative:

May have 20,000 - 35,000 individuals in some years. However, because this taxon is an annual, the number and distribution pattern of individuals fluctuates greatly from year to year, depending on winter and spring rainfall and temperatures during the seed germination and seedling establishment season (USFWS 2002). Approximately 14 occurrences are believed extant, with another 1 historical and 1 of unknown status, when mapped using the separation distance of the California Natural Diversity Database (CNDDB). Other reports, using a much smaller separation distance, have broken the total population into a smaller number of "patches" (e.g. 93 patches reported by SBNF cited in USFWS 2002) (NatureServe, 2015). Low resiliency, representation and redundancy are inferred based on the low number of known population and the limited geography in which this species is found.

Threats and Stressors

Stressor: Off-highway vehicle (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: The final listing rule indicated off-road vehicle use and energy development projects were a threat to Cushenbury oxytheca and its habitat. Such activities could impact the species' habitat through ground disturbance or dust creation. About 7 acres (3 hectares) of occupied habitat and 36 acres (15 hectares) of designated critical habitat for Cushenbury oxytheca overlap with roads and motorized vehicle trails (USFWS 2005a, p. 267). The San Bernardino National Forest closed road 3N77 and placed signs and barriers on the other roads (USFWS 2001, p. 18), which should limit impacts due to off-road vehicle use. Additionally, road 3N11A is proposed for decommissioning, and roads 3N03D, 3N54, 3N88, and 3N88B are proposed for reclassification as administrative use only (USFWS 2009, p. 2), which should reduce vehicle activity in the area and further reduce the threat to the species (USFWS, 2009).

Stressor: Hydroelectric project (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: We are unaware of any energy development projects occurring since listing that affect Cushenbury oxytheca (USFWS, 2009).

Stressor: Mining (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Mining activity remains the primary threat for Cushenbury oxytheca (USFWS 2005a, p. 246). Mining activities can impact habitat for the plants through the removal of mined materials, disposal of overburden, and road construction (USFWS, 2009).

Stressor: Dust/artificial lighting (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Other impacts to the plants are associated with dust and artificial lighting (USFWS 1997, pp. 13, 15–18). Dust can affect Cushenbury oxytheca's habitat by altering soil chemistry and light penetration into seedbanks (USFWS 1997, pp. 17-18). Artificial lighting may affect Cushenbury oxytheca's growing conditions by altering the photoperiod response or the behavior of pollinators or seed dispersers (USFWS 1997, p. 18) (USFWS, 2009).

Stressor: Recreational activities (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Several threats such as dispersed target shooting, dispersed camping areas, fuelwood collection, and fire suppression activities have been identified since listing (USFWS 2001, pp. 4–11). These activities can result in trampling of Cushenbury oxytheca and can impact its habitat through ground disturbance or dust creation (USFWS, 2009).

Stressor: Predation (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: The threat of predation from burro grazing was identified after listing (USFWS 2001). However, burros are expected to have minimal effects to Cushenbury oxytheca due to the low numbers of burros present (about 60), the dispersal of the burros across a large area, the burros preference for wetter habitats, and the short stature and scarce nature of carbonate plants, which makes foraging on them unlikely (USFWS 2001, p. 39) (USFWS, 2009).

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: While both CEQA and NEPA may provide some discretionary conservation benefit to Cushenbury oxytheca, the Act is the primary regulatory mechanism mandating Cushenbury oxytheca conservation. With the majority of suitable and occupied habitat on U.S. Forest Service lands (Figure 1), the Act remains the primary regulatory mechanism for ensuring that Cushenbury

oxytheca is addressed during planning efforts for land management actions potentially affecting this species (USFWS, 2009).

Stressor: Stochastic extinction (USFWS, 2009)

Exposure:

Response:

Consequence: Extinction

Narrative: The final rule indicates the risk of stochastic extinction of Cushenbury oxytheca resulting from random events was considered high due to the low numbers of plants (USFWS 1994, p. 43662). Because this species is restricted to certain, limited soils, it is likely that its population has always been small. Despite this, the population has persisted. This suggests even though the magnitude of this threat may be high, its immediacy is low. However, the potential for stochastic extinction could be increased by habitat loss, fragmentation, and drought. Habitat fragmentation can result in areas too limited and isolated to support pollinators or other seed dispersal agents (USFWS 1997, p. 16).

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Cushenbury oxytheca is endemic to isolated occurrences of particular carbonate soils in the San Bernardino Mountains. Therefore, any combination of environmental conditions, such as those attributed to climate change above, that force an upward shift in the distribution of the species, poses a profound threat to the taxon's persistence and recovery. If this species is affected by elevational shifts resulting from climate change, then there will be no suitable habitat when the elevational range exceeds the species' maximum elevation. As this occurs, the density and distribution may concentrate the species into a smaller area. This, in turn, may make the species even more susceptible to stochastic extinction. To date, no species-specific monitoring has been conducted to detect an elevational shift in its range (USFWS, 2009).

Recovery

Reclassification Criteria:

The priority ranked habitat areas have been protected. Priority for protection shall be determined according but not limited to: 1) population size; 2) habitat quality; 3) manageability/defensibility of site; and 4) connectivity. The initial preserve area should be 5,000 acres (2,000 hectares) based on known areas occupied by the plants and should include protection for the threatened species, *Erigeron parishii* (which is discussed separately under the delisting objective and criteria). Priority areas and populations include, but are not limited to, the following: 1) Sites within the White Mountain Management Unit; 2) populations just north/northeast of Hitchcock Spring; 3) upper Crystal Creek Drainage; 4) Upper Furnace Canyon and prioritized populations in the lower Furnace Canyon area; 5) populations just north of Holcomb Valley; 6) Arctic Canyon; 7) Marble Canyon; 8) Bertha Ridge and slopes to Big Bear Lake; 9) Monarch Flats and northern slopes; 10) eastern and western slopes of Cushenbury Canyon including the vicinity of Whiskey Springs; 11) Burnt Flat; 12) Blackhawk Mountain and slopes; 13) Round Mountain; 14) Grapevine Creek; 15) Top Spring/Lone Valley/Squirrel Spring; 16) Granite Spring; 17) Arrastre Creek/Rose Mine Valley; 18) Rattlesnake Canyon; 19) Sugarlump/Sugarloaf Mountain; and 20) the outlying populations of *Erigeron parishii* in the Little

San Bernardino Mountains. The species and ecosystem-level attributes of these priority areas make them necessary for the survival and recovery of these species. Taxonomic assessment of the eastern populations of *Oxytheca parishii* var. *goodmaniana* may affect the recovery priority and reserve needs of this variety. To count toward reclassification of the plants, reserves must have been designed to minimize or eliminate indirect threats due to adjacent land uses. This includes protection of carbonate plant habitat from human disturbance to hydrology, soil integrity, fire ecology, habitat microclimates, and light regimes. Appropriate management and restorative measures should reduce habitat-degrading effects such as surface disturbances, windblown sediments, fugitive night lighting, and off-highway vehicle use (USFWS, 2009).

Protect additional lands needed to complete otherwise isolated reserves, to protect new populations that may be discovered in the future, and to provide strategic buffer zones and potential population reintroduction and/or expansion areas. The interim estimate of additional lands needed to secure habitat connectivity, buffers, and natural community context is 4,600 acres (1,860 hectares), including lands to meet Delisting Criterion #2 for *Erigeron parishii*. This figure may be further refined as additional information becomes available (USFWS, 2009).

Adaptive population monitoring/adaptive management programs must be functioning so that early detection is assured for any population instability or other problems in the reserve system. Studies will have shown whether there is a need for reintroductions and/or augmentations of existing populations. Research results to support adaptive management will be available, including at least preliminary results on pollination ecology, seed dispersal mechanisms, population dynamics, microclimate effects of vegetation removal/bare areas, seedbank dynamics, and fire ecology (USFWS, 2009).

Delisting Criteria:

The reserve system designed to allow downlisting is intended to suffice for delisting, provided that monitoring and research demonstrate that the reserves work as planned to remove the threats identified during the listing process. As monitoring and research results become available, delisting criteria will be established (USFWS, 2009).

Recovery Actions:

- **Reclassification:** This criterion implicitly addresses listing Factors A (habitat loss) and E (stochastic events). The U.S. Forest Service and Bureau of Land Management have partnered to develop the Carbonate Habitat Management Strategy. The goals of the Carbonate Habitat Management Strategy are to: 1) protect the listed plants and the habitat components they require; 2) guide impact minimization and compensation for unavoidable impacts; 3) streamline reviews of mining activities in carbonate plant habitat; 4) guide habitat restoration; and 5) plan and provide for long-term needs of both the mining industry and listed species conservation. One of the primary goals of the Carbonate Habitat Management Strategy is the establishment of conservation areas for carbonate plants. The Carbonate Habitat Management Strategy provides parameters for allowing mining while ensuring the protection of listed carbonate plant species in perpetuity through the establishment of habitat reserves. The Service provided a programmatic nonjeopardy and no adverse modification biological opinion on May 2, 2005, for the Carbonate Habitat Management Strategy regarding potential effects to Cushenbury oxytheca and other federally listed carbonate plant species. Upon successful implementation of the Carbonate Habitat Management Strategy, habitat preservation will meet or exceed Downlisting

Criterion #1 (USFWS 2005a, p. 247). This includes preservation of at least 425 acres (172 hectares) (82 percent) of occupied habitat and 2,157 acres (873 hectares) (69 percent) of designated critical habitat for Cushenbury oxytheca (USFWS 2005b, pp. 24 and 27). However, the Carbonate Habitat Management Strategy is a programmatic strategy to allow mining and protect carbonate plants; participation by mining interests is voluntary. The reserve system under the Carbonate Habitat Management Strategy is not yet developed and future projects may or may not be implemented under the provisions of the Carbonate Habitat Management Strategy. This criterion has not been met at this time (USFWS, 2009). Delisting: As documented above, a reserve system is planned, but not established. Thus, the necessary monitoring and research associated with the reserve has not been completed. This criterion has not been met at this time (USFWS, 2009).

- Reclassification: This criterion implicitly addresses listing Factors A (habitat loss) and E (stochastic events). In addition to the protection of occupied areas, the Carbonate Habitat Management Strategy provides for the conservation of suitable habitat including about 14,709 acres (5,953 hectares) for Cushenbury oxytheca (USFWS 2005b, p. 28). Because the Carbonate Habitat Management Strategy is only a programmatic strategy, these lands are not yet conserved. This criterion has not been met at this time (USFWS, 2009).
- Reclassification: This criterion addresses listing Factors A (habitat loss) and E (stochastic events). Because the reserve system is not yet in place, this criterion is not yet applicable. Further, focused research on pollination ecology, seed dispersal mechanisms, population dynamics, microclimate effects of vegetation removal/bare areas, seedbank dynamics, and fire ecology of Cushenbury oxytheca has not yet occurred. This criterion has not been met at this time (USFWS, 2009).

Conservation Measures and Best Management Practices:

- Finalize Recovery Plan: Prepare a new threats-based recovery plan specific to Cushenbury oxytheca that identifies a recovery strategy, objectives, and criteria for reclassification to threatened, objectives and specific criteria for removal from the list of endangered and threatened species, and prioritizes recovery actions. In the interim, seek implementation of elements of the Carbonate Habitat Conservation Strategy that have direct benefit to the conservation of Cushenbury oxytheca (USFWS, 2009).
- Monitor Existing Populations: Work with the San Bernardino National Forest to conduct systematic monitoring of Cushenbury oxytheca throughout known and potentially occupied sites as necessary to track the status of the species and identify management priorities. There is a need to continue to obtain quantitative information regarding the status of this species to evaluate the effectiveness of conservation efforts over time, especially in light of potential effects associated with global climate change (USFWS, 2009).
- Management of Occupied Cushenbury Oxytheca Habitat: Work with partners, such as the San Bernardino National Forest, to help conserve Cushenbury oxytheca by identifying opportunities to:
 - a) Continue monitoring programs for the effectiveness of measures to protect Cushenbury oxytheca from recreational activities and make adjustments to signs, barriers, and roads as necessary.
 - b) Avoid new developments in or near Cushenbury oxytheca habitat (USFWS, 2009).

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SPECIES ACCOUNT: *Oxytropis campestris* var. *chartacea* (Fassett's locoweed)

Species Taxonomic and Listing Information

Listing Status: Threatened 09/28/1988; Great Lakes-Big Rivers Region (R3) (USFWS, 2015)

Physical Description

A perennial herb with compound leaves and with herbage that is covered with dense, white-silky hairs, giving the plant a silvery-gray appearance. Spikes of rose-purple flowers, each about 2 cm long, bloom from late spring-early summer. (NatureServe, 2015)

Taxonomy

A distinct taxon. (NatureServe, 2015)

Historical Range

Historic populations in Bayfield and Waushara counties. (NatureServe, 2015)

Current Range

Restricted to small inland lakes at eight sites in central and northwestern Wisconsin: Waushara, Portage, and Bayfield counties. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 2013)

Lifespan

Adult: Mean 1-4 years; up to 14 years (USFWS, 2013)

Dependency on Other Individuals or Species

Adult: Pollinated by bees and butterflies (USFWS, 2013)

Breeding Season

Adult: Flowers primarily late May to mid-June (USFWS, 2013)

Reproduction Narrative

Adult: Fassett's locoweed blooms primarily at the end of May through mid-June, although occasional plants bloom as late as November (Tracy Feldman, pers. obs., 2009-2012). The mean lifespan of Fassett's locoweed appears to vary from 1-4 years depending upon the life stage, the lake from which data were used, and the year data were collected, but the maximum can range to potentially over 14 years (Tracy Feldman, pers. comm., 2013). Seed production is variable,

having the potential to vary from zero (even in a "reproductive" plant) to well over 10,000 seeds per plant, but actual numbers range from fairly low in small plants to several hundred (or even in the 1000s) of seeds for larger plants, on average (Tracy Feldman, pers. comm., 2012) (Feldman 2012). Data suggest that the seed banks on Plainfield and Pickerel Lakes are patchy but could be very large (Feldman 2010). While seed banks may be large, seed germination rates vary, and in the field germination rates may be low, from 50-95%; however, only 0-1% of intact seeds germinated in greenhouse and field germination experiments. Seeds appear to germinate in bands along the shoreline at some range of distances above the water line. (Feldman 2012) (USFWS, 2013)

Habitat Type

Adult: Palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Open gravelly lake (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Fluctuating lake levels (USFWS, 1991)

Spatial Arrangements of the Population

Adult: Pure stands to scattered individuals (USFWS, 1991)

Environmental Specificity

Adult: Narrow. Specialist with key requirements common. (NatureServe, 2015)

Site Fidelity

Adult: High (inferred from USFWS, 1991)

Habitat Narrative

Adult: Fassett's locoweed occurs on sandy or gravelly shorelines of small landlocked seepage lakes. It is apparently intolerant of competition and shading and dependent on lake level fluctuations to eliminate competition and maintain an open habitat. (NatureServe, 2015) In all cases, Fassett's locoweed occurs in areas which are completely exposed to sunlight or receive only partial shade from other species. Particularly along the open shorelines but also throughout the sandy lakeside habitat, the soil surface is subjected to extreme temperature fluctuations, high solar radiation, strong winds, and soil moisture stress. However, it is in these areas, where competition from other plant species appears to be very low, that Fassett's locoweed occurs in the densest colonies. (USFWS, 1991)

Dispersal/Migration**Dispersal**

Adult: Low (USFWS, 1991)

Dispersal/Migration Narrative

Adult: The mature fruits release numerous, small black seeds which have no evident adaptation for dispersal. As in many other plant species (Harper 1977, Johnson and Anderson 1986), the seeds of Fassett's locoweed probably tend to disperse in a clumped pattern around the parent

plant. However, they may be moved short distances by wind, rain, or lake water during periods of inundation. (USFWS, 1991)

Population Information and Trends

Population Trends:

Fluctuating, but apparently increasing (USFWS, 2013)

Species Trends:

Fluctuating, but apparently increasing (USFWS, 2013)

Resiliency:

Moderate (inferred from USFWS, 2013)

Representation:

Low (inferred from USFWS, 2013)

Redundancy:

Moderate (inferred from USFWS, 2013)

Population Growth Rate:

Fluctuating (USFWS, 2013)

Number of Populations:

10 (USFWS, 2013)

Population Size:

Approximately 190,000 in 2012 (USFWS, 2013)

Adaptability:

Low (USFWS, 2013)

Population Narrative:

Of the 10 lakes that support Fassett's locoweed, the plant currently occurs in highest numbers (thousands) at four lakes; Pigeon, Mountain, Plainfield, and Pickerel lakes. Populations of Fassett's locoweed have fluctuated considerably over time. From 2009 to 2012, populations at Plainfield and Pickerel lakes have been stable or increasing due to increases in the number of seedlings (in the thousands) and small plants, most of which do not survive long enough to reproduce (Feldman 2009, 2010, 2011, 2012). Numbers of reproductive plants have decreased over the last four years at these two lakes. Predictions using projection matrix population models indicate that these populations have the potential to decrease in the near future (Feldman 2012). Up to 2000 plants were observed at Second Lake from 2006-2008, however the current population level is unknown. Populations number in the hundreds at Weymouth and Sherman (Marks) lakes. Very small populations (30 plants or less) have been consistently recorded at Lake Huron, Deer Print Lake, and Wolf Lake. (USFWS, 2013) Fluctuations in water levels maintain habitat but also determine population size from year to year. In one year, unusually high water levels may reduce populations to only a few plants and in the next year, lower water levels may result in thousands of plants (USFWS 2009). (NatureServe, 2015)

Threats and Stressors

Stressor: Development (USFWS, 1991; 2013)

Exposure:

Response:

Consequence:

Narrative: Development, primarily construction of homes and cottages, was considered a significant threat in the Recovery Plan (USFWS, 1991). This threat has been reduced through acquisition of locoweed sites, conservation education and agreements, protective signage, designation of State Natural Areas which are managed to protect and maintain native landscapes. Residential development is still an issue for the Lake Huron site, although many homeowners at this site are caging plants, distributing information and occasionally pulling invasive weeds. (USFWS, 2013)

Stressor: Human impacts (USFWS, 1991; 2013)

Exposure:

Response:

Consequence:

Narrative: A county boat ramp on Pickerel Lake is a threat, along with fishing and swimming. A summer camp is also on this lake. In the past, Fassett's locoweed areas on camp property had been roped off (Darcy Kind, pers. comm., 2012), however no ropes were in place as of at least 2009. ATV use and hiking may trample plants. (USFWS, 1991; 2013)

Stressor: Other vegetation (USFWS, 1991; 2013)

Exposure:

Response:

Consequence:

Narrative: Invasive plants, such as the non-native sweet clover can spread readily in open areas. It is considered a threat to recovering prairies, because it may compete with native species for resources or otherwise alter the edaphic conditions of the plant community (Eckardt 1987). The invasive orange hawkweed is quite abundant a few meters above the high waterline and grows in association with Fassett's locoweed in that zone. This species is of concern because of its possible allelopathic properties and the potential impact on Fassett's locoweed (Waller 1989). Trees and other vegetation may grow sufficiently to block out sunlight required by the locoweed. (USFWS, 1991; 2013)

Stressor: Nutrient enrichment (USFWS, 1991; 2013)

Exposure:

Response:

Consequence:

Narrative: The Fassett's locoweed recovery plan (USFWS 1991) identified nutrient enrichment of shorelines supporting Fassett's locoweed resulting from run-off as a threat, as this may result in loss of habitat due to competition from other plant species that would not typically be able to compete with Fassett's locoweed in its nutrient poor habitat. (USFWS, 2013)

Stressor: Reduced groundwater levels (USFWS, 2013)

Exposure:

Response:**Consequence:**

Narrative: Fassett's locoweed is found on sandy-gravel lakeshores of seepage lakes, fed by groundwater, with fluctuating lake levels. Fluctuating lake levels are critical in maintaining suitable open shoreline habitat for the species. Aggressive plant competitors may be eliminated during periods of high water. Fluctuating water levels also help maintain low substrate fertility (preferred by the species) and distribute seeds within the site. The amount of available habitat at each site depends on current and recent lake levels. Generally, lower lake levels expose more shoreline area which provides more suitable habitat for the species, resulting in higher population numbers, especially of seedlings. However, continued low water conditions may decrease habitat due to succession. High lake levels which eliminate shoreline habitat, generally reduce overall population numbers. In addition, water level fluctuations within seasons may cause mortality of plants through submersion or desiccation (Tracy Feldman, UW-SP, pers. comm., 2012.) Lake levels may be affected by the use of high capacity wells used for crop irrigation. (USFWS, 2013)

Stressor: Herbivory (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: Flowers have been eaten from a number of plants at one site, possibly by deer (WDNR, unpublished data). At Plainfield and Pickerel lakes in 2009-2012, Feldman observed racemes removed from Fassett's locoweed plants, potentially by deer. Insect herbivores may also affect Fassett's locoweed plants and seeds. At Plainfield and Pickerel lakes between 2009 and 2012, Tracy Feldman (UW-SP) observed caterpillars on racemes, spittlebugs on leaves, and occasional chewed leaves or racemes. At Pickerel Lake in 2012 he also observed holes in mature Fassett's locoweed fruits, reminiscent of weevil damage. (USFWS, 2013)

Stressor: Herbicides (USFWS, 1991; 2013)

Exposure:**Response:****Consequence:**

Narrative: Herbicide and pesticide use is heavy in the agricultural areas. In addition, many of the lakes with Fassett's locoweed are lined with residential properties and lawns. Problems are possible from spray drift or run-off onto Fassett's locoweed habitat. Any decrease in the protective wooded buffer around each lake could result in increased overland flow of sediment-laden run-off into the water. (USFWS, 1991) The threat from herbicides is ongoing. (USFWS, 1991; 2013)

Recovery**Delisting Criteria:**

Removal of Fassett's locoweed from the list of US. Endangered and Threatened Species will be considered when six populations are permanently protected and managed, and monitoring indicates the populations to be self-sustaining. (USFWS, 1991)

Recovery Actions:

- Protect and manage Fassett's locoweed at all sites with naturally-occurring populations. This includes the six extant [now 10 (USFWS, 2013)] populations as well as any new occurrences which might be found. Adequate protection will be accomplished not only through legal agreements with landowners but by increasing public awareness on the high-use lake shorelines. Education must be seen as integral to protection. (USFWS, 1991)
- Management to maintain appropriate habitat, including such activities as fencing populations in certain areas or removing invading, nonnative species, will be necessary at some sites. (USFWS, 1991)
- It is essential to conduct research which will contribute to recovery. Included here are seed bank research and genetic studies. (USFWS, 1991)
- Introduction of the species may become a future priority if protection of extant populations cannot be achieved. (USFWS, 1991)

Conservation Measures and Best Management Practices:

- Land protection and site monitoring (USFWS, 2013)
- Site protection (USFWS, 2013)
- Population monitoring at Plainfield and Pickerel lakes (USFWS, 2013)
- Population augmentation (USFWS, 2013)
- Searches for new sites and potential reintroductions (USFWS, 2013)
- Actions to address threats due to continued low lake levels (USFWS, 2013)
- Pollinator studies (USFWS, 2013)
- Seed storage (USFWS, 2013)
- Seed bank studies (USFWS, 2013)

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SPECIES ACCOUNT: *Packera franciscana* (San Francisco Peaks ragwort)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/22/1983; Southwest Region (Region 2) (USFWS, 1983)

Physical Description

A dwarf alpine perennial, 3.1-10.2 cm tall, with deeply lobed leaves; upper leaves smaller than lower leaves. Small yellow-gold flower heads, composed of 1-6 flowers. (NatureServe, 2015)

Taxonomy

The San Francisco Peaks ragwort was listed as *Senecio franciscanus*. (USFWS, 1983)

Historical Range

It is believed that the plant inhabits much of the same area it occupied when it was first described in 1884 (USDA 1987). (USFWS, 2010)

Current Range

Endemic to the San Francisco Peaks, a high altitude mountain range in Coconino County, northern Arizona; range about 4.44 sq km. (NatureServe, 2015)

Critical Habitat Designated

Yes; 11/22/1983.

Legal Description

On November 22, 1983, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Astragalus holmgreniorum* (Holmgren milk-vetch) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Arizona (48 FR 52743-52747).

Critical Habitat Designation

The critical habitat designation for *Astragalus holmgreniorum* includes one CHU in Coconino County, Arizona (48 FR 52743-52747).

Coconino County; Coconino National Forest, Agassiz Peak and Humphreys Peak, T22N, R7E, N½ of NW¼ Sec. 5; T23N, R7E, W½ Section 32 and W½ Section 29.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Astragalus holmgreniorum* critical habitat consists of one component (48 FR 52743-52747):

Primary constituent elements are the loose cinder talus slopes of the alpine tundra system of the San Francisco Peaks and the absence of disturbance and damage from hikers.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Primarily vegetative by rhizomes, but also sexual (NatureServe, 2015)

Breeding Season

Adult: August to mid-September (USFWS, 1987)

Reproduction Narrative

Adult: Reproduction is primarily vegetative by mat-forming rhizomes although sexual reproduction also occurs from matures achenes. (NatureServe, 2015)

Habitat Type

Adult: Scree/talus slopes (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Alpine tundra (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clustered (inferred from USFWS, 1987)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Site Fidelity

Adult: High (USFWS, 1987)

Habitat Narrative

Adult: The San Francisco Peaks groundsel occurs in alpine tundra areas on sparsely vegetated loose talus slopes, at 3350-3750 m. It is usually just above southwestern montane spruce-fir or bristlecone pine (*Pinus aristata*) forests. (NatureServe, 2015)

Dispersal/Migration**Dispersal**

Adult: Low (inferred from USFWS, 2010)

Dispersal/Migration Narrative

Adult: Personal observations indicate that the plant does occur in avalanche-disturbed areas and it is possible that these disturbances may allow for the plant to spread and/or take root in new areas. (USFWS, 2010)

Population Information and Trends**Population Trends:**

Stable (USFWS, 2010)

Species Trends:

Stable (USFWS, 2010)

Resiliency:

Low to moderate (inferred from USFWS, 2010)

Representation:

Low (USFWS, 2010)

Redundancy:

Low (inferred from USFWS, 2010)

Population Growth Rate:

Unknown (NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

At least 100,000 clones (USFWS, 2010)

Adaptability:

Low (USFWS, 2010)

Population Narrative:

This species appears to be reproductively healthy. (Boucher and Goodwin 1984, Holden et. al. 1984, Phillips and Peterson 1980). Fletcher (Boucher and Goodwin 1984, Holden et al. 1984) estimates that there are probably greater than 100,000 clones of San Francisco Peaks groundsel on the Peaks, and even this estimate may be lower. (USFWS, 1987) It is locally common in a small area. (NatureServe, 2015) While quantitative comparisons cannot be made about population trends due to inconsistent and non-comparable estimation methods, recent information would indicate that the plant is stable. (USFWS, 2010)

Threats and Stressors

Stressor: Trampling (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: At the time of listing, the greatest threat to the species was thought to be the activity of summer hikers using a multitude of user-created trails and the lack of a designated trail to minimize effects to the San Francisco Peaks ragwort (USFWS 1983). Since the species was listed, trails, or plans for them, have been modified to avoid impacting areas where the plant occurs. Off trail use is expected to be minimal because of the steep and loose terrain. (USFWS, 2010)

Stressor: Ski area expansion (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: When the ragwort was listed, the expansion of the Arizona Snowbowl, a local ski area located on Humphreys Peak, was predicted to have a serious detrimental effect on *P. franciscana* (USFWS 1983). However, after listing, the planned improvements to the ski area were adjusted to not affect known populations or individual *P. franciscana* plants, but some activities will occur within designated critical habitat. (USFWS, 2010)

Stressor: Avalanches (USFWS 2010)

Exposure:

Response:

Consequence:

Narrative: Avalanches tend to create disturbance areas that can impact existing vegetation. However, the plant seems to be adapted to some amount of disturbance, and it is not understood if this is a disturbance that results in negative, positive, or neutral impacts to the plant. Negative results may occur if plants are uprooted and destroyed. Personal observations indicate that the plant does occur in avalanche-disturbed areas and it is possible that these disturbances may allow for the plant to spread and/or take root in new areas. (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Global climate change may be the greatest threat to this alpine tundra-dependent species. Studies have shown that since 1950, the snowmelt season in some watersheds of the western U.S. has advanced by about 10 days (Dettinger and Cayan 1995, Dettinger and Diaz 2000, Stewart et al. 2004). In alpine habitats, climate change intensifies natural drought cycles and the ensuing stress placed upon high elevation specialist species (IPCC 2007, Cook et al. 2004, Breshears et al. 2005, Mueller et al. 2005). The San Francisco Peaks ragwort may be threatened with extinction in the future if climate change results in the loss of tundra habitat on the San Francisco Peaks. Since the highest peak on the mountain is at 3,850 m (12,633 ft), there is little habitat available for the plant to migrate upward in a warming climate scenario, and we have speculated that the species may be vulnerable to extinction due to climate change. (USFWS, 2010)

Recovery

Delisting Criteria:

Demonstrated long-term stability in population levels and habitat size and quality at current levels or greater through monitoring studies. (USFWS, 1987)

Actions identified in Alpine Tundra Management Plan are implemented. (USFWS, 1987)

Extend the improved trail system to the top of Humphrey's Peak; provide an alternate exit from the alpine zone. (USFWS, 1987)

Develop a cooperative agreement between the Forest Service and the Fish and Wildlife Service on monitoring and enforcement of closure. (USFWS, 1987)

Recovery Actions:

- Remove threats to San Francisco Peaks groundsel by enforcement of existing regulations and by management for protection. (USFWS, 1987)
- Study populations in their natural habitat. (USFWS, 1987)
- Establish and maintain an ex situ population of *Senecio franciscanus*. (USFWS, 1987)
- Develop public awareness, appreciation, and support for preservation of San Francisco Peaks Groundsel. (USFWS, 1987)

Conservation Measures and Best Management Practices:

- We recommend that the USFWS, U.S. Forest Service Rocky Mountain Research Station, and Coconino National Forest establish a statistically robust, baseline population size estimate for the entire mountain and within the San Francisco Peaks Recreation Natural Area. This is necessary for us to better understand the true status and to accurately document responses and trends of the *P. franciscana* population. (USFWS, 2010)
- We recommend that the USFWS initiate revision of the Recovery Plan (which is 23 years old) and develop specific delisting criteria for *P. franciscana*. (USFWS, 2010)
- We recommend that the USFWS, U.S. Forest Service Rocky Mountain Research Station, and Coconino National Forest conduct long-term monitoring of the *P. franciscana* population centroid determined by Fowler et al. (2009) to allow detection of altitudinal migration. (USFWS, 2010)
- We recommend that the USFWS, U.S. Forest Service Rocky Mountain Research Station, Coconino National Forest, and other partners conduct research on the reproductive biology of *P. franciscana* evaluating the genetic diversity within and between colonies, the breeding system involved with sexual reproduction, pollination, and fertilization. (USFWS, 2010)
- We recommend that the USFWS, U.S. Forest Service Rocky Mountain Research Station, Coconino National Forest, and other partners conduct research on *P. franciscana* seed viability, seedling establishment, survivorship, and fecundity to better understand the life history characteristics of this species. (USFWS, 2010)
- We recommend that the USFWS, U.S. Forest Service Rocky Mountain Research Station, Coconino National Forest, and other partners conduct research examining the effect of natural and manmade disturbance on *P. franciscana* persistence and distribution. (USFWS, 2010)

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SPECIES ACCOUNT: *Paronychia chartacea* (Papery whitlow-wort)

Species Taxonomic and Listing Information

Listing Status: Threatened; 2/20/1987; Southeast Region (R4)

Physical Description

The papery whitlow-wort is mat-forming with many bright yellowish-green branches radiating flatly from a strong taproot (Kral 1983, Small 1933). The stems are 5 to 20 cm long and are wiry. The leaf blades are sessile, 1.5 to 3.0 mm long, ovate to triangular-ovate in shape, and strongly revolute. It has numerous small cream-colored to greenish flowers (Small 1933, FWS 1996) that produce a very thin-walled utricle (Kral 1983). There are two geographically isolated subspecies of this small herb: *P. chartacea* ssp. *chartacea* in central Florida and *P. chartacea* ssp. *minima* L. Anderson in the Florida panhandle. Much of the distinction between the two subspecies is a matter of degree (Anderson 1991). The *P. chartacea* ssp. *minima* is somewhat less pubescent than ssp. *chartacea*. There are also differences in their base stems, leaf width, and flower cluster (Anderson 1991). (USFWS, 1999)

Taxonomy

The papery whitlow-wort was first named by Small (1925) as *Nychia pulvinata*. In 1936 Fernald transferred the species to the genus *Paronychia* as *P. chartacea* because the name *P. pulvinata* was pre-empted (Anderson 1991). In 1991 Anderson formally described two geographically distinct subspecies, *P. chartacea* ssp. *chartacea* and *P. chartacea* ssp. *minima*. The subspecies *P. chartacea* ssp. *minima* was formally described by Anderson (1991), several years after *P. chartacea* had been listed as a threatened species. Because the entire species was listed as threatened, the newly described subspecies is also protected. (USFWS, 1999)

Historical Range

See current range/distribution.

Current Range

P. chartacea ssp. *chartacea* occurs in the Lake Wales Ridge in Highlands, Polk, Osceola, Orange, and Lake counties, Florida. *P. chartacea* ssp. *minima* occurs in the karst region of the Florida panhandle, Washington and Bay counties. (USFWS, 1999)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Flowering and fruiting occur in late summer or fall (Anderson 1991) and the seeds mature in September or October (T. Race, Bok Tower Gardens, personal communication 1996). This species is a short-lived perennial (Anderson 1991 and observations by staff at the Historic Bok Sanctuary).

Habitat Type

Adult: Sand scrub/rosemary balds

Habitat Narrative

Adult: Papery whitlow-wort is most frequently seen in open, sunny gaps in rosemary balds within scrub vegetation (Abrahamson et al. 1984, Christman 1988, Menges and Kohfeldt 1995). At Archbold Biological Station, rosemary scrubs are found only on the higher ridges and knolls surrounded by scrubby flatwoods with dense oaks. The main soil types are St. Lucie and Archbold (Abrahamson et al. 1984), which are both well-drained white sands (U.S. Dept. of Agriculture, Soil Conservation Service 1989). The fire cycle in rosemary scrub can range from 10 to as long as 100 years (Johnson 1982, Myers 1990). Rosemary scrub has abundant Florida rosemary (*Ceratiola ericoides*) and scrub oaks including Chapman oak (*Quercus chapmannii*), sand live oak (*Q. geminata*), Archbold oak (*Q. inopina*) and occasional sand pine (*Pinus clausa*). The open sandy areas of rosemary scrub contain small herbs and lichens (Abrahamson et al. 1984, Hawkes and Menges 1996). These gaps in the dense vegetation are more persistent in rosemary scrubs than in scrubby flatwoods (Hawkes and Menges 1996). Papery whitlow-wort also occurs in high pineland (upland longleaf pine vegetation, also called “sandhill”) in the Walk in the Water tract of LWR State Forest (A. Cox, Florida Division of Forestry, personal communication 2002), at TNC’s Crooked Lake Sandhill Preserve (B. Pace-Aldana, TNC, in litt. 2002), and at the Tiger Creek Preserve. In studies of the responses of plants to fire in rosemary balds, Johnson and Abrahamson (1990) and Ostertag and Menges (1994) identified two groups of scrub plants—those that resprout after a fire and those that return from seed. They found that papery whitlow-wort appeared in rosemary balds after fires, even though it had been rare or absent prior to the burn. This strongly indicates that papery whitlow-wort maintains seed banks in the soil, waiting for suitable germination conditions. Within about 9 to 12 years after a fire, papery whitlow-wort was displaced by Florida rosemary and reindeer lichens (*Cladonia* and *Cladina*) (Johnson and Abrahamson 1990). Some gap plants such as snakeroot and Highlands scrub hypericum disappear relatively quickly after fires and require large populations consisting of tens of thousands of plants to persist (Quintana-Ascencio and Menges 2000), but papery whitlow-wort persists longer after fire and it has many large populations over a relatively large geographic range, compared to other LWR endemic plants. The density of papery whitlow-wort increases in relation to available open space (Hawkes and Menges 1996; Menges and Kohfeldt 1995), so the species is most abundant in disturbed, sandy areas such as road rights-of-way and recently cleared high pine (Abrahamson et al. 1984; Christman 1988; Service 1996). Papery whitlow-wort can become very abundant after a fire or on disturbed sites such as along fire lanes or trails (Service 1996; Johnson and Abrahamson 1990) and is least likely of the federally-listed scrub plants to suffer local extirpations as open areas become covered by shrubs. Loose sand affects papery whitlow-wort. According to research by Petru and Menges (2004), “the demographic responses of the species to sand movements indicate that mobile sands create constantly shifting arrays of microsites that can influence post-dispersal seed germination, survival, and growth of Florida scrub herbs. Roadside habitats have more dynamic patterns of sand movement than natural gaps and may alter selection regimes important for demographic variation of endemic Florida scrub plants.” Papery whitlow-wort persists on road edges in the absence of fire in the vegetation. These roadside sandy areas constitute habitats that are significantly different from the bare areas within the vegetation, and may be less suitable for persistence of the species. This research bolsters the already-substantial evidence that prescribed fire is essential to maintain Florida scrub vegetation and its biota, including other federally listed plants and animals. Management for papery whitlow-wort requires burning

regimes that mimic the natural fire cycles of rosemary scrub. Relationships among fire, open space, and plant distributions within a xeric scrub are complex and need to be studied further (Hawkes and Menges 1996). Management practices for rosemary scrub should include fire at intervals suitable for a variety of plants and animals, rather than at intervals optimized for just a single species (Hawkes and Menges 1996; Quintana-Ascencio et al. 2003).

Dispersal/Migration***Population Information and Trends*****Resiliency:**

Found in disturbed sites; can tolerate and probably promoted by fire. (NatureServe, 2015)

Representation:

Found in disturbed sites; can tolerate and probably promoted by fire. (NatureServe, 2015)

Redundancy:

Found in disturbed sites; can tolerate and probably promoted by fire. (NatureServe, 2015)

Number of Populations:

21 - 80 (NatureServe, 2015)

Population Size:

2500 - 10,000 individuals (NatureServe, 2015)

Adaptability:

Found in disturbed sites; can tolerate and probably promoted by fire. (NatureServe, 2015)

Population Narrative:

Papery whitlow-wort occurs on the Lake Wales and at least one smaller nearby ridge (Kral 1983), in Highlands, Polk, Osceola, Orange, and Lake Counties (Anderson 1991). It is present on the small ridge at the Lake McLeod tract of LWR National Wildlife Refuge, but not on the Bombing Range Ridge on Avon Park Air Force Range. On the LWR, it is present in essentially all of the scrub conservation lands. Since the last comprehensive survey (Schultz et al. 1999), it has been found in high pineland at the Walk in Water tract of LWR State Forest (Anne Cox, LWR State Forest, personal communication 2002). It is also present in high pineland on the Tiger Creek Preserve, owned by The Nature Conservancy. The northern range limit of papery whitlow-wort is in Lake County, where it occurs on the north side of Lake Louisa at Crooked River Preserve, owned by the Lake County Water Authority. It was possibly present at a nearby site, Schofield Sandhill, which had been proposed for acquisition under the Florida Forever program, but the acquisition proposal did not come to fruition. The only site on conservation lands in Orange County (also at the northern range limit) is the small Shadow Bay Park (formerly Lake Cane-Marsha Park) near where the Florida Turnpike crosses Interstate 4. The species was reported from localities in western Orange County, but the area has since become urbanized, and there are few if any opportunities for setting aside conservation lands in this area. The only papery whitlow-wort site in Osceola County for that has been proposed for State acquisition is at Lake Davenport, in the northwestern corner of the County. It has not been purchased (Florida Natural Areas Inventory 2005). Papery whitlow-wort is present on essentially all conservation lands

with scrub on the LWR in Polk and Highlands Counties. The southernmost sites on conservation lands are Gould Road (part of the LWR Wildlife and Environmental Area operated by the FWC) and Archbold, both in Highlands County south of Lake Placid (Schultz et al. 1999). During 2003, the Florida Fish and Wildlife Conservation Commission and Archbold Biological Station purchased adjoining portions of a ranch that bordered the Biological Station's preserve to the west. The recently-acquired land provides an important buffer for Archbold, and it protects additional habitat for this species, both occupied and restorable. Although FNAI data provide the best available overall view of the distribution of this species, intensive local inventories add important detail. The LWR State Forest is represented in the FNAI database by nine element occurrences, yet the Arbuckle tract of the Forest has 188 records of this plant in its GIS database, based upon an inventory by K. DeLaney in 1988 (data provided by A. Cox, LWR State Forest). Of the 188 records, 23 represented more than 100 individuals. Archbold Biological Station has not monitored this plant because it thrives in fire lanes that usually do not have exotic plant problems (E. Menges and M. Deyrup, Archbold, personal communication 1995, in Service 1996). The propensity of this species to occupy fire lanes, roadsides, and other artificially disturbed areas is a primary conservation concern for the papery whitlow-wort, because it tends to be far more abundant in such disturbed areas than within the vegetation itself. This situation was researched by Petru and Menges (2004), and they confirmed that prescribed fire is essential to create and restore open, sandy habitat for this and other plants. The papery whitlow-wort occurs in association with several other federally listed species: in scrub, Florida bonamia, Highlands scrub hypericum, wireweed, Florida perforate cladonia, snakeroot, and scrub blazing star. In high pineland at the Tiger Creek Preserve, pygmy fringe tree, pigeon wings, scrub buckwheat, Britton's beargrass, scrub plum, and Carter's mustard. Papery whitlow-wort is the most abundant and widespread of the listed LWR scrub and high pineland plants, and it has benefited greatly from acquisition of conservation lands in its range. Like several other scrub species, including Highlands scrub hypericum, is particularly abundant in human-disturbed areas such as road edges and fire lanes. Researchers based at Archbold Biological Station are interested in finding ways to lessen these plants' dependence on such artificial habitats through restoration of fire regimes.

Threats and Stressors

Stressor: Habitat destruction or modification

Exposure:

Response:

Consequence:

Narrative: For subspecies chartacea, about 30% of FNAI EORs are not protected from threats that are range-wide in scope. Fire suppression is pervasive at unprotected sites and gradually alters habitat over a period of years. Habitat loss through agricultural and residential development is immediate, ongoing, and cumulative. Seventy percent of FNAI EORs occur within one of the 26 managed areas listed in C(1)(d) above. Loss of populations off the LWR in Orange, Polk, and Glades Counties would constitute a significant curtailment of the historic range of chartacea (Turner et al. 2006). Some of these sites may already have been lost. For subspecies minima, it is unknown how many populations have already been lost and its historical range has apparently not been documented. Eight of 12 extant sites appear to be in imminent danger of being lost; all are on privately owned land and could be destroyed if development or habitat modification occurs on those lands. For both subspecies a range-wide survey is needed to determine the current status of populations and the threats to each. (USFWS, 2008)

Stressor: Inadequacy of existing regulatory mechanisms

Exposure:

Response:

Consequence:

Narrative: Papery whitlow-wort is listed as endangered by the State of Florida on the Regulated Plant Index (Florida Department of Agriculture and Consumer Services Rule 5B-40). This law regulates the taking, transport, and sale of listed plants. Property owners are not prohibited under this law from destroying populations of listed plants nor are they required to manage habitats to maintain populations. Existing federal and state regulations prohibit the removal or destruction of listed plant species on public lands. However, they afford no protection to listed plants on private lands. In addition, state regulations are less stringent than federal regulations on land management practices that may adversely affect populations of listed plants. Existing regulatory mechanisms are inadequate to protect this species. (USFWS, 2008)

Stressor: Inadequate management (fire or mechanical disturbance)

Exposure:

Response:

Consequence:

Narrative: Maintenance of viable populations of imperiled plant species depends largely on the determination of the appropriate management regime of populations on managed areas. For subspecies chartacea, inadequate use of fire or the use of mechanical treatments as a surrogate for fire may reduce population sizes or adversely affect demographic performance. For subspecies chartacea, appropriate management means burning Florida rosemary scrub often enough to maintain large gaps within the rosemary shrub matrix. In the absence of data on the biology and autecology of subspecies minima, its management needs cannot be determined. The preferred habitat of subspecies minima on the margins of karst ponds suggests that disturbances other than fire may be required for the maintenance of its populations. (USFWS, 2008)

Recovery

Reclassification Criteria:

Not relevant. (USFWS, 1999)

Delisting Criteria:

1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to ensure 95% probability of persistence for 100 years. (USFWS, 1999)
2. When these sites, within the historic range of *P. chartacea*, are adequately protected from habitat loss, degradation, and fragmentation. (USFWS, 1999)
3. When these sites are managed to maintain the rosemary phase of xeric oak scrub communities to support *P. chartacea*. (USFWS, 1999)
4. When monitoring programs demonstrate that these sites support the appropriate numbers of self-sustaining populations, and those populations are stable throughout the historic range of the species. (USFWS, 1999)

Recovery Actions:

- Determine current distribution of *P. chartacea*. Some portions of *P. chartacea*'s range have been well surveyed yet a total distribution has not been ascertained for this species. A thorough survey is needed to determine the distribution for this species. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, has been isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Conduct research on life history characteristics of *P. chartacea*. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species, more specific biological information is needed. (USFWS, 1999)
- Monitor populations of *P. chartacea*. Develop monitoring protocol to assess population trends for *P. chartacea*. Develop a quantitative description of the population structure of *P. chartacea*. (USFWS, 1999)
- Provide public information about *P. chartacea*. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Care is needed, though, to avoid revealing specific locality information about *P. chartacea*. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of *P. chartacea* and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- Habitat-level Recovery Actions: Prevent degradation of existing habitat. Manage and enhance habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

Conservation Measures and Best Management Practices:

- A taxonomic study evaluating the distinctiveness of the two subspecies should be conducted. (USFWS, 2008)
- A study of the reproductive biology of the two subspecies should be conducted to determine the degree of floral dimorphism/sexual gender and sex ratios of populations. (USFWS, 2008)
- For *P. c. chartacea*, surveys should be conducted to assess the status of the FNAI EORs that occur on unprotected sites and to evaluate the feasibility of protecting additional populations. Following Turner et al. (2006), extant parcels in the Green Swamp and at Fisheating Creek, Avon Park Lakes, Lake Davenport and other sites should be targeted for acquisition. Acquisition of these sites would also extend protection to other federally listed plants. (USFWS, 2008)
- For *P. c. minima*, It is unclear how well existing FNAI EORs reflect the historic range of the taxon. It is possible that additional surveys of areas with appropriate habitat are needed. The possibility of acquiring additional populations also needs to be assessed. (USFWS, 2008)
- Habitat maintenance requirements of *P. c. minima* need to be investigated. (USFWS, 2008)
- For both subspecies, the minimal monitoring should be establishment of level 2 monitoring (sensu Menges and Gordon 1996) to track changes in population sizes over time. Level 2 monitoring

requires that surveys be repeated at defined intervals (e.g., annually, biannually, every five years, or both before and after imposition of management treatments) and that surveys take place within well-defined areas (e.g., within plots small enough to be searched thoroughly within a minimum of effort). ABS' s Population Dynamics of Endemic Plants (PDEP) project was designed as a model of level 2 monitoring that can be deployed by other agencies. Presence/absence data (level 1 monitoring sensu Menges and Gordon 1996) or the periodic accumulation of GPS points cannot provide meaningful data for determining population trends or for quantifying responses to prescribed fire or other management activities.(USFWS, 2008)

- To conduct population viability analyses, detailed demographic data (level 3 monitoring sensu Menges and. Gordon 1996) should be collected from multiple populations of both subspecies. These data need to be collected across the full geographic range of both subspecies, from populations in contrasting habitats (e.g., rosemary scrub vs. roadsides for subspecies chartacea, pond margins vs. sandhill for subspecies minima), and in sites with differing management histories. (USFWS, 2008)
- Studies should be conducted to understand the genetic diversity of both subspecies; this may aid in the identification of new acquisition needs. (USFWS, 2008)
- Where monitoring is being conducted, data should be collected on fire management activities to aid in the interpretation of trends and identifying the most favorable treatments. (USFWS, 2008)
- A revised recovery plan should be developed to address the existence of two subspecies with separate geographic ranges and their potential need for differing management practices to ensure recovery. (USFWS, 2008)
- Habitat for *P. c. chartacea* needs to be maintained through burning Florida rosemary scrub within the modal fire return interval defined by other gap specialists and by Florida rosemary (Menges 2007). (USFWS, 2008)

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SPECIES ACCOUNT: *Parvisedum leiocarpum* (Lake County stonecrop)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A low annual herb, generally only 1-3.5 cm tall, with fleshy leaves that fall off the stem by flowering time. Flowers (April-May) are small and yellow. (NatureServe, 2015)

Taxonomy

USFWS tracks as *Parvisedum leiocarpum* (9/93). (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Known from only a small number of populations within a 10-square-mile area. This species occurs on more or less level sites in shallow depressions that retain water seasonally. Known microhabitats include Northern Basalt Flow and Northern Volcanic Ashflow vernal pools (Sawyer and Keeler-Wolf 1995), low areas in meadows and gravelly flats, and hollows in exposed rocks. A few plants were found on a man-made berm within a flat area that supported a large population. Substrates on which *S. leiocarpa* occur frequently are of volcanic origin and often are gravelly (Patterson 1986). The species occurs at elevations of 518 to 793 meters (1,700 to 2,600 feet). (USFWS, 2009)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Habitat Type

Adult: Terrestrial, palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Vernal pools and margins (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits margins of vernal pools and depressions in bedrock which act as shallow vernal pools and volcanic substrates (NatureServe, 2015).

Dispersal/Migration

Population Information and Trends

Population Trends:

Decreasing (NatureServe, 2015)

Resiliency:

Low (NatureServe, 2015)

Representation:

Low (NatureServe, 2015)

Redundancy:

Low (NatureServe, 2015)

Population Narrative:

At least 50% of the known populations have been destroyed in the last 60 years. Decline of 50-70% (NatureServe, 2015). Low resiliency, representation and redundancy are based on the low number of known populations and individuals.

Threats and Stressors

Stressor: Altered hydrology (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Altered hydrology is listed as a threat to this species (USFWS, 2009).

Stressor: Road maintenance/widening (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Road maintenance/widening is listed as a threat to this species (USFWS, 2009).

Stressor: Agricultural land conversion (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Agricultural land conversion is listed as a threat to this species (USFWS, 2009).

Stressor: Off-highway vehicle use (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Off-highway vehicle use is listed as a threat to this species (USFWS, 2009).

Stressor: Trampling by cattle (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Trampling by cattle is listed as a threat to this species (USFWS, 2009).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The final rule finds inadequacies with the Federal Clean Water Act, the California Environmental Quality Act, and the California Endangered Species Act in addressing threats to this species (USFWS, 2009).

Stressor: Likelihood of Stochastic Extinction (USFWS, 2009)

Exposure:

Response:

Consequence: Extinction

Narrative: The combination of restricted range, few populations, and highly specific and vulnerable habitat makes this species vulnerable to destruction of all, or a significant part, of any population from random events such as floods or droughts (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Climate change is listed as a possible threat to this species (USFWS, 2009).

Recovery

Delisting Criteria:

Habitat protection: Accomplish habitat protection that promotes vernal pool ecosystem function sufficient to contribute to population viability of the covered species. Suitable vernal pool habitat within each prioritized core area for the species is protected. Species localities distributed across the species geographic range and genetic range are protected. Protection of the extreme edges of the population protects the genetic differences that occur there. Reintroduction and introductions must be carried out and meet success criteria. Additional localities that are detected (and determined essential for recovery goals) are permanently protected. Habitat protection results in protection of hydrology essential to vernal pool ecosystem function, and monitoring indicates that hydrology that contributes to population viability has been maintained through at least one multi-year period that includes above average, average, and below average local rainfall as defined above, a multi-year drought, and a minimum of 5 years of post-drought monitoring (USFWS, 2009).

Adaptive habitat management and monitoring. Habitat management and monitoring plans that facilitate maintenance of vernal pool ecosystem function and population viability have been developed and implemented for all habitat protected, as previously discussed in sections 1A-E. Mechanisms are in place to provide for management in perpetuity and long-term monitoring of 1A-E, as previously discussed (funding, personnel, etc.). Monitoring indicates that ecosystem function has been maintained in the areas protected under 1A-D for at least one multi-year period that includes above average, average and below average local rainfall, a multi-year drought, and a minimum of 5 years post drought monitoring. Seed banking actions have been completed for species that would require it as insurance against risk of stochastic extirpations or

that will require reintroductions or introductions to contribute to meeting recovery criteria (USFWS, 2009).

Status surveys: Status surveys, 5-year status reviews, and population monitoring show populations within each vernal pool region where the species occur are viable (e.g., evidence of reproduction and recruitment) and have been maintained (stable or increasing) for at least one multi-year period that includes above average, average, and below average rainfall, a multi-year drought and a minimum of 5 years of post drought monitoring. Status surveys, status reviews, and habitat monitoring show that threats identified during and since the listing process have been ameliorated or eliminated. Site-specific threats identified through standardized site assessments and habitat management planning must be ameliorated or eliminated (USFWS, 2009).

Research: Research actions necessary for the recovery and conservation of the covered species have been identified. Research actions on species biology and ecology, habitat management and restoration, and methods to eliminate or ameliorate threats have been completed and incorporated into habitat protection, habitat management and monitoring, and species monitoring plans, and refinement of recovery criteria and actions. Research on genetic structure has been completed and results incorporated into habitat protection plans to ensure that within and among population genetic variation is fully representative by populations protected in the Habitat Protection section of this document as previously described in sections 1A-E. Research necessary to determine appropriate parameters to measure population viability for each species have been completed (USFWS, 2009).

Participation and outreach: Recovery Implementation Team is established and functioning to oversee rangewide recovery efforts. Vernal pool regional working groups are established and functioning to oversee regional recovery efforts. Participation plans for each vernal pool region have been completed and implemented. Vernal pool regional working groups have developed and implemented outreach and incentive programs that develop partnerships contributing to achieving recovery criteria 1-4 (USFWS, 2009).

Conservation Measures and Best Management Practices:

- Protect habitat. Currently none of the known localities of the species are protected. Preservation of Zone 1 core area should be pursued to preserve known localities (USFWS, 2009).
- Control erosion (USFWS, 2009).
- Conduct research at as many of the extant localities as possible (USFWS, 2009).
- Collect seeds for future introduction and/or reintroductions into suitable habitat (USFWS, 2009).
- Formally change the name in the Code of Federal Regulations from *Parvisedum leiocarpum* to *Sedella leiocarpa* (USFWS, 2009).
- Correct the downlisting criteria, if necessary, to also apply to the Dry Lake core area (USFWS, 2009).

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SPECIES ACCOUNT: *Pedicularis furbishiae* (Furbish lousewort)

Species Taxonomic and Listing Information

Listing Status: Endangered; Northeast Region (R5) (USFWS, 2015); Proposed Reclassification to Threatened

Physical Description

A perennial herb in the Scrophulariaceae (snapdragon family) that produces 1 or more flowering stems, up to 1 m tall, from a basal rosette of leaves. Leaves are deeply divided and have toothed edges. Yellow, 2-lipped flowers bloom in a spike at the top of the flowering stalk from mid-July to late-August. (NatureServe, 2015)

Taxonomy

The genus *Pedicularis* contains over 600 species, most of which are common in tundra, alpine, and subalpine floras in Asia, Europe and North America (Robart et al. 2015, p. 229). The center of *Pedicularis* species diversity is in the northern Himalayas, China, and Siberia. The Furbish's lousewort has the most restricted distribution of any species of the genus *Pedicularis* (Gawler 1983, p. 28). The Furbish's lousewort (*Pedicularis furbishiae* Sereno Watson 1882) is a member of the broomrape family, Orobanchaceae (formerly from the snapdragon family Scrophulariaceae) (Olmstead et al. 2001). The taxonomic identity of the Furbish's lousewort as a distinct species is unquestioned, but its taxonomic position within the genus *Pedicularis* is not certain (Macior pers. comm. in Stirrett 1980, p. 21) and has been a topic of considerable conjecture and discussion (Gawler 1983, pp. 28-29, Robart et al. 2015, p. 253). Dr. Peter Nelson at the University of Maine at Fort Kent and Rick Ree at the Field Museum in Chicago are continuing genetic research to identify the "sister species" and document the unique phylogeny of the Furbish lousewort. Dr. Nelson has collected samples at numerous subpopulations in Maine and New Brunswick to evaluate the genetic structure and variation within the Furbish's lousewort metapopulation. Similar to the electrophoretic genetic results published by Waller et al. (1987, entire), preliminary results indicate low genetic variability in the Furbish's lousewort population (P. Nelson email November 11, 2017). Additional results will be available in 2018. (USFWS, 2018)

Historical Range

See current range/distribution.

Current Range

Endemic to the Saint John River Valley of northern Maine and adjacent New Brunswick. The entire range of *Pedicularis furbishiae* covers 225 km of the St. John River, extending from a point 1.5 miles upriver of the confluence with the Big Black River in Aroostook County, Maine to the town of Andover, New Brunswick in Canada. (NatureServe, 2015)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (outcrossing) and asexual (USFWS, 1991)

Dependency on Other Individuals or Species

Adult: *Bombus vagans*, a common bumblebee which also forages on other co-flowering species such as red clover, is the exclusive pollinator of *Pedicularis furbishiae* (Macior 1978a). (USFWS, 1991)

Breeding Season

Adult: July to August (USFWS, 1991)

Reproduction Narrative

Adult: *Pedicularis furbishiae* is a herbaceous perennial which takes several years to reach sexual maturity. Reproduction is solely by seed. Louseworts flower from mid-July to mid-August, with seeds dispersing in early September. Recent experiments (Waller et al. 1988) have shown that selfed and outcrossed flowers are equally successful at setting capsules, contradicting Macior's (1978) conclusion that *Pedicularis furbishiae* is self-incompatible. The success of capsule maturation varies widely among populations and years. On average an inflorescence will produce 7—17 capsules, each averaging 25 seeds (Menges et al. 1985, 1986; Gawler et al. 1986). (USFWS, 1991)

Habitat Type

Adult: Palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Herbaceous wetland, riparian, scrub-scrub wetland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: High soil moisture; flooding is essential for habitat (USFWS, 1991)

Geographic or Habitat Restraints or Barriers

Adult: Ice scouring and succession can limit habitat; low vegetative cover (USFWS, 1991)

Environmental Specificity

Adult: Narrow. Specialist or community with key requirements common. (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (USFWS, 1991)

Habitat Narrative

Adult: This species inhabits the riverbanks of the Saint John River, mostly in the steep, highly diverse shrub- or forb-dominated zone between open river cobbles and boreal forest. The habitat is notable for the high frequency and the severity of disturbance by ice scour and vertical river bank slumping. (The Saint John River drains one of the largest watersheds in the northeast, yet it has relatively little headwater storage, making it subject to dramatic seasonal and longer-term fluctuations in water level and to severe ice-jams.) The zone in which *Pedicularis furbishiae* occurs bears the brunt of regular ice scouring - tree establishment does not occur here and

vegetation cover tends to be moderate. Plants grow on glacial lacustrine or till deposits. (NatureServe, 2015) *Pedicularis furbishiae* is a fugitive species, succeeding in early— to mid— successional vegetation, and relying on disturbance to open up new areas for colonization. The growth rate of a lousewort population depends largely on site characteristics, principally soil moisture and time since disturbance. Excluding effects of succession, populations on saturated soils grow most rapidly, those on moist soils grow moderately fast, and those on dry soils grow slowly or even decline (Gawler 1988). (USFWS, 1991; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seeds appear to be dispersed by wind and water (Waller et al. 1988).

Population Information and Trends

Population Trends:

Long-term trends suggest declines of 30 to 50%, whereas short-term trends indicate declines of 10 to 30% (NatureServe, 2015)

Species Trends:

Declining (NatureServe, 2015)

Resiliency:

Low (inferred from USFWS, 1991)

Representation:

Low (inferred from USFWS, 1991)

Number of Populations:

20 subpopulations distributed across 140 river-miles (USFWS, 2019)

Population Size:

~2397 (USFWS, 2018)

Adaptability:

Low (inferred from USFWS, 1991)

Additional Population-level Information:

All subpopulations at or near lowest recorded numbers since 1980. Two subpopulations good condition, 2 subpopulations fair/good, 3 subpopulations fair, and 8 subpopulations poor condition. Six upriver subpopulations maintaining resiliency and redundancy. Fourteen downriver populations losing resiliency and redundancy; absent from 6 subpopulations. Largest contiguous habitats upriver; smallest, fragmented, eroded habitats downriver. One upriver subpopulation partially protected. One downriver subpopulation partially protected and one New Brunswick site protected. Habitat degradation (erosion, poor riparian buffer) greatest in downriver habitats. (USFWS, 2018)

Population Narrative:

Although Furbish's Lousewort is adapted to this highly dynamic riparian habitat, the species is vulnerable to high degrees of the annual ice scouring and flooding. Little genetic variability has been detected in this species. Populations of Furbish's Lousewort have declined since historic times. Long-term population trends suggest declines of 30 to 50%, whereas short-term trends indicate declines of 10 to 30%. The number of stems fluctuate widely with varying hydrological or environmental changes but in Maine have ranged from over 6000 plants to just over 2000 plants over a 25-year period. In New Brunswick the numbers of plants have ranged from 68 to over 1000 plants. Two element occurrences (one historic & one extant) are known in New Brunswick, whereas it is estimated that about three or four extant EOs occur in Maine. Lousewort populations are notoriously difficult to delineate, because the linearity and dynamism of the habitat dictate that populations are rarely discrete units. (NatureServe, 2015)

Threats and Stressors

Stressor: Alterations in hydrology (USFWS, 1991)

Exposure:

Response:

Consequence:

Narrative: The cycle of intermittent disturbance by floods is crucial to the survival of the species. Damming free-flowing waters of the St. John would not only inundate some populations, but would affect all populations by preventing the ice scour and floods which now shape riverbank vegetation. New Brunswick Power is still pursuing possible modification of the existing dam at Grand Falls, New Brunswick as well as the creation of an additional hydropower facility near Morrill, New Brunswick. Potential and known populations in Canada and the United States from Madawaska to Hamlin would be eliminated by implementation of these projects. (USFWS, 1991)

Stressor: Land use (USFWS, 1991)

Exposure:

Response:

Consequence:

Narrative: Aside from the continuing, albeit muffled, potential for dam construction on the St. John, widespread effects on lousewort populations resulting from changing land uses along the river as well as from increased river flows are the major concern at this time. changes in land use on the banks of the St. John River have occurred through the clearing of vegetation, especially trees, for individual houselots, views, and agricultural fields. The removal of trees to the river's edge eliminates shade conducive to lousewort growth and reproduction, while the subdivision of the riverbank into residential and commercial building lots increases the difficulty of implementing conservation strategies. These land use practices within the St. John River watershed appear to affect Furbish lousewort habitat and populations. (USFWS, 1991)

Stressor: Increased runoff (USFWS, 1991)

Exposure:

Response:

Consequence:

Narrative: In addition, there is evidence that the spring flows of the St. John River have been increasing since the 1940's (Menges and Gawler 1986), possibly due to excess runoff. Increased runoff (Gawler and Menges 1984), perhaps caused by accelerated timber harvesting within the watershed, may exacerbate the disturbance impacts to lousewort habitat. For instance,

deforested areas can reduce the water retention capability of the watershed; increased river flows and resultant bank slumping may then eliminate habitat and populations at an artificially high rate. (USFWS, 1991)

Stressor: Habitat alteration (USFWS, 1991)

Exposure:

Response:

Consequence:

Narrative: More localized activities such as direct habitat alteration and the burial of individual plants by the dumping of refuse and slash continue to be minor threats to particular lousewort populations. Causes of habitat degradation associated with shorefront developing include dumping of refuse, slash, and fill; motorized vehicles, vegetation clearing, ATV use along the river bank, personal boat access, and impermeable surfaces that focus runoff. (USFWS, 1991; USFWS, 2007)

Stressor: All-terrain vehicles (USFWS, 1991)

Exposure:

Response:

Consequence:

Narrative: Impacts from all—terrain vehicle traffic and bank use by recreationists may become threats as these activities increase in the area. (USFWS, 1991)

Stressor: Residential development (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: The conversion of farms for residential development, which alters the riparian forest or riverbank vegetation, is an increasing conservation concern. (USFWS, 2007)

Stressor: Invasive species (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Competition for invasive species is a threat to the unique riverbank ecosystem in the lower river segments. Phragmites, Japanese knotweed, non-native grasses, and purple loosestrife have all been documented in lousewort habitat. These invasive plant species are linked to human activities such as riverbank clearing, trails, and mowing, and spread of invasive species is one consequence of shorefront development. (USFWS, 2007)

Stressor: Forest management (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Forest management in the watershed could increase siltation and run-off (Menges and Gawler 1986). (USFWS, 2007)

Stressor: Climate change (USFWS, 2007; USFWS, 2019)

Exposure:

Response:**Consequence:**

Narrative: Climate change is expected to affect the ice regime of northern rivers, including the St. John, by increasing the frequency of severe ice-scour events and patterns of spring ice breakup (Beltaos 1997, Beltaos and Prowse 2001). Beltaos (1999) did a hydroclimatic analysis for the upper St. John River using long-term climate and flow records and documented that a small rise in winter air temperatures over the past 80 years has already resulted in a substantial increase in the number of mild winter days and the amount of winter rainfall- previous rare occurrences in this region. These two factors have augmented river flows, causing increased breakup of ice cover and flow peaks in late winter and the frequency of spring ice jams and flooding. (USFWS, 2007); The Furbish's lousewort is identified as one of Maine's plant species most vulnerable to climate change (Jacobson et al. 2009, p. 33). The species depends on periodic disturbance of the riverbank from ice scour; not too frequent or too infrequent and not too severe (section 2.4). Climate change is expected to affect the ice regime of northern rivers, including the St. John, by increasing the frequency and severity of severe ice-scour and flood events (Beltaos 1997, entire; Beltaos and Prowse 2001, entire; Beltaos and Prowse 2009, entire). In summary, there is evidence suggesting that climate change is indirectly affecting the ice dynamics of the St. John River and these factors have the potential to increase the severity of the spring breakup and increased severity of flooding (Beltaos 2002, entire). We will evaluate climate change as a stressor further in our assessment of future scenarios. (USFWS, 2018)

Stressor: Increased frequency of ice jam events (USFWS, 2007)

Exposure:**Response:****Consequence:**

Narrative: The increased frequency of ice jam events is a particular concern. The frequency of flooding events on the St. John River has increased since the 1940s (Menges and Gawler 1986). Lousewort biology suggests that a disturbance interval of less than 6 to 10 years would interfere with maturation and seed production (Menges 1990). (USFWS, 2007)

Stressor: Development (USFWS, 2018)

Exposure:**Response:****Consequence:**

Narrative: Changes in land use on the banks of the St. John River in downriver areas have occurred through the clearing of vegetation, especially trees, for agriculture, individual house lots, roads, and river views. These land use changes within the St. John River valley may have negatively affected some of Furbish's lousewort subpopulations' habitat through removal or reduction of the forested riparian buffer and subsequent loss of shade critical to lousewort growth and reproduction. Areas cleared of forest and impermeable surfaces associated with development have led to erosion and subsidence of the unconsolidated glacial till soils, and caused slumping and erosion of Furbish's lousewort habitat. We will evaluate development as a stressor further in our assessment of future scenarios. (USFWS, 2018)

Recovery**Reclassification Criteria:**

In light of the recommendation to reclassify the Furbish's lousewort as threatened, downlisting criteria in the 1991 Recovery Plan (USFWS 1991) are now obsolete. (USFWS, 2019)

Delisting Criteria:

Criterion 1. The metapopulation is viable, comprising a 30-year median of 4,400 flowering stems or greater, and distributed as follows: Upriver: a 30-year median of 2,800 flowering stems or greater in at least 6 subpopulations with at least 3 good and 3 fair subpopulations; Downriver: a 30-year median of 1,600 flowering stems or greater in at least 9 subpopulations with at least 3 good and 6 fair subpopulations. Once the upriver and downriver criteria are reached, the median number of flowering stems for each respective river section will remain stable or increase over a period of at least 30 years (three generations) without augmentation, reintroduction, or hand- pollinating of plants. Additionally, in New Brunswick there is a 30-year median of 1,100 plants distributed among at least 5 subpopulations (Resiliency and Redundancy). (USFWS, 2019)

Criterion 2. There is long-term habitat protection for all subpopulations in Maine that provides for the species' needs throughout its life cycle. Long-term habitat protection mechanisms must assure important species' needs: forest overstory shade conditions (about 50-percent sunlight) by protecting or restoring a forested riparian buffer of 250 feet adjacent to suitable habitat; moist soil conditions and seeps by limiting further shoreline erosion and bank slumping, and restoring suitable habitat where it has been damaged from past events; native vegetation that newly germinated Furbish's lousewort plants can parasitize; site conditions without excessive plant competition, especially from tall shrubs and robust herbs; populations of the half-black bumble bee sufficient to assure pollination and subsequent seed production. (USFWS, 2019)

Recovery Actions:

- 1. Monitor the Furbish's lousewort population and demographics and periodically assess the status of the bumble bee pollinator to document trends. (USFWS, 2019)
- 2. Improve the health and viability of extant subpopulations and restore extirpated subpopulations throughout the historical range. (USFWS, 2019)
- 3. Achieve long-term habitat protection for each subpopulation. (USFWS, 2019)
- 4. Conduct scientific investigations to improve understanding of stressors, viability, propagation, restoration, and genetic needs. (USFWS, 2019)
- 5. Periodically review progress toward achieving recovery criteria and employ strategic conservation and adaptive management to address threats. (USFWS, 2019)
- Contingency recovery strategies will be implemented if the metapopulation in Maine falls below 1,200 flowering stems OR if there are 4 or fewer upriver subpopulations OR if there are 2 or fewer downriver subpopulations OR if seed production is not sufficient to achieve a stable or increasing metapopulation. (USFWS, 2019)
- 6. Establish new subpopulations in unoccupied areas having suitable habitat. (USFWS, 2019)
- 7. Store seeds and establish captive populations. (USFWS, 2019)
- 8. Enhance seed production. (USFWS, 2019)
- 9. Work with Canadian partners to implement strategies that prevent extinction. (USFWS, 2019)

Conservation Measures and Best Management Practices:

- To be considered for delisting in the near future, the Service needs specific information on: 1) the degree of threat from residential development in river segments 2, 3, and 4; 2) the degree of threat from climate change and severe ice jams and flooding; and 3) population viability in the context of a dynamic environment. (USFWS, 2007)
- New recovery criteria should be developed based on current information on population viability and responses to habitat perturbations, specifically related to improving municipal shoreland zoning, addressing habitat restoration caused by catastrophic ice scour events, and controlling invasive species. (USFWS, 2007)
- Efforts to protect lousewort habitat in the lower river reaches should be emphasized. (USFWS, 2007)

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SPECIES ACCOUNT: *Pediocactus (=Echinocactus,=Utahia) sileri* (Siler pincushion cactus)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/26/1979; Southwest Region (Region 2) (USFWS, 2016)

Physical Description

The Siler pincushion cactus is a small, solitary or occasionally clustered, globose cactus about 10 cm (4 in) tall and 7.5-10 cm in diameter. Each areole contains 3-7 brownish-black straight or slightly curved central spines, becoming pale gray or nearly white with age. There are, in addition, 11-16 whitish radial spines per areole. The central spines are about 2.5 cm long, the radials slightly less. Flowers are about 2.5 cm in diameter, with yellowish marginally scarious petals with maroon veins. Fruits are greenish-yellow, somewhat enlarged upwards, with scales toward the top. They are dry at maturity; seeds are gray. (USFWS, 1986)

Taxonomy

This species has been through several nomenclatural changes and has two recognized synonyms: *Echinocactus sileri* and *Utahia sileri*. This species was originally described as a species of *Echinocactus* (Coulter 1896), and was later placed in the genus *Utahia* by Britton and Rose (1922). Lyman Benson combined into the genus *Pediocactus* various species that formerly had been placed in six different genera due to their diversity in spination, body proportion, and flower color. This combination includes *P. sileri*. (USFWS, 1986)

Historical Range

See current range.

Current Range

The geographic range of Siler pincushion cactus extends from southeast of Fredonia, extreme northwestern Coconino County, Arizona, west for about 70 air miles in north-central Mohave County, Arizona. It also includes about 3 miles of southern Utah in Washington and Kane Counties (USFWS, 2008).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Blooms April-mid May. (USFWS, 1986)

Reproduction Narrative

Adult: Little variation exists within populations. These populations can be separated by distances of several miles even when there is suitable habitat. Further, dispersal within populations appears to be staggered throughout the growing season from shortly after seeds are produced

in June to fall. This dispersal strategy may be disadvantageous for the genus, however, populations in the genus when left undisturbed seem to be healthy with all age classes represented (Heil et al. 1981). Flowers bloom from April to May. (NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Desert, forest/woodland, grassland/herbaceous, woodland- conifer (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Elevations between 2,800 and 5,400 ft (USFWS, 2008)

Spatial Arrangements of the Population

Adult: Solitary or occasionally clustered (USFWS, 1986).

Environmental Specificity

Adult: Narrow. Specialist or community with key requirements common. (NatureServe, 2015)

Habitat Narrative

Adult: Siler pincushion cactus grows on gypsiferous clay and sandy soils derived from the Moenkopi Formation. The majority of the plants are associated with the Shnabkaib Member of this particular formation. The Shnabkaib Member is composed of 65 percent siltstone, 25 percent gypsum, and 10 percent limestone and dolomite (Stewart et al. 1972). Siler pincushion cacti are also found scattered on the Middle Red Member of the formation, which is a reddish siltstone with thin to thick layers of gypsum. The cacti are found growing on elevations between 2,800 and 5,400 feet, in the Great Basin Desert Shrub community (USFWS, 2008).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Members of *Pediocactus* produce dry, dull-colored fruit which are presumed not to be dispersed by birds or rodents, but rather wind or water. (NatureServe, 2015)

Population Information and Trends**Species Trends:**

Short-term trends indicate declines of 10-30% (NatureServe, 2015)

Number of Populations:

~ 25 NatureServe, 2015)

Population Size:

~10,000 or more individuals (USFWS, 2008)

Population Narrative:

Short-term population trends indicate declines of 10-30%. Several 100, possibly 10,000 or even more plants. In 2006, BLM estimated there were over 10,000 individuals (BLM 2006 cited by

USFWS 2008). BLM has documented approximately 22 occurrences in Arizona, and populations in the Kanab and St. George areas of Utah. In the NatureServe central database, there are approximately 25 extant occurrences (EO data in the NatureServe central database as of August 2013). (NatureServe, 2015)

Threats and Stressors

Stressor: Habitat modification from uranium mining and prospecting (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: From 1980-1985, 81 of 246 uranium mining plans of operations (MPOs) were located in Siler pincushion cactus habitat. Of those, 30 were modified to avoid or minimize impacts to Siler pincushion cactus. Only one of the MPOs occurred in a dense P. sileri area near Atkin Well; no cacti were damaged as a result of the drilling. The Service does not know how much Siler pincushion cactus habitat was affected or modified by these activities. The BLM reports that since 1990, there has been no uranium mining and very little gypsum exploration. The 2005-2006 resurgence in uranium mining was limited to Kaibab limestone near uranium mines that were already active since the 1980s and 1990s. In the Draft Environmental Impact Statement (DEIS), there is a map of uranium resource potential (U.S. Department of Interior 2005). There are two areas characterized on the map: 1) Sandstone uranium (SSU) high potential, abundant direct evidence, and 2) breccia pipe uranium (BPU) high potential, abundant direct evidence. All areas known to support Siler pincushion habitat are within these units. Based on this information, there is still potential for Siler pincushion plants and their habitat to be negatively affected by new uranium mining claims. (USFWS, 2008)

Stressor: Habitat modification from oil and gas leases (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: In the DEIS for the revised RMP, BLM states that known oil and gas reserves within the Planning Area are not significant and no economic occurrences of gas or oil have been encountered to date (U.S. Department of Interior 2005). The BLM rated oil and gas potential within the Planning Area; areas in the north central and extreme western portions were rated as moderate potential. Good potential was assigned to the Shnabkaib Member of the Moenkopi Formation, which corresponds to the geologic formation that supports habitat for Siler pincushion cactus. Although we do not consider oil and gas production to be a threat at this time, the Service cannot rule it out as a future threat due to the increasing interest in domestic sources of oil production. All areas that are mapped as having moderate potential for oil and gas are within Siler pincushion habitat. (USFWS, 2008)

Stressor: Habitat modification from gypsum mining (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: In the 2005 DEIS, BLM states that within the Planning Area potentially favorable areas for the occurrence of gypsum include sabkha environments associated with marine regressions in Permian and Triassic-aged rocks (U.S. Department of Interior 2005). Large gypsum deposits

occur in the northwestern portion of the Planning Area, associated with the Harrisburg Member of the Kaibab Formation (does not support Siler pincushion cactus) and the Moenkopi Formation. Again, the entire area beneath Siler pincushion habitat is classified as high gypsum potential, with abundant direct evidence. According to the BLM (2006), gypsum deposits within areas supporting Siler pincushion cactus were considered non-economically viable, at least in the 1980's when the mineral feasibility report was completed. While the Service does not consider gypsum mining a threat at this time, given the rapidly changing market for saleable minerals, the Service cannot rule it out as a future threat for Siler pincushion. (USFWS, 2008)

Stressor: Off-highway vehicles (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: This type of use has killed tagged Siler pincushion cactus within the Warner Ridge plot (Utah). The threat from OHV activity is very high in this area due to the proximity of St. George, which is experiencing rapid urban growth. There is increased use of open space around the city for recreational activities. The BLM (Dixie Resource Area) (1999) and the Arizona Strip RMPs established the Fort Pierce and Warner Ridge areas as Areas of Critical Environmental Concern (ACEC). The areas are closed to OHV use and are signed. The areas are patrolled regularly and on peak high-use weekends. The Warner Ridge ACEC is 4,281 acres in size and 1,790 acres are fenced. (USFWS, 2008)

Stressor: Livestock trampling (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Siler pincushion cacti can be trampled by livestock. A total of five Siler pincushion cacti mortalities attributable to livestock trampling were documented in all of the BLM monitoring plots for years 1986-2006. This number is small in comparison to the 258 and 322 mortalities attributed to rodent herbivory and natural causes (likely drought related), respectively. The highest mortality from livestock trampling (3) occurred in the Atkins Well grazed plot; the plot is located near a water tank, which typically receives high use. The Service assumes that additional plants are trampled outside of the monitoring plots, because almost all of Siler pincushion habitat is within grazing allotments. However, the Service suspects that the numbers trampled are small. (USFWS, 2008)

Stressor: Water pipeline (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: FWS has recently become involved with a permit request from the Utah Board of Water Resources to the Federal Energy Regulatory Commission (FERC) to construct a water pipeline from Lake Powell to St. George. This proposed pipeline plan is in the preliminary stages of development, and there are 3 alignments being considered at this time. One of the alignments would cross through the northern portion of BLM land on the Arizona Strip, which would go through Siler pincushion cactus habitat. Preliminary engineering studies were started in the summer of 2007, and by summer 2009, a completed license application will be submitted to FERC. Under the current timeline, construction would begin in 2013. The project will require

section 7 consultation with FWS, but the effects to Siler pincushion cactus and its habitat could be substantial, depending on which alignment is chosen. In addition, the assured water supply to St. George may contribute to increasing development in the general area, which would likely affect Siler pincushion cactus and its habitat near St. George. (USFWS, 2008)

Stressor: Herbivory and insect predation (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Herbivory and insect predation on Siler pincushion cacti are addressed in the HMP under “Natural Factors”. Herbivory and insect predation result in death to individual cacti. Actions taken or recommended were the construction of raptor perches near dense populations of Siler pincushion cacti in order to reduce rodent herbivory and continued monitoring of the species. There were no actions described for reducing or eliminating insect predation. There have been observations of insect predation on Siler pincushion cactus. The BLM (2006) report indicates that insect larvae hollow out plants, resulting in cacti death. There are six species of Moneilema beetles recognized in North America, which were thought to be specialists on Opuntia spp. However, recent observations indicate the genus predaes other cacti species as well. The Opuntia borer beetle (Moneilema semipunctatum) has been observed feeding on and killing the endangered Wright fishhook cactus (Sclerocactus wrightiae) in south central Utah (Kass 2001), and the threatened Mesa Verde cactus (Sclerocactus mesa-verdae) in New Mexico and Colorado (Smith 2001). Adult beetles feed on cacti and females lay eggs near the base of the plant. Once hatched, larvae tunnel into the plant, often causing death of the infested plant. Moneilema corrugans (no common name) has been known to kill the threatened Cochise pincushion cactus (Coryphantha robbinsorum) in southeastern Arizona (Zimmerman 1985). Additional research needs to be done to identify insects that infest Siler pincushion cactus and determine effects that insects have on cacti population dynamics. Insect infestations may be correlated with drought cycles; additional work is needed to examine if there is a relationship. The majority of mortalities (over 98 percent) observed in BLM monitoring plots were attributed to natural causes (likely drought), mammal herbivory, and insect predation. (USFWS, 2008)

Stressor: Drought (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Ongoing drought, which has been in place in much of the southwest since the late 1990's, has affected Siler pincushion cactus populations. Increased mortality and reduced or non-existent germination and recruitment have been observed on the monitoring plots. Other populations in Utah seem to have disappeared, likely due to drought. There are no recovery criteria that address this threat. The only action called for in the HMP is continued monitoring on BLM lands to quantify the effect. There are no actions to minimize or alleviate this threat to Siler pincushion cacti populations outside of BLM lands. (USFWS, 2008)

Stressor: Climate change (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Periods of drought in the southwest are not uncommon. But, the frequency and duration of droughts may be altered by climate change. Global warming, and associated effects on regional climatic regimes, is not well understood, but weather predictions for the southwestern United States include less overall precipitation and longer periods of drought. Seager et al. (2007) predict, based on broad consensus among 19 climate models, that the southwest will dry in the 21st century and that this drier climate change is already occurring. Increased aridity associated with the current on-going drought and the 1950's drought will become the norm for the American southwest within a timeframe of years to decades if the models are correct. The 2007 Intergovernmental Panel on Climate Change (IPCC) report outlines several scenarios that are virtually certain or very likely to occur in the 21st century. These are: 1) over most land, there will be warmer and fewer cold days and nights, and warmer and more frequent hot days and nights, 2) areas affected by drought will increase, and 3) the frequency of warm spells/heat waves over most land areas will likely increase. The IPCC makes equally sobering predictions for ecosystems; the resilience of many ecosystems is likely to be exceeded this century by an unprecedented combination of climate change, associated disturbances (e.g. flooding, drought, wildfire, insects), and other global drivers (IPPC 2007). With medium confidence, IPPC predicts that approximately 20-30% of plant and animal species assessed so far are likely to be at an increased risk of extinction if increases in global average temperature exceed 1.5 – 2.5°C (IPPC 2007). Almost certainly this species, along with its habitat, will be affected in some manner by climate change; the magnitude and extent of the change cannot be quantified at this time. (USFWS, 2008)

Recovery

Reclassification Criteria:

Not applicable; species was downlisted to Threatened status in 1993 (USFWS, 2008).

Delisting Criteria:

1. Demonstration of long-term population stability in population levels. (USFWS, 2008)
2. Implementation of the habitat management plan. (USFWS, 2008)
3. Suitability of downlisting actions. (USFWS, 2008)
4. Continued assurance of no mineral threats. (USFWS, 2008)

Recovery Actions:

- The development and implementation of habitat management plans that alleviate the threats of collecting and habitat modification. (USFWS, 1986)
- The enforcement of existing regulations on collecting and trade. (USFWS, 1986)
- The study of population biology to develop the understanding needed to sustain healthy populations in their natural habitat. (USFWS, 1986)
- The development of public awareness, appreciation and support for preservation of the Siler pincushion cactus. (USFWS, 1986)

Conservation Measures and Best Management Practices:

- The 1986 Recovery Plan should be updated. The recovery criteria need to be measurable and threats based. In addition, the BLM has better maps and location information that should be in the Plan. (USFWS, 2008)
- Assistance (technical and monetary) should be provided to the Kaibab Paiute Indian Tribe to conduct surveys and develop conservation measures for Siler pincushion cactus on their lands. (USFWS, 2008)
- The BLM monitoring protocol should be revised in order to quantify seedling survivorship. Random plots/transects should be used in order to make estimates for the population as a whole. (USFWS, 2008)
- The Siler pincushion cactus population in Utah should be monitored on a regular basis, especially to quantify and address threats from climate change related drought. An adaptive management plan should be developed to address this issue. (USFWS, 2008)
- The BLM should pursue mineral withdrawals on the established ACECs or in the areas that support dense concentrations of Siler pincushion cactus. (USFWS, 2008)
- The BLM should close areas that support dense concentrations of Siler pincushion cactus to off-road vehicle use. (USFWS, 2008)
- Research to examine insect predators on Siler pincushion cactus should be conducted. (USFWS, 2008)

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SPECIES ACCOUNT: *Pediocactus bradyi* (Brady pincushion cactus)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/26/1979; Southwest Region (Region 2) (USFWS, 2016)

Physical Description

Pediocactus bradyi is a small, semiglobose cactus with single stems (although rare, 2 to 4), 3.2 to 6.2 cm long and 2.6 to 4 cm in diameter. The spines are dense (typically no central spine) with each elliptic areole (white or yellow-villous) numbering 13 to 16 radial spines, 3 to 5 mm long (white or yellowish tan). The straw-yellow flowers are 2 cm long and 1.5 cm in diameter and its smooth green fruit (7 to 10 mm long and 10 mm diameter) turns reddish-brown at maturity. The fruit is top-shaped and constricted at the base, the apex slightly convex, dehiscent by a vertical slit. Seeds are brownish black, 2.8 mm long and 1.7-2.0 mm wide (Heil and Porter 2001). (USFWS, 2012)

Taxonomy

In 1961-1962, Lyman Benson combined into the genus *Pediocactus* (including *p. bradyi*) species that formerly were distributed over six different genera due to their great diversity in spination, body proportions, and flower color. Benson recognized an overriding similarity; the structure and method of dehiscence of the fruits (dry at maturity and dehiscent usually both by a dorsal slit and by a ring around the circumscissile apex), as well as several other common characteristics (Benson 1962c). *Pediocactus bradyi* can readily be distinguished from its closest relative, *p. winkleri*, by the latter's peach-colored flowers and fewer spines (mostly g-11). Also, the radial spines of *p. winkleri* are less pectinate than those of *p. bradyi*. (USFWS, 1985)

Current Range

Restricted to a specific and limited limestone soil type and known only from Coconino County, in northern Arizona, along Marble Canyon. The species' range comprises an area approximately 23 kilometers (km) in length, north to south, and varies in width from 1.6 km to 4.58 km (USFWS 2012).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (NatureServe, 2015)

Lifespan

Adult: 10-20 years (USFWS, 2012)

Breeding Season

Adult: March to April (USFWS, 2012)

Reproduction Narrative

Adult: Little variation exists within populations. These populations can be separated by distances of several miles even when there is suitable habitat. Further, dispersal within populations appears to be staggered throughout the growing season from shortly after seeds are produced in June to fall. This dispersal strategy may be disadvantageous for the species, however, populations in the genus when left undisturbed seem to be healthy with all age classes represented (Heil et al. 1981). *P. bradyi* breeding system as cross-pollinated and self-incompatible. Tepedino (2000) also found the cactus to be insect-pollinated, and sweat bees (*Dialictus* spp.) were observed to be the primary pollinators. Vegetative reproduction has not been documented in literature reviewed. If the conditions are favorable the cacti will flower typically between March and April (Spence 2008). The longevity of *P. bradyi* was not clearly understood in 1985. Information provided in the Recovery Plan indicates the cactus has a lifespan of 10 to 15 years (USFWS 1985). Spence (2008) describes the species as long-lived and suggests recruitment occurs perhaps once every 10 to 20 years. Roth estimates the cactus may live approximately 20 years. Long-lived and exhibits relatively low fecundity, which would increase the potential for a genetic bottleneck in conjunction with its isolated and restricted distribution (USFWS, 2012; NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Desert, shrubland/chaparral (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Prefers exposed, sunny locations; responds to summer rainfall events by expanding above soil (USFWS, 2012)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 1170 and 1,370 m; vegetation is open and sparse (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Habitat Narrative

Adult: Navajoan Desert on benches and terraces made up of Kaibab limestone chips overlying Moenkopi shale and sandstone-derived soils. The plants grow in gravelly alluvium on the gently sloping (0-10") benches, in exposed, sunny situations. The cactus occurs between 1,177 and 1368 meters (m) (3,861 and 4,488 feet [ft]) in elevation, which is the altitude of the Kaibab Formation (USFWS 1985). In the summer and winter months, *P. bradyi* spends most of its time below ground level covered by loose limestone fragments along the Marble Canyon plateaus of the Colorado River. The cacti typically respond to summer rainfall events by expanding above the soil (Heil et al. 1981). The vegetation where *P. bradyi* occurs is generally open and sparse, and characterized by low shrubs, grasses, and annuals. Associated plants include shadscale (*Atriplex confertifolia*), snakeweed (*Gutierrezia sarothrae*), and Mormon tea (*Ephedra viridis*). (USFWS, 1985; USFWS, 2012; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Members of *Pediocactus* produce dry, dull-colored fruit which are presumed not to be dispersed by birds or rodents, but rather wind or water. (NatureServe, 2015)

Population Information and Trends**Population Trends:**

Short-term trends indicate a decline of 10-30% (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

8 (NatureServe, 2015)

Population Size:

<2,500 (USFWS, 2012)

Population Narrative:

Long-lived and exhibits relatively low fecundity, which would increase the potential for a genetic bottleneck in conjunction with its isolated and restricted distribution, and limited micro-habitat (USFWS 2012). Navajo Nation populations are typically found in small widely scattered groups of 2 to 15 cacti. In 2004, only one population contained over 100 plants (Roth 2004). Scattered populations throughout its limited range. Short-term population trends indicate a decline of 10-30%. There are approximately 8 extant occurrences in Arizona (EO data in the NatureServe central database as of August 2013). Total population abundance is still unknown. There are less than 2500 individuals (Butterworth and Porter 2013). (USFWS, 2012; NatureServe, 2015)

Threats and Stressors

Stressor: Off-highway vehicles (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Several reports discuss the current or potential threat from OHV use on BLM, NPS, and NN lands. Historically, the threat from OHV activity was described by BLM as random and sparse (BLM 1986); Spence (1992) mentions that the most immediate threat at the time was OHV traffic on NPS lands; and since the early 1990s NN has documented unauthorized public vehicles accessed in areas where *P. bradyi* and its habitat occur (Roth 2008). For BLM, improvements were made through road closures, and monitoring reports (2002, 2004, and 2007) have not

documented any recent OHV activity that resulted in effects to *P. bradyi* (Hughes 2009). For the NPS, the location of *P. bradyi* near the Lee's Ferry road suggests that the potential for OHV damage could exist; however, there is no current monitoring or documentation of such occurrence. Unauthorized vehicle access to *P. bradyi* habitat on the NN has been a problem in the past. In 2008, the NDFW installed a low running cable to prevent vehicle access to the area. Provided the cable on the NN is effective and additional road closures on BLM lands remain in place, the Service believes the threat from OHVs to *P. bradyi* is low and are no longer considered significant. (USFWS, 2012)

Stressor: Uranium mining (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Historically, uranium mining and exploration were considered potential threats due to a number of exploration and mining permits near *P. bradyi* populations that were submitted for review in the mid-1980s (USFWS 1985). As stated previously, no active uranium mining occurs within *P. bradyi* habitat and the Secretary of the Interior approved a withdrawal of approximately one million acres of public land surrounding Grand Canyon National Park from mineral entry for 20 years (DOI 2012). No mines will occur in the House Rock Valley and, therefore, will not pose a threat to *P. bradyi*. Thus, the Service believes uranium mining has become an insignificant threat to the species and is not expected to occur in the foreseeable future. (USFWS, 2012)

Stressor: Livestock grazing (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Historical livestock use, prior to the 1930s, on the BLM's Portion of the Kane Ranch was estimated to have about 3,000 head of cattle until the Grand Canyon Cattle Company became the operators and the herd was increased to 20,000 head. By 1934, the Taylor Grazing Act set into motion public lands grazing regulations (BLM 1999). Currently, management actions such as the 1992 ACEC plan and subsequent 1994 plan, and the Biological Opinion for the Kane Ranch Allotment Management Plan provided actions to protect *P. bradyi*, including moving livestock waters, closing areas to vehicles, and monitoring to determine livestock trampling effects on the cactus (Hughes 2005). The most recent RMP (BLM 2007) provides management actions for special status plants (including *P. bradyi*) where disturbance, injury, or mortality of such plants from livestock grazing will be minimized or eliminated through the implementation of conservation measures. As discussed previously in section 2.2.3, livestock trampling transects on the Kane Ranch Allotment (completed in 2001, 2002, and 2003) identified a total of 15 cacti that were stepped on and only 1 of those resulted in mortality (Hughes 2005). Although livestock trampling is possible, BLM recognizes that the occurrence is infrequent to uncommon (BLM 2007). Thus we believe as long as grazing continues where *P. bradyi* occur, the threat from livestock will remain but the severity of impact is considered low and is not considered to increase in the foreseeable future due to current management practices on BLM lands. As of 1992, the NPS lands were not grazed by cattle, and no sign of livestock activity was seen in the area (Spence 1992). There is no additional information available to suggest that the status of livestock activity in the area has changed to date. Thus the Service believes livestock grazing on NPS lands will continue to be an insignificant threat to *P. bradyi*. (USFWS, 2012)

Stressor: Collection (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Threats related to collection of *P. bradyi* were discussed in reports from BLM (HMP 1986), NPS (Spence 1992), and the Recovery Plan (USFWS 1985). Historically collections were considered a serious threat; however, annual monitoring of the cactus indicates collection is rare on BLM and NPS lands (Hughes 2005 and Spence 2008) and Roth (2008) indicates illegal collection appears to be a minor threat on NN lands. Thus the Service believes the threat from collection is low and is no longer considered a significant threat to *P. bradyi*. (USFWS, 2012)

Stressor: Recreational off-highway vehicles (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Off-road vehicle recreational use has been reduced to a minimum on BLM and NPS lands but NN lands may continue to have violations if the low running cable to deter vehicles in *P. bradyi* habitat is ineffective. As stated previously, provided the cable on the NN is effective and additional road closures on BLM lands remain in place, the Service believes the threat from OHVs to *P. bradyi* is low and are no longer considered a significant threat. (USFWS, 2012)

Stressor: Filming crews and movie set locations (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: On the NN, the Navajo Office of Broadcasting Services (Navajo Nation Department of Parks and Recreation [NDFW]) regularly gives out permits for filming along the picturesque rims of Marble Canyon. These permits do not require film crews to clear an area through biological assessments or evaluations. Because of the short timeframe of the filming activities and the remoteness of the habitat, the NDFW may not be aware of all ground-disturbing activities in the habitat of *P. bradyi* (Daniela Roth, former NN botanist, summary of email communication, July 27, 2010). At this time the Service is not aware of any resolutions or changes in communication between the two departments, and threats from filming crews will likely continue in the future. As stated previously (section 2.2.3) disturbance occurred in 1993 and 1994 from a film crew and in 2001 from a stunt jumper. These ground disturbing activities resulted in mortality and in soil compaction which restricts recovery and seedling recruitment. The Service concludes that recreational and commercial filming activities are having and will continue to have impacts on *P. bradyi* on the NN. (USFWS, 2012)

Stressor: Predation (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Disease is not mentioned as a new threat; however, there have been instances where predation by rodents has impacted populations during times of drought. Significant mortality attributed to rodents reduced the total population in the North Canyon plot (on BLM lands) from 240 individual cacti in 1989 to 81 in 1990 with an additional 40 cacti removed through predation in 1991. Future interactions with climate could increase the likelihood of predation for the

cactus. We believe the potential threat from rodents is significant and is likely to have adverse impacts to populations of *P. bradyi* in the future, particularly under drought conditions, when other sources of moisture for rodents become scarcer. (USFWS, 2012)

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Based on the unequivocal evidence of warming of the earth's climate from observations of increases in average global air and ocean temperatures, widespread melting of glaciers and polar ice caps, and rising sea levels recorded in the Intergovernmental Panel on Climate Change Report (IPCC 2007), climate change is now a consideration for Federal agency analysis (GAO 2007). The earth's surface has warmed by an average of 0.74 C (1.3 F) during the 20th century (IPCC 2007) and, since 1960, the annual average temperature across the United States has increased by more than 2 F (1.1C) (Global Climate Change Impacts in the United States [GCCIOUS] 2009). The IPCC (2007) projects that there will very likely be an increase in the frequency of hot extremes, heat waves, and heavy precipitation events as a result of climate change. Overall effects from climate change to *P. bradyi* are unknown, but diminished seedling recruitment and overall population numbers described above could be exacerbated by recent temperature increases and precipitation decreases. Depending on the specialization of the native bee pollinators of this cactus, changes in climate could alter the blooming and foraging phenologies between the cactus and its insect pollinators, leading to changes in pollination occurrence and efficiency, and ultimately, impacts to sexual reproduction. Interactions among population demographics should be monitored in conjunction with climate changes to understand and track the status of this cactus. Although the effects of climate change are not clearly understood at this time, the Service believes the impacts to the populations of *P. bradyi* could be severe in the future. (USFWS, 2012)

Stressor: Invasive plant species (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: The rapid increase in the exotic species Mediterranean grass (*Schismus barbatus*) in the locality *P. bradyi* may have been triggered by recent changes in climate. Spence (2008) states the proliferation of this exotic grass could negatively affect soil moisture within suitable habitat for *P. bradyi*, and increase the potential for fire in high density years. This information described by Spence (2008) is anecdotal and speculative in theory and there are no current data available to confirm or dispute the potential influences of exotic grasses to cacti at this time. But, as we describe above, other nonnative invasive grasses outcompete native species for soil nutrients and water (Melgoza et al. 1990, Aguirre and Johnson 1991, Brooks 2000) and we expect that Mediterranean grass could have the same impact to *P. bradyi*. The impacts from altered pollinator behavior and a reduction of soil nutrients and water could adversely affect *P. bradyi* populations; however, the extent of these impacts is unknown at this time. Thus, we believe the threat is low to moderate and may continue to affect *P. bradyi* in the future. The potential for increased fire frequency and severity is a significant threat to *P. bradyi* since the habitat in which they reside is not fire adapted. Invasions of annual, nonnative species are well documented to contribute to increased fire frequencies (Brooks and Pyke 2002, Grace et al. 2002, Brooks et al. 2003). The disturbance caused by increased fire frequencies creates favorable conditions for

increased invasion by nonnative grasses. The end result is a downward spiral where an increase in invasive species results in more fires, more fires create more disturbances, and more disturbances lead to increased invasive species densities. The risk of fire is expected to increase from 46 to 100 percent when the cover of cheatgrass (*Bromus tectorum*) increases from 12 to 45 percent or more (Link et al. 2006). The invasion of nonnative grasses into the Mojave Desert of western North America poses similar threats to fire regimes, native plants, and other federally protected species (Brooks et. al. 2004). Brooks (1999) also found that high interspace biomass of nonnative grasses resulted in greater fire danger in the Mojave Desert. Brooks (1999) goes on to state that the ecological effects of nonnative grass-driven fires are significant because of their intensity and consumption of perennial shrubs. Although *P. bradyi* does not grow in the Mojave Desert, the studies above include Mediterranean grass. Furthermore, the Great Basin Desert Scrub community that *P. bradyi* occur in does not receive much more rainfall; therefore, the effects of Mediterranean grass on *P. bradyi* are anticipated to be similar to those described in the Mojave Desert. Although specific information on the genus *Pediocactus* and fire adaptations are unknown, we expect the invasion of annual, nonnative species will likely increase the frequency and severity of fire beyond historical conditions within the *P. bradyi* habitat. For example, the Paradine plain cactus (*Pediocactus paradine*) was impacted by the Warm Fire in 2006. The area burned experience high vegetation mortality and the Forest Service expects many of the cacti were killed since surveys did not produce any live cacti (USDA 2007). It was suggested that the modification of historical management practices resulted in vegetation changes and the spread of nonnatives that altered the fire behavior from low intensity to more severe fires (USDA 2007). Thus, we believe the threat from nonnative grasses and the potential for increased fire behavior is a severe threat to *P. bradyi* and is likely to increase in the future. (USFWS, 2012)

Stressor: Small population size and limited genetic mixing (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: The species' low population level, restricted gene pool, and geographic limitations were described as natural factors affecting the population in the Recovery Plan (USFWS 1995). Although the reason for small population sizes and the potentially limited genetic mixing between *P. bradyi* has not been confirmed or evaluated, Benson (1982) suggests that the species of *Pediocactus* we have today are relicts of a more variable group of plants that once occupied suitable intervening sites between the present areas of distribution. For these relictual populations, the structural differences, extremely disjunct distribution, together with the lack of special means of seed dispersal and the physiological limitation of each species to a specific underlying rock or soil type, indicate long evolutionary periods of isolation. Although the specific reasons for small population sizes are unknown, the isolated distribution could create conditions of lowered connectivity among *P. bradyi* locations and depauperate genetic diversity. Thus, we believe small populations and potentially limited genetic mixing are likely a severe threat to *P. bradyi*; however, additional research is needed to determine the extent of the threat. (USFWS, 2012)

Recovery

Reclassification Criteria:

1. Permanent protection of 75 percent of the known habitat. (USFWS, 1985)

Delisting Criteria:

Delisting criteria are not available.

Recovery Actions:

- Management of ORV use, livestock grazing, and mining within habitat of populations on Federal lands. (USFWS, 1985)
- Inventory for new populations of *P. bradyi* (USFWS, 1985)
- Monitor and study existing populations. (USFWS, 1985)
- Development of a cactus trade management plan for all cacti. (USFWS, 1985)

Conservation Measures and Best Management Practices:

- The 1985 Recovery Plan should be updated with recovery criteria that reflect current threats to *P. bradyi*. Objective, measurable criteria for downlisting and delisting should be established. (USFWS, 2012)
- Studies should be conducted to evaluate the climate data for each plot or plots at various elevations. Studies should focus on site specific climate changes such as precipitation, snowfall, and temperature that influence reproduction, retraction, and seed germination. Appropriate climate gauges should be installed throughout *P. bradyi* habitat within BLM, NPS, and NN lands. (USFWS, 2012)
- Studies should be conducted to evaluate the effectiveness of seed germination and seedling establishment and if new populations can be established by seed or require transplants of already established plants (Spence 2008). (USFWS, 2012)
- Studies should be conducted to evaluate the pollination ecology of *P. bradyi* and evaluate whether the species is pollinator limited due to its early flowering (March-April) (Spence 2008). (USFWS, 2012)
- Identify and implement the control or eradication of nonnative species where needed. (USFWS, 2012)
- Improve coordination and communication between the NDFW and Navajo Office of Broadcast Services for actions permitted within *P. bradyi* habitat. (USFWS, 2012)
- Establish consistent monitoring protocols that allow comparison of data for population trend analyses. (USFWS, 2012)
- Work with the NN to develop a grazing plan within *P. bradyi* habitat. (USFWS, 2012)
- Construct fencing exclosures with educational signage around *P. bradyi* populations that appear to be more exposed to film sets or that need protection from OHV use. (USFWS, 2012)
- Studies specific to genetics or trends in genetic variation should be completed. (USFWS, 2012)

References

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USFWS. 2012. Brady Pincushion Cactus (*Pediocactus bradyi*) 5-Year Review: Summary and Evaluation. Arizona Ecological Service Field Office, Phoenix, Arizona

SPECIES ACCOUNT: *Pediocactus despainii* (San Rafael cactus)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/16/1987; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

A small, spiny succulent. Stems can swell to up to 6 dm in height, but during dry or cold weather the plants may not appear above ground at all; the species is easily overlooked except in the spring, when bronze-tinted, yellow to peach-colored flowers are in bloom (NatureServe, 2015).

Taxonomy

The plant genus *Pediocactus* contains nine species (eFloras 2014). Winkler cactus and San Rafael cactus are very closely related with a blending of morphological characteristics where their ranges meet (Porter et al. 1999) (USFWS, 2015).

Historical Range

Endemic to south central Utah (USFWS, 2015).

Current Range

San Rafael cactus is found exclusively in Emery County, Utah. Overall, the known San Rafael cactus populations are found from Dripping Spring in the north, to Big Ridge South/Keesle Country to the south (approximately 122 km (78.5 mi) north to south), and from Mussentuchit Mine in the west, near the border of Sevier to the Humbug population in the east (approximately 88 km (48.5 mi) east-west) (USFWS, 2015).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (USFWS, 2015)

Lifespan

Adult: 20+ years (USFWS, 2015)

Breeding Season

Adult: March - May (USFWS, 2015)

Key Resources Needed for Breeding

Adult: Bee pollinators (USFWS, 2015)

Reproduction Narrative

Adult: It is reported to have low fruit/seed output (USFWS 2007; NatureServe, 2015). Some monitored cacti lived at least 20 years after tagging, although the age of the cacti at the time of

tagging was unknown (Clark et al. 2015). The species reproduces sexually, is self-incompatible; cross pollination is needed to produce viable seeds (Tepedino 2000). Pollinators visiting San Rafael cactus include many species of bees, from multiple families. Flowering occurs from March to May with fruiting from May to June (Heil 1984) (USFWS, 2015).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Semi-arid grassland, desert pavements in pinyon-juniper woodlands (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 4,760-6,820 ft. elevation (USFWS, 2015)

Environmental Specificity

Adult: Moderate (inferred from USFWS, 2015)

Habitat Narrative

Adult: Inhabits desert pavements of cobble or pebble in pinyon-juniper woodlands (Flora of North America Editorial Committee 2003). Hills, benches and flats, of open, semi-arid grassland with scattered junipers and pinyon pines. (NatureServe, 2015). San Rafael cactus grows in a wide variety of soils, although it may favor fine textured mildly alkaline soils rich in calcium and derived from limestone substrates of the Carmel Formation and the Sinbad member of the Moenkopi formation. It has also been found on shale barrens of the Brushy Basin member of the Morrison, Carmel, Mancos and Dakota geologic formations and in areas of primarily alluvial and colluvium soils. It is found hill tops, and gentle slopes, and most abundantly on sites with a south exposure at elevations of 1450-2080 m (4760-6820 ft.). San Rafael cactus requires intact habitats relatively free of invasive species. This species also requires the presence of native plants which support their pollinators in order to successfully reproduction (USFWS, 2015).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Members of *Pediocactus* produce dry, dull-colored fruit which are presumed not to be dispersed by birds or rodents, but rather wind or water. Further, dispersal within populations appears to be staggered throughout the growing season from shortly after seeds are produced in June, to fall (NatureServe, 2015).

Population Information and Trends**Population Trends:**

Not available

Species Trends:

10 - 30% decline (NatureServe, 2015)

Resiliency:

Low (inferred from USFWS, 2015; see current range/distribution)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Moderate (inferred from USFWS, 2015)

Number of Populations:

21 (USFWS, 2015)

Population Size:

~8,200 (USFWS, 2015)

Minimum Viable Population Size:

Unknown; probably 500 individuals per population (USFWS, 2015)

Adaptability:

Low (inferred from NatureServe, 2015)

Population Narrative:

Little variation exists within populations. The fragile habitat makes the species vulnerable to disturbances. USFWS 2007). The short term population trend is decreasing (10 - 30%) (Butterworth and Porter 2013) (NatureServe, 2015). There are 20 populations of San Rafael cactus, with a total of approximately 8,200 documented individuals (BLM 2012, 2012a, 2013a; Truman 2014, 2015). Based on the most recent survey data, the estimated area of the known populations is approximately 152,971 ha (378,000 ac) (USFWS 2014). The minimum viable population size for this cacti species is unknown. It is likely that population sizes of at least 500 individuals per population are necessary to avoid extirpation (USFWS, 2015).

Threats and Stressors

Stressor: Recreation (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: The majority of the known San Rafael cactus individuals occur near established unpaved roads and are subject to dust effects. Pressures from recreation, including OHV use and biking are extremely high at the two largest known San Rafael cactus populations. All recorded individuals of San Rafael cactus occur on BLM (85 percent) or SITLA (15 percent) land that is open to OHV use on designated routes only. Two heavily used, unofficial OHV recreational areas are located adjacent to or within occupied habitat areas and are impacting individual plants and their habitat. In addition to OHV use, other forms of recreation, including camping and bike riding, exert pressure on some San Rafael cactus populations, particularly the Wedge and Millsite populations (USFWS, 2015).

Stressor: Livestock disturbance (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Trampling by livestock has been recognized as a threat to San Rafael cactus since at least 1981, with impacts to cacti documented regularly since that time (Heil et al. 1981; Spector 2013). Grazing is permitted throughout the known range of San Rafael cactus and evidence of livestock has been recorded in every population, although grazing pressure is not equal at every population or every surveyed site within a population. San Rafael cactus occurs on 19 grazing allotments managed by the BLM Price Field office (USFWS, 2015).

Stressor: Ungulate disturbance (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Deer prints have been documented within 15 cm (5.9 in) of San Rafael cactus at several sites and can locally be more abundant than livestock tracks but are not as widespread (Spector 2013). For example, in the Millsite/Clawson population, deer disturbance within 15 cm (5.9 in) was found in places at rates over 20 percent, including one survey site with a rate of 95% (BLM 2012); the survey sites are located near an area called Diversion Hollow (BLM 2012; Truman 2014). Deer winter in the area and spring use is high in some parts of the Millsite/Clawson population area. Impacts and disturbance to plants and habitat from wild horses and burros can be very similar to those of cattle and other livestock grazing. Wild horses and burros occur within a portion of San Rafael cactus range in the BLM Price Field Office planning area (BLM 2008a). (USFWS, 2015).

Stressor: Energy and mineral exploration and development (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Approximately 86 percent of the total population San Rafael cactus occurs on BLM land that is open to oil and gas leasing either with no additional constraints or subject to minor constraints, including the entirety of the two largest populations (The Wedge and Millsite/Clawson). Previous energy development activity in the Millsite area has destroyed individual plants and occupied habitat (BLM 2008a; Clark 2011). There is a high level of interest in development throughout the range and the majority of the species' occupied habitat is open to leasing. The negative impacts on cactus habitat from oil, gas, and mining development, are well documented (USFWS, 2015).

Stressor: Paleontological exploration (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: San Rafael cactus may be subject to some impacts from paleontological exploration and excavation. Emery County is the location of a number of paleontological sites, including the Cleveland-Lloyd Dinosaur Quarry near Price. Paleontological interest in the area has been increasing with recent finds on BLM land (Truman 2014). Disturbance to plants from paleontological activities can include direct injury or mortality of plants situated at an excavation site, effects from dust due to surface disturbance at excavation sites, and impacts from associated activities such as camping near and hiking into sites by paleontological field crews (USFWS, 2015).

Stressor: Invasive plants (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Non-native invasive species are known throughout the ranges of San Rafael cactus, the most common of which are cheatgrass (*Bromus tectorum*), halogeton (*Halogeton glomeratus*), and Russian thistle (*Salsola tragus*). San Rafael cactus inhabits sparsely vegetated areas that are not prone to fire, but the presence of invasive plants can alter local fire regimes (Stoddart et al. 1951; Harper et al. 1996; Brooks and Pyke 2001; Brooks et al. 2003; Duda et al. 2003). Cacti are not adapted to frequent fires in their habitats and are therefore not expected to persist through more frequent and intense fire cycles. In addition, fires may produce intense heat that can kill seeds, thereby reducing seedbank viability (Brooks and Pyke 2001) (USFWS, 2015).

Stressor: Collection (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: This species is highly desired in cactus collections and gardens and are sought by hobby and commercial cactus collectors (Hochstatter 1990; Heil 1984). The fact that this species is difficult to maintain in garden settings stimulates a continual demand for replacement plants as cultivated garden and greenhouse plants die. Cactus collectors are active in the Colorado Plateau, going from the habitat of one species of *Pediocactus* to the next to collect a complete set of the genus (Heil 1994; 52 FR 32914, September 16, 1987; 63 FR 44587, August 20, 1998) (USFWS, 2015).

Stressor: Predation (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: The species is susceptible to infestations and mortality of insect larvae, including the flightless cactus borer beetle (*Moneilema semipunctatum*). The cactus borer beetle larvae enter the plant by eating tunnels, usually at ground level in the stem of the plant and ultimately ingest most of the plant stems' succulent cortex. Cactus-borer beetle predation can result in 25 to 30 percent mortality in cacti populations, and episodic die offs of significant portions of this species populations due to cactus borer beetles were observed within the past 25 years (Kass 1990; Neese 1987; USFWS 1995; 52 FR 32914, September 16, 1987; 63 FR 44587, August 20, 1998). San Rafael cactus is also predated by weevils. At the Wedge population, 3 percent were found to be infested with weevils which consume the flower buds thereby preventing reproduction. An additional 5 percent were noted to have damage from an unidentified rodent or insect, and several were observed to be infested with the cactus borer beetle (Robinson 2011) (USFWS, 2015).

Stressor: Small population size (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Of the known populations of San Rafael cactus, more than half consist of less than 100 recorded individuals and all but three consist of less than 500 individuals (even if the five populations in the McKay flats allotment were shown to be connected, that population would still consist of less than 500 individuals based on current data). This means a majority of populations of this species are moderately to extremely vulnerable to extirpation from known threats and stochastic events. Very little data on genetic diversity within this species exists, and none at all for many of these populations. The loss of any one population could constitute a major loss of genetic diversity for the species (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: climate change and its impacts to the region are well documented and projected to continue and increase. There was a documented decline of Winkler cactus during the 1999-2003 drought, and the similarity of San Rafael to Winkler cactus suggests a comparable response. (Clark and Clark 2008). Additionally, rare plants have a negative response to drought (Roth 2003, 2004; Van Buren and Harper 2003, 2004), and drought severity and frequency is set to increase due to climate change (IPCC 2007; Karl et al. 2009) (USFWS, 2015).

Recovery

Reclassification Criteria:

Not available

Delisting Criteria:

1. Based on analysis and modeling implemented under the recovery actions, trends for San Rafael cactus populations are shown to be stable or improving according to the following measures: a) Species presence is maintained at all known San Rafael cactus populations; and b) Within at least three-quarters of the known populations that represent the majority of the total known individuals (and including the Wedge, Millsite/Clawson, and all of the McKay Flats populations) and represent the range of geographical, morphological, and genetic diversity of San Rafael cactus, plant density within occupied habitat is stable or improving over a 20-year period. These populations would be designated as Recovery Populations and this measurement would be based on a standardized, long term monitoring protocol developed by the Recovery Team and managing agencies; and c) Predictive modeling using data from an additional 10-year period (30 years total), collected in accordance with a standardized monitoring protocol, provides an indication of long-term demographic stability as well as a projected survival probability of at least 95 percent over 100 years for the species (USFWS, 2015).

2. Based on best available data, the available habitat base for each recovery population of the species is of sufficient quality and large enough to allow for natural population dynamics, population expansion where needed, and the continued presence of pollinators, with sufficient connectivity to allow for needed gene flow within and, where possible, among populations (USFWS, 2015).

3. Population and habitat management is implemented for all populations of the species in accordance with management plans developed under Recovery Action 1 (Section 3.4). The

management plan will include a course of action that addresses the following needs: habitat protection and management, threats abatement, biological and threats monitoring, and reporting and evaluation (USFWS, 2015).

4. Federal land protection through long-term management agreements or plans is achieved for all known San Rafael cactus populations. Protection considerations from grazing impacts, development, mining, oil and gas, and recreation must be included in the management agreements and the protected areas must meet the size and connectivity parameters determined through research to be adequate to sustain those populations. These may include but are not limited to resource management plans, conservation agreements, recreation management plans, and travel management plans (USFWS, 2015).

5. Management agreements or plans in place and being implemented for all San Rafael cactus populations on all federal lands must include measures to address and curtail illegal collection activities. These plans should include criteria for appropriate law enforcement at correct times and places to prevent illegal collection and sales of plants or any plant parts (USFWS, 2015).

6. Adverse population-level effects from herbivory, disease, or predation, if any, are identified, monitored and abated to the extent that at least three quarters of known San Rafael cactus population trends are stable or increasing, as evidenced by demographic monitoring results from studies that have adhered to monitoring protocols developed under Recovery Action 2.4 (Section 3.4). Programs to control excessive herbivory or predation will be developed to adaptively manage each population per criterion P-3, and must take into consideration the degree which climate change may impact disease or herbivory levels in the future (USFWS, 2015).

7. Land protection covering the habitat of all populations for the species and/or statutory and regulatory protections for plants are such that the protections of the ESA are no longer needed to compensate for regulatory inadequacies (USFWS, 2015).

8. A long-term ex-situ conservation program is ongoing for all extant San Rafael cactus populations. This would include seed collection and storage, germination and viability trials, and development of a protocol for successful reproduction under greenhouse conditions. This would help avert the risk of extinction from stochastic events or environmental catastrophes (USFWS, 2015).

9. In conjunction with recovery criterion P-2 (criterion 2), the available habitat base for each of the populations designated under criterion P-1 (criterion 1) is of sufficient quality and large enough to offset the threat of loss or restriction of the species' pollinators. Effective measurement criteria will be developed through research under Recovery Action 3 (USFWS, 2015).

Recovery Actions:

- Protect and conserve known extant Winkler cactus and San Rafael cactus populations and their habitat (USFWS, 2015).
- Survey for additional populations, and monitor all populations in order to apply conservation measures where and when needed (USFWS, 2015).

- Conduct in depth research into the biology, requirements, threat responses, and life histories of both species in order to develop and implement appropriate management practices for the purposes of achieving recovery (USFWS, 2015).
- Promote communication by encouraging and creating dialog regarding these species between managing agencies, land owners, developers, and the public in order to raise awareness and aid recovery (USFWS, 2015).
- Coordinate and work together with all stakeholders to achieve recovery (USFWS, 2015).

Conservation Measures and Best Management Practices:

- Survey and repeat inventory efforts were completed throughout the range of the species beginning in 1987. These were a responsibility of the Interagency team from 1998 through 2008, which then transferred to individual managing agencies from 2011-2013. Because of these efforts, there is a better understanding of the status and distribution of the species as well as habitat requirements. Although many more occupied sites and populations are now known than at the time of listing, not all suitable habitat has been surveyed. There is currently no comprehensive, funded plan from any of the managing agencies for continued inventory and monitoring of the species (USFWS, 2015).
- A habitat modelling project for the species has been initiated by the USGS, with funding from USFWS and the support of the BLM and CRNP, which will use existing inventory and site data to help determine potential suitable habitat and delineate the range of San Rafael cactus. The model will identify the most influential environmental factors of presence/absence for the species. This will be useful in locating additional sites and populations, as well as helping determine the need for cactus surveys prior to proposed projects that impact potential habitat (USFWS, 2015).
- Seeds of San Rafael cactus have been collected for conservation purposes, most recently in 2013. Seeds are currently stored and maintained at the National Center for Genetic Resource Preservation in Ft. Collins, CO and at Red Butte Garden in Utah. No plants are currently being propagated (USFWS, 2015).

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SPECIES ACCOUNT: *Pediocactus knowltonii* (Knowlton's cactus)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/28/1979; Southwest Region (Region 2) (USFWS, 2016)

Physical Description

A small succulent with solitary or clustered stems, up to 5.5 cm tall, but usually only barely protruding from the soil. The stem is dotted with small projections, each encircled at the top by a ring of white spines. The Knowlton cactus is solitary or clustered, globular, ranging in size from 0.7-5.5 cm tall and 1-3 cm in diameter, light gray-green; no central spines; radial spines minute, 18-24 from areole at tip of tubercle, white, pectinate-spreading, 2 mm long (Earle 1980). From mid-April through early May, pink, yellow-centered flowers bloom on top of the stems. (USFWS, 1985; NatureServe, 2015)

Taxonomy

The most recent taxonomic treatment of the genus *Pediocactus* maintains the species rank of *Pediocactus knowltonii* for this taxon (Heil and Porter 2003). Chloroplast DNA sequence analysis provides support that it is a recent developmental mutation from its closest relative, *Pediocactus simpsonii* (Heil and Porter 2003). (USFWS, 2010)

Current Range

Known only from one site in northwestern New Mexico in northern San Juan County. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (outcrossing) and asexual (NatureServe, 2015)

Breeding Season

Adult: May (NatureServe, 2015)

Reproduction Narrative

Adult: Flowering occurs in early May and fruits ripen in June and July (Sivinski and McDonald 2004). Most *P. knowltonii* bloom at 3-4 years of age. The fruit dehisces from mid-to-late June by a vertical slit along one side of the ovary wall. The seeds fall to the base of the parent plant. (USFWS; 1985; NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest/woodland, woodland- conifer (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found under the shade of trees and shrubs and in open areas in dry pinyon-juniper woodlands at 1800-2000 m elevation. (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Patchy (USFWS, 1985)

Habitat Narrative

Adult: *Pediocactus knowltonii* grows on tertiary alluvial deposits that have formed gravelly, dark, sandy loams on slopes or hills. It is found under the shade of trees and shrubs and in open areas in dry pinyon-juniper woodlands at 1800-2000 m elevation. The annual precipitation for this region is 30 cm (12 in), mostly during summer and winter months. The seeds are carried downslope and are trapped among the cobbles and pebbles, or by the duff under a sagebrush, pinyon, or juniper plant. This may account for the patchily distributed seedlings. (USFWS, 1985; NatureServe, 2015)

Dispersal/Migration**Dispersal**

Adult: Low to medium (USFWS, 1985)

Dispersal/Migration Narrative

Adult: The seeds fall from the fruit of the plant to the base of the parent plant. Running water appears to be the major factor in carrying the seeds away from the parent plants. *P. knowltonii* has dry fruits and probably is dispersed by wind and water given the scattered high-density colonies, and not often dispersed long distances by animals (Gucker 2007). (USFWS, 1985; NatureServe, 2015)

Population Information and Trends**Population Trends:**

Long-term trends indicate a decline of >90%, whereas short-term trends suggest a decline of 10-30% (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

1 (NatureServe, 2015)

Population Size:

5,000-10,000 individuals (NatureServe, 2015)

Population Narrative:

Knowlton's cactus occurs within a single natural population in northern San Juan County, New Mexico. Long-term trends populations indicate a decline of >90%, whereas short-term trends suggest a decline of 10-30%. There were 9,000 individuals documented in the wild in 1986. In 1992, there were about 12,000 individuals (Sivinski and McDonald 2007 cited by USFWS 2010). The peak was about 14,000 individuals in 1994. By 2008, the population had declined to about 6,100 (Sivinski 2008 cited by USFWS 2010). There have been plants transplanted to three other locations but none are considered viable populations (USFWS 2010). (NatureServe, 2015)

Threats and Stressors

Stressor: Gas exploration and development (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The Public Utilities Company of New Mexico donated the title to the surface rights of the preserve to TNC in 1983; however, TNC does not own mineral rights beneath the land. This region is severely impacted by natural gas development and an active well pad is adjacent to the south fence of the TNC preserve boundary. New Mexico Oil and Gas Conservation rules require a minimum well spacing of 65 ha (160 ac). The Oil and Gas Commission may grant exceptions for lesser spacing; however, it is unknown whether they would grant an exception that would impact a TNC preserve for an endangered cactus. Six energy firms hold mineral rights beneath the TNC lands (Service 1985). Therefore, the potential for natural gas exploration, development, and production in and around the TNC lands exists. (USFWS, 2010)

Stressor: Illegal collections (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Cacti are desirable plants whose wild populations in the U. S. and Mexico have been subject to illegal collection and trade (Robbins 2003). Some cactus hobbyists, known as cactophiles, are well known for their passion and interest in rare and recently discovered cactus species and have gone to illegal lengths to obtain certain species for their private collections (Robbins 2003). After being listed and protected as an endangered species under the Act, the Knowlton's cactus population on TNC lands began to recover and was less impacted by cactus collectors. Commercial collecting of large quantities of cacti from the field appears to have been reduced because of the difficulty in marketing these plants legally. (USFWS, 2010)

Stressor: Predation (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Knowlton's cactus appears to be relatively free of disease organisms (Robert Sivinski, unpublished observations, 1990-2008). Predation by rabbits or rodents is a significant cause of mortality (Sivinski and McDonald 2007; Sivinski 2008). This type of predation removes all or most of the above-ground part of the plant and is more frequent during periods of drought. The maturing fruits of Knowlton's cactus are also preyed upon by rodents, presumably deer mice (*Peromyscus* sp.). An attempt to gather seed from the TNC population to plant at a new location

failed because almost all the seeds in mature fruits were eaten by rodents as soon as the fruit ripened (Sivinski and McDonald 2007). Seed predation by rodents was almost 100 percent in June of 1993 (Sivinski 1993). (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Climate models project substantial changes in New Mexico's climate over the next 50 to 100 years. Projected climate changes by mid- to late-21st century include: air temperatures warmer by 6-12°F on average, but more in winter, at night, and at high elevations; more episodes of extreme heat, fewer episodes of extreme cold, and a longer frost-free season; more intense storm events and flash floods; and winter precipitation falling more often as rain than as snow (IPCC 2007). Some climate models project that average precipitation will increase, while others predict a decrease (NMCCAG 2005). Demographic trends in the natural Knowlton's cactus population appear to be influenced by climate. Rodent or rabbit predation on adult cacti increases during periods of drought and significant germination events have not been observed since 1994 (Sivinski 2008). The natural population has been in continuous decline for 14 years (Sivinski 2008). In fact, the estimated Knowlton's cactus population in 2008 was 6,100, the lowest number ever recorded, comprising less than half of the 14,000 observed in 1994 (Sivinski 2008). Weather cycles that positively influence germination and establishment of northwestern New Mexico plants are more frequent than 14 years (Sivinski and Knight 2001; Sivinski 2007). This unusually long period of decline in the natural Knowlton's cactus population may be indicating that a climatic threshold for this species has been crossed and future demographic trends will continue to decline. (USFWS, 2010)

Recovery

Reclassification Criteria:

Reclassification criteria are not available.

Delisting Criteria:

Delisting criteria are not available.

Recovery Actions:

- Secure cooperation of the Nature Conservancy. (USFWS, 1985)
- Reintroduce the cactus into sites within its historical range. (USFWS, 1985)
- Monitor the species to obtain population data that can be used to suggest other recovery strategies and management techniques. (USFWS, 1985).

Conservation Measures and Best Management Practices:

- The recovery plan for the species needs to be revised to incorporate new information on biology, ecology, and management recommendations. Objective and measurable recovery criteria for down and delisting of the species should be developed which also address all listing factors relevant to the species. (USFWS, 2010)
- Legally grown seeds and plants of Knowlton's cactus should continue to be made available in the commercial succulent trade, but law enforcement must remain vigilant against the theft of cacti from the TNC population. (USFWS, 2010)

- Provide viable Knowlton's cactus seeds to a seed bank operating under the Center for Plant Conservation guidelines. (USFWS, 2010)
- Continue the monitoring program, including documenting losses attributed to illegal collectors. Monitor the species' response to changes in seasonal rainfall and temperature patterns. (USFWS, 2010)

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SPECIES ACCOUNT: *Pediocactus peeblesianus fickeiseniae* (Fickeisen Plains cactus)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/31/2013; Southwest Region (Region 2) (USFWS, 2013)

Physical Description

The Fickeisen plains cactus is a small, unbranched to occasionally branched, globose (globular) cactus. At maturity, many plants are the size of a quarter making them difficult to locate even when their location is known. The stems of mature Fickeisen plains cactus are 2.5 to 6.5 cm (1.0 to 2.6 in) tall and up to 5.5 cm (2.2 in) in diameter; covered with tubercles (knoblike projections on the main stem) that form a spiral pattern around the plant. Each tubercle has 6 to 7 radial spines per areole (tip where spines develop), 4 to 7 millimeters (mm) (0.15 to 0.27 in) in length, and 1 central spine (15 to 18 mm (0.59 to 0.70 in) long) that is straight to strongly curved. Spines are soft and corky (spongy) and white to pale gray in color. Flowers are 2.5 cm (0.98 in) in diameter, cream-yellow or yellowish-green in color, and produced on the apex (top) of the stem. Fruits are turbinate (top-shaped), and turn reddish-brown at maturity. The seeds are dark brown to black, 3 mm (0.11 in) long, and 2 mm (0.08 in) wide. (USFWS, 2013)

Taxonomy

The Fickeisen plains cactus was first discovered near Cameron, Arizona, in the late 1950s. It was originally described in the scientific literature by Benson (1969), then later by Heil et al. (1981), who recognized the name and taxon in a review of the genus *Pediocactus*. The Flora of North America treats the taxon as a subspecies of *Pediocactus peeblesianus*, finding that the name "*Pediocactus peeblesianus* var. *fickeiseniae*" was not validly published by Benson. The Service considers *Pediocactus peeblesianus* var. *fickeiseniae* to be a valid taxon since it was classified as a candidate species in 1980. Our previous documentation referring to the Fickeisen plains cactus used the name "*P. peeblesianus* var. *fickeiseniae*", and we will continue to use this name. Other synonyms of *Pediocactus peeblesianus* var. *fickeiseniae* that have been used are *Navajoa fickeisenii* and *Toumeyia fickeisenii*.

Historical Range

Very little is known about its historical range. It has been described as widespread along the ledges of the Little Colorado and Colorado Rivers to the hills of the lower House Rock Valley; also with a range northern Arizona from the hills in northeast Mohave County to the vicinity of the Colorado and Little Colorado rivers near the Grand Canyon National Park and southeast Coconino County. (USFWS, 2013)

Current Range

The current range is in Coconino and Mohave Counties in northern Arizona, extending from Mainstreet Valley of the Arizona Strip (i.e., the area north of the Colorado River to the Arizona-Utah border) to House Rock Valley; along the canyon rims of the Colorado River and Little Colorado River; the area of Gray Mountain; and along the canyon rims of Cataract Canyon on the Coconino Plateau. (USFWS, 2013)

Critical Habitat Designated

Yes; 9/19/2016.

Legal Description

On August 18, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective September 19, 2016) for *Pediocactus peeblesianus fickeiseniae* (Fickeisen Plains cactus) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six critical habitat units (CHUs), in three counties in Arizona (81 FR 55266--55313).

Critical Habitat Designation

The critical habitat designation for *Pediocactus peeblesianus fickeiseniae* (Fickeisen plains cactus) includes six CHUs (including 10 sub-units) in Maricopa, Pima, and Pinal Counties, Arizona. This species' critical habitat encompasses approximately 17,456 acres (ac) (7,062 hectares (ha)). Brief descriptions are presented below. Maps depicting the CH units are available in the Final Rule. (81 FR 55266--55313)

Unit 1: Hurricane Cliffs: The Hurricane Cliffs Unit is located on the Arizona Strip in the north-central area of Mohave County, Arizona. The unit lies predominantly on the Shivwits Plateau and is bounded to the west by Mainstreet Valley and to the east by the Hurricane Cliffs. The unit consists of four subunits totaling 3,044 ha (7,524 ac) and includes small areas of private land, lands owned by the State of Arizona, and federally owned land managed by the BLM. The entire unit occurs within the area referred as the Arizona Strip that is managed by the BLM for multiple land use purposes such as livestock grazing, fuels management, energy, and recreation. The BLM manages grazing leases for large allotments comprised of a mix of their lands as well as State lands. Occupancy of the Hurricane Cliffs Unit by the Fickeisen plains cactus has been documented since 1986 (BLM 1986, p. 1). The taxon was considered generally rare, but in abundant numbers at Dutchman Draw with a few scattered individuals located in small clusters adjacent to Dutchman Draw populations. These smaller clusters include the Navajo, Ward, Salaratus Draw I, Salaratus Draw II, Temple Trail, and Toquer Tank populations. This entire unit helps to maintain the geographical range of the species and provide opportunity for population growth. This unit also provides a core population of the species. **Subunit 1a: Dutchman Draw—** Subunit 1a consists of 1,527 ha (3,774 ac) of land near Dutchman Draw in Mainstreet Valley. The subunit occurs within the Shivwits Plateau and along an exposed fault. Lands within this subunit were occupied at the time of listing. A monitoring plot was established at this site in 1986. The BLM has visited the plot regularly since then. Monitoring information has shown fluctuations in plant numbers between years, but among all years, there is an overall decline in plant numbers from a peak of 219 individuals in 1992 to 5 individuals in 2012. This subunit also includes the Navajo and Ward cluster plots that were established to note presence or absence of the cactus. These small plots were last visited in 2001, and 10 plants were found at each of the plots. This subunit contains all of the primary constituent elements of the physical or biological features essential to the conservation of the Fickeisen plains cactus. Occupied habitat areas in this subunit occur predominantly within the Plains and Great Basin grassland with a small portion in the Great Basin desertscrub vegetation communities. Plants occur amongst tall, dense clumps of grama grass with some desert shrubs. The subunit is located at the foot of a gently sloping hill in fine alluvium deposits. Most of the bedrock surface is limestone, siltstone, and gypsum of the Kaibab Formation. **Subunit 1b: Salaratus Draw—**Subunit 1b consists of 724 ha (1,789 ac) of land near Salaratus Draw. The subunit overlies an active fault on the Shivwits Plateau. Lands within this subunit were occupied at the time of listing and include Salaratus Draw I and Salaratus Draw II

populations. This site was visited only three times between 1986 and 2001. At most, 44 plants were located in this subunit when last visited in 1994. This subunit contains all of the primary constituent elements of the physical or biological features essential to the conservation of the Fickeisen plains cactus. Subunit 1c: Temple Trail—Subunit 1c consists of 443 ha (1,096 ac) of land in Lower Hurricane Valley. This subunit lies on the Hurricane Cliffs. It is bounded by the Shivwits Plateau to the west and the Uinkaret Plateau to the east, separated by an active fault that runs north along the Hurricane Cliffs. Lands within this subunit were occupied at the time of listing. This site was last visited in 2001 when seven individuals were found. This subunit contains all of the primary constituent elements of the physical or biological features essential to the conservation of the Fickeisen plains cactus. Subunit 1d: Toquer Tank—Subunit 1d consists of 350 ha (865 ac) of land in Lower Hurricane Valley. Lands within this subunit were occupied at the time of listing. This site was regularly monitored from 1986 to 1991, when abundance counts ranged from 7 to 13 plants. This site was last visited in 1994, and seven individuals were found. This subunit contains all of the primary constituent elements of the physical or biological features essential to the conservation of the Fickeisen plains cactus. The features essential to the conservation of the species within this unit are threatened by livestock grazing; nonnative, invasive species issues; small mammal predation on the cactus; and long-term drought coupled with increased minimum winter temperatures. Special management considerations or protection may be required to minimize habitat disturbance to Fickeisen plains cactus individuals, soil, and associated native vegetation; and to prevent or remove nonnative, invasive species within its habitat.

Unit 2: Sunshine Ridge: The Sunshine Ridge Unit is located on the Arizona Strip and lies on the Kanab Plateau in Mohave County, Arizona. The unit totals 754 ha (1,863 ac). This unit contains land that is federally and State owned. The entire unit is managed primarily by the BLM for multiple land use purposes such as livestock grazing, fuels management, energy, and recreation. Plants are located east of the Uinkaret Plateau and east of the range of the *Pediocactus sileri* (Siler pincushion cactus). Occupancy of the Sunshine Ridge Unit by the Fickeisen plains cactus has been documented since 1977 (AGFD 2011b, entire). This population has been regularly monitored since 1986, and has 34 plants as of 2011. Land within this unit was occupied at the time of listing and contains all of the primary constituent elements of the physical or biological features essential to the conservation of the Fickeisen plains cactus. This unit helps to maintain the geographical range of the species and provide opportunity for population growth. This unit also provides a core population of the species. The features essential to the conservation of the species within this unit are threatened by livestock grazing; nonnative, invasive species issues; small mammal predation on the cactus; and long-term drought coupled with increased minimum winter temperatures. Special management considerations or protection may be required to minimize habitat disturbance to Fickeisen plains cactus individuals, soil, and associated native vegetation; and to prevent or remove nonnative, invasive species within its habitat.

Unit 3: Clayhole Valley: The Clayhole Valley Unit is located in Upper Clayhole Valley on the Arizona Strip and lies within the Uinkaret Plateau in Mohave County, Arizona. The unit consists of 414 ha (1,024 ac) of land that is federally and State owned. The entire unit is managed primarily by the BLM for multiple land use purposes including livestock grazing. Occupancy of the Clayhole Valley Unit by the Fickeisen plains cactus has been documented since 1980 (AGFD 2011b, entire). The population has been monitored annually since 1986. As of 2011, the population contains 42 plants. Land within this unit was occupied at the time of listing and contains all of the primary constituent elements of the physical or biological features essential to the conservation of the

Fickeisen plains cactus. This unit helps to maintain the geographical range of the species and provide opportunity for population growth. This unit also provides a core population of the species. The features essential to the conservation of the species within this unit are threatened by livestock grazing; nonnative, invasive species issues; small mammal predation on the cactus; and long-term drought coupled with increased minimum winter temperatures. Special management considerations or protection may be required to minimize habitat disturbance to Fickeisen plains cactus individuals, soil, and associated native vegetation; and to prevent or remove nonnative, invasive species within its habitat.

Unit 4: South Canyon: The South Canyon is located on the eastern boundary of the North Kaibab Ranger District of the Kaibab National Forest in Coconino County, Arizona. It is bounded by the Colorado River near Marble Canyon at House Rock Valley. It includes land originally designated as the Grand Canyon National Game Preserve that is now referred to as the Buffalo Ranch Management Area. It contains 110 ha (272 ac) of federally owned land that is administered by the Kaibab National Forest. This unit contains at least 62 individual Fickeisen plains cactus scattered among 6 areas along the rim of South Canyon Point. This unit contains all of the primary constituent elements of the physical or biological features essential to the conservation of the Fickeisen plains cactus. This unit helps to maintain the geographical range of the species and provide opportunity for population growth. This unit also provides a core population of the species. The primary land uses within this unit include big game hunting and recreational activities throughout the year. The area is very remote and may receive limited numbers of hikers, hunters, or campers. Under a memorandum of understanding, the Kaibab National Forest and the AGFD commit to managing the natural resources of this area, mainly big game species, to ensure that sensitive resources are not impacted and desired conditions are achieved (USFS 2012, p. 92). Livestock grazing by cattle and mining activities are not authorized within the Buffalo Ranch Management Area. Special management considerations or protection may be required within the unit to minimize habitat disturbance to the soil and associated native vegetation, and prevent invasion of nonnative plants. The features essential to the conservation of the species within this unit are threatened by nonnative, invasive species issues and long-term drought coupled with increased minimum winter temperatures. Special management considerations or protection may be required to minimize conditions that may promote or encourage encroachment and establishment of nonnative, invasive species; and reduce the likelihood of wildfires affecting the population and nearby plant community.

Unit 5: House Rock Valley: The House Rock Valley is located on the eastern edge of the Arizona Strip near the North Rim of the Grand Canyon National Park in Coconino County, Arizona. The unit consists of four subunits totaling 1,893 ha (4,678 ac) of land. The unit consists of land that is federally and State owned. The entire unit is managed primarily by the BLM, mainly for livestock grazing. Lands within this unit were occupied at the time of listing and contain all of the primary constituent elements of the physical or biological features essential to the conservation of the Fickeisen plains cactus. This entire unit helps to maintain the geographical range of the species and provide opportunity for population growth. This unit also provides a core population of the species. Occupancy of the Fickeisen plains cactus in the House Rock Valley Unit was first documented in 1979 (Phillips 1979, entire; AGFD 2011b, entire), at Beanhole Well, Marble Canyon, and South Canyon. These sites have not been visited for more than 21 years. However, we have no reason to believe these sites were not occupied at the time of listing for reasons provided in the "Distribution and Range" section of the final listing rule (78 FR 60608). Occupancy at the North Canyon Wash site was documented in 1986, and it has been regularly

monitored since. The House Rock Valley Unit is bounded by the Colorado River to the east, U.S. Highway 89A to the north, and the Kaibab National Forest to the west. Subunit 5a: Beanhole Well—Subunit 5a consists of 745 ha (1,841 ac) of federally owned land that is managed by the BLM, and 126 ha (312 ac) of Stateowned land. Lands within this subunit were occupied at the time of listing. Three plants were documented at Beanhole Well in 1979, and the site has been visited by Hughes since then, and while occupied habitat was observed, no plant numbers were reported to us (Calico 2012, pers. comm.). This subunit contains all of the primary constituent elements of the physical or biological features essential to the conservation of the Fickeisen plains cactus. Subunit 5b: North Canyon Wash— Subunit 5b consists of 472 ha (1,166 ac) of federally owned land that is managed by the BLM. Lands within this subunit were occupied at the time of listing. This site has been regularly monitored since 1986. As of 2011, the site contains 39 Fickeisen plains cacti. This subunit contains all of the primary constituent elements of the physical or biological features essential to the conservation of the Fickeisen plains cactus. Subunit 5c: Marble Canyon—Subunit 5c consists of 214 ha (528 ac) of federally owned land that is managed by the BLM. Lands within this subunit were occupied at the time of listing. Eight plants were documented at Marble Canyon in 1979. This site has not been visited for many years. This subunit contains all of the primary constituent elements of the physical or biological features essential to the conservation of the Fickeisen plains cactus. Subunit 5d: South Canyon—Subunit 5d consists of 336 ha (831 ac) of Federal land in House Rock Valley along the rim of Marble Canyon. Lands within this subunit were occupied at the time of listing. A total of 52 plants have been documented at this site historically. This subunit contains all of the primary constituent elements of the physical or biological features essential to the conservation of the Fickeisen plains cactus. The features essential to the conservation of the species within this unit are threatened by livestock grazing; nonnative, invasive species issues; small mammal predation on the cactus; and long-term drought coupled with increased minimum winter temperatures. Special management considerations or protection may be required to minimize habitat disturbance to Fickeisen plains cactus individuals, soil, and associated native vegetation; and to prevent or remove nonnative, invasive species within its habitat.

Unit 6: Gray Mountain: The Gray Mountain Unit is located in the vicinity of the town of Gray Mountain, Arizona, on Highway 89 in Coconino County. The unit consists of two subunits totaling 847 ha (2,095 ac). The unit includes a checkerboard mix of private land, lands owned by the State, and federally owned land managed by the BLM. Lands within this unit are considered occupied at the time of listing. Occupancy at the Gray Mountain unit was first documented in 1962, and consists of two very small populations on both sides of Highway 89. Occupied sites were visited in 2013, and a few plants in flower were observed. This unit contains all of the primary constituent elements of the physical or biological features essential to the conservation of the Fickeisen plains cactus. This entire unit helps to maintain the geographical range of the species and provide opportunity for population growth. This unit also provides a core population of the species. Subunit 6a: Mays Wash—Subunit 6a is located southeast of Highway 89 and consists of 326 ha (807 ac) of land. The subunit includes private land, land owned by the State, and federally owned land managed by the BLM. The entire subunit lies within a cattle ranch and is managed privately for livestock grazing. Lands in this subunit are considered occupied at the time of listing. Occupancy at this site was documented in 1981 and 1984, when 31 plants were found (AGFD 2011b, entire). A site visit to BLM land in 2013 located a few plants in flower. This subunit contains all of the primary constituent elements of the physical or biological features essential to the conservation of the Fickeisen plains cactus. Subunit 6b: Gray Mountain—Subunit 6b is located west of Highway 89 and borders the boundary of the Navajo Nation. This subunit

consists of 521 ha (1,288 ac) of land that is owned by the State and privately owned land. The entire subunit lies within a cattle ranch and is managed privately for livestock grazing. Lands in this subunit are considered occupied at the time of listing. Occupancy was documented in 2009 when three individuals were found (NNHP 2011a, p. 2). An individual in bloom was observed in 2013. This subunit contains all of the primary constituent elements of the physical or biological features essential to the conservation of the Fickeisen plains cactus. The features essential to the conservation of the species within this unit are threatened by livestock grazing by horses and sheep; nonnative, invasive species issues; mineral development and associated infrastructure; and long-term drought coupled with increased minimum winter temperatures. Special management considerations or protection may be required to minimize disturbance or destruction to the bedrock substrate and associated limestone soils; to prevent or remove nonnative, invasive species within its habitat; and protect the native vegetation communities.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Pediocactus peeblesianus fickeiseniae* critical habitat consists of the following components (81 FR 55266--55313):

- (i) Soils derived from limestone that are found on mesas, plateaus, terraces, the toe of gentle sloping hills with up to 20 percent slope, margins of canyon rims, and desert washes. These soils have the following features: (A) They occur on the Colorado Plateau in Coconino and Mohave Counties of northern Arizona and are within the appropriate series found in occupied areas; (B) They are derived from alluvium, colluvium, or eolian deposits of limestone from the Harrisburg member of the Kaibab Formation and limestone, siltstone, and sandstone of the Toroweap and Moenkopi Formations; (C) They are nonsaline to slightly saline, gravelly, shallow to moderately deep, and well-drained with little signs of soil movement. Soil texture consists of gravelly loam, fine sandy loam, gravelly sandy loam, very gravelly sandy loam, clay loam, and cobbly loam.
- (ii) Native vegetation within the Plains and Great Basin grassland and Great Basin desertscrub vegetation communities from 1,310 to 1,813 m (4,200 to 5,950 ft) in elevation that has a natural, generally intact surface and subsurface that preserves the bedrock substrate and is supportive of microbiotic soil crusts where they are naturally found.
- (iii) Native vegetation that provides for habitat of identified pollinators within the effective pollinator distance of 1,000 m (3,280 ft) around each individual Fickeisen plains cactus.

Special Management Considerations or Protections

When designating critical habitat, the Services assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features which are essential to the conservation of the species and which may require special management considerations or protection. All areas designated as critical habitat as described below may require some level of management to address the current and future threats to the physical or biological features essential to the conservation of the Fickeisen plains cactus. In all of the described units, special management may be required to ensure that the primary constituent elements for the cactus are conserved and the habitat provides for the biological needs of the cactus. Some of the management activities that could ameliorate these threats include, but are not limited to, those discussed below. (1) Practice livestock grazing in a manner that maintains, improves, and expands the quantity and quality of desertscrub and grassland habitat. Special

management considerations or protection may include the following: Manage livestock grazing sustainably with the natural landscape by determining appropriate areas, seasons, and use consistent within the carrying capacity of rangeland in response to current and future drought and warming trends; improve monitoring and documentation of grazing practices; manage cattle and feral hoofed mammals (ungulates) (e.g., horses, burros) to reduce the risk of plants trampled and soil compaction; and manage for other small mammal species to restore desired processes to increase habitat quality and quantity. (2) Manage for nonnative, invasive species, such as *Bromus tectorum* (cheatgrass), *Bromus rubens* (red brome), or *Erodium cicutarium* (redstem filaree), by minimizing conditions that may promote or encourage encroachment or establishment of nonnative, invasive species and restore or reestablish conditions that allow native plants to thrive. Within the range of the Fickeisen plains cactus, the establishment and success of nonnative, invasive species has been a result of historic land use and management practices such as logging, grazing, wildfire suppression actions, mining, and ORV use. Actions have been taken by land management agencies to reduce the spread of invasive species and reduce the risk of wildfire they pose from creating fine fuel loads. Nonnative, invasive species occur near Fickeisen plains cactus habitat and may pose a threat through competition for resources or increase the risk of fire. Special management considerations or protection may include the following: Prevent or restrict establishment of nonnative, invasive species; minimize ground-disturbing activities that may facilitate their spread; implement post-disturbance restoration activities such as native plant propagation; practice active removal of nonnative, invasive plant species and targeted herbicide application (provided herbicides can be shown not to negatively impact the Fickeisen plains cactus or the native pollinators); and improve monitoring and documentation on a site-by-site basis where nonnative, invasive species are present in occupied habitat to assess any effect (beneficial or negative) they pose of the cactus. (3) Protect bedrock surfaces and associated limestone soils that provide suitable habitat from mineral development and associated infrastructure (new roads). Numerous breccia pipes (vertical, pipe-shaped bodies of highly fractured rock that collapsed into voids created by dissolution of underlying rock) are located across the Colorado Plateau and are expressed as circular collapse structures, minor folds, and other surface irregularities associated with the Kaibab and Toroweap Formations. Exploration and development of uranium has peaked and waned in accordance with market values. Areas of interest and oil and gas leasing/exploration overlap Fickeisen plains cactus habitat. These activities could result in direct habitat loss or alteration by removing or degrading limestone soils to such an extent that the soils would no longer support the growth of the Fickeisen plains cactus. Special management considerations or protection may include the following: Protect lands that support suitable habitat and site future development such that the destruction or removal of limestone from the Kaibab, Toroweap, and Moenkopi formations is minimized and depositional areas are preserved. (4) Manage or protect native desertscrub and plains grassland vegetation communities from recreational impacts. Special management considerations or protections may include the following: Managing trails, campsites, and ORVs; and reduce the likelihood of wildfires affecting the population and nearby plant community. These management activities will protect the physical or biological features essential to the conservation of the Fickeisen plains cactus by reducing the direct and indirect effects of habitat loss, alteration, or fragmentation; preserving the bedrock surfaces and associated limestone soils that form the basis of its habitat; and maintaining the native vegetation communities and its pollinators. In summary, the primary constituent elements of the Fickeisen plains cactus habitat may be impacted by livestock grazing; nonnative, invasive species; mineral development and associated transportation infrastructure; and recreation. We find that these activities may not be direct threats to the species as a whole, but may negatively impact

the primary constituent elements. The areas designated as critical habitat within the geographical area occupied by the taxon at the time of listing contain the physical or biological features essential to the conservation of the Fickeisen plains cactus. Special management considerations or protection may be required to eliminate, or reduce to a negligible level, the threats affecting each unit or subunit and to preserve and maintain the essential features that the critical habitat units and subunits provide to the cactus.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (NatureServe, 2015)

Lifespan

Adult: The lifespan of the Fickeisen plains cactus is estimated to be between 10 to 15 years. (USFWS, 2013)

Breeding Season

Adult: Mid-April for flowering with fruiting in June (USFWS, 2013)

Other Reproductive Information

Adult: Reproduction has not been specifically studied on the Fickeisen plains cactus. For other species in the genus *Pediocactus*, reproduction occurs through cross-pollination by native bees. Insects observed visiting flowers of the Fickeisen plains cactus include species of hover flies (family Syrphidae) and bee flies (family Bombyliidae), mining bees (family Andrenidae), and sweat bees (family Halictidae). Although flies may pollinate flowers of the Fickeisen plains cactus, the primary pollinators of the plant are believed to be halictid bees from the genera *Lasioglossum*, *Halictus*, and *Agapostemon*, based on several studied species of *Pediocactus*. (USFWS, 2013)

Reproduction Narrative

Adult: *Pediocactus peeblesianus* var. *fickeiseniae* flowers in April to May and fruits mature in May to June. The cacti tend to produce abundant flowers (1-5 per plant) but not many seeds. Flowers generally open mid-morning (10-10:30 am) on fair, warm days but fail to open or only partially open in cold, cloudy or extremely windy weather (Navajo Natural Heritage Program 1994). Rainfall is very variable in the regions where Fickeisen Plains cactus grows and it exhibits episodic germination that is tied to the amount of precipitation. (NatureServe, 2015)

Habitat Type

Adult: Terrestrial (USFWS, 2013)

Habitat Vegetation or Surface Water Classification

Adult: Shallow, well-draining, gravelly loam soils derived from limestone (USFWS, 2013)

Dependencies on Specific Environmental Elements

Adult: Rainfall is very variable in the regions where it grows and it exhibits episodic germination that is tied to the amount of precipitation. (USFWS, 2013)

Geographic or Habitat Restraints or Barriers

Adult: 1200 - 1600 m elevation, 0 - 20 % slope (USFWS, 2013)

Environmental Specificity

Adult: Narrow endemic (USFWS, 2013)

Habitat Narrative

Adult: The Fickeisen plains cactus is a narrow endemic restricted to exposed layers of Kaibab limestone on the Colorado Plateau. Plants are found in shallow, well-draining, gravelly loam soils formed from alluvium, colluvium, or Aeolian deposits derived from limestone of the Harrisburg Member the Kaibab Formation and Toroweap Formation; Coconino Sandstone; and the Moenkopi Formation. Most populations occur on the margins of canyon rims, flat terraces, limestone benches, or on the toe of well-drained hills. Plants are found primarily on slopes of 0 to 5 percent but some also occur on slopes up to 20 percent at elevations between 1,280 to 1,814 m (4,200 to 5,950 ft). (USFWS, 2013)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: The mechanisms of seed dispersal in the Fickeisen plains cactus have not been investigated and are poorly understood. Most site visits to areas occupied by the Fickeisen plains cactus have observed seedlings established very close to the adult plant. The general shared belief is that most species of *Pediocactus*, including the Fickeisen plains cactus, lack a good mechanism for seed dispersal, which is a contributing factor to its endemism and isolated, localized populations. (USFWS, 2013)

Population Information and Trends**Population Trends:**

Short-term trends indicate a decline of 10-30% (NatureServe, 2015)

Number of Populations:

33 (USFWS, 2016)

Population Size:

1,132 (USFWS, 2016)

Population Narrative:

Approximately 1,132 plants occur in 33 populations documented within an 8,668-square-kilometer (sq km) (3,347-square-mile (sq mi)) range. About 90 percent of individuals occur in Coconino County (USFWS, 2016). Short-term population trends indicate a decline of 10-30%. This species has low seed production, small populations and very specific habitat requirements which suggest that it will always be naturally rare (Hughes 2000). The majority of suitable habitat on BLM lands has been surveyed, and the number of plants on BLM lands is estimated to be less than 1,000 individuals and possibly less than 500 (L. Hughes pers. comm. 2005 cited in Falk 2007). In 1994, the Navajo Natural Heritage Program documented the presence of 280 cacti on the Navajo Nation. Recent resurveys of these sites suggest that the number of plants is

declining (D. Roth pers. comm. 2007 cited in Falk 2007). No population estimates are available from the Kaibab National Forest (Falk 2007), which contains three occurrences. Estimates using the most recent counts from each occurrence suggest a total population size of about 850 total individuals (using extrapolation for a few uncounted occurrences); the number of mature individuals will be less than this, but probably not much less, as evidenced from some sites where the number of reproductive vs. vegetative plants has been recorded. Estimating using the highest number of plants ever recorded at each occurrence generates an estimate close to 2400 total plants. Approximately 35 occurrences are believed extant, 19 in Arizona and 16 on Navajo Nation lands. There are no known extirpated occurrences, although numbers at some occurrences do appear to have declined significantly since their original discovery. (NatureServe, 2015)

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: The Fickeisen plains cactus and its habitat is threatened by direct loss of plants and habitat loss and modification due to the direct and indirect effects of livestock grazing and drought and climate change. These threats, in and of themselves, may not result in significant population-level impacts to the Fickeisen plains cactus. However, the above factors appear to be acting synergistically, placing a major stress on the known plants monitored rangewide with little indication of population growth and age-class diversity (USFWS, 2013).

Stressor: Herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Small mammal herbivory on cactus species is known to occur during dry conditions when animals seek available moisture from the plant or available food from cactus fruit. Although clear evidence is lacking of the scope of the impact that rodent predation has had on the Fickeisen plains cactus and its seeds, taken in conjunction with other habitat disturbances occurring across its range, low recruitment, and small population size, we find that rodent or rabbit predation is likely to rise to the level where it becomes a significant threat to the plant (USFWS, 2013)..

Stressor: Small population size (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Small populations that are restricted by habitat requirements are more vulnerable to the effects of climate change, such as prolonged droughts and increased fire frequencies. Although small population size makes the species intrinsically more vulnerable, it is uncertain whether this alone would rise to the level of threat. However, when combined with the threats from livestock grazing, drought and climate change, and rodent and rabbit predation, small population size likely exacerbates the effects of these threats on the Fickeisen plains cactus (USFWS, 2013).

Stressor:
Exposure:
Response:
Consequence:
Narrative:

Recovery

Reclassification Criteria:

Reclassification criteria are not available.

Delisting Criteria:

Delisting criteria are not available.

Recovery Actions:

- Recovery actions are not available.

Conservation Measures and Best Management Practices:

- Conservation measures are not available.

References

USFWS. 2013. Endangered Species Status for *Echinomastus erectocentrus* var. *acunensis* (Acuña Cactus) and *Pediocactus peeblesianus* var. *fickeiseniae* (Fickeisen Plains Cactus) Throughout Their Ranges. Final Rule. 78 FR 60608 - 60652 (October 1, 2013).

U.S. Fish and Wildlife Service. 2016. Designation of Critical Habitat for the Acuna Cactus and the Fickeisen Plains Cactus. Final Rule. 81 FR 55266 - 55313 (August 18, 2016).

USFWS. 2013. Endangered Species Status for *Echinomastus erectocentrus* var. *acunensis* (Acuña Cactus) and *Pediocactus peeblesianus* var. *fickeiseniae* (Fickeisen Plains Cactus) Throughout Their Ranges. Final Rule. 78 FR 60608 - 60652 (October 1, 2013)

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

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Designation of Critical Habitat for the Acuna Cactus and the Fickeisen Plains Cactus. Final rule. 81 FR 55265 - 55313 (August 18, 2016).

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SPECIES ACCOUNT: *Pediocactus peeblesianus* var. *peeblesianus* (Peebles Navajo cactus)

Species Taxonomic and Listing Information

Commonly-used Acronym: PNC

Listing Status: Endangered; 11/28/1979; Southwest Region (Region 2) (USFWS, 2016)

Physical Description

A minute, spiny and globose succulent, usually solitary with rounded stems, up to 3 cm tall (often only the top of the stems protrude above ground, and in dry weather, the stems retract entirely into the soil). White spines are arranged in precise, white crosses on the stem. Flowers (late April) are yellow-green. (NatureServe, 2015)

Taxonomy

The species that Lyman Benson combined into the genus *Pediocactus* in 1961-1962 formerly were in six different genera due to their great diversity in spination, body proportions, and flower color. Benson recognized an overriding similarity: the structure and method of dehiscence of the fruits (dry at maturity and dehiscent usually both by a dorsal slit and by a ring around the circumscissile apex) as well as several other characteristics in common (Benson 1962b). The Peebles Navajo cactus is separated from its nearest relative, *P. peeblesianus* var. *fickeiseniae*, primarily on the basis of spine characters, size, and distribution. Peebles Navajo cactus lacks a central spine, and has fewer of the corky radials [4 (3-5) versus 6 (7)] characteristic of the other variety. It is also smaller in all parts and grows in the vicinity of Holbrook, whereas var. *fickeiseniae* grows to the west in the vicinity of the Little Colorado and Colorado rivers and on the Arizona Strip (Benson 1962a). (USFWS, 1984)

Current Range

Endemic to Navajo County, Arizona near Joseph City and Holbrook (USFWS 2008). Its range is very small, approximately 7 miles in length by 1 mile in width (USFWS 2008). (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Late April (NatureServe, 2015)

Reproduction Narrative

Adult: Flowers (late April) are yellow-green. Growth rates are slow and reproduction does not occur until plants are > 8 years old. (NatureServe, 2015; USFWS, 2008)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Desert, grassland/herbaceous (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Prefers sunny exposed areas (USFWS, 2008)

Geographic or Habitat Restraints or Barriers

Adult: Occurs between 5,100 and 5,650 feet in elevation (USFWS, 2008)

Spatial Arrangements of the Population

Adult: Widely scattered, sometimes in clumps (USFWS, 2008)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: High (inferred from USFWS, 2008)

Site Fidelity

Adult: High (inferred from USFWS, 2008)

Habitat Narrative

Adult: Habitat requirements for the PNC have been determined to include well to extremely well drained soils that formed in mixed alluvium belonging to the Gypsiorthids-Torriorthents-Haplargids Association, low soil microelement values, and the presence of vesicular-arbuscular endomycorrhizae, such as *Glomus deserticola*, for colonization of the roots (Phillips and Phillips 1995). The PNC occurs between 5,100 and 5,650 feet above sea level on gentle slopes on all facing aspects (Stuart et al. 1972; USFWS 1984; AGFD 2004). This species prefers exposed sunny weakly alkaline, gravelly soils of the Little Colorado paleochannels (Taylor, 2008), and above the Shinarump in weakly alkaline, very coarse sand to cobble gravel deposits that unconformably overlie the finer grained facies of the Chinle Formation (Burch and Anderson, 2002). It is found in Great Basin desert scrub and desert grasslands (Flora of North America Editorial Committee 2003). PNC occurs at low to moderate densities that are often widely scattered, sometimes in clumps, even when apparently suitable habitat is contiguous (Heil et al. 1981). (USFWS, 2008; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Population Growth Rate:

Slow (NatureServe, 2015)

Number of Populations:

6 (NatureServe, 2015)

Population Size:

<1000 individuals (NatureServe, 2015)

Population Narrative:

Growth rates are slow and reproduction does not occur until plants are > 8 years old. During the dry months, the cacti retreat below soil surface level. "Reproduction may be insufficient to maintain populations over the long term" (Arizona Ecological Services 2009). Less than 1,000 plants are known to exist in six small populations (three occurrences), in a tiny area in northern Arizona. (NatureServe, 2015)

Threats and Stressors

Stressor: Habitat loss (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Progress has been made in identifying and protecting habitat on public and private lands that supports PNC populations since the Federal listing of this species. However, residential and commercial development, and its infrastructure, remains a potential threat to the PNC on private lands. To date, there are no long-term conservation programs, such as conservation easements, in place for these key parcels; but, stakeholders remain optimistic that such programs may be implemented in the future. Non-government organizations continue to negotiate with private property owners to this end. A total of 40 acres have been fenced from livestock, OHV, and gravel mining activities in the Tanner Wash ACEC which has effectively reduced risks to cacti from trampling or crushing. (USFWS, 2008)

Stressor: Non-native species (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Nonnative species, most notably camelthorn (*Alhagi maurorum*), have been identified as a potential future threat to the PNC (pers. comm. Dr. Barbara Phillips, Zone Botanist,

Coconino, Kaibab, and Prescott National Forests). Commonly observed with other nonnative invasive plant species in the southwest, camelthorn may out-compete the PNC and other native species. A secondary risk of increased ground cover caused by a nonnative species is the enhanced risk of fire. The habitat in which the PNC occurs is not fire adapted and has not experienced significant fire losses to date (pers. comm. Dr. Barbara Phillips, Zone Botanist, Coconino, Kaibab and Prescott National Forests). Camelthorn has not been identified in habitat on the mesas that is occupied by PNC, but it has been observed “down below the mesas very abundantly, however, and spreading” (pers. comm. Dr. Barbara Phillips, Zone Botanist, Coconino, Kaibab and Prescott National Forests). (USFWS, 2008)

Stressor: Herbivory (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Small mammalian herbivores such as rabbits and/or rodents have been observed eating PNC as vegetative preferences in diet shift in response to drought conditions (Phillips and Phillips 1997; 2004). Due to the importance of precipitation on germination and recruitment of PNC cohorts, drought conditions not only adversely affect the PNC by limiting these key life history events, but synergistically amplify adverse effects of herbivory. This has the potential to appreciably affect populations of PNC because of the inherent risks associated with this species’ limited recruitment potential. Predicted warming and increased drought conditions in the southwest due to global climate change are likely to accelerate and exacerbate these effects (see discussion under 2.3.2.5, below). As stated previously, predator control may also positively influence populations of rabbits and rodents, which could heighten levels of rabbit and rodent herbivory on PNC, especially during drought conditions. However, more research is necessary to confirm these relationships. (USFWS, 2008)

Stressor: Climate change (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Drought is identified above as a significant concern for the conservation and recovery of the PNC. Phillips and Thomas (2005) provided streamflow records that indicate that the drought Arizona experienced between 1999 and 2004 was the worst drought since the early 1940s and possibly earlier. Prolonged drought conditions have been observed in the immediate region where the PNC occurs as well as other areas statewide (Phillips and Phillips 2004). Should current drought conditions persist for several years into the future, the recovery potential for the PNC may become severely compromised. The Intergovernmental Panel on Climate Change (IPCC) stated, “Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level” (IPCC 2007). According to 18 of 19 regional climate models, the levels of aridity of recent drought conditions and perhaps those of the 1950s drought years will become the new climatology for the southwestern United States within years or decades and annual mean precipitation levels will continue to decrease over the next century (Seager et al. 2007). Persistent drought conditions over years are likely to reduce the frequency and duration of flowering and/or germination events, lower the recruitment of individuals, compromise the viability of populations, lessen the recovery potential for this species, and therefore adversely affect the long-term persistence of the PNC. Increased risk of invasive

species such as camelthorn and an associated increased risk of wildfire in PNC habitat, as well as increased herbivory by rabbits and rodents are identified threats that may be exacerbated by long-term drought conditions associated with climate change. (USFWS, 2008)

Stressor: Alternative energy (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: Future alternative energy development needs to be considered a threat as well. For example, a large wind farm is located about 2 miles north of the northern and western most occurrence. (NatureServe, 2015)

Stressor: Off-highway vehicles OHVs) (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: The two western populations are about 1 mile east of Joseph City north of I-40 with the northern site potentially impacted by off-road highway use. (NatureServe, 2015)

Stressor: Gravel mining NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: The eastern population, is located in close proximity to a gravel mining operation. (NatureServe, 2015)

Recovery

Reclassification Criteria:

1. The protection, maintenance, and enhancement of existing natural populations. (USFWS, 1984)
2. An increase in the numbers of the cactus from the present approximately 1,000 to 10,000. (USFWS, 1984)
3. Establishment of a program to curtail collecting through enforcement and through a commercial artificial propagation program. (USFWS, 1984)

Delisting Criteria:

Delisting criteria are not available.

Recovery Actions:

- Removal of off-road vehicle use, livestock grazing, and mining from the habitat of populations on Federal lands. (USFWS, 1984)
- Designation of a restricted use area (ACEC) on BLM lands. (USFWS, 1984)
- Development of management plans for all populations. (USFWS, 1984)
- Protection of habitat for privately owned populations. (USFWS, 1984)
- Monitoring and study of existing populations. (USFWS, 1984)

- Development of an artificial propagation program to provide stock for reintroductions and to provide techniques for use in the commercial cactus trade. (USFWS, 1984)

Conservation Measures and Best Management Practices:

- The recovery plan for this species requires revision. The number of plants and populations referenced in the current recovery plan that are required for long-term viability of the species are unrealistic and should be revised. Recovery criteria should focus on habitat protection and acquisition, seed banking, researching dispersal mechanisms, seed collection and long-term storage, as well as inclusion of this species into the Center for Plant Conservation Collection. (USFWS, 2008)
- In addition, coordination with species experts needs to occur with an emphasis on conservation planning with respect to implementation of actions in the event of continuing long-term drought. These activities may include, but are not limited to, exploring new areas for transplants, captive propagation and reintroduction, or other means to help secure existing populations using artificial means (water supplementation, etc.). (USFWS, 2008)
- Because the known historical and current distribution of the PNC is limited, the Service views these actions as essential, in conjunction with continued management and enforcement of protection measures. The Service also recommend concerted efforts be implemented to ensure long-term viability of this species on private lands through various conservation incentive programs available to private landowners. (USFWS, 2008)

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SPECIES ACCOUNT: *Pediocactus winkleri* (Winkler cactus)

Species Taxonomic and Listing Information

Listing Status: Threatened; 08/20/1998; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

Winkler cactus (*Pediocactus winkleri*) was first discovered by Agnes Winkler in the late 1960's. It is a small, sub-globose cactus. Individuals range in size from 0.5 to 7 cm tall and 0.5 to 8 cm in diameter. Stems, which are ribbed with tubercles 0.4 - 0.7 cm long, are normally solitary but may be multi-stemmed, especially if damaged. Spine-bearing areoles are borne at the apex of the tubercles. The areoles are elliptic and densely wooly pubescent with spines obscuring or partially obscuring the stem. Central spines are lacking; radial spines commonly number 9 to 11. The spines are 1.5 - 4 millimeters (mm) long. Flowers are 1.7 to 2.2 cm in length with peach to pink color. Stamens are yellow and stigmas are green. The fruit is 0.7 to 1.0 cm long with a smooth surface, initially green turning reddish-brown with age. Seeds are shiny black. For a complete technical description of the Winkler cactus, please refer to Heil (1979) and Welsh et al. (2008).

Current Range

Winkler cacti grow on fine textured alkaline soils derived primarily from the following geologic formations: Dakota, Morrison, Summerville, Entrada and Emery sandstone member of the Mancos formation (Heil 1984, Neese 1987, Clark 1998b, Clark 1999). It is generally found at elevations between 1,500 and 2,130 meters (4,900 and 7,000 feet) on rocky, alkaline hill tops and benches, and gentle slopes on barren, open sites in salt desert shrub communities. Heil (1984) describe it as typically occurring on the tops and sides of rocky hills or benches in *Atriplex* (saltbush) dominated desert shrub communities. Winkler cactus is endemic to Wayne, Emery and Sevier counties in south central Utah. Populations of the species occur primarily on lands managed by the Utah BLM through the Richfield Field Office and by the NPS at CRNP. The range of Winkler cactus extends approximately 48 km (30 miles) in a narrow band from Notom in central Wayne County to the Last Chance Desert in southwestern Emery County, Utah. Plants are estimated to occupy only 80 hectares (200 acres) within this band (Spector 2013b). The majority of the known populations occur on lands managed by BLM.

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Lifespan

Adult: ~ 14 years

Breeding Season

Adult: Flowering occurs from April through mid-May and fruits are set mid-May to June.

Reproduction Narrative

Adult: Winkler cacti are typically only above ground during the growing season. When temperatures increase in mid-February or early March and rainfall is adequate, cacti emerge from below ground to flower. The cactus stem emerges up to 5 cm above ground. Flowering occurs from April through mid-May and fruits are set mid-May to June. The specific time varies from year to year apparently due to temperature and moisture conditions of late winter and early spring. After flowering, the plants shrink back to ground surface or below defending themselves against an annual cycle of extreme heat, drought and cold. Resurfacing in the spring appears to be dependent on winter and spring moisture (Clark 1999). Winkler cactus can survive underground for up to two years during drought conditions (Clark and Clark 2008a). We do not fully understand the factors leading to dormancy in Winkler cactus. Reproduction is presumed to be primarily sexual. No research has been conducted on pollination mechanisms, pollinators or seed germination success for Winkler cactus. Work conducted on the closely related San Rafael cactus found that species to be self-incompatible and pollinated by several native bee species. Pollination of species that reproduce sexually and are self-incompatible is necessary to produce viable seeds. Seedling ecology is unknown (San Juan College 1994). Winkler cactus is a long lived species. The lifespan of Winkler cactus is unknown but we know they live at least 14 years and most likely even longer. Information from a long-term study shows that Winkler cactus can survive at least 12-14 years (Clark and Clark 2008a). We do not know how old the Winkler cacti were when they were marked for the study and we do not know how long they lived after the study ended so it is highly likely the species can live longer than 14 years.

Environmental Specificity

Adult: Alkaline soils

Habitat Narrative

Adult: Winkler cactus is endemic to specific, fine textured soils derived from the Dakota formation and Morrison formation in the lower Fremont River in Wayne County and southeast Sevier Counties of south-central Utah. It is generally found at elevations between 1,500 - 2,130 meters (m) (4,900 - 7,000 feet (ft)) on rocky, alkaline hill tops and benches, and gentle slopes on barren, open sites in salt desert shrub communities. These communities are associated with species such as Indian rice grass (*Achnatherum hymenoides*), blue grama (*Bouteloua gracilis*), curly grass (*Pleuraphis jamesii*), alkali sacaton (*Sporobolus airoides*), sand hill muhly (*Muhlenbergia pungens*), prickly pear cactus (*Opuntia polyacantha*), Mormon tea (*Ephedra torreyana*), little-leaf mountain mahogany (*Cercocarpus intricatus*), shadscale (*Atriplex confertifolia*), four-wing salt bush (*Atriplex canescens* var. *canescens*), phlox (*Phlox* spp.), locoweed (*Astragalus* spp.), halogeton (*Halogeton glomeratus*), snakeweed (*Gutierrezia sarothrae*), and viscid rabbitbrush (*Chrysothamnus viscidiflorus*). It is also found among piñonjuniper (*Pinus edulis*-*Juniperus osteosperma*) woodland stands (Clark 2008; Welsh et al. 2003). (USFWS, 2015)

Dispersal/Migration

Population Information and Trends

Number of Populations:

4 (USFWS, 2015)

Population Size:

5411 (USFWS, 2015)

Population Narrative:

Most of the range of the species and 98 percent of the known localities occur within three active grazing allotments managed by the BLM Richfield Field Office and CRNP. The Hartnet and Sandy 1 allotments are managed by both the BLM Richfield Field Office and by CRNP, while the Blue Bench allotment is managed solely by the BLM Richfield Field Office. The remaining 2% of Winkler cactus individuals are located within CRNP in the Rock Springs allotment, which has been retired from grazing since 1999 (CRNP 2014a). In total, 46% of recorded Winkler cactus individuals (2,479) occur within CRNP (44% in the active Hartnet grazing allotment and 2% in the retired Rock Springs allotment). The remaining 54% individuals (2,932) occur on land managed by the BLM Richfield Field Office, primarily on the Hartnet and Sandy 1 allotments. The Blue Bench allotment contains a new population discovered in 2014, comprising 4% (229) of recorded individuals. Winkler cactus is also known to occur on State Institutional Trust Lands Administration (SITLA) and private lands within these areas, but no official surveys have been conducted on non-Federal lands. Based upon surveys conducted over the past five years we know of approximately 5,400 individuals and we estimate the total population of Winkler cactus to be between 6,000 and 10,000 individuals (USFWS 2010, pers. comm. T. Switek). Approximately 3,000 Winkler cacti were documented in surveys conducted by the NPS and BLM between 1998 and 2008 (Clark 1998a, 1999, 2008e). Inventory efforts within CRNP during 2011 - 2013 documented 2,380 Winkler cacti at 58 localities. A cactus locality is an area with one or more individual cactus. This should be considered a conservative number as counting and mapping efforts at each locality were limited to four person-hours, and therefore not all cacti at a locality were counted. During the 2014 field season CRNP staff conducted 106 belt transects to gather presence/absence data on Winkler and Wright fishhook cacti within suitable habitat that had not been previously inventoried (Clark 2014). These efforts located 134 previously unmapped Winkler cacti. Drought plays a large role in the population dynamics of the species. During the drought from 1999-2003 (Wilkowske 2003), Clark and Clark (2008a) documented the largest rates of adult mortality recorded during a 13 year study of Winkler cactus. Adult mortality was coupled with low rates of recruitment resulting in a declining population during years of drought.

Threats and Stressors

Stressor: Off-highway vehicle (OHV) use and other recreational activities, and impacts associated with roads (USFWS, 2015)

Exposure: Moderate

Response: Basic need inhibited/injury/mortality

Consequence:

Narrative: In summary, and based on available information regarding OHV use in Winkler cactus habitat, OHV use has a documented detrimental effect on cactus and cactus habitat. Although direct impacts from OHV appears to be low, the little amount of compliance data for OHV use on BLM and SITLA land over the entire range where Winkler cactus occurs and the proximity of significant percentages of the population to unpaved roads and OHV routes is cause for concern. Therefore, we designate the threat level from OHV use and impacts associated with roads for Winkler cactus as moderate. This level may be reassessed if more detailed OHV use and

compliance data near Winkler cactus occurrences is collected showing high rates of compliance. (USFWS, 2015)

Stressor: Livestock grazing (USFWS, 2015)

Exposure: Moderate

Response: Basic need inhibited/injury/mortality

Consequence:

Narrative: In summary, the negative effects to Winkler cacti from livestock grazing increase with increasing livestock use. Very few to no cacti were recorded as trampled during low to moderate livestock activity. As livestock activity increases, so does disturbance levels near cacti (Clark 2008b). There is extremely high grazing pressure throughout the majority of the species' range. The negative impacts of livestock grazing on the species and the habitat are well documented. Additionally, livestock grazing exacerbates other threat factors (including response to drought potentially caused by climate change and predation). Therefore, we designate a high threat level to Winkler cactus from livestock grazing and trampling. This threat level may be reassessed if changes in land use and grazing pressure on Winkler cactus populations occur. (USFWS, 2015)

Stressor: Native Ungulate Disturbance (USFWS, 2015)

Exposure: Small

Response: Basic need inhibited/injury/mortality

Consequence:

Narrative: Monitoring shows that elk and deer prints near listed cacti at Capitol Reef National Park are not as severe or regularly occurring as that from livestock. Elk prints within 15 cm (5.9 in) of Winkler cacti ranged from 2-10 percent of cacti surveyed in 2011-2012. Deer prints were found within 15 cm (5.9 in) of only 1-1.7 percent of Winkler cactus (NPS 2013). Between 2011 and 2013, five survey sites in the Hartnet population within CRNP had greater than 5 percent disturbance rates by native ungulates (22-31 percent), which correlated with the survey sites that had lower amounts of disturbance by livestock. Of the 2,380 plants surveyed in CRNP between 2011 and 2013, 15 were recorded as being trampled by elk (NPS 2013). In the Hartnet population outside of CRNP and in the Notom population, native ungulate disturbance was found at only 1 percent of surveyed cacti and no damage was recorded. This discrepancy may be due to the higher elevations of some of the survey sites at CRNP. Surveys for native ungulate disturbance have not been performed at the Blue Bench population. Due to the localized nature of native ungulate impacts, we designate a low threat level for native ungulate disturbance at this time. This level may be reassessed if native ungulate patterns change or additional populations in areas of high use by native ungulates are discovered. (USFWS, 2015)

Stressor: Energy and Mineral Exploration and Development (USFWS, 2015)

Exposure: Moderate

Response: Basic need inhibited/mortality

Consequence:

Narrative: In summary, the detrimental effects of energy and mineral exploration and development are well documented, but there is a general lack of current and historic mining activity and oil and gas development within the range of the species and low potential in the foreseeable future. Therefore, we designate a low threat level for energy and mineral exploration and development on Winkler cactus at this time. Surface disturbance permitting on active mining claims or the sale of leases for fluid or non-energy solid minerals within the range in the future

could cause the threat level to increase, as could discovery of additional populations in areas with more active mineral development. (USFWS, 2015)

Stressor: Road and Utility Corridor Development or Other Construction (USFWS, 2015)

Exposure: Small

Response: Basic need inhibited/mortality

Consequence:

Narrative: Unauthorized utility and road development within the Notom population of Winkler cactus caused individual plant mortality and habitat degradation in 1995 (63 FR 44587, August 20, 1998). Currently, no plans for road or utility corridor development intersect with known San Rafael or Winkler cactus populations. One construction project exists that will impact San Rafael cactus. The Natural Resources Conservation Service is proposing to raise the level of the Millsite Reservoir Dam and this will affect several individual San Rafael cacti by flooding and increased recreational impacts; however, impacts from this project to the range-wide population of San Rafael cactus will be minimal (NRCS 2015). There are many existing roads within both species' habitat, primarily unpaved. Several populations or portions of populations of both species are located directly along dirt roads. Maintenance of these roads may impact individuals and care should be taken by local authorities to avoid cactus populations when performing this maintenance. Because there is no currently pending construction, road, or utility corridor development projects within known occupied habitat of Winkler cactus and only one pending project in known occupied habitat of San Rafael cactus, we designate a low threat level for road and utility corridor development or other construction for Winkler cactus and San Rafael cactus at this time. This level may be reassessed if new projects are put forward that would impact known cacti populations, or if new populations are discovered that would be impacted by road and utility corridor development projects. (USFWS, 2015)

Stressor: Invasive Species (USFWS, 2015)

Exposure: Moderate

Response: Basic need inhibited

Consequence:

Narrative: In summary, there is a low incidence of invasive species in cacti habitat. There is also and the lack of high risk level at this time to any particular population or portion of a population, although there is legitimate concern that predation from insects or rodents on cacti may increase in the future. (USFWS, 2015)

Stressor: Commercial and Hobby Collecting (USFWS, 2015)

Exposure: High

Response: Mortality

Consequence:

Narrative: In summary, there is a known historic impact on these species from illegal collect. The current scale of illegal collection is unknown, although many populations have locations well known to cactus collectors. However, new sites and populations have been discovered recently which are less accessible and not well known to collectors. Therefore, we designate a moderate threat level from illegal commercial and hobby collecting for Winkler cactus and San Rafael cactus. This threat level may be reassessed if hard data on collecting activities is obtained or new methods of protection for cactus at vulnerable sites are implemented (Factor D). (USFWS, 2015)

Stressor: Small mammal and insect predation (USFWS, 2015)

Exposure: Moderate

Response: Basic need inhibited/injury/mortality

Consequence:

Narrative: In summary, despite the potential for the cactus borer beetle to impact the cacti, we have found no conclusive information to indicate that it is having an unprecedented, population level effect on Winkler cactus or San Rafael cactus. The recently documented die-offs from beetle borer may be part of the species' natural life cycle. The recent levels of recorded damage or mortality to San Rafael cactus and Winkler cactus from insects and rodents during recent surveys are relatively low. Also, the predators thus far recorded have been species native to the ecosystem. Therefore, we designate a low threat level for insect and rodent predation on Winkler cactus and San Rafael cactus at this time. This threat level will be reassessed if data shows pressure from predation to be increasing due to climate change or other factors, or that predation poses a substantial threat to particular populations. (USFWS, 2015)

Stressor: Inadequacy of Federal, State, and Local Laws and Regulations (USFWS, 2015)

Exposure: Moderate

Response: Basic need inhibited/injury/mortality

Consequence:

Narrative: In summary, existing regulatory mechanisms, secured through the ESA, have reduced some threats on Federal lands. In the absence of the ESA's protective regulatory mechanisms, we believe the threats to the species would be amplified and cause further declines to both species. There are no state laws specifically protecting the species in Utah. Without the protection of the ESA, impacts to the species from OHV use, livestock grazing, and recreational activities would likely increase. These activities can kill or damage cacti, and degrade cactus habitat. In addition, the lack of monitoring data makes it difficult to determine the species' needs and provide long-term protection. Reducing pressure on the species from collection and unauthorized access is difficult because of limited law enforcement resources and the remoteness of the habitat. Continued efforts are needed through law enforcement and habitat protection to ensure the species is protected over the long-term and the ESA provides the legal protection to the species to enforce unauthorized harvest. We therefore determine the inadequacy of regulatory mechanisms is a moderate threat to Winkler cactus and San Rafael cactus. This threat level may be reassessed if management policies that specifically address the protection of Winkler cactus and San Rafael cactus independent of the ESA are enacted throughout significant portions of their range. (USFWS, 2015)

Stressor: Climate Change (USFWS, 2015)

Exposure: High

Response: Basic need inhibited/mortality

Consequence:

Narrative: In summary, climate change and its impacts to the region are well documented and projected to continue and increase. There was a documented decline of Winkler cactus during the 1999-2003 drought, and the similarity of San Rafael to Winkler cactus suggests a comparable response. (Clark and Clark 2008). Additionally, rare plants have a negative response to drought (Roth 2003, 2004; Van Buren and Harper 2003, 2004), and drought severity and frequency is set to increase due to climate change (IPCC 2007; Karl et al. 2009). Therefore, we designate a high threat level from global climate change on Winkler cactus and San Rafael cactus. There are uncertainties in our threat evaluation since downscaled climate projections are not available for our specific location, and a vulnerability assessment has not been performed for these species.

We will re-assess the degree of threat climate change poses when more specific information becomes available. (USFWS, 2015)

Recovery

Delisting Criteria:

P-1. Based on analysis and modeling implemented under the recovery actions trends for San Rafael cactus and Winkler cactus populations are shown to be stable or improving according to the following measures: Species presence is maintained at all known Winkler cactus populations and (1) These criteria must be met for all known Winkler cactus populations due to the low number of known populations at this time. If additional Winkler cactus populations are discovered in the future, it may be determined that delisting is appropriate even if some populations are not stable or increasing, and (2) Predictive modeling using data from an additional 10-year period (30 years total), collected in accordance with a standardized monitoring protocol, provides an indication of long-term demographic stability as well as a projected survival probability of at least 95 percent over 100 years for each species. (USFWS, 2015)

T-1. Federal land protection through long-term management agreements or plans is achieved for all known Winkler cactus populations. Protection considerations from grazing impacts, development, mining, oil and gas, and recreation must be included in the management agreements and the protected areas must meet the size and connectivity parameters determined through research to be adequate to sustain those populations. These may include but are not limited to resource management plans, conservation agreements, recreation management plans, and travel management plans. (USFWS, 2015)

P-2. Based on best available data, the available habitat base for each recovery population of each species is of sufficient quality and large enough to allow for natural population dynamics, population expansion where needed, and the continued presence of pollinators, with sufficient connectivity to allow for needed gene flow within and, where possible, among populations. (USFWS, 2015)

T-2. Management agreements or plans in place and being implemented for all Winkler cactus populations on all federal lands must include measures to address and curtail illegal collection activities. These plans should include criteria for appropriate law enforcement at correct times and places to prevent illegal collection and sales of plants or any plant parts. (USFWS, 2015)

T-3. Adverse population-level effects from herbivory, disease, or predation, if any, are identified, monitored and abated to the extent that all known Winkler cactus population trends are stable or increasing, as evidenced by demographic monitoring results from studies that have adhered to monitoring protocols developed under recovery action 2.4. Programs to control excessive herbivory or predation will be developed to adaptively manage each population per criterion P-3, and must take into consideration the degree which climate change may impact disease or herbivory levels in the future. (USFWS, 2015)

T-4. Land protection covering the habitat of all populations for each species and/or statutory and regulatory protections for plants are such that the protections of the ESA are no longer needed to compensate for regulatory inadequacies. (USFWS, 2015)

T-5. A long-term ex-situ conservation program is ongoing for all extant Winkler cactus populations. This would include seed collection and storage, germination and viability trials, and development of a protocol for successful reproduction under greenhouse conditions. This would help avert the risk of extinction from stochastic events or environmental catastrophes. (USFWS, 2015)

T-6. In conjunction with recovery criterion P-2, the available habitat base for each of the populations designated under criterion P-1 is of sufficient quality and large enough to offset the threat of loss or restriction of the species' pollinators and impacts from climate change, if feasible. Effective measurement criteria will be developed through research under Recovery Action 3. (USFWS, 2015)

Recovery Actions:

- Protect and conserve known extant Winkler cactus and San Rafael cactus populations and their habitat.
- Survey for additional populations, and monitor all populations in order to apply conservation measures where and when needed.
- Conduct in depth research into the biology, requirements, threat responses, and life histories of both species in order to develop and implement appropriate management practices for the purposes of achieving recovery.
- Promote communication by encouraging and creating dialog regarding these species between managing agencies, land owners, developers, and the public in order to raise awareness and aid recovery.
- Coordinate and work together with all stakeholders to achieve recovery.

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SPECIES ACCOUNT: *Penstemon debilis* (Parachute beardtongue)

Species Taxonomic and Listing Information

Listing Status: Threatened; 08/26/2011; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

A mat-forming perennial herb with thick, blue-green leaves, each about 2 cm long and 1 cm wide. Funnel-shaped, white to pale lavender flowers bloom June-July (NatureServe, 2015).

Taxonomy

Parachute beardtongue was discovered in 1986, and was first described by O’Kane and Anderson in 1987 (USFWS, 2016). Traditionally, the genus *Penstemon* was included in the Scrophulariaceae (figwort) family. However, *Penstemon* is now considered to be within the Plantaginaceae (plantain) family due to recent research using DNA sequences (Oxelman et al. 2005, p. 415) (USFWS, 2013).

Historical Range

The historical range and distribution for this species is unknown (USFWS, 2016). *Penstemon debilis* is endemic to Garfield County, Colorado (NatureServe, 2015).

Current Range

All of the currently known occurrences occupy about 91.8 ac (37.2 ha) on the Green River geologic formation in Garfield County, Colorado (USFWS, 2016).

Critical Habitat Designated

Yes; 8/13/2012.

Legal Description

On August 13, 2012, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Penstemon debilis* (Parachute beardtongue) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four critical habitat units (CHUs), in Colorado (77 FR 48356-48415).

Critical Habitat Designation

The critical habitat designation for *Penstemon debilis* includes four CHUs in Garfield County, Colorado. This species critical habitat encompasses approximately 15,510 acres (ac) (6,277 hectares (ha)) (77 FR 48356-48415).

Unit 1, the Brush Mountain Unit, consists of 1,437 ac (582 ha) of federally owned lands, managed by BLM through the Grand Junction Field Office. It is located approximately 16 mi (26 km) northwest of the town of DeBeque in Garfield County, Colorado. It is northwest of the intersection of Roan Creek Road (County Road 204) and Brush Creek Road (County Road 209). This Unit is not currently occupied. This Unit has all the physical and biological features essential to the conservation of the species, including the Rocky Mountain Cliff and Canyon plant community (NatureServe 2004, spatial data) with less than 10 percent plant cover, suitable elevational ranges of 6,234 to 8,222 ft (1,900 to 2,506 m), outcrops of the Parachute Creek Member of the Green River Formation, steep slopes of these soil outcrops that lend to the

appropriate disturbance levels, pollinator habitat, and a climate with between 12 to 18 in. (30 and 46 cm) in annual rainfall and winter snow. Because of the presence of these features, we believe this may make a good introduction area for *Penstemon debilis* in the future and is needed to ensure conservation of the species. The primary threat to *Penstemon debilis* in this Unit is energy development and associated activities. *Penstemon debilis* consists of only 4,100 known individuals (little redundancy), and all occur within 2 concentrated areas (little resilience). For adequate redundancy and resiliency, we believe it is necessary for survival and recovery that additional populations be established. Therefore, we have identified this Unit as critical habitat for *P. debilis*.

Unit 2, the Cow Ridge Unit, is 4,819 ac (1,950 ha) of federally owned lands managed by BLM through the Grand Junction Field Office. It is located approximately 8 mi (13 km) northwest of the town of DeBeque in Garfield County, Colorado, and north of Dry Fork Road. This Unit is not currently occupied. This Unit has all the physical and biological features essential to the conservation of the species, including the Rocky Mountain Cliff and Canyon plant community (NatureServe 2004, spatial data) with less than 10 percent cover, suitable elevational ranges of 6,273 to 8,284 ft (1,912 to 2,525 m), outcrops of the Parachute Creek Member of the Green River Formation, steep slopes of these soil outcrops that lend to the appropriate disturbance levels, habitat for pollinators, and a climate with between 12 to 18 in (30 and 46 cm) in annual rainfall and winter snow. Because of the presence of these features, we believe this may make a good introduction area for *Penstemon debilis* in the future and is needed to ensure conservation of the species. The primary threat to *Penstemon debilis* in this Unit is energy development and associated activities. *Penstemon debilis* consists of only 4,100 known individuals (little redundancy) and all within 2 concentrated areas (low resilience). For adequate redundancy and resiliency, we believe it is necessary for survival and recovery that additional populations be established. Therefore, we have identified this Unit as a CHU for *P. debilis*.

Unit 3, the Mount Callahan Unit, consists of 4,369 ac (1,768 ha) of Federal and private land. It is located approximately 2 mi (3 km) west of the town of Parachute on the south-facing slopes of Mount Callahan and westward along the cliffs of the Roan Plateau. Fifty-five percent of Unit 3 is managed by the BLM under the management of two field offices: 80 Percent of these Federal lands are managed by the Colorado River Valley Field Office and 20 percent are managed by the Grand Junction Field Office. Oxy has been a partner in the conservation of *Penstemon debilis* since 1987. We have excluded all Oxy lands based on: (1) This continuing partnership, (2) existing CNA Agreements (674 ac (273 ha)) for two CNAs (the Mount Callahan and Mount Callahan Saddle), (3) commitments to create a third CNA (the Logan Wash Mine Natural Area) totaling 82 ac (33 ha), (4) already-implemented and further commitments to develop Best Management Practices for the CNAs as well as other adjacent lands, and (5) commitments on Oxy lands to conserve newly discovered *P. debilis* populations with more than 75 individuals. This exclusion totals 3,350 ac (1,356 ha). These exclusions are discussed in further detail below under Exclusions. Three percent of this Unit falls on private lands. This Unit is currently occupied. Once Oxy lands were excluded, four parcels (two BLM and two private) of land remained along the northern edge of the CHU, as proposed. We have elected not to include three (both BLM and one of the two private parcels) of these four parcels in our critical habitat designation because: (1) They would be isolated from the rest of Unit 3; (2) they contain no suitable habitat for *Penstemon debilis* (only pollinator habitat); (3) the pollinator and habitat protection measures on Oxy lands will provide adequate protections for the pollinators on their lands, making these three parcels less important; and (4) they are distant (at least 2,133 ft (650 m)) from occupied

and suitable habitat; and (5) we believe they are not necessary for the conservation of the species. The remaining private parcel (137 ac (55 ha)) is closer to occupied habitat, contains suitable habitat, and, therefore, is included in our critical habitat designation. This Unit currently has all the physical and biological features essential to the conservation of *Penstemon debilis*, including the Rocky Mountain Cliff and Canyon plant community (NatureServe 2004, spatial data) with less than 10 percent cover, suitable elevational ranges of 5,413 to 8,809 ft (1,650 to 2,685 m), outcrops of the Parachute Creek Member of the Green River Formation, suitable pollinators and habitat for these pollinators, steep slopes of these soil outcrops that lend to the appropriate disturbance levels, and a climate with between 12 to 18 in (30 and 46 cm) in annual rainfall and winter snow. The primary threat to *Penstemon debilis* and its habitat in this Unit is energy development and associated activities.

Unit 4, the Anvil Points Unit, consists of 4,885 ac (1,977 ha) of Federal and private land. It is located approximately 1 mi (2 km) north of the town of Rulison in Garfield County, Colorado. Seventy percent of this Unit is managed by the BLM, Colorado River Valley Field Office. Twenty-three percent of the Unit (1,102 ac (446 ha)) is within several potential BLM Areas of Critical Environmental Concern (ACECs). If these become ACECs, they would have several stipulations to protect *Penstemon debilis*, particularly from oil and gas development. These areas are discussed further in the proposed (75 FR 35732; June 23, 2010) and final listing rules (76 FR 45054). Thirty percent of this Unit is on private lands. This Unit is currently occupied. This Unit currently has all the physical and biological features essential to the conservation of *Penstemon debilis*, including the Rocky Mountain Cliff and Canyon plant community (NatureServe 2004, spatial data) with less than 10 percent plant cover, suitable elevational ranges of 6,318 to 9,288 ft (1,926 to 2,831 m), outcrops of the Parachute Creek Member of the Green River Formation, suitable pollinators and habitat for these pollinators, steep slopes of these soil outcrops that lend to the appropriate disturbance levels, and a climate with between 12 to 18 in (30 and 46 cm) in annual rainfall and winter snow. The primary threat to *Penstemon debilis* and its habitat in this Unit is energy development and associated activities. This Unit falls within the boundary of the BLM's Roan Plateau RMP. The RMP has two lease stipulations that directly address endangered, threatened and candidate plants. A no surface occupancy lease stipulation (NSO-12) protects occupied habitat and adjacent potential habitat from ground disturbing activities, with narrow exceptions. A controlled surface use stipulation (CSU-12) protects special status plant species and plant communities by authorizing BLM to impose special design, operation, mitigation and reclamation measures, including relocation of ground disturbing activities by more than 200 meters, with some exceptions. Special management considerations and protections are thus contemplated.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Penstemon debilis* critical habitat consists of five components (77 FR 48356-48415):

(i) Suitable soils and geology. (A) Parachute Member and the Lower Part of the Green River Formation. (B) Appropriate soil morphology characterized by a surface layer of small to moderate shale channers (small flagstones) that shift continually due to the steep slopes and below a weakly developed calcareous, sandy to loamy layer with 40 to 90 percent coarse material.

(ii) Elevation and climate. Elevations from 5,250 to 9,600 ft (1,600 to 2,920 m). Climatic conditions similar to those of the Mahogany Bench, including suitable precipitation and temperatures.

(iii) Plant community. (A) Barren areas with less than 10 percent plant cover. (B) Other oil shale endemics, which can include: *Mentzelia rhizomata*, *Thalictrum heliophilum*, *Astragalus lutosus*, *Lesquerella parviflora*, *Penstemon osterhoutii*, and *Festuca dasyclada*. (C) Presence of *Penstemon caespitosa* for support of pollinators and connectivity between sites.

(iv) Habitat for pollinators. (A) Pollinator ground, twig, and mud nesting areas. Nesting and foraging habitats suitable for a wide array of pollinators and their life-history and nesting requirements. A mosaic of native plant communities and habitat types generally would provide for this diversity (see paragraph (2)(iii) of this entry). These habitats can include areas outside of the soils identified in paragraph (2)(i) of this entry. (B) Connectivity between areas allowing pollinators to move from one population to the next within units. (C) Availability of other floral resources such as other flowering plant species that provide nectar and pollen for pollinators. Grass species do not provide resources for pollinators. (D) A 3,280-ft (1,000-m) area beyond occupied habitat to conserve the pollinators essential for plant reproduction.

(v) High levels of natural disturbance. (A) Very little to no soil formation. (B) Slow to moderate but constant downward motion of the oil shale that maintains the habitat in an early successional state.

Special Management Considerations or Protections

The features essential to the conservation of this species (plant community and competitive ability, elevation, slope, soils, climate, reproduction, and disturbance regime) may require special management considerations or protection to reduce threats. Extremely low numbers and a highly restricted geographic range make *Penstemon debilis* particularly susceptible to becoming endangered in the foreseeable future. Threats to the species and its habitat include energy development, road maintenance, and inadequacy of existing regulatory mechanisms (76 FR 45054). Special management considerations or protections are required within critical habitat areas to address these threats. Management activities that could ameliorate these threats include (but are not limited to): The introduction of new *Penstemon debilis* populations; the establishment of permanent conservation easements or the acquisition of land to protect the species on private lands; the continuation and adequate management of *P. debilis* through the CNA Agreement with Oxy (see Exclusions section below); regulations and/or agreements that balance conservation with energy development in areas that would affect the species and its pollinators; the designation of protected areas with specific provisions and protections for the plant; the elimination or avoidance of activities that alter the morphology and status of the shale slopes; and avoidance of placing roads in habitats that would affect the plant or its pollinators. These management activities would protect the PCEs for the species by preventing the loss of habitat and individuals, maintaining or restoring plant communities and natural levels of competition, protecting the plant's reproduction by protecting its pollinators, and managing for appropriate levels and types of disturbance.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (USFWS, 2016); asexual: vegetative (inferred from NatureServe, 2015)

Lifespan

Adult: Long-lived (NatureServe, 2015)

Dependency on Other Individuals or Species

Adult: *Osmia brevis* (NatureServe, 2015)

Breeding Season

Adult: June - July (NatureServe, 2015)

Key Resources Needed for Breeding

Adult: Bee pollinators, several months of moist chilling (NatureServe, 2015)

Reproduction Narrative

Adult: This species is long-lived and thought to be slow to reach reproductive maturity. It is also thought that species with these life history characters have low reproductive rates (O'Kane and Broderick 2004). *Penstemon debilis* flowers from mid-June to mid-July (Scheck 1994) and fruits in mid July - August (CNHP 1998). The plants are bee pollinated and *Osmia brevis* is the primary pollinator. Amy McMullen at Utah State University is currently researching the biology of *P. debilis*. The following was compiled from her 1997 field season findings, unless otherwise stated: *P. debilis* requires several months of moist chilling to break dormancy. Breeding system experiments found low fruit production. This species does seem to be well adapted to its habitat, producing long rhizomes in response to a shifting substrate (NatureServe, 2015). Parachute beardtongue plants require cross pollination, and have many different pollinators that vary between occurrences (USFWS, 2016).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Parachute Creek Member of the Green River Formation (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: < 10% plant cover, > 15% slope, shifting slopes that maintain early successional habitat (USFWS, 2012); high insolation (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 5,250 to 9,600 ft. elevation (USFWS, 2013); > 10% plant cover (inferred from USFWS, 2012)

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Inhabits oil shale outcrops, on south-facing, steep white shale talus on the Mahogany Zone of the Parachute Creek Member of the Green River Formation. The substrate is a mixture of thin shale fragments and clay. The barren, white surface of the slopes creates a very high insolation. Vegetation is sparse but other species, including at least 4 other oil shale endemics, occur as scattered individuals on the slopes. Associated species include: *Agropyron spicatum*, *Cercocarpus montanus*, *Chrysothamnus viscidiflorus*, *Cymopterus hendersonii*, *Eriogonum lonchophyllum*, *Galium coloradoense*, *Holodiscus dumosus*, *Machaeranthera grindeliodes*, *Monardella odoratissima*, *Astragalus lutosus*, *Festuca dasyclada*, *Mentzelia argillosa*, *Thalictrum heliophilum* (O'Kane and Anderson 1987), *Penstemon caespitosus*, and *P. mensarum* (A. McMullen, pers. comm. 1998). The environmental specificity is narrow; the substrate is relatively common in the region, but the plant is rare and may have other specific requirements (NatureServe, 2015). The Service has identified a suitable elevation range from 5,250 to 9,600 ft. (1,600 to 2,920 m) that allows for pollinator habitat and changing climate (77 FR 48368) (USFWS, 2013). Sparse vegetation (with less than 10 percent plant cover), assembled of other oil shale specific plants, including *P. caespitosus*, and not dominated by any one species; moderate to steep slopes, generally over 15 percent slope; slow to moderate, but constant, downward motion of the oil shale that maintains the habitat in an early successional state are physical or biological features for this plant (USFWS, 2012).

Dispersal/Migration**Dispersal**

Adult: Low (inferred from USFWS, 2016)

Dispersal/Migration Narrative

Adult: Parachute beardtongue plants produce a small number of seeds that are dispersed by gravity (USFWS, 2016).

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Species Trends:

10 - 30% decline (NatureServe, 2015)

Resiliency:

Very low (inferred from USFWS, 2016)

Representation:

Low (USFWS, 2012)

Redundancy:

Low (inferred from USFWS, 2016)

Number of Populations:

4 (USFWS, 2016)

Population Size:

< 7,600 (inferred from NatureServe, 2015 and USFWS, 2013)

Adaptability:

Low (inferred from USFWS, 2013)

Population Narrative:

This species is rare on a fairly widely distributed habitat type. This may suggest that this species is fairly fragile and vulnerable to some natural threats and human disturbance as well. The long term population trend is unknown. There has been a short term decline of 10 - 30%. The estimated sum of individuals from 6 occurrences is 7600. All of the occurrences have been observed fairly recently, at least within 20 years (as of 2012) (NatureServe, 2015). The total area of the plant's geographic range is about 2 mi (3 km) wide and 17 mi (27 km) long. Six occurrences of Parachute beardtongue were found between 1986 and 2005; two of them are no longer viable (USFWS, 2016). Extremely low numbers and a highly restricted geographic range make Parachute beardtongue particularly susceptible to becoming endangered in the foreseeable future due to the current threats (USFWS, 2013). The Wolfe (2010, pp. 1-7) study demonstrates that genetic diversity is low for *P. debilis*, implying a lowered fitness (USFWS, 2012).

Threats and Stressors

Stressor: Oil and gas development (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Natural gas wells on Mt. Callahan and the Mt. Callahan Saddle have been developed and managed according to Natural Areas agreements and best management practices, which have been effective in avoiding impacts to the plants and habitat (see II. C.). These 2 natural areas support 40 percent of the occupied habitat and 69 percent of the plants. The Smith Gulch population is not included in the Natural Areas agreement or the designated critical habitat. It has 15 percent of the occupied habitat and about 1 percent of the plants (76 FR 45064). The persistence of plants in Smith Gulch near a well pad on BLM land is uncertain because the plants are subject to natural erosion within an ephemeral (short-lived) streambed (USFWS, 2013).

Stressor: Oil shale extraction and mine reclamation (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Anvil Points mine and Logan Wash mine were oil shale mines, which are now closed. Logan Wash mine road maintenance and reclamation activities have impacted habitat and destroyed plants on private and BLM land, and some of these activities are ongoing (76 FR 45054, CNAP 2012, p. 3) (USFWS, 2013).

Stressor: Vehicle access through occupied habitat (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: Continuing use of the Anvil Points mine road to access a Garfield County communications facility prevents natural reclamation of the road by young plants on shifting shale. The road cuts through the middle of this largest population of plants on BLM land (USFWS, 2013).

Stressor: Climate change, drought, and impacts to the vegetative community (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: Climate change is likely to affect long-term survival of native species, including beardtongue, especially if longer or more frequent droughts occur. However, species' response to climate change are complex and current information does not allow strong conclusions regarding the effects of climate change on Parachute beardtongue. Critical habitat for this species has been extended 328 ft. (100 m) upward and downward from the known occupied range in an attempt to provide areas where the plant could migrate, given shifting climates (77 FR 48368) (USFWS, 2013).

Stressor: Invasive species (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: Invasive weeds are often able to out-compete native species under drought conditions (Everard et al. 2010). An invasion of large thistles among the beardtongue plants was observed one year on the bank above the Logan Mine road (USFWS, 2013).

Recovery**Reclassification Criteria:**

Not available - recovery plan not yet developed.

Delisting Criteria:

Not available - recovery plan not yet developed.

Recovery Actions:

- Completion of a comprehensive plant survey on suitable habitat throughout the species' range (USFWS, 2013).
- Continue ongoing trend monitoring efforts and expand monitoring to include areas impacted by reclamation activities and invasive species (USFWS, 2013).
- Identify sites in urgent need of habitat protection, set protection priorities, and implement protective measures. Land management agencies should establish formal land management designations and stipulations to provide for long-term protection of important populations and habitat (USFWS, 2013).
- Oil and gas leasing and oil shale extraction activities should avoid occupied, critical, and suitable habitat (USFWS, 2013).
- Closed oil shale mines in plant habitat should remain closed (USFWS, 2013).

- Develop and implement standard conservation recommendations to minimize future project and use impacts on both private and federal lands (USFWS, 2013).
- Coordinate with land management agencies, project proponents, private landowners and other partners early in the planning process to limit direct and indirect impacts of planned activities (USFWS, 2013).
- Continue to implement Colorado Natural Areas agreements and extend best management practices for habitat adjacent to the CNAs to protect pollinators and habitat (USFWS, 2013).
- The Garfield County communications site on Anvil Points mine road should be moved out of occupied habitat and the site reclaimed in a manner that will allow recolonization of Parachute beardtongue (USFWS, 2013).
- Continue research into Parachute beardtongue life history and ecology, including pollinators (USFWS, 2013).
- Experiment with propagation techniques, soil (shale) and habitat conditions, and management needed to maximize the success of Parachute beardtongue introduction efforts with seeds, soil seed banks, seedlings, and transplants (USFWS, 2013).
- Study population dynamics and conduct a population viability analysis (USFWS, 2013).
- Encourage investigations that project the species' vulnerability and response to climate change (USFWS, 2013).
- Monitor changes in invasive species prevalence and impacts on Parachute beardtongue; explore approaches to minimize the risk posed by invasives and associated remediation actions (USFWS, 2013).

Conservation Measures and Best Management Practices:

- Oil and gas development, reclamation or other activities on the Natural Areas will be conducted in accordance with best management practices (BMPs) included in the agreement. Termination of the agreements must be preceded by 2 years notice. These BMPs include specific provisions to minimize impacts to the species, pollinators, and habitat by the following measures: • Controlled collection of plant materials • Controlled surface disturbances • Reclamation and revegetation • Updated rare plant surveys, monitoring, and reporting • Noxious and invasive weed management and revegetation • Pollinator promotion –maintenance of nesting habitat • Placement of surface facilities • Fugitive dust control (USFWS, 2013).
- At Anvil Points mine BLM worked with the Service and contractors to minimize impacts to plants during closure of several mine tunnel openings, transplant unavoidable individuals, and monitor the effects to plants and habitat. One section of the road through plant habitat was ripped up to make it impassable to vehicles. The majority of transplants survived, some marked plants were buried by sliding shale, and the ripped road surface is not being recolonized because too much soil is mixed in with the shale (DeYoung 2012, pers. comm.) (USFWS, 2013).
- Surveys and monitoring of plants at the Mt. Callahan populations and Anvil Points mine are conducted annually. Surveys at Logan Wash mine may not be complete; monitoring is not yet implemented. The current draft BMPs for Logan Wash may differ from those at Mt. Callahan because reclamation must continue around the mine site. In 2008, BLM designated the Anvil Points Area of Critical Environmental Concern (ACEC), as an area for management of sensitive resources including Parachute beardtongue (BLM 2008b, p. 4) (USFWS, 2013).

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SPECIES ACCOUNT: *Penstemon haydenii* (Blowout penstemon)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/01/1987; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

The blowout penstemon (*Penstemon haydenii*), a member of the snapdragon family, is a hairless perennial that grows 1 to 2 feet high. The stems are often decumbent, simple, or branched, and very leafy. The stem leaves are linear to lanceolate, entire, 3 to 5 inches long by 1 to 3 inches wide, sessile and clasping. The inflorescence is a compactly crowded thyrse. A thyrse is composed of (1) a main axis of an inflorescence made up of flowers born on stalks of about equal length along an elongated axis that continues to grow during flowering and open in succession from below and (2) secondary and later axes of the inflorescence that terminate in single flowers. Floral bracts are ovate to lanceolate, nearly equaling the flowers. The corolla is milky blue to pale lavender (rarely pink or white) and 1.5 to 2 inches long. The sterile staminode is glabrous and/or hairy. Fruits are 0.5 to 0.6 inch long capsules, acute, with light brown, disc-shaped seeds having winged margins (Heidel 2005, USFWS 1987).

Current Range

Blowout penstemon is a regional endemic of the Nebraska Sandhills, the largest sand dune system in North America, located in north central Nebraska (Stokes and Swinehart 1997, Forman et. al 2001). The Nebraska Sandhills is an area of stabilized sand dunes covering 5 million hectares (approximately 12.4 million acres). In 2008, 32 blowout penstemon subpopulations (10 native and 22 introduced) were known to occur in the Sandhills (Stubbendieck 2008). In Wyoming, 3 populations (in addition to 6 subpopulations) of blowout penstemon are located in the Ferris Dunes of northwestern Carbon County, separated from the Nebraska Sandhills by about 175 miles (282 km). The Ferris Dunes cover an area less than 124,000 hectares (50,000 acres). See Figure 1 Geography below.

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: flowers from mid-May to late June in Nebraska

Reproduction Narrative

Adult: The species flowers from mid-May to late June in Nebraska. The flowers have a strong, persistent fragrance that lures several kinds of bees and other pollinators. The fruit (capsule) matures and splits in early to mid-August and the seeds either fall near the base of the plant or are transported primarily by wind to other areas within the blowout or outside of the blowout. All healthy flowering plants are thought to produce seed (USFWS 1992). Most blowout penstemon plants begin to bloom at 2 to 3 years of age (Stubbendieck et al. 1993) and have been successfully cultivated in the greenhouse (Flessner and Stubbendieck 1989, 1992).

Flowering in Wyoming occurs later than in Nebraska (late June to early July), probably in response to drier and cooler climatic conditions (Fertig 2001). Each fruit of the blowout penstemon contains an average of 25-35 seeds with as many as 1500 seeds per plant. The seeds are winged presumably to aid in wind dispersal although, given the high degree of herbivory of this plant, some questions have been raised that animals might also be an important avenue of seed dispersal (Heidel 2005). Seeds are released from late August through September. The seeds, potentially remaining dormant in the sand for 20 years, have a thick outer coat and germination is enhanced after some degree of scarification. Axillary root branching may be an adaptation to survive burial by wind-blown sand rather than a common form of reproduction. By digging around individual blowout penstemon plants, Heidel (2005, 2012) did not find evidence of long-distance underground connectivity between adjacent plants.

Habitat Type

Adult: Sand dunes

Habitat Narrative

Adult: Characterized as a "primary" blowout species (Pool 1914) on active sand dunes in Nebraska sandhills prairie (Stubbendieck et al. 1989, Kuchler 1964). The term 'blowout' refers to a naturally occurring depression in the Nebraska Sandhills. These depressions are caused when vegetation at the upper slope of a hill is disturbed, typically by fire or grazing animals. The 'blowout' may take as many as ten years to become a full scale and active blow out. The process is started when sand is deposited from the windward side of the slope to the leeward side, and this process continues until eventually the roots of the surrounding vegetation are exposed and finally ripped up by the force of the wind. Eventually, a crater is created where there is constant wind action, so succession is continually taking place (Stubbendieck et al. 1989). For a detailed description of blowout ecology, see Stubbendieck et al. (1989). *Penstemon haydenii* occurs within the blowout usually near the leeward side only after the sand has stabilized, and it declines once vegetation is established. All sites have less than 10% basal ground cover (Heidel 1981). Initial colonization of dunes is by *Redfieldia flexuosa*. *Psoralea lanceolata* is locally common where *P. haydenii* is found (Heidel 1981). Other common associates include: *Andropogon hallii*, *Artemisia campestris*, *Asclepias arenaria*, *Astragalus longifolia*, *Calamovilfa longifolia*, *Cirsium plattensis*, *Helianthis* spp., *Hymenopappus corymbosus*, *Lathyrus polymorphus*, *Linum sulcatum*, *Lithospermum incisum*, *Lygodesmia rostrata*, *Oenothera serrulata*, *Oryzopsis hymenoides*, *Petalostemum villosum*, *Rumex venosus*, *Tradescantia occidentalis*, and *Yucca glauca* (Heidel 1981; Lichvar 1982). (NatureServe, 2015). Blowout penstemon was first collected along the North Loup River in the Sandhills area of Nebraska by Ferdinand V. Hayden, probably in 1857 (Sutherland 1988). This specimen was without flowers or fruits and was referred to as sharp leaf penstemon, *Penstemon acuminatus*. Seno Watson originally named and described the species as *Penstemon haydeni*, based on a collection made by H. L. Webber near the Dismal River in Thomas County, Nebraska in 1891 (Watson 1891). Later, Francis W. Pennell could not locate the original 1857 Hayden specimen, and he substituted the Webber specimen as the type collection (Pennell 1920). Both the Hayden specimen and type specimen were deposited at the Gray Herbarium at Harvard. A second "i" was later added to the specific epithet "haydeni" to make it etymologically correct (Sutherland 1988). The most recent morphological descriptions report a deep taproot and stems which root adventitiously in shifting sand (Great Plains Flora Association 1991). No other populations of blowout penstemon were known outside of Nebraska until 1996. In 1996, the Bureau of Land Management (Frank Blomquist) discovered a small colony of blowout

penstemon south of the Ferris Dunes (Fertig 1999). Plant samples were later collected and verified by Dr. Noel Holmgren of the New York Botanical Gardens for verification in 1999. Field identification was subsequently confirmed by additional specimens sent to Dr. James Stubbendieck of the University of Nebraska and Dr. Holmgren. There has been some reason to question whether the populations in Wyoming and Nebraska should be considered members of the same species. Blowout penstemon individuals in Wyoming have divergent flower traits that had not been previously reported (Heidel 2007). At the time of the Five year review, there were still questions as to whether the morphological differences between the Nebraska and Wyoming populations are due to phenotypic plasticity, genetic differences, or a combination of these factors affecting populations. Further consultation with taxonomic experts is ongoing. All known blowout penstemon sites are well-developed blowouts in dune complexes with active sand and accompanying environmental extremes in wind, temperature, evapotranspiration, and soil moisture stress. Blowout penstemon plants are most frequently in microsites that are, or recently have been, zones of sand accumulation. The plant apparently is successional and is a pioneer species that does not persist when a blowout becomes completely vegetated. The species survives burial in sand by sending off shoots at successively higher nodes. It withstands initial erosion and has a rhizomatous system with extensive lateral roots to survive erosion that may uncover much of its root length (USFWS 1987).

Dispersal/Migration

Population Information and Trends

Population Narrative:

Blowout penstemon is a short-lived perennial plant, which requires actively moving sand in blowouts to thrive. It grows from a tap root, initially producing a single stem that often becomes decumbent. The stem roots readily where nodes are buried in the sand. Buds located at the base of the stem break dormancy in the second spring, often producing multi-stemmed plants. These plants typically flower in the second or third year (Kottas 2009), and individual plants live for six to eight years (Stubbendieck et al. 1997). The lavender (or occasionally blue or white) flowers produce two-sided capsules (ovaries) bearing 14 to 35 discoid brown to black seeds (USFWS 1992; Kottas 2009). Seeds have a thick, hard seed coat and germination in the field is typically very low. The seeds are adapted to dispersal by wind, which often distributes seed downwind across the edge of the blowout into the area of sand accumulation. Wind and animals aid in the seed dispersal (Stubbendieck, pers. comm. 2009). Seed numbers are highly variable among years and sites (Kottas 2009). Individual plants may produce approximately 1,400 to 1,500 seeds (Kottas 2009; USFWS 1992), but seed viability can reduce reproductive potential to an average of approximately 530 viable seeds per plant (Kottas 2008). The number of seeds in the seedbank is typically low, due mainly to predation by small mammals at the time of seed rain (Kottas 2009; Stubbendieck, pers. comm. 2009). Kottas (2009) investigated the effects of floral herbivory by insects and fungal infection on seed production and viability. She reported that treatments of plants with insecticide or fungicide did not significantly affect total seed output, weight or viability (Kottas 2009). Consequently, site specific herbivore, granivore and fungal impacts may be important when seed production is low or when the surrounding vegetation invades blowout penstemon habitat, bringing additional herbivory with it (Kottas 2009). The genus *Penstemon* is endemic to North America. Of 275 species in the *Penstemon* genus, only the blowout penstemon and one other species are fragrant (Kottas 2009). The common name of the blowout penstemon comes from the blowouts in the Sandhills of

Nebraska. Blowouts are round or conical eroded areas, depressions formed in the sand when prevailing northwesterly winds scoop out the sides of the hills (Pool 1914 in Kottas 2009). These eroded areas form on the sides of dunes when vegetative cover is removed or disturbed and wind action further exposes the slopes (Stubbendieck et al. 1989). Blowout penstemon is a pioneer species in these blowouts, frequently found among blowout grass (*Redfieldia flexuosa*) which is often the first pioneer in a blowout (Kottas 2009). Neither blowout grass nor blowout penstemon persists after other grasses begin to invade the blowout. The amount of suitable, active blowout habitat has declined markedly since settlement of the Sandhills region in the early 20th century (USFWS 2012). In Wyoming, blowout penstemon is found primarily on the rim and lee slopes of blowouts, or the rim and steep faces of sandy slough slopes. These deposits are found at the base of mountains or ridges, which represent topographic barriers. Shifting sand dunes are prevented from becoming fully stabilized and overgrown because of wind and gravity. The dunes may be 60 to 120 feet high at elevations between 5860-7440 feet (Heidel et.al 2007). The blowout penstemon is found in the early stages of plant community development which can be composed of blowout grass, lemon scurfpea, and thickspike wheatgrass or Indian ricegrass (Heidel 2005). The Wyoming sites differ from Nebraska Sandhills in that the populations occur at higher elevations, the mean annual precipitation is lower, and Wyoming has cooler minimum and maximum summer temperatures.

Threats and Stressors

Stressor:

Exposure:

Response:

Consequence:

Narrative: At the time of listing in 1987, the species was known to exist in only six population centers in four counties of the Nebraska Sandhills. Approximately 7000 plants occurred on less than 10 hectares (25 acres). Improved range management practices and fire suppression which promote blowout healing, were a major cause of the species decline in Nebraska and that remains a major threat today. Given the nature of the different habitats occupied by blowout penstemon plants in Nebraska as compared to those in Wyoming, the degree of threat to populations in these two states may differ. When the blowout penstemon was listed as endangered under the Act, only the Nebraska populations were known, therefore only the threats to populations in Nebraska were considered. In Nebraska, despite conservation strategies to increase numbers of plants and populations within the range, two main areas hamper recovery: 1) Continual loss of blowout habitat due to the stabilization of sand dunes (and lack of habitat management) 2) Lack of plans to guide habitat management and a way to include written agreements to implement such habitat management into conservation plans that could protect the species where it primarily occurs (private land). Additional threats identified and discussed in the 5 year review include: drought, overgrazing, ORV use, construction practices, pesticides, and natural outbreaks of the pyralid moth. In Wyoming, populations have basically been preserved in more or less a natural state because of the isolated, currently inaccessible nature of the sites. However, there is potential moderate to significant impacts from future energy development to the species. As with other forms of development, wind energy facilities, have the potential to affect the natural dynamics of a dune system by directly or indirectly causing changes to the erosion and deposition of sand. Blowout penstemon may be negatively impacted by changes in the dynamics of the dune system (i.e. loss of key habitat attributes, competition, etc.).

Stressor: Mining

Exposure:

Response:

Consequence:

Narrative: Sand mining is currently not occurring in close proximity to any blowout penstemon sites, however more accessible sand deposits in the Rawlins Resource Area are currently being mined. The sand mined from those locations is used for golf courses and road maintenance. Presently, it seems impractical for sand mining to occur near blowout penstemon sites because of their relative isolation, rugged terrain, and limited access. Blowout penstemon populations in Wyoming are located over 7 miles from primary unpaved county roads to the north and east, and at least 15 miles from primary county roads to the west. Future changes in the accessibility to these habitats could affect the profitability and establishment of sand mines near blowout penstemon sites. Other valuable minerals located near the Seminoe Mountains to the south of the blowout penstemon populations include iron, copper, and gold (from Hausel 1989, in Heidel 2012).

Stressor: • Water Development

Exposure:

Response:

Consequence:

Narrative: Near blowout penstemon habitat at Bradley Peak, Bear Mountain, and Junk Hill in Wyoming are excavated ponds, as well as natural ponds and springs used for sources of livestock water. It would not be feasible to develop these water sources as irrigation water for cultivated fields or central pivot irrigation as is done in Nebraska. Nevertheless, further livestock water sources developed near blowout penstemon populations could potentially concentrate livestock near these habitats causing increased grazing or trampling effects to the plants (Heidel 2005).

Stressor: • Oil and Gas Leasing

Exposure:

Response:

Consequence:

Narrative: Oil and gas leasing occurs at the west end of the Bear – Mountain – Junk Hill – Ferris blowout penstemon population. This development includes pumps, pumping stations, and a pipeline corridor (Heidel 2012).

Stressor: • Off-Highway Vehicle Use

Exposure:

Response:

Consequence:

Narrative: Off-highway vehicle (OHV) use has been observed within a blowout penstemon population in Nebraska, and many plants were damaged (USFWS 1992). Hill climbing and associated OHV recreation activities may ensure continued disturbance and erosion of the sand hills and dunes, but driving over and crushing plants may cause severe negative impacts to the plants (USFWS 1992).

Stressor: • Changes in Habitat Quality

Exposure:

Response:**Consequence:**

Narrative: Historically, fires removed the protective cover from the soil in the Nebraska Sandhills region resulting in shifting sand dunes and blowouts. Control of prairie fires followed the area's settlement period. Virtual elimination of fire from the Sandhills ecosystem allowed the vegetation to advance into the majority of the eroded areas and to stabilize the sand, resulting in a decline in suitable habitat for the species (USFWS 1992). However, continual summer grazing by cattle during the first half of this century caused enough disturbances to maintain many blowouts. More recently however, the increased use of planned grazing systems (rotational grazing) during the past 30 years has greatly reduced disturbance and has been responsible for decreasing wind erosion. Other advanced range management practices in Nebraska, including techniques to more evenly distribute livestock on rangeland, have been responsible for decreasing blowout penstemon habitat, as well as the numbers of populations, and the numbers of individual plants (USFWS 1992).

Stressor: • Livestock Trampling and Grazing

Exposure:**Response:****Consequence:**

Narrative: Sheep previously grazed the allotments occupied by blowout penstemon in Wyoming. Cattle and horses are now commonly found on the rangelands of both Nebraska and Wyoming. The influence of horses on blowout penstemon has not been documented. Cattle, however, have frequently been observed near blowout penstemon plants. Many individual plants have been inspected during and after cattle grazing periods. When adequate other forage is available, cattle occasionally graze a portion of a plant but seldom does this cause major damage to the plant (BLM 2012, USFWS 1992). Under these normal range conditions, the use of high livestock stocking rates as a disturbance factor to maintain habitat for the blowout penstemon is considered beneficial (USFWS 1992). Advanced grazing methods, referred to as "holistic resource management", may further decrease blowout penstemon habitat by reducing active erosion. Techniques which more evenly distribute livestock on rangelands such as "planned grazing systems" or "management intensive grazing" may have been responsible for decreasing blowout penstemon habitat, numbers of populations, and numbers of individual plants in Nebraska (USFWS 1992). The occasional removal of a terminal portion of a shoot of a blowout penstemon plant by a grazing herbivore may be desirable because growth of other shoots is stimulated (USFWS 1992). However, during years of low precipitation, livestock forage may be limited and blowout penstemon plants may be more intensively grazed during those times. In Nebraska during times of limited forage availability, cattle have been observed to closely graze nearly every available blowout penstemon plant. One occurrence of close grazing by cattle may or may not impact blowout penstemon plants, but repeated years of close grazing will severely weaken plants and may be the direct cause of plant death (USFWS 1992) or reduce population numbers. o Cattle trampling of established plants has not been observed to be a problem. Infrequently, cattle will break a blowout penstemon shoot, which poses no threat to the plant (USFWS 1992). Livestock trampling damage is typically not significant to blowout penstemon plants because the plants are sparsely distributed in shifting substrate areas which cattle do not normally frequent. For Wyoming populations, it has been hypothesized that wildlife are the primary source of blowout penstemon herbivory. Wild ungulates, such as deer and elk, may have a larger grazing impact on blowout penstemon plants than cattle in Wyoming. Fertig (2001) observed stem damage from deer and elk trampling on 10 percent of the population at Bear

Mountain and on 60 to 80 percent of the stems at Bradley Peak. The tracks of elk and pronghorn antelope were repeatedly observed near browsed plants during survey efforts in Wyoming (Heidel 2005).

Stressor: • Over-collection

Exposure:

Response:

Consequence:

Narrative: The blowout penstemon is attractive and has been cultivated. Horticultural collecting is a potential threat for this species (USFWS 1987). To date, private and commercial collectors have had little impact on blowout penstemon. It would be an attractive and desirable landscape plant, but most of the plants are in locations which are too remote or inaccessible (USFWS 1992).

Stressor: • Pesticide Use

Exposure:

Response:

Consequence:

Narrative: The direct impact of herbicides on blowout penstemon is not known, although it is highly probable that broadleaf weed killers would negatively influence this plant (USFWS 1992). Herbicide use is thought to be minimally used on sand hills/dune regions due to the sparse cover of its habitat. It is doubtful that ranchers would even inadvertently apply herbicide to blowout penstemon, because most ranchers try to encourage the growth of all vegetation in blowouts. Use of insecticides could negatively impact the pollinators of blowout penstemon. Numerous types of insects may be responsible for pollination; however, it is unlikely that localized insecticide use would completely eliminate insect pollination (Heidel 2005).

Stressor: • Encroachment by other plants

Exposure:

Response:

Consequence:

Narrative: Non-native species in or adjoining blowout penstemon habitat in Wyoming included cheatgrass (*Bromus tectorum*) and Russian knapweed (*Centaurea repens*). Russian knapweed (*C. repens*) recently got introduced at the base of the Bradley Peak population site and could become a major infestation, possibly entering blowout penstemon habitat. Cheatgrass (*B. tectorum*) is one of the more common non-native species in the Pathfinder population and has been observed to be spreading in some of the Bear Mountain subpopulations (Heidel 2012). Weeds pose may pose threats as competitors. Any herbicides used to control the noxious weeds may pose a threat to the blowout penstemon.

Stressor: • Construction Activities

Exposure:

Response:

Consequence:

Narrative: The area between the Ferris and Seminoe Mountains is an area of particularly high mean turbulent kinetic energy, responsible for sand deposition on steep slip-face slopes hundreds of feet high. In recent years, there have been wind energy permit applications that encompass blowout penstemon populations. Any alteration of on-site or upwind flow patterns, or related access development and construction, could affect the species and its habitat. There

are four separate dead-end roads to occupied habitat, and if there were any road developments between them, it would provide more access to occupied habitat.

Stressor: • Vulnerability Based on Small Population Size

Exposure:

Response:

Consequence:

Narrative: At the time of listing in 1987, the species was known to exist in only six population centers in four counties of the Nebraska Sandhills. Approximately 7000 plants occurred on less than 10 hectares (25 acres). The small populations known at the time were thought to make the species vulnerable to localized environmental changes. In addition, the species occupies a successional niche in the development and eventual revegetation of blowout habitats. As the vegetation in these areas increases, blowout penstemon undergoes local extirpation. At the time of listing, the species was not only rare, but did not appear vigorous at the known localities in Nebraska, possibly because these blowouts had reached a stage of revegetation that exceeded the optimum habitat conditions for the species. Furthermore, the number of new blowouts was decreasing (USFWS 1987). In Wyoming, 3 populations (in addition to 6 subpopulations). The isolation of these populations from each other, as well as the isolation of these populations from other blowout penstemon populations in Nebraska, makes the Wyoming populations similarly vulnerable to the threat of random stochastic events (such as prolonged drought, introduction of invasive species) that could lead to reduction or loss of these populations.

Stressor: • Natural Threats

Exposure:

Response:

Consequence:

Narrative: Damaging insects and periods of drought may be the greatest natural threats to the survival of this species (USFWS 1992). Prior to the drought of the 1930's, the blowout penstemon was listed as one of the most common species in sand blowouts. Following the drought of the 1930's which severely influenced the vegetation of the Great Plains, the blowout penstemon was thought extinct until it was rediscovered in Nebraska in 1959. At one time, it was thought that a localized drought of a few years duration could eliminate most of the remaining blowout penstemon plants in Nebraska (USFWS 1992). o Destructive insects may be a primary cause of decline in populations (USFWS 1992). Several insects (and arachnids) have been observed feeding on blowout penstemon plants, including spider mites, grasshoppers, and an insect larvae which burrows into the inflorescence. Populations of invertebrates are generally at low levels. However, large numbers of penstemon aphids (*Aphis pentstemonicola*) were observed on two individual transplanted blowout penstemon plants growing in a blowout near Alliance, Nebraska. Foliage of the infested plants appeared wilted, grayish-green, and stunted. Several seed predators have also been found active on blowout penstemon. The most serious insect threat appears to be the pyralid moth. Larvae of a pyralid moth did extensive damage to one population of blowout penstemon in 1990. Adult female pyralid moths deposit their eggs on blowout penstemon plants. After hatching, the larvae burrow into the stems and are active until reaching the pupal stage. These larvae damage or kill blowout penstemon plants by boring into the crown area below the plant's buds.

Stressor: • Disease

Exposure:

Response:**Consequence:**

Narrative: Blowout penstemon plants are also quite susceptible to fungal root rots. Plants infected with these fungi wilt, rot, and usually die (USFWS 1992).

Stressor: • Encroachment by Other Plants

Exposure:**Response:****Consequence:**

Narrative: The blowout penstemon is well adapted to the rigorous environment of an actively eroding blowout, but it does not grow in close association with most other plants. It generally grows as widely spaced plants in nearly bare sand indicating that these plants may not have the ability to compete with each other or plants of other species for moisture. Its associate in Nebraska, blowout grass, does not use large amounts of soil moisture. Blowout penstemon populations in Nebraska have been known to rapidly decline as members of new species, primarily sand bluestem (*Adropogon hallii*) and prairie sandreed (*Calamovilfa longifolia*) increase and begin to use significant amounts of soil moisture following stabilization of the sand habitat (USFWS 1992).

Recovery**Reclassification Criteria:**

Blowout penstemon will be considered eligible for reclassification to threatened when: 1. a minimum of 10,000 individuals in at least 5 population groups is established; and 2. the 5 populations have the minimum level of protection that will ensure their continued existence.

Delisting Criteria:

Blowout penstemon will be considered eligible for delisting when: 1. a minimum of 15,000 individuals in at least 10 population groups, each with a minimum population of 300 plants is established; and 2. the 10 populations are demonstrated to be at minimum viable population levels.

Recovery Actions:

- 1. Protect and monitor naturally occurring, reintroduced, and introduced populations. 2. Inventory suitable habitat for naturally occurring populations and determine potential reintroduction sites. 3. Conduct research to determine life history, minimum viable population parameters, and management criteria. 4. Establish new populations of blowout penstemon. 5. Establish and implement management plans for each population.

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SPECIES ACCOUNT: *Penstemon penlandii* (Penland beardtongue (aka Kremmling beardtongue))

Species Taxonomic and Listing Information

Listing Status: Endangered; 08/14/1989; Mountain-Prairie Region (R6)

Physical Description

A short plant with linear leaves and several clumped, pubescent stems up to 25 centimeters (10.0 inches) tall. There are 5-15 bright bicolored flowers with blue lobes and a violet throat, 1.2-1.5 centimeters (0.5-0.6 inches) long, per inflorescence; the fruits are small brown capsules. (USFWS, 1992)

Taxonomy

Penstemon penlandii was independently discovered in July 1986 by David Johnson of Western Resource Development Company and John Anderson, then a botanist — with the U.S. Fish and Wildlife Service (Service), on visits to the Osterhout milkvetch site along Troublesome Creek near Sulphur Springs. It was described the same year by Dr. William Weber of the University of Colorado (Weber 1986). A member of the snapdragon family (Scrophulariaceae). (USFWS, 1992)

Historical Range

Endemic to Middle Park near Kremmling in Grand County, Colorado (USFWS, 1992).

Current Range

Near Kremmling in Grand County, Colorado. (USFWS, 1992)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual: vegetative, sexual: cross-pollination, self-pollination (USFWS, 2016)

Lifespan

Adult: Unknown (USFWS, 2016)

Breeding Season

Adult: June - July (USFWS, 2016)

Key Resources Needed for Breeding

Adult: Bee pollinators, especially *Osmia* spp. (USFWS, 2016)

Reproduction Narrative

Adult: Blooms in June and July. Kremmling beardtongue has rhizomes and vegetative growth. It is not known how long-lived *Penstemon penlandii* individuals are. The plant exhibits a mixed mating system: it can produce seed with pollen from the same plant but is significantly more successful with pollen from another plant. Pollen must be moved from plant to plant with the assistance of pollinators. The primary pollinators are native solitary bees, especially those in the genus *Osmia* (USFWS, 2016).

Habitat Type

Adult: Terrestrial (USFWS, 2016)

Habitat Vegetation or Surface Water Classification

Adult: Troublesome Formation shale (USFWS, 2016); sagebrush (USFWS, 1992)

Geographic or Habitat Restraints or Barriers

Adult: ~7,500 ft. elevation (USFWS, 1992)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2016)

Habitat Narrative

Adult: The Kremmling beardtongue is only known to occur on white to tan barren shale soil exposures. The plant is locally abundant but highly restricted to sparsely vegetated shales of the Troublesome Formation that are high in selenium. The plant community is dominated by grasses and mixed shrubs (especially sagebrush, rabbitbrush, and bitterbrush) (USFWS, 2016). It inhabits a high elevation sagebrush park at 7,500 feet. Penland beardtongue is only known Pierre Shales and of late Tertiary (Miocene Troublesome Formation) siltstone sediments (USFWS, 1992). It occurs on alkaline clays containing selenium, which is toxic to most plants. Optimum habitat for *P. penlandii* appears to be in runoff channels, shaded by the deeply cut banks (NatureServe, 2015).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Stable (NatureServe, 2015)

Number of Populations:

1 (USFWS, 2016)

Population Size:

~1.4 million (NatureServe, 2015)

Population Narrative:

There is only one population of the Kremmling beardtongue. It is estimated the species occupies less than 1500 acres (USFWS, 2016). Estimates from Ecotone 2010 surveys are approximately 1.4 million individuals. In 2008, DBG staff set up one temporary macroplot and conducted a point in time count estimate. When compared to visual estimates from the same site in 2005, the population appears stable or increasing (Neale et al. 2008) (NatureServe, 2015).

Threats and Stressors

Stressor: Off-road vehicles (USFWS, 1992)

Exposure:

Response:

Consequence:

Narrative: The badlands on which *Penstemon penlandii* occurs are currently vulnerable to degradation from off-road vehicle use because of their fragile soils, steep topography, and arid environment. There are dirt roads running through the badlands which provide easy access for off-road vehicle use. Off-road vehicle damage and mineral exploration have occurred on the area. The resulting modification of the habitat could result in a reduction of the range for *Penland beardtongue* (USFWS, 1992).

Stressor: Collection (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: CNHP considers all *Penstemon* species locations as sensitive information because of the risk of collectors targeting populations for use in gardens (NatureServe, 2015).

Recovery**Reclassification Criteria:**

The following criteria should ensure the continued existence of the species and the maintenance of its habitat:

1. Land management designations are established and habitat management programs are developed and implemented for all known populations of *Penstemon penlandii* (USFWS, 1992).
2. The species is protected from detrimental environmental impacts through fulfillment of informal and formal consultation responsibilities under Section 7 and protection regulations under Section 9 of the Endangered Species Act (USFWS, 1992).
3. Factors required to establish and maintain minimum viable populations of the species are identified and minimum viable populations are documented as being maintained (USFWS, 1992).

Delisting Criteria:

Removal from the list of endangered and threatened species (recovery) is not considered feasible because of small natural populations, limited habitat, and persistent nature of potential threats (USFWS, 1992).

Recovery Actions:

- Inventory any remaining potential habitat: Identifying and surveying potential habitat is important for both species, but especially so for *Penstemon penlandii* due to its very limited known distribution. The best way to ensure this species long-term viability would be to discover more populations and ensure their protection and management. Most populations of *Penstemon oenlandii* occur on private lands. The discovery of additional populations of this species on public lands would decrease the species vulnerability and help ensure its long-term viability. Surveys for this species on public lands are a high priority need. (USFWS, 1992)
- Protect existing habitat: Because of the limited amount of habitat, it is important that known habitats be impacted as little as possible. Various strategies are needed for the different threats and landownerships. (USFWS, 1992)
- Protect pollinators Successful reproduction and maintenance of genetic diversity requires sufficient numbers and types of pollinators. (USFWS, 1992)
- Conduct life history/ecology studies In order to understand how to establish and maintain minimum viable populations of each species, additional population biology and ecology studies are necessary. (USFWS, 1992)
- Future actions: The necessity of these actions will be determined by the results of the studies described above. These may include: Management of surface disturbance; Management of plant communities; and Restoration of disturbed habitats. (USFWS, 1992)

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SPECIES ACCOUNT: *Pentachaeta bellidiflora* (White-rayed pentachaeta)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An annual herb. Stems are 6-17 cm long. Leaves are linear. Flower heads have white ray flowers surrounding a yellow disk. Blooms March-May. (NatureServe, 2015)

Taxonomy

Pentachaeta bellidiflora (white-rayed pentachaeta) was first collected in 1853 to 1854 near Corte Madera by John Milton Bigelow, surgeon and botanist for a railway route exploration (Van Horn 1973). The plant was described as *Pentachaeta bellidiflora* (Greene 1884). Keck (1958) transferred the entire genus to *Chaetopappa*. Van Horn (1973) studied *Chaetopappa* and *Pentachaeta* and concluded that the two genera are not closely related. Based on differences in floral and vegetative morphology and chromosome number, Van Horn (1973) reinstated the genus *Pentachaeta* (USFWS, 1998).

Historical Range

See current range/distribution.

Current Range

At the time of listing, *Pentachaeta bellidiflora* was known from a single large occurrence in the Triangle area which extended east of I-280 into Eastwood Regional Park. Historically, the species was more widespread and was known from at least nine locations in Marin, San Mateo, and Santa Cruz Counties. Most of the occurrences were lost due to urbanization or disturbance from off-road vehicles (CNDDDB 2010). The Triangle remains the only known verified occurrence of *P. bellidiflora* (CNDDDB 2010); however, since the time of listing, a small occurrence of *P. bellidiflora* may have been found on the west side of Upper Crystal Springs Reservoir in San Mateo County (M. Vasey, San Francisco State University, in litt., May 28, 2010). Further surveys need to be done to confirm this occurrence (USFWS, 2010)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (USFWS, 1998)

Breeding Season

Adult: Pentachaeta bellidflora flowers from March to May (Van Horn 1973) and may be visited by the federally threatened bay checkerspot butterfly (Euphydryas editha bayensis) (USFWS, 1998).

Reproduction Narrative

Adult: Pentachaeta bellidflora flowers from March to May (Van Horn 1973) and may be visited by the federally threatened bay checkerspot butterfly (Euphydryas editha bayensis). The butterfly may incidentally pollinate the plant, but the primary pollinators of Pentachaeta bellidflora are unknown (Robison and Morey 1992b). Given that the seeds apparently do not over-winter well, the species may have a limited soil seed bank (Van Horn 1973). Detailed data on the reproductive biology of Pentachaeta bellidflora are not available (USFWS, 1998).

Habitat Type

Adult: Bunchgrass communities (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Serpentine soils (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits bunchgrass communities associated with serpentine soils (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the species unique habitat requirements and low number of known populations.

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Population Narrative:

Surveys conducted prior to the listing in 1995 showed that the occurrence at the Triangle contained about 1.5 million plants in each of the two years the plant was surveyed in the early 1990's (U.S. Fish and Wildlife Service 1995). The most recent surveys reported to the CNDDDB in 2000 noted only that the species numbered in the millions of plants. This population extends to the east side of I-280 on Edgewood Park land; this portion of the population was found to contain 43 plants in 2004 (CNDDDB 2010). No abundance information is available for the possible occurrence near Crystal Springs Reservoir (USFWS, 2010).

Threats and Stressors

Stressor: Recreation (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Construction of a trail is no longer proposed on the San Francisco Water Department land within the Triangle site (S. Foree, in litt., May 19, 2010) which alleviates this source of non-native plants as a threat. The SFPUC is proposing to create the Adobe Gulch Grassland Restoration Site near the southwest edge of Crystal Springs Reservoir, immediately adjacent to the possible location of a second occurrence of *P. bellidiflora* (Winzler and Kelly 2010). The proposed actions within the Restoration Site include enhancing the coastal terrace prairie by shrub removal. Potential habitat for *P. bellidiflora* may exist within the Restoration Site; however, surveys have not been conducted to determine if the area supports additional plants. Disturbance to the Restoration Site may encourage invasive plants to become established (M. Vasey pers. comm., June 29, 2010) and compete with the *Pentachaeta bellidiflora* if it exists there (USFWS, 2010).

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The Endangered Species Act is the primary Federal law that has provided protection for these species since the dates of their listing as endangered in 1985 and 1995. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent their status under the Act. Therefore, we continue to believe other laws and regulations have limited ability to protect the species in absence of the Endangered Species Act (USFWS, 2010).

Stressor: Non-native plants (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Invasive plant species that are present on the Triangle site are teasel, jubata grass, fennel, harding grass, hoary mustard, bull thistle, and Spanish broom; however, these plants do not directly threaten the *Pentachaeta bellidiflora* which is located on a hillside that supports fewer weedy plants (S. Foree, in litt., May 21, 2010). Weiss and Luth (2003); however, have conducted research on the effects of nitrogen deposition in a serpentine grassland in the Santa Clara Valley which has bearing on threats to *P. bellidiflora*. Weiss and Luth found that nitrogen deposition from automobiles on Interstate 280 were responsible for higher nitrogen levels within

400 meters on the west side of the roadway. Grass cover was higher in these areas. The authors noted that the only known occurrence of *P. bellidiflora* exists east of the freeway. There is an elevated zone of nitrogen-deposition extending out approximately 100 meters on the east side of the freeway and the species may be at long-term risk from invasions of nitrogen-loving grasses and other weedy plant species. *P. bellidiflora* is restricted to the thinnest soils in that 100 meter zone; beyond 100 meters, it is one of the dominant plants in the grassland. (S. Weiss in litt, May 25, 2010). Invasions of these nitrogen loving plants into nitrogen-limited grasslands and shrublands appears to be a common response to atmospheric nitrogen deposition (USFWS, 2010).

Stressor: Natural catastrophes (USFWS, 2010)

Exposure:

Response:

Consequence: Extinction

Narrative: Because the species is found at a single site, it is threatened by natural catastrophes that could effect the entire occurrence such as fire, disease, genetic depletion, or drought. These events could increase the risk of genetic changes that decreases the ability of the species to survive (USFWS, 2010).

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Although the specific effects of climate change on *Acanthomintha obovata* ssp. *duttonii*, *Cirsium fontinale* var. *fontinale*, and *Pentachaeta bellidiflora* are unknown, the effects of increased winter flooding and drought conditions in the spring have the potential to adversely affect these species (USFWS, 2010).

Recovery

Reclassification Criteria:

Pentachaeta bellidiflora may be downlisted to threatened status when: 1. A total of five populations are secured and protected from incompatible uses. These include occupied and former known habitat at the Triangle and Edgewood Park and at the new potential occurrence if it is confirmed to be *P. bellidiflora* along with additional populations and adjacent unoccupied habitat and a 150-meter (500-foot) buffer (USFWS, 2010).

2. A management plan is approved and implemented for recovery areas and includes survival of the species as an objective for all populations and any adjacent areas identified as essential to continued survival of the species (USFWS, 2010).

3. Population monitoring in specified recovery areas shows stable or increasing numbers of plants with evidence of increasing numbers over a 20-year period that includes a normal precipitation cycle (or longer if suggested by the results of demographic monitoring) (USFWS, 2010).

4. Seeds stored in at least two Center for Plant Conservation-certified facilities; seed germination and propagation techniques understood (USFWS, 2010).

Delisting Criteria:

Pentachaeta bellidiflora may be delisted when: 1. A total of ten populations are secured and protected from incompatible uses with at least 3 populations in each of Marin, San Mateo, and Santa Cruz Counties (USFWS, 2010).

2. A management plan is approved and implemented for recovery areas and includes survival of the species as an objective for all populations and any adjacent areas identified as essential to continued survival of the species (USFWS, 2010).

3. Population monitoring in specified recovery areas shows no decline in numbers of plants after downlisting with evidence of increasing numbers over a 20-year period that includes a normal precipitation cycle (or longer if suggested by the results of demographic monitoring) (USFWS, 2010)

Recovery Actions:

- Reclassification criteria: This criterion has not been met. No occurrences other than the Triangle site occurrence have been verified. No introductions or reintroductions of the species have taken place. No additional information about the potential new occurrence near Crystal Springs Reservoir is available (USFWS, 2010). Delisting criteria: This criterion has not been met. No occurrences other than the single Triangle site occurrence in San Mateo County have been verified. A second occurrence near the Crystal Springs Reservoir has been reported but must be confirmed. No information is available regarding whether other occurrences which are presumed by CNDDDB to be extirpated have been revisited since the time of listing (USFWS, 2010).
- Reclassification criteria: This criterion has partially been met. As noted above in the section on *Cirsium fontinale* var. *fontinale*, the San Francisco Public Utilities Commission has developed and implemented the Peninsula Watershed Management Plan (http://sfwater.org/detail.cfm/MC_ID/20/MSD_ID/177/C_ID/2162, accessed May 25, 2010). This plan covers the Lower Crystal Springs Reservoir and the Triangle. The plan addresses rare plants (S. Foree, in litt., May 21, 2010). Policy V5 and V6 of the Plan are as follows: V5. Protect, preserve, and enhance significant botanical resources, including populations of rare, threatened, endangered, and sensitive plant species and their habitat; V6. Encourage and allow investigations of special status plants and communities on the watershed to further the SFPUC's understanding of the watershed's vegetation and its condition. This plan does not specifically identify which areas are essential to the continued survival of the species (USFWS, 2010). Delisting criteria: This criterion has not been completely met. The San Francisco Public Utilities Commission has developed and implemented Peninsula Watershed Management Plan (http://sfwater.org/detail.cfm/MC_ID/20/MSD_ID/177/C_ID/2162, accessed May 25, 2010). This plan covers the Lower Crystal Springs Reservoir and the Triangle. The plan addresses rare plants (S. Foree, in litt., May 21, 2010). Policy V5 and V6 of the Peninsula Watershed Management Plan are as follows: V5. Protect, preserve, and enhance significant botanical resources, including populations of rare, threatened, endangered, and sensitive plant species and their habitat; V6. Encourage and allow investigations of special status plants and communities on the watershed to further the SFPUC's understanding of the watershed's vegetation and its condition. This plan does not specifically identify which areas are essential to the continued survival of the of the species (USFWS, 2010).

- Reclassification criteria: This criterion has not been met. Monitoring in the late 1980's and early 1990's (CNDDDB 2010) has shown numbers of plants at the Triangle were apparently stable; however, no monitoring has been reported since 2000. The portion of the occurrence that is located in Edgewood Park has declined from 100 plants in 1989 to 43 plants in 2004 (CNDDDB 2010). No monitoring data is available at the potential Crystal Springs Reservoir site. Monitoring has not been continuous over a 20-year period. Only the Triangle occurrence is known to occur. No introductions or reintroductions have taken place (USFWS, 2010). Delisting criteria: This criterion has not been met. The downlisting criterion has not been met. Only one verified occurrence is known to exist. Monitoring in the late 1980's and early 1990's (CNDDDB 2010) has shown numbers of plants were apparently stable; however, no monitoring has been reported since 2000. The portion of the occurrence that is located in Edgewood Park declined from 100 plants in 1989 to 43 plants in 2004 (CNDDDB 2010). Monitoring has not been continuous over a 20-year period (USFWS, 2010).
- Reclassification criteria: This criterion has been partially met. Approximately 15,000 seeds were collected from the Triangle occurrence in 2010 by staff from San Francisco Public Utilities Commission and UC Berkeley Botanical Garden. Seed will be sent to U.S.D.A. National Center for Genetic Resource Preservation in Fort Collins, Colorado for germination testing (USFWS, 2010).

Conservation Measures and Best Management Practices:

- Conduct surveys at occurrences of all three species which have not been visited for five years to determine if habitat remains and whether these areas would be suitable reintroduction sites if the species is no longer present (USFWS, 2010).
- Collect information on habitat preferences for all species in order to facilitate the search for suitable habitat for outplanting. Data to be collected should include associated plant communities, soil types, soil nutrients, pollinators, and hydrology of the currently occupied habitat as well as the historically occupied sites. Conditions at currently occupied sites may not represent the habitat that supported the species at historic locations, particularly for *Pentachaeta bellidiflora* which had a far greater range historically and likely more variability between sites (USFWS, 2010).
- Conduct research on propagation methods for the *Cirsium fontinale* var. *fontinale* and *Pentachaeta bellidiflora* for future outplantings and habitat restoration (USFWS, 2010).
- Conduct research on the relationship between *Cirsium fontinale* var. *fontinale* and *Deschampsia caespitosa* ssp. *holciformis* (tufted hairgrass). Determine if *D. caespitosa* ssp. *holciformis* is critical to outplantings and restoration of *C. fontinale* var. *fontinale* occurrences (USFWS, 2010).
- Determine identity and importance of pollinators for *Acanthomintha obovata* ssp. *duttonii* and *Pentachaeta bellidiflora*. (This information has already been collected for *Cirsium fontinale* var. *fontinale*). Determine habitat needs of the pollinators and ways to incorporate this information into management and restoration/outplanting plans for the species (USFWS, 2010).

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SPECIES ACCOUNT: *Pentachaeta lyonii* (Lyon's pentachaeta)

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/28/1997; Pacific Southwest (R8)

Physical Description

An annual herb, 6-48 cm tall, with yellow flower heads that bloom in the spring. Each plant may produce 30 or more flower heads. (NatureServe, 2015)

Taxonomy

Pentachaeta lyonii was described by Asa Gray (1886) based on a plant collected by William S. Lyon "near Palos Verdes Mountain" in Los Angeles County. David D. Keck (1958) combined *Pentachaeta* with *Chaetopappa* and published the combination *Chaetopappa lyonii*. This was recognized by Munz and Keck (1959) and Munz (1974). Van Horn (1973) conducted a taxonomic status of *Pentachaeta* and *Chaetopappa* and demonstrated that the two genera were distinct in morphological, anatomical features, and breeding systems. This treatment has been followed in current floristic treatments (Raven et al. 1986, Lane 1993) (USFWS, 1999).

Historical Range

See current range/distribution.

Current Range

Endemic to coastal southern California, where currently known only from eastern Ventura and western Los Angeles Counties, in the Santa Monica Mountains and western Simi Hills (CNDDB 2008 cited in USFWS 2008). Formerly also known from the Palos Verdes Peninsula and Santa Catalina Island, but now believed historical/extirpated from these areas (CNDDB 2008 cited in USFWS 2008). (NatureServe, 2015)

Critical Habitat Designated

Yes; 12/14/2006.

Legal Description

On November 14, 2006, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective 12/14/2006) for *Pentachaeta lyonii* (Lyon's pentachaeta) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes seven critical habitat units (CHUs), in California (71 FR 66374-66423).

Critical Habitat Designation

The critical habitat designation for *Pentachaeta lyonii* includes six CHUs in Ventura, and Los Angeles Counties, California. Approximately 3,396 ac (1,372 ha) fall within the boundaries of the critical habitat designation. The critical habitat units are located in Ventura and Los Angeles Counties, California. Brief descriptions are presented below; detailed coordinates and maps are included in the Final Rule. (USFWS, 2006).

Unit 1: Simi Valley Unit: This unit is located east of Moorpark and west of Simi Valley in Ventura County and consists of 390 ac (157 ha) of private land. This unit is divided into four subunits

(subunits 1a, 1b, 1c, and 1d) and mapped from occurrences known at the time of listing. The subunits are in the same geographic area; they are all within 2.5 mi (4000 m) of each other.

Unit 2: Montclef Ridge Unit: This unit is located along Montclef Ridge, northwest of Newbury Park in Ventura County. It consists of 892 ac (361 ha) of local agency land (Lynmere, Wildwood Park, and Mount Clef Ridge) owned and managed by COSCA and Conejo Recreation and Parks District, and 265 ac (107 ha) of private land. This unit is divided into three subunits (subunits 2a, 2b, and 2c) that occur within the same geographic area, and are mapped from occurrences known at the time of listing and one occurrence identified after listing.

Unit 3: Thousand Oaks Unit: This unit is located in Thousand Oaks near Lake Sherwood in Ventura and Los Angeles Counties. It consists of 671 ac (272 ha) of local agency land (COSCA, Las Virgenes Metropolitan Water District, and Mountain Resources Conservation Authority) and 588 ac (238 ha) of private land. This unit is divided into three subunits (Subunits 3a, 3b, 3c (eastern portion), and 3d (western portion)) mapped from occurrences known at the time of listing and two occurrence identified after listing.

Unit 4: Triunfo Canyon Unit: This unit is located in unincorporated Los Angeles County. It consists of 197 ac (80 ha) of local agency land owned by Mountains Recreation and Conservation Authority, and 9 ac (3 ha) of private land. It is mapped from an occurrence known at the time of listing and includes multiple patches within a large, single population complex.

Unit 5: Mullholland Drive Unit: This unit is located in the Santa Monica Mountains in Los Angeles County and consists of 105 ac (42 ha) of Federal land (Santa Monica Mountains National Recreation Area) and 187 ac (75 ha) of private land. It is divided into 4 subunits (Subunits 5a, 5b, 5c, and 5d) mapped from occurrences known at the time of listing and occurrences identified after listing.

Unit 7: Malibu Lake Unit: This unit is located in the Santa Monica Mountains in Los Angeles County and consists of 58 ac (23 ha) of State land (Malibu Creek State Park) and 34 ac (14 ha) of private land. It is mapped from an occurrence known at the time of listing.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Pentachaeta lyonii* critical habitat consists of three components (71 FR 66374-66423):

- (i) Clay soils of volcanic origin;
- (ii) Exposed soils that exhibit a microbiotic crust, which may inhibit invasion by other plant competitors; and
- (iii) A mosaic of bare ground (>10%) patches in an area with less than 60 percent cover.

Special Management Considerations or Protections

Threats that may require special management are specified in the Final Rule for each Critical Habitat Unit: Unit 1. The invasion of annual grasses and nonnative plants that could crowd out *P. lyonii*, and grazing, edge effects from urban development, road maintenance, and vehicle

traffic, which could result in removal or trampling of plants. Unit 2: The invasion by annual grasses and nonnative plants that could crowd out *P. lyonii*; recreation, including equestrian activities, foot traffic, and off-road vehicles, which could result in trampling of plants; illegal dumping, urban development, which could result in removal of plants; and edge effects from existing urban development. Unit 3: Edge effects from urban development, removal of plants for urban development or fuel management, invasion by annual grasses and nonnative plants that could crowd out *Pentachaeta lyonii*, and equestrian and foot traffic that could result in trampling of plants. Unit 4: The invasion by annual grasses and nonnative plants, which could crowd out *P. lyonii*, fuel management, which could result in removal of plants, and foot traffic, which could result in trampling of plants. Unit 5: The potential for development, which could result in removal of plants; fuel management, which could also result in removal of plants; and invasion by annual grasses and nonnative plants, which could crowd out *Pentachaeta lyonii*. Unit 7: Recreation activities such as foot traffic, which may result in trampling of plants. (USFWS, 2006)

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (NatureServe, 2015, USFWS, 2006))

Reproduction Narrative

Adult: *Pentachaeta lyonii* is not capable of self-pollination, but is dependent upon insect pollinators for successful seed production (Fotheringham and Keeley 1998). Pollinators of *P. lyonii* include digger bees, andrenid bees, and megachilid bees (Braken and Verhoeven 1998; Fotheringham and Keeley 1998). These pollinators are polylectic, meaning that they utilize several plant species within an area (Braken and Verhoeven 1998), and a variety of plants are necessary to sustain pollinator populations. Known pollinators of *P. lyonii* have the ability to pollinate individual plants up to 1,968 ft (600 m) from the pollen source, suggesting that genetic connectivity occurs between populations that are up to 1,968 ft (600 m) apart from each other. (USFWS, 2006). Seeds have deciduous pappus bristles, suggesting that this species is not often dispersed long distances by wind. However, seeds of species in this family (Asteraceae) are also sometimes transported by small seed-eating mammals and birds (Martin et al. 1961 cited in USFWS 2008). This species' seeds likely persist in the soil for several years during extended dry spells (Fotheringham and Keeley 1998 cited in USFWS 2008).; Predominantly outcrossing; SEXUAL; BIOTIC; Hymenoptera (NatureServe, 2015).

Habitat Narrative

Adult: Species occurs in saddles between hills, on the tops of small knolls, or in flat areas at the base of slopes. Plants are found within small open, grassy sites that intergrade with fire-adapted chaparral and coastal sage scrub; also on road and trail edges. Occupied sites tend to feature a mosaic of bare ground patches in an area with low overall vegetative cover. Tends to occur on exposed, rocky clay soils of volcanic origin that exhibit a microbiotic crust. Does not compete well with dense annual grasses or shrubs; can apparently persist without disturbance if site conditions (e.g. exposed soils with a microbiotic crust) inhibit the growth of plant competitors, otherwise periodic disturbance to remove these competitors may be necessary. 85 - 628 m (USFWS 2008). (NatureServe, 2015)

Dispersal/Migration**Dispersal**

Adult: Wind/mammals (USFWS, 2006)

Dispersal/Migration Narrative

Adult: produce on the order of 1,000 seeds. The seeds likely persist in the soil for several years during extended dry spells (Fotheringham and Keeley 1998). Plant seeds are frequently dispersed by a variety of vectors, some which result in short-distance dispersal, and others which result in long-distance dispersal (Cain et al. 2000; Nathan and MullerLandau 2000). The presence of deciduous pappus bristles on the seeds indicates that the plant does not exhibit long-distance dispersal by wind, as do many other species in this family, reducing the likelihood of colonization of new areas and contributing to the limited distribution by this method (Keeley and Baer-Keeley 1992; Fotheringham and Keeley 1998). Longdistance dispersal, however, is likely achieved by transport of seeds by wildlife. Seeds from species within the Asteraceae family are known to be transported by small seed-eating mammals, including ground squirrels (*Citellus* sp.) pocket mice (*Perognathus* sp.), kangaroo rats (*Dipodomys* sp.), and birds, including quail (*Lophortyx* sp.) (Martin et al. 1961). Small mammals facilitate seed dispersal through consumption and elimination of undigested seed and through seed caching (Cain et al. 2000; Sieg 1987) (USFWS, 2006).

Population Information and Trends**Population Trends:**

Decreasing (NatureServe, 2015)

Population Growth Rate:

This species has apparently been extirpated from the southern portion of its historical range (Palos Verdes Peninsula and Santa Catalina Island) (CNDDDB 2008 cited in USFWS 2008). Decline of 50-90% (NatureServe, 2015)

Number of Populations:

21 - 80 (NatureServe, 2015)

Population Size:

65,000-70,000 plants (NatureServe, 2015)

Population Narrative:

This species has apparently been extirpated from the southern portion of its historical range (Palos Verdes Peninsula and Santa Catalina Island) (CNDDDB 2008 cited in USFWS 2008). Decline of 50-90% Approximately 65,000-70,000 plants as of most recent counts, but this species is an annual known to exhibit large year-to-year fluctuations in population size, so this particular number may not have much meaning in terms of the species' long-term persistence. Annual fluctuations are believed to occur in response to external factors such as rainfall and competition with other plant species (USFWS 2008). Approximately 32 occurrences are believed extant, with an additional 5 considered historical. At least 3 occurrences have been extirpated. (NatureServe, 2015)

Threats and Stressors

Stressor: Urban Development (USFWS, 2008)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: At the time of listing, the primary threats to *Pentachaeta lyonii* were destruction of habitat from urban development. An indirect threat to the species was the influence of urban development on the surrounding environment, which facilitated the introduction of competitive weeds and altered ecosystem processes. Effects of urban development include habitat fragmentation, which reduces gene flow between sites, reduces insect pollinators, and displaces *P. lyonii* as a result of changes to the structure and composition of pocket grassland communities (i.e., introduction of competitive weeds, changes in local hydrology, and increased gopher activity) (Alberts et al. 1993, Conservation Biology Institute 2000). Gophers are known to till the soil and can facilitate the growth of annual grasses. One site was extirpated in 1993 after the site was burned and non-native annual grasses and gophers became prevalent at the site (CNDDDB 2008) (USFWS, 2008).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2008)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Inadequacy of existing regulatory mechanisms was identified in the final listing document as a threat in determining endangered status for *Pentachaeta lyonii*. The species is listed as endangered under the California Endangered Species Act (CESA). Although CESA prohibits “take” of State-listed plants, this appears to be inadequate to protect against the taking of plants via habitat modification or land use change by landowners. After the California Department of Fish and Game (CDFG) notifies a landowner that a State-listed plant grows on his or her property, CDFG Code only requires that the landowner notify CDFG “at least 10 days in advance of changing the land use to allow salvage of such plant” (chapter 10 sec. 1913). Determinations by local lead agencies under the California Environmental Quality Act (CEQA) have resulted in negative impacts to *P. lyonii* (62 FR 4172). Because the intent of CEQA is to disclose project impacts, proposed mitigation measures do not necessarily guarantee protection and conservation of sustainable populations of *P. lyonii* (USFWS, 2008).

Stressor: Fire (USFWS, 2008)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Despite efforts to suppress fires in coastal southern California, the present fire frequency of every 15 years or less, is substantially higher than it was historically, which is thought to be every 50 to 100 years (Keeley 2006). Over a period of 60 years, most of the Santa Monica Mountains burned an average of three to five times, with an average interval of every 12.4 to 20.7 years (Radtke et al. 1982). This current fire frequency may have negatively impacted *Pentachaeta lyonii* by displacing chaparral and coastal sage scrub communities with annual invasive grasses that displace *P. lyonii*. In addition, fire prevention and suppression activities such

as spraying fire retardant and discing the soil around urban development remains a threat because it facilitates the growth of annual grasses (USFWS, 2008).

Stressor: Human recreation (USFWS, 2008)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Some light recreation is thought to be compatible and even beneficial to the species. Trails create a zone of compacted soils, and may reduce competition from annual grasses and allow *Pentachaeta lyonii* to grow. One of the largest populations, with a population of 100,000 plants reported, occurs alongside a popular trail (CNDDDB 2008). However, higher intensity uses such as equestrian or vehicle use is a threat to the species. A portion of the population on NPS land was severely reduced after an increase in equestrian use (CNDDDB 2008). The remaining portions of the population have been fenced and have shown some signs of recovery (NPS unpublished data 2007) (USFWS, 2008).

Stressor: Stochastic extinction (USFWS, 2008)

Exposure:

Response:

Consequence: Extinction

Narrative: Ten of the 30 known occurrences have greater than 10,000 plants; the remaining populations are small, with several reported at less than 1,000 plants (CNDDDB 2008; Appendix A). The small populations are vulnerable to extirpation by demographic, environmental, and genetic stochasticity, and natural catastrophes (Shaffer 1981). Demographic stochasticity is random variability in survival or reproduction among individuals within a population (Shaffer 1981), and could play a role in the extirpation of small populations of *Pentachaeta lyonii*. Environmental stochasticity refers to annual variation in birth and death rates in response to weather, disease, competition, predation, or other factors external to the population (Shaffer 1981). This could play a role in extirpations of small populations because the species exhibits large annual fluctuations in population size, probably in response to external factors such as rainfall and competition with other plant species. Genetic stochasticity results from changes in gene frequencies due to founder effect, random fixation, or inbreeding (Shaffer 1981). The low levels of genetic variation among and within populations (Arias et al. no date) could impair the species' ability to adapt to changes in the environment or contribute to inbreeding depression (i.e., loss of reproductive fitness or vigor). Natural catastrophes such as fire, landslide, or prolonged drought could result in extirpation of populations (Shaffer 1981). The entire range of *P. lyonii* occurs within a distance of 24 km (15 mi); therefore, all populations would be expected to experience similar rainfall patterns or could be affected by a single fire (USFWS, 2008).

Stressor: Climate change (USFWS, 2008)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Hayhoe et al. 2004, Cayan et al. 2005, Intergovernmental Panel on Climate Change (IPCC) 2007). Recently, the potential impacts of climate change on the flora of California were discussed by Loarie et al. (2008). Based on modeling, they predicted that

species' distributions will shift in response to climate change, specifically that the species will "move" or disperse to higher elevations and northward, depending on the ability of each species to do so. Species diversity will also shift in response to these changes with a general trend of diversity increases shifting towards the coast and northwards with these areas becoming de facto future refugia. The Santa Monica Mountains is expected to increase in diversity becoming one of these potential future refugia (Loarie et al. 2008). These increases in species diversity in the refugia, due to climate change, have the potential to result "...in new species mixes, with consequent novel patterns of competition and other biotic interactions..." to the species present (Loarie et al. 2008) with unknown consequences to the species present. We recognize that climate change is an important issue with potential effects to listed species and their habitats. While we lack adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors such as small population size, will affect *Pentachaeta lyonii*, small ranged species, such as *Pentachaeta lyonii*, are more vulnerable to extinction due to these changing conditions (Pimm and Raven 2000, Loarie et al. 2008) (USFWS, 2008).

Recovery

Reclassification Criteria:

1. When 10 populations of 10,000 or more plants, from the 30 current sites (see Table 2 of the Recovery Plan), are fully protected and self-sustaining (as demonstrated through monitoring) (USFWS, 1999)
2. When the populations from Reclassification Criterion 1 are managed to control threats such as alien plants (USFWS, 1999)
3. When the populations from Reclassification Criterion 1 are self-sustaining over a minimum of 15 years (or longer, if data suggest large population fluctuations). (USFWS, 1999)

Delisting Criteria:

1. When 20 populations of 10,000 or more plants, from the 30 current sites (see Table 2 of the Recovery Plan), are fully protected and self-sustaining (as demonstrated through monitoring) (USFWS, 1999)
2. When the populations from Delisting Criterion 1 are managed to control threats such as alien plants (USFWS, 1999)
3. When the populations from Delisting Criterion 1 are self-sustaining over a minimum of 15 years (or longer, if data suggest large population fluctuations). (USFWS, 1999)

Recovery Actions:

- Protect and secure populations and habitat on unprotected lands. Habitat for the listed plants must be protected and secured in perpetuity, from identified threats of loss. Methods for securing lands include permanent conservation easements established through land use decisions, in-fee purchase, gifts of easement, or fee interest by property owner (USFWS, 1999).
- Manage and monitor protected areas. The process of evaluating past and current management and making adjustments as needed is termed "adaptive management." Public

and private conservation lands should be adaptively managed to maximize their potential to support listed species and their habitats. (USFWS, 1999)

- Survey historic locations and other potential habitat where species may occur, Surveys of the potential albeit limited, habitat within the species range should be done. Several California Natural Diversity Database occurrence records for the listed species are represented only by observations. Information on population status, threats, and abundance is also needed for these sites. Information gathered from the additional details will be used to provide lead agencies to determine protective land use designation for the listed plant species. Data gathered will assist in determining the range of site characteristics, population vigor, and species viability to help establish minimum population standards for rare plant reserves, and consequently, for recovery. (USFWS, 1999)
- Conduct biological and ecological research to define life history strategies and population dynamics to guide recovery/conservation efforts. A better understanding of the population dynamics and identification of ecological factors that may be affecting those dynamics are needed to develop appropriate management plans to recover the plant species. (USFWS, 1999).
- Develop outreach plans to conserve the species. Outreach is an important component of implementing this recovery plan. This plan should be developed to enhance the public's understanding of issues related to conservation and recovery of the listed species. Participation from both public and private entities should be encouraged for the establishment of conservation plans for the listed species. (USFWS, 1999)
- Recommendations for Future Actions from 2019 5-Year Review: • Increase monitoring of within and among mainland occurrences for better understanding of population trends. • Monitor the Santa Catalina Island occurrence for better understanding of population numbers, trends, and geographic extents. • Collect additional seed for banking from both mainland and Santa Catalina Island occurrences. • Augment existing occurrences when possible. • Search for additional suitable outplanting locations on protected lands and establish new occurrences. (USFWS, 2019)

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SPECIES ACCOUNT: *Peperomia subpetiolata* (`Ala `ala wai nui)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (Region 1) (USFWS, 2017)

Physical Description

A perennial, succulent herb with unbranched or few-branched stems about 6-15 dm long. Leaves whorled, 5-8 per node, 12-20 cm long, and very narrow. Flower spikes one to several, terminal and axillary. (NatureServe, 2015)

Taxonomy

Genus Pantropical, species endemic to East Maui. (NatureServe, 2015) A member of the pepper family (Piperaceae) (USFWS, 2016).

Historical Range

Historically, *P. subpetiolata* was known only from the lower Waikamoi (Kula pipeline) area on the windward side of Haleakala on east Maui (Wagner et al. 1999g, p. 1,035; HBMP 2010) (USFWS, 2016).

Current Range

Restricted to the northwestern (windward) slope of Haleakala, east Maui, Hawaiian Islands (USFWS 2004). (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Peperomia subpetiolata* (`Ala `ala wai nui) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes five detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Peperomia subpetiolata* includes five CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Montane Wet—Unit 1 (and) *Palmeria dolei*—Unit 10—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 10— Montane Wet This area consists of 1,313 ac (531 ha) of State land and 798 ac (323 ha) of privately owned land, at Haiku Uka on the northern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Cyanea duvalliorum*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *Phyllostegia pilosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 1 is not known to be occupied by the plants *Adenophorus periens*,

Asplenium peruvianum var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 11—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 11— Montane Wet This area consists of 4,075 ac (1,649 ha) of State land, 9,633 ac (3,898 ha) of privately owned land, and 875 ac (354 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Puukaukanu and upper Waihoi Valley, on the northern and northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Geranium hanaense*, *G. multiflorum*, and *Wikstroemia villosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 2 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea glabra*, *C. maritae*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, and *Schiedea jacobii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 3 (and) *Palmeria dolei*—Unit 12—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 12— Montane Wet This area consists of 2,228 ac (902 ha) of federally owned land (Haleakala National Park) in Kipahulu Valley, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. maritae*, and *Melicope ovalis*, and by the forest bird, kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 3 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea duvalliorum*, *C. glabra*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*,

Cyrtandra ferripilosa, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest bird, the akohekohe (*Palmeria dolei*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 4 (and) *Palmeria dolei*—Unit 13—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 13— Montane Wet This area consists of 180 ac (73 ha) of State land and 1,653 ac (669 ha) of federally owned land (Haleakala National Park), in Kaapahu Valley on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *Cyrtandra ferripilosa*, and *Huperzia mannii*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 4 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea duvalliorum*, *C. glabra*, *C. mceldowneyi*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 5 (and) *Palmeria dolei*—Unit 14—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 14— Montane Wet This area consists of 222 ac (90 ha) of State land, and 165 ac (67 ha) of federally owned land (Haleakala National Park), near Kaumakani on the eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plant *Bidens campylotheca* ssp. *pentamera*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 5 is not currently occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu

(*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Peperomia subpetiolata* critical habitat consists of one component. Montane wet (east Maui) (81 FR 17790-18110):

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: *Ferns*, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the

conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkii*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Lifespan

Adult: < 10 years (inferred from USFWS, 2016)

Reproduction Narrative

Adult: It is a short-lived perennial (USFWS, 2016).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Montane wet ecosystem (USFWS, 2016)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: Mesic native forest extensively planted with alien tree species. (NatureServe, 2015) It occurs in the montane wet ecosystem (USFWS, 2016).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Long-term trends are unknown, whereas short-term trends suggest declines of 10-30% (NatureServe, 2015)

Resiliency:

Very low (inferred from NatureServe, 2015)

Redundancy:

Very low (inferred from NatureServe, 2015)

Population Growth Rate:

Unknown (NatureServe, 2015)

Number of Populations:

1 (NatureServe, 2015)

Population Size:

<50 (NatureServe, 2015)

Population Narrative:

Long-term trends are unknown, whereas short-term trends suggest declines of 10-30%. In 2001, there were approximately 40 individuals of *Peperomia subpetiolata*; *P. cookiana* and *P. hirtipetiola* also occur in the area (NTBG 2009; Oppenheimer 2010 cited by USFWS 2012). In 2007, there were 20 to 30 hybrid plants (NTBG 2009 cited by USFWS 2012). All plants observed in 2007 and 2010 are considered to be hybrids, mostly between *P. subpetiolata* and *P. cookiana*, with a smaller number of hybrids between *P. subpetiolata* and *P. hirtipetiola* (NTBG 2009; Lau 2011 cited by USFWS 2012). Known from a single location (USFWS 2004). (NatureServe, 2015)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs), nonnative plants, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, rats, and slugs) is considered an ongoing threat to *Peperomia subpetiolata* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor: Small populations and hybridization (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: *Peperomia subpetiolata* faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). Historically known from lower Waikamoi on east Maui, the identification of wild individuals of *Peperomia subpetiolata* has not been confirmed since 2001, although hybrids between this species and other species of *Peperomia* are reported in this area. Hybridization will adversely impact this species because it may lead to extinction of one or both of the original genotypically distinct species. The current status of *Peperomia subpetiolata* is

unknown because only hybrids between *P. subpetiolata* and *P. cookiana*, and perhaps *P. ertapetiola*, are known from its historically reported locations on east Maui (USFWS, 2013).

Recovery**Reclassification Criteria:**

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species. Final rule. 81 FR 17789 - 18110 (March 30, 2016).

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SPECIES ACCOUNT: *Peperomia wheeleri* (Wheeler's peperomia)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 1/14/1987

Physical Description

An evergreen, glabrous, erect herb which may reach 1 meter in height. The stems root only at the base and may be up to 1 centimeter in diameter. The opposite leaves are entire, fleshy, elliptic to ellipticobovate, with 3 or 5 main veins ascending from the base. They may be 5 to 7 centimeters long and 2 to 3 centimeters wide with the base tapered to a 1 centimeter petiole. The lower side of the leaf is inconspicuously black punctate. Inflorescences are spikes, 10 to 16 centimeters long and 5 millimeters in diameter, which are borne solitary and opposite the leaves or at the leaf axils. Flowers are minute, approximately .5 millimeter in diameter. (USFWS, 1990)

Taxonomy

During this review we have received information that *Peperomia myrtifolia* is frequently misidentified as *P. wheeleri*. *Peperomia myrtifolia* is a highly variable taxon distributed throughout the Lesser Antilles and the Virgin Islands (Axelrod 2011). Presently, some species experts agree that *P. wheeleri* is not a distinctive species from *P. myrtifolia* because the major difference between the two species is the leaf shape and leaf apex (Axelrod 2011, J. Vélez-Gavilan, UPRM, 2014, pers. comm.). Hence, some authors (e.g., Axelrod 2011) treat *P. wheeleri* as a synonym of *P. myrtifolia*. Currently, no genetic studies have been conducted to demonstrate that *P. wheeleri* is not a valid species. Thus, for the purpose of this review we are treating *P. wheeleri* as a valid species. This taxonomic issue should be appropriately assessed in the future. When the recovery plan for *P. wheeleri* was approved in 1990, no common name was recognized for the species. Presently, the name Wheeler's peperomia seems to be widely accepted. This common name has been adopted by the USDA PLANTS database, the Integrate Taxonomic Information System (ITIS) and the IUCN Red List. Therefore, the Service intends to use this common name for this federally listed plant (USFWS, 2014).

Historical Range

See current range/distribution.

Current Range

Known only from Culebra, a small island approximately 27 kilometers to the east of Puerto Rico. The species has not been reported from adjacent small islands or the main island of Puerto Rico (USFWS, 1990)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Biotic (USFWS, 1990)

Breeding Season

Adult: Little is known about natural reproduction, however, individuals growing at Fairchild Tropical Garden (Garden) in Miami, Florida, flowered from June through August in 1989 (USFWS, 1990).

Key Resources Needed for Breeding

Adult: Flowers of Wheeler's peperomia (*Peperomia wheeleri*) are bisexual. Pollination may be carried out by insects or wind, although the pollination biology of this species has not been studied. Many individuals have been observed flowering or in fruit and numerous seedlings are scattered throughout the area (Vivaldi and Woodbury 1981, U.S. Fish and Wildlife Service 1987). Little is known about natural reproduction, however, individuals growing at Fairchild Tropical Garden (Garden) in Miami, Florida, flowered from June through August in 1989. Seed collected from this flowering began germination after 34 days; germination rate in this initial trial was less than 10 percent. Branches which have broken off and fallen to the ground in the Garden also root easily where they have fallen on humus (Lippincott pers. comm.). Cuttings root easily and many individuals are currently growing at the Garden (USFWS, 1990).

Other Reproductive Information

Adult: Following Hurricane Hugo's devastating attack on Culebra in 1989, 25 cuttings were collected by the Refuge Manager at Culebra National Wildlife Refuge (NWR) from the Monte Resaca area. These were planted at the Department of Sports and Recreation nursery in Vega Alta, Puerto Rico and rooted quickly. The forest of the Monte Resaca area was defoliated by the hurricane but cover returned quickly, and the *Peperomia wheeleri* population suffered limited damage (USFWS, 1990).

Habitat Type

Adult: Semi-evergreen forest (USFWS, 1990)

Environmental Specificity

Adult: Narrow/specialist (USFWS, 1990)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1990)

Site Fidelity

Adult: High (inferred from USFWS, 1990)

Habitat Narrative

Adult: *Peperomia wheeleri*, a herbaceous plant, occurs on large granodiorite boulders beneath the semi-evergreen seasonal forest of the Monte Resaca area of Culebra Island (USFWS, 1990)

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Increasing (USFWS, 2014)

Species Trends:

Increasing (USFWS, 2014)

Resiliency:

Low (inferred from USFWS, 2014)

Representation:

Low (inferred from USFWS, 2014)

Redundancy:

Low (inferred from USFWS, 2014)

Number of Populations:

Four (USFWS, 2014)

Population Size:

~ 1,400 (USFWS, 2014)

Population Narrative:

USFWS (2014) notes that the species status is improving. When the recovery plan for this species was signed, it was known to occur only in one locality in Culebra Island, with an estimated population of several hundred individuals. In 1995, Santiago-Valentín and Vives-Helyger (1997) visited a 3 new population of the species in the municipality of Isabela in northern Puerto Rico, and estimated around 50 plants in that population. On February 2007, Service biologist Carlos Pacheco conducted a rapid assessment of the species' populations in Puerto Rico, providing the more up-to-date information on its status. Pacheco estimated about 1,387 individuals on Culebra Island, and approximately 154 individuals in an area known as El Costillar in Isabela (C. Pacheco, USFWS unpublished data, 2007 a, b). Since 2007, the Service has propagated approximately 140 individuals of Wheeler's peperomia, introducing the species in three localities in Puerto Rico, including both private and public lands managed for conservation (Table 1; USFWS, unpublished data, 2013). Based on the new information, we believe that Wheeler's peperomia abundance and distribution has increased, particularly because no significant changes to its current habitat have occurred in Culebra Island and Isabela. Therefore, we considered the overall species status as improving (USFWS, 2014). USWAS (2014) also notes that there are four known populations of this species. Low representation, resiliency and redundancy are inferred based on the low number of known populations and individuals as well as the specific habitat requirements of this species.

Threats and Stressors

Stressor: Escaped domestic fowl (USFWS, 1990)

Exposure:

Response:

Consequence: Loss of/Damage to plants

Narrative: Populations of *Peperomia wheeleri*, although protected as part of the Culebra National Wildlife Refuge, continue to face the threat of foraging by escaped domestic fowl (USFWS, 1990).

Stressor: Cattle grazing (USFWS, 1990)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The possibility of impacts from erosion by cattle passing through the area is listed as a threat to this species (USFWS, 1990).

Stressor: Over collection (USFWS, 1990).

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Collecting has not been documented as a factor in the continued decline of *Peperomia wheeleri*. However, the number of remaining plants is small enough that taking of the species for any purpose could become a threat in the future, particularly if horticultural interest in the species develops (USFWS, 1990).

Stressor: Deforestation (USFWS, 1990)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Forest cover is essential for healthy plants and continued reproduction. Any disturbance in this area could result in the loss of these plants (USFWS, 1990).

Stressor: Hurricanes (USFWS, 2014)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Due to limited distribution, hurricanes are listed as a threat to this species (USFWS, 2014).

Stressor: Human induced fires (USFWS, 2014)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Due to limited distribution, human induced fires are listed as a threat to this species (USFWS, 2014).

Stressor: Genetic variation (USFWS, 2014)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Given the extremely limited geographic distribution of Wheeler's *peperomia*, it is highly likely that its genetic variability is very low. This would result in a loss of alleles by random genetic drift, which would limit the species' ability to respond to changes in the environment

(Honney and Jacquemyn, 2007). In order to safeguard the remaining genetic diversity, the protection and monitoring of known adult individuals should be considered as a high priority for the conservation of the species. Based on the above, we consider the potential lack of genetic variation as a possible threat to the species (USFWS, 2014).

Stressor: Climate change (USFWS, 2014)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Changes in climate can have a variety of direct and indirect impacts on species, and can exacerbate the effects of other threats. Rather than assessing “climate change” as a single threat in and of itself, we examine the potential consequences to species and their habitats that arise from changes in environmental conditions associated with various aspects of climate change. Vulnerability to climate change impacts is a function of sensitivity to those changes, exposure to those changes, and adaptive capacity (IPCC 2007; Glick et al. 2011). An expected effect of the climate change is the increase in intensity of hurricanes and tropical storm, followed by extended period of drought (IPCC 2012). This climate change may alter (modify) the microclimate and the surrounding vegetation around the populations of the Wheeler’s peperomia. Hurricane effects followed by extended period of drought may result in changes in soil conditions and microclimate and may allow other plants (native or non-native, herbaceous or woody) adapted to drier conditions to become established (Lugo 2000). Invasive species (e.g. *Megathyrus maximus*) may spread and colonized the Wheeler’s peperomia habitat, and it could alter fire regimen, microclimate, and nutrient cycling of the habitat that the species depend. Due to its limited distribution and number of natural populations, we consider the cumulative effects by hurricanes, genetic variation, and exotic and invasive species (plants and animals) as detrimental to the Wheeler’s peperomia as a whole. The population dynamics of the species is poorly known (e.g., depressed genetic variability and its competitive abilities), there are only few known natural populations, and there is a lack of information to determine what constitutes a viable population. Therefore, we consider the above mentioned threats as high in magnitude because the species has only few known populations; but not imminent because threats like climate change are not likely to occur in near future (USFWS, 2014).

Recovery

Reclassification Criteria:

The existing population is adequately protected. [Note: This includes all known occurrences at the time the plan was written.] (USFWS, 2014).

Two additional populations are established within the Culebra National Wildlife Refuge or on other protected areas on Culebra Island (USFWS, 2014).

Delisting Criteria:

1) Existing populations of *P. wheeleri* in Culebra Island (2 populations) and Puerto Rico (2 populations) exhibit a stable or increasing population trend, evidenced by natural recruitment, and multiple age classes (addresses Factors A, C, and E) (USFWS, 2019)

2) Establish or discover two additional populations (as defined in criterion 1) of *P. wheeleri* on lands protected via conservation mechanism on Culebra Island (Addresses Factors A and E). (USFWS, 2019)

3) Establish two additional populations *P. wheeleri* (as defined in criterion 1) on lands protected via a conservation mechanism on mainland Puerto Rico (Addresses Factors A and E). (USFWS, 2015)

4) Threats have been addressed and/or managed to the extent that the species will remain viable into the foreseeable future (addresses Factors C and E) (USFWS, 2019)

Recovery Actions:

- The first criterion has been partially met. Currently, two of the four known natural populations of Wheeler's peperomia in Puerto Rico are protected as they are located within lands set aside for conservation (Table 1). On Culebra Island, the populations at the Radio tower and Playa Brava are located within the Culebra National Wildlife Refuge (CNWR), land managed by the Service for the conservation of fish and wildlife resources (USFWS 2012). Additionally, the Comprehensive Conservation Plan (CCP) for the Culebra National Wildlife Refuge includes measures for the protection and recovery of the Wheeler's peperomia within this refuge (USFWS 2012). However, the other two natural populations (i.e., El Costillar and Monte Resaca south; Table 1) are not adequately protected because they occur in privately-owned land subjected to urban development and agricultural practices such as cattle and goat grazing. Since 2009, Wheeler's peperomia has been introduced in private and Commonwealth lands managed for conservation (Table 1). These new populations are considered adequately protected because conservation measures have been taken to avoid or minimize threats to the species at each site (USFWS, 2014).
- The second criterion has been partially met. This criterion states that two additional populations of the Wheeler's peperomia should be established within protected areas on Culebra Island. Given that the species has been found in other areas outside Culebra Island, we recommend that this criterion should be reconsidered. Since the recovery plan for this species was approved, two new populations of Wheeler's peperomia have been found in Culebra Island, and another population was discovered at an area known as El Costillar in the municipality of Isabela, in northern Puerto Rico. Additionally, the Wheeler's peperomia has been introduced in three other locations in Puerto Rico (Figure 2). In 2009, the Service and the PRDNER established two populations within the Guajataca Commonwealth Forest, located between the municipalities of Isabela and Quebradillas (Monsegur and Pacheco, USFWS, unpubl. data, 2009). At El Tallonal, a private land in the municipality of Arecibo, the Service established two populations of Wheeler's peperomia in 2010; this property is managed for conservation by the local non-government organization Ciudadanos del Karso (Monsegur and Colón-Merced, USFWS, unpubl. data, 2010). In 2013, the Service and the local Trust Para la Naturaleza planted 40 individuals of Wheeler's peperomia at the Río Encantado Natural Reserve, a private land managed for conservation located between the municipalities of Ciales and Florida (R. Rodríguez, Para la Naturaleza, unpubl. data, 2013). Thus, now there are three populations of this species in the northern karst region of Puerto Rico (USFWS, 2014).
- Conduct genetic studies to determine whether *P. wheeleri* is a synonym of *P. myrtifolia*. (USFWS, 2019)

- International coordination is needed for the implementation of protection and management actions in the other Caribbean Islands and to ensure species' viability outside of US jurisdiction (USFWS, 2019)

Conservation Measures and Best Management Practices:

- Conduct genetic studies to verify if *Peperomia wheeleri* is a valid species or a synonym of *Peperomia myrtifolia* (USFWS, 2014).
- Develop measurable objective criteria for delisting the species (USFWS, 2014).
- Conduct studies on the biology and ecology of the Wheeler's peperomia (USFWS, 2014)
- Continue a propagation program for the species and establish new populations in protected areas or increase / augment existing populations (USFWS, 2014).
- Continue working with landowners to enhance existing populations or establish new ones within protected areas that ensure their long-term protection (USFWS, 2014).
- Incorporate the private landowners in habitat conservation programs (e.g., Partners for Fish and Wildlife, Coastal Program, PRDNER-Bosque Auxiliary) (USFWS, 2014).
- Evaluate the abundance and distribution of the species through surveys within traditional and non-traditional sites, using the best available plant survey methodology to determine current population numbers and number of viable populations necessary to protect and stabilize Wheeler's peperomia populations (wild, naturally-reproducing populations large enough to maintain sufficient genetic variation and evolve and respond to natural habitat changes) (USFWS, 2014).
- Appropriate government agencies should continue evaluating and implementing conservation measures to minimize possible adverse effects on natural drainages on Culebra Island (USFWS, 2014).
- Quantify predation pressure on the species and determine if predation is a limiting factor for its recovery (USFWS, 2014)

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SPECIES ACCOUNT: *Peucedanum sandwicense* (Makou)

Species Taxonomic and Listing Information

Listing Status: Threatened; 02/25/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

Peucedanum sandwicense, a short-lived perennial and member of the Apiaceae (parsley) family, is a parsley-scented, sprawling herb. Hollow stems arise from a short, vertical, perennial stem with several fleshy roots. The compound leaves are generally three-parted with stalkless leaflets, each egg- or lance-shaped and toothed. The larger terminal leaflet is usually one- to three-lobed and 7 to 13 cm (2.8 to 5.1 inches) long. The other leaflets have leaf stalks 10 to 50-cm (4 to 20 inches) long or are stalkless. Flowers are clustered in a compound umbel of 10 to 20 flowers. The round petals are white and bent inward at the tips. The flat, dry, oval fruits are 10 to 13 mm (0.4 to 0.5 inches) long and 5 to 8-mm (0.2 to 0.3 inches) wide, splitting in half to release a single flat seed. This species differs from the other Kauai members of the parsley family in having larger fruit and pinnately compound leaves with broad leaflets. This species is the only member of the genus on the Hawaiian Islands (Wagner et al 1999) (USFWS, 2016).

Historical Range

Historically, *Peucedanum sandwicense* is known from Molokai, Maui, and Kauai, and discoveries in 1990 extended the known distribution of this species to Oahu (USFWS, 2016).

Current Range

Current populations from Kauai and Maui; historical records from Molokai.

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Peucedanum sandwicense* (Makou) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 25 detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Peucedanum sandwicense* (Makou) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Peucedanum sandwicense* (77 FR 57648-57862). The critical habitat designation includes 8 critical habitat units, which encompass approximately 1,449 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Peucedanum sandwicense* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Peucedanum sandwicense* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Peucedanum sandwicense* includes 25 CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Coastal—Unit 1 consists of 2 ac (1 ha) on Keopuka Rock on the northern coast of east Maui. This unit is State-owned, and is classified as a State Seabird Sanctuary. It is occupied by the plant *Peucedanum sandwicense* and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui-Coastal—Unit 1 is not known to be occupied by *Brighamia rockii*, *Cyperus pennatifolius*, *Ischaemum byrsonae*, or *Vigna o-wahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 1 consists of 70 ac (28 ha) of privately owned land, and 54 ac (22 ha) of federally owned land (U.S. Coast Guard) at Laau Point, from Kahaiawa to Keawakalani, along the western coast of Molokai. This unit is occupied by the plant *Marsilea villosa*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 1 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrsonae*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 2 consists of 16 ac (6 ha) of State land, and 9 ac (4 ha) of privately owned land, from Wahinepee Stream to Moiki Point on the northern coast of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). Although Maui—Coastal—Unit 2 is not currently occupied by *Brighamia rockii*, *Cyperus pennatifolius*, *Ischaemum byrsonae*, *Peucedanum sandwicense*, or *Vigna o-wahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the physical or biological features necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Molokai—Coastal—Unit 2 consists of 263 ac (106 ha) of State land, and 710 ac (287 ha) of privately owned land, from Ilio Point to Kaa Gulch, along the northwestern coast of Molokai. This unit is occupied by the plant *Marsilea villosa* and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 2 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 3 consists of 10 ac (4 ha) of privately owned land at Pauwahu Point on the northern coast of east Maui. This unit is occupied by the plant *Ischaemum byrone* and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Coastal—Unit 3 is not known to be occupied by *Brighamia rockii*, *Cyperus pennatifolius*, *Peucedanum sandwicense*, or *Vigna o-wahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 3 consists of 794 ac (321 ha) of State land, and 3 ac (1 ha) of federally owned land (Kalaupapa National Historical Park), from Kahi Point to Wainene, along the north-central coast of Molokai. This unit is occupied by the plants *Pittosporum halophilum*, *Schenkia sebaeoides*, and *Tetramolopium rockii*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 3 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Marsilea villosa*, *Peucedanum sandwicense*, or *Sesbania tomentosa*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 4 consists of 40 ac (16 ha) of State land, and 35 ac (14 ha) of privately owned land, from Papiha Point to Honolulu Nui Bay on the northeastern coast of east Maui. This unit is occupied by the plant *Cyperus pennatifolius* and includes the mixed herbland and

shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Coastal—Unit 4 is not known to be occupied by *Brighamia rockii*, *Ischaemum byrone*, *Peucedanum sandwicense*, or *Vigna owahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 4 consists of 10 ac (4 ha) on Mokapu Island on the northern coast of Molokai. This area is State-owned, and is classified as a State Seabird Sanctuary. This unit is occupied by the plants *Peucedanum sandwicense* and *Pittosporum halophilum*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 4 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Marsilea villosa*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 5 consists of 26 ac (11 ha) of State land from Keakulikuli Point to Pailoa Bay on the northeastern coast of east Maui. This unit is occupied by the plant *Ischaemum byrone* and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Coastal—Unit 5 is not known to be occupied by *Brighamia rockii*, *Cyperus pennatiformis*, *Peucedanum sandwicense*, or *Vigna o-wahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 5 consists of 1 ac (0.5 ha) on Huelo islet on the northern coast of Molokai. This area is State-owned, and is classified as a State Seabird Sanctuary. This unit is occupied by the plants *Brighamia rockii*, *Peucedanum sandwicense*, and *Pittosporum halophilum*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing

wild populations. Although Molokai—Coastal—Unit 5 is not known to be occupied by *Bidens wiebkei*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Marsilea villosa*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 6 consists of 356 ac (144 ha) of State land at Kamanamana on the southern coast of East Maui. This unit is occupied by the plant *Vigna owahuensis* and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Coastal—Unit 6 is not known to be occupied by *Brighamia rockii*, *Cyperus pennatiformis*, *Ischaemum byrone*, or *Peucedanum sandwicense*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 6 consists of 190 ac (77 ha) of State land, and 1,685 ac (682 ha) of privately owned land, from Kaholaiki Bay to Halawa Bay, on the northeastern coast of Molokai. This unit is occupied by the plants *Bidens wiebkei*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, and *Ischaemum byrone*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 6 is not known to be occupied by *Brighamia rockii*, *Hibiscus brackenridgei*, *Marsilea villosa*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 7 consists of 30 ac (12 ha) of State land, and 15 ac (6 ha) of privately owned land, from Kailio Point to Waiuha Bay, on the southern coast of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). Although Maui—Coastal—Unit 7 is not currently occupied by *Brighamia rockii*, *Cyperus pennatiformis*, *Ischaemum byrone*, *Peucedanum sandwicense*, or *Vigna owahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes,

suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 7 consists of 49 ac (20 ha) of privately owned land from Alanuihipaka Ridge to Kalanikaula, on the northeastern coast of Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). Although Molokai—Coastal—Unit 7 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrnei*, *Marsilea villosa*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 8 consists of 493 ac (199 ha) of State land from Kiakeana Point to Manawainui on the southern coast of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). Although Maui—Coastal—Unit 8 is not currently occupied by *Brighamia rockii*, *Cyperus pennatifolius*, *Ischaemum byrnei*, *Peucedanum sandwicense*, or *Vigna owahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 1 (and) *Palmeria dolei*—Unit 38—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 38— Lowland Wet This area consists of 2,195 ac (888 ha) of State land, and 754 ac (305 ha) of privately owned land (partly within The Nature Conservancy's Pelekunu Preserve), from Pelekunu Valley to Wailau Valley, in north-central Molokai. These units are occupied by the plant *Cyrtandra filipes*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Wet—Unit 1 is not known to be occupied by *Asplenium dielerectum*, *Bidens wiebkei*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Lysimachia maxima*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 2 (and) *Palmeria dolei*—Unit 39—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 39— Lowland Wet This area consists of 1,356 ac (549 ha) of State land and 594 ac (241 ha) of privately owned land, from Kahanui to Pelekunu Valley, in north-central Molokai. These units are occupied by the plant *Lysimachia maxima*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Wet—Unit 2 is not known to be occupied by *Asplenium dielirectum*, *Bidens wiebkai*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Cyrtandra filipes*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 3 consists of 94 ac (38 ha) of State land, and 3,125 ac (1,265 ha) of privately owned land, from Waiahookalo gulch to Moaula stream and Puniuhua, on eastern Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Molokai—Lowland Wet—Unit 3 is not known to be occupied by *Asplenium dielirectum*, *Bidens wiebkai*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Cyrtandra filipes*, *Lysimachia maxima*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 2 (and) *Palmeria dolei*—Unit 3—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 3— Lowland Wet (and) *Newcombia cumingi*—Unit 1—Lowland Wet This area consists of 65 ac (26 ha) of State land at Moomoku, on the northwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. Although Maui—Lowland Wet—Unit 2 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendrion pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), or by the Newcomb's tree snail (*Newcombia cumingi*), we have

determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 3 (and) *Palmeria dolei*—Unit 4—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 4— Lowland Wet This area consists of 1,247 ac (505 ha) of State land at Honanana Gulch on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta*, *Cyanea asplenifolia*, and *Pteris lidgatei*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 3 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 4 (and) *Palmeria dolei*—Unit 5—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 5— Lowland Wet This area consists of 864 ac (350 ha) of State land at Kahakuloa Valley on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta* and *Cyanea asplenifolia*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 4 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 5 (and) *Palmeria dolei*—Unit 6—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 6— Lowland Wet This area consists of 30 ac (12 ha) of State land at Iao Valley on the eastern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 5 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielarectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 6 (and) *Palmeria dolei*—Unit 7—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 7— Lowland Wet This area consists of 136 ac (55 ha) of State land at Honokowai and Wahikuli valleys on the western slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 6 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielarectum*, *Bidens conjuncta*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 7 (and) *Palmeria dolei*—Unit 8—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 8— Lowland Wet This area consists of 898 ac (364 ha) of State land at Olowalu Valley, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Alectryon macrococcus*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 7 is not currently occupied by the plants *Asplenium dielarectum*, *Bidens conjuncta*, *B. micrantha* ssp.

kalealaha, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 8 (and) *Palmeria dolei*—Unit 9—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 9— Lowland Wet This area consists of 230 ac (93 ha) of State land at upper Ukumehame Gulch, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 8 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat designation for *Peucedanum sandwicense* includes 8 critical habitat units, covering one ecosystem type, which encompasses approximately 1,449 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8 .

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area

consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac(105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

The critical habitat designation for *Peucedanum sandwicense* includes three units totaling 1,929 acres in Kauai County, Hawaii. The units are Kauai 7—*Peucedanum sandwicense*— a and Kauai 11—*Peucedanum sandwicense*—b, c.

Kauai 7—*Peucedanum sandwicense*—a: This unit is critical habitat for *Peucedanum sandwicense* and is 21 ha (53 ac) on private land. This unit contains Haupu Summit and Queen Victoria's Profile. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Peucedanum sandwicense* and is currently occupied with one plant. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. It provides habitat for the westernmost range of the species. The habitat features contained in this unit that are essential for this species include, but are not limited to, cliff habitats in mixed shrub coastal dry cliff communities or diverse mesic forest. This unit provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Kauai 11—*Peucedanum sandwicense*— b: This unit is critical habitat for *Peucedanum sandwicense* and is 579 ha (1,431 ac) on State land (Kuia NAR and Na Pali Coast State Park). This unit contains portions of Kuia and Mahanaloa Valleys, and Milolii Ridge. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial *Peucedanum sandwicense* and is currently occupied with 55 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. It provides habitat for the westernmost range of the species. The habitat features contained in this unit that are essential for this species include, but are not limited to, cliff habitats in mixed shrub coastal dry cliff communities or diverse mesic forest. This unit provides for two populations within this multi-island species' historical range on Kauai that are some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event. Kauai 11—*Peucedanum sandwicense*— c: This unit is critical habitat for *Peucedanum sandwicense* and is 181 ha (447 ac) on State land (Hono o Na Pali NAR and Na Pali Coast State Park). This unit contains portions of Kaaalahina Ridge, and Alealau, Kanakou, Keanapuka, and Puu Ki Summits. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Peucedanum sandwicense* and is currently occupied with 100 to 200 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. It provides habitat for the westernmost range of the species. The habitat features contained in this unit that are essential for this species include, but are not limited to, cliff habitats in mixed shrub coastal dry cliff communities or diverse mesic forest. This

unit provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Peucedanum sandwicense* critical habitat consists of two components. Coastal (east Maui and Molokai) and Lowland wet (west Maui and Molokai) (81 FR 17790-18110):

Ecosystem: Coastal. Elevation: <980 ft (<300 m). Annual precipitation: <20 in (<50 cm). Substrate: Well-drained, calcareous, talus slopes; dunes; weathered clay soils; ephemeral pools; mudflats. Canopy: Hibiscus, Myoporum, Santalum, Scaevola. Subcanopy: Gossypium, Sida, Vitex. Understory: Eragrostis, Jacquemontia, Lyceum, Nama, Sesuvium, Sporobolus, Vigna.

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Peucedanum sandwicense* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Peucedanum sandwicense* occurs within the indicated ecosystem in the Waianae Mountain caldera complex:

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. (F) Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Cliff habitats in mixed shrub coastal dry cliff communities or diverse mesic forest and containing one or more of the following associated native plant species: *Acacia koa*, *Artemisia australis*, *Bidens* spp., *Brighamia insignis*, *Carex meyenii*, *Chamaesyce celastroides*, *Diospyros* spp., *Dodonaea viscosa*, *Eragrostis variabilis*, *Hibiscus kokio*, *Lobelia niihauensis*, *Metrosideros polymorpha*, *Panicum lineale*, *Psydrax odorata*, *Psychotria* spp., or *Wilkesia* spp.; and

(ii) Elevations between 119 and 1,232 m (391 and 4,041 ft).

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special

management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-

Lowland Mesic— Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; MauiWet Cliff—Units 6 and 7; and MolokaiMontane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Peucedanum sandwicense* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and

augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Little is known about the life history of *P. sandwicense*. Flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown (Service 1999b) (USFWS, 2016).

Habitat Type

Adult: Sea cliffs (USFWS, 2016)

Habitat Narrative

Adult: *Peucedanum sandwicense* grows in cliff habitats from sea level to above 900 m (3,000 ft) and is associated with native species such as *Artemisia australis*, *Chamaesyce* sp., *Diospyros sandwicensis*, *Eragrostis variabilis*, and *Metrosideros polymorpha* (USFWS, 2016).

Dispersal/Migration

Population Information and Trends

Population Trends:

Stable (USFWS, 2016)

Number of Populations:

10 (USFWS, 2016)

Population Size:

1000-5000 (USFWS, 2016)

Population Narrative:

The 10 Kauai occurrences are distributed in Waimea Canyon and along the Na Pali Coast within 2.4 km (1.5 mi) of the ocean (Service 1999b; 68 FR 35950). It is also difficult to assess changes in the abundance *P. sandwicense*. However, the total number of individuals on Oahu appears to be relatively stable from the time the species range-wide abundance was first estimated in 1991. Similarly, the overall number of individuals of this species appears to be relatively stable on the other islands where it occurs (Maui, Molokai and Kauai) (Table SB 28) (USFWS, 2016).

Threats and Stressors

Stressor: Feral ungulates (USFWS, 2016)

Exposure:**Response:****Consequence:** Loss of habitat/loss of individuals**Narrative:** Habitat degradation and browsing by feral ungulates is listed as a threat to this species (USFWS, 2016).**Stressor:** Hikers (USFWS, 2016)**Exposure:****Response:****Consequence:** Loss of individuals**Narrative:** Trampling by hikers is listed as a threat to this species (USFWS, 2016).**Stressor:** Landslides (USFWS, 2016)**Exposure:****Response:****Consequence:** Loss of habitat/loss of individuals**Narrative:** Landslides are listed as a threat to this species (USFWS, 2016).**Stressor:** Non-native plants (USFWS, 2016)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** Non-native plants are listed as a threat to this species (USFWS, 2016).***Recovery******Conservation Measures and Best Management Practices:***

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References

USFWS 2016. Status of the Species and Critical Habitat: *Peucedanum sandwicense* (Makou). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016

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Final Rule . 81 FR 17790-18110 (March 30, 2016).

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SPECIES ACCOUNT: *Phacelia argillacea* (Clay phacelia)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/29/1978; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

A winter annual, 1-4 dm tall, with deeply lobed leaves. The plants produce clusters of lavender-purple flowers in summer (NatureServe, 2015).

Taxonomy

A member of the waterleaf family. Clay phacelia is very closely related to *Phacelia glandulosa* Nutt., a west slope Idaho, Wyoming, and Montana native (NatureServe, 2015).

Historical Range

It was initially collected at Pleasant Valley Junction, Wasatch County, Utah, in 1883. It was collected a second time at Clear Creek, Utah County, Utah, in 1894 (USFWS, 1982).

Current Range

It is only found in Utah along the Douglas Creek and Gordon Gulch members of the Green River formation in the Wasatch Mountains in Pleasant Valley (NatureServe, 2015).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (NatureServe, 2015), cross-pollination (USFWS, 2013)

Lifespan

Adult: 2 years (USFWS, 2013)

Breeding Season

Adult: May - July (NatureServe, 2015)

Key Resources Needed for Breeding

Adult: Late summer or early autumn storms, two rain events per summer, seed bank, insect pollinators (USFWS, 2013)

Reproduction Narrative

Adult: Clay phacelia reproduces sexually. It is unknown whether this species is an obligate selfer, a facultative selfer, or an obligate out-crosser (Harper 1990). Seeds typically germinate in spring and fall, although they sometimes germinate in mid-summer if there is enough available moisture (England 1989). The plant blooms in late July, but non-flowering rosettes have been observed in both June and August (Matheson 1989). England (1989) verifies that advanced

plants have been observed in the spring with early flowering in late May or early June. The pollen vector is unknown; however, a 1988 Bee Biology and Systematics Lab field collection at the Tucker site "yielded the largest series of specimens recorded of a rare species of colletid bee, *HYLAEUS GRANULATUS*" (Tepedino 1989). Although the very first observed females of this rare bee were among the specimens collected, Harper (1990) surmises that this bee species is far too rare to be the primary pollinator for Clay phacelia. He further speculates that wind, or the more common ground-nesting bees in the area, could prove to be the major pollinators for Clay phacelia. Clay phacelia has the capacity of developing four mature seeds per fruit. In the summer of 1987, England (1989) estimated that as many as 8000 seeds were produced on one adult winter annual. Embryo viability of seed collected in June 1988 was tested by means of a tetrazolium (TZ) test. The TZ equaled 95% or 19 viable seeds out of the 20 tested (Matheson 1989) (NatureServe, 2015). Clay phacelia was formerly considered a winter annual but new data supports the idea that it is instead a true biennial (Meyer 2011b). Germination seems to be triggered by late summer or early autumn storms and two rain events per summer seem to be critical for survival (Meyer 2011a). The species harbors an extended seed bank, and one successful recruitment event every 10-15 years, coupled with high seed output, may be enough for the species survival through time (Meyer 2011a, 2011b). Seeds produced in one year germinate over the course of several years thus ensuring a robust seedbank that can withstand stochastic events. Clay phacelia are likely obligate outcrossers (Smith et al. 1989) that require insect pollinators. The flower is large and showy and is visited by a variety of pollinators, including native sweat and carpenter bee species (USFWS, 2013).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Juniper-pinyon and mountain brush communities (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Cool, subhumid climate (NatureServe, 2015); soil pH 7.7 - 7.9 (USFWS, 2016)

Geographic or Habitat Restraints or Barriers

Adult: 6,000 - 7,000 ft. elevation, vegetative cover > 10% (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Scattered (inferred from NatureServe, 2015)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Clay phacelia occurs on steep slopes in sparse juniper-pinyon and mountain brush communities (Welsh 1987. The general climate for all of the element occurrence sites can, however, be classified as cool and subhumid (England 1989). The majority of plants grow on slopes facing west through southeast. At each site, the plants occur on a xeric, exposed slope of the Green River Formation, somewhere between 6,000 and 7,000 feet elevation (Franklin and Tuhy 1989). The slope at the site which holds the largest number of plants was measured at 70 percent (Armstrong 1990). *P. argillacea* is dependent upon available, disturbed ground, with

little or no competition (England, 1990). Extant populations of Clay phacelia cover only three to five percent of the slope's surface area in the patches where they occur. Overall vegetative cover is about ten percent in these same areas of critical habitat (England 1989) (NatureServe, 2015). All soils where Clay phacelia occurs are basic, with pH ranging from 7.7- 7.9 for the occupied sites (Armstrong 1992) (USFWS, 2016).

Dispersal/Migration

Dispersal

Adult: Typically low (inferred from NatureServe, 2015)

Dispersal/Migration Narrative

Adult: It is surmised by England (1989) that short distant seed dispersal is achieved primarily by wind, water, and gravity. Rosettes are generally located below or in association with mature adult plants. Some long-distance dispersal may be achieved through grazing and defecation, but the plants are probably grazed prior to seed set (England 1989) (NatureServe, 2015).

Population Information and Trends

Population Trends:

Unknown (USFWS, 2013)

Resiliency:

Very low (inferred from USFWS, 2013)

Redundancy:

Low (inferred from USFWS, 2013)

Number of Populations:

3 (USFWS, 2013)

Population Size:

~340 individuals range-wide (USFWS, 2019)

Population Narrative:

The number of individuals is currently unknown. There are only three known populations of the plant that are occupied. The range of clay phacelia extends along a 7.5 mile (12 kilometer) stretch of Highway 6 in Spanish Fork Canyon in Utah County, Utah. The Service does not have accurate population estimates or trends (USFWS, 2013).; The population size of the Tucker – Clear Creek population is larger now, with 237 individuals documented in 2017, and includes habitat on private and Bureau of Land Management (BLM) lands (Skopec et al. 2018). The Water Hollow – Garner Canyon population contains approximately 100 individuals based on the last partial-population estimate in 2006. At the time of our last 5-Year Review, we did not provide a range-wide total population estimate for clay phacelia (USFWS 2013); we now cautiously estimate there are 340 individuals range-wide. Surveys for the species since our last 5-year review have not documented new occurrences and pilot introduction attempts on U.S. Forest Service (USFS) lands (Tie Fork and Water Hollow – Garner Canyon) were not large enough to maintain the species' presence on Federal lands. Researchers are able to propagate the species

from seed, and two propagation efforts are underway to prepare for future introduction efforts on Federal lands. (USFWS, 2019)

Threats and Stressors

Stressor: Small population size

Exposure:

Response:

Consequence:

Narrative: Numerous threats exist for Clay phacelia. Probably the most significant current threat is the species' inherent vulnerability due to small population size and number. In populations with less than 1000 individuals, demographic uncertainties can play a significant role in extinction probability (Shaffer 1987). This may be mitigated by a presumably large soil seed bank. However, the 1987 sheep staging episode significantly impacted the habitat, and the little soil that had accumulated in the area was partly washed away in subsequent thunderstorms. In spite of this, England still suspects a sizeable seed bank (England 1989) (NatureServe, 2015).

Stressor: Habitat modification (NatureServe, 2015; USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: Human land-use activities in and near the critical habitats have played the largest role in Clay phacelia's recent dramatic decline. Livestock and sheep have grazed and trampled the plants and their surrounding habitat. The Denver and Rio Grande Western (D&RGW) railroad is adjacent to the Clear Creek site. Construction activities have already modified the neighboring habitat through stabilization of cuts and fills, runoff control, and material storage (Gill et al. 1982). In addition, Highway 6 bisects the Tucker population. Highway maintenance and construction activities such as burning and shoulder stabilization may also impact both potential and existing Clay phacelia and accompanying bee (pollen vector) habitats (NatureServe, 2015).; Within the species' small range, highway construction and maintenance, and transportation and transmission line development are threats that are likely to result in continued habitat loss and fragmentation. There continues to be potential for widening of the Highway 6 corridor into occupied habitat of clay phacelia. The Highway 6 corridor in Spanish Fork Canyon is a designated national energy corridor under section 368 of the Energy Policy Act of 2005. The national energy corridor designation encourages and facilitates the installation of additional transmission lines, and two transmission lines are planned within the species' range (USFWS 2016a and 2016b). Project proponents for two planned transmission lines committed to avoiding and minimizing impacts to clay phacelia through section 7 consultation of the Act, however there are likely to be future transmission line proposals in this area (USFWS, 2019)

Stressor: Grazing (NatureServe, 2015; USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: Grazing from endemic ungulates and herbivory from small native herbivores has collectively impacted Clay phacelia. Specific threats include mule deer, elk, and occasional moose that frequent the area of critical habitat in the winter. The exposed south- and west-facing slopes provide a welcome winter home with food and relatively warm areas for bedding down. Rock

squirrels have also been sighted nibbling on the herbage (Gill et al. 1982) (NatureServe, 2015).; Herbivory by native and domesticated ungulates is another threat to clay phacelia. Periodic herbivory, largely from mule deer, at the Tucker – Clear Creek population has repeatedly resulted in significant plant losses (Skopec et al. 2018). There are plans by The Nature Conservancy, BLM, USFS, and Weber State University to actively manage the threat of herbivory by installing fences and cages, repairing existing fences, and monitoring wildlife activity at the Tucker – Clear Creek, Tie Fork, and Water Hollow – Garner Canyon populations. (USFWS, 2019)

Stressor: Competition (NatureServe, 2015; USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: Long-term monitoring of exotic and native species which grow in association with Clay phacelia has not been conducted. However, this should be looked at closely, especially in the absence of grazing. Both *MARUBIUM VULGARE* and *CYNOGLOSSUM OFFICINALE* could pose significant competition to *P. ARGILLACEA* (England 1989) (NatureServe, 2015).; Weeds are another threat to clay phacelia. Weed invasion into occupied habitat by houndstongue (*Cynoglossum officinale*), horehound (*Marrubium vulgare*), and white top (*Lepidium draba*) can increase competition for soil moisture and alter the suitability of the habitat for clay phacelia (USFWS 2013). Private, state, Federal and university partners are actively managing weeds in the Tucker – Clear Creek population. We are exploring the use of alternative non-chemical weed control methods and low-residual herbicides in and near occupied habitat. (USFWS, 2019)

Stressor: Climate change (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: The impacts of global climate change at this time are uncertain, and could either be positive or negative for this species. Overall temperatures may not be a problem, but changes in precipitation and precipitation patterns may alter survivability and retention of a viable seed bank (Meyer 2011a). Because this species is particularly dependent on multiple rains in the summer and fall to produce successful progeny for the year, changes in rainfall patterns have the potential to affect the seed bank and therefore long-term viability of the species (USFWS, 2013).

Stressor: Wildfire (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: Wildfire is a potential threat to clay phacelia due to the high frequency of wildfire occurrence in Spanish Fork Canyon. Wildfire has not impacted clay phacelia or its habitat to date; however, the risk and severity of wildfire in occupied habitat may increase with the spread and coverage of weeds from adjacent road and other habitat disturbances. (USFWS, 2019)

Recovery

Reclassification Criteria:

1. To establish a self-sustaining population of 2,000 to 3,000 individuals on 120 acres of protected habitat, and possibly establish at least one new population (USFWS, 2013).

Delisting Criteria:

We are developing objective and measureable delisting recovery criteria for clay phacelia. The delisting criterion identified in the 1982 recovery plan (USFWS 1982) is not objective or measurable: I. Clay phacelia will be delisted when the U.S. Fish and Wildlife Service through collaboration with professional botanists, including the Utah Native Plant Society, is satisfied that adequate self-sustaining populations have been established. (USFWS, 2019)

Recovery Actions:

- Protect individual specimens and habitat (USFWS, 1982).
- Inventory Green River Formation and surrounding areas (USFWS, 1982).
- Introduce plants into new habitat (USFWS, 1982).
- Conduct a public information program (USFWS, 1982).
- Monitor existing and new populations (USFWS, 1982).

Conservation Measures and Best Management Practices:

- Continue present efforts to establish new populations on USFS lands (USFWS, 2013).
- Provide funding for ongoing and future research (USFWS, 2013).
- Maintain partnerships with TNC, the USFS, and Red Butte Gardens to continue current research and monitoring projects (USFWS, 2013).
- Protect species from further population and habitat fragmentation from development and maintenance of developed areas (USFWS, 2013).
- Continue to protect species from trampling and habitat degradation from livestock activities (USFWS, 2013).
- Develop and implement an invasive, exotic plant management control plan with appropriate stakeholders (USFWS, 2013).
- Secure remaining occupied habitat under conservation management (USFWS, 2013).
- In conjunction with the Utah Division of Wildlife Resources, develop and implement a wildlife management plan to protect the species from ungulate and lagomorph herbivory (USFWS, 2013).
- Continue to monitor population size of this species through time (USFWS, 2013).
- Monitor seed bank viability, seedling recruitment, and seedling survivorship (USFWS, 2013).
- Document and quantify herbivory pressure from free-ranging herbivores (USFWS, 2013).
- Revisit the sites, creating GPS coordinates for each plant location, and identify areas to survey where the plant may occur (USFWS, 2013).
- Monitor invasive, exotic species distribution and abundance in suitable habitat (USFWS, 2013).
- Complete a population viability analysis (PVA) for this species and reevaluate the number of individuals needed for a healthy population (USFWS, 2013).
- Continue collecting and maintaining a genetically representative ex-situ seed collection for the species (USFWS, 2013).
- Augment introduced sites to ensure genetic representation of the species on Federal lands (USFWS, 2013).
- Study the effects of climate change on this species including how altered precipitation, water volume, availability, and timing of rain events may affect the species (USFWS, 2013).
- Determine the environmental conditions and tolerances necessary for each life stage of the species (USFWS, 2013).
- Determine if and how road and railway traffic volume influences this species, and its community associates such as pollinators (USFWS, 2013).

- Determine the extent to which the plants and their pollinators are being affected by road and railroad maintenance activities (USFWS, 2013).
- Re-examine the genetic diversity of this species in the future to determine if genetic diversity has been maintained or been reduced through time, using samples from multiple years (USFWS, 2013).
- Study the plants' pollinators and the pollinators' habitats (USFWS, 2013).
- Determine the effects of erosion on the species and identify actions that may restore soil conditions (USFWS, 2013).
- Examine conditions surrounding seedling emergence, the dynamics and characteristics of the seed bank including seed dormancy and germination (USFWS, 2013).

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SPECIES ACCOUNT: *Phacelia formosula* (North Park phacelia)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/01/1982; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

A biennial herb, 1.5-2.2 dm high, with deeply divided, leaves and bearing violet-purple flowers in a coiled, scorpion tail-like cluster. The species has been observed in flower in July and August, but flowering and fruiting times may be somewhat variable depending on rainfall and other environmental conditions (NatureServe, 2015).

Taxonomy

A member of the waterleaf family (NatureServe, 2015). *P. formosula* appears to be most closely related to *P. glandulosa* (USFWS, 1986).

Historical Range

It was first collected near Walden, Colorado (Jackson County) in 1918 (USFWS, 1986).

Current Range

Known from Jackson and possibly Larimer counties, Colorado. The species is found within about 60 square miles in North Park, from Michigan Creek west to the North Platte River in Jackson County, and potentially in an additional six square miles in the Laramie River Valley in Larimer County. Estimated range is 534 square kilometers, calculated in GIS by drawing a minimum convex polygon around the known occurrences, including the Laramie River sites (NatureServe, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: self-pollination, cross-pollination (USFWS, 2012)

Lifespan

Adult: 2 years (USFWS, 2016)

Breeding Season

Adult: July - August (USFWS, 2016)

Key Resources Needed for Breeding

Adult: Bee pollinators (USFWS, 2012)

Reproduction Narrative

Adult: It blooms in July and August and is a biennial surviving for one year as a rosette of leaves before flowering and dying the following year (USFWS, 2016). *Phacelia formosula* plants can self-pollinate, but are typically pollinated by a variety of bees (USFWS, 2012).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Bare rock/talus/scree (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 8,000 to 8,300 ft. elevation (USFWS, 2016)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: The terrestrial habitat is characterized as bare rock/talus/scree. It inhabits barren, raw exposures of the Coalmont Formation, a rusty-colored sandy substrate. The species grows most abundantly on the steepest, most sparsely vegetated, and most erodible slopes, such as on the sides of deeply cut ravines (NatureServe, 2015). The species is found at about 8,000 to 8,300 feet in elevation (USFWS, 2016).

Dispersal/Migration**Dispersal**

Adult: Low (USFWS, 2012)

Dispersal/Migration Narrative

Adult: Seeds are poorly dispersed (Warren 1990, p. 3) (USFWS, 2012).

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Species Trends:

Stable (NatureServe, 2015)

Resiliency:

Very low (inferred from USFWS, 2016)

Redundancy:

Low (inferred from USFWS, 2016)

Number of Populations:

6 (USFWS, 2016)

Population Size:

~16,000 (USFWS, 2016)

Population Narrative:

The long term data population trend is unknown. Although there are no data to indicate a specific trend, the species seems to be stable within its limited available habitat (NatureServe, 2015). Roughly 16,000 individuals are known from six separate populations and the entire species is known only to an area measuring roughly 10 miles in either direction (north to south, east to west) (USFWS, 2016).

Threats and Stressors

Stressor: Cattle grazing (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Grazing by cattle is ubiquitous across the range of *Phacelia formosula*. Cattle trampling and compaction of the soil and trampling of rosettes and mature plants is an ongoing threat because *P. formosula*, like most small herbaceous plants, can be severely damaged in heavily travelled areas, such as around watering areas and fences and along trails (CNAP 1996, p. 5). A few heavily impacted sites have been documented (CNHP 2010a, pp. 1, 4, 5, 9, 11, 18). Some of the adverse effects from livestock include changes in the timing and availability of pollinator food plants (Kearns and Inouye 1997, pp. 298–299); changes to insect communities (Kearns and Inouye 1997, pp. 298–299; Debano 2006, pp. 2547–2564); damage to ground-nesting pollinators and their nests (Sugden 1985, p. 309); changes in water infiltration due to soil compaction (Jones 2000, Table 1); disturbance to soil microbiotic crusts (Belnap et al. 1999, p. 167; Jones 2000, Table 1); subsequent nonnative invasive plant invasions (Parker et al. 2006, pp. 1459–1461); and soil erosion from hoof action (Jones 2000) (USFWS, 2012).

Stressor: Range improvements (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: The recovery plan cites the potential for range improvements, such as vegetation manipulation or spraying and changing water source locations, to affect the species, although no examples were available. The effects of range improvements on occurrences of *Phacelia formosula* on private lands have not been documented due to lack of access. This is considered a potential threat because future changes (such as altering water sources which forces cattle to congregate in certain areas) could impact the species (USFWS, 2012).

Stressor: Off-road vehicles (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: ORV tracks have been noted at five of the nine occurrences. The Airport occurrence is the most heavily impacted by ORV use. Plants still exist at this occurrence, but its viability is ranked as poor because the habitat is disturbed by ORVs and other general public uses that facilitate the introduction of nonnative invasive plants that can compete with *P. formosula* (CNHP

2010a, pp. 1-3). As on other BLM lands in western Colorado, ORV use is likely to increase (Colorado Off-Highway Vehicle Coalition 2009, p. 1-2). These activities can destroy more plants and damage habitat for *P. formosula*. Unpaved access roads on BLM and private land cause habitat fragmentation because they create abrupt transitions in vegetation; are sources of pollutants; and act as filters (allowing some species to cross but not others) and barriers (prohibiting movement) (Spellerberg 1998, pp. 317–333) (USFWS, 2012).

Stressor: Oil and gas development (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: BLM lands in North Park have been leased for oil, gas, and coal development since before the implementation of the ESA (USFWS 1986, p. 6). Three *Phacelia formosula* occurrences have oil and gas leases that have been issued since 2001. The leases include 144.3 ac (58.4 ha) of occupied habitat for the species. Of these occupied acres, 41.3 ac (16.7 ha) are within 500 meters of wells (Glenne 2011a, pers. comm.) (USFWS, 2012).

Stressor: Residential development (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Development of home sites on ranch land has been cited as a threat to *Phacelia formosula* (Kram et. al. 2008, p. 4). TNC has secured a conservation agreement for the species that allows a home to be built on a parcel that also has a protected area of plant habitat (Handwerk 2009, pers. comm.). Residential development is a potential threat of low magnitude that is likely to increase as more development occurs in North Park, depending on the economy (USFWS, 2012).

Stressor: Seed predation (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Seed predation by insect larvae was observed in 1980. In 1990, lepidopteran larvae were reportedly destroying half of the seed pods that were inspected. In 1993, many seed pods were destroyed by unidentified insect predation (CNAP 1994, p. 4) (USFWS, 2012).

Stressor: Stochastic events (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: The final listing rule and the recovery plan state that any human threats to this species would exacerbate the possibility of small populations going extinct through natural population fluctuations. They also cite lack of species occurrence and environmental data and uninformed land managers, administrators, and landowners as contributing to risk factors. Given current population levels, these factors remain a concern (USFWS, 2012).

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:**Consequence:**

Narrative: Climate change is a potential threat to *Phacelia formosula* because the species is highly sensitive to changes in precipitation and temperature. Typical future summer monthly temperatures will be as warm as or warmer than the hottest 10% of summers that occurred between 1950 and 1999 (CWCB 2009, p. 1). *Phacelia formosula* is particularly sensitive to precipitation and temperature during germination, seedling and rosette growth, and especially while developing into flowering adults at the height of summer heat and drought (McCormick and Wu 1999, p. 5). *P. formosula* also is sensitive to extreme weather events, such as the thunderstorms that are common in North Park which can cause rill and sheet erosion and carry away the *P. formosula* plants (USFWS, 2012).

Recovery**Reclassification Criteria:**

Locate and secure five occurrences of approximately 500 mature flowering individuals each (USFWS, 1986).

Delisting Criteria:

Ten other areas of suitable habitat are identified and secured with 500 mature flowering individuals each (USFWS, 1986).

Recovery Actions:

- Disseminate information on the known occurrences and potential occurrences of *P. formosula* habitat (USFWS, 1986).
- Implement conservation strategies for the perpetuation of the essential habitat of the species (USFWS, 1986).
- Develop strategies to assist in the perpetuation of the essential habitat and the species (USFWS, 1986).
- Initiate scientific research on known and potential habitat and the biology of the species (USFWS, 1986).
- Publicize as appropriate the value of the North Park *phacelia* and the recovery effort (USFWS, 1986).
- Investigate the advantages of habitat acquisition and/or conservation easements (USFWS, 1986).

Conservation Measures and Best Management Practices:

- The recovery plan for *Phacelia formosula* should be revised so that it reflects the best scientific and commercial information available. The revised recovery plan should include objective, measurable criteria which, when met, will result in a determination that the species be removed from the Federal List of Endangered and Threatened Plants. Recovery criteria should address all threats impacting the species. The recovery plan also should estimate the time required and the cost to carry out those measures needed to achieve the goal for recovery and delisting. Finally, the recovery plan should evaluate and map geographic areas essential for the conservation of *P. formosula* (USFWS, 2012).
- Work with the CRPCI to develop a list of recovery priorities and implement conservation actions (USFWS, 2012).

- Develop conservation agreements and easements with partners such as land trusts, TNC, NRCS, CNAP, and Partners for Fish and Wildlife to protect *Phacelia formosula* on private lands across the entire range of the species (USFWS, 2012).
- Inventory unsurveyed suitable and potential habitat for *Phacelia formosula* on public and private lands. Report results to CNHP, BLM, and USFWS. These surveys will provide better information to guide recovery and conservation actions as well as project planning (USFWS, 2012).
- Monitor phenology of the plants and log weather patterns to inform climate change studies (USFWS, 2012).
- Develop and implement a long-term range management monitoring plan to guide grazing management for protection of *Phacelia formosula* habitat (USFWS, 2012).
- Establish and implement a range-wide trend monitoring protocol (USFWS, 2012).
- Control the location and timing of livestock movement and concentration to minimize impacts to the species (USFWS, 2012).
- Regularly monitor impacts from ORV use. If impacts from ORV use are detected, work with the land manager on reducing those effects (USFWS, 2012).
- BLM plans to expand the existing ACEC and create new ACECs to include contiguous occupied and suitable habitat for the plant and its pollinators. Oil leases have been deferred within the potential ACECs until the new RMP is final (USFWS, 2012).
- Work with the BLM Kremmling Field Office to develop and implement consistent conservation measures in the RMP revision that will avoid and minimize impacts to *Phacelia formosula* and its habitat from livestock trampling, ORV activities, and energy development (USFWS, 2012).
- Continue ongoing seed collection, germination testing, and long-term storage and preservation of seeds (USFWS, 2012).
- Undertake a study to improve understanding of dormancy characteristics in *Phacelia formosula* seed banks (USFWS, 2012).
- Conduct a study to identify pollinators and their habitat needs (USFWS, 2012).
- Perform long-term study of local changes in weather patterns and effects on plants (USFWS, 2012).
- Study livestock impacts on plants and habitat (USFWS, 2012).
- Complete the analysis of the genetic relationship between *Phacelia formosula* and *Phacelia scullyi* (the population of *Phacelia* discovered in the Laramie River Valley approximately 20 mi (~30 km) north of known *Phacelia formosula* populations) (USFWS, 2012).
- Reach out to Jackson County, the town of Walden, the State of Colorado, applicable Federal agencies, and other potential stakeholders with information about the plants, habitat requirements, and known locations in order to proactively engage partners to ensure that projects avoid impacts to *Phacelia formosula* (USFWS, 2012).
- Educate private landowners about the plant and how they can help protect the species (USFWS, 2012).

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SPECIES ACCOUNT: *Phacelia insularis ssp. insularis* (Island phacelia)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An annual herb, usually about 1.5 dm tall. Small lavender to violet, bell-shaped flowers bloom in March and April. (NatureServe, 2015)

Taxonomy

The summary and table of the July 31, 1997 notice in the Federal Register (in which the USFWS determines this taxon as endangered) lists the taxon as *Phacelia insularis* SSP. *insularis*; in the text the taxon is referred to as a subspecies and as a variety. The treatment the notice appears to follow is Wilken et al. (1993; in Hickman) which treats the taxon as a variety. (NatureServe, 2015)

Historical Range

Endemic to the California Channel Islands and, at the time of listing in 1997, a single population on Santa Rosa Island was the only known population of the species. By the time the recovery plan was published in 2000, island phacelia was known to occur in five localities: the one on Santa Rosa Island at Carrington Point and the four on San Miguel Island (see Santa Rosa Island and San Miguel Island maps, pp. 15-16). Both islands occur on lands managed by Channel Islands National Park (Park). The Santa Rosa Island population occupies about 15 acres (6 hectares (ha)) based on its maximum observed extent in 1998. The San Miguel Island populations range from about 0.02 to 0.86 acres (0.01 to 0.35 ha). These figures are from USGS surveys made in April and May, 1998, when the largest number of plants were observed (McEachern in litt. 2007b). Surveys since 1998 have not seen such extensive numbers of plants in those same areas; however, a seed bank likely still exists (McEachern in litt. 2007b). (USFWS, 2008)

Current Range

This variety occurred only in Santa Rosa and San Miguel Islands, Santa Barbara county, California. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Currently, little life history information is available for this species. This annual flower blooms from March through April (USFWS, 2000).

Habitat Type

Adult: Sandy valley and foothill grassland communities, bluffs, dunes, dominated by alien grasses with some scattered native bunchgrasses, shrubs, and herbs; at or near sea level (partly based on Calif. Nat. Diversity Database, May/1998 report). (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Sandy valley and foothill grassland communities, bluffs, dunes, dominated by alien grasses with some scattered native bunchgrasses, shrubs, and herbs; at or near sea level (partly based on Calif. Nat. Diversity Database, May/1998 report). (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Sandy valley and foothill grassland communities, bluffs, dunes, dominated by alien grasses with some scattered native bunchgrasses, shrubs, and herbs; at or near sea level (partly based on Calif. Nat. Diversity Database, May/1998 report). (NatureServe, 2015)

Habitat Narrative

Adult: Sandy valley and foothill grassland communities, bluffs, dunes, dominated by alien grasses with some scattered native bunchgrasses, shrubs, and herbs; at or near sea level (partly based on Calif. Nat. Diversity Database, May/1998 report). (NatureServe, 2015)

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Not available

Resiliency:

Low (inferred from NatureServe, 2015)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Narrative:

USFWS reports a population of 31 plants from Santa Rosa Island in 1994. No populations have been relocated in San Miguel Island. As of 2001, no populations exist. The California Natural Diversity Database (May/1998) reports four occurrences, none of which have been observed in the last 20 years; but USFWS (1997) reports that Sarah Chaney found one small population in 1994 in Santa Rosa Island. (NatureServe, 2015). Low redundancy, representation and resiliency are inferred based on low population numbers and low number of individuals.

Threats and Stressors

Stressor: Predation (USFWS, 2008)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Some progress has been made toward eliminating non-native animals from Santa Rosa Island since the time of listing. We believe the removal of pigs by 1993, removal of cattle by 1998, and smaller populations of deer and elk since 1998 have reduced browsing pressure on island phacelia. Although habitat conditions on Santa Rosa Island and San Miguel Island show the effects of long-term grazing, the USGS believes that at the landscape level, conditions are improving (McEachern in litt. 2007b). In fact, browsing by an animal is rarely seen, although predation does occur from mice that are known to harvest the fruits (McEachern in litt. 2007b) (USFWS, 2008).

Stressor: Non-native plants (USFWS, 2008)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Invasion of habitats by non-native annual grasses, especially ripgut brome, continues to impact the species, particularly germination. Non-native annual grasses and the litter they produce also appear to inhibit successful establishment of phacelia seedlings in field experiments (McEachern in litt. 2007b, Levine et al. 2007) (USFWS, 2008).

Stressor: Small population size (USFWS, 2008)

Exposure:

Response:

Consequence: Loss of genetic variability/extinction

Narrative: At the time of listing, island phacelia was threatened by the risk of stochastic extinction due to small population size and limited distribution (62 FR 40954). The conservation biology literature commonly notes the vulnerability of taxa known from one or very few locations and/or from small and highly variable populations (e.g., Shaffer 1981, 1987; Primack 2006; Groom et al. 2006). In particular, the small size of each population makes it difficult for this species to persist while sustaining the impacts of soil damage and habitat alteration from non-native species. The species remains vulnerable to extirpation due to its small population size, high inter-annual variability in plant numbers, limited distribution, and low survival rate (USFWS, 2008).

Stressor: Climate change (USFWS, 2008)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Island phacelia may be particularly threatened by climate change because its geographic distribution is so narrow and its current range is unlikely to overlap regions that would be climatically favorable in the future (Levine et al. 2007). This is particularly acute for species on islands because they are unable to disperse to more favorable habitat as the environment changes. Because of this, Levine et al. (2007) suggest that the persistence of many rare species depends on how populations respond to climate change in their current locations (USFWS, 2008).

Recovery**Reclassification Criteria:**

Secure populations of a minimum of 2,000 individuals (USFWS, 2008).

Discover or establish 10 populations per island (San Miguel Island and Santa Rosa Island) (USFWS, 2008).

Maintain populations as stable or increasing with evidence of natural recruitment for a period of 15 years that includes the normal precipitation cycle (USFWS, 2008).

Delisting Criteria:

Discover or establish five additional populations per island (USFWS, 2008).

No decline after downlisting for 10 years (USFWS, 2008).

Recovery Actions:

- **Reclassification Criteria:** Although surveys in historical and other suitable habitat have been conducted, additional populations have not been found and no reintroduced populations have been established on Santa Rosa Island. Therefore, this criterion has not been met. We believe this criterion may be possible on San Miguel Island because, although these plants have every specific habitat requirements, there are several places on the island where suitable habitat conditions exist and the plant now occurs (McEachern, in litt. 2007a). However, this criterion is not appropriate with respect to the recovery of the species on Santa Rosa Island because suitable habitats appear to be extremely rare on the island. Suitable habitat may be available on Carrington Point; otherwise, suitable habitat on the island appears to be limited. Therefore, a more realistic goal would be to establish one additional population on Santa Rosa Island. Results of restoration field experiments over time would help establish whether or not the goal of one more population is feasible (McEachern, in litt. 2007a). **Delisting Criteria:** This criterion has not been met. We believe this criterion may be possible on San Miguel Island where three populations exist now but it is not realistic with respect to the recovery of the species on Santa Rosa Island for the same reasons described in downlisting criterion #1 above (USFWS, 2008).
- **Reclassification Criteria:** **Delisting Criteria:** This criterion has not been met. Although we believe the intent of this criterion is appropriate, we think it should be refined to focus on long-term trends, rather than a short-term, absolute decline, once additional information about the life history of the species and the species' response to recovery actions are better understood. Factor B is not relevant to this species. Factor D is relevant but is not addressed in the recovery criteria (USFWS, 2008).
- **Reclassification criteria:** A precipitation cycle includes periods of drought and wet years, with annual rainfall starting at 100 to 135 percent of average, dropping below 65 percent of average, and returning to at least average (Service 2000). Because the species has not been listed for a minimum of 15 years, this criterion has not been met. We believe this criterion is adequate and appropriate with respect to the recovery of the species (USFWS, 2008).

Conservation Measures and Best Management Practices:

- The USGS-BRD and NPS should seek additional funding to continue field surveys and monitoring, demographic monitoring, population viability analyses, and further investigations into recovery projects (USFWS, 2008).
- The Service should work cooperatively with NPS and USGS-BRD to refine the generalized downlisting criteria to take into consideration new information. Attaining the recovery objective of securing several populations containing a minimum of 2,000 plants each is unrealistic for this species (USFWS, 2008).
- The Service should work cooperatively with NPS and USGS-BRD to refine delisting criteria to emphasize long-term population growth trends rather than short-term gains or declines (USFWS, 2008).
- The USGS-BRD and NPS should investigate the community-level factors that influence population abundance, distribution, and demographic trends (USFWS, 2008).

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SPECIES ACCOUNT: *Phacelia submutica* (DeBeque phacelia)

Species Taxonomic and Listing Information

Listing Status: Threatened; 08/26/2011; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

Annual plant, stems 2-8 cm long, often branched at the base, mostly prostrate, leaves hairy, oblong or egg-shaped, flowers crowded, petals 3.5-4.5 mm long, white or cream colored becoming yellowish with age, stamens not protruding beyond the petals. (NatureServe, 2015)

Taxonomy

Phacelia submutica was first described by Howell based on specimens collected from the town of DeBeque, Mesa County, Colorado, in 1911 and 1912 (Howell 1944, pp. 370– 371 Halse (1981, pp. 121, 129, 130) reduced it to varietal status as *P. scopulina* var. *submutica*. This has been challenged as incorrect by O’Kane (1987, p. 2), who claimed Halse used inadequate collection materials, and that *P. submutica* is geographically isolated from *P. scopulina* (O’Kane 1987, p. 2; 1988, p. 462). *Phacelia submutica* is recognized at the species rank by current floristic treatments in Weber and Wittmann (1992, p. 98; 2001, p. 203) and by the Director of the Biota of North America Program (Kartesz 2008, pers. comm.). While the Integrated Taxonomic Information System (2001) database cites John Kartesz as the expert source for this species, it is not updated with his currently accepted name for the species: *Phacelia submutica* (Kartesz 2008, pers. comm.). *Phacelia* is included in the Hydrophyllaceae (waterleaf family). Recent molecular data suggest that this family should be combined in an expanded Boraginaceae (borage family). There are conflicting views on the configuration of this larger Boraginaceae and the lead author of the family treatment for the upcoming Flora of North America has chosen to retain the Hydrophyllaceae. Therefore, we will retain *Phacelia* in the Hydrophyllaceae family for this proposal (USFWS, 2010).

Current Range

Phacelia submutica is endemic to Colorado and known only from Garfield and Mesa counties. Estimated range is 356 square kilometers, calculated in GIS by drawing a minimum convex polygon around the known occurrences.

Critical Habitat Designated

Yes; 8/13/2012.

Legal Description

On August 13, 2012, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Phacelia submutica* (DeBeque phacelia) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four critical habitat units (CHUs), in Colorado (77 FR 48356-48415).

Critical Habitat Designation

The critical habitat designation for *Phacelia submutica* includes nine CHUs in Garfield and Mesa Counties, Colorado. This species critical habitat encompasses approximately 25,484 acres (ac) (10,313 hectares (ha)) (77 FR 48356-48415).

Unit 1, the Sulphur Gulch Unit, consists of 1,046 ac (423 ha) of federally owned land. The Unit is located approximately 7.7 mi (12.5 km) southwest of the town of DeBeque in Mesa County, Colorado. This Unit is managed by BLM, through the Grand Junction Field Office. This Unit is currently occupied. This Unit currently has all the physical and biological features essential to the conservation of the species including barren clay badlands with less than 20 percent plant/vegetation cover, suitable elevational ranges of 5,480 to 6,320 ft (1,670 to 1,926 m), appropriate topography, and shrink-swell alkaline clay soils within the Atwell Gulch and Shire members of the Wasatch Formation. All lands within this Unit are leased as grazing allotments, and less than 1 percent is managed as an active pipeline ROW by the BLM. While these lands currently have the physical and biological features essential to the conservation of *Phacelia submutica*, because of a lack of cohesive management and protections, special management will be required to maintain these features in this Unit. Threats to *Phacelia submutica* and its habitat in this Unit include energy development, recreation (especially OHV use), domestic and wild ungulate grazing and use, and nonnative invasive species, such as *Bromus tectorum*.

Unit 2, the Pyramid Rock Unit, is the largest Unit we are designating and consists of 17,321 ac (7,010 ha) of federally and privately owned lands in Mesa and Garfield Counties, Colorado. This Unit is approximately 1.6 mi (2.6 km) west of the town of DeBeque. The eastern boundary borders Roan Creek, and Dry Fork Creek runs through the northern quarter of the Unit. Eighty-nine percent is managed by BLM through the Grand Junction Field Office, and 11 percent is under private ownership. Three percent of this Unit is within the Pyramid Rock Natural Area and Pyramid Rock ACEC that was designated, in part, to protect *Phacelia submutica*, as discussed in the proposed (75 FR 35739) and final listing rules (76 FR 45054). This Unit is currently occupied. This Unit currently has all the physical and biological features essential to the conservation of the species including barren clay badlands with less than 20 percent plant/vegetation cover, suitable elevational ranges of 4,960 to 6,840 ft (1,512 to 2,085 m), the appropriate topography, and shrink-swell alkaline clay soils within the Atwell Gulch and Shire members of the Wasatch Formation. Ninety-four percent of this Unit is managed as a grazing allotment on BLM and private lands. Additionally, 11 percent of this Unit is managed as an active pipeline ROW. While these lands currently have the physical and biological features essential to the conservation of *Phacelia submutica*, because of a lack of cohesive management and protections, special management will be required to maintain these features in this Unit. Threats to *Phacelia submutica* and its habitat in this Unit include energy development, recreation (especially OHV use), livestock and wild ungulate grazing and use, and nonnative invasive species including *Bromus tectorum* and *Halogeton glomeratus*. The Westwide Energy corridor runs through this Unit. The corridor covers almost 10 percent of this Unit (Service 2011c, p. 9).

Unit 3, the Roan Creek Unit, consists of 54 ac (22 ha) of federally and privately owned lands in Garfield County, Colorado. The Unit is located 3.3 mi (5.4 km) north of the town of DeBeque and for 1.7 mi (2.7 km) along both sides of County Road 299. Ninety-seven percent of this Unit is privately owned. Three percent of this Unit is managed by BLM through the Grand Junction Field Office. This Unit is currently occupied. This Unit currently has all the physical and biological features essential to the conservation of the species including barren clay badlands with less than 20 percent cover, suitable elevational ranges of 5,320 to 5,420 ft (1,622 to 1,652 m), the appropriate topography, and shrink-swell alkaline clay soils within the Atwell Gulch and Shire members of the Wasatch Formation. The entire Unit is within a grazing allotment. While these lands currently have the physical and biological features essential to the conservation of *Phacelia submutica*, because of a lack of cohesive management and protections, special management

will be required to maintain these features in this Unit. Threats to *Phacelia submutica* and its habitat in this Unit include recreation (especially OHV use), livestock and wild ungulate grazing and use, nonnative invasive species including *Bromus tectorum* and *Halogeton glomeratus*, and a lack of protections on private lands.

Unit 4, the DeBeque Unit, consists of 530 ac (215 ha) of Federal and private lands in Mesa County, Colorado. This Unit is located 0.25 mi (0.4 km) north of DeBeque between Roan Creek Road and Cemetery Road. Seventy-six percent of this Unit is managed by BLM through the Grand Junction Field Office. This Unit is currently occupied. This Unit currently has all the physical and biological features essential to the conservation of the species including barren clay badlands with less than 20 percent plant/vegetation cover, suitable elevational ranges of 5,180 to 5,400 ft (1,579 to 1,646 m), the appropriate topography, and shrink-swell alkaline clay soils within the Atwell Gulch and Shire members of the Wasatch Formation. While these lands currently have the physical and biological features essential to the conservation of *Phacelia submutica*, because of a lack of cohesive management and protections, special management will be required to maintain these features in this Unit. Threats to *Phacelia submutica* and its habitat in this Unit include energy development, residential development, recreation (especially OHV use), livestock and wild ungulate grazing and use, and nonnative invasive species including *Bromus tectorum* and *Halogeton glomeratus*. Since 24 percent of the Unit is privately owned and borders the north of the town of DeBeque, this Unit is threatened by potential urban or agricultural development. The Westwide Energy corridor runs through this Unit. The corridor covers almost 66 percent of this Unit (Service 2011c, p. 9).

Unit 5, the Mount Logan Unit, consists of 277 ac (112 ha) of Federal and private lands in Garfield County, Colorado. The Unit is located 2.7 mi (4.4 km) north, northeast of the town of DeBeque, Colorado, and 0.5 mi (0.8 km) west of Interstate 70. Eighty-eight percent of this Unit is managed by BLM through the Grand Junction Field Office. The remainder of this Unit is privately owned. This Unit is currently occupied. This Unit currently has all the physical and biological features essential to the conservation of the species including barren clay badlands with less than 20 percent plant/vegetation cover, suitable elevational ranges of 4,960 to 5,575 ft (1,512 to 1,699 m), the appropriate topography, and shrink-swell alkaline clay soils within the Atwell Gulch and Shire members of the Wasatch Formation. Eighty-eight percent of this Unit is managed as a grazing allotment by BLM, and 53 percent is managed as an active pipeline ROW. An access road runs through the Unit connecting several oil wells and associated infrastructure. While these lands currently have the physical and biological features essential to the conservation of *Phacelia submutica*, because of a lack of cohesive management and protections, special management will be required to maintain these features in this Unit. Threats to *Phacelia submutica* and its habitat in this Unit include energy development, recreation (especially OHV use), livestock and wild ungulate grazing and use, and nonnative invasive species, including *Bromus tectorum* and *Halogeton glomeratus*.

Unit 6, the Ashmead Draw Unit, consists of 1,276 ac (516 ha) of Federal and private lands in Mesa County, Colorado. The Unit is located 1.5 mi (2.5 km) southeast of the town of DeBeque, Colorado, and east of 45.5 Road (DeBeque Cut-off Road). Eighty-seven percent of this Unit is managed by BLM through the Grand Junction Field Office, the remainder is private lands. This Unit is currently occupied. We slightly increased the size of this Unit from our proposed critical habitat designation in our notice of availability (77 FR 18162) to include sites that were revisited and more accurately mapped during the spring of 2011 (Service 2011e, pp. 1-3). This Unit

currently has all the physical and biological features essential to the conservation of the species including barren clay badlands with less than 20 percent plant/vegetation cover, suitable elevational ranges of 4,940 to 5,808 ft (1,506 to 1,770 m), the appropriate topography, and shrink-swell alkaline clay soils within the Atwell Gulch and Shire members of the Wasatch Formation. A network of access roads runs through the Unit. Eighty-eight percent of this Unit is within a BLM grazing allotment, and 84 percent is within the Grand Junction Field Office's designated energy corridor. Thirty percent of the Unit is managed as an active pipeline ROW. While these lands currently have the physical and biological features essential to the conservation of *Phacelia submutica*, because of a lack of cohesive management and protections, special management will be required to maintain these features in this Unit. Threats to *Phacelia submutica* and its habitat in this Unit include energy development, recreation (especially OHV use), livestock and wild ungulate grazing and use, and nonnative invasive species, including *Bromus tectorum* and *Halogeton glomeratus*. The Westwide Energy corridor runs through this Unit. The entire Unit is within the Westwide Energy corridor, and 88 percent is within several grazing allotments.

Unit 7, the Baugh Reservoir Unit, consists of 430 ac (174 ha) of Federal and private lands in Mesa County, Colorado. The Unit is located 6 mi (10 km) south of DeBeque, Colorado, near Kimball Mesa and Horse Canyon Road. Thirty-nine percent is managed by BLM through the Grand Junction Field Office, and the remaining 61 percent is on private lands. This Unit is currently occupied. We slightly increased the size of this Unit from our proposed critical habitat designation in our notice of availability (77 FR 18162) to include sites that were revisited and more accurately mapped during the spring of 2011 (Service 2011e, pp. 5-8). This Unit currently has all the physical and biological features essential to the conservation of the species, including barren clay badlands with less than 20 percent plant/vegetation cover, a suitable elevational range of 5,400 to 5,700 ft (1,646 to 1,737 m), the appropriate topography, and shrink-swell alkaline clay soils within the Atwell Gulch and Shire members of the Wasatch Formation. An access road runs through the Unit, close to the occurrence of *Phacelia submutica*. While these lands currently have the physical and biological features essential to the conservation of *P. submutica*, because of a lack of cohesive management and protections, special management will be required to maintain these features in this Unit. Threats to *Phacelia submutica* and its habitat in this Unit include energy development, recreation, livestock and wild ungulate grazing and use, and nonnative invasive species including *Bromus tectorum* and *Halogeton glomeratus*. The Westwide Energy corridor runs through this Unit. The entire Unit is within the Westwide Energy corridor and one grazing allotment.

Unit 8, the Horsethief Mountain Unit, consists of 4,209 ac (1,703 ha) of Federal and private lands in Mesa County, Colorado. It is located approximately 3.5 mi (5.6 km) southeast of DeBeque, Colorado, and along the eastern side of Sunnyside Road (V Road). Thirty-four percent is managed by BLM through the Grand Junction Field Office, 29 percent by the White River National Forest, 23 percent by the Grand Mesa Uncompahgre National Forest, and 14 percent is on private lands. This Unit is currently occupied. This Unit currently has all the physical and biological features essential to the conservation of the species, including barren clay badlands with less than 20 percent plant/vegetation cover, a suitable elevational range of 5,320 to 6,720 ft (1,622 to 2,048 m), the appropriate topography, and shrink-swell alkaline clay soils within the Atwell Gulch and Shire members of the Wasatch Formation. While these lands currently have the physical and biological features essential to the conservation of *Phacelia submutica*, because of a lack of cohesive management and protections, special management will be required to

maintain these features in this Unit. A portion of the site on USFS lands is within a proposed Research Natural Area. Threats to *Phacelia submutica* and its habitat in this Unit include energy development, recreation (especially OHV use), livestock and wild ungulate grazing and use, and nonnative invasive species, including *Bromus tectorum* and *Halogeton glomeratus*.

Unit 9, the Anderson Gulch Unit, consists of 341 ac (138 ha) of State and private lands in Mesa County, Colorado. It is located 11 mi (17 km) southeast of DeBeque, Colorado, and 3.5 mi (5.5 km) north of the town of Molina, Colorado. Within the Unit, 56 percent of the lands are managed by CDOW, within the Plateau Creek State Wildlife Area, and 44 percent is private. This Unit is currently occupied. We slightly increased the size of this Unit from our proposed critical habitat designation in our notice of availability (77 FR 18162) to include sites that were revisited and more accurately mapped during the spring of 2011 (CNHP 2012b, spatial data). This Unit currently has all the physical and biological features essential to the conservation of the species, including barren clay badlands with less than 20 percent plant/vegetation cover, a suitable elevational range of 5,860 to 6,040 ft (1,786 to 1,841 m), the appropriate topography, and shrink-swell alkaline clay soils within the Atwell Gulch and Shire members of the Wasatch Formation. Forty-two percent of the Unit is a pending pipeline ROW. While these lands currently have the physical and biological features essential to the conservation of *Phacelia submutica*, special management may be required to maintain these features in this Unit. Threats to *Phacelia submutica* and its habitat in this Unit include energy development, recreation (especially from OHV use), livestock and wild ungulate grazing and use, and nonnative invasive species, including *Bromus tectorum* and *Halogeton glomeratus*.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Phacelia submutica* critical habitat consists of five components (77 FR 48356-48415):

(i) Suitable soils and geology. (A) Atwell Gulch and Shire members of the Wasatch formation. (B) Within these larger formations, small areas (from 10 to 1,000 ft² (1 to 100 m²)) on colorful exposures of chocolate to purplish brown, light to dark charcoal gray, and tan clay soils. These small areas are slightly different in texture and color than the similar surrounding soils. Occupied sites are characterized by alkaline (pH range from 7 to 8.9) soils with higher clay content than similar nearby unoccupied soils. (C) Clay soils that shrink and swell dramatically upon drying and wetting and are likely important in the maintenance of the seed bank.

(ii) Topography. Moderately steep slopes, benches, and ridge tops adjacent to valley floors. Occupied slopes range from 2 to 42 degrees with an average of 14 degrees.

(iii) Elevation and climate. (A) Elevations from 4,600 ft (1,400 m) to 7,450 ft (2,275 m). (B) Climatic conditions similar to those around DeBeque, Colorado, including suitable precipitation and temperatures. Annual fluctuations in moisture (and probably temperature) greatly influences the number of *Phacelia submutica* individuals that grow in a given year and are thus able to set seed and replenish the seed bank.

(iv) Plant community. (A) Small (from 10 to 1,000 ft² (1 to 100 m²)) barren areas with less than 20 percent plant cover in the actual barren areas. (B) Presence of appropriate associated species that can include (but are not limited to) the natives *Grindelia fastigiata*, *Eriogonum*

gordonii, *Monolepis nuttalliana*, and *Oenothera caespitosa*. Some presence, or even domination by, invasive nonnative species, such as *Bromus tectorum*, may occur, as *Phacelia submutica* may still be found there. (C) Appropriate plant communities within the greater pinyon-juniper woodlands that include: (1) Clay badlands within the mixed salt desert scrub; or (2) Clay badlands within big sagebrush shrublands.

(v) Maintenance of the seed bank and appropriate disturbance levels. (A) Within suitable soil and geologies (see paragraph (2)(i) of this entry), undisturbed areas where seed banks are left undamaged. (B) Areas with light disturbance when dry and no disturbance when wet.

Special Management Considerations or Protections

The features essential to the conservation of this species (plant community and competitive ability, elevation, topography, soils, climate, reproduction and seed bank, and disturbance regime) may require special management considerations or protection to reduce threats. Specifically, the clay soils on which *Phacelia submutica* are found are relatively stable when dry but are extremely vulnerable to disturbances when wet. The current range of *P. submutica* is subject to human-caused modifications from natural gas exploration and production with associated expansion of pipelines, roads, and utilities; development within the Westwide Energy Corridor; increased access to the habitat by OHVs; soil and seed disturbance by livestock and other human-caused disturbances; nonnative invasive species including *Bromus tectorum* and *Halogeton glomeratus* (halogeton); and inadequacy of existing regulatory mechanisms (76 FR 45054). Special management considerations or protections are required within critical habitat areas to address these threats. Management activities that could ameliorate these threats include (but are not limited to): Development of regulations and agreements to balance conservation with energy development and minimize its effects in areas where the species resides; the establishment of additional protection areas that provide greater protections for the species; minimization of OHV use; placement of roads and utility lines away from the species and its habitat; minimization of livestock use or other human-caused disturbances that disturb the soil or seeds; and the minimization of habitat fragmentation. These management activities would protect the PCEs for the species by preventing the loss of habitat and individuals, protecting the plant's habitat and soils, and managing for appropriate levels of disturbance.

Criteria Used To Identify Critical Habitat As required by section 4(b)(2) of the Act, we used the best scientific data available to designate critical habitat. We reviewed available information pertaining to the habitat requirements of this species. In accordance with the Act and its implementing regulation at 50 CFR 424.12(e), we considered whether designating additional areas-- outside those currently occupied as well as those occupied at the time of listing--are necessary to ensure the conservation of the species. We are designating critical habitat in areas within the geographical area occupied by *Ipomopsis polyantha*, *Penstemon debilis*, and *Phacelia submutica* at the time of listing in 2011. We also are designating specific areas outside the geographical area occupied by *I. polyantha* and *P. debilis* at the time of listing because we have determined that such areas are essential for the conservation of the species. All units are designated based on sufficient elements of physical and biological features being present to support *Ipomopsis polyantha*, *Penstemon debilis*, and *Phacelia submutica* life-history processes. Small populations and plant species with limited distributions, like those of *Ipomopsis polyantha* and *Penstemon debilis*, are vulnerable to relatively minor environmental disturbances (Given 1994, pp. 66-76; Frankham 2005, pp. 135-136), and are subject to the loss of genetic diversity from genetic drift, the random loss of genes, and inbreeding (Ellstrand and Elam 1993, pp. 217-237; Leimu et al. 2006, pp. 942-952). Plant populations with lowered genetic diversity are more

prone to local extinction (Barrett and Kohn 1991, pp. 4, 28). Smaller plant populations generally have lower genetic diversity, and lower genetic diversity may in turn lead to even smaller populations by decreasing the species' ability to adapt, thereby increasing the probability of population extinction (Newman and Pilson 1997, p. 360; Palstra and Ruzzante 2008, pp. 3428-3447). Because of the dangers associated with small populations or limited distributions, the recovery of many rare plant species includes the creation of new sites or reintroductions to ameliorate these effects. Genetic analysis of *Ipomopsis polyantha* has not been conducted; therefore, we do not understand the genetic diversity of this species. Given the species' limited extent and presence in only two populations, we expect the species may be suffering from low genetic diversity, or could in the future. Genetic research on *Penstemon debilis*, based on neutral genetic markers, has found that there is more genetic diversity in larger populations than smaller populations, that the northeastern populations are more closely related to one another than to the southwestern populations, that inbreeding is common within each population, and that genetic diversity for the species is low when compared with other species of plants with similar life-history traits (Wolfe 2010, p. 1). The plant is partially clonal, which likely explains the lowered genetic diversity and further reduces the actual population size. Small population sizes with few individuals are a problem for this species, as supported by this research. When designating critical habitat for a species, we consider future recovery efforts and conservation of the species. Realizing that the current occupied habitat is not enough for the conservation and recovery of *Ipomopsis polyantha* and *Penstemon debilis*, we worked with species' experts to identify unoccupied habitat essential for the conservation of these two species. The justification for why unoccupied habitat is essential to the conservation of these species and methodology used to identify the best unoccupied areas for consideration for inclusion is described below. Habitat fragmentation can have negative effects on biological populations, especially rare plants, and affect survival and recovery (Aguilar et al. 2006, pp. 968-980; Aguilar et al. 2008, pp. 5177-5188; Potts et al. 2010, pp. 345-352). Fragments are often not of sufficient size to support the natural diversity prevalent in an area, and thus exhibit a decline in biodiversity (Fahrig 2003, pp. 487-515). Fragmentation effects are especially prevalent in systems where multiple generations have elapsed since the fragmentation occurred (Aguilar et al. 2008, p. 5177). Habitat fragmentation has been shown to disrupt plant-pollinator interactions and predator-prey interactions (Steffan-Dewenter and Tscharnkte 1999, p. 432-440; Aguilar et al. 2006, pp. 968-980; Eckert et al. 2010, pp. 35-43), alter seed germination percentages (Menges 1991, pp. 158-164), affect recruitment (Santos and Telleria 1997, pp. 181-187; Quesada et al. 2003, pp. 400-406), and result in lowered fruit set (Burd 1994, pp. 83-139; Cunningham 2000, pp. 1149-1152; Eckert et al. 2010, p. 38). In general, habitat fragmentation causes habitat loss, habitat degradation, habitat isolation, changes in species composition, changes in species interactions, increased edge effects, and reduced habitat connectivity (Fahrig 2003, pp. 487-515; Fisher and Lindenmayer 2007, pp. 265-280). These effects are more prevalent in arid ecosystems with low native vegetation cover (Fisher and Lindenmayer 2007, p. 272). Habitat fragments are often functionally smaller than they appear because edge effects (such as increased nonnative invasive species or wind speeds) impact the available habitat within the fragment (Lienert and Fischer 2003, p. 597). Shaffer and Stein (2000) identify a methodology for conserving imperiled species known as the three Rs: Representation, resiliency, and redundancy. Representation, or preserving some of everything, means conserving not just a species but its associated plant communities, pollinators, and pollinator habitats. Resiliency and redundancy ensure there is enough of a species so it can survive into the future. Resiliency means ensuring that the habitat is adequate for a species and its representative components. Redundancy ensures an adequate number of sites and individuals. This methodology has been

widely accepted as a reasonable conservation strategy (Tear et al. 2005, p. 841). We have addressed representation through our PCEs for each species (as discussed above) and by providing habitat for pollinators of *Ipomopsis polyantha* and *Penstemon debilis* (as discussed further under "*Ipomopsis polyantha*" below). For *Phacelia submutica*, we believe that the occupied habitat provides for both resiliency and redundancy and that with conservation of these areas, the species should be conserved and sustained into the future. For *I. polyantha*, there are only two known populations, both with few or no protections in place (low resiliency). For adequate resiliency, we believe it is necessary for the conservation and recovery of *I. polyantha* that additional populations with further protections be established. Therefore, we have identified two unoccupied areas as designated CHUs for *I. polyantha*. For *P. debilis*, there are only approximately 4,000 known individuals (low redundancy), all within 2 concentrated areas (low resiliency). For adequate redundancy and resiliency, we believe it is necessary for conservation and recovery that additional populations of *P. debilis* be established. Therefore, we have identified two unoccupied areas as designated CHUs for *P. debilis*.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Insect pollinated/Asexual (USFWS, 2013)

Lifespan

Adult: One year (USFWS, 2013)

Breeding Season

Adult: DeBeque phacelia plants flower between late April and late June and set seed from midMay through late June (USFWS, 2013).

Reproduction Narrative

Adult: DeBeque phacelia plants flower between late April and late June and set seed from midMay through late June. Preliminary evidence on the pollination biology of the species indicates that insect pollinators are not necessary for reproduction (Langton and Schupp 2012a). Yearly germination is variable depending on precipitation patterns and can fluctuate widely (Burt and Spackman 1995). For example, DeBeque phacelia numbers at Horsethief Mountain fluctuated from 1,700 plants in 1986, to 50 in 1992, up to 1,070 in 2003, and down to only a few from 2006 to 2008 (Colorado Natural Heritage Program (CNHP) 2010) (Figure 1). This strategy of maintaining seed dormancy through unfavorable conditions is common among annual plant species of arid environments (Anderson et al. 2012; Baskin and Baskin 1998). Maintenance of a large seed bank is also vital to the persistence of these species through unpredictable and long periods of drought (Anderson et al. 2012). No information is currently available on the density and longevity of the species' seed bank, nor the environmental conditions required to break seed dormancy, but studies are under way (Langton and Schupp 2012b) (USFWS, 2013).

Habitat Type

Adult: Ridge tops (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Xeric ridge tops (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (NatureServe, 2015)

Site Fidelity

Adult: High (NatureServe, 2015)

Habitat Narrative

Adult: Species occurs on steep slopes and ridge-tops on xeric sites in chocolate-brown or gray clay adobe badlands of Western Colorado which often have high shrink-swell potential (large cracks in the soil). The species is adapted to grow only in very early pioneer habitats with sparse vegetation cover (Scheck 1994). The species occurs on Atwell Gulch and Shire Members of Wasatch Formation (O'Kane 1987). Associated species are *Grindelia fastigiata*, *Sarcobatus vermiculatus*, *Atriplex confertifolia*, *Eriogonum gordonii*, *Monolepis nuttalliana*, *Oenothera caespitosa*, *Astragalus flavus*, *Helianthus* sp., *Lepidium* sp., *Chenopodium* sp., *Rumex* sp., *Cymopterus planus*, *Sitanion hystrix*, *Ceratocephala testiculata*, *Lactuca serriola*, *Euphorbia fendleri*, *Asclepias cryptoceras*, *Mentzelia* sp., *Thelypodopsis* sp., *Oryzopsis hymenoides*, *Bromus tectorum*, *Sphaeralcea coccinea*, *Gutierrezia sarothrae* (O'Kane 1987). Other rare species occurring in the area are *Sclerocactus glaucus* and *Astragalus debequaeus* (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are based on the species specific habitat requirements as well as its restricted geographic range.

Dispersal/Migration**Dispersal**

Adult: Low (USFWS, 2010)

Dispersal/Migration Narrative

Adult: Numbers of flowering plants fluctuate, but they do not disperse seeds beyond the existing patches of unique soil that are separated from one another by a few yards or several miles (Ewing 2008b, map) (USFWS, 2010).

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Resiliency:

Low (NatureServe, 2015)

Representation:

Low (NatureServe, 2015)

Redundancy:

Low (NatureServe, 2015)

Number of Populations:

21 - 80 (NatureServe, 2015)

Population Size:

10,000 - 100,000 individuals (NatureServe, 2015)

Population Narrative:

Vulnerable to changes in habitat conditions, especially surface disturbances such as trampling of soil. An annual species whose population size varies widely from year to year. Because *Phacelia submutica* is adapted to a very specific geologic substrate and habitat type, a range extension is unlikely. Approximately 35,000-40,000 individuals have been documented within 21 of the 22 occurrences. However, this species is a seed-banking annual with numbers of visible plants varying drastically from year to year. There are 22 principal occurrences documented in the Colorado Natural Heritage Program database. Six of the occurrences have not been observed in over 20 years (as of 2012). The USFS Conservation Assessment documents 40 occurrences (Ladyman 2003). It is likely that this discrepancy in the total number of occurrences is because some of the sites reported by Ladyman are represented in the Heritage database as portions of other occurrences and not reported separately (NatureServe, 2015). Low resilience, representation and redundancy are based on the low number of known populations, the relatively narrow geographic area this species inhabits and the variability in numbers from year to year.

Threats and Stressors

Stressor: Oil and gas development (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Increasing oil and gas development in the Piceance Basin is a significant concern in the recovery of the species. About 95 percent of occupied habitat is on BLM lands leased for energy extraction (Service 2012). Ongoing energy development activities include well pad and road construction, installation of pipelines, and construction of associated buildings, holding tanks, and other facilities. Oil and gas pipelines and well pads are present within thirteen EOs (Service 2012). Several pipelines and pipeline right-of-ways already exist within 20 ft (6 m) of DeBeque phacelia EOs (Lincoln 2008, pers. comm.; Service 2012). Roads used for energy extraction bisect and cross the edges of eleven EOs (Service 2012) (USFWS, 2013).

Stressor: Utility and Energy Corridors: (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Utility and energy corridors provide pathways for future pipelines and electrical transmission lines. A portion of the designated Westwide Energy Corridor crosses 22,404 ac (9,066.6 ha) of BLM land within the range of DeBeque phacelia (see Figure 3) (Service 2012). Eight of the 20 EOs and 13 percent of critical habitat are within the Westwide Energy Corridor (Service 2012). Continued development of pipeline and transmission lines within the energy corridor is likely to affect DeBeque phacelia and its habitat (USFWS, 2013).

Stressor: Livestock Use and Trampling (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Potential threats related to livestock, deer, and elk use include the direct effects from trampling, and the indirect effects of habitat degradation. Ninety percent of DeBeque phacelia EOs are under management by the BLM as a grazing allotment (Service 2011a). Livestock trampling has occurred or is a threat at 14 EOs (CNHP 2010). Livestock can easily trespass from BLM or private grazing allotments onto USFS property where grazing is not allowed. This has been documented at two occurrences, one obtaining frequent disturbance from its proximity to a pond (Langton 2012). No research or monitoring has been conducted to evaluate the effects of livestock, deer, or elk use on DeBeque phacelia. However, the deleterious effects of livestock on western arid ecosystems are well documented (Milchunas et al. 1992; Jones 2000). Some of the adverse effects from livestock include changes in water infiltration due to soil compaction (Jones 2000, Table 1); changes to the physical and structural properties of soils (Kinlock and Friedel 2002); disturbance to soil microbiotic crusts (Evans and Belnap 1999; Jones 2000); subsequent nonnative invasive plant invasions (Parker et al. 2006); and soil erosion from hoof action (Jones 2000). Effects from livestock grazing to DeBeque phacelia and its habitat are occurring will likely continue (USFWS, 2013)

Stressor: Off-Highway Vehicle Use (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Off-highway-vehicle (OHV) use occurs on lands throughout the range of DeBeque phacelia. OHV recreation has damaged plants and habitat at seven EOs (CNHP 2012). On Federal lands, vehicles stray from designated roads to climb clay barrens for recreational purposes (Johnston 2012; Mayo 2008d). OHV trespass has even been documented within the Pyramid Rock Natural Area and BLM Area of Critical Environmental Concern (ACEC). The ACEC is fenced with post and cable, and an information sign is posted near an access point. The visible effects of OHV recreation within DeBeque phacelia habitat has been seen to persist for several years (Johnston 2012). Surface disturbances from OHV recreation cause accelerated erosion, fugitive dust production, soil compaction, sedimentation, and potentially irreversible changes to soil physical properties and chemistry (Iverson et al. 1981; Pagliali et al. 2003). Additionally, these changes in the soil environment can affect ecosystem function (DeFalco 2009). OHV use is expected to increase in the region with the construction of additional roadways for energy development and the increasing popularity of OHV recreation. With OHV recreation within the range of the species, direct losses of plants and the seed bank, as well as indirect affects to the species and its habitat will continue to occur (USFWS, 2013).

Stressor: Invasive Nonnative Plants (USFWS, 2013)

Exposure:**Response:****Consequence:** Loss of habitat**Narrative:** The threat from invasive nonnative plant species (weeds) is a growing concern in the recovery of DeBeque phacelia. Weeds have been documented at 15 EOs (CNHP 2012a).

Disturbances such as roads, grading, and livestock grazing generally introduce and spread exotic species (Gelbard and Belnap 2003). Weeds invade and alter all types of plant communities, sometimes resulting in nonnative plant monocultures that support little wildlife or native plants (D'Antonio and Vitousek 1992; Olson 1999; Mooney and Cleland 2001). Many experts believe that, following habitat destruction, nonnative invasive plants are the next greatest threat to biodiversity (Randall 1996). Nonnative invasive plants alter different ecosystem attributes including geomorphology, fire regime, hydrology, microclimate, nutrient cycling, and productivity (Dukes and Mooney 2004). Species known to occur within DeBeque phacelia habitat include cheatgrass (*Bromus tectorum*), bur buttercup (*Ranunculus testiculatus*), and annual wheatgrass (*Eremopyrum triticeum*). These weeds are prevalent on public and private lands within the range of the DeBeque phacelia. Recent data suggest that weed cover in DeBeque phacelia sites is related to distance from roads, while the number of flowers was found to be higher at distances away from roads (BioLogic 2011). The control of weeds on public lands, especially around well pads, utility corridors, and roads, may also pose a danger to DeBeque phacelia. For example, herbicide drift from well pad spraying has led to the mortality of Colorado hookless cacti near DeBeque (Perkins 2012, pers. comm.) (USFWS, 2013).

Stressor: Water Reservoirs (USFWS, 2013)**Exposure:****Response:****Consequence:** Loss of habitat

Narrative: Two water reservoir projects known as Roan Creek and Sulphur Gulch were proposed within potential and occupied habitat of DeBeque phacelia (Bray and Drager 2008, pers. comm.; Grand River Consulting Corporation 2009). The proposals were withdrawn and are not imminent. However, the sites have been identified as potential reservoir locations that could be developed within 20 years if warranted by increased demands for water. Increased demands are likely, depending on the oil shale market, urban development in Colorado, and less (or altered) precipitation due to climate change. If developed, construction and inundation of these reservoirs would permanently destroy DeBeque phacelia plants and habitat within the project areas (USFWS, 2013).

Stressor: The Inadequacy of Existing Regulatory Mechanisms (USFWS, 2013)**Exposure:****Response:****Consequence:** Loss of habitat/loss of individuals

Narrative: Removal, damage, or destruction of plants on private lands is not prohibited under the Endangered Species Act (Act). We are not aware of any state, county, city, or local laws, ordinances or zoning that provide for the protection or conservation of DeBeque phacelia or its habitat. Though no state regulations protect rare plants in Colorado, the Colorado Natural Areas Program manages a State Natural Area on BLM land protecting 510.9 ac (206.7 ha) of the species' habitat within the Pyramid Rock population. This agreement between Colorado Natural Areas Program and the BLM can, however, be terminated with a 90-day written notice by either party. Additional habitat on state land includes 7.5 ac (3 ha) of the Anderson Gulch population. This

population contains the only “A” - ranked Elemental Occurrence (CNHP 2012a) meaning it has excellent estimated viability/ecological integrity. The majority of this population (90 percent) is within the Piceance Creek State Wildlife Area and is managed by Colorado Parks and Wildlife (USFWS, 2013).

Stressor: Climate Change and Drought (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: According to the Intergovernmental Panel on Climate Change (IPCC), “Warming of the climate system in recent decades is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global sea level” (IPCC 2007). Research indicates that warming is occurring more rapidly in the southwest region of the United States than elsewhere in the country with an increase of 1.5°F (0.8°C) since 1979 (Karl et al. 2009). Additionally in the west, the onset of spring has been advancing since the 1970’s (Cayan et al. 2001). Annual temperature is predicted to increase approximately 2.2°C (4°F) in the southwest by 2050, with summers warming more than winters (Ray et al. 2008). Effects of climate change include persistent or prolonged drought conditions, changes in the vegetative community including increased invasions by weeds (Everard et al. 2010). Climate change is likely to affect many rare plant species because seed germination, seed dormancy, and persistence of the seed bank are all directly dependent on precipitation and temperature patterns (Levine et al. 2008). However, we do not understand how these changes may affect the long-term persistence of DeBeque phacelia because no information is available on the ecology of the species. Improved localized projections and precipitation models are also needed to better understand the threat of climate change to the species. The potential impacts of climate change will be significant at a global scale and we expect the predicted increased drought conditions to affect the recovery of DeBeque phacelia (USFWS, 2013).

Recovery

Reclassification Criteria:

The preliminary plan lists three basic steps for recovery: 1: Protect and maintain all extant populations (USFWS, 2013).

2. Prevent or minimize habitat disturbing threats (USFWS, 2013).

Develop and implement rangewide monitoring (USFWS, 2013).

Conservation Measures and Best Management Practices:

- Protection of Extant Populations and Habitat: Establish and implement protective measures for all known populations (USFWS, 2013).
- Threats Abatement: Implement protective measures such as fencing, controlled management of livestock use, nonnative species control and additional measures to avoid or minimize impacts to the species and its habitat (USFWS, 2013).
- Threats Abatement: Coordinate with land managers, project proponents, and other partners early in the planning process to limit direct and indirect effects of oil and gas development, grazing, OHV recreation, weeds, and additional threats that arise (USFWS, 2013).

- Threats Abatement: Work with land management agencies and other partners to formally establish land management designations to provide for long-term protection of populations and habitat (USFWS, 2013).
- Threats Abatement: Ensure that additional oil and gas leases avoid or take into consideration occupied and suitable habitat (USFWS, 2013).
- Threats Abatement: Consider installing livestock exclosures for both protection and monitoring purposes (USFWS, 2013).
- Surveys and Monitoring: Complete a comprehensive survey throughout the species' range, including areas designated as "potential habitat". Survey results should provide an accurate population estimate and allow us to identify core population areas so we can more effectively protect the species (USFWS, 2013).
- Surveys and Monitoring: Establish a survey protocol to identify areas of suitable habitat during years in which few above-ground plants are found. This protocol must take into account an evaluation of habitat components that support DeBeque phacelia (USFWS, 2013).
- Surveys and Monitoring: Establish a long-term monitoring plan to document rangewide population demographics and trends, and quantify the affects from threats. An adaptive management approach that uses feedback from implemented, site-specific recovery tasks should be integrated into the plan to inform recovery activities (USFWS, 2013).
- Surveys and Monitoring: Gain permission from landowners to survey for DeBeque phacelia on private lands with potential habitat (USFWS, 2013).
- Research: Continue research into DeBeque phacelia life history and ecology, including pollination biology, seed bank density, seed bank longevity, seed germination ecology, and habitat and soil requirements (USFWS, 2013).
- Research: Study population genetics and demographics (USFWS, 2013).
- Research: Conduct a population viability analysis (USFWS, 2013).
- Research: Conduct investigations that project DeBeque phacelia vulnerability and response to climate change (USFWS, 2013).
- Research: Improve our understanding of livestock and native ungulate grazing impacts (USFWS, 2013).
- Research: Monitor changes in invasive species prevalence and conduct research on impacts to DeBeque phacelia (USFWS, 2013).
- Research: Continue to refine a survey protocol for delineating suitable habitat (USFWS, 2013).
- Research: Continue to analyze the effects of dispersed oil and gas development and roads (USFWS, 2013).
- Seed Banking: Store genetic material in the form of seed in an appropriate repository to provide a back-up supply of genetic stock that represents as much of the available genetic diversity within the species as possible (USFWS, 2013).

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Listing *Ipomopsis polyantha* (Pagosa Skyrocket) as Endangered Throughout Its Range, and Listing *Penstemon debilis* (Parachute Beardtongue) and *Phacelia submutica* (DeBeque Phacelia) as Threatened Throughout Their Range. Proposed Rule. FR Vol. 75, No. 120. Pages 35721 - 35746

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SPECIES ACCOUNT: *Phlox hirsuta* (Yreka phlox)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

Cespitose perennial subshrub from a stout, woody base. Stems stout, to 1.5dm tall. Herbage copiously hirsute with long, jointed hairs. Leaves crowded Blooms April-June. (NatureServe, 2015)

Taxonomy

Elias Nelson (1899) described *P. hirsuta* based on a collection made by Edward L. Greene in 1876. A complete nomenclatural history can be found in Appendix 1 of the Recovery Plan for *Phlox hirsuta* (Yreka Phlox) (U.S. Fish and Wildlife Service 2006). No changes in taxonomy have occurred since the time of listing (USFWS, 2007).

Historical Range

Phlox hirsuta is known to occur at five locations, which are referred to as the “China Hill,” “Soap Creek Ridge,” “Cracker Gulch,” “Greenhorn Creek,” and “Jackson Street” occurrences. In addition, the locality information from a single 1930 collection indicates a possible historical location in the vicinity of Etna or in the vicinity of Echo Mill, near Soap Creek Ridge (California Department of Fish and Game 1986; J. Molter in litt. 2001; Appendix 1, prepared by F. Lang in U.S. Fish and Wildlife Service 2006). A *P. hirsuta* location or occurrence is defined as a group of at least 200 individual plants that is separated from any other *P. hirsuta* locality by at least 0.40 kilometer (0.25 mile). (USFWS, 2007)

Current Range

In and near the towns of Yreka and Etna in Siskiyou County, northern California (USFWS 1995). Range extent is approximately 34 sq mi. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Dispersal/Migration

Population Information and Trends

Threats and Stressors

Recovery

References

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USFWS. 2015. Environmental Conservation Online System (ECOS) – Species Profile. <http://ecos.fws.gov/ecp0/>. Accessed June 2016.

SPECIES ACCOUNT: *Phlox nivalis* ssp. *texensis* (Texas trailing phlox)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/30/1991; Southwest Region (Region 2) (USFWS, 2016)

Physical Description

The Texas trailing phlox is an evergreen perennial that forms clumps (but seldom mats). The plants are herbaceous or subshrubby. Stems tend to spread along the ground surface, and are erect only for the terminal 2—15 centimeters (0.8-5.9 in). Leaves are needlelike to lanceolate, densely packed on the stem (producing an appearance somewhat like a juniper seedling), usually less than 1.5 cm (0.6 inch) long, and more or less glandular pubescent. Older stems have smaller and darker green leaves, and typically lie directly on the ground surface. Young stems produce the flowers, are more or less erect, and have longer, slightly wider, and lighter—green leaves. Inflorescences are 3-12 flowered cymes, terminal on (typically) the tallest stems. The calyx is tubular with five sepals, which are fused for most of their length. The corolla is rotate, with a tube approximately 1.5 centimeters (0.6 inch) long. The five petals, each about 1 centimeter (0.4 inch) long, are pink to magenta in color, and darker near the throat. Petals are reported to be white in some individuals. Pistils have three styles, and the ovule is usually single. Fruits are achene—like, and apparently indehiscent (this character description of the fruit differs from previously published summaries). Flowering occurs from March to May. (USFWS, 1994)

Taxonomy

Texas trailing phlox belongs to the family Polemoniaceae, which includes such plants as sweet William, Jacob's ladder, Texas plume, and phlox. Texas trailing phlox is one of two subspecies recognized in *P. nivalis*. The nominal subspecies (ssp. *nivalis*) occurs in pine/oak barrens or scrub on the Coastal Plain or Piedmont, from Alabama to Florida and north to Virginia. Flowers of this subspecies are typically white or pale pink, with plants of forma *roseiflora* having deep rose or magenta flowers (Fernald 1970). According to Wherry (1955), the major difference between the two subspecies is the presence of minute glandular hairs on *texensis*, and their absence on *nivalis*. Currently, the nearest known populations of ssp. *nivalis* to those of *texensis* are located more than 1000 kilometers (600 miles) eastward in northern Florida. Wherry included *Phlox nivalis* in series *Subulatae*, along with *Phlox subulata* and *Phlox oklahomensis*. Both of the latter species have gross morphological features similar to that of *P. nivalis*, but Bogler (1992) expressed the opinion that, based on Texas specimens, fl. *nivalis* is most similar to *P. oklahomensis*. Populations of *P. oklahomensis* found in Texas are disjunct from the main range of *P. oklahomensis* (located further north in Oklahoma), lying approximately equidistant between it and range of *P. nivalis* ssp. *texensis*. (USFWS, 1994)

Historical Range

Although its historic range includes Hardin, Polk, and Tyler Counties of Texas, the Texas trailing phlox is presently known from only two sites in southeast Texas. (USFWS, 1994)

Current Range

Endemic to the Pineywoods of the West Gulf Coastal Plain of east Texas. Texas trailing phlox is presently known from only two sites, one each in Tyler and Hardin counties, Texas. (USFWS, 1994; NatureServe, 2015)

Critical Habitat Designated

Yes;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Asexual (vegetative) and sexual (outcrossing) (USFWS, 1994)

Breeding Season

Adult: Flowering generally occurs between late March and early April (Ajilvsgi 1979, Poole et al. 2007, U.S. National Park Service (USNPS) 2015), sometimes extending into May depending on precipitation and management (i.e. prescribed burning). (USFWS, 2018)

Other Reproductive Information

Adult: Flies, bees, and butterflies have been observed at flowers. Based on the plant's floral structure, butterflies are the most likely pollinators. (USFWS, 1994)

Reproduction Narrative

Adult: Flies, bees, and butterflies have been observed at flowers. Based on the plant's floral structure, butterflies are the most likely pollinators. Typically, no more than one seed is produced per flower and, based on limited field observation, fruit set is low. An individual plant may have 3 to 50+ flowers and primarily depending on number of flowers. Its low population numbers are likely due to a combination of anthropogenic factors and a naturally low reproductive rate. (USFWS, 1994); Little is known about the reproduction of the Texas trailing phlox. Their populations are small and consist of a few scattered, inconspicuous individuals (Mahler 1980). This could make asexual reproduction very important for recruitment (Parker and Warnock 1993) but this frequency is unknown. Texas trailing phlox is mostly an outcrossing species pollinated by moths and butterflies (Bogler 1992). However, it is not known whether flowers are obligate or facultative outcrossers (Maxey and Warnock 1996, USFWS 1995). Pollinators include carpenter bees (M. Quinn, pers. comm. 2008), Nessus sphinx moth (*Amphion floridensis*) (G. Grant, pers. comm. 2017), and Tiger swallowtail butterfly (*Papilio glaucus*) (G. Grant, pers. comm. 2014). Other bees and butterflies, as well as flies could also serve as pollinators (USFWS 1995, Maxey and Warnock 1996, TPWD 1997). Poole et al. (2000) noted that there is the potential of large terrestrial arthropods to act as pollinators. Also, seed and seedling biology (seed maturation, dormancy, seed viability) are largely unknown for the Texas trailing phlox. We lack information about seed dispersal; however, dehiscence could play a role in local dispersal. (USFWS, 2018)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest/woodland, savanna, shrubland/chaparral, woodland - hardwood (NatureServe, 2015)

Habitat Narrative

Adult: Texas trailing phlox occurs in southeast Texas in the southern portion of the Pineywoods vegetational area. Within the range of Texas trailing phlox, annual precipitation averages 125 cm (49 in), with no pronounced summer drought. The average frost-free period is 244 days (Bogler 1992), from early March through mid-December (Larkin and Bomar 1983). Elevation ranges from 9 to 75 meters (30-240 feet), and topography is nearly level. This species prefers deep, sandy soils in fire-maintained openings in upland longleaf pine (*Pinus palustris*) savannahs or post oak-bluejack oak (*Quercus stellata*-*Q. incana*) woodlands. Field studies suggest that sandy surface soil, coupled with moisture-bearing clays or sandy-clay soils at depths of 0.5-2 meters (1.6-6.6 feet), provide the best soil structure for Texas trailing phlox. Overstory cover at sites of Texas trailing phlox occurrence typically ranges from 25-75 percent. Understory and shrub cover is less than 25 percent at most plant sites, but ranges up to nearly 100 percent at some. However, the best growth of Texas trailing phlox is seen at the lower percentages of understory and shrub cover. The degree of ground cover associated with optimum growth of Texas trailing phlox appears to be 25-75 percent. Litter depth is generally 3-5 cm (1.2-2.0 in), and coverage is usually 75-100 percent. The most common canopy trees associated with Texas trailing phlox are *Pinus palustris*, *P. elliotii*, *R. taeda*, *Quercus incana*, *Q. falcata*, and *Q. stellata* and *Carva texana*. (USFWS, 1994; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Long-term trends indicate a decline of 30 to 70%, whereas short-term trends suggest a relatively stable population (NatureServe, 2015)

Resiliency:

Low (inferred from USFWS, 1994)

Redundancy:

Low (inferred from USFWS, 1994)

Number of Populations:

7 (USFWS, 2018)

Population Size:

<750 individuals (NatureServe, 2015)

Population Narrative:

Long-term trends indicate a decline of 30 to 70%, whereas short-term trends suggest a relatively stable population. Although its historic range includes Hardin, Polk, and Tyler Counties of Texas, the Texas trailing phlox is presently known from only two sites in southeast Texas. Although nineteen collections of Texas trailing phlox are reported in historical records, these appear to originate from only six definable population systems, however, only two are extant populations.

Reintroductions are being attempted in areas where there were historic populations. (NatureServe, 2015); When the species was listed as endangered in 1995, there were only 2 known populations in southeast Texas, one in Hardin County (the type locality) and another from Tyler County. Since then, 17 populations were observed in Hardin, Polk, and Tyler counties, however, these are considered extirpated. The USFWS Recovery Plan (1995) provides a definition of a “population” and a “plant”. Based on this definition, the USFWS recognizes that there are 7 known extant populations in Hardin, Polk, and Tyler counties that include: 1) Sunflower road (Element of Occurrence (EO) 17) and Big Thicket National Preserve (BTNP), Big Sandy Creek reintroduction; 2) Farm-to-Market 1276 right-of-way (EO 21); 3) Campbell Units (EO 22 and 23); 4) The Nature Conservancy, Roy E. Larsen Sandylands Sanctuary (EOs 3, 5, 13); 5) Resource Management Services (EO 9); 6) Hancock Timber (introduced); and 7) BTNP, Turkey Creek reintroduction. Land ownership includes private, public, and state lands. (USFWS, 2018)

Threats and Stressors

Stressor: Habitat loss (USFWS, 1994)

Exposure:

Response:

Consequence:

Narrative: Habitat loss has been caused by housing development; land—clearing and site preparation for pine plantations and pasture; encroachment of a closed canopy forest onto formerly open forest or savanna due to fire suppression; exposure to herbicides; and activities associated with pipeline, powerline, railroad, and highway construction. (USFWS, 1994)

Stressor: Human activities (USFWS, 1994; NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: Factors adversely affecting the habitat of Texas trailing phlox, combined with other potentially adverse activities such as off-road vehicle use, illegal dumping, burning of debris, and commercial take of plants, may continue to restrict the species to critically low population levels. Current threats include continued habitat loss due to canopy closure/encroachment of hardwood trees and soil disturbances associated with human activities. (USFWS, 1994; NatureServe, 2015)

Stressor: Clearcuts (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: Much of this taxon's habitat had been clearcut and converted to slash-pine plantations, urbanized, and/or altered by fire suppression. (NatureServe, 2015)

Recovery

Reclassification Criteria:

1. At least 12 self-sustaining populations, distributed across the known geographic range of Hardin, Polk, and Tyler counties, Texas, are established. There should be at least three populations located in each county in order to provide adequate representation. The remaining three populations can be distributed in any fashion among the available habitat across the

geographic range. A population will be considered self-sustaining if it reaches and maintains a population number of at least 600 reproductive individual plants. A population is considered a group of plants separated by a distance of at least 2 kilometers (km) (1.2 miles (mi)) from any other Texas trailing phlox plants, as to promote healthy populations of pollinators and the exchange of genetic material. A “plant” is defined as a cluster of Texas trailing phlox stems with no above-ground connection to other groups of stems, and separated by a distance of at least 5 decimeters (dm) (1.6 feet (ft)). Habitat will be of sufficient quality as defined by Maxey and Warnock (1996), that it promotes the success of Texas trailing phlox. The numbers of plants and populations must be verified through adequate monitoring. Populations can include both natural and ex-situ (introduction and reintroduction) efforts. To be considered under this criterion, the habitats of Texas trailing phlox must be managed in a manner that promotes the continued survival of the subspecies. Management can include, but is not limited to, prescribed burning and/or restoration of longleaf pine habitat. (USFWS, 2019)

2. Sufficient, documented protection measures and management plans have been established for these 12 self-sustaining populations. Long-term, binding agreements that aim to conserve and protect the subspecies, and its habitat, are preferred. Private lands should be a priority focus for these agreements; however, protected areas can and should include lands owned by federal, state, or local government agencies. (USFWS, 2019)

Delisting Criteria:

1. To secure redundancy of the subspecies into the foreseeable future, we conclude that more populations would be needed for delisting. Therefore, at least 15 populations distributed across the known geographic range of Hardin, Polk, and Tyler counties, Texas, have been established. At least four populations should be located in each of the counties in order to provide representation of the potential genetic and ecological diversity of the subspecies. The remaining three populations can be distributed in any fashion among the available habitat within the range. A population will be considered self-sustaining if it reaches and maintains a population number of at least 600 reproductive individual plants. Ex-situ efforts should be focused within the known geographic range unless habitat suitability mapping proves otherwise. Habitat will be of sufficient quality, as defined by Maxey and Warnock (1996), that it promotes the success of Texas trailing phlox. (USFWS, 2019)

2. Monitoring efforts indicate that the MVP level of 600 reproductive plants at each population has remained stable or has increased over a monitoring time period of 30 years. Monitoring must be routine in order to gauge subspecies’ viability. Site-specific management plans should be aligned with landscape scale strategies to attain optimal habitat quality conditions that promotes the Texas trailing phlox. (USFWS, 2019)

Recovery Actions:

- Monitor, protect, and manage existing populations. (USFWS, 1994)
- Locate or establish additional populations of sufficient number to meet downlisting criteria. (USFWS, 1994)
- Obtain biological data necessary to refine downlisting criteria. (USFWS, 1994)
- Characterize suitable habitat of plant and determine the management regime needed to preserve suitable habitat. (USFWS, 1994)
- Determine limiting factors on reproduction. (USFWS, 1994)

- Establish captive populations to protect genetic integrity. (USFWS, 1994)
- 1) Conduct Genetics Investigations: Conduct studies to determine genetic diversity of the Texas trailing phlox. Conduct studies to determine the genetic relatedness between individual plants within a population. Determine relatedness between populations across the species geographic range. Determine the relationship between Texas trailing phlox plants to Phlox oklahomensis, found in Texas, and to Phlox nivalis, found in Louisiana. Use this new genetic information to re-evaluate the criteria used in the Texas trailing phlox Recovery Plan to define a population and an individual plant. (USFWS, 2018)
- 2) Promote Landowner Stewardship and Outreach: Encourage awareness of Texas trailing phlox, its management needs within longleaf pine savanna habitat, and its habitat structure/composition. Develop outreach resources for landowners and land managers. Provide technical support for management, surveys, monitoring, and conservation efforts. Provide financial support for management and/or leverage funds for restoration and recovery efforts. (USFWS, 2018)
- 3) Monitor Extant Populations: Continue to monitor extant populations of Texas trailing phlox to assess species viability, habitat conditions, and management needs. Continue management on sites and acquire long-term conservation easements, where feasible, or conservation agreements. (USFWS, 2018)
- 4) Survey for New Populations: Develop a habitat suitability map to assist in identifying new parcels of land for surveying, restoration, and ex-situ opportunities. Outreach to new landowners and land managers. Conduct surveys of potential Texas trailing phlox habitat, with landowner permission, throughout species' known geographic range. (USFWS, 2018)
- 5) Revisit Historic Populations: Use herbarium records, field data, and expert input to determine and revisit sites presumed to be extirpated. Coordinate with landowners and land managers to access sites. Educate landowners and land managers about the Texas trailing phlox and its habitat. Conduct surveys of suitable areas with permission. Submit data to TPWD's Texas Natural Diversity Database. (USFWS, 2018)
- 6) Actively Manage Habitat: Develop management plans with landowners and land managers with the primary goal of restoring or maintaining longleaf pine savanna habitat for Texas trailing phlox. Investigate plant response to management practices (prescribed burning, mowing, thinning), conducted in various frequency and intensity schemes. (USFWS, 2018)
- 7) Develop Reintroduction Plan: Develop a Controlled Propagation and Reintroduction Plan (per USFWS policy). Limit reintroduction work to the known geographic range of the species (Hardin, Tyler, Polk counties). Coordinate with the Center for Plant Conservation Institutions' guidelines for augmentation procedures. (USFWS, 2018)
- 8) Conduct Essential Life History Studies: Investigate pollinating species of Texas trailing phlox and promote pollinator conservation. Conduct seed biology (seed maturation, fecundity, seedbank) and seedling studies (longevity of plant, mortality). Encourage collaboration, ingenuity, financial support, and technical support between partners and the USFWS to conduct these studies. (USFWS, 2018)

Conservation Measures and Best Management Practices:

- Conservation measures are not available.

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SPECIES ACCOUNT: *Phyllanthus saffordii* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/02/2015; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Phyllanthus saffordii (NCN), a woody shrub in the Phyllanthaceae family. (USFWS, 2015)

Historical Range

Phyllanthus saffordii (NCN), a woody shrub in the Phyllanthaceae family, is historically known only from the southern part of Guam within the savanna ecosystem. (USFWS, 2015)

Current Range

Currently, *P. saffordii* is known from 4 scattered occurrences on southern Guam, totaling fewer than 1,400 individuals (Gutierrez 2013, in litt.; Gawel et al. 2013, in litt.). (USFWS, 2015)

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (USFWS, 2015)

Habitat Narrative

Adult: *Phyllanthus saffordii* (NCN), a woody shrub in the Phyllanthaceae family, is historically known only from the southern part of Guam within the savanna ecosystem (USFWS, 2015).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Decreasing (USFWS, 2015)

Resiliency:

Low (inferred from USFWS, 2015)

Redundancy:

Low (inferred from USFWS, 2015)

Number of Populations:

4 (USFWS, 2015)

Population Size:

<1,400 (USFWS, 2015)

Population Narrative:

Populations of *P. saffordii*, a single island endemic, are thus decreasing from initial numbers observed on Guam. Currently, *P. saffordii* is known from 4 scattered occurrences on southern Guam, totaling fewer than 1,400 individuals (Gutierrez 2013, in litt.; Gawel et al. 2013, in litt.). (USFWS, 2015)

Threats and Stressors

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: The Service anticipates the effects of climate change will further exacerbate many of these threats in the future. (USFWS, 2015)

Stressor: Urban development (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Other urban development (primarily involving housing development) will further impact the ecosystems that support native species. On Guam, a housing development is proposed for the Sigua highlands, where *Phyllanthus saffordii* is known to occur (Kelman 2013, in litt.). (USFWS, 2015)

Stressor: Habitat disturbance via development, military training, and urbanization (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Development, military training, urbanization (Guam DAWR 2006, p. 69), and the associated destruction or degradation of habitat through loss of forest and savanna areas, disturbance of caves, and dewatering of streams, are serious threats to 13 of the 14 plants including *Phyllanthus saffordii*. (USFWS, 2015)

Stressor: Alien ungulates (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: The presence of alien mammals is considered one of the primary factors underlying the alteration and degradation of native plant communities and habitats on the Mariana Islands. The destruction or degradation of habitat due to nonnative ungulates, including pigs, goats,

cattle, water buffalo, and deer, is currently a threat to 17 of the 23 species addressed in this final rule including *Phyllanthus saffordii*. (USFWS, 2015)

Stressor: Wildfire (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Wildfire is a threat to nine plant species including *Phyllanthus saffordii*, because individuals of these species occur in the savanna ecosystem or the forest ecosystem adjacent to the savanna ecosystem, on southern Guam (i.e., Cetti Watershed area) and on the Rota Sabana, where fires are common (Grimm 2012, in litt.; Gutierrez 2012, in litt.; Gutierrez 2013, in litt.). (USFWS, 2015)

Stressor: Recreational vehicles (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: The savanna areas of Guam are popular for use of recreational vehicles. Damage and destruction caused by these vehicles are a direct threat to the plants *Hedyotis megalantha* and *Phyllanthus saffordii*, listed as endangered species in this final rule. (USFWS, 2015)

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

References

USFWS. 2016. Environmental Conservation Online System (ECOS) – Species Profile. <http://ecos.fws.gov/ecp0/>. Accessed September 2016

USFWS. 2015. Endangered and Threatened Wildlife and Plants

Endangered Status for 16 Species and Threatened Status for 7 Species in Micronesia. Federal Register 80(190): 59424-59497

Endangered Status for 16 Species and Threatened Status for 7 Species in Micronesia. Federal Register 80(190): 59424-59497.

U.S. Fish and Wildlife Service. 2015. Endangered Status for 16 Species and Threatened Status for 7 Species in Micronesia

Final Rule. 80 Federal Register 190, October 1, 2015. Pages 59424-59497.

SPECIES ACCOUNT: *Phyllostegia bracteata* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (Region 1) (USFWS, 2016a)

Physical Description

A climbing perennial herb, somewhat woody toward the base. Inflorescences 10-30 cm long. Flowers 4-6 per verticillaster. Corollas white. (NatureServe, 2015)

Taxonomy

Genus nearly a Hawaiian endemic, with one species in Tahiti, species endemic to Maui. (NatureServe, 2015) A member of the mint family (Lamiaceae) (USFWS, 2016b).

Historical Range

Historically, this species was known from the east Maui mountains at Ukulele, Puu Nianiau, Waikamoi Gulch, Koolau Gap, Kipahulu, Nahiku-Kuhiwa trail, Waihoi Valley, and Manawainui; and from the west Maui mountains at Puu Kukui and Hanakao (HBMP 2010). (USFWS, 2016b)

Current Range

Island of Maui, state of Hawaii. Reported from both East Maui and West Maui. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service designated critical habitat for *Phyllostegia bracteata*.

Critical Habitat Designation

Maui—Lowland Wet—Unit 2, Maui— Lowland Wet—Unit 3, Maui—Lowland Wet—Unit 4, Maui—Lowland Wet— Unit 5, Maui—Lowland Wet—Unit 6, Maui—Lowland Wet—Unit 7, Maui— Lowland Wet—Unit 8, Maui—Montane Wet—Unit 1, Maui—Montane Wet— Unit 2, Maui—Montane Wet—Unit 3, Maui—Montane Wet—Unit 4, Maui— Montane Wet—Unit 5, Maui—Montane Wet—Unit 6, Maui—Montane Wet— Unit 7, Maui—Montane Mesic—Unit 1, Maui—Subalpine—Unit 1, Maui— Subalpine—Unit 2, Maui—Wet Cliff— Unit 1, Maui—Wet Cliff—Unit 2, Maui—Wet Cliff—Unit 3, and Maui—Wet Cliff—Unit 4 constitute critical habitat for *Phyllostegia bracteata* on Maui.

Maui—Lowland Wet—Unit 2 consists of 65 ac (26 ha) of State land at Moomoku, on the northwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. Although Maui—Lowland Wet—Unit 2 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*,

Diplazium molokaiense, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, by the forest birds, the akohekohe (*Palmeria dolei*) and kiwiku (*Pseudonestor xanthophrys*), or by the Newcomb's tree snail (*Newcombia cumingi*), the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 3 consists of 1,247 ac (505 ha) of State land at Honanana Gulch on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. They are occupied by the plants *Bidens conjuncta*, *Cyanea asplenifolia*, and *Pteris lidgatei*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 3 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwiku (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 4 consists of 864 ac (350 ha) of State land at Kahakuloa Valley on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. They are occupied by the plants *Bidens conjuncta* and *Cyanea asplenifolia*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 4 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwiku (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 5 consists of 30 ac (12 ha) of State land at Iao Valley on the eastern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. Although Maui—Lowland Wet—Unit 5 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwiku* (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 6 consists of 136 ac (55 ha) of State land at Honokowai and Waihi valleys on the western slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 6 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwiku* (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 7 consists of 898 ac (364 ha) of State land at Olowalu Valley, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. These units are occupied by the plant *Alectryon macrococcus*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 7 is not currently occupied by the plants *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H.*

arbuscula, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 8 consists of 230 ac (93 ha) of State land at upper Ukumehame Gulch, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. Although Maui—Lowland Wet—Unit 8 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 1 consists of 1,313 ac (531 ha) of State land and 798 ac (323 ha) of privately owned land, at Haiku Uka on the northern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem. These units are occupied by the plants *Cyanea duvalliorum*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *Phyllostegia pilosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 1 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *Cyrtandra ferrispilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haleakalae*, *P. mannii*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, the Service has determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 2 consists of 4,075 ac (1,649 ha) of State land, 9,633 ac (3,898 ha) of privately owned land, and 875 ac (354 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Puukaukanu and upper Waihoi Valley, on the northern and northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem. These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Geranium hanaense*, *G. multiflorum*, and *Wikstroemia villosa*, and by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 2 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea glabra*, *C. maritae*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, and *Schiedea jacobii*, the Service has determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 3 consists of 2,228 ac (902 ha) of federally owned land (Haleakala National Park) in Kipahulu Valley, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem. These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. maritae*, and *Melicope ovalis*, and by the forest bird, *kiwikiu* (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 3 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea duvalliorum*, *C. glabra*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest bird, the *akohekohe* (*Palmeria dolei*), the Service has determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 4 consists of 180 ac (73 ha) of State land and 1,653 ac (669 ha) of federally owned land (Haleakala National Park), in Kaapahu Valley on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem. These units are occupied by the plants *Clermontia*

samuelii, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *Cyrtandra ferripilosa*, and *Huperzia mannii*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 4 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea duvalliorum*, *C. glabra*, *C. mceldowneyi*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 5 consists of 222 ac (90 ha) of State land, and 165 ac (67 ha) of federally owned land (Haleakala National Park), near Kaumakani on the eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem. These units are occupied by the plant *Bidens campylotheca* ssp. *pentamera*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 5 is not currently occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 6 consists of 1,113 ac (451 ha) of State land, and 286 ac (116 ha) of privately owned land, at the summit and surrounding areas on west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem. They are occupied by the plants *Bidens conjuncta*, *Calamagrostis hillebrandii*, *Cyanea kunthiana*, *Geranium hillebrandii*, *Myrsine vaccinioides*, and *Sanicula purpurea*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 6 is not known to be occupied by the plants *Acaena exigua*, *Cyrtandra oxybapha*, *Huperzia mannii*, *Phyllostegia bracteata*, or *Platanthera holochila*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to

be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 7 consists of 80 ac (32 ha) of State land near Hanaula and Pohakea Gulch on the southeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem. They are occupied by the plants *Cyrtandra oxybapha* and *Platanthera holochila*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 7 is not known to be occupied by the plants *Acaena exigua*, *Bidens conjuncta*, *Calamagrostis hillebrandii*, *Cyanea kunthiana*, *Geranium hillebrandii*, *Huperzia mannii*, *Myrsine vaccinioides*, *Phyllostegia bracteata*, or *Sanicula purpurea*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 1 consists of 6,593 ac (2,668 ha) of State land, 707 ac (286 ha) of privately owned land, and 3,672 ac (1,486 ha) of federally owned land (Haleakala National Park), from Kealahou to Puualae, nearly circumscribing the summit of Haleakala on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem. They are occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Asplenium dielerectum*, *A. peruvianum* var. *insulare*, *Clermontia lindseyana*, *Cyanea horrida*, *C. obtusa*, *Cyrtandra ferripilosa*, *C. oxybapha*, *Diplazium molokaiense*, *Geranium arboreum*, *G. multiflorum*, *Huperzia mannii*, *Melicope adscendens*, and *Neraudia sericea*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 1 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Cyanea glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. mceldowneyi*, *Phyllostegia bracteata*, *P. mannii*, *Santalum haleakalae* var. *lanaiense*, *Wikstroemia villosa*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Subalpine—Unit 1 consists of 10,785 ac (4,365 ha) of State land, 1,622 ac (656 ha) of privately owned land, and 3,568 ac (1,444 ha) of federally owned land (Haleakala National Park), from Kanaio north to Puu Nianiau on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the subalpine ecosystem. They are occupied by the

plants *Bidens micrantha* ssp. *kalealaha* and *Geranium arboreum*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Subalpine—Unit 1 is not known to be occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Asplenium peruvianum* var. *insulare*, *Geranium multiflorum*, *Phyllostegia bracteata*, *Schiedea haleakalensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these subalpine species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Subalpine—Unit 2 consists of 50 ac (20 ha) of privately owned land, and 9,836 ac (3,981 ha) of federally owned land (Haleakala National Park), from the summit north to Koolau Gap and east to Kalapawili Ridge on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the subalpine ecosystem. They are occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Geranium multiflorum*, and *Schiedea haleakalensis*, and by the forest bird, the akohekohe (*Palmeria dolei*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Subalpine—Unit 2 is not known to be occupied by the plants *Asplenium peruvianum* var. *insulare*, *Bidens micrantha* ssp. *kalealaha*, *Geranium arboreum*, *Phyllostegia bracteata*, or *Zanthoxylum hawaiiense*, or by the forest bird, the kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these subalpine species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 1 consists of 290 ac (117 ha) of privately owned land along the wall of Keanae Valley on the northern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem. Although Maui—Wet Cliff—Unit 1 is not currently occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *Cyanea horrida*, *Melicope ovalis*, *Phyllostegia bracteata*, *P. haliakalae*, or *Plantago princeps*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 2 consists of 475 ac (192 ha) of State land, 20 ac (8 ha) of privately owned land, and 912 ac (369 ha) of federally owned land (Haleakala National Park), from Kalapawili Ridge along Kipahulu Valley and north to Puuhoolio, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff

ecosystem. They are occupied by the plants *Bidens campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *Melicope ovalis*, *Phyllostegia bracteata*, and *Plantago princeps*. These units also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations.

Maui—Wet Cliff—Unit 3 consists of 5 ac (2 ha) of State land and 433 ac (175 ha) federally owned land (Haleakala National Park) along the south rim of Kipahulu Valley on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem. Although Maui—Wet Cliff—Unit 3 is not currently occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. horrida*, *Melicope ovalis*, *Phyllostegia bracteata*, *P. haliakalae*, or *Plantago princeps*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 4 consists of 184 ac (75 ha) of State land along the north wall of Waihoi Valley, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem. They are occupied by the plant *Bidens campylotheca* ssp. *pentamera* and *B. campylotheca* ssp. *waihoiensis*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 4 is not known to be occupied by the plants *Cyanea copelandii* ssp. *haleakalaensis*, *C. horrida*, *Melicope ovalis*, *Phyllostegia bracteata*, *P. haliakalae*, or *Plantago princeps*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

(i) In units Maui—Lowland Wet—Unit 2, Maui—Lowland Wet—Unit 3, Maui—Lowland Wet—Unit 4, Maui—Lowland Wet—Unit 5, Maui—Lowland Wet—Unit 6, Maui—Lowland Wet—Unit 7, and Maui—Lowland Wet—Unit 8, the physical and biological features of critical habitat are: (A) Elevation: Less than 3,300 ft (1,000 m). (B) Annual precipitation: Greater than 75 in (190 cm). (C) Substrate: Clays; ashbeds; deep, well-drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (F) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

(ii) In units Maui—Montane Wet—Unit 1, Maui—Montane Wet—Unit 2, Maui—Montane Wet—Unit 3, Maui—Montane Wet—Unit 4, Maui—Montane Wet—Unit 5, Maui—Montane Wet—Unit 6, and Maui—Montane Wet—Unit 7, the physical and biological features of critical habitat are: (A) Elevation: 3,300 to 6,500 ft (1,000 to 2,000 m). (B) Annual precipitation: Greater than 75

in (190 cm). (C) Substrate: Well-developed soils, montane bogs. (D) Canopy: Acacia, Charpentiera, Cheirodendron, Metrosideros. (E) Subcanopy: Broussaisia, Cibotium, Eurya, Ilex, Myrsine. (F) Understory: Ferns, Carex, Coprosma, Leptecophylla, Oreobolus, Rhynchospora, Vaccinium.

(iii) In unit Maui—Montane Mesic— Unit 1, the physical and biological features of critical habitat are: (A) Elevation: 3,300 to 6,500 ft (1,000 to 2,000 m). (B) Annual precipitation: 50 to 75 in (130 to 190 cm). (C) Substrate: Deep ash deposits, thin silty loams. (D) Canopy: Acacia, Ilex, Metrosideros, Myrsine, Nestegis, Nothoestrum, Pisonia, Pittosporum, Psychotria, Sophora, Zanthoxylum. (E) Subcanopy: Alyxia, Charpentiera, Coprosma, Dodonaea, Kadua, Labordia, Leptecophylla, Phyllostegia, Vaccinium. (F) Understory: Ferns, Carex, Peperomia.

(iv) In units Maui—Subalpine—Unit 1 and Maui—Subalpine—Unit 2, the physical and biological features of critical habitat are: (A) Elevation: 6,500 to 9,800 ft (2,000 to 3,000 m). (B) Annual precipitation: 15 to 40 in (38 to 100 cm). (C) Substrate: Dry ash; sandy loam; rocky, undeveloped soils; weathered lava. (D) Canopy: Chamaesyce, Chenopodium, Metrosideros, Myoporum, Santalum, Sophora. (E) Subcanopy: Coprosma, Dodonaea, Dubautia, Geranium, Leptecophylla, Vaccinium, Wikstroemia. (F) Understory: Ferns, Bidens, Carex, Deschampsia, Eragrostis, Gahnia, Luzula, Panicum, Pseudognaphalium, Sicyos, Tetramolopium.

(v) In units Maui—Wet Cliff—Unit 1, Maui—Wet Cliff—Unit 2, Maui—Wet Cliff—Unit 3, and Maui—Wet Cliff— Unit 4, the physical and biological features of critical habitat are: (A) Elevation: Unrestricted. (B) Annual precipitation: Greater than 75 in (190 cm). (C) Substrate: Greater than 65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: Broussaisia, Cheirodendron, Leptecophylla, Metrosideros. (F) Understory: Bryophytes, ferns, Coprosma, Dubautia, Kadua, Peperomia.

Special Management Considerations or Protections

The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland, cliffs (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Lowland wet, montane mesic, montane wet, subalpine, and wet cliff ecosystems; disturbance (USFWS, 2016b)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: This species appears to be short-lived, ephemeral, and disturbance-dependent, in the lowland wet, montane mesic, montane wet, subalpine, and wet cliff ecosystems (NTBG 2009h, p.1). (USFWS, 2016b)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Long-term trends are unknown, whereas short-term trends suggest 10-30% (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Population Growth Rate:

Unknown (NatureServe, 2015)

Number of Populations:

1-3 (NatureServe, 2015)

Population Size:

<100 (NatureServe, 2015)

Population Narrative:

Long-term population trends are unknown, whereas short-term trends suggest 10-30%. No more than 100 individuals (Russell 2004). The species was reported several times between 1981 and 2001, at Waihoi Crater Bog, Waikamoi Preserve, Waikamoi flume, and Kipahulu on east Maui, and at Pohakea Gulch on west Maui; however, none of these individuals were extant as of 2009 (PEPP 2009 cited by USFWS 2012). In 2009, one individual was found at Kipahulu on east

Maui, but was not relocated later that same year (NTBG 2009 cited by USFWS 2012). There may be 1 to 3 extant occurrences on Maui. (NatureServe, 2015)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs and cattle), nonnative plants, fire, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Fire can destroy dormant seeds and plants, even in steep and inaccessible areas. Successive fires can remove habitat for native species by altering microclimate conditions favorable to alien plants. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, cattle, and slugs) is considered an ongoing threat to *Phyllostegia bracteata* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor: Small populations (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: *Phyllostegia bracteata* faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). Only one individual of *Phyllostegia bracteata* was known as recently as 2009, but even this single individual was not relocated later in the same year. Botanists continue to search potentially suitable habitat near the last known location for this ephemeral species (USFWS, 2013).

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

References

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Accessed September 2016

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<http://ecos.fws.gov/ecp0/>. Accessed September 2016

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U.S. Fish and Wildlife Service. 2016. Endangered and Threatened Wildlife and Plants

Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species. Final rule. 81 FR 17789 - 18110 (March 30, 2016).

Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species. Federal Register 81(61): 17790-18110

USFWS. 2013. Determination of Endangered Status for 38 Species on Molokai, Lanai, and Maui

Final Rule. 78 Federal Register 102, May 28, 2013. Pages 32014 - 32065.

SPECIES ACCOUNT: *Phyllostegia brevidens* (No common name)

Species Taxonomic and Listing Information

Listing Status: Proposed Endangered; 09/30/2015; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

A scandent (climbing) subshrub (USFWS, 2016)

Taxonomy

In the mint family (Lamiaceae) (USFWS, 2016).

Historical Range

Known historically from the Island of Hawaii. (NatureServe, 2015)

Current Range

No current range. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Habitat Narrative

Adult: This species is found in dry, moist, and wet shrublands. On ridgecrests and steep slopes. (NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

None

Representation:

None

Redundancy:

None

Number of Populations:

0 (NatureServe, 2015)

Population Size:

Unknown (NatureServe, 2015)

Population Narrative:

Currently there are no occurrences and 2 historical occurrences. The population size is unknown. (NatureServe, 2015)

Threats and Stressors

Stressor: Climate change and drought (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: The effects of climate change are likely to further exacerbate the threats identified for *Phyllostegia brevidens* (USFWS, 2016).

Stressor: Habitat destruction and modification (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from feral pigs, nonnative plants, erosion, and landslides. The disturbance of soils by these animals causes erosion and creates fertile seedbeds for nonnative plants, leading to further habitat degradation. Ungulates also trample seedlings. Nonnative plants modify availability of light, alter soil-water regimes, modify nutrient cycling, alter fire regimes, and ultimately convert native dominated plant communities to nonnative plant communities. Erosion and landslides change native plant and animal communities by destabilizing substrates, damaging or destroying individual plants, and altering hydrological patterns. Adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Herbivory and competition (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Herbivory by feral pigs is threat to this species on Maui. Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of

ungulates to eliminate habitat modification and destruction or herbivory by these animals. Herbivory by slugs is a threat to the remaining individual on Maui. Nonnative plants, such as *Clidemia hirta* and *Hedychium gardnerianum*, modify and destroy habitat and outcompete *P. brevidens* on Maui (USFWS, 2016).

Stressor: Small populations (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: The effects resulting from having a reduced number of individuals and occurrences poses a threat to *Phyllostegia brevidens*. This species is considered to be especially vulnerable to extinction due to threats associated with small occurrence size or small number of occurrences because there are only three individuals of *Phyllostegia brevidens* remaining (USFWS, 2016).

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

References

NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Accessed September 2016

USFWS. 2016. Environmental Conservation Online System (ECOS) – Species Profile. <http://ecos.fws.gov/ecp0/>. Accessed September 2016

USFWS. 2016. Endangered Status for 49 Species From the Hawaiian Islands

Final Rule. 81 Federal Register 190, September 30, 2015. Pages 67786 - 67860.

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

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USFWS. 2016. Endangered and Threatened Wildlife and Plants

Endangered Status for 49 Species From the Hawaiian Islands

Final Rule. 81 Federal Register 190, September 30, 2016. Pages 67786 - 67860.

SPECIES ACCOUNT: *Phyllostegia floribunda* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/29/2013; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Erect subshrubs. Stems 3-9 dm long. Flowers on short, leafless, lateral branches 4-7 cm or (rarely) up to 12 cm long. Corollas maroon to red, white at the base. (NatureServe, 2015)

Taxonomy

Genus nearly endemic to Hawaiian Islands, except one species in Tahiti. Species endemic to Island of Hawaii. (NatureServe, 2015) A member of the mint family (Lamiaceae) (USFWS, 2013).

Historical Range

Historically, *P. floribunda* was reported in the lowland wet, montane mesic, and montane wet ecosystems at scattered sites along the slopes of the Kohala Mountains; southeast through Hamakua, Laupahoehoe NAR, Waiakea FR, and Upper Waiakea FR; and southward into Hilo, HVNP, and Puna. One report exists of the species occurring from north Kona and a few occurrences in south Kona (Cuddihy et al. 1982, in litt.; Wagner et al. 2005b—Flora of the Hawaiian Islands database; Perlman et al. 2008, in litt.; HBMP 2010h; Bishop Museum 2011—Herbarium Database) (USFWS, 2013).

Current Range

Found only on the island of Hawaii. Currently, there are 2 occurrences within HVNP, at Kamoama (1 individual) (HBMP 2010h) and near Napau Crater (4 individuals) (Pratt 2005, in litt.; Pratt 2007b, in litt.; HBMP 2010h); 1 occurrence behind the Volcano solid waste transfer station (10 to 50 individuals) (Flynn 1984, in litt.; Perlman and Wood 1993—Hawaii Plant Conservation Maps database; Pratt 2007b, in litt.; HBMP 2010h); 1 occurrence (with an unknown number individuals) in the Wao Kele O Puna NAR (HBMP 2010h); 1 occurrence with 20 individuals in a fenced enclosure in the Upper Waiakea FR (Perry 2012, in litt.); at least 1 occurrence each (with a few individuals each) in the Puu Makaala NAR, Waiakea FR, and TNC's Kona Hema Preserve (PR) (Perry 2006, in litt.; Perlman 2007, in litt.; Giffin 2009, in litt.; PEPP 2008, pp. 106–107; Perlman et al. 2008, in litt.; Pratt 2008a, in litt.; Pratt 2008b, in litt.; Agorastos 2010, in litt.); 2 occurrences (each with an unknown number of individuals) from the South Kona FR; 1 occurrence (one individual) in the Kipahoe NAR; and 1 occurrence (with an unknown number of individuals) in the Lapahoehoe NAR (Moriyasu 2009, in litt.; HBMP 2010h; Agorastos 2010, in litt.) (USFWS, 2013).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: Short-lived (NatureServe, 2015)

Reproduction Narrative

Adult: The species appears to be a very short-lived perennial (Russell 2002). (NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Lowland wet, montane mesic, and montane wet ecosystems (USFWS, 2013)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: Phyllostegia floribunda is found in moist and wet forests on old volcanic substrates. (NatureServe, 2015) Occurs in the lowland wet, montane mesic, and montane wet ecosystems (USFWS, 2013).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Long-term trends are unknown, whereas short-term trends suggest declines of 10-30% (NatureServe, 2015)

Species Trends:

High seedling mortality (USFWS, 2013)

Resiliency:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

12 (USFWS, 2013)

Population Size:

< 100 (USFWS, 2013)

Population Narrative:

Currently, there are 12 known occurrences of *P. floribunda* totaling fewer than 100 individuals. Since 2003, over 400 individuals have been outplanted at HVNP, Waiakea FR, Puu Makaala NAR, Honomalino in TNC's Kona Hema PR, and Kipahoe NAR (Brueggemann 2006, in litt.; HDLNR 2006, p. 38; Tangalin 2006, in litt.; Belfield 2007, in litt.; Pratt 2007b, in litt.; VRPF 2008, in litt.; VRPF 2010, in litt.; Bio 2008, in litt.; Agorastos 2010, in litt.). However, for reasons unknown, approximately 90 percent of the outplantings experience high seedling mortality (Pratt 2007b, in litt.; Van DeMark et al. 2010, pp. 24–43) (USFWS, 2013). Long-term trends are unknown, whereas short-term trends suggest declines of 10-30%. Fewer than 100 plants have been reported in the past 25 years (Hawai'i Biodiversity and Mapping Program 2004). However, there is much potential habitat that is seldom visited by botanists, such that the actual number of extant plants is uncertain (Hawai'i Biodiversity and Mapping Program 2004). Total number of occurrences are 20, of those 3 are extant occurrences found only on the island of Hawaii. Observation records range from 1993-2006. (NatureServe, 2015)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs), nonnative plants, fire, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Fire can destroy dormant seeds and plants, even in steep and inaccessible areas. Successive fires can remove habitat for native species by altering microclimate conditions favorable to alien plants. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs) is considered an ongoing threat to *Phyllostegia floribunda* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor:

Exposure:

Response:

Consequence:

Narrative:**Stressor:****Exposure:****Response:****Consequence:****Narrative:****Stressor:****Exposure:****Response:****Consequence:****Narrative:****Stressor:****Exposure:****Response:****Consequence:****Narrative:****Stressor:****Exposure:****Response:****Consequence:****Narrative:*****Recovery*****Reclassification Criteria:**

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

References

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Final Rule. 78 Federal Register 209, October 29, 2013. Pages 64638 - 64690.

SPECIES ACCOUNT: *Phyllostegia glabra* var. *lanaiensis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/20/1991; Pacific Region (R1) (USFWS, 2016); Proposed Delisting

Physical Description

Phyllostegia glabra var. *lanaiensis* (Wagner et al. 1990, depicts the very similar *Phyllostegia glabra* var. *glabra*) is a robust, erect to decumbent (reclining, with the end ascending), glabrous, perennial herb in the mint family (Lamiaceae). Its leaves are thin, narrow, lance-shaped, 8 to 24 cm (3.2 to 9.5 in) long and 1.6 to 2.5 cm (0.63 to 0.98 in) wide, often red-tinged or with red veins, and toothed at the edges. The flowers are in clusters of 6 to 10 per leaf axil, mostly at the ends of branches. The flowers are white, occasionally tinged with purple, and are variable in size, about 1 to 2.5 cm (0.39 to 0.98 in) long. The fruit consists of four small, fleshy nutlets. (USFWS, 1994)

Taxonomy

Genus nearly endemic to Hawaiian Islands, except one species in Tahiti. Species endemic to Hawaiian Islands, variety endemic to Lanai. Taxonomy *Phyllostegia glabra* var. *lanaiensis* was described as a variety of *Phyllostegia glabra* from specimens collected from Lana'i by Ballieu, Munro, and Mann & Brigham. It differs from var. *glabra* in its longer calyx (10-11 mm or 0.3 in) and narrowly lanceolate leaves (Wagner et al. 1990). (USFWS, 1994; NatureServe, 2015)

Historical Range

Historically known from Lanai. (NatureServe, 2015)

Current Range

No current range. (NatureServe, 2015)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Habitat Narrative

Adult: *Phyllostegia glabra* var. *lanaiensis* has been observed in lowland mesic to wet forest in gulch bottoms and sides, often in quite steep areas, in the same habitat as the endangered *Cyanea macrostegia* subsp. *gibsonii* (also known as *C. gibsonii*) (USFWS 1995). (USFWS, 2012)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Short-term trends suggest declines >30% (NatureServe, 2015)

Resiliency:

None (USFWS, 2012)

Representation:

None (USFWS, 2012)

Redundancy:

None (USFWS, 2012)

Number of Populations:

0 (USFWS, 2012). Likely extinct (USFWS, 2019)

Population Size:

0 (USFWS, 2012)

Adaptability:

Fragility unknown. (NatureServe, 2015)

Population Narrative:

As of 2010, the taxon was last seen in 1914 and no individuals or populations are currently known to exist (USFWS 2010). In their latest annual report, the Plant Extinction Prevention Program (2010) included *Phyllostegia glabra* var. *lanaiensis* on their list of taxa that, after evaluation, are believed to be extinct. However, since the gulches and valleys of Lanaihale are rugged, steep-walled, and only rarely explored by botanists, there may be hope that the taxon still exists (USFWS 1991, 1995). (USFWS, 2012). This taxon was last seen in Maunalei Valley in the 1980s by Hobdy (USFWS 1991). In 2003, designation of critical habitat was considered not prudent in the proposed critical habitat rule for plant species from the island of Lānaʻi because this plant had not been observed in the wild in over 20 years and no viable genetic material was available for recovery efforts (USFWS 2000). Despite repeated surveys of historical and suitable habitat by botanists since 2006, *P. glabra* var. *lanaiensis* has not been found (Plant Extinction Prevention Program (PEPP) 2012, Oppenheimer 2019, in litt.). In 2012, PEPP reported that *P. glabra* var. *lanaiensis* was likely extinct (USFWS, 2019).

Threats and Stressors

Stressor: Axis deer (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Assuming that this taxon remains extant in its known habitat, there are a number of potential threats to its continued survival, including browsing and habitat disturbance by axis deer (Axis axis) (USFWS 1991, 1995). (USFWS, 2012)

Stressor: Invasive plants (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Established ecosystem-altering invasive plant species degradation of habitat - Assuming that this taxon remains extant in its known habitat, ecosystem-altering invasive plant species could potentially threaten its survival (USFWS 1991, 1995). (USFWS, 2012)

Stressor: Small population size (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Last collected in 1914, this species may be extinct in the wild (USFWS 2003; Plant Extinction Prevention Program 2010). (USFWS, 2012)

Stressor: Climate change related loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: We previously reported that effects due to climate change may pose a threat to this species, anticipating an analysis by 2013. The assessment conducted by Fortini et al. (2013) concluded that *P. glabra* is vulnerable to the impacts of climate change, with a vulnerability score of 0.284 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change) (USFWS, 2019).

Recovery

Reclassification Criteria:

1. A total of five to seven populations are documented on Lanai and at least one other island where they now occur or occurred historically. (USFWS, 1994)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1994)

3. Each of these populations must persist at this level for at least 5 consecutive years before downlisting is considered. (USFWS, 1994)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Lanai and at least one other island where they now occur or occurred historically. (USFWS, 1994)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1994)
3. Each population should persist at this level for at least 5 consecutive years before delisting is considered. (USFWS, 1994)

Recovery Actions:

- Secure and manage current populations and their habitat. (USFWS, 1994)
- Conduct essential research to the conservation of the species. (USFWS, 1994)
- Expand current populations. (USFWS, 1994)
- Establish new populations as needed to reach recovery objectives. (USFWS, 1994)
- Validate and revise recovery objectives. (USFWS, 1994)
- New management actions:
 - Surveys and inventories — PEPP surveys and monitors rare plant species on Lānaʻi and botanical surveys are conducted on a rotational basis, based on the needs for collections and monitoring. No observations of *P. glabra* var. *lanaiensis* have been reported since the 1980s. By 2012, PEPP determined that this variety was likely extirpated (PEPP 2012). However, botanists were still searching for it on any surveys in or near its last known location and other suitable habitat as recently as January 2019 (Oppenheimer 2019, in litt.).
 - Habitat and natural process management and restoration — The environmental conservation organization Pūlama Lānaʻi has begun to provide conservation benefits for plant and animal species on Lānaʻi. These benefits are demonstrated by the initiation of conservation efforts on the island, the commitment to develop the Lānaʻi Natural Resources Plan (LNRP), and a memorandum of understanding (MOU) between USFWS and Pūlama Lānaʻi (USFWS 2015). Actions covered by the MOU include completion of construction of an ungulate-proof fence at the Lānaʻihale summit area, construction of a tree snail enclosure, establishment of the LNRP planning team and implementation of management actions such as ungulate control, invasive plant control, predator control, fire control, restoration, research and monitoring, and overall improvement of the ecological status of covered species, as detailed in the plan. If *P. glabra* var. *lanaiensis* is rediscovered within a fenced and managed area on Lānaʻi, it may benefit from these management actions. Kaiholena Gulch (the last known location of this taxon) is within Increment 1 of the Lānaʻihale fence (USFWS, 2019).
- Recommendations for future actions: There are instances where rare Hawaiian plants were rediscovered after they were presumed extinct. Should *Phyllostegia glabra* var. *lanaiensis* be rediscovered, we will reassess its status and possibly recommend the following actions be implemented for habitat protection, propagation, and reintroduction.
 - Surveys and inventories — If the variety is rediscovered, survey for additional populations of *Phyllostegia glabra* var. *lanaiensis* in areas of potentially suitable habitat on Lānaʻi.
 - Ungulate monitoring and control — If the variety is rediscovered, construct an ungulate-proof enclosure around the population.
 - Captive propagation for genetic storage and reintroduction — If the variety is rediscovered, collect material for genetic storage.

Climate change adaptation strategy — If the variety is rediscovered, assess the modeled effects of climate change to determine future landscape needed for recovery of the species.

- Alliance and partnership development — If the variety is rediscovered, work with the Lānaʻi landowner and land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management of sites for potential reintroduction (USFWS, 2019).

Conservation Measures and Best Management Practices:

- Conduct a thorough survey of the historical range of the species and any additional potentially suitable habitat on the island of Lanai. (USFWS, 2012)
- If the species is rediscovered, collect material for genetic storage. (USFWS, 2012)
- If the species is rediscovered, construct ungulate-proof fenced exclosures around the newly found population. (USFWS, 2012)
- Work with Hawaii Division of Forestry and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management for sites to reintroduce this species if it is rediscovered. (USFWS, 2012)

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USFWS. 1994. Lanaʻi Plant Cluster Recovery Plan: *Abutilon eremitopetalum*, *Abutilon menziesii*, *Cyanea macrostegia* ssp. *gibsonii*, *Cyrtandra munroi*, *Gahnia lanaiensis*, *Phyllostegia glabra* var. *lanaiensis*, *Santalum freycinetianum* var. *lanaiense*, *Tetramolopium remyi*, and *Viola lanaiensis*. U.S. Fish and Wildlife Service, Portland, OR

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SPECIES ACCOUNT: *Phyllostegia haliakalae* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (R1) (USFWS, 2016)

Physical Description

An apparently suberect perennial herb. Inflorescences short, compact, compound, about 6-8 cm long. Corollas probably white. (NatureServe, 2015)

Taxonomy

Generally recognized Hawaiian endemic species. Wagner (1999, Novon 9: 274) reports discovering an earlier name for this species, *P. haliakalae*, which was misapplied to plants he now recognizes as *P. pilosa* that were in turn formerly included in *P. mollis*. In the Supplement to the Manual of the Flowering Plants of Hawaii (Wagner and Herbst 1999, Wagner et al. 2003), *P. haliakalae* is recognized as distinct and considered to occur on Moloka'i, East Maui, and Lanai. (*P. mollis* occurs on O'ahu). Examination of the type of *P. haliakalae*, "showed it to be the same as *P. imminuta*" (Wagner et al. 2003). (NatureServe, 2015)

Historical Range

Endemic to the islands of Molokai, Lanai, and the eastern portion of the island of Maui in the state of Hawaii. (NatureServe, 2015)

Current Range

No extant occurrences known. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Phyllostegia haliakalae* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 11 detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Phyllostegia haliakalae* includes 11 CHUs in Maui County, Hawaii with detailed unit information. There are also an unknown number of units on Lanai that contain this species (number of units is unknown because detailed unit descriptions for Lanai are not available) (81 FR 17790-18110).

Molokai—Lowland Mesic—Unit 1 (and) Palmeria dolei—Unit 37—Lowland Mesic (and) Pseudonestor xanthophrys—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants Alectryon macrococcus, Ctenitis squamigera, Cyanea dunbariae, C. mannii, C. profuga, Cyperus fauriei, Cyrtandra filipes, Gouania hillebrandii, Labordia triflora, Neraudia sericea, Santalum haleakalae var. lanaiense, Schiedea lydgatei, S. sarmentosa, Silene alexandri, S. lanceolata, Spermodopsis hawaiiensis, and

Zanthoxylum hawaiiense, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Lowland Mesic—Unit 1 is not known to be occupied by *Asplenium dielerectum*, *Bonamia menziesii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea procera*, *C. solanacea*, *Diplazium molokaiense*, *Festuca molokaiensis*, *Flueggea neowawraea*, *Isodendron pyriformis*, *Kadua laxiflora*, *Melicope mucronulata*, *M. munroi*, *M. reflexa*, *Phyllostegia haliakalae*, *P. mannii*, *P. pilosa*, *Sesbania tomentosa*, *Stenogyne bifida*, or *Vigna o-wahuensis*, or the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 1 (and) *Palmeria dolei*—Unit 2—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 2—Lowland Wet This area consists of 6,616 ac (2,677 ha) of State land, 7,425 ac (3,005 ha) of privately owned land, and 2,038 ac (825 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Kipahulu Valley on the northern and eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *waihoiense*, *Clermontia samuelii*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *M. ovalis*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 1 is not known to be occupied by the plants *Clermontia oblongifolia* ssp. *mauiensis*, *C. peleana*, *Mucuna sloanei* var. *persericea*, *Phyllostegia haliakalae*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 1 (and) *Palmeria dolei*—Unit 10—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 10—Montane Wet This area consists of 1,313 ac (531 ha) of State land and 798 ac (323 ha) of privately owned land, at Haiku Uka on the northern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Cyanea duvalliorum*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *Phyllostegia pilosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 1 is not known to be occupied by the plants *Adenophorus periens*,

Asplenium peruvianum var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 11—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 11— Montane Wet This area consists of 4,075 ac (1,649 ha) of State land, 9,633 ac (3,898 ha) of privately owned land, and 875 ac (354 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Puukaukanu and upper Waihoi Valley, on the northern and northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Geranium hanaense*, *G. multiflorum*, and *Wikstroemia villosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 2 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea glabra*, *C. maritae*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, and *Schiedea jacobii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 3 (and) *Palmeria dolei*—Unit 12—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 12— Montane Wet This area consists of 2,228 ac (902 ha) of federally owned land (Haleakala National Park) in Kipahulu Valley, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. maritae*, and *Melicope ovalis*, and by the forest bird, kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 3 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea duvalliorum*, *C. glabra*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*,

Cyrtandra ferripilosa, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest bird, the akohekohe (*Palmeria dolei*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 4 (and) *Palmeria dolei*—Unit 13—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 13— Montane Wet This area consists of 180 ac (73 ha) of State land and 1,653 ac (669 ha) of federally owned land (Haleakala National Park), in Kaapahu Valley on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *Cyrtandra ferripilosa*, and *Huperzia mannii*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 4 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea duvalliorum*, *C. glabra*, *C. mceldowneyi*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 5 (and) *Palmeria dolei*—Unit 14—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 14— Montane Wet This area consists of 222 ac (90 ha) of State land, and 165 ac (67 ha) of federally owned land (Haleakala National Park), near Kaumakani on the eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units area occupied by the plant *Bidens campylotheca* ssp. *pentamera*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 5 is not currently occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu

(*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 1 (and) *Palmeria dolei*—Unit 30—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 30—Wet Cliff This area consists of 290 ac (117 ha) of privately owned land along the wall of Keanae Valley on the northern slopes of east Maui. These units include the mixed hermland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff—Unit 1 is not currently occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *Cyanea horrida*, *Melicope ovalis*, *Phyllostegia bracteata*, *P. haliakalae*, or *Plantago princeps*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 2 (and) *Palmeria dolei*—Unit 31—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 31—Wet Cliff This area consists of 475 ac (192 ha) of State land, 20 ac (8 ha) of privately owned land, and 912 ac (369 ha) of federally owned land (Haleakala National Park), from Kalapawili Ridge along Kipahulu Valley and north to Puuhoolio, on the northeastern slopes of east Maui. These units include the mixed hermland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plants *Bidens campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *Melicope ovalis*, *Phyllostegia bracteata*, and *Plantago princeps*. These units also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 2 is not known to be occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Cyanea horrida*, or *Phyllostegia haliakalae*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 3 (and) *Palmeria dolei*—Unit 32—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 32—Wet Cliff This area consists of 5 ac (2 ha) of State land and 433 ac (175 ha) federally owned land (Haleakala National Park) along the south rim of Kipahulu Valley on east Maui. These units include the mixed hermland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff—Unit 3 is not currently occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. horrida*, *Melicope ovalis*, *Phyllostegia bracteata*, *P. haliakalae*,

or *Plantago princeps*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 4 (and) *Palmeria dolei*—Unit 33—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 33—Wet Cliff This area consists of 184 ac (75 ha) of State land along the north wall of Waihoi Valley, on the northeastern slopes of east Maui. These units include the mixed hermland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plant *Bidens campylotheca* ssp. *pentamera* and *B. campylotheca* ssp. *waihoiensis*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 4 is not known to be occupied by the plants *Cyanea copelandii* ssp. *haleakalaensis*, *C. horrida*, *Melicope ovalis*, *Phyllostegia bracteata*, *P. haliakalae*, or *Plantago princeps*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Phyllostegia haliakalae* critical habitat consists of five components. Lowland mesic (Molokai), Lowland wet (east Maui), Montane wet (east Maui), Dry cliff (Lanai) and Wet cliff (east Maui and Lanai) (81 FR 17790-18110):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Ecosystem: Dry Cliff. Elevation: unrestricted. Annual precipitation: <75 in (<190 cm). Substrate: >65 degree slope, rocky talus. Canopy: None. Subcanopy: *Antidesma*, *Chamaesyce*, *Diospyros*, *Dodonaea*. Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Schiedea*.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. Understory: *Bryophytes*, *Ferns*, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative

ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland, cliffs (NatureServe, 2015; USFWS, 2016)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 2016)

Habitat Narrative

Adult: *Phyllostegia haliakalae* was last reported from the lowland mesic ecosystem on Molokai in 1928, and from the dry cliff and wet cliff ecosystems on Lanai in the early 1900s (TNC 2007; HBMP 2010). The type specimen was collected by Wawra in 1869 or 1870, in a dry ravine at the foot of Haleakala. An individual was found in flower on the eastern slope of Haleakala, in the wet cliff ecosystem, in 2009. (USFWS, 2016)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Short-term trends indicate declines of >30% (NatureServe, 2015)

Resiliency:

None (USFWS, 2016)

Representation:

None (USFWS, 2016)

Redundancy:

None (USFWS, 2016)

Number of Populations:

0 wild, 100 outplanted (USFWS, 2016)

Population Size:

0 (USFWS, 2016)

Adaptability:

Fragility unknown. (NatureServe, 2015)

Population Narrative:

Short-term population trends indicate declines of >30%. Currently no individuals are known in the wild on Maui, Molokai, or Lanai; however, over 100 individuals have been outplanted (HNP 2012, in litt). (USFWS, 2016)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (cattle), nonnative plants, fire, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Fire can destroy dormant seeds and plants, even in steep and inaccessible areas. Successive fires can remove habitat for native species by altering microclimate conditions favorable to alien plants. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (cattle, and slugs) is considered an ongoing threat to *Phyllostegia haliakalae* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor: Small populations (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: *Phyllostegia haliakalae* faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). The last known wild individual of *Phyllostegia haliakalae* on Maui had died by 2010, although there are outplantings of this species near the location of this individual. Botanists continue to search potentially suitable habitat on Maui for this species. *Phyllostegia haliakalae* has not been relocated on Molokai or Lanai for close to 100 years (USFWS, 2013).

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

References

NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Accessed September 2016

USFWS. 2016. Environmental Conservation Online System (ECOS) – Species Profile. <http://ecos.fws.gov/ecp0/>. Accessed September 2016

U.S. Fish and Wildlife Service. 2016. Endangered and Threatened Wildlife and Plants

Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

Final Rule . 81 FR 17790-18110 (March 30, 2016).

NatureServe. 2015. NatureServe Explorer: an encyclopedia of life [web application]. Accessed September 2016

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species. Federal Register 81(61): 17790-1110

USFWS. 2013. Determination of Endangered Status for 38 Species on Molokai, Lanai, and Maui

Final Rule. 78 Federal Register 102, May 28, 2013. Pages 32014 - 32065.

SPECIES ACCOUNT: *Phyllostegia helleri* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2017)

Physical Description

A weakly erect to sprawling perennial herb. Inflorescences leafy, compound. Corollas white with lavender-tinged lobes. (NatureServe, 2015)

Taxonomy

Genus nearly endemic to Hawaiian Islands, with one species in Tahiti, species endemic to Kauai. (NatureServe, 2015)

Historical Range

Phyllostegia helleri is historically known from mesic and wet forests at Kaholuamanu (State Na Pali-Kona Forest Reserve) and Mt. Kahili (private), on the island of Kauai (Wagner et al. 1999, p. 817). (USFWS, 2014)

Current Range

This species is currently known from fewer than 10 individuals scattered in Wainiha Valley, which lies within the Wainiha Preserve, on the island of Kauai (PEPP 2014, in litt.). (USFWS, 2014)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (USFWS, 2016)

Habitat Vegetation or Surface Water Classification

Adult: Diverse forest (USFWS, 2016)

Dependencies on Specific Environmental Elements

Adult: Lowland wet, montane wet, and wet cliff ecosystems (USFWS, 2016)

Geographic or Habitat Restraints or Barriers

Adult: 2,800 - 4,000 ft. elevation (USFWS, 2016)

Habitat Narrative

Adult: This species occurs on ridges or spurs from 2,800 to 4,000 ft (860 to 1,200 m) in diverse forest on Kauai in the lowland wet, montane wet, and wet cliff ecosystems (Wagner et al. 1999, p. 817; TNCH 2007; HBMP 2010) (USFWS, 2016).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Resiliency:

Very low (inferred from USFWS, 2014)

Redundancy:

Very low (inferred from USFWS, 2014)

Number of Populations:

1 (USFWS, 2016)

Population Size:

4 (USFWS, 2016)

Population Narrative:

Currently, this species is limited to one occurrence of four individuals (PEPP 2014, p. 35; Kishida 2015, in litt.) (USFWS, 2016). *Phyllostegia helleri* Scientific research on specific species in Hawaii is limited because of their rarity and the generally challenging logistics associated with conducting field work in Hawaii (e.g., areas are typically remote, difficult to survey in a comprehensive manner, and the target species are exceptionally uncommon). Therefore, it is likely additional occurrences exist, which have not yet been surveyed. (USFWS, 2014)

Threats and Stressors

Stressor: Foraging and trampling by feral ungulates (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Foraging and trampling of native plants by goats (*Capra hircus*), pigs (*Sus scrofa*), and black-tailed deer (*Odocoileus hemionus*) results in severe erosion of watersheds because these mammals inhabit terrain that is often steep and remote (Cuddihy and Stone 1990, p. 63). They destabilize soils that support native plant communities, bury or damage native plants, and adversely affect water quality due to runoff over exposed soils. They also destroy the seeds and seedlings of native plant species (Cuddihy and Stone 1990, p. 63), which facilitates the conversion of disturbed areas from native to nonnative vegetative communities. (USFWS, 2014)

Stressor: Soil disturbances by pigs (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Disturbance of soils by feral pigs creates fertile seedbeds for nonnative species (Cuddihy and Stone 1990, p. 65). (USFWS, 2014)

Stressor: Nutrient increases by pigs (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Nutrient availability increases as a result of pigs rooting in the nitrogen-poor soils, thus facilitating the establishment of nonnative invasive weeds. Invasive weeds are more adapted to nutrient rich soils than native plants (Cuddihy and Stone 1990, p. 63), and rooting activity creates open areas in forests allowing alien species to completely replace native stands. (USFWS, 2014)

Stressor: Predation by rodents (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Rodents damage plant propagules, seedlings, or native trees, which changes forest composition and structure (Cuddihy and Stone 1990, p. 67). (USFWS, 2014)

Stressor: Predation by non-native insects (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Non-native insects feed on and defoliate native plants which reduces the geographic range of some species (Cuddihy and Stone 1990, p. 71). Nonnative insects also predate native insect pollinators, which can affect the reproductive success of native plant species (Cuddihy and Stone 1990, p. 71). (USFWS, 2014)

Stressor: Changes in nutrient cycling by non-native invertebrates (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Large numbers of non-native invertebrates such as earthworms, ants, slugs, isopods, millipedes, and snails can cause significant changes in nutrient cycling processes resulting in changes to the composition and structure of plant communities (Cuddihy and Stone 1990, p. 73). (USFWS, 2014)

Stressor: Isolation (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Species that are endemic to single islands or small island groups are inherently more vulnerable to extinction than are widespread species because of the increased risk of genetic bottlenecks, random demographic fluctuations, climate change effects, and localized

catastrophes such as hurricanes, drought, rockfalls, landslides, and disease outbreaks (Pimm. 1988, p. 757; Mangel and Tier 1994, p. 607). (USFWS, 2014)

Stressor: Small population size (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: These problems are further magnified when populations are few and restricted to a very small geographic area, and when the number of individuals in each population is very small. Populations with these characteristics face an increased likelihood of stochastic extinction due to changes in demography, the environment, genetics, or other factors (Gilpin and Soule 1986, pp. 2434). (USFWS, 2014)

Stressor: Reduced genetic diversity (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Small, isolated populations often exhibit reduced levels of genetic variability, which diminishes the species capacity to adapt and respond to environmental changes, thereby lessening the probability of long-term persistence (e.g., Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361). (USFWS, 2014)

Stressor: Demographic fluctuations (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: The problems associated with small population size and vulnerability to random demographic fluctuations or natural catastrophes are further magnified by synergistic interactions with other threats (e.g., nonnative plants and animals, drought, or fire). (USFWS, 2014)

Stressor: Climate change (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to the ecosystem that supports this species. Fortini et al. (2013, pp. 1-134) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013, p. 89) concluded that is highly vulnerable to the impacts of climate *Phyllostegia helleri* change. (USFWS, 2014)

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Survey for populations of *Phyllostegia helleri* in areas of potentially suitable habitat. (USFWS, 2014)
- Begin propagation efforts for maintenance of genetic stock. (USFWS, 2014)
- Reintroduce individuals into suitable habitat within historic range that is being managed for additional known threats (e.g., nonnative animals and plants) to this species. (USFWS, 2014)

References

USFWS. 2017. Environmental Conservation Online System (ECOS) – Species Profile.
<http://ecos.fws.gov/ecp0/>. Accessed March 2017

USFWS. 2014. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form. Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii

NatureServe Explorer: an encyclopedia of life [web application]. Accessed September 2016

USFWS. 2016. Endangered and Threatened Wildlife and Plants

Endangered Status for 49 Species From the Hawaiian Islands. Final rule. 81 FR 67786 - 67860 (September 30, 2016).

SPECIES ACCOUNT: *Phyllostegia hirsuta* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

Phyllostegia hirsuta is an erect, short-lived perennial subshrub or liana in the Lamiaceae (mint family). Its hirsute oval-shaped leaves range in length from 14.5 to 30.0 cm (5.7 to 11.8 in) and width from 6.5 to 18.0 cm (2.6 to 7.1 in). The aromatic, two-lipped flowers are found in axillary verticillasters (false whorls) and range in length from 7 to 11 mm (0.3 to 0.4 in). Nutlets are about 2.5 to 3.0 mm (0.1 in) long (Wagner et al. 1999). In Hawaii, there are 27 recognized endemic species of *Phyllostegia*. The ranges for three of these species, *P. mollis*, *P. kaalaensis* and *P. parviflora* ssp. *lydgatei*, overlap with that of *P. hirsuta*; however, hybrids have never been observed (U.S. Army 2003a). *P. hirsuta* is considered to be most closely related to *P. parviflora* (Wagner et al. 1999).

Historical Range

Historically, *Phyllostegia hirsuta* was widely distributed throughout the Waianae and Koolau Mountains on Oahu. In these mountains, the species ranged from the head of Kukuiula Gulch (Pahole) to north Palawai Gulch and most of the entire length of the Koolau Mountains from Pupukea-Kahuku trail to Palolo (HINHP Database 2001).

Current Range

Currently, between 243 and 254 individuals are known to be extant in 19 occurrences at south Halemano (4 individuals), Opaepa (2), Kawai Iki (2), south branch of north Kaukonahua (1), north Kaukonahua and Poamoho (1), Kawainui (2), north Halemano and Punaluu (1), north Mohiaka Gulch (50), Waianae Kai/Haleauau Ridge (20), central Haleauau (20), south Kaukonahua (9), Puu Hapapa (20), leeward Puu Kaua (1), Ekahanui (51), Kaluaa (30), north Huliwai (20 to 30), Makaha/Waianae Kai Ridge (2 to 3), Kaluanui (6), and Kaipapau (1) (K. Kawelo, U.S. Army, pers. comm. 2003; J. Lau, HINHP, pers. comm. 2003).

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Phyllostegia hirsuta* under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Phyllostegia hirsuta* (77 FR 57648-57862). The critical habitat designation includes 32 critical habitat units, which encompass approximately 39,247 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Phyllostegia hirsuta* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Phyllostegia hirsuta* includes 32 critical habitat units, covering four ecosystem types, which encompass approximately 39,247 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7; Oahu—Lowland Wet—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; Oahu—Montane Wet—Unit 1; Oahu—Wet Cliff—Units 1, 2, 3, 4, 5, 6, 7, 8

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

Oahu—Lowland Wet—Unit 1 [541 ac (219 ha)]. This area consists of 428 ac (173 ha) of State land and 112 ac (46 ha) of City and County of Honolulu land in the lowland wet ecosystem on the windward side of the Waianae Mountains, and partially within the Mokuleia and Waianae Kai Forest Reserves. Oahu—Lowland Wet—Unit 2 [20 ac (8 ha)]. This area consists of 19 ac (8 ha) of State land in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puuhapapa. Oahu—Lowland Wet—Unit 3 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puukanehoa. Oahu—Lowland Wet—Unit 4 [27 ac (11 ha)]. This area consists of 27 ac (11 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains on State land at Puukaua. Oahu—Lowland Wet—Unit 5 [74 ac (30 ha)]. This area consists of 74 ac (30 ha) of State land in the lowland wet ecosystem, on the windward side of the Waianae Mountains at Palikea. Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Waialele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Hauula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the

Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waiee, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet—Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet—Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu—Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamo Ridge.

Oahu—Montane Wet—Unit 1 [370 ac (150 ha)]. This area consists of 18 ac (7 ha) of City and County of Honolulu land, 352 ac (142 ha) of State land, and less than 1 ac (less than one ha) of privately-owned land in the montane wet ecosystem at the summit of the Waianae Mountains at Kaala, and partially within the Mokuleia Forest Reserve and the Kaala Natural Area Reserve.

Oahu—Wet Cliff—Unit 1 [235 ac (95 ha)]. This area consists of 167 ac (68 ha) of State land, 68 ac (28 ha) of City and County of Honolulu land, and less than 1 ac (less than 1 ha) of privately owned land in the wet cliff ecosystem in the Waianae Mountains, near the summit of Kaala, and partially within the Mokuleia and Waianae Kai FRs and the Kaala Natural Area Reserve. Oahu—Wet Cliff—Unit 2 [3 ac (1 ha)]. This area consists of 3 ac (1 ha) of State land in the wet cliff ecosystem in the Waianae Mountains at Puuhapapa, within a small area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Oahu—Wet Cliff—Unit 3 [16 ac (6 ha)]. This area consists of 16 ac (6 ha) in the wet cliff ecosystem on State land in the Waianae Mountains at Puukanehoa, partially within an area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Oahu—Wet Cliff—Unit 4 [23 ac (9 ha)]. This area consists of 23 ac (9 ha) in the wet cliff ecosystem on State land in the Waianae Mountains at Puukaua, partially overlapping an area

that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and recently acquired by the State. Oahu—Wet Cliff—Unit 5 [31 ac (13 ha)]. This area consists of 31 ac (13 ha) of State land in the wet cliff ecosystem in the Waianae Mountains, at Palikea and north of Palikea. Oahu—Wet Cliff—Unit 6 [151 ac (61 ha)]. This area consists of 151 ac (61 ha) in the wet cliff ecosystem on State land on the windward side of the Koolau Mountains in Kaipapau Gulch, entirely within the Kaipapau Forest Reserve. Oahu—Wet Cliff—Unit 7 [144 ac (58 ha)]. This area consists of 144 ac (58 ha) in the wet cliff ecosystem in State land on the windward side of the Koolau Mountains in Hauula Gulch, entirely within the Hauula Forest Reserve. Oahu—Wet Cliff—Unit 8 [4,649 ac (1,881 ha)]. This area consists of 1,479 ac (598 ha) of State land, 1,281 ac (519 ha) of City and County of Honolulu land, 5 ac (2 ha) of Federal land, and 1,884 ac (762 ha) of privately owned land, in the wet cliff ecosystem along the summit of the Koolau Mountains, overlapping portions of Sacred Falls State Park, the Waiahole FR (Waiahole and Iolekaa sections), the Kaneohe and Honolulu Watershed FRs, and the Nuuanu Pali State Wayside.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Phyllostegia hirsuta* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Phyllostegia hirsuta* occurs within the Lowland mesic, Lowland wet, Montane wet and Wet cliff ecosystems and the Lowland mesic, Lowland wet and Wet cliff ecosystems in the Koolau Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Oahu—Lowland Wet—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (F) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Oahu—Montane Wet—Unit 1. (A) Elevation: 3,300–6,600 ft (1,000-2,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Well-developed soils, montane bogs. (D) Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. (E) Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. (F) Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Oahu—Wet Cliff—Units 1, 2, 3, 4, 5, 6, 7, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: >65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. (F) Understory: Bryophytes, Ferns, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Phyllostegia hirsuta* to avoid further degradation or destruction of the

habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Wild specimens have been observed in flower in February and in fruit in June (K. Kawelo, U.S. Army, pers. comm. 2003) with cultivated material blooming in July. Additional information on reproductive cycles, longevity, pollinators, or limiting factors is limited. *P. hirsuta* is considered to be a shortlived perennial species (Service 1998a).

Habitat Type

Adult: Mesic or wet forests

Habitat Narrative

Adult: *Phyllostegia hirsuta* is typically found on steep, shaded slopes, cliffs, ridges, gullies, and stream banks in mesic or wet forests dominated by *Metrosideros polymorpha* or a mixture of *Metrosideros polymorpha* and *Dicranopteris linearis*. It occurs at elevations that range between 195 and 1,202 m (640 and 3,943 ft). Associated native plant species include *Antidesma platyphyllum*, *Astelia* spp., *Broussaisia arguta*, *Chamaesyce multiformis*, *Cibotium* spp., *Claoxylon sandwicense*, *Clermontia kakeana*, *Coprosma longifolia*, *Cyanea membranacea*, *Cyrtandra waianaeensis*, *Diplazium sandwichianum*, *Dryopteris unidentata*, *Dubautia laxa*, *Dubautia sherffiana*, *Elaeocarpus bifidus*, *Freycinetia arborea*, *Hedyotis schlechtendahlana*, *Hedyotis terminalis*, *Hibiscus* spp., *Ilex anomala*, *Labordia kaalae*, *Liparis hawaiiensis*, *Lysimachia hillebrandii*, *Machaerina angustifolia*, *Melicope* spp., *Myrsine lessertiana*, *Myrsine sandwicensis*, *Neraudia* spp., *Nothocestrum* spp., *Perottetia sandwicensis*, *Phyllostegia grandiflora*, *Pipturus* spp., *Pisonia* spp., *Pleomele* spp., *Pouteria sandwicensis*, *Psychotria* spp., *Rumex albescens*, *Scaevola gaudichaudiana*, *Streblus pendulinus*, *Zanthoxylum kauaense*, and several fern species (HINHP Database 2001; Service 1998a; 61 FR 53089).

Dispersal/Migration

Population Information and Trends

Number of Populations:

19

Population Size:

~ 234 - 254

Population Narrative:

Currently, between 243 and 254 individuals are known to be extant in 19 occurrences at south Halemano (4 individuals), Opaepa (2), Kawai Iki (2), south branch of north Kaukonahua (1), north Kaukonahua and Poamoho (1), Kawainui (2), north Halemano and Punaluu (1), north Mohiaka Gulch (50), Waianae Kai/Haleauau Ridge (20), central Haleauau (20), south Kaukonahua (9), Puu Hapapa (20), leeward Puu Kaua (1), Ekahanui (51), Kaluaa (30), north Huliwai (20 to 30), Makaha/Waianae Kai Ridge (2 to 3), Kaluanui (6), and Kaipapau (1) (K. Kawelo, U.S. Army, pers. comm. 2003; J. Lau, HINHP, pers. comm. 2003).

Threats and Stressors

Stressor:

Exposure:

Response:

Consequence:

Narrative: The primary threats to *Phyllostegia hirsuta* include potential adverse effects of continued and future Army training activities, habitat degradation and/or destruction by feral pigs and goats, predation by rats, and competition from non-native plant species (e.g., *Adiantum raddianum*, *Athyrium* spp., *Axonopus fissifolius*, *Blechnum appendiculatum*, *Buddleia asiatica*, *Clidemia hirta*, *Drymaria cordata*, *Lantana camara*, *Melinis minutiflora*, *Passiflora suberosa*, *Paspalum conjugatum*, *Physalis peruviana*, *Pimenta dioica*, *Psidium cattleianum*, *Rubus argutus*, *Rubus rosifolius*, and *Schinus terebinthifolius*) (HINHP Database 2001).

Recovery

Conservation Measures and Best Management Practices:

- A State-wide management plan should be developed and implemented for the long-term conservation of all known occurrences of *Phyllostegia hirsuta*. This plan should also include broader landscape actions that are needed for the recovery of this plant throughout its range. The recovery plan for this species identifies the following important conservation actions. Conservation actions should include the construction of exclosures to protect the known occurrences from feral pigs and goats, subsequent control and/or removal of ungulates and rats, along with competitive non-native plant species. Priority for all of these actions should be given to those occurrences with only a few individuals (e.g., south branch of north Kaukonahua, leeward Puu Kaua, Kaipapau). Additional surveys are also needed throughout suitable habitat to locate new occurrences and update the status of those occurrences that have not been seen in recent years (Service 1998a). On-going Conservation Actions: One accession of seeds was made from State lands in the Koolau Mountains in 1997. This collection resulted in 70 individual plants which flowered at Hawaii's Division of Forestry and Wildlife Pahole Rare Plant Facility (Service 1998a). Both Lyon Arboretum and National Tropical Botanical Garden have *Phyllostegia hirsuta* as seed or cuttings for genetic storage. Lyon Arboretum has material from two collections from the island of Oahu, while National Tropical Botanical Garden has approximately 485 seeds from two separate collections (Service 2002). The Service is currently not aware of any other conservation efforts for this species.

References

USFWS 2016. Status of the Species and Critical Habitat: *Phyllostegia hirsuta* (No Common Name). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016.

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

U.S. Fish and Wildlife Service. 2012. Endangered and Threatened Wildlife and Plants

Endangered Status for 23 Species on Oahu and Designation of Critical Habitat for 124 Species. Final Rule. 77 FR 57648-57862 (September 18, 2012)

SPECIES ACCOUNT: *Phyllostegia hispida* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/17/2009; Pacific Region (R1) (USFWS, 2016)

Physical Description

A diffuse perennial vine with many-branched stems, often forming large tangled masses. Inflorescences unbranched, leafy, ca. 5 - 20 cm long. Corollas are white (NatureServe, 2015).

Taxonomy

A member of the mint family (Lamiaceae) (USFWS, 2016). The genus is nearly endemic to the Hawaiian Islands, with one species in Tahiti, this species is endemic to Molokai (NatureServe, 2015).

Historical Range

Endemic to the eastern portion of the island of Molokai in the Hawaiian islands (NatureServe, 2015). Historically, this species also occurred in the lowland wet ecosystem (TNC 2007; HBMP 2010) on Molokai (USFWS, 2016).

Current Range

Phyllostegia hispida currently occurs entirely on public lands or lands that are managed by the State of Hawai'i's Department of Land and Natural Resources, Division of Forestry and Wildlife, Natural Area Reserve System in Pu'u Ali'i, and The Nature Conservancy's Kamakou and Pelekunu Preserves (USFWS, 2013).

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Phyllostegia hispida* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes nine detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Phyllostegia hispida* includes nine CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Molokai—Lowland Wet—Unit 1 (and) *Palmeria dolei*—Unit 38—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 38— Lowland Wet This area consists of 2,195 ac (888 ha) of State land, and 754 ac (305 ha) of privately owned land (partly within The Nature Conservancy's Pelekunu Preserve), from Pelekunu Valley to Wailau Valley, in north-central Molokai. These units are occupied by the plant *Cyrtandra filipes*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland

Wet—Unit 1 is not known to be occupied by *Asplenium dielirectum*, *Bidens wiebkei*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Lysimachia maxima*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 2 (and) *Palmeria dolei*—Unit 39—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 39— Lowland Wet This area consists of 1,356 ac (549 ha) of State land and 594 ac (241 ha) of privately owned land, from Kahanui to Pelekunu Valley, in north-central Molokai. These units are occupied by the plant *Lysimachia maxima*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Wet—Unit 2 is not known to be occupied by *Asplenium dielirectum*, *Bidens wiebkei*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Cyrtandra filipes*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 3 consists of 94 ac (38 ha) of State land, and 3,125 ac (1,265 ha) of privately owned land, from Waiahookalo gulch to Moaula stream and Puniuohua, on eastern Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Molokai—Lowland Wet—Unit 3 is not known to be occupied by *Asplenium dielirectum*, *Bidens wiebkei*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Cyrtandra filipes*, *Lysimachia maxima*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 1 (and) *Palmeria dolei*—Unit 40—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 40— Montane Wet This area consists of 1,545 ac (625 ha) of State land, and 1,851 ac (749 ha) of privately owned land, from the headwaters of Waialelia

Stream and above Pelekunu Valley, eastward along the summit area to Mapulehu, in northcentral Molokai. These units are occupied by the plants *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. profuga*, *Phyllostegia hispida*, and *Pteris lidgatei*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Montane Wet—Unit 1 is not known to be occupied by *Adenophorus periens*, *Cyanea procera*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Melicope reflexa*, *Phyllostegia mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 41—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 41—Montane Wet This area consists of 871 ac (353 ha) of State land, and 39 ac (16 ha) of privately owned land, from Honukaupu to Olokui (between Pelekunu and Wailau valleys), in north-central Molokai. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). Although Molokai—Montane Wet—Unit 2 is not known to be occupied by *Adenophorus periens*, *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. procera*, *C. profuga*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Melicope reflexa*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Pteris lidgatei*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 3 consists of 77 ac (31 ha) of State land, and 726 ac (294 ha) of privately owned land, above the east rim of Wailau Valley on eastern Molokai. This unit is occupied by the plant *Melicope reflexa*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Montane Wet—Unit 3 is not known to be occupied by *Adenophorus periens*, *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. procera*, *C. profuga*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Pteris lidgatei*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and

space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Wet Cliff—Unit 1 (and) *Palmeria dolei*—Unit 43—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 43— Wet Cliff This area consists of 1,395 ac (565 ha) of State land, and 212 ac (86 ha) of privately owned land, and encircles the plateau between Pelekunu and Wailau valleys, in north-central Molokai. These units are occupied by the plants *Brighamia rockii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea munroi*, and *Hibiscus arnottianus* ssp. *immaculatus*, and include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Wet Cliff—Unit 1 is not known to be occupied by *Cyanea grimesiana* ssp. *grimesiana*, *Hesperomannia arborescens*, *Phyllostegia hispida*, *Pteris lidgatei*, or *Stenogyne bifida*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Wet Cliff—Unit 2 (and) *Palmeria dolei*—Unit 44—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 44— Wet Cliff This area consists of 462 ac (187 ha) of State land, and 806 ac (326 ha) of privately owned land (partly within The Nature Conservancy's Pelekunu Preserve), along the rim of Pelekunu Valley from Kipapa Ridge to Mapulehu, in central Molokai. These units are occupied by the plants *Clermontia oblongifolia* ssp. *brevipes* and *Phyllostegia hispida*, and include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Wet Cliff—Unit 2 is not known to be occupied by *Brighamia rockii*, *Canavalia molokaiensis*, *Cyanea grimesiana* ssp. *grimesiana*, *C. munroi*, *Hesperomannia arborescens*, *Hibiscus arnottianus* ssp. *immaculatus*, *Pteris lidgatei*, or *Stenogyne bifida*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Wet Cliff—Unit 3 consists of 1,137 ac (460 ha) of State land, and 225 ac (91 ha) of privately owned land, along the rim of Wailau Valley from Mapulehu to Kahiwa Gulch, in eastern Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Molokai—Wet Cliff—Unit 3 is not known to be occupied by *Brighamia rockii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea grimesiana* ssp. *grimesiana*, *C. munroi*, *Hesperomannia arborescens*, *Hibiscus arnottianus* ssp. *immaculatus*, *Phyllostegia hispida*, *Pteris lidgatei*, or *Stenogyne bifida*, we have determined

this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Phyllostegia hispida* critical habitat consists of three components. Lowland wet (Molokai), Montane wet (Molokai) and Wet cliff (Molokai)(81 FR 17790-18110):

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. Understory: Bryophytes, Ferns, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua*

coriacea, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkii*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C.*

maritae, C. mceldowneyi, C. profuga, C. solanacea, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Dubautia plantaginea ssp. humilis, Geranium hanaense, G. multiflorum, Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (inferred from USFWS, 2013)

Lifespan

Adult: < 10 years (USFWS, 2016)

Key Resources Needed for Breeding

Adult: Insects, based on genus (USFWS, 2013)

Reproduction Narrative

Adult: It is a short-lived perennial (USFWS, 2016). The fragrant flowers of Phyllostegia species are generally associated with insect pollination. Phyllostegia hispida has been observed in fruit during April to June (H. Oppenheimer, Plant Extinction Prevention Program, pers. comm. 2008a) (USFWS, 2013).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Montane wet ohia forest, wet cliff ecosystem (USFWS, 2016; USFWS, 2013; NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Natural disturbance (USFWS, 2013)

Geographic or Habitat Restraints or Barriers

Adult: 3,650 - 4,200 ft. elevation (USFWS, 2013)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits wet forests. The environmental specificity is unknown (NatureServe, 2015). It occurs in the montane wet and wet cliff ecosystems (USFWS, 2016). Phyllostegia hispida is typically found in wet Metrosideros polymorpha ('ohi'a)-dominated forest, occurring between 1,112 and 1,280 meters (3,650 and 4,200 feet) elevation. It appears that Phyllostegia hispida is

dependent on habitat that has been disturbed, such as landslides and riparian corridors. *Phyllostegia hispida* is also known to colonize windthrow areas, which are areas where trees have been uprooted or overthrown by wind (H. Oppenheimer, pers. comm. 2009) (USFWS, 2013).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Presumed extinct in the wild until rediscovery in 1998 and 2005 (USFWS, 2016)

Resiliency:

Very low (inferred from NatureServe, 2015; see historic range/distribution)

Redundancy:

Low (inferred from USFWS, 2016)

Number of Populations:

4 (USFWS, 2016)

Population Size:

<10 (USFWS, 2018)

Population Narrative:

Until an individual was rediscovered in 1996, *P. hispida* was thought to be extinct in the wild. This individual died in 1998, and *P. hispida* was thought to be extirpated, until another plant was found in 2005. Currently *P. hispida* is known from 4 occurrences totaling 25 individuals (USFWS, 2016). In 2015, two individuals were found at Kawela and one individual was found at Hanalilolilo, and in 2016, three individuals were discovered at Pu'uuli'i (PEPP 2015, 2016) (USFWS, 2018).

Threats and Stressors

Stressor: Feral pigs (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Feral pigs contribute to the modification and degradation of habitat. They do so by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil. Feral pigs are also a major vector for the dispersal of invasive, nonnative plant species (USFWS 2008a; 2013).

Stressor: Small population size/stochastic events (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: In the case of *Phyllostegia hispida*, the entire population of the species is small and restricted to a highly localized geographic area. This renders it highly vulnerable to the risk of extinction in the wild due to the lack of redundancy in populations. These consequences of small population size (e.g., insufficient natural reproduction, loss of genetic diversity), in conjunction with the risk of losing the entire population in the wild due to factors such as localized events (e.g., hurricanes), render the species highly vulnerable to extinction at any time. Although some species are naturally rare, the poor survivorship of *P. hispida* suggests that the requisite biological or ecological needs of the species are not being met under current conditions. The shortage of reproductive individuals and age-structure of the population toward young plants pose a significant threat to the species. Recruitment and the consequences of small population size may not be sufficient to offset mortality in the population (USFWS 2009) (USFWS, 2013).

Stressor: Invasive plants (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: Introduced plant species compete with native plants for water, light, and nutrients. They may modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community. The most common introduced plant species impacting *Phyllostegia hispida* are *Axonopus fissifolius* (narrow-leaved carpetgrass), *Clidemia hirta* (Koster's curse), *Erechtites valerianifolia* (fireweed), *Juncus effusus* (Japanese mat rush), *Rubus rosifolius* (thimbleberry), *Sacciolepis indica* (Glenwood grass) (USFWS 2008), *Phytolacca octandra* (Southern pokeberry), *Rubus argutus* (blackberry), and *Tibouchina herbacea* (cane tibouchina) (H. Oppenheimer, pers. comm. 2011a, Plant Extinction Prevention Program 2009) (USFWS, 2013).

Stressor: Predation (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: Predation or herbivory by rats and nonnative slugs is a threat to this species. Rats (*Rattus* sp.) have been noted as a threat to *Phyllostegia hispida* at the Kamakou Preserve (Plant Extinction Prevention Program 2009, 2010, 2011). There are three species of introduced rats in the Hawaiian Islands, the Polynesian rat (*Rattus exulans*), the black rat (*R. rattus*), and the Norway rat (*R. norvegicus*). Rats impact native plants by eating fleshy fruits, seeds, flowers, stems, leaves, roots, and other plant parts (Atkinson and Atkinson 2000), and can seriously affect regeneration. Rats have caused declines or even the total elimination of island plant species (Campbell and Atkinson 1999, cited in Atkinson and Atkinson 2000). In the Hawaiian Islands, rats may consume as much as 90 percent of the seeds produced by some trees, or in some cases prevent the regeneration of forest species completely (Cuddihy and Stone 1990). The direct effect of nonnative slugs on the decline of this species has not been reported. However, slugs pose a threat by feeding primarily on plant seedlings and low-statured herbs (Hanley et al. 1995), by mechanical damage, destruction of plant parts (photosynthetic tissue and reproductive organs), and mortality (Joe 2006, Joe and Daehler 2008). Unidentified native caterpillar species may also be a threat to this species (H. Oppenheimer, pers. comm. 2009). Reintroduced

individuals were dying from unknown causes possibly related to herbivory by unknown species of native caterpillars (H. Oppenheimer, pers. comm. 2009). Native Lepidoptera species often use plants in the genus *Phyllostegia* as host plants (Zimmerman 1958) (USFWS, 2013).

Stressor: Landslides and flooding (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Landslides and flooding adversely impact the habitats of *Phyllostegia hispida* by destabilizing substrates, damaging and destroying individual plants, and altering hydrological patterns. Landslides and flooding result in habitat destruction or modification, and changes to native plant communities. During storms, rain may fall at 76 millimeters (3 inches) per hour or more, and sometimes may reach nearly 1,000 millimeters (40 inches) in 24 hours, causing destructive flash-flooding in streams and narrow gulches (Wagner et al. 1999b; adapted from Price (1983) and Carlquist (1980)) (USFWS, 2013).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: We previously reported that climate change may pose a threat to this species, anticipating an analysis by 2013. The assessment conducted by Fortini et al. (2013) concluded that *Phyllostegia hispida* is vulnerable to the impacts of climate change, with a vulnerability score of 0.586 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions may be needed to conserve this taxon into the future (USFWS, 2018).

Recovery

Reclassification Criteria:

1. A total of at least five viable populations of *Phyllostegia hispida* are documented in suitable habitat on Moloka'i. Each of these populations must be naturally reproducing, stable or increasing in number, and threats must be managed so that a minimum of 300 mature individuals are maintained per population (USFWS, 2013).
2. Habitat around each population must be managed to ensure that it will support the long-term persistence of *Phyllostegia hispida*. To achieve this, each of the five populations identified in Downlisting Criterion 1 must have implemented management and monitoring plans that will identify actions and procedures necessary to ensure that all threats are controlled and populations are stable or increasing (USFWS, 2013).
3. All of the populations that meet Downlisting Criterion 1 above must be fenced and protected from ungulates, with agreements from conservation partners to maintain those protections in perpetuity. The agreements will also include provisions for removal of invasive introduced plants, as appropriate, and adaptive management plans to address habitat degradation by feral pigs and herbivory by caterpillars and other unforeseeable threats. In addition, the agreements will include provisions for maximizing native plant biodiversity in these areas that is appropriate for that particular habitat and location (USFWS, 2013).

Delisting Criteria:

1. A total of at least eight viable populations are documented in suitable habitat on Moloka'i. Each of these populations must be naturally reproducing, stable or increasing in number, and threats must be managed so that a minimum of 300 mature individuals are maintained per population (USFWS, 2013).
2. Habitat around each population must be managed to ensure that it will support the long-term persistence of *Phyllostegia hispida*. To achieve this, each of the eight populations identified in Delisting Criterion 1 must have implemented management and monitoring plans that will identify actions and procedures necessary to ensure that all threats are controlled and populations are stable or increasing (USFWS, 2013).
3. All of the populations that meet Delisting Criterion 1 above must be fenced and protected from ungulates, with agreements from conservation partners to maintain those protections in perpetuity. The agreements will also include provisions for invasive introduced plant removal, as appropriate, and adaptive management plans to address habitat degradation by feral pigs and herbivory by caterpillars and other unforeseeable threats. In addition, the agreements will include provisions for maximizing native plant biodiversity in these areas that is appropriate for that particular habitat and location (USFWS, 2013).

Recovery Actions:

- Validate and revise recovery criteria (USFWS, 2013).
- Protect habitat and control threats (USFWS, 2013).
- Expand existing wild populations through natural recruitment and if needed, augmentation (USFWS, 2013).
- Conduct essential research (USFWS, 2013).
- Develop and implement detailed monitoring plans for all populations (USFWS, 2013).
- Establish new populations as needed to reach recovery objectives (USFWS, 2013).
- New Management Actions:
 - Surveys and inventories—The Plant Extinction Prevention Program (PEPP) surveys for and monitors individuals of *Phyllostegia hispida* on Moloka'i (PEPP 2013, 2014, 2015, 2016, 2017a).
 - Invasive plant monitoring and control—PEPP monitors all known populations on Moloka'i and removes invasive nonnative plants.
 - Captive propagation for genetic storage and reintroduction—
 - o In 2017, Lyon Arboretum reported almost 3,500 containers of propagules in storage of *P. hispida* collected between 2005 and 2016 from at least nine founders. The Lyon Seed Conservation Laboratory reported almost 4,000 seeds in storage from plants at Kawela and Pu'uuli'i collected between 2015 and 2016 (Lyon Arboretum 2017).
 - o The Plant Extinction Prevention Program (PEPP) has collected from 17 founders at three locations at Pu'uuli'i, from one founder from one subpopulation at Kawela, and from one founder at Pelekunu Valley (PEPP 2017b).
 - o PEPP collects seeds, cuttings, and vouchers from all known populations (PEPP 2013, 2014, 2015, 2016, 2017a).
 - o The National Tropical Botanical Garden (NTBG) continues to store almost 2,000 seeds collected from individuals at Pu'uuli'i near Pelekunu Valley rim (NTBG 2017).
 - o Olinda Rare Plant Facility (ORPF) reported propagation of more than 2,000 plants from fruit collected from individuals at Pu'uuli'i, Pēpē'ōpae, and Kawela (ORPF 2017, 2018).
 - Stochastic events—Build resiliency and redundancy—
 - o PEPP has augmented populations or created new sites for reintroduction of *P. hispida* and reintroduced nearly 1,600

- individuals at Pu‘uali‘i, Hanalilolilo, Kawela, and Pēpē‘ōpae (PEPP 2017b). o ORPF reported distribution of over 2,000 propagated plants for reintroduction to Kawela, Pu‘uali‘i, and Pēpē‘ōpae (ORPF 2017, 2018) (USFWS, 2018).
- Recommendations for Future Actions: We are not aware of any new threats or significant new information regarding the species’ biological status since the last 5-year review in 2014. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2018.
 - Population viability and monitoring analysis—Continue to monitor the wild populations of *Phyllostegia hispida* on Moloka‘i.
 - 4 • Ungulate monitoring and control—Fence the outplanted individuals of *P. hispida* in Kamakou Preserve and any remaining unprotected individuals.
 - Invasive plant monitoring and control—Control established ecosystemaltering nonnative invasive plant species within the vicinity of all known individuals.
 - Predator and herbivore monitoring and control—Control slugs and rodents within the vicinity of all known *P. hispida* populations.
 - Captive propagation for genetic storage and reintroduction—
 - o Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range.
 - o Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species’ vulnerability to climate change.
 - Reintroduction and translocation—Continue to augment current wild populations and reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.
 - Other threats control research—Identify unknown invertebrate damaging the fruit and flowers of the remaining wild individuals.
 - Climate change adaptation strategy—Research the suitability of habitat for reintroduction of the species in the future due to the impacts of climate change.
 - Alliance and partnership development—Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2018).

Conservation Measures and Best Management Practices:

- Conservation measures implemented for *Phyllostegia hispida* have included micropropagation (i.e., tissue culture); reintroduction of seedlings and cuttings cultivated from wild individuals; removal, control, and herbicide treatment of invasive introduced plants within occupied habitat; and temporary and permanent fencing to exclude introduced feral ungulates (USFWS, 2013).
- Staff from the Plant Extinction Prevention Program have targeted this species and have purposely conducted surveys, revisited individual plants, and followed up on observations by The Nature Conservancy and Natural Area Reserve System staff specifically for the recovery of *Phyllostegia hispida* (H. Oppenheimer, pers. comm. 2011b) (USFWS, 2013).
- To maintain the genetic variation remaining in the population, the Plant Extinction Prevention Program also attempts to collect genetic material from every wild individual known. All of the known individuals are mapped with a GPS and tagged with a unique identification number (USFWS, 2013).
- As of 2012, The Nature Conservancy of Hawai‘i continues to conduct surveys for ungulates and control pigs within the Kamakou and Pelekunu Preserves (Russell Kallstrom, Information Coordinator, The Nature Conservancy, pers. comm. 2012). In Fiscal Year 2013, The Nature Conservancy plans to begin construction on an estimated 2.4 kilometers (1.5 mile) fence extension from the existing Kamakou Preserve east boundary fence to connect to the existing Nature Conservancy- Pu‘u Ali‘i Natural Area Reserve fence (R. Kallstrom, pers. comm. 2012). This fence will protect approximately 327 hectares (808 acres) of wet forest in Kamakou Preserve to prevent pig ingress, and as a result is expected to protect most of the known populations of *Phyllostegia hispida* within the Preserve (USFWS, 2013).

- In addition to ungulate control, The Natural Conservancy conducts periodic surveys and removal efforts for invasive plant species such as *Rubus argutus* (blackberry) within their Preserves (H. Oppenheimer, pers. comm. 2011b; R. Kallstrom, pers. comm. 2012) (USFWS, 2013).
- Invasive plant species are also controlled by the Moloka'i Invasive Species Committee, which focuses on incipient ecosystem-altering invasive plant species. Aerial surveys for *Miconia calvescens* (miconia), which is not yet known from Moloka'i, are periodically conducted by the Moloka'i Invasive Species Committee in areas where *Phyllostegia hispida* is known to occur (H. Oppenheimer, pers. comm. 2011b) (USFWS, 2013).

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SPECIES ACCOUNT: *Phyllostegia kaalaensis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

Phyllostegia kaalaensis is a short-lived perennial herbaceous plant in the Lamiaceae (mint family). It has long stems extending from the base of the plant with oppositely arranged leaves 5 to 13 cm (2.0 to 5.1 in) long. Inflorescences are borne at the stem tips on stalks with nodes of 3 to 6 white, tubular, slightly fragrant flowers. Each segment of the black, four-segmented fruits contains a single seed surrounded by fleshy pulp (Wagner et al 1999; Makua Implementation Team 2003) (USFWS, 2016).

Current Range

Phyllostegia kaalaensis is endemic to the Waianae Mountains of Oahu, where it has been known only since the 1970s (USFWS, 2016).

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Phyllostegia kaalaensis* under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Phyllostegia kaalaensis* (77 FR 57648-57862). The critical habitat designation includes 11 critical habitat units, which encompass approximately 7,332 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Phyllostegia kaalaensis* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Phyllostegia kaalaensis* includes 11 critical habitat units, covering two ecosystem types, which encompass approximately 7,332 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3; Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the

lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac (105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Phyllostegia kaalaensis* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Phyllostegia kaalaensis* occurs within the indicated the Lowland mesic and Dry cliff ecosystems in the Waianae Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (F) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. (F) Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Phyllostegia kaalaensis* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes,

landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (USFWS, 2016)

Lifespan

Adult: <10 years (USFWS, 2016)

Breeding Season

Adult: Flowering and fruiting occur from January to June (USFWS, 2016).

Reproduction Narrative

Adult: Flowering and fruiting occur from January to June. The flowers are presumably pollinated by moths, and the fleshy black fruits are characteristic of seed dispersal by fruit-eating birds (Makua Implementation Team 2003). The branches of *Phyllostegia kaalaensis* often touch ground and take root to produce a separate plant, and reproduction in this species may be primarily through vegetative means. The longevity of *Phyllostegia kaalaensis* individuals is unknown but is probably less than 10 years as with other perennial herbaceous plants; however, vegetative clones have the potential to live indefinitely (Makua Implementation Team 2003). Other demographic information for *Phyllostegia kaalaensis* in the wild is unknown, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, pollination and seed dispersal in the wild, and specific environmental requirements (USFWS, 2016).

Habitat Type

Adult: Gulch (USFWS, 2016)

Habitat Narrative

Adult: *Phyllostegia kaalaensis* typically was found in mesic to dry-mesic areas in gulch bottoms and upper gulch slopes at elevations of 490 to 760 m (1,610 to 2,500 ft). It occurred most commonly in forests dominated by the native trees *Diospyros sandwicensis* and/or *Sapindus oahuensis*, or in forests containing a mix of several tree species, under forest canopy and in sunny openings (USFWS, 2016). Moist forests on gulch slopes and in gulch bottoms. (NatureServe, 2015).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: The fleshy black fruits are characteristic of seed dispersal by fruit-eating birds (Makua Implementation Team 2003) (USFWS, 2016).

Population Information and Trends

Population Trends:

Unknown

Number of Populations:

1 (USFWS, 2016)

Population Size:

2 individuals (USFWS, 2016)

Population Narrative:

Available survey data indicate that *P. kaalaensis* has been extirpated in the wild since the late 1990s. The causes for its extirpation are unknown. The Waianae Kai population unit, for example, was first discovered in 1993 at about 30 plants, all of which had disappeared by 2004. Currently, there is one existing population unit with only two augmented immature plants located on State land in the Keawapilau to Pahole population unit (Table SB 29) (U.S. Army Garrison 2006c). This population unit is being established at two reintroduction sites using greenhouse-propagated stock, and is far from reaching minimum numerical stabilization criterion (defined as 50 mature, reproducing individuals per population unit). Moreover, these reintroductions have not been very successful, with very low survival rates. Demographic data for this species indicate reproduction in this species is probably primarily through vegetative cloning, as most of the previously known, naturally occurring plants occurred in dense patches far away from any other plants of the species. In addition, cuttings were salvaged from the Keawapilau to Pahole, Palikea Gulch, and Waianae Kai population units and are now being maintained as ex situ living collections. The Keawapilau to Pahole population unit and Palikea Gulch population unit are located within the Makua action area and the Schofield Barracks Military Reservation action area, respectively, where they are at zones of very low risk to training-related wildfire. Thus, *P. kaalaensis* is characterized by one reintroduced population unit containing only two augmented immature individuals (USFWS, 2016).

Threats and Stressors**Stressor:** Trampling (USFWS, 2016)**Exposure:****Response:****Consequence:** Loss of individuals

Narrative: *Phyllostegia kaalaensis* was listed as endangered because of major, ecosystem-level threats to its survival and recovery, which are described in the introduction to the “Status and Environmental Baseline of the Species and Critical Habitat” section, and are tabulated in Appendix E. Outplants of *P. kaalaensis* in rocky gulch slopes and bottoms are vulnerable to trampling damage because of its extensive underground rhizome growth (USFWS, 2016).

Recovery**Delisting Criteria:**

Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1998a). At least 50 mature, reproducing

individuals are needed per population unit to attain stability for short-lived perennials. The Keawapilau to Pahole population unit is only partially fenced. This population unit needs augmentation and reintroduction, and reintroductions are needed in the Makaha and Manuwai population units that represent all available genetic stock. Research is needed to test a variety of outplanting techniques and site characteristics. If indications of inbreeding depression are observed, controlled experiments should be conducted by mixing different stocks. Extirpated sites also should be monitored periodically for regeneration. Reintroductions for establishment of this and other population units cannot proceed until fences are built for the Upper Kapuna, Manuwai, and Makaha Management Units. The Makaha Management Unit and part of the Upper Kapuna Management Unit are scheduled for fence construction in 2007 or shortly thereafter (USFWS, 2016).

Conservation Measures and Best Management Practices:

- Since listing, the Makua Implementation Team (2003) has developed stabilization protocols for *Phyllostegia kaalaensis*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). Only the Pahole portion of the Keawapilau to Pahole population unit is fenced and partially weeded. *Phyllostegia kaalaensis* can be successfully propagated from cuttings. However, this species has the lowest survival rate for any taxon the Army has outplanted so far (maximum 32 percent) (U.S. Army Garrison 2005b). In 2005, *P. kaalaensis* was represented in ex situ collections that included 723 apical and lateral vegetative buds in micropropagation (Harold L. Lyon Arboretum), 104 cuttings in a nursery (Harold L. Lyon Arboretum), and three seedlings in a nursery (Harold L. Lyon Arboretum) (Service 2005b). Very little seed was ever collected and no seed has ever been tested for storage and most storage is with cuttings from now-extinct occurrences in the Keawapilau to Pahole, Palikea Gulch, and Wiaiane Kai population units (U.S. Army Garrison 2005b) (USFWS, 2016).

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SPECIES ACCOUNT: *Phyllostegia knudsenii* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

An erect perennial herb or vine. Flowers are borne on short leafless branches arising in the axils below the lowest leaves (NatureServe, 2015; USFWS, 2003).

Taxonomy

A nonaromatic member of the mint family (Lamiaceae) (USFWS, 2003).

Historical Range

At the time of Federal listing *Phyllostegia knudsenii* was known from one location with one individual in Koaie Canyon, Kauai (USFWS 1996; 2009).

Current Range

Unknown (USFWS, 2009)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Phyllostegia knudsenii* on the island of Kuaai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Phyllostegia knudsenii* includes one unit totaling 735 acres in Kauai County, Hawaii. The unit is Kauai 11—*Phyllostegia knudsenii*—a.

Kauai 11—*Phyllostegia knudsenii*—a This unit is critical habitat for *Phyllostegia knudsenii* and is 297 ha (735 ac) on State land (Alakai Wilderness Preserve). This unit contains portions of Kawaiiki and Kipalau Valleys. This unit provides habitat for three populations of 300 mature, reproducing individuals of the shortlived perennial *Phyllostegia knudsenii* and is currently occupied with 4 to 13 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, *Metrosideros polymorpha* lowland mesic or wet forest. Although the Service does not feel that there is enough habitat designated to reach the recovery goal of 8 to 10 populations, this species is a very narrow endemic and probably never naturally occurred in more than a single or a few populations.

Primary Constituent Elements/Physical or Biological Features

Within this unit, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) *Metrosideros polymorpha* lowland mesic or wet forest containing one or more of the following associated native plant species: *Bobea timonioides*, *Claoxylon sandwicense*, *Cryptocarya mannii*, *Cyrtandra kauaiensis*, *Cyrtandra paludosa*, *Diospyros sandwicensis*, *Elaeocarpus bifidus*, *Ilex anomala*, *Myrsine linearifolia*, *Perrottetia sandwicensis*, *Pittosporum kauaiense*, *Pouteria sandwicensis*, *Pritchardia minor*, *Selaginella arbuscula*, *Tetraplasandra oahuensis*, or *Zanthoxylum dipetalum*; and

(ii) Elevations between 401 and 1,059 m (1,315 and 3,475 ft).

Special Management Considerations or Protections

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species in paragraph (b) of this section and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Vegetative (USFWS, 2009)

Lifespan

Adult: < 10 years (USFWS, 2009)

Breeding Season

Adult: Unknown (USFWS, 2003)

Key Resources Needed for Breeding

Adult: Unknown (USFWS, 2003)

Reproduction Narrative

Adult: The species can grow from runners touching the ground and rooting. It is a short-lived perennial (fewer than ten years) (USFWS, 2009). Its flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown (Service 1998a) (USFWS, 2003).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Mesic to wet lowland ohia forest (USFWS, 2003)

Geographic or Habitat Restraints or Barriers

Adult: 1,309 - 3,475 ft. elevation (USFWS, 2003)

Habitat Narrative

Adult: Inhabits moist forests on gulch slopes (NatureServe, 2015). *Phyllostegia knudsenii* is found in *Metrosideros polymorpha* lowland mesic or wet forest at elevations between 399 and 1,059 m (1,309 and 3,475 ft.) (USFWS, 2003).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Number of Populations:

None currently known (USFWS, 2009)/ Possibly Extinct (USFWS, 2017)

Population Narrative:

Ken Wood (National Tropical Botanical Garden, pers. comm. 2008) confirmed that the population at Koaie Canyon died several years ago and that the population in Kawai Iki has not been relocated since 2001. No plants have been located in recent years but there is more suitable habitat that needs surveying (USFWS, 2009). At the time of the last 5-year review in 2009 there were no known populations or individuals. In 2005, botanists surveyed the last known area of occurrence, but were unable to locate any individuals. In 2011, PEPP added *Phyllostegia knudsenii* to its "PEP-EXTINCT" list. In 2015, *Phyllostegia knudsenii* was assessed as Critically Endangered (Possibly Extinct) on the IUCN Red List of Threatened Species (Clark 2015) (USFWS, 2017).

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The major threats to *Phyllostegia knudsenii* include habitat degradation by feral pigs (*Sus scrofa*) and goats (*Capra hircus*) (USFWS, 2009).

Stressor: Invasive plants (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Competition with introduced invasive plant species such as *Rubus rosifolius* (thimbleberry), *R. argutus* (prickly Florida blackberry), *Paspalum conjugatum* (Hilo grass), *Erigeron karvinskianus* (daisy fleabane), *Erechtites valerianifolia* (fireweed), *Bryophyllum pinnatum* (airplant), *Drymaria cordata* (pipili), *Psidium cattleianum* (strawberry guava), *Passiflora tarminiana* (banana poka), *Gravillea robusta* (silk oak), *Setaria parviflora* (marsh bristlegrass), *Cyperus meyenianus* (Meyen's flatsedge), *Myrica faya* (firetree), and *Lantana camara* (lantana) (Lorence et al. 1995; USFWS 1996, 1998, 2003, 2008; K. Wood, pers. comm. 2008) is a threat to this species (USFWS, 2009).

Stressor: Stochastic events (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: In addition to other threats, species such as *Phyllostegia knudsenii* that are endemic to a small portion of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, reduced reproductive vigor, and disease outbreaks (USFWS, 2009).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Phyllostegia knudsenii* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.941 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this species has no overlap between current and future climate envelopes, and is unlikely to tolerate expected changes in climate at its last known location. This means that this species must persist within suitable microrefugia, or move to newly available climate-compatible areas to avoid extinction. Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery

Reclassification Criteria:

1. A total of five to seven populations should be documented on Kauai and at least one other island where they now occur or occurred historically (USFWS, 1998).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population for short-lived perennials (USFWS, 1998).
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 1998).

Delisting Criteria:

1. A total of eight to ten populations should be documented on Kauai and at least one other island where they now occur or occurred historically (USFWS, 1998).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population for short-lived perennials (USFWS, 1998).
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 1998).

Recovery Actions:

- Protect current populations, control threats and monitor (USFWS, 1998).
- Expand current populations (USFWS, 1998).
- Conduct research essential to conservation of the species (USFWS, 1998).
- Establish new populations as needed to reach recovery objectives (USFWS, 1998).
- Validate and revise recovery objectives (USFWS, 1998).
- Devise and implement a public education program (USFWS, 1998).
- Maintenance of adequate genetic stock (USFWS, 1998).
- Construct enclosure to protect against feral ungulates and control alien plant species (USFWS, 1998).
- Recommendations for Future Actions: No new threats and no other significant new information regarding the species' biological status have been reported since the last 5-year review in 2009. Therefore, the following recommendations for future actions are reiterated for the 5-year review for 2017. • Surveys and inventories—Survey suitable habitat within historic range to locate additional individuals. • Ungulate monitoring and control—Protect all occurrences against browsing and disturbances from feral ungulates. Continue to construct fenced enclosures to protect all known individuals from feral ungulates. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative species that compete with the species around all populations. • Predator and herbivore monitoring and control—Implement effective control methods for rodents. • Captive propagation for genetic storage and reintroduction—Initiate propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Stochastic events—

Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides. • Population biology research—Study *Phyllostegia knudsenii* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Survey suitable habitat within geographical and historical range to locate extant individuals (USFWS, 2009).
- Collect genetic resources from any found individuals for storage, future propagation, and reintroduction into protected suitable habitat within historical range (USFWS, 2009).
- Construct enclosure fences to protect all found individuals from feral pigs, and eradicate introduced invasive plant species within the enclosures (USFWS, 2009).
- Work with Hawaii Division of Forestry and Wildlife to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species in Koaie Canyon (USFWS, 2009).
- Develop methods for propagation and establish ex situ genetic collection (USFWS, 2009).

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SPECIES ACCOUNT: *Phyllostegia mannii* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/08/1992; Pacific Region (R1) (USFWS, 2016)

Physical Description

A perennial sprawling vine with many-branched stems. Flowers are probably white (NatureServe, 2015).

Taxonomy

A member of the mint family (Lamiaceae) (USFWS, 2016). Mann (1868) published the name *Stenogyne parviflora* for a plant he and Brigham collected on Haleakala, Maui. In 1934, Sherff transferred this taxon to the genus *Phyllostegia*; as the name *Phyllostegia parviflora* had previously been used for another species, he selected a new name, *Phyllostegia mannii*, for the taxon (Sherff 1934b). In the same year, Sherff (1934a) published the name *Phyllostegia racemosa* var. *bryanii* for the plants from the island of Molokai. In the current treatment (Wagner et al. 1990), *Phyllostegia mannii* is the name applied to both the Molokai plants and specimens of the apparently extinct Maui plants (USFWS, 1996).

Historical Range

Historically, *P. mannii* occurred in Molokai's lowland mesic and lowland wet ecosystems, and the montane wet and montane mesic ecosystems on east Maui (TNC 2007; Perlman 2009k, in litt.; HBMP 2010; Oppenheimer 2010u, in litt.; Wood 2010c, in litt.) (USFWS, 2016).

Current Range

Currently, it occurs on Molokai in Hanalilolilo (USFWS, 2016).

Critical Habitat Designated

Yes; 5/14/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Phyllostegia mannii* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes nine detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Phyllostegia mannii* includes nine CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Molokai—Lowland Mesic—Unit 1 (and) *Palmeria dolei*—Unit 37—Lowland Mesic (and) *Pseudonestor xanthophrys*—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Ctenitis squamigera*, *Cyanea dunbariae*, *C. mannii*, *C. profuga*, *Cyperus fauriei*, *Cyrtandra filipes*, *Gouania hillebrandii*, *Labordia triflora*, *Neraudia sericea*, *Santalum haleakalae* var. *lanaiense*, *Schiedea lydgatei*, *S. sarmentosa*, *Silene alexandri*, *S. lanceolata*, *Spermolepis hawaiiensis*, and

Zanthoxylum hawaiiense, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Lowland Mesic—Unit 1 is not known to be occupied by *Asplenium dielirectum*, *Bonamia menziesii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea procera*, *C. solanacea*, *Diplazium molokaiense*, *Festuca molokaiensis*, *Flueggea neowawraea*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Melicope mucronulata*, *M. munroi*, *M. reflexa*, *Phyllostegia haliakalae*, *P. mannii*, *P. pilosa*, *Sesbania tomentosa*, *Stenogyne bifida*, or *Vigna o-wahuensis*, or the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 2 (and) *Palmeria dolei*—Unit 39—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 39—Lowland Wet This area consists of 1,356 ac (549 ha) of State land and 594 ac (241 ha) of privately owned land, from Kahanui to Pelekunu Valley, in north-central Molokai. These units are occupied by the plant *Lysimachia maxima*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Lowland Wet—Unit 2 is not known to be occupied by *Asplenium dielirectum*, *Bidens wiebkkei*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Cyrtandra filipes*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 3 consists of 94 ac (38 ha) of State land, and 3,125 ac (1,265 ha) of privately owned land, from Waiahookalo gulch to Moaula stream and Puniuohua, on eastern Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Molokai—Lowland Wet—Unit 3 is not known to be occupied by *Asplenium dielirectum*, *Bidens wiebkkei*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Cyrtandra filipes*, *Lysimachia maxima*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes,

suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 41—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 41— Montane Wet This area consists of 871 ac (353 ha) of State land, and 39 ac (16 ha) of privately owned land, from Honukaupu to Olokui (between Pelekunu and Wailau valleys), in north-central Molokai. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). Although Molokai— Montane Wet—Unit 2 is not known to be occupied by *Adenophorus periens*, *Bidens wiebkiei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. procera*, *C. profuga*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Melicope reflexa*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Pteris lidgatei*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 3 consists of 77 ac (31 ha) of State land, and 726 ac (294 ha) of privately owned land, above the east rim of Wailau Valley on eastern Molokai. This unit is occupied by the plant *Melicope reflexa*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Montane Wet—Unit 3 is not known to be occupied by *Adenophorus periens*, *Bidens wiebkiei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. procera*, *C. profuga*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Pteris lidgatei*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 11—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 11— Montane Wet This area consists of 4,075 ac (1,649 ha) of State land, 9,633 ac (3,898 ha) of privately owned land, and 875 ac (354 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Puukaukanu and upper Waihoi Valley, on the northern and northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Geranium hanaense*, *G. multiflorum*, and *Wikstroemia villosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*).

These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 2 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea glabra*, *C. maritae*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, and *Schiedea jacobii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 3 (and) *Palmeria dolei*—Unit 12—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 12—Montane Wet This area consists of 2,228 ac (902 ha) of federally owned land (Haleakala National Park) in Kipahulu Valley, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. maritae*, and *Melicope ovalis*, and by the forest bird, *kiwiku* (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 3 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea duvalliorum*, *C. glabra*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest bird, the *akohekohe* (*Palmeria dolei*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 5 (and) *Palmeria dolei*—Unit 14—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 14—Montane Wet This area consists of 222 ac (90 ha) of State land, and 165 ac (67 ha) of federally owned land (Haleakala National Park), near Kaumakani on the eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plant *Bidens campylotheca* ssp. *pentamera*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 5 is not currently occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*,

G. multiflorum, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 1 (and) *Palmeria dolei*—Unit 40—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 40— Montane Wet This area consists of 1,545 ac (625 ha) of State land, and 1,851 ac (749 ha) of privately owned land, from the headwaters of Waialelia Stream and above Pelekunu Valley, eastward along the summit area to Mapulehu, in northcentral Molokai. These units are occupied by the plants *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. profuga*, *Phyllostegia hispida*, and *Pteris lidgatei*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Montane Wet—Unit 1 is not known to be occupied by *Adenophorus periens*, *Cyanea procera*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Melicope reflexa*, *Phyllostegia mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Phyllostegia mannii* critical habitat consists of four components. Lowland mesic (Molokai), Lowland wet (Molokai), Montane wet (east Maui and Molokai) and Montane mesic (east Maui) (81 FR 17790-18110):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepidia*.

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*,

Cheirodendron, Metrosideros. Subcanopy: Broussaisia, Cibotium, Eurya, Ilex, Myrsine.
Understory: Ferns, Carex, Coprosma, Leptecophylla, Oreobolus, Rhynchospora, Vaccinium.

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: Acacia, Ilex, Metrosideros, Myrsine, Nestegis, Nothocestrum, Pisonia, Pittosporum, Psychotria, Sophora, Zanthoxylum. Subcanopy: Alyxia, Charpentiera, Coprosma, Dodonaea, Kadua, Labordia, Leptecophylla, Phyllostegia, Vaccinium. Understory: Ferns, Carex, Peperomia.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative

ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Lifespan

Adult: < 10 years (USFWS, 2011)

Breeding Season

Adult: July (USFWS, 1996)

Reproduction Narrative

Adult: It is a short-lived perennial (fewer than 10 years) (USFWS, 2011). This species was observed with fruit in July 1979 (HHP 1990f) (USFWS, 1996).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Wet ohia forest (USFWS, 1996)

Dependencies on Specific Environmental Elements

Adult: Shade (USFWS, 1996)

Geographic or Habitat Restraints or Barriers

Adult: 3,300 - 5,000 ft. elevation (USFWS, 1996)

Habitat Narrative

Adult: Inhabits wet forests on ridges and in gulches (NatureServe, 2015). It grows in shaded sites in sometimes foggy and wind-swept, wet, open, ohia-dominated forests with a native shrub and tree fern (hapuu) understory at 1,010 to 1,525 meters (3,300 to 5,000 feet) in elevation (USFWS 1992; 1996).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Extirpated from Maui (USFWS, 1996)

Species Trends:

Declining (USFWS, 2011; 2016)

Resiliency:

Very low (inferred from USFWS, 2016; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2011)

Number of Populations:

0 (inferred from USFWS, 2018; see current range/distribution)

Population Size:

0 wild (USFWS, 2018)

Population Narrative:

In 1996, four individuals were known from two populations, both in Hanalei. It has not been seen on Maui for over 70 years and is apparently extirpated on that island (USFWS 1992; USFWS 1996). There are 18 outplanted individuals (USFWS, 2011). There are currently three individuals known (USFWS, 2016). New Status Information: • All wild individuals on Moloka'i have died (PEPP 2014). • In 2016, seven critical habitat units in the lowland mesic, lowland wet, and montane wet ecosystems were designated on Moloka'i (21,997 ac, 8903 ha) and six critical habitat units in the montane wet and montane mesic ecosystems were designated on Maui (32,060 ac; 12,996 ha) (81 FR 17790, March 30, 2016) (USFWS, 2018).

Threats and Stressors

Stressor: Habitat modification (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Threats that modify the habitat of *Phyllostegia mannii* include feral goats (*Capra hircus*) and pigs (*Sus scrofa*). Landslides may occur because of erosion caused by feral ungulates (USFWS, 2011). Well known as a major destroyer of these forest habitats, feral pigs root extensively, trample native vegetation cover, and generally degrade native habitat (USFWS 1992). Feral pigs are major disseminators of alien plant seeds by carrying them internally or on their bodies, and they often carry the seeds into more pristine forests, further degrading the native ecosystem. The replacement of native vegetation is attributed to the large number of goats. Due to their agility, goats can reach vegetation not usually accessible to other animals (USFWS 1992). As a result, various native plants are confined to areas inaccessible to goats (USFWS, 1996).

Stressor: Predation (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Rats (*Rattus* sp.) and slugs (unidentified species) apparently feed on this non-aromatic species of the mint family (Perlman 2010; Wood 2010) (USFWS, 2011).

Stressor: Invasive plants (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species such as *Axonopus fissifolius* (narrow leaved carpetgrass), *Erigeron karvinskianus* (daisy fleabane), *Juncus effusus* (Japanese mat rush), and *Rubus rosifolius* (thimbleberry) also degrade the habitat and may inhibit native plant regeneration (Perlman 2010; Wood 2010). Invasive plants are also a threat to *Phyllostegia mannii* because they compete with the species for water, light, and nutrients (USFWS, 2011).

Stressor: Stochastic events (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Species like *Phyllostegia mannii* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding, and disease outbreaks. The extent of these natural processes on this single island endemic are exacerbated by anthropogenic threats, such as habitat loss for human development or predation by introduced species (USFWS 1996; 2011).

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species (USFWS, 2011).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: We previously reported that climate change may pose a threat to this species, anticipating an analysis by 2013. The assessment conducted by Fortini et al. (2013) concluded that *Phyllostegia mannii* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.616 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions may be needed to conserve this taxon into the future (USFWS, 2018).

Recovery

Reclassification Criteria:

1. A total of five to seven populations should be documented on Molokai and at least one other island where they now occur or occurred historically (USFWS, 1996).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1996).
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1996).

Delisting Criteria:

1. A total of 8 to 10 populations should be documented on Molokai and at least 1 other island where they now occur or occurred historically (USFWS, 1996).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1996).

3. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1996).

Recovery Actions:

- Protect habitat and control threats (USFWS, 1996).
- Expand existing wild populations (USFWS, 1996).
- Conduct essential research (USFWS, 1996).
- Develop and implement detailed monitoring plans for all species (USFWS, 1996).
- Establish new populations as needed to reach recovery objectives (USFWS, 1996).
- Validate and revise recovery criteria (USFWS, 1996).
- In order to prevent this species from going extinct, the propagation and maintenance of ex situ genetic stock should be continued, as well as the protection of remaining wild individuals from the effects of pigs (USFWS, 1996).
- New Management Actions:
 - Surveys and inventories—The Plant Extinction Prevention Program (PEPP) continues to survey for individuals of *Phyllostegia mannii* on Moloka'i (PEPP 2017a).
 - Invasive plant monitoring and control—PEPP monitors all outplanted individuals (PEPP 2014).
 - Captive propagation for genetic storage and reintroduction—
 - o In 2017, Lyon Arboretum reported 331 containers of propagules from two founders of *Phyllostegia mannii* in storage. The Lyon Seed Conservation Laboratory reported 466 seeds in storage from one founder (Lyon Arboretum 2017).
 - o The National Tropical Botanical Garden (NTBG) continues to store 18 seeds collected from individuals south of Pu'uuli'i in 2008 (NTBG 2017).
 - Stochastic events—Build resiliency and redundancy—PEPP has reintroduced fewer than five individuals. The condition of the last individual outplanted at Pu'uuli'i is unknown (PEPP 2012, 2015, 2017b) (USFWS, 2018).
- Recommendations for Future Actions: We are not aware of any new threats or significant new information regarding the species' biological status since the last 5-year review in 2011. Thus, the following recommendations for future actions are reiterated for 5-year review for 2018.
 - Surveys and inventories—Continue to survey for additional populations of *Phyllostegia mannii* in areas of potentially suitable habitat on Maui and Moloka'i. Regularly monitor known populations.
 - Ungulate monitoring and control—Fence existing reintroduced plants to provide protection of *P. mannii* from the impacts of feral ungulates.
 - Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations.
 - Predator and herbivore monitoring and control—
 - o Develop and implement effective control methods for slugs.
 - o Control rats in the vicinity of any plants.
 - Captive propagation for genetic storage and reintroduction—Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range.
 - Reintroduction and translocation—Continue propagation and reintroduction of individuals into suitable habitat within historic range that is being managed for known threats to this species.
 - Climate change adaptation strategy—Assess the modeled effects of climate change on this species to determine future landscape needed for recovery of the species.
 - Alliance and partnership development—Continue to work with land managers and The Nature Conservancy to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2018).

Conservation Measures and Best Management Practices:

- Monitor known populations and collect any available seeds for genetic storage and reintroduction (USFWS, 2011).
- Fence existing populations to provide protection from the negative impacts of feral ungulates (USFWS, 2011).
- Control invasive introduced species around known populations (USFWS, 2011).
- Control rats in the vicinity of these populations (USFWS, 2011).
- Develop and implement methods to control slugs (USFWS, 2011).
- Propagate to augment the existing populations (USFWS, 2011).
- Establish additional populations within protected suitable habitat (USFWS, 2011).
- Survey areas where *Phyllostegia mannii* have been reported to determine the current status of the species (USFWS, 2011).
- Work with The Nature Conservancy of Hawaii and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2011).
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2011).

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SPECIES ACCOUNT: *Phyllostegia mollis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/29/1991; Pacific Region (R1) (USFWS, 2016)

Physical Description

Phyllostegia mollis is a herbaceous perennial subshrub in the Lamiaceae (mint family). The leaves, which range in length from 5 to 13 cm (2.0 to 5.1 in), are oppositely arranged on long stems which extend from the base of the plant. Three to six tubular, white, and slightly fragrant flowers are found at the tip of the stems. The fruits, which turn black at maturity, are segmented into four sections, each containing a single seed surrounded by fleshy pulp. There are 27 endemic species of *Phyllostegia* recognized in Hawaii (Wagner et al. 1999). The ranges of three of these species, *P. hirsuta*, *P. kaalaensis* and *P. parviflora* ssp. *lydgatei*, overlap with *P. mollis*; however, hybrids are unknown (U.S. Army 2003a).

Historical Range

Historically, *Phyllostegia mollis* was known from Molokai, Maui, and Oahu from the central and southern Waianae Mountains, Mt. Kaala to Honouliuli, and Makiki in the Koolau Mountains.

Current Range

Currently, this species is only known from Oahu and Maui. On Oahu, 98 to 118 individuals are found in eight occurrences: south Mohiakea Gulch (5 individuals), Mohiakea Gulch (50 to 70), north Palawai (1), central Kaluaa (1), Huliwai Gulch (2), Waieli (7), Pualii Gulch (16), and Ekahanui (16) (J. Lau, HINHP, pers. comm. 2003; K. Kawelo, U.S. Army, pers. comm. 2003). On East Maui, it is known from Waiopai Gulch (Service 1998a).

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Phyllostegia mollis* under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Phyllostegia mollis* (77 FR 57648-57862). The critical habitat designation includes 12 critical habitat units, which encompass approximately 8,512 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Phyllostegia mollis* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Phyllostegia mollis* includes 12 critical habitat units, covering two ecosystem types, which encompass approximately 8,512 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7; Oahu—Lowland Wet—Units 1, 2, 3, 4, 5.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

Oahu—Lowland Wet—Unit 1 [541 ac (219 ha)]. This area consists of 428 ac (173 ha) of State land and 112 ac (46 ha) of City and County of Honolulu land in the lowland wet ecosystem on the windward side of the Waianae Mountains, and partially within the Mokuleia and Waianae Kai Forest Reserves. Oahu—Lowland Wet—Unit 2 [20 ac (8 ha)]. This area consists of 19 ac (8 ha) of State land in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puuhapapa. Oahu—Lowland Wet—Unit 3 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puukanehoa. Oahu—Lowland Wet—Unit 4 [27 ac (11 ha)]. This area consists of 27 ac (11 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains on State land at Puukaua. Oahu—Lowland Wet—Unit 5 [74 ac (30 ha)]. This area consists of 74 ac (30 ha) of State land in the lowland wet ecosystem, on the windward side of the Waianae Mountains at Palikea.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Phyllostegia mollis* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Phyllostegia mollis* occurs within the Lowland mesic and Lowland wet ecosystems in the Waianae Mountain caldera complex and was known historically (last observed > 20 yrs ago) from the Lowland mesic ecosystem in the Koolau Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Oahu—Lowland Wet—Units 1, 2, 3, 4, 5. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. (E) Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. (F) Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Phyllostegia mollis* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: The family is primarily bee pollinated (Proctor and Yeo 1973) (NatureServe, 2015). Flowering in *P. mollis* has been reported from January to June (Nagata 1980) and moths are the presumed pollinators. Due to the presence of fleshy fruits, it is presumed that seeds are dispersed by birds. Branches of *P. mollis* have the ability to root when they touch the ground, with the rooted stems forming separate plants. It is believed that vegetative reproduction may be the primary method of reproduction as most extant individuals of this species are found in dense patches some distance from others in the species, and there are no reports of seedlings or individuals that obviously germinated from seed (U.S. Army 2003a).

Habitat Type

Adult: Wet forest

Habitat Narrative

Adult: *Phyllostegia mollis* typically grows on steep slopes and in gulches as a component of mesic to wet forest at elevations between 519 and 928 m (1,702 and 3,044 ft). Associated native plant species include *Acacia koa*, *Alyxia oliviformis*, *Antidesma platyphyllum*, *Carex meyenii*, *Chamaesyce multifloris*, *Claoxylon sandwicense*, *Diospyros hillebrandii*, *Dryopteris unidentata*, *Metrosideros polymorpha*, *Myrsine* spp., *Pipturus alba*, *Pisonia umbellifera*, *Pouteria sandwicensis*, *Psychotria hathewayi*, and *Urera glabra* (HINHP Database 2001; Service 1998a).

Dispersal/Migration

Population Information and Trends

Number of Populations:

8

Population Size:

~98 - 118

Population Narrative:

Currently, this species is only known from Oahu and Maui. On Oahu, 98 to 118 individuals are found in eight occurrences: south Mohiakea Gulch (5 individuals), Mohiakea Gulch (50 to 70), north Palawai (1), central Kaluaa (1), Huliwai Gulch (2), Waieli (7), Pualii Gulch (16), and Ekahanui (16) (J. Lau, HINHP, pers. comm. 2003; K. Kawelo, U.S. Army, pers. comm. 2003). On East Maui, it is known from Waiopai Gulch (Service 1998a).

Threats and Stressors**Stressor:****Exposure:****Response:****Consequence:**

Narrative: Threats to *Phyllostegia mollis* include potential effects of ongoing and future Army training activities, habitat degradation by feral ungulates, and competitive non-native plant species. Additionally, arthropod damage has been observed on the stems of this species (U.S. Army 2003a). Since all of the extant occurrences of *P. mollis* are found in small patches, they are vulnerable to extirpation due to natural disasters and stochastic events.

Recovery**Conservation Measures and Best Management Practices:**

- A State-wide management plan should be developed and implemented for the long-term conservation of all known occurrences of *Phyllostegia mollis*. This plan should also include broader landscape actions that are needed for the recovery of this plant throughout its range. The recovery plan for this species identifies the following important conservation actions: construction of exclosures around known occurrences of this species to reduce impacts from feral ungulates, control and/or removal of feral ungulates, and control and/or removal of competitive non-native plant species (Service 1998a). The level of threat from arthropod activity should be determined and actions taken to reduce identified significant threats. Ongoing Conservation Actions: The occurrence of *Phyllostegia mollis* in Palawai Gulch has been fenced by The Nature Conservancy of Hawaii. In addition, genetic material of *P. mollis*, in the form of seeds and cuttings from five collections on Oahu, is being held at Lyon Arboretum and *P. mollis* is being successfully propagated at Lyon Arboretum and National Tropical Botanical Garden (Service 1998a, 2002). The Service is currently not aware of any other conservation efforts for this species.

References

USFWS 2016. Status of the Species and Critical Habitat: *Phyllostegia mollis* (No Common Name). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016.

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

U.S. Fish and Wildlife Service. 2012. Endangered and Threatened Wildlife and Plants

Endangered Status for 23 Species on Oahu and Designation of Critical Habitat for 124 Species. Final Rule. 77 FR 57648-57862 (September 18, 2012)

SPECIES ACCOUNT: *Phyllostegia parviflora* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

A perennial herb. The egg-shaped to broadly egg-shaped, wrinkled leaves are usually 19 to 33 centimeters (7.5 to 13 inches) long and 7.5 to 15.3 centimeters (3 to 6 inches) wide. The leafstalks are typically 6 to 13.5 centimeters (2.4 to 5.3 inches) long. Usually six flowers are arranged along a flowering stalk. The corolla is white, sometimes tinged with purple, and about 9 to 13 millimeters (0.4 to 0.5 inch) long. The upper corolla lip is about 3 millimeters (0.1 inch) long while the lower lip is about 6 to 9 millimeters (0.2 to 0.4 inch) long. The fruits are nutlets (USFWS, 1999).

Taxonomy

A member of the mint family (Lamiaceae) (USFWS, 1999). At the time this species was listed, only two varieties were recognized, *Phyllostegia parviflora* var. *glabriuscula* and *P. parviflora* var. *parviflora* (USFWS 1996). Currently, three varieties are recognized, the third variety being *P. parviflora* var. *lydgatei*, from Oahu (Wagner et al. 1999) (USFWS, 2008).

Historical Range

Historically, *Phyllostegia parviflora* was known from the islands of Oahu, Hawaii, and Maui (Wagner et al. 1999; Wagner 1999) (USFWS, 2015).

Current Range

P. parviflora var. *glabriuscula* is known only from Hawaii Island, *P. parviflora* var. *parviflora* is found on Maui and in the Koolau Mountains of Oahu, and *P. parviflora* var. *lydgatei* is known from the Waianae Mountains of Oahu (Wagner 1999) (USFWS, 2015).

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On September 18, 2012, the U.S. Fish and Wildlife Service (Service), under the Endangered Species Act of 1973, as amended (Act), designated revised critical habitat for *Phyllostegia parviflora* on the island of Oahu. Critical habitat on Oahu was originally designated on June 17, 2003 (68 FR 35950).

Critical Habitat Designation

The critical habitat designation for *Phyllostegia parviflora* includes 21 units totaling 37,879 acres on Oahu. The units are Oahu—Lowland Mesic—Unit 1, 2, 3, 4, 5, 6, 7; Oahu—Lowland Wet—Unit 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; Oahu—Wet Cliff—Unit 6, 7, 8.

Oahu—Lowland Mesic—Unit 1 consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to

the Waianae Kai Forest Reserve (FR). Although this unit is not known to be occupied by *Phyllostegia parviflora*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Mesic—Unit 2 consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Although this unit is not known to be occupied by *Phyllostegia parviflora*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Mesic—Unit 3 consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit is occupied by *Phyllostegia parviflora* and includes the mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem. This unit also contains unoccupied habitat that is essential to the conservation of the species by providing the PCEs necessary for the expansion of the existing wild populations. Oahu—Lowland Mesic—Unit 4 consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. This unit includes the lowland mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem. Although this unit is not known to be occupied by *Phyllostegia parviflora*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Mesic—Unit 5 consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. This unit includes the mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem. Although this unit is not known to be occupied by *Phyllostegia parviflora*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Mesic—Unit 6 consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Although this unit is not known to be occupied by *Phyllostegia parviflora*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical

range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Mesic—Unit 7 consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge. Although this unit is not known to be occupied by *Phyllostegia parviflora*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Wet—Unit 6 consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihihi, Waialele, and Koloa gulches. Although this unit is not known to be occupied by *Phyllostegia parviflora*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Wet—Unit 7 consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Haula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Although this unit is not known to be occupied by *Phyllostegia parviflora*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Wet—Unit 8 consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikēkee, and Uwao streams. This area is occupied by the plant *Cyrtandra kaulantha*, and by the invertebrates, the blackline and crimson Hawaiian damselflies. This area includes the wet forest and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. Although this unit is not known to be occupied by *Phyllostegia parviflora*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Wet—Unit 9 consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream, and is occupied by *Phyllostegia parviflora*. This area includes the wet forest and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species

identified as physical or biological features in the lowland wet ecosystem and contains unoccupied habitat that is essential to the conservation of the species by providing the PCEs necessary for the expansion of the existing wild populations. Oahu—Lowland Wet—Unit 10 consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. This area is occupied by the blackline Hawaiian damselfly, and includes the wet forest and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. Although this unit is not known to be occupied by *Phyllostegia parviflora*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Wet—Unit 11 consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. This area is occupied by the blackline and oceanic Hawaiian damselflies, and includes the wet forest and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem, as well as unique PCEs for the Hawaiian damselflies. Although this unit is not known to be occupied by *Phyllostegia parviflora*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Wet—Unit 12 consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. This area is occupied by the blackline Hawaiian damselfly, and includes the wet forest and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. Although this unit is not known to be occupied by *Phyllostegia parviflora*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Wet—Unit 13 consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. This area is occupied by the blackline Hawaiian damselfly, and includes the wet forest and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. Although this unit is not known to be occupied by *Phyllostegia parviflora*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Wet—Unit 14 consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast

to Moole Stream. Although this unit is not known to be occupied by *Phyllostegia parviflora*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Wet—Unit 15 consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Although this unit is not known to be occupied by *Phyllostegia parviflora*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Wet—Unit 16 consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamo Ridge. Although this unit is not known to be occupied by *Phyllostegia parviflora*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Wet Cliff—Unit 6 consists of 151 ac (61 ha) in the wet cliff ecosystem on State land on the windward side of the Koolau Mountains in Kaipapau Gulch, entirely within the Kaipapau Forest Reserve. This area includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem. Although this unit is not known to be occupied by *Phyllostegia parviflora*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Wet Cliff—Unit 7 consists of 144 ac (58 ha) in the wet cliff ecosystem in State land on the windward side of the Koolau Mountains in Hauula Gulch, entirely within the Hauula Forest Reserve. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem. Although this unit is not known to be occupied by *Phyllostegia parviflora*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Wet Cliff—Unit 8 consists of 1,479 ac (598 ha) of State land, 1,281 ac (519 ha) of City and County of Honolulu land, 5 ac (2 ha) of Federal land, and 1,884 ac (762 ha) of privately owned land, in the wet cliff ecosystem along the summit of the Koolau Mountains, overlapping portions of Sacred Falls State Park, the Waiahole FR (Waiahole and Iolekaa sections), the Kaneohe and Honolulu Watershed FRs, and the Nuana Pali

State Wayside. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem. This unit is occupied by *Phyllostegia parviflora* and contains unoccupied habitat that is essential to the conservation of the species by providing the PCEs necessary for the expansion of the existing wild populations.

Primary Constituent Elements/Physical or Biological Features

- (i) In units Oahu—Lowland Mesic— Unit 1, Oahu—Lowland Mesic—Unit 2, and Oahu—Lowland Mesic—Unit 3, the physical and biological features of critical habitat for *Phyllostegia parviflora* var. *lydgatei* are: (A) Elevation: Less than 3,300 ft (1,000 m). (B) Annual precipitation: 50 to 75 in (130 to 190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.
- (ii) In units Oahu—Lowland Mesic— Unit 4, Oahu—Lowland Mesic—Unit 5, Oahu—Lowland Mesic—Unit 6, and Oahu—Lowland Mesic—Unit 7, the physical and biological features of critical habitat for *Phyllostegia parviflora* var. *parviflora* are: (A) Elevation: Less than 3,300 ft (1,000 m). (B) Annual precipitation: 50 to 75 in (130 to 190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.
- (iii) In units Oahu—Lowland Wet— Unit 6, Oahu—Lowland Wet—Unit 7, Oahu—Lowland Wet—Unit 8, Oahu— Lowland Wet—Unit 9, Oahu—Lowland Wet—Unit 10, Oahu—Lowland Wet— Unit 11, Oahu—Lowland Wet—Unit 12, Oahu—Lowland Wet—Unit 13, Oahu— Lowland Wet—Unit 14, Oahu— Lowland Wet—Unit 15, and Oahu— Lowland Wet—Unit 16, the physical and biological features of critical habitat for *Phyllostegia parviflora* var. *parviflora* are: (A) Elevation: Less than 3,300 ft (1,000 m). (B) Annual precipitation: Greater than 75 in (190 cm). (C) Substrate: Clays; ashbeds; deep, well-drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (F) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.
- (iv) In units Oahu—Wet Cliff—Unit 6, Oahu—Wet Cliff—Unit 7, and Oahu— Wet Cliff—Unit 8, the physical and biological features of critical habitat for *Phyllostegia parviflora* var. *parviflora* are: (A) Elevation: Unrestricted. (B) Annual precipitation: Greater than 75 in (190 cm). (C) Substrate: Greater than 65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. (F) Understory: *Bryophytes*, *Ferns*, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

All critical habitat, except in the coastal ecosystem on Oahu, requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs and goats). Feral ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant

species into native habitats. Particular attention is required during nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat posed by fire to 25 of the designated ecosystem critical habitat units in particular: Oahu—Lowland Mesic—Unit 2, Oahu—Lowland Mesic—Unit 3, Oahu—Lowland Mesic—Unit 7, Oahu—Dry Cliff—Unit 2, Oahu—Dry Cliff—Unit 3, Oahu—Dry Cliff—Unit 4, Oahu—Dry Cliff—Unit 6, Oahu—Dry Cliff—Unit 7 (Oahu—Dry Cliff—Unit 7a and Oahu—Dry Cliff—Unit 7b), and Oahu—Dry Cliff—Unit 8. Oahu—Lowland Mesic—Unit 1, Oahu—Lowland Mesic—Unit 2, Oahu—Lowland Mesic—Unit 3, Oahu—Lowland Mesic—Unit 4, Oahu—Lowland Mesic—Unit 5, Oahu—Lowland Mesic—Unit 7, Oahu—Lowland Wet—Unit 1, Oahu—Lowland Wet—Unit 2, Oahu—Lowland Wet—Unit 3, Oahu—Lowland Wet—Unit 4, Oahu—Lowland Wet—Unit 7, Oahu—Lowland Wet—Unit 8, Oahu—Lowland Wet—Unit 9, Oahu—Lowland Wet—Unit 10, Oahu—Lowland Wet—Unit 11, Oahu—Lowland Wet—Unit 12, Oahu—Lowland Wet—Unit 13, Oahu—Lowland Wet—Unit 14, Oahu—Lowland Wet—Unit 15, Oahu—Lowland Wet—Unit 16, Oahu—Wet Cliff—Unit 3, Oahu—Wet Cliff—Unit 5, Oahu—Wet Cliff—Unit 6, Oahu—Wet Cliff—Unit 7, and Oahu—Wet Cliff—Unit 8) may require special management to reduce the threat of landslides, rockfalls, and flooding.

Life History**Food/Nutrient Resources****Lifespan**

Adult: < 10 years (USFWS, 2015)

Breeding Season

Adult: Possibly winter (inferred from USFWS, 1999)

Key Resources Needed for Breeding

Adult: Unknown (USFWS, 1999)

Reproduction Narrative

Adult: It is a short-lived perennial (fewer than 10 years) (USFWS, 2015). Plants on Oahu have been observed in fruit in January (K. Kawelo, in lift. 1998). Reproductive cycles, longevity, specific environmental requirements, and limiting factors are unknown (USFWS, 1999).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Mesic to wet ohia-uluhe forest, uluhe lowland wet forest (USFWS, 2008)

Geographic or Habitat Restraints or Barriers

Adult: 761 - 2,890 ft. elevation (USFWS, 2008)

Habitat Narrative

Adult: Inhabits moist forests on gulch slopes (NatureServe, 2015). *Phyllostegia parviflora* var. *lydgatei* was typically found in loose granular soil, with some talus, often in wet side bowls of gulches or near the bottom of small side streams. It likes high humidity and wet, but well drained soils. It grows on moderate to steep slopes in mesic to wet *Metrosideros* (ohia) - *Dicranopteris* (uluhe) forest from 555 to 881 meters (1,820 to 2,890 feet) elevation. *Phyllostegia parviflora* var. *parviflora* occurs in the Koolau Mountains, at elevations from 232 to 867 meters (761 to 2,844 feet) in *Metrosideros Dicranopteris linearis* (uluhe) lowland wet forest. A habitat description for the newly rediscovered *Phyllostegia parviflora* var. *glabriuscula* is not yet available (USFWS, 2008).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Species Trends:

Slightly decreasing (USFWS, 2015)

Resiliency:

Low (inferred from USFWS, 2015; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2015)

Number of Populations:

3 (USFWS, 2015)

Population Size:

~175 wild; 6 outplanted (USFWS, 2015)

Population Narrative:

Overall, the numbers of individuals have decreased from the approximately 200 wild individuals reported in the previous 5-year review to approximately 175 wild individuals in 2015. There are 3 populations (USFWS, 2015).

Threats and Stressors

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate

change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Phyllostegia parviflora* is minimally vulnerable to the impacts of climate change (USFWS, 2015).

Stressor: Stochastic events (USFWS, 2015 and 2008)

Exposure:

Response:

Consequence:

Narrative: Drought may exacerbate the effects of ungulates and has direct adverse impacts on *P. parviflora* var. *lydgatei* (PEPP 2012) (USFWS, 2015). Fire is a potential threat in the Waianae Mountains (USFWS, 2008).

Stressor: Habitat degradation (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: The major threats to the habitat of *Phyllostegia parviflora* var. *lydgatei* and var. *parviflora* are habitat degradation and destruction of individuals by feral pigs (*Sus scrofa*). In addition, feral goats (*Capra hircus*) and mouflon (*Ovis montanus*) are threats to *P. parviflora* var. *glabriuscula*. Habitat degradation by and competition with invasive introduced plant species is another threat to *Phyllostegia parviflora* (USFWS, 2008).

Stressor: Disease and predation (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Wild plants and nursery stock are highly susceptible to powdery mildew. Mildew fungus is lethal for some wild plants, especially seedlings or immature individuals. Slug predation on seedlings and older plants is also assumed to be a very significant threat. Rats are also a threat (Perlman 2007). The species is susceptible to standard nursery pests including white flies, broadleaf and other mites, mealy bugs, and fungi in cultivation (The Nature Conservancy 2007) (USFWS, 2008).

Stressor: Military activities (USFWS, 1999)

Exposure:

Response:

Consequence:

Narrative: Military activities are a possible threat to the North Kaukonahua Stream population (USFWS, 1999).

Recovery

Reclassification Criteria:

1. A total of five to seven populations should be documented on islands where it now occurs or occurred historically (USFWS, 1999).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 1999).

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1999).

Delisting Criteria:

1. A total of 8 to 10 populations should be documented on islands where it now occurs or occurred historically (USFWS, 1999).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 1999).

3. Each population should persist at this level for a minimum of five consecutive years (USFWS, 1999).

Recovery Actions:

- Protect habitat and control threats (USFWS, 1999).
- Expand existing wild populations (USFWS, 1999).
- Conduct essential research (USFWS, 1999).
- Develop and maintain monitoring plans (USFWS, 1999).
- Reestablish wild populations within the historic range (USFWS, 1999).
- Validate and revise recovery criteria (USFWS, 1999).
- Control competing alien plant species (USFWS, 1999).
- Maintain adequate genetic stock (USFWS, 1999).
- Enhance wild populations and establish new populations (USFWS, 1999).
- Conduct surveys (USFWS, 1999).

Conservation Measures and Best Management Practices:

- Surveys / inventories – Survey geographical and historical range for a current assessment of the species' status (USFWS, 2015).
- Captive propagation for genetic storage and reintroduction – Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range (USFWS, 2015).
- Ungulate monitoring and control – Maintain existing exclosures and monitor for potential incursions (USFWS, 2015).
- Invasive plant monitoring and control – Eradicate invasive introduced plants within ungulate exclosures and maintain exclosures free of invasive plants (USFWS, 2015).
- Population viability monitoring and analysis – Continue monitoring wild and reintroduced individuals (USFWS, 2015).
- Taxonomy research – Determine whether the Hawaii Volcanoes National Park population is this species or *Phyllostegia stachyoides* (USFWS, 2015).
- Climate change adaptation strategy – Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change (USFWS, 2015).

- Alliance and partnership development – Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2015).

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SPECIES ACCOUNT: *Phyllostegia pilosa* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (R1) (USFWS, 2016)

Physical Description

A vine (USFWS, 2016).

Taxonomy

A member of the mint family (Lamiaceae) (USFWS, 2016). Newly recognized Hawaiian endemic species of Moloka'i and Maui, formerly treated within *Phyllostegia mollis* (e.g., Wagner et al., Hawaii, 1990, and Kartesz 1994 and 1999). Recognized as *P. haleakalae* in Wagner and Herbst's 1999 Supplement, with *P. mollis* considered endemic to O'ahu only. However, Wagner (1999, Novon 9: 274-275) has subsequently decided that *P. pilosa* is the correct name for the plants called "*P. haliakalae*", with the latter name actually applying to the species previously known as *P. imminuta* (NatureServe, 2015)

Historical Range

Historically known from Molokai. (NatureServe, 2015). The individuals identified as *P. pilosa* on Molokai, at Kamoku Flats (montane wet ecosystem) and at Mooloa (lowland mesic ecosystem), have not been observed since the early 1900s (TNC 2007; HBMP 2010) (USFWS, 2016).

Current Range

It occurs west of Puu o Kaka'e on east Maui (USFWS, 2016).

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Phyllostegia pilosa* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes eight detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Phyllostegia pilosa* includes eight CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Molokai—Lowland Mesic—Unit 1 (and) *Palmeria dolei*—Unit 37—Lowland Mesic (and) *Pseudonestor xanthophrys*—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Ctenitis squamigera*, *Cyanea dunbariae*, *C. mannii*, *C. profuga*, *Cyperus fauriei*, *Cyrtandra filipes*, *Gouania hillebrandii*, *Labordia triflora*, *Neraudia sericea*, *Santalum haleakalae* var. *lanaiense*, *Schiedea lydgatei*, *S. sarmentosa*, *Silene alexandri*, *S. lanceolata*, *Spermolepis hawaiiensis*, and *Zanthoxylum hawaiiense*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological

features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Mesic—Unit 1 is not known to be occupied by *Asplenium dielirectum*, *Bonamia menziesii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea procera*, *C. solanacea*, *Diplazium molokaiense*, *Festuca molokaiensis*, *Flueggea neowawraea*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Melicope mucronulata*, *M. munroi*, *M. reflexa*, *Phyllostegia haliakalae*, *P. mannii*, *P. pilosa*, *Sesbania tomentosa*, *Stenogyne bifida*, or *Vigna o-wahuensis*, or the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 1 (and) *Palmeria dolei*—Unit 40—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 40— Montane Wet This area consists of 1,545 ac (625 ha) of State land, and 1,851 ac (749 ha) of privately owned land, from the headwaters of Waialeia Stream and above Pelekunu Valley, eastward along the summit area to Mapulehu, in northcentral Molokai. These units are occupied by the plants *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. profuga*, *Phyllostegia hispida*, and *Pteris lidgatei*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Montane Wet—Unit 1 is not known to be occupied by *Adenophorus periens*, *Cyanea procera*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Melicope reflexa*, *Phyllostegia mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 3 consists of 77 ac (31 ha) of State land, and 726 ac (294 ha) of privately owned land, above the east rim of Wailau Valley on eastern Molokai. This unit is occupied by the plant *Melicope reflexa*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Montane Wet—Unit 3 is not known to be occupied by *Adenophorus periens*, *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. procera*, *C. profuga*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Pteris lidgatei*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and

space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 4 (and) *Palmeria dolei*—Unit 13—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 13— Montane Wet This area consists of 180 ac (73 ha) of State land and 1,653 ac (669 ha) of federally owned land (Haleakala National Park), in Kaapahu Valley on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *Cyrtandra ferripilosa*, and *Huperzia mannii*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 4 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea duvalliorum*, *C. glabra*, *C. mceldowneyi*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 41—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 41— Montane Wet This area consists of 871 ac (353 ha) of State land, and 39 ac (16 ha) of privately owned land, from Honukaupu to Olokui (between Pelekunu and Wailau valleys), in north-central Molokai. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). Although Molokai— Montane Wet—Unit 2 is not known to be occupied by *Adenophorus periens*, *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. procera*, *C. profuga*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Melicope reflexa*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Pteris lidgatei*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 11—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 11— Montane Wet This area consists of 4,075 ac (1,649 ha) of State land, 9,633 ac (3,898 ha) of privately owned land, and 875 ac (354 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Puukaukanu and upper Waihoi Valley, on the northern and northeastern slopes of east Maui. These units include the mixed herbland and

shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Geranium hanaense*, *G. multiflorum*, and *Wikstroemia villosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 2 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea glabra*, *C. maritae*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, and *Schiedea jacobii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 3 (and) *Palmeria dolei*—Unit 12—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 12—Montane Wet This area consists of 2,228 ac (902 ha) of federally owned land (Haleakala National Park) in Kipahulu Valley, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. maritae*, and *Melicope ovalis*, and by the forest bird, kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 3 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea duvalliorum*, *C. glabra*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest bird, the akohekohe (*Palmeria dolei*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 5 (and) *Palmeria dolei*—Unit 14—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 14—Montane Wet This area consists of 222 ac (90 ha) of State land, and 165 ac (67 ha) of federally owned land (Haleakala National Park), near Kaumakani on the eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units area occupied by the plant *Bidens campylotheca* ssp. *pentamera*. These units also contain unoccupied habitat that is

essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 5 is not currently occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Phyllostegia pilosa* critical habitat consists of two components. Lowland mesic (Molokai) and Montane wet (east Maui and Molokai) (81 FR 17790-18110):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: *Ferns*, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The

125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant

species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Lifespan**

Adult: < 10 years (inferred from USFWS, 2016)

Reproduction Narrative

Adult: It is a short-lived perennial (USFWS, 2016).

Habitat Type

Adult: Terrestrial (USFWS, 2012)

Habitat Vegetation or Surface Water Classification

Adult: Montane wet and lowland mesic forest (USFWS, 2012; NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: < 3,300 - 6,500 ft. elevation (USFWS, 2012)

Habitat Narrative

Adult: It occurs in the lowland mesic ecosystem (grasslands, shrublands, and forests, generally below 3,300 ft. (1,000 m) elevation), and montane wet ecosystem (grasslands, shrublands, forests, and bogs) found at elevations between 3,300 and 6,500 ft. elevation) (USFWS, 2012). Habitat is characterized as forest (NatureServe, 2015).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Very low (inferred from USFWS, 2016; see current range/distribution)

Redundancy:

Very low (inferred from USFWS, 2016)

Number of Populations:

2 (USFWS, 2016)

Population Size:

7 (USFWS, 2016)

Population Narrative:

There are two occurrences totaling seven individuals (USFWS, 2016).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs and goats), nonnative plants, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, goats, and slugs) is considered an ongoing threat to *Phyllostegia pilosa* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor: Small populations (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: *Phyllostegia pilosa* faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). The seven known individuals of *Phyllostegia pilosa* are not protected from direct predation by feral pigs and goats on Maui. This species has not been observed on Molokai for over 100 years (USFWS, 2013).

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- Not available

References

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

USFWS. 2016. Environmental Conservation Online System (ECOS) – Species Profile.
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USFWS 2016. Endangered and Threatened Wildlife and Plants

Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species. 81 Federal Register 61. March 30, 2016. Pages 17789 - 18110.

U.S. Fish and Wildlife Service. 2016. Endangered and Threatened Wildlife and Plants

Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

Final Rule . 81 FR 17790-18110 (March 30, 2016).

USFWS 2012. Endangered and Threatened Wildlife and Plants

Listing 38 Species on Molokai, Lanai, and Maui as Endangered and Designating Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

Proposed Rule. 77 Federal Register 112. June 11, 2012. Pages 34464 - 34775

USFWS. 2016. Endangered and Threatened Wildlife and Plants

USFWS. 2013. Determination of Endangered Status for 38 Species on Molokai, Lanai, and Maui

Final Rule. 78 Federal Register 102, May 28, 2013. Pages 32014 - 32065.

SPECIES ACCOUNT: *Phyllostegia racemosa* (Kiponapona)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

A climbing vine with many-branched, square stems and spicy-smelling leaves. Leaves are opposite, moderately covered with short, soft hairs, dotted with small glands, 3.4 to 6 cm (1.3 to 2.4 inches) long, and 1.4 to 4.3 cm (0.6 to 1.7 inches) wide, with shallow, rounded teeth. The leafstalks are densely covered with short hairs. Flower clusters, densely covered with short, soft hairs, are comprised of 6 to 12 flowers with individual flower stalks 1 to 3 millimeters (0.04 to 0.12 inch) long and leaflike bracts. The green bell-shaped calyx is about 3.5 to 5 millimeters (0.1 to 0.2 inch) long, covered with glands, and has triangular lobes. The white corolla is two-lipped, with a tube about 7 to 10 millimeters (0.3 to 0.4 inch) long, upper lip 2 to 2.5 millimeters (0.08 to 0.1 inch) long, and lower lip 4 to 5 millimeters (0.16 to 0.2 inch) long. Fruits are divided into four nutlets about 1.5 to 2 millimeters (0.06 to 0.08 inch) long (USFWS, 1998).

Taxonomy

The genus is nearly endemic to Hawaii except one species in Tahiti, this species is endemic to the island of Hawaii (NatureServe, 2015). A member of the mint family (Lamiaceae). *Phyllostegia racemosa* may be transferred into the genus *Stenogyne* at a later date, if further molecular data suggest either that 1) *Phyllostegia* is polyphyletic, or 2) if *Stenogyne* is shown to be paraphyletic with respect to *Phyllostegia*. Evidence of hybridization also suggests that the two genera may warrant combining (Wagner 1999). In the mint family (Lamiaceae) (USFWS, 2012).

Historical Range

In addition to current range, the species also was found historically at several sites between Mauna Kea and Mauna Loa (USFWS 2012).

Current Range

Phyllostegia racemosa is endemic to the Island of Hawaii. It occurs on the windward slopes of Mauna Kea and Mauna Loa (USFWS, 2012).

Critical Habitat Designated

Yes; 7/2/2003.

Legal Description

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Phyllostegia racemosa* on the island of Hawaii (68 FR 39623 - 39722).

Critical Habitat Designation

The critical habitat designation for *Phyllostegia racemosa* includes three units totaling 7,134 acres in Hawaii County, Hawaii. The units are Hawaii 1—*Phyllostegia racemosa*—a, Hawaii 2—*Phyllostegia racemosa*—b, Hawaii 30—*Phyllostegia racemosa*—c. Two of the units, Hawaii 1—*Phyllostegia racemosa*—a and Hawaii 2—*Phyllostegia racemosa*—b, are currently occupied. This unit is essential to the conservation of *P. racemosa* because it supports an extant colony of this

species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The unoccupied unit, Hawaii 30—*Phyllostegia racemosa*— c, is essential to the conservation of *P. racemosa* because it supports an extant colony of this species (12 individuals on the adjacent excluded Kamehameha Schools lands) and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. Each unit is geographically separated from other critical habitat for this island-endemic species within its historical range in order to reduce the likelihood of all recovery populations being destroyed by one naturally occurring catastrophic event. The three units being designated for this species on the island of Hawaii provide for a total of 10 populations, each with 300 mature, reproducing individuals.

Hawaii 1—*Phyllostegia racemosa*—a [938 ha (2,317 ac)]: This unit contains Puu Akala and portions of Awehi, Honoliii, and Kapue streams. It is bordered by the Kolekole watershed in the north and Wailuku watershed in the south, with Honolii and Kapue watersheds in the central portion. The unit is completely within Hakalau Forest NWR; provides habitat for 3 populations, each with 300 individuals of *P. racemosa*; and is currently occupied by 2 individuals.

Hawaii 2—*Phyllostegia racemosa*—b [1,683 ha (4,158 ac)]: This unit contains a portion of Nauhi Gulch, and the northern portion is in the Haakoa watershed, the southern portion in the Umauma watershed, and the central portion in the Waikaumalo watershed. The northern and southern portions of this unit lie partly within Hakalau Forest NWR, and the central portion lies in the Hilo Forest Reserve. This unit provides habitat for 2 populations of 300 individuals of *P. racemosa* and is currently occupied by 31 to 41 individuals.

Hawaii 30—*Phyllostegia racemosa*— c [267 ha (659 ac)]: This unit contains no named natural features and is completely within the Kaahakini watershed. This unit also lies completely within Olaa-Kilauea Partnership lands. The unit provides, in combination with the adjacent excluded Kamehameha Schools lands (see “Analysis of Impacts Under 4(b)(2)”), habitat for 5 populations of 300 mature, reproducing individuals of the shortlived perennial *P. racemosa* and is currently unoccupied.

Primary Constituent Elements/Physical or Biological Features

Habitat features that are essential for this species include, but are not limited to, *Acacia koa*, *Metrosideros polymorpha*, and *Cibotium* dominated montane mesic or wet forests.

Special Management Considerations or Protections

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for this species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when

known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Lifespan**

Adult: < 10 years (USFWS, 2012)

Reproduction Narrative

Adult: It is a short-lived perennial (fewer than 10 years) (USFWS, 2012).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Mesic to wet ohia and koa forest (USFWS, 2012)

Geographic or Habitat Restraints or Barriers

Adult: 2,300 - 6,350 ft. elevation (USFWS, 2012)

Habitat Narrative

Adult: Inhabits moist and wet forests on old volcanic substrates (NatureServe, 2015). It occurs in mesic to wet forests between 700 to 1,935 meters (approximately 2,300 to 6,350 feet) elevation. Based on information contained on specimens housed at Bishop Museum (2010), *P. racemosa* typically grows in forests dominated by *Metrosideros polymorpha* (ohia) and *Acacia koa* (koa) (USFWS, 2012).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Extinct in the wild (USFWS, 2012)

Resiliency:

Very low (inferred from USFWS, 2012; see current range/distribution)

Representation:

Low (inferred from USFWS, 2012)

Redundancy:

Very low (inferred from USFWS, 2012)

Number of Populations:

1 (USFWS, 2012)

Population Size:

24 mature (USFWS, 2012)

Adaptability:

Low (inferred from USFWS, 2012)

Population Narrative:

There are no known naturally occurring individuals in the wild. Outplanting from captive propagation facilities is ongoing but survivorship is low and there is only one outplanted population of 24 mature individuals that is naturally reproducing (USFWS, 2012).

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Feral pigs (*Sus scrofa*), cattle (*Bos taurus*), mouflon sheep (*Ovis montanus*); invasive plant species: *Ehrharta stipoides* (meadow ricegrass), *Grevillea robusta* (silk oak), *Psidium cattleianum* (strawberry guava), *Passiflora ligularis* (sweet granadilla), *Passiflora tarminiana* (banana poka), *Pennisetum clandestinum* (kikuyu grass); logging; and lava flow (USFWS, 2012).

Stressor: Herbivory (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Cattle and mouflon sheep (USFWS, 2012).

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species (USFWS, 2012).

Recovery**Reclassification Criteria:**

1. A total of five to seven populations should be documented on the Big Island (USFWS, 1998).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1998).

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1998).

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on the Big Island (USFWS, 1998).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1998).

3. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1998).

Recovery Actions:

- Protect current populations and manage threats (USFWS, 1998).
- Conduct essential research (USFWS, 1998).
- Expand existing wild populations, as necessary (USFWS, 1998).
- Create new populations within historical range, as necessary (USFWS, 1998).
- Evaluate and validate recovery objectives (USFWS, 1998).
- Construct fenced exclosures around the known populations, and initiate removal of feral ungulates and alien plant taxa (USFWS, 1998).
- Outplant new populations in areas of reduced threat (USFWS, 1998).

Conservation Measures and Best Management Practices:

- Surveys / inventories – Survey the historical range of the species for surviving populations (USFWS, 2012).
- Captive propagation for genetic storage and reintroduction: Continue to collect seeds and/or cuttings and send to at least two or three different venues for propagation and storage. Collect cuttings or seed from tagged individuals, keeping close track of the maternal source for use in ex situ propagation (USFWS, 2012).
- Reintroduction / translocation protocol development – Develop proper horticultural protocols and pest management practices for rare plant nurseries (USFWS, 2012).
- Reintroduction / translocation implementation – Continue to reintroduce the species back into its known historical range (USFWS, 2012).
- Reintroduction / translocation site identification – While surveying for new populations or reintroduced populations, identify sites that are least invaded by invasive introduced plant species and that appear to have the highest likelihood of maintaining new reintroductions (USFWS, 2012).
- Ungulate exclosures – Construct fenced exclosures that are sturdy enough to exclude cattle and feral pigs around all populations (USFWS, 2012).
- Ungulate control – Continue to protect all populations against disturbances from feral ungulates (USFWS, 2012).

- Ecosystem-altering invasive plant species control – Control invasive introduced plant species around all populations (USFWS, 2012).
- Genetic research – Conduct molecular fingerprinting of ex situ stocks (USFWS, 2012).
- Site / area / habitat protection – Develop and implement effective measures to reduce the impact of logging (USFWS, 2012).
- Population biology research: Carry out field studies to determine what agents pollinate the flowers and disperse the seeds. Determine if the species ever grows as a true epiphyte, wherein the apex of the root crown is situated on a tree or other object above ground level (USFWS, 2012).
- Threat monitoring and control – Monitor all populations for evidence of insect damage and plant diseases. If threats are found implement effective control methods (USFWS, 2012).
- Alliance and partnership development – Continue to work with Hawaii Division of Forestry and Wildlife, Hakalau Forest National Wildlife Refuge, and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2012).
- Threats research – Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2012).

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SPECIES ACCOUNT: *Phyllostegia renovans* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (R1) (USFWS, 2016)

Physical Description

Erect subshrub when young, becoming scandent and the stems up to 3 - 4 m long. Leaves are narrowly ovate to ovate, sometimes broadly so, 12.5 - 20 cm long, 5.0 - 8.8 cm wide.

Inflorescences are racemose, 18 - 34 cm long, apparently the stem resuming vegetative growth after flowering. Corollas white, ca. 19 - 22 mm long. Nutlets ca. 8 - 9 mm long, greenish black (NatureServe, 2015).

Taxonomy

A member of the mint family (Lamiaceae) (USFWS, 2010b).

Historical Range

First discovered in 1989 in the headwaters of the Wainiha River (USFWS, 2010b).

Current Range

It is currently known from Limahuli Valley, Wainiha, Kalalau Valley, Lumahai Valley, Kapalaoa, and the headwaters of Kamooloa Stream (Kauai) (K. Wood 1994, p. 4; Wagner 1999, p. 275; HBMP 2007, D. Burney, NTBG, pers. comm. 2009) (USFWS, 2010b).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Phyllostegia renovans* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes nine critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Phyllostegia renovans* includes nine CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Lowland Wet—Section 1: Lowland Wet—Section 1 consists of 1,164 ac (471 ha) in the lowland wet ecosystem (117 ac (47.4 ha) on State land; 1,047 ac (424 ha) on private land), including wet forest extending from Kulanalilia into Limahuli Valley to Honoanapali, in the Halelea Forest Reserve (Figure 2-A). The section includes 1,099 ac (445 ha) of State and privately owned land within previously designated critical habitat and 65 ac (26 ha) of newly designated critical habitat on private land. The area that falls within designated critical habitat lies within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and newly designated Critical Habitat Unit 20, Map 217c. This section is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Labordia helleri*, and *Phyllostegia renovans*. This section also contains unoccupied habitat that is essential to the conservation of these four species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory

plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 1 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Melicope paniculata*, *M. puberula*, *Platydesma rostrata*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 2: Lowland Wet—Section 2 consists of 172 ac (70 ha) in the lowland wet ecosystem, including wet forest extending from Alealau to Pohakea, within the Hono o Na Pali NAR and the Na Pali Coast State Park (Figure 2-A, above). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plant *Melicope puberula*. This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 2 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope paniculata*, *Phyllostegia renovans*, *Platydesma rostrata*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 3: Lowland Wet—Section 3 consists of 756 ac (306 ha) in the lowland wet ecosystem, including wet forest in upper Wainiha Valley, on privately owned land in the Halelea Forest Reserve (Figure 2-B). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyrtandra oenobarba*, *Melicope puberula*, *Phyllostegia renovans*, and *Stenogyne kealiae*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 3 is not known to be occupied by the species *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope paniculata*, *Platydesma rostrata*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 4: Lowland Wet—Section 4 consists of 591 ac (239 ha) in the lowland wet ecosystem, including wet forest at the head of Lumahai Valley, on State (10 ac, 4.1 ha) and privately owned (581 ac, 235 ha) land in the Halelea Forest Reserve (Figure 2-B, above). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyrtandra oenobarba*, *Melicope paniculata*, *Phyllostegia renovans*, and *Platydesma rostrata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 4 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope puberula*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population numbers of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 5: Lowland Wet—Section 5 consists of 1,541 ac (624 ha) in the lowland wet ecosystem, including wet forest extending from the headwaters of the Wailua River at “Blue Hole” south to Iole, on State (442 ac, 179 ha) and privately owned (1,099 ac, 445 ha) land in the Lihue-Koloa Forest Reserve (Figure 2-C). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36a, and is occupied by the plants *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Melicope paniculata*, *Phyllostegia renovans*, and *Platydesma rostrata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 5 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Labordia helleri*, *Melicope puberula*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 6: Lowland Wet—Section 6 consists of 789 ac (319 ha) in the lowland wet ecosystem, including wet forest extending from Kapalaoa to Kanaele Bog and Lauahihaihai in the Wahiawa Mountains, on State (134 ac, 54 ha) and privately owned (655 ac, 265 ha) land in the Lihue-Koloa Forest Reserve (Figure 2-D). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36a, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Platydesma rostrata*, and *Tetraplasandra bisattenuata*. This section also contains unoccupied habitat that is essential to the conservation of these five

species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 6 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Labordia helleri*, *Melicope paniculata*, *M. puberula*, *Phyllostegia renovans*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Montane Wet—Section 1: Montane Wet—Section 1 consists of 13,055 ac (5,257 ha) in the montane wet ecosystem, extending across the Alakai Plateau from Hanakoa to Mount Waialeale, on State (12,628 ac, 5,110 ha) and privately owned (427 ac, 173 ha) land in the Na Pali Coast State Park, the Alakai Wilderness Preserve, the Na PaliKona and Halelea forest reserves, and Hono o Na Pali NAR (Figure 4). It is occupied by the plants *Astelia waialealae*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *K. helenae*, *Labordia helleri*, *L. pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, and *Platydesma rostrata*; by the akekee and akikiki; and by the picture-wing fly. This section also contains unoccupied habitat that is essential to the conservation of these 18 species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the montane wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and the species-specific PCEs including (1) bogs (identified as PCEs for *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*) (2) bog hummocks (identified as PCEs for *Astelia waialealae* and *Lysimachia daphnoides*); (3) arthropod prey (identified as PCEs for the akekee and the akikiki); and (4) larval-stage host plants, *Cheirodendron* and *Tetraplasandra* sp., (identified as a PCE for the picture-wing fly). Although Montane Wet—Section 1 is not known to be occupied by the plants *Dubautia kalalauensis*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, those portions of the section that overlie previously designated critical habitat fall within two existing Critical Habitat Units of 50 CFR 17.99(a)(1): Unit 10, Map 35a; and Unit 11, Map 64a. The previously undesignated land comprises Unit 23, Map 217f; and Unit 24, Map 217g. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 4—Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 4—Montane Wet).

Kauai—Montane Wet—Section 2: Montane Wet—Section 2 consists of 790 ac (320 ha) in the montane wet ecosystem, extending from Kahuamaa Flat south to the edge of Waimea Canyon, on State-owned land in Kokee State Park (Figure 4, above). The entire section is within previously designated critical habitat, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Dubautia kalalauensis*, *Labordia helleri*, *Melicope puberula*, *Platydesma rostrata*, *Psychotria grandiflora*,

and *Tetraplasandra flynnii*, and by the akekee. This section includes montane wet forest, potentially some small-scale boggy areas, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and arthropod prey (identified as a species-specific PCE for the akekee). Although Montane Wet–Section 2 is not known to be occupied by the plants *Astelia waialeale*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialeale*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *Myrsine mezii*, and *Phyllostegia renovans*; by the akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. This area also supports the arthropod prey identified as a PCE for the akikiki, and the larval-stage host plants (*Cheirodendron* and *Tetraplasandra* spp.) identified as a PCE for the picturewing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within previously designated Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 5–Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 5– Montane Wet).

Kauai—Montane Wet—Section 3: Montane Wet–Section 3 consists of 413 ac (167 ha) in the montane wet ecosystem, encompasses the summit of Namolokama, on State (156 ac, 63 ha) and privately owned (257 ac, 104 ha) land in the Halelea Forest Reserve (Figure 4, above). It is entirely within previously designated critical habitat, and is occupied by the plants *Keysseria erici* and *Labordia pumila*. This section includes the montane wet forest, the moisture regime, and the canopy, subcanopy, and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and bogs (identified as a species-specific PCE for *K. erici*). Although Montane Wet–Section 3 is not known to be occupied by the plants *Astelia waialeale*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia kalalauensis*, *D. waialeale*, *Geranium kauaiense*, *Keysseria helenae*, *Labordia helleri*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*; by the akekee and akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. It also supports the arthropod prey identified as a PCE for the akekee and akikiki, and the larval-stage host plants (*Cheirodendron* and *Tetraplasandra* spp.) identified as a PCE for the picture-wing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 6–Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 6–Montane Wet).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Phyllostegia renovans* critical habitat consists of two components (Lowland wet and Montane wet) (75 FR 18960-19165):

Ecosystem: Lowland Wet. Elevation: <3,000 ft (<914 m). Annual precipitation: >75 in (>190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

Ecosystem: Montane Wet. Elevation: 3,000–5,243 ft (914–1,598 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: Acacia, Charpentiera, Cheirodendron, Metrosideros. Subcanopy: Broussaisia, Cibotium, Eurya, Ilex, Myrsine. Understory: Ferns, Carex, Coprosma, Leptecophylla, Oreobolus, Rhynchospora, Vaccinium.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular

attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available

Habitat Type

Adult: Terrestrial, riparian (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: *Metrosideros polymorpha* lowland and montane wet forest (USFWS, 2010b)

Geographic or Habitat Restraints or Barriers

Adult: 2,700 - 3,700 ft. elevation (USFWS, 2010b)

Habitat Narrative

Adult: Inhabits wet forests near streams (NatureServe, 2015). It occurs at elevations from 2,700 to 3,700 ft. (225 to 1,125 m) in *Metrosideros polymorpha* wet forest in the lowland wet and montane wet ecosystems (HBMP 2007; TNCH 2007) (USFWS, 2010b).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Very low (inferred from USFWS, 2010b; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2010a)

Number of Populations:

9 (USFWS, 2017)

Population Size:

~70 (USFWS, 2017)

Population Narrative:

There are 4 populations totaling 30 individuals (USFWS, 2010a). There are currently about 70 wild individuals of *Phyllostegia renovans* in nine locations (USFWS, 2017).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from non-native plants, pigs, goats, hurricanes, landslides, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Landslides destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities.

Stressor: Predation and herbivory (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species present an immediate and significant threat to *Phyllostegia renovans* throughout its range due to documented browsing

and trampling by pigs, goats, and deer, and documented mechanical damage by rats (USFWS, 2010).

Stressor: Small populations (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: *Phyllostegia renovans* is threatened by the effects of small population size (fewer than 50 wild individuals). Research on *Pittosporum* species suggests that small populations are susceptible to loss of genetic variation through inbreeding and drift (USFWS, 2010).

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor: Ungulate degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Feral pigs (*Sus scrofa*), goats (*Capra hircus*), and black-tailed deer (*Odocoileus hemionus*), modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil. Habitat destruction and erosion caused by feral pigs and goats are noted to be a threat to all occurrences of *Phyllostegia renovans* (HBMP 2010; NTBG 2010b-d, 2011b, 2013a-b, 2014a-d, 2015a, c-d, 2016b-c). Habitat destruction and erosion caused by black-tailed deer is reported to be a threat at the Hanakoa occurrence (NTBG 2014a) (USFWS, 2017).

Stressor: Landslides and flooding loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Landslides and erosion due to natural weathering destabilize substrates, damage and destroy individual plants, and alter hydrological patterns (Stearns 1985). Landslides are reported to be a threat to the occurrences of *Phyllostegia renovans* at Lumahai, Limahuli, and Wainiha (HBMP 2010; NTBG 2012; PEPP 2014) (USFWS, 2017).

Stressor: Hurricanes—Loss and degradation of habitat

Exposure:

Response:

Consequence:

Narrative: In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed

(Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013) (USFWS, 2017).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Phyllostegia renovans* is vulnerable to the impacts of climate change with a vulnerability score of 0.404 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Stressor: Established ecosystem-altering invasive plant modification and degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species modify habitat occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community. Invasive introduced plants with the greatest impacts on *Phyllostegia renovans* are: *Adiantum raddianum* (NCN), *Andropogon glomeratus* (bushy beardgrass), *Axonopus fissifolius* (narrow-leaved carpetgrass), *Blechnum appendiculatum* (NCN), *Buddleia asiatica* (dog tail), *Clidemia hirta* (Koster's curse), *Cyperus 11 meyenianus* (NCN), *Erigeron karvinskianus* (daisy fleabane), *Hedychium gardnerianum* (kahili ginger), *Juncus planifolius* (rush), *Kalanchoe pinnata* (air plant), *Paspalum urvillei* (vasey grass), *Psidium guajava* (common guava), *P. cattleianum* (strawberry guava), *Rhodomyrtus tomentosa* (downy myrtle), *Rubus argutus* (prickly Florida blackberry), *R. rosifolius* (thimbleberry), and *Sphaeropteris cooperi* (Australian tree fern) (NTBG 2010a-d, 2011b, 2012, 2013a-b, 2014a-d, 2015a-d, 2016a-d) (USFWS, 2017).

Recovery

Reclassification Criteria:

In addition to achieving 5 to 10 populations with 500 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the

species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats (USFWS, 2017).

Delisting Criteria:

In addition to achieving 5 to 10 populations with 500 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis (USFWS, 2017).

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys (USFWS, 2010a).
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units (USFWS, 2010a).
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys (USFWS, 2010a).
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range (USFWS, 2010a).
- Conduct research on control methods for introduced slugs and avian malaria (USFWS, 2010a).
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction (USFWS, 2010a).
- Identify threats and prioritize which ones to address first for the two birds (USFWS, 2010a).
- Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program (USFWS, 2010a).
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security (USFWS, 2010a).
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems (USFWS, 2010a).

- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations (USFWS, 2010a).
- Current Management Actions:
 - Predator and herbivore monitoring and control—Outplantings at Kanaele Bog are within a fenced enclosure (NTBG 2011c; PEPP 2011).
 - Surveys and inventories—Surveys are ongoing and new occurrences have been found (PEPP 2011, 2014, 2015).
 - Captive propagation for genetic storage and reintroduction—Lyon Arboretum has over 1700 seeds from eight different founders from a total of three locations (Lyon Arboretum 2017). The Kokee rare Plant Facility has five plants of one of these founders (DOFAW 2016). NTBG has a few hundred seeds from six different locations. NTBG also has planted a few dozen plants in their gardens and around 300 plants in their nursery (NTBG 2017).
 - Reintroduction and translocation—NTBG has reintroduced over 500 individuals in a fenced enclosure at Kanaele Bog, in which 90 individuals remain (NTBG 2011c, 2013c; PEPP 2011; PEPP 2017). PEPP reintroduced over 200 individuals at Wailua River (Blue Hole) (PEPP 2017) (USFWS, 2017).
- RECOMMENDATIONS FOR FUTURE ACTIONS
 - Surveys and inventories—Continue to survey for populations of *Phyllostegia renovans* in areas of potentially suitable habitat.
 - Ungulate monitoring and control—Protect all occurrences against browsing and disturbances from feral ungulates. Continue to construct and maintain fenced enclosures around existing populations to prevent imminent extinction.
 - Invasive plant monitoring and control
 - o Control established ecosystem-altering nonnative invasive plant species around all populations.
 - o Control invasive nonnative plant species around all populations that compete with the species.
 - Rodent predation or herbivory control—Implement effective measures to control rodents around all populations.
 - Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock.
 - Reintroduction and translocation—Continue reintroduction of individuals into suitable habitat within historic range that is being managed for known threats to this species.
 - Population biology research—Study *Phyllostegia renovans* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats.
 - Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered throughout historic range to reduce impacts from landslides and storms.
 - Based on the recovery criteria above, consider development of a recovery plan (USFWS, 2017).

Conservation Measures and Best Management Practices:

- The Hawaii Division of Forestry and Wildlife has established over 20 small-scale enclosures, largely in lowland and montane mesic ecosystems, and continues to control invasive introduced plants within them. While these fenced areas are extremely small, they have allowed for small-scale protection of remaining wild populations and reintroductions of this species, preventing its extinction (Hawaii Division of Forestry and Wildlife 2005, The National Tropical Botanical Garden 2007) (USFWS, 2010a).

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SPECIES ACCOUNT: *Phyllostegia stachyoides* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2017)

Physical Description

A weakly erect to sprawling subshrub. Flowers are white, usually with the upper lip tinged pink. (NatureServe, 2015)

Taxonomy

Genus nearly endemic to Hawaii, species endemic to Molokai, Maui, and Hawaii. (NatureServe, 2015) A member of the mint family (Lamiaceae) (Wagner et al. 1999, p. 823) (USFWS, 2016).

Historical Range

Phyllostegia stachyoides is historically known from the eastern and central Molokai, west Maui, and wide-ranging occurrences on Hawaii Island (Wagner et al. 1999, p. 823; HBMP 2010; VanDeMark 2016, in litt.) (USFWS, 2016).

Current Range

Current range in Molokai, Maui, Hawaii. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Habitat Type

Adult: Mesic to wet forest (USFWS, 2015)

Dependencies on Specific Environmental Elements

Adult: Montane wet and montane mesic ecosystems (USFWS, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 3,600 to 4,600 ft. elevation (USFWS, 2015)

Habitat Narrative

Adult: *Phyllostegia stachyoides* occurs in mesic to wet forest at 3,600 to 4,600 ft (1,000 to 1,400 m), in the montane wet (Hawaii Island, Maui, and Molokai) and montane mesic (Hawaii Island and Maui) ecosystems (Wagner et al. 1999, p. 823; TNCH 2007; HBMP 2010) (USFWS, 2015).

Dispersal/Migration

Population Information and Trends

Population Trends:

Not available

Resiliency:

Low (inferred from USFWS, 2016)

Redundancy:

Low (inferred from USFWS, 2016)

Number of Populations:

Molokai: 5 (USFWS, 2016)

Population Size:

Maui: 15, Molokai: < 30 (USFWS, 2016)

Population Narrative:

Currently, occurrences on west Maui total about 15 individuals (Oppenheimer 2015, in litt.). Those on Molokai occur at 5 locations and total fewer than 30 individuals (Orlando 2015, in litt.; PEPP 2012, p. 156). Plants on Hawaii Island are now considered to be *P. ambigua* (VanDeMark 2016, in litt.) (USFWS, 2016). *P. stachyoides* was previously known from seven occurrences, totaling 20 individuals. Occurrences on west Maui, at Honokokau, Puu Kukui, Luakoi, and Lihau, total about 15 individuals. Those on Molokai occur at Kamakou, Hanalilolilo, and Kumueli (total of 5 individuals). Several individuals resembling *P. stachyoides* were observed at Kaohe on Hawaii Island; however, their identity is not yet confirmed (PEPP 2012, p. 156.). The known individuals are restricted to small areas on west Maui and Molokai, and continue to be negatively affected by habitat modification and destruction by ungulates and by direct competition with nonnative plants, combined with herbivory by slugs and rats. The small number of remaining individuals may limit this species' ability to adapt to environmental changes (USFWS, 2015).

Threats and Stressors

Stressor: Nonnative plants (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Nonnative plants such as *Erigeron karvinskianus*, *Tibouchina herbacea*, and *Ageratina adenophora* (Maui pamakani) compete with *P. stachyoides*, modify and destroy its native habitat, and displace other native Hawaiian plant species (Smith 1985, pp. 180–250; Vitousek et al. 1987 in Cuddihy and Stone 1990, p. 74) (USFWS, 2015).

Stressor: Herbivory (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Herbivory by slugs and rats on leaves and nutlets of *P. stachyoides* poses a threat to this species at known locations on Maui and Molokai (PEPP 2014, pp. 140–142) (USFWS, 2015).

Stressor: Stochastic events (USFWS, 2015)

Exposure:**Response:****Consequence:** Loss of habitat/extinction**Narrative:** On Maui, stochastic events such as drought pose a threat to small, isolated occurrences of *P. stachyoides*, and rockfalls and landslides pose a threat to occurrences on Molokai (PEPP 2014, pp. 140–142) (USFWS, 2015).**Stressor:** Climate change (USFWS, 2015)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** Climate change may result in alteration of the environmental conditions and ecosystems that support this species, through flooding and drought. *Phyllostegia stachyoides* may be unable to tolerate or respond to changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini et al. 2013, p. 84) (USFWS, 2015).**Stressor:** Feral ungulates (USFWS, 2015)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** Feral pigs, goats, and axis deer modify and destroy the habitat of *Phyllostegia stachyoides* on Maui, with evidence of the activities of these animals reported in areas where this species occurs (HBMP 2010) (USFWS, 2015).**Stressor:** Reduced vegetative vigor (USFWS, 2015)**Exposure:****Response:****Consequence:** Extinction**Narrative:** This species may experience reduced reproductive vigor due to reduced levels of genetic variability, leading to diminished capacity to adapt to environmental changes, and thereby lessening the probability of long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361) (USFWS, 2015).**Recovery****Recovery Actions:**

- A recovery plan has not been completed for this species.

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Endangered Status for 49 Species From the Hawaiian Islands

Proposed Rule. FR Vol. 80, No. 189. Pages 58820-58909.

Proposed Rule. FR Vol. 80, No. 189. Pages 58820-58909

SPECIES ACCOUNT: *Phyllostegia velutina* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

A climbing vine with dense, backward-pointing hairs on the leaves and square stems. The hairs are silky on the opposite, narrow, toothed leaves, which are 9.2 to 17.5 cm (3.6 to 6.9 inches) long and 2.5 to 5 cm (1 to 2 inches) wide. Six to 10 flowers are borne in an unbranched inflorescence with conspicuous leaflike bracts. The green bell-shaped calyx is 6 to 7 mm (0.2 to 0.3 inch) long, densely covered with upward-pointing hairs, and has triangular lobes. The white corolla is densely covered with upward-pointing hairs and is two-lipped, with a slightly curved tube about 12 mm (0.4 inch) long, upper lip 5 to 7 mm (0.2 to 0.3 inch) long, and lower lip 4 to 5 mm (0.1 to 0.2 inch) long. Fruits are divided into four nutlets about 4 to 5 mm (0.1 to 0.2 inch) long (USFWS, 1998).

Taxonomy

The genus is nearly endemic to the Hawaiian Islands, except one species in Tahiti. This species is endemic to the Mauna Loa region of the island of Hawaii (NatureServe, 2015). A member of the mint family (Lamiaceae). A study concluded that Hawaiian mints are evolutionarily (cladistically) nested within the North American genus *Stachys* L. If further studies corroborate these results then members of *Phyllostegia* may be transferred into the genus *Stachys* at a later time (USFWS, 2012).

Historical Range

Historically, *Phyllostegia velutina* was reported on the southern slopes of Hualalai and the eastern, western, and southern slopes of Mauna Loa (Wagner 1999; USFWS 2010) (USFWS, 2012).

Current Range

Current range includes slopes of Mauna Loa, Hawaii (NatureServe, 2015). It occurs in Puuwaawaa, Honuaula Forest Reserve, and Kulani /Keauhou area (USFWS, 2012).

Critical Habitat Designated

Yes; 7/2/2003.

Legal Description

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Phyllostegia velutina* on the island of Hawaii (68 FR 39623 - 39722).

Critical Habitat Designation

The critical habitat designation for *Phyllostegia velutina* includes two units totaling 9,009 acres in Hawaii County, Hawaii. The units are Hawaii 24—*Phyllostegia velutina*—a and Hawaii 30—*Phyllostegia velutina*—b. Both units are currently occupied. Each unit is geographically separated from other critical habitat for this island-endemic species within its historical range in order to reduce the likelihood of all recovery populations being destroyed by one naturally occurring

catastrophic event. The units designated for this species on the island of Hawaii provide habitat to support a total of 10 populations of *P. velutina*, each with 300 mature, reproducing individuals.

Hawaii 24—*Phyllostegia velutina*—a [2,466 ha (6,093 ac)]: This unit contains a portion of Uwewale and Waihaka gulches and is completely within the Pahala watershed. The unit also lies completely within the Kau Forest Reserve; provides habitat for 4 populations of 300 individuals of *P. velutina*; and is currently occupied by an unknown number of individuals. This unit is essential to the conservation of *P. velutina* because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population.

Hawaii 30—*Phyllostegia velutina*—b [1,180 ha (2,916 ac)]: This unit contains the northeastern portion of Kulani summit and lies completely within the Kaahakini watershed. The unit also lies completely within Olaa-Kilauea partnership lands. In combination with the adjacent excluded Kamehameha Schools lands, this unit provides habitat for 6 populations of 300 individuals of *P. racemosa* and is currently occupied by 6 individuals (there also is 1 individual in the excluded adjacent lands). This unit is essential to the conservation of *P. velutina* because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable.

Primary Constituent Elements/Physical or Biological Features

Habitat features that are essential for this species include, but are not limited to, *Metrosideros polymorpha*-*Acacia koa* dominated montane mesic and wet forests.

Special Management Considerations or Protections

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for this species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Lifespan

Adult: < 10 years (USFWS, 2012)

Reproduction Narrative

Adult: It is a short-lived perennial (fewer than ten years) (USFWS, 2012).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Ohia and koa montane dry, mesic, and wet forest (USFWS, 2012; 1998)

Geographic or Habitat Restraints or Barriers

Adult: 4,900 - 6,000 ft. elevation (USFWS, 1998)

Habitat Narrative

Adult: Inhabits moist and wet forests on old volcanic substrates (NatureServe, 2015). The species is found in montane mesic and dry forests to montane wet forests with annual rainfall that varies from 12 to over 100 inches (300 to over 2,000 millimeters) (USFWS, 2012). *Phyllostegia velutina* typically grows in ohia- and koa-dominated Montane Mesic and Wet Forests at elevations between 1,490 and 1,800 meters (4,900 and 6,000 feet) (USFWS, 1998).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Species Trends:

121 reintroductions since 1991 (USFWS, 2012)

Resiliency:

Very low (inferred from USFWS, 2012; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2012)

Number of Populations:

3 - 4 (USFWS, 2012)

Population Size:

> 116 (USFWS, 2012)

Population Narrative:

Currently, *Phyllostegia velutina* is known from populations in three areas with estimates of more than 116 individuals (USFWS 1998; Giffin 2009; N. Agorastos, pers. comm. 2011). Another population was reported from the general area of Waiea Tract on State-owned land in South Kona, but the exact location and current status of this population are unknown (USFWS 1998).

Since 1991, a total of 121 individuals of *Phyllostegia velutina* have been reintroduced into Hakalau Forest National Wildlife Refuge (Jeffrey and Horiuchi 2008) (USFWS, 2012).

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Cattle (*Bos taurus*), feral pigs (*Sus scrofa*), sheep (*Ovis aries*); invasive plants: *Pennisetum clandestinum* (kikuyu grass), *Pennisetum setaceum* (fountain grass), *Rubus ellipticus* (yellow Himalayan raspberry); volcanic activity; logging; road clearing (USFWS, 2012).

Stressor: Herbivory (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Land snails have been reported on leaves of *Phyllostegia velutina*, although the species were not indicated (Giffin 2009). A heteropteran species of the genus *Sarona* (mirid leaf bugs) and an undetermined species of leafhopper (*Nesophyrne* sp.) have been observed on *P. velutina* (Giffin 2009) (USFWS, 2012).

Stressor: Human disturbance (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Prison expansion (USFWS 1996, 2010); Hiking, trail maintenance, road work, ranching, and logging (USFWS 1996) (USFWS, 2012).

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species (USFWS, 2012).

Recovery

Reclassification Criteria:

1. A total of five to seven populations should be documented on the Big Island (USFWS, 1998).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1998).
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1998).

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on the Big Island (USFWS, 1998).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1998).
3. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1998).

Recovery Actions:

- Protect current populations and manage threats (USFWS, 1998).
- Conduct essential research (USFWS, 1998).
- Expand existing wild populations, as necessary (USFWS, 1998).
- Create new populations within historical range, as necessary (USFWS, 1998).
- Evaluate and validate recovery objectives (USFWS, 1998).
- Construct fenced exclosures around the known population on private property, and initiate removal of feral ungulates and alien plants (USFWS, 1998).
- Outplant new populations in area of reduced threat (USFWS, 1998).
- Construct fenced exclosure around a small group of ~20 individuals at Kulani and remove feral pigs and cattle within the exclosure (USFWS, 1998).

Conservation Measures and Best Management Practices:

- Captive propagation for genetic storage and reintroduction: Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation and genetic storage. Collect cuttings or seed from tagged individuals, keeping close track of the maternal source for use in ex situ propagation (USFWS, 2012).
- Reintroduction / translocation implementation – Continue to reintroduce the species back into its known historical range (USFWS, 2012).
- Reintroduction / translocation site identification – While surveying for new populations or reintroduced populations, determine which sites are least invaded by invasive introduced plant species and which appear to have the highest likelihood of maintaining new reintroductions (USFWS, 2012).
- Ungulate exclosures – Continue to construct fenced exclosures around all populations. Reinforce existing fencing, if there is evidence that it is being breached (USFWS, 2012).
- Ungulate control – Protect all populations against disturbances from feral ungulates (USFWS, 2012).
- Ecosystem-altering invasive plant species control – Control invasive introduced plant species around all populations (USFWS, 2012).
- Surveys / inventories – Survey the historical range of the species for additional populations (USFWS, 2012).
- Site / area / habitat protection – Develop and implement effective measures to reduce the impact of timber management (logging), road clearing, human disturbance, and hiking and trail maintenance (USFWS, 2012).
- Threat monitoring and control – Continue to survey known populations for evidence of plant disease and insect predation. If threats are found, implement effective control methods (USFWS, 2012).

- Population biology research – Carry out field studies to determine what agents pollinate the flowers and disperse the seeds of this species (USFWS, 2012).
- Alliance and partnership development – Work with the Hawaii Division of Forestry and Wildlife, Hakalau Forest National Wildlife Refuge, and other land managers to continue implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2012).
- Threats research – Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2012).

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SPECIES ACCOUNT: *Phyllostegia waimeae* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/25/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

A rambling subshrub. Flowers are pale pink to pink (NatureServe, 2015). Characteristics that distinguish this species from others in the genus are the nearly stalkless bracts that partially overlap and cover the flowers, and relatively fewer oil glands on the leaves (Wagner et al. 1999) (USFWS, 2003).

Taxonomy

A nonaromatic member of the mint family (Lamiaceae) (USFWS, 2008).

Historical Range

Historically, *Phyllostegia waimeae* was known from Kaholuamanu and Kaaha on Kauai (USFWS, 2003).

Current Range

Phyllostegia waimeae is currently known to occur in two locations on Kauai; Kawaiiki and the Koaie drainage above Twin Falls (USFWS, 2008).

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Phyllostegia waimeae* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Phyllostegia waimeae* includes two units in Kauai County, Hawaii; unit a totals 901 acres; the acreage for unit b is not provided. The units are Kauai 11—*Phyllostegia waimeae*—a, b.

Kauai 11—*Phyllostegia waimeae*—a This unit is critical habitat for *Phyllostegia waimeae* and is 365 ha (901 ac) on State land (Alakai Wilderness Preserve), containing portions of Kawaiiki Ridge. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Phyllostegia waimeae* and is currently occupied with six plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, *Acacia koa*-*Metrosideros polymorpha* dominated wet or mixed mesic forest with *Cheirodendron* spp. or *Dicranopteris linearis* as co-dominants. Although the Service does not feel that there is enough habitat designated to reach the recovery goal of 8 to 10 populations, this species is a very narrow endemic and probably never naturally occurred in more than a single or a few populations.

There is no description provided for Kauai 11—*Phyllostegia waimeae*—b.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) *Acacia koa*-*Metrosideros polymorpha* dominated wet or mixed mesic forest with *Cheirodendron* spp. or *Dicranopteris linearis* as co-dominants and containing one or more of the following associated native plant species: *Broussaisia arguta*, *Claoxylon sandwichense*, *Diplazium sandwichianum*, *Dubautia knudsenii*, *Elaphoglossum* spp., *Gunnera kauaiensis*, *Hedyotis* spp., *Myrsine lanaiensis*, *Pleomele aurea*, *Psychotria* spp., *Sadleria* spp., *Scaevola procera*, *Syzygium sandwichensis*, or *Vaccinium* spp.; and

(ii) Elevations between 655 and 1,224 m (2,149 and 4,016 ft).

Special Management Considerations or Protections

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species in paragraph (b) of this section and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Lifespan**

Adult: < 10 years (USFWS, 2008)

Breeding Season

Adult: Unknown (USFWS, 2003)

Key Resources Needed for Breeding

Adult: Unknown (USFWS, 2003)

Reproduction Narrative

Adult: It is a short-lived perennial (fewer than 10 years) (USFWS, 2008). Flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown Service 1995) (USFWS, 2003).

Habitat Type

Adult: Terrestrial; riparian (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Wet ohia-koa forest, mixed mesic forest (USFWS, 2003)

Geographic or Habitat Restraints or Barriers

Adult: 2,149 - 4,016 ft. elevation (USFWS, 2003)

Habitat Narrative

Adult: Inhabits moist and wet forests on gulch slopes and along streams (NatureServe, 2015). This species typically grows in Acacia koa-Metrosideros polymorpha dominated wet or mixed mesic forest with Cheirodendron spp. or Dicranopteris linearis as co-dominants at elevations between 655 and 1,224 m (2,149 and 4,016 ft.) (USFWS, 2003).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Very low (inferred from USFWS, 2003)

Redundancy:

Very low (inferred from USFWS, 2003)

Number of Populations:

1-2 (USFWS, 2017)

Population Size:

1-11 (USFWS, 2017)

Population Narrative:

Currently, one occurrence with six individuals persists on State land in Kawaiiki Valley within the Na Pali-Kona Forest Reserve (K. Wood, in litt. 2001) (USFWS, 2003). New Status Information: In addition to those populations cited in the previous 5-year review, new observations include the following: • At the time of the last 5-year review in 2008 there were four individuals last observed in Kawaiiki in 2002, and two individuals last observed in Koaie in 2001, but their status in 2008 was unknown. PEPP has been monitoring this species since that time. There were two individuals in Kawaiiki as of 2011, and nine individuals at Koaie as of 2014 (NTBG 2009, 2010; PEPP 2011, 2014). Clark (2015) reports one occurrence of one individual (USFWS, 2017).

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Major threats to *P. waimeae* include feral pigs (*Sus scrofa*) and goats (*Capra hircus*) uprooting plants and causing habitat degradation and erosion. Habitat degradation is also caused by invasive introduced plant species such as *Grevillea robusta* (silk oak), *Morella/aya* (firetree), *Rubus argutus* (prickly Florida blackberry), *Psidium cattleianum* (strawberry guava), and *Lantana camara* (*Lantana*) that compete with and degrade habitat of *P. waimeae* (USFWS, 2008).

Stressor: Disease and predation (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Rats (*Rattus* spp.) eat leaves and seeds. In the nursery, *P. waimeae* is attacked by spider mites, mealy bugs, *Phytophthora* fungus and mildew (R. Nishek, National Tropical Botanical Garden, pers. comm. 2006) (USFWS, 2008).

Stressor: Collection (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Over-collecting for scientific purposes (USFWS, 2008).

Stressor: Small population size (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: This species is at risk of extinction from stochastic events and reduced reproductive vigor due to the small number of individuals (68 FR 9116; Perlman 2006; Wood 2006) (USFWS, 2008).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Phyllostegia waimeae* is extremely vulnerable to the impacts of climate change, with a vulnerability score of 0.98 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this species has no overlap between current and future climate envelopes, and is unlikely to tolerate expected changes in climate at its last known location. This means that this species must persist within suitable microrefugia, or move to newly available climate-compatible areas to avoid extinction. Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Stressor: Fire destruction or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Fire can destroy dormant seeds as well as individual plants. Successive fires burn farther and farther into native habitat and alter microclimate conditions to further alter habitat conditions to favor nonnative plants. Nonnative plants convert native plant communities to nonnative dominated plant communities D'Antonio and Vitousek 1992; Tunison et al. 2002). Fire is noted as a threat to *Phyllostegia waimeae* at Kawaiiki (NTBG 2009) (USFWS, 2017).

Stressor: Hurricanes—Loss and degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Hurricanes were omitted in the last five year review. In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event, and 70 percent of all listed plant species on Kauai are only found on Kauai. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013) (USFWS, 2017).

Recovery

Reclassification Criteria:

1. A total of five to seven populations should be documented on Kauai and at least one other island where they now occur or occurred historically (USFWS, 1995).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population for short-lived perennials (USFWS, 1995).

3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 1995).

Delisting Criteria:

1. A total of eight to ten populations should be documented on Kauai and at least one other island where they now occur or occurred historically (USFWS, 1995).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population for short-lived perennials (USFWS, 1995).

3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 1995).

Recovery Actions:

- Protect current populations, control threats and monitor (USFWS, 1995).
- Expand current populations (USFWS, 1995).
- Conduct research essential to conservation of the species (USFWS, 1995).
- Establish new populations as needed to reach recovery objectives (USFWS, 1995).
- Validate and revise recovery objectives (USFWS, 1995).
- Devise and implement a public education program (USFWS, 1995).
- In order to prevent this taxon from going extinct, this taxon first needs to be relocated (USFWS, 1995).
- Propagation efforts and the maintenance of adequate genetic stock ex situ should be undertaken immediately, as well as the protection of remaining wild individuals from feral goats and alien weed threats (USFWS, 1995).
- New Management Actions: • PEPP has outplanted a total of 126 individuals in two areas within a fenced enclosure at Kawaiiki (PEPP 2010, 2011, 2012, 2013, 2014). The area is monitored and nonnative plants are removed. Eighteen plants are currently alive (PEPP 2017). • Kokee Resource Conservation Program controls the nonnative *Sphaeropteris cooperi* (Australian tree fern) at the Kawaiiki wild population (PEPP 2010). • NTBG is collecting seeds from the Kawaiiki population for storage and propagation (NTBG 2013). PEPP reports collecting hundreds of seeds and some cuttings for storage and propagation at Lyon Arboretum and NTBG (PEPP 2010, 2011, 2012). There are three founders represented by seeds in the Lyon Arboretum seed bank from the Kawaiiki population, collected in 2010 and 2011. There are three plants at the NTBG nursery from a fruit collection from one of the same three founders that is at Lyon. There is one plant in the NTBG nursery that represents a clone from a founder at the Koaie population. This one plant is the only representation of this population (USFWS, 2017).
- Recommendations for Future Actions: Fire is reported as a new threat at the Kawaiiki population. No other significant new information regarding the species' biological status has come to light since the last 5-year review in 2008. Therefore, the following

recommendations for future actions are added or reiterated for 5-year review for 2017. • Surveys and inventories—Survey suitable habitat within historic range to locate additional individuals. • Ungulate monitoring and control—Protect all occurrences against disturbances from feral ungulates. Fence remaining populations and control ungulates to maintain the remaining populations and prevent imminent extinction. Maintain current fenced exclosures. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative species that compete with the species around all populations. • Fire monitoring and control—Develop and implement fire prevention management plans. • Predator and herbivore control research—Study *Phyllostegia waimeae* populations to determine level of threat from invertebrate herbivory and any additional needed recovery actions. • Predator and herbivore monitoring and control—Implement effective measures to control rodents around all known populations. • Captive propagation for genetic storage and reintroduction—Continue to increase the number of individuals in cultivation and genetic storage through controlled propagation. • Reintroduction and translocation—Continue to reintroduce populations in areas of suitable habitat that can be protected from goats, other ungulates, and rats. Augment populations as plants and protected habitat become available. • Human interaction monitoring and management—Develop and implement effective measures to prevent the impacts of collecting. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and drought. • Population biology research—Study *Phyllostegia waimeae* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Increase the number of individuals in cultivation and genetic storage through controlled propagation (USFWS, 2008).
- Survey for populations in suitable habitat within historical sites (USFWS, 2008).
- Augment populations as plants become available in nurseries and habitat is protected (USFWS, 2008).
- Reintroduce populations in areas of suitable habitat that can be protected from goats and other ungulates, rats, and human disturbance (USFWS, 2008).
- Fence remaining populations and control ungulates to maintain the remaining populations (USFWS, 2008).
- Control introduced invasive plant species around the remaining populations (USFWS, 2008).
- Study new or reintroduced *Phyllostegia waimeae* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2008).

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SPECIES ACCOUNT: *Phyllostegia warshaueri* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

Either a sprawling or climbing vine with end branches turning up, covered with upward-pointing fine, short hairs on the square stems which are about 1 to 3 meters (3.3 to 10 feet) long. The opposite, nearly hairless, toothed leaves are 9.5 to 20 cm (3.7 to 7.9 inches) long and 2 to 6.6 cm (0.8 to 2.6 inches) wide. Six to 14 flowers are borne in an unbranched inflorescence up to 20 cm (7.9 inches) long with a main stalk 25 to 40 mm (1.0 to 1.6 inches) long and conspicuous leaflike bracts. The green, hairless, cone-shaped calyx is 6 to 8 mm (0.2 to 0.3 inch) long and has triangular lobes. The corolla is white with a dark rose upper lip, sparsely hairy, and has a tube about 18 to 20 mm (0.7 to 0.8 inch) long, upper lip about 6 mm (0.2 inch) long, and lower lip 12 to 15 mm (0.5 to 0.6 inch) long. Fruits are divided into four nutlets about 6 to 7 mm (0.2 to 0.3 inch) long (USFWS, 1998).

Taxonomy

A member of the mint family (Lamiaceae). A study found a large but poorly resolved clade that included species of *Phyllostegia* intermixed with members of *Stenogyne*. These genera may in time be merged with *Stachys* if further data corroborate initial studies (Lindqvist and Albert 2002; Lindqvist et al. 2003) (USFWS, 2012).

Historical Range

Historically, *Phyllostegia warshaueri* is known from the northern slopes of Mauna Kea (Laupahoehoe) and from the Kohala Mountains (Wagner et al. 1999) (USFWS, 2012).

Current Range

Current range includes Northern Island of Hawaii (NatureServe, 2015). Individuals have been reintroduced at Kohala, Laupahoehoe Natural Area Reserve, and Puuwaawaa (USFWS, 2012).

Critical Habitat Designated

Yes; 7/2/2003.

Legal Description

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Phyllostegia warshaueri* on the island of Hawaii (68 FR 39623 - 39722).

Critical Habitat Designation

The critical habitat designation for *Phyllostegia warshaueri* includes two units totaling 9,013 acres in Hawaii County, Hawaii. The units are Hawaii 3—*Phyllostegia warshaueri*—a and Hawaii 8—*Phyllostegia warshaueri*—b. Both units are occupied. Each unit is essential to the conservation of *P. warshaueri* because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The units are geographically separated for this island-endemic species within its historical range in order to reduce the likelihood of all recovery populations being destroyed by one naturally

occurring catastrophic event. The two unit being designated for this species on the island of Hawaii provide habitat for a total of 10 populations, each with 300 mature, reproducing individuals.

Hawaii 3—*Phyllostegia warshaueri*— a [2,471 ha (6,105 ac)]: This unit contains portions of Haakoa, Kilau, and Kawilahilahi streams and is bordered in the northwest by the Kaiwiki and Kaula watersheds, in the southeast by the Maulua watershed, and has portions of the Haakoa, Kaawali, Kaiwilahilahi, Kilau, Laupahoehoe, Manowaiopae, and Pahala watersheds in the central portion. This unit contains a portion of Hilo Forest Reserve, Manowaialee Forest Reserve, and Laupahoehoe NAR. The unit provides habitat for 7 populations of 300 individuals each of *P. warshaueri* and is currently occupied by 13 individuals.

Hawaii 8—*Phyllostegia warshaueri*— b [1,177 ha (2,908 ac)]: This unit contains Kaiholena summit and Puu Ohu, and the northern portion is in the Wailoa/Waipio watershed, with the southern portion in the Waikoloa/ Waiulaula watershed. The unit is completely within the Kohala Forest Reserve; provides habitat for 3 populations of 300 individuals of *P. warshaueri*; and is currently occupied by 1 individual.

Primary Constituent Elements/Physical or Biological Features

Habitat features that are essential for this species include, but are not limited to, *Metrosideros polymorpha* and *Cibotium montane* and lowland wet forest in which *Acacia koa* or *Cheirodendron trigynum* may co-dominate.

Special Management Considerations or Protections

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for this species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Lifespan

Adult: < 10 years (USFWS, 2012)

Breeding Season

Adult: Unknown (USFWS, 2012)

Key Resources Needed for Breeding

Adult: Unknown (USFWS, 2012)

Reproduction Narrative

Adult: It is a short-lived perennial (fewer than 10 years). Its flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors remain unknown (USFWS 2002) (USFWS, 2012).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Ohia and hapuu montane and lowland wet forests (USFWS, 2012)

Geographic or Habitat Restraints or Barriers

Adult: 2,395 - 3,773 ft. elevation (USFWS, 2012)

Habitat Narrative

Adult: Inhabits wet forests on old volcanic substrates (NatureServe, 2015). *Phyllostegia warshaueri* is typically found on old volcanic substrates between 730 and 1,150 meters (2,395 to 3,773 feet) elevation (USFWS 1998). It occurs in *Metrosideros polymorpha* (ohia) and *Cibotium* spp. (hapuu) forests in montane and lowland wet forests, where *Acacia koa* (koa) or *Cheirodendron trigynum* (olapa) may co-dominate (USFWS 1998, 2002) (USFWS, 2012).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Very low (inferred from NatureServe, 2015; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2012)

Number of Populations:

4 - 7 (inferred from USFWS, 2012)

Population Size:

3 wild, 197 reintroduced (USFWS, 2012)

Population Narrative:

There are only three wild individuals known. The Volcano Rare Plant Facility (2011) reported 197 individuals were reintroduced between 2010 and 2011 at Kohala (155 individuals), Laupahoehoe Natural Area Reserve (28 individuals), and Puuwaawaa (14 individuals) (USFWS, 2012).

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Feral pigs (*Sus scrofa*), cattle (*Bos taurus*); invasive plants: *Clidemia hirta* (Koster's curse), *Cyathea cooperi* (Australian tree fern), *Hedychium gardnerianum* (kahili ginger), *Psidium cattleianum* (strawberry guava); agricultural and urban development: ditch improvements and maintenance (USFWS 1996, 1998; Hawaii Department of Land and Natural Resources 2005) (USFWS, 2012).

Stressor: Small population size (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Low numbers (USFWS 1996, 1998; Hawaii Department of Land and Natural Resources 2005) (USFWS, 2012).

Stressor: Human disturbance (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Hiking and trail maintenance (USFWS 1996, 1998; Hawaii Department of Land and Natural Resources 2005) (USFWS, 2012).

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species (USFWS, 2012).

Recovery**Reclassification Criteria:**

1. A total of five to seven populations should be documented on the Big Island (USFWS, 1998).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1998).

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1998).

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on the Big Island (USFWS, 1998).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1998).
3. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1998).

Recovery Actions:

- Protect current populations and manage threats (USFWS, 1998).
- Conduct essential research (USFWS, 1998).
- Expand existing wild populations, as necessary (USFWS, 1998).
- Create new populations within historical range, as necessary (USFWS, 1998).
- Evaluate and validate recovery objectives (USFWS, 1998).
- Construct fenced exclosures on State lands in the Kohala Mountains and Laupahoehoe around the known populations, and initiate removal of feral ungulates and alien plants from its habitat (USFWS, 1998).
- Outplant new populations in areas of reduced threat (USFWS, 1998).

Conservation Measures and Best Management Practices:

- Captive propagation for genetic storage and reintroduction: Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation and genetic storage. Collect cuttings or seed from tagged individuals, keeping close track of the maternal source for use in ex situ propagation (USFWS, 2012).
- Reintroduction / translocation site identification – Reintroduction attempts should be made in the Kohala Mountains and Laupahoehoe Natural Area Reserve within sites that are free from ungulates (fenced) and introduced invasive plant species (USFWS, 2012).
- Reintroduction / translocation implementation – Continue to reintroduce the species back into its known historical range (USFWS, 2012).
- Genetic research – Conduct genetic fingerprinting research to determine the relative level of genetic diversity among remaining individuals (USFWS, 2012).
- Ecosystem-altering invasive plant species control – Control invasive introduced plant species around all populations (USFWS, 2012).
- Ungulate exclosures – Continue to construct ungulate-proof fenced exclosures around all known populations in the Kohala Mountains and Laupahoehoe area (USFWS, 2012).
- Ungulate control – Protect all populations against disturbances from feral ungulates (USFWS, 2012).
- Surveys / inventories – Re-survey the known historical range of the species for surviving populations and potentially undiscovered populations (USFWS, 2012).
- Site / area / habitat protection – Develop and implement effective measures to reduce the impact of road clearing and hiking and trail maintenance (USFWS, 2012).

- Population biology research – Carry out field studies to determine what agents pollinate the flowers and disperse the seeds of this species and other aspects of its life history cycle (USFWS, 2012).
- Threat monitoring and control – Monitor the health of existing populations and determine if any insects or plant diseases might be affecting the survival of individuals. If threats are found, implement effective control methods (USFWS, 2012).
- Alliance and partnership development – Work with the Hawaii Division of Forestry and Wildlife and other land managers to continue implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2012).
- Threats research – Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2012).

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SPECIES ACCOUNT: *Phyllostegia wawrana* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

A probably sprawling, perennial herb, woody toward the base. Flower color unknown (NatureServe, 2015).

Taxonomy

A nonaromatic member of the mint family (Lamiaceae) (USFWS, 2003). This genus is endemic to Hawaii except 1 species in Tahiti, this species is endemic to northern Kauai (NatureServe, 2015).

Historical Range

Phyllostegia wawrana was reported to be found at Hanalei on Kauai in the 1800s and along Kokee Stream in 1926 (USFWS, 2003).

Current Range

It currently occurs in Koaie Canyon, Moaalele, Awaawapuhi Valley, and Makaleha on State-owned land within the Alakai Wilderness Preserve, Hono o Na Pali NAR, and Kokee State Park (GDSI 2000; HINHP Database 2000) (USFWS, 2003).

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Phyllostegia wawrana* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Phyllostegia wawrana* includes four units totaling 4,318 acres in Kauai County, Hawaii. The units are Kauai 4—*Phyllostegia wawrana*—a and Kauai 11—*Phyllostegia wawrana*—b, c, d.

Kauai 4—*Phyllostegia wawrana*—a: This unit is critical habitat for *Phyllostegia wawrana* and is 351 ha (871 ac) on State (Kealia Forest Reserve) and private land. This unit contains Leleiwi, Makaleha, Uluawaa, and Wekiu Summits. This unit provides habitat for two populations of 300 mature, reproducing individuals of the shortlived perennial *Phyllostegia wawrana* and is currently occupied with 25 to 35 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, *Acacia koa*-*Metrosideros polymorpha*-*Cheirodendron* mixed mesic forest. This unit is geographically separated from the other three units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 11—*Phyllostegia wawrana*—b: This unit is critical habitat for *Phyllostegia wawrana* and is 1,038 ha (2,565 ac) on State (Alakai Wilderness Preserve, Halelea Forest Reserve, Hono o Na Pali NAR, and Na Pali Coast State Park) and private land. This unit contains Hanakoa Valley, and Alealau Summit, Hono O Napali, Keanapuka, Moaalele, Pali eleele, Pohakea, Puu Ki, and Waiahuakua Summits. This unit provides habitat for three populations of 300 mature, reproducing individuals of the short-lived perennial *Phyllostegia wawrana* and is currently occupied with three plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, *Acacia koa*-*Metrosideros polymorpha*-*Cheirodendron* mixed mesic forest. This unit is geographically separated from the other three units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Phyllostegia wawrana*—c: This unit is critical habitat for *Phyllostegia wawrana* and is 108 ha (268 ac) on State land (Alakai Wilderness Preserve), containing portions of Kipalau Valley. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial *Phyllostegia wawrana* and is currently occupied with 1 to 10 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, *Acacia koa*-*Metrosideros polymorpha*-*Cheirodendron* mixed mesic forest. This unit is geographically separated from the other three units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Phyllostegia wawrana*—d: This unit is critical habitat for *Phyllostegia wawrana* and is 251 ha (620 ac) on State land (Kokee and Na Pali Coast State Parks). This unit contains portions of Honopu Trail, Kainamanu and Kalahu Summits, and Kalalau Lookout. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Phyllostegia wawrana* and is currently occupied with 5 to 6 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, *Acacia koa*-*Metrosideros polymorpha*-*Cheirodendron* mixed mesic forest. This unit is geographically separated from the other three units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) *Acacia koa*-*Metrosideros polymorpha*-*Cheirodendron* mixed mesic forest containing one or more of the following associated native plant species: *Alectryon macrococcus*, *Asplenium polyodon*, *Athyrium microphyllum*, *Carex* spp., *Claoxylon sandwicense*, *Cyanea fissa*, *Delissea rivularis*, *Dianella sandwicensis*, *Diplazium sandwichianum*, *Dodonaea viscosa*, *Doodia kunthiana*, *Dryopteris wallichiana*, *Dubautia knudsenii*, *Dubautia laevigata*, *Hedyotis tryblum*, *Machaerina angustifolia*, *Panicum nephelophilum*, *Peperomia* spp., *Perrottetia sandwicensis*, *Poa*

sandwicensis, Pleomele aurea, Pteridium aquilinum var. decompositum, Sadleria pallida, Scaevola procera, Schiedea stellarioides, Syzygium sandwicensis, Touchardia latifolia, or Vaccinium dentatum; and

(ii) Elevations between 400 and 1,284 m (1,311 and 4,212 ft).

Special Management Considerations or Protections

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species in paragraph (b) of this section and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Lifespan

Adult: < 10 years (USFWS, 2009)

Reproduction Narrative

Adult: It is a short-lived perennial (fewer than ten years) (USFWS, 2009).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Mixed mesic forest (USFWS, 2003)

Geographic or Habitat Restraints or Barriers

Adult: 1,306 - 4,212 ft. elevation (USFWS, 2003)

Habitat Narrative

Adult: Inhabits moist and wet forests on slopes (NatureServe, 2015). This species grows at elevations between 398 and 1,284 m (1,306 and 4,212 ft.) in Acacia koa-Metrosideros polymorpha-Cheirodendron mixed mesic forest (USFWS, 2003).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Increasing (USFWS, 2009)

Resiliency:

Very low (inferred from USFWS, 2003; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2009)

Number of Populations:

2-3 (USFWS, 2017)

Population Size:

~3-6 (USFWS, 2017)

Population Narrative:

In 2004, new surveys increased the numbers to approximately 45 to 55 individuals in three populations (Perlman 2006) (USFWS, 2009). At the time of the last 5-year review in 2009 there were three populations totaling 45 to 55 individuals. NTBG and PEPP have been monitoring this species since that time. Clark (2015) reports two subpopulations totaling three individuals. Currently, there are three populations, two individuals in Koaie valley, one individual in Mohihi, and approximately three individuals in Makaleha (NTBG 2015a-c, 2016; PEPP 2015; PEPP 2017) (USFWS, 2017).

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The major threats to *Phyllostegia wawrana* include habitat degradation by feral pigs (*Sus scrofa*) and goats (*Capra hircus*) (USFWS, 2009).

Stressor: Invasive plants (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Competition with introduced invasive plant species such as *Rubus rosifolius* (thimbleberry), *R. argutus* (prickly Florida blackberry), *Erigeron karvinskianus* (daisy fleabane), *Passiflora tarminiana* (banana poka), *Paspalum conjugatum* (Hilo grass), *Erechtites valerianifolia* (fireweed), and *Melastoma candidum* (Indian rhododendron) (USFWS 1996, 1998, 2003, 2008) (USFWS, 2009).

Stressor: Small population size (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Species like *Phyllostegia wawrana* that are endemic to a small portion of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides and disease outbreaks (USFWS, 2009).

Stressor: Rodent predation or herbivory

Exposure:

Response:

Consequence:

Narrative: Herbivory by rats is noted to be a threat to *Phyllostegia wawrana* at both the Koaie and Mohihi populations (NTBG 2013, 2014, 2015b-c; PEPP 2014, 2015). Rats eat virtually every part of plants and at every stage: fleshy fruits, seeds, flowers, stems, leaves, shoot, seedlings, and roots (Russell 1980; Cuddihy and Stone 1990). The effects on plants range from reduced vigor and decreased reproduction to mortality of individuals and complete lack of recruitment (USFWS, 2017).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: —Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Phyllostegia wawrana* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.556 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery

Reclassification Criteria:

1. A total of five to seven populations should be documented on Kauai and at least one other island where they now occur or occurred historically (USFWS, 1998).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population for short-lived perennials (USFWS, 1998).
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 1998).

Delisting Criteria:

1. A total of eight to ten populations should be documented on Kauai and at least one other island where they now occur or occurred historically (USFWS, 1998).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population for short-lived perennials (USFWS, 1998).
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 1998).

Recovery Actions:

- Protect current populations, control threats and monitor (USFWS, 1998).
- Expand current populations (USFWS, 1998).
- Conduct research essential to conservation of the species (USFWS, 1998).
- Establish new populations as needed to reach recovery objectives (USFWS, 1998).
- Validate and revise recovery objectives (USFWS, 1998).
- Devise and implement a public education program (USFWS, 1998).
- Maintenance of adequate genetic stock (USFWS, 1998).
- Construct enclosures to protect against feral ungulates and control alien plant species (USFWS, 1998).
- New Management Actions: • PEPP has outplanted 13 individuals within a fenced enclosure along Waimea Canyon rim (PEPP 2017). The area is monitored and nonnative plants are removed. • NTBG is collecting seeds and cuttings from the Koaie and Mohihi populations for storage and propagation (NTBG 2017). PEPP reports collecting seeds and some cuttings for storage and propagation at Lyon Arboretum and NTBG (PEPP 2014, 2015). Two founders from Mohihi are represented in the Lyon Arboretum Micropropagation Lab. Those two founders, plus one founder from Koaie, are represented at the Lyon Arboretum Seed Bank (Lyon Arboretum 2017). One of the represented Mohihi founders is also at the Kokee Rare Plant Facility (DOFAW 2016). The other represented Mohihi founder is at the NTBG nursery, along with a second founder from the Koaie population which is represented as a clone via cuttings (NTBG 2017). In total, four of six plants of this species are represented in off-site collections (USFWS, 2017).
- Recommendations for Future Actions: Rodent predation and herbivory is reported as a new threat at the Koaie and Mohihi populations. No other significant new information regarding the species' biological status has been reported since the last 5-year review in 2009.

Therefore, the following recommendations for future actions are added or reiterated for 5-year review for 2017. • Surveys and inventories—Survey for populations of *Phyllostegia wawrana* in areas of potentially suitable habitat. • Ungulate monitoring and control—Protect all occurrences against disturbances from feral ungulates. Construct small-scale enclosure fences to protect remaining individuals from the negative impacts of feral ungulates to prevent imminent extinction. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative species that compete with the species around all populations. • Predator and herbivore monitoring and control—Implement effective measures to control rodents around all known populations. • Captive propagation for genetic storage and reintroduction—Increase the number of individuals in cultivation and genetic storage through controlled propagation. • Reintroduction and translocation—Continue to reintroduce plants within historic range or suitable habitat within protected areas. • Genetic research—Assess genetic variability within extant populations. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from reduced reproductive vigor. • Population biology research—Study *Phyllostegia wawrana* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Develop methods for propagation and establish ex situ genetic collection (USFWS, 2009).
- Construct enclosure fences to protect individuals from the negative impacts of feral ungulates, and eradicate introduced invasive plant species within the enclosures (USFWS, 2009).
- Enhance current natural populations to increase the number of individuals (USFWS, 2009).
- Survey geographical and historical range for a thorough current assessment of species (USFWS, 2009).
- Assess genetic variability within extant populations (USFWS, 2009).
- Study *Phyllostegia wawrana* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2009).

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SPECIES ACCOUNT: *Physaria douglasii* ssp. *tuplashensis* (White Bluffs bladderpod)

Species Taxonomic and Listing Information

Listing Status: Threatened; 05/23/2013; Pacific Region (R1) (USFWS, 2016)

Physical Description

White Bluffs bladderpod is a low growing, herbaceous, perennial plant with a sturdy tap root and a dense rosette of broad gray-green pubescent leaves (WDNR 2010). The subspecies produces showy yellow flowers (USFWS, 2013a).

Taxonomy

Although specimens of this taxon were originally collected from a population in 1883, the plant material was in poor condition, no definitive identification could be made, and the plant was not recognized as a species at that time. The population was rediscovered in 1994, and was described and published as a species, *Lesquerella tuplashensis*, by Rollins et al. (1996, pp. 319–322). Based on molecular, morphological, phenological, reproductive, and ecological data, the conclusions in AlShehbaz and O’Kane (2002, p. 322) and Caplow et al. (2006, pp. 8–10) combining the genera *Lesquerella* and *Physaria* and reducing the species *Lesquerella tuplashensis* to *Physaria douglasii* subsp. *tuplashensis*, provide the most consistent and compelling information available to date (USFWS, 2013a).

Historical Range

In 1996, White Bluffs bladderpod was only known from a single population that occurred along the upper edge of the White Bluffs of the Columbia River in Franklin County, Washington (USFWS, 2013a). It is endemic to a small band about 17 km long by about 10 meters wide (NatureServe, 2015).

Current Range

White Bluffs bladderpod is still known only from the single population that occurs along the upper edge of the White Bluffs of the Columbia River, Franklin County, Washington (USFWS, 2013a). Extensive searches of suitable substrate elsewhere in Washington have been conducted but no other plants have been found (USFWS, 2004; NatureServe, 2015).

Critical Habitat Designated

Yes; 4/23/2013.

Legal Description

On April 23, 2013, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Physaria douglasii* ssp. *tuplashensis* (White Bluffs bladderpod) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Washington (78 FR 76995-77005; 78 FR 24008-24032).

Critical Habitat Designation

The critical habitat designation for *Physaria douglasii* ssp. *tuplashensis* includes one CHU in Franklin County, Washington. This species critical habitat encompasses approximately 2,033.4 acres (ac) (822.9 hectares (ha)) (78 FR 76995-77005; 78 FR 24008-24032).

White Bluffs bladderpod is only known from a single population that occurs in a narrow band approximately 10 m (33 ft) wide by 17 km (10.6 mi) long, at the upper edge of the White Bluffs of the Hanford Reach. The subspecies only occurs at the upper surface areas of a near-vertical exposure of paleosol (ancient, buried soil whose composition may reflect a climate significantly different from the climate now prevalent in an area). This surface material overlies several hundred feet of easily eroded sediments of the Ringold Geologic Formation, a sedimentary formation made up of soft Pleistocene lacustrine deposits of clay, gravel, sand, and silt (Newcomb 1958, p. 328). The upper part of the Ringold Formation is a heavily calcified and silicified cap layer that exists to a depth of at least 4.6 m (15 ft). This layer is geologically referred to as "caliche," although it lacks the nitrate constituents found in true caliche. The caliche-like layer is a resistant caprock underlying a 275–305 m (900–1,000 ft) plateau extending north and east from the White Bluffs (Newcomb 1958, p. 330). The entire population of White Bluffs bladderpod is down-slope of irrigated agricultural land, and is being impacted to differing degrees by landslides induced by water-seepage (see Factor A). The potential for landslide is greatest in the southern portion of the subspecies' distribution where irrigated lands are closer to, or directly adjacent to, the bluffs (Lindsey 1997, p. 12). In addition, field investigations have determined that *Lesquerella* (now *Physaria*) plants can be outcompeted by nonnative, weedy plant species associated with irrigation projects and other disturbance (TNC 1998, p. 5). Therefore, based on the information above, we identify the weathered cliffs at approximately 210–275 m (700–900 ft) above sea level of the White Bluffs of the Ringold Formation exposed by natural erosion as a physical and biological feature essential to the conservation for White Bluffs bladderpod. The habitat includes the adjacent cliff breaks, moderate to gentle slopes (<100 percent slope) to the toe of slope, and flat or gently sloping cliff tops with exposed alkaline paleosols. This habitat is stable with a minimal amount of landslide occurrence. This critical habitat unit was mapped using Universal Transverse Mercator, Zone 11, North American Datum 1983 (UTM NAD 83) coordinates. These coordinates establish the vertices of the unit boundaries. The map in this entry, as modified by any accompanying regulatory text, establish the boundaries of the critical habitat designation. The coordinates or plot points or both on which the map is based are available to the public at the field office internet site (<http://www.fws.gov/wafwo/HanfordPlants/FLFCH.html>), <http://www.regulations.gov> at Docket No. FWS–R1–ES–2013–0012, and at the Service's Washington Fish and Wildlife Office. You may obtain field office location information by contacting one of the Service regional offices, the addresses of which are listed at 50 CFR 2.2.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Physaria douglasii* ssp. *tuplashensis* critical habitat consists of five components (78 FR 76995-77005; 78 FR 24008-24032):

(i) Weathered alkaline paleosols and mixed soils overlying the Ringold Formation. These soils occur within and around the exposed caliche-like cap deposits associated with the White Bluffs of the Ringold Formation, which contain a high percentage of calcium carbonate. These features occur between 210–275 m (700–900 ft) in elevation.

(ii) Sparsely vegetated habitat (less than 10–15 percent total cover), containing low amounts of nonnative or invasive plant species (less than 1 percent cover).

(iii) The presence of insect pollinator species.

(iv) The presence of native shrub steppe habitat within the effective pollinator distance (300 m (approximately 980 ft)).

(v) The presence of stable bluff formations with minimal landslide occurrence.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and that may require special management considerations or protection. All areas designated as critical habitat as described below may require some level of management to address the current and future threats to the physical and biological features essential to the conservation of Umtanum desert buckwheat. In all of the described units, special management may be required to ensure that the habitat is able to provide for the biological needs of the species. Further studies leading to an enhancement or reintroduction plan may be necessary to increase population size and prepare for recovery postwildfire. More research is needed to determine habitats most suitable for expansion of the current population. In summary, special management considerations or protections should address activities that would be most likely to result in the loss of Umtanum desert buckwheat plants or the disturbance, compaction, or other negative impacts to the species' habitat. These activities could include, but are not limited to, recreational activities and associated infrastructure, off-road vehicle activity, dispersed recreation, wildfire, and wildfire suppression activities. Special management considerations or protection will conserve the primary constituent elements for the species. Management activities that could ameliorate these threats include, but are not limited to, the fire management plan that has been completed for the Hanford installation (DOE 2011, p. 93) and recently revised to incorporate more detailed management objectives and standards. Though not intended to specifically address Umtanum desert buckwheat, implementation of this plan will contribute to the protection of the primary constituent elements (and physical or biological features) by: (1) Using a map of "sensitive resources" on the site during implementation, including the location of Umtanum desert buckwheat habitat; (2) requiring a biologist to assist the command staff in protecting these environments during wildfire suppression efforts; and (3) restricting public access to the entire Umtanum desert buckwheat site, including the pollinator use area. Public access without security clearance is currently prohibited at the Umtanum desert buckwheat site, reducing the risk of trampling or crushing the plants by ORV use. Special management to protect the designated critical habitat areas and the features essential to the conservation of Umtanum desert buckwheat from the effects of the current wildfire regime may include preventing or restricting the establishment of invasive, nonnative plant species, post-wildfire restoration with native plant species, and reducing the likelihood of wildfires affecting the population and nearby plant community components. These actions may be achieved by detailed fire management planning by the DOE, including rapid response and mutual support agreements between the DOE, the Monument, the U.S. Department of the Army, Bureau of Land Management, and the Washington Department of Fish and Wildlife for wildfire control. These agreements should contain sufficient detail to identify

actions by all partners necessary to protect habitat for Umtanum desert buckwheat from fire escaping from other ownerships.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 2013a)

Lifespan

Adult: 4 - 5 years (USFWS, 2013a)

Breeding Season

Adult: May - July (USFWS, 2013a)

Reproduction Narrative

Adult: In a presentation of preliminary life history studies, Dunwiddie et al. (2002, p. 7) reported that most individuals reach reproductive condition in their first or second year, most adult plants flower every year, and the lifespan of this short-lived subspecies is probably 4 to 5 years. Flowers are produced in May, June, and July (USFWS, 2013a).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliff, shrubland/chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 900 - 1,000 ft. elevation (USFWS, 2013a)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Habitat Narrative

Adult: Found on a dry, barren, vertical exposure of caliche (a hard, highly alkaline, highly calcareous substrate) capping a bluff (Hallock 2002; Washington Natural Heritage 2002). The environmental specificity is very narrow; it is known only from one extensive rock formation (the White Bluffs of the Columbia River), where the plants occur in a highly alkaline caliche-type cemented paleosol that caps several hundred feet of easily eroded alkaline lacustrine sediments (USFWS, 2004). Terrestrial habitat is characterized as cliff or shrubland/chaparral (NatureServe, 2015). The uppermost part of the Ringold Formation is a heavily calcified and silicified cap layer to a depth of at least 4.6 m (15 ft.). This layer is commonly called “caliche” although in this case, it lacks the nitrate constituents found in true caliche. The “caliche” layer is a resistant caprock underlying the approximately 274–304 m (900–1,000 ft.) elevation (above sea level) plateau extending north and east from the White Bluffs (Newcomb 1958, p. 330) (USFWS, 2013a).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends**Population Trends:**

Decline of 30 - 50% (NatureServe, 2015)

Species Trends:

10 - 30% decline (NatureServe, 2015)

Resiliency:

Very low (inferred from NatureServe, 2015; see historical range/distribution)

Redundancy:

Very low (inferred from NatureServe, 2015)

Number of Populations:

1 (NatureServe, 2015)

Population Size:

Variable between years; 47,593 - 58,887 in 2011 (USFWS, 2013a)

Adaptability:

Low (inferred from NatureServe, 2015)

Population Narrative:

Since all individuals are in a more or less contiguous single occurrence, the species is highly vulnerable to novel diseases or exotic pests or parasites. This species has experienced a long term population decline of 30 - 50%. This species is continuing to decline by 10 - 30%, as habitat-destroying landslides and other effects of agricultural irrigation continue. This species is known only from a single, extensive occurrence along a blufftop (NatureServe, 2015). The size of the population varies considerably between years. Total population was estimated at 47,593 to 58,887 plants in 2011 (USFWS, 2013a).

Threats and Stressors

Stressor: Irrigation (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: About one-third of the population is located near or adjacent to irrigated land, where excess groundwater seepage has triggered mass-slope failures (landslides) in the past that obliterate the narrow blufftop soil band in which these plants are found; *Lesquerella tuplashensis* has not been found in areas disturbed by these landslides (USFWS 2004). Recent incorporation of the area into a national monument/national wildlife refuge may increase capabilities to mitigate

this threat somewhat; however, irrigation-dependent farming continues in the area (NatureServe, 2015).

Stressor: Pesticide use (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: Pollinators may be affected by use of agricultural pesticides nearby (USFWS, 2004; NatureServe, 2015).

Stressor: Invasive species (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: Yellow star thistle (*Centaurea solstitialis*), a highly invasive exotic weed, has been documented in the vicinity (USFWS 2003 & 2004). A seed-predator insect has also been noted in recent years (USFWS, 2004), but it is not known if this is a natural phenomenon or an exotic species introduction (NatureServe, 2015). Cheatgrass is an introduced annual grass that is widely distributed in the western United States, and has been documented in the White Bluffs bladderpod population. Cheatgrass can outcompete native plants for water and nutrients in the early spring, since it is actively growing when native plants are initiating growth. It also completes its reproductive process and becomes senescent before most native plants (Pellant 1996, p. 1–2) (USFWS, 2013b).

Stressor: Off-road vehicles (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: Off-road vehicles, including mountain bikes, have increased disturbance and erosion, and destroyed individual plants (F. Caplow, pers. comm. cited in USFWS 2003 & 2004) (NatureServe, 2015).

Stressor: Fire (USFWS, 2013b)

Exposure:

Response:

Consequence:

Narrative: Fire is considered to be a threat to White Bluffs bladderpod, although the decline in population numbers after the 2007 fire indicated the population estimate was still within the known range of variability. Fire events tend to be large and unpredictable in the Hanford Reach (see Table 3) and can potentially affect large numbers of plants and significant areas of pollinator habitat. In addition, wildfire also impacts pollinator communities by directly causing mortality, altering habitat, and reducing native plant species diversity (USFWS, 2013b).

Stressor: Predation (USFWS, 2013b)

Exposure:

Response:

Consequence:

Narrative: Since 1996, some predation by larval insects on developing fruits of White Bluffs bladderpod has been observed. Larvae of a species of Cecidomyiid fly have been observed infesting and destroying flowering buds, and an unidentified insect species has been documented boring small holes into young seed capsules and feeding on developing ovules. However, the overall effect of these insect species on the plants or population is not known (TNC 1998, p. 5). Although insect predation may be a potential threat to White Bluffs bladderpod, more thorough investigations are necessary to determine its significance to seed production (USFWS, 2013b).

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- Fencing, placement of signs controlling human foot traffic, ongoing invasive weed treatments, and future planning for targeted treatments of *Centaurea solstitialis* (yellow starthistle) are ongoing in the vicinity of the White Bluffs bladderpod. A Monument CCP has been developed (USFWS 2008), which includes management and monitoring actions for White Bluffs bladderpod based on the priorities of the refuge. The CCP states that protection of this population, and thus the species, requires that these issues be addressed in any management action. Long-term demographic monitoring was initiated on this species in 1997 (USFWS 2008, p. 3–95) and periodic aerial monitoring has been undertaken by the Monument since then. Other management actions may include restoration of priority areas, access control, and bluff stabilization. There currently is a need for improved monitoring of White Bluffs bladderpod at the northern locations, where access is more difficult. White Bluffs bladderpod has been germinated by Monument staff and grown in pots to a size suitable for the first dormant outplanting project, planned for December 2012 or January 2013 (Newsome 2012, pers. comm.) (USFWS, 2013b).

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Designation of Critical Habitat for *Eriogonum codium* (Umtanum Desert Buckwheat) and *Physaria douglasii* subsp. *tuplashensis* (White Bluffs Bladderpod). April 23, 2013. Pages 24007 - 24032.

U.S. Fish and Wildlife Service. 2013. Endangered and Threatened Wildlife and Plants

Threatened Status for *Eriogonum cadium* (Umtanum Desert Buckwheat) and *Physaria douglasii* subsp. *tuplashensis* (White Bluffs Bladderpod) and Designation of Critical Habitat. Final Rule. 78 FR 76995-77005 (December 20, 2013). U.S. Fish and Wildlife Service. 2013. Endangered and Threatened Wildlife and Plants

Threatened Status for *Eriogonum cadium* (Umtanum Desert Buckwheat) and *Physaria douglasii* subsp. *tuplashensis* (White Bluffs Bladderpod) and Designation of Critical Habitat. Final Rule. 78 FR 24008-24032 (April 23, 2013).

USFWS 2013b. Endangered and Threatened Wildlife and Plants

Threatened Status for *Eriogonum cadium* (Umtanum Desert Buckwheat) and *Physaria douglasii* subsp. *tuplashensis* (White Bluffs Bladderpod)

Final Rule. 78 Federal Register 78. April 23, 2013. Pages 23983 - 24005.

USFWS. 2013b. Endangered and Threatened Wildlife and Plants

SPECIES ACCOUNT: *Physaria filiformis* (Missouri bladderpod)

Species Taxonomic and Listing Information

Listing Status: Threatened; 01/08/1987; Great Lakes-Big Rivers Region (R3) (USFWS, 2015)

Physical Description

The Missouri bladderpod is a winter annual, up to 2.5 dm tall, which produces yellow flowers which are especially showy against the plant's silvery stems and foliage. The plants flower, set seed, and die in early spring; the seeds germinate in autumn and overwinter as rosettes. (NatureServe, 2015)

Taxonomy

Previously known as *Lesquerella filiformis* (USFWS, 2008)

Historical Range

In addition to its current range, the bladderpod is believed to be extirpated in Jasper and Lawrence counties, Missouri. (USFWS, 1987)

Current Range

The Missouri bladderpod currently occurs in four counties in Missouri and five counties in Arkansas and the species is distributed on limestone glades in Southwest Missouri, dolomite glades in northern Arkansas (a report for Missouri on a dolomitic glade has not been confirmed, George Yatskievych, pers. comm. Aug. 11, 2014), and shale glades in the Ouachita Mountains in central Arkansas (Witsell, 2008). (USFWS, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual; self-incompatible (USFWS, 2015)

Lifespan

Adult: Less than one year (USFWS, 1988)

Dependency on Other Individuals or Species

Adult: Numerous insect species as pollinators (USFWS, 2015)

Reproduction Narrative

Adult: The Missouri bladderpod is a winter annual, germinating in the fall and overwintering in the form of basal rosettes. Plants send up flowering stems in late April and flower, fruit and senesce by the end of June. Seeds lie dormant on the limestone glades through the summer and germinate in the fall, starting the life cycle over again. There is considerable variation in these life history details from year to year. (USFWS, 1988) This bladderpod is an obligate outcrosser,

being dependent upon several species of pollinators for pollination and fruit set. No less than 38 species of insects in four orders, visited Missouri bladderpod plants (Edens-Meier et al., 2011). (USFWS, 2015)

Habitat Type

Adult: Unglaciaded prairie areas (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Limestone and dolomitic glades or grazed pastures (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Limestone, dolomitic, or shale substrate (USFWS, 2015)

Spatial Arrangements of the Population

Adult: Clumped (inferred from USFWS, 2015)

Environmental Specificity

Adult: Narrow/specialist on specific soils (inferred from USFWS, 2015)

Site Fidelity

Adult: High (USFWS, 2015)

Habitat Narrative

Adult: The Missouri bladderpod is most commonly found in open limestone glades, barrens, and outcrops within unglaciaded prairie areas. It occasionally occurs in dolomitic glades, and is known from one site on a shale substrate. It is often associated with grazed pastures. Cedar invasion of glade sites is common. (NatureServe, 2015; USFWS, 2015)

Dispersal/Migration**Dispersal**

Adult: Low (USFWS, 1988)

Dispersal/Migration Narrative

Adult: Seeds are mainly dispersed by falling from dried capsules although some dispersal occurs by seeds being washed downhill by rainwater runoff. (USFWS, 1988)

Population Information and Trends**Population Trends:**

Increasing (USFWS, 2015)

Species Trends:

Increasing (USFWS, 2015)

Resiliency:

Moderate (inferred from USFWS, 2015)

Representation:

Moderate (inferred from USFWS, 2015)

Redundancy:

High (inferred from USFWS, 2015)

Population Growth Rate:

Increasing, but annually variable (USFWS, 2015)

Number of Populations:

76 (USFWS, 2015)

Population Size:

10,000 to >1,000,000 individuals (NatureServe, 2015)

Adaptability:

Somewhat compatible with residential development and grazing. (NatureServe, 2015)

Population Narrative:

When listed, the Missouri bladderpod was not yet known from Arkansas and there were only 11 known populations in Missouri (USFWS, 2003). As of 2015, the species is known from 66 sites in four counties in Missouri and 10 sites in five counties in Arkansas (USFWS, 2003); Rhonda Rimer, pers. comm. Mar.10, 2014, Jan. 14, 2015; Cindy Osborne, pers. comm., Aug. 13, 2014). While the total number of populations now far exceeds the number when listed, an assessment as to whether or not they are self-sustaining is problematic because populations of *Physaria filiformis* can vary widely from year to year depending on different climatic and edaphic factors and in response to various management practices. For example, Young (2013) monitored populations of *Physaria filiformis* over a 25-year period on the largest bladderpod site on the Wilson Creek National Battlefield in Missouri and demonstrated that plants fluctuated from a few thousand in 1990, to 261,000+ in 1991, to a few thousand in 1992, to zero in 1993 and 1994, and then rebounded to highs of between 30,000+ and 137,000+ in 1995, and between 42,000+ and 114,000+ in 2011. Similar results have been noted in other areas (USFWS, 2003). While some of the currently known bladderpod sites exceed one-half acre in size, many are much smaller and the distributions of some populations are limited due to the availability of suitable glade habitat. (USFWS, 2015)

Threats and Stressors

Stressor: Human disturbance and collection (USFWS, 1987)

Exposure:

Response:

Consequence:

Narrative: The low number of individual plants make the species vulnerable to collecting and other human disturbance. Two of the populations are within the Wilson's Creek National Battlefield, where a system of interpretive trails extends through the sites. These populations receive some disturbance from the more than 124,000 annual visitors to the Battlefield site, but Morgan (1983) concluded that disturbance may help maintain the *Lesquerella filiformis* populations. In addition, wildflower collectors may reduce populations in more accessible sites.

As Steyermark (1963) pointed out, this plant with handsome yellow flowers makes a desirable addition to rock gardens and may be vulnerable to overcollecting. (USFWS, 1987)

Stressor: Lack of management research (USFWS, 1987)

Exposure:

Response:

Consequence:

Narrative: Research is needed to determine proper management techniques for maintenance of the species, especially at disturbed sites. (USFWS, 1987)

Stressor: Right-of-way maintenance (USFWS, 1987)

Exposure:

Response:

Consequence:

Narrative: Three populations of *Lesquerella filiformis* occur in Dade County within Missouri highway rights-of-way. Two of these populations extend onto private land. Because of yearly right-of-way treatments, there is a threat of destruction to these populations. Cooperation with the State Department of Highways and Transportation is necessary in order to provide these sites additional protection from accidental mowing or chemical treatment. (USFWS, 1987)

Stressor: Seed destruction (USFWS, 1987)

Exposure:

Response:

Consequence:

Narrative: Seed predation by insects and fungal infection of developing capsules have been reported by Morgan (1983). It is not known whether the ensuing loss of reproductive capacity constitutes a significant threat to the species. (USFWS, 1987)

Stressor: Competition from native and exotic plants (USFWS, 2003; 2015)

Exposure:

Response:

Consequence:

Narrative: Shortly after listing, the Service (1988) documented the presence of exotic plant species, such as *Bromus tectorum* (a cheat grass), in bladderpod habitat as a significant threat, and this was further supported by observations by Hickey (1988, 2000) and Thomas (1996, 1998). (USFWS, 2003) Witsell (2008) and Eulinger and Skinner (2007) noted that encroachment by Eastern red cedar onto glades causes habitat degradation and this threat will need to be continually monitored. (USFWS, 2015)

Stressor: Development (USFWS, 2003)

Exposure:

Response:

Consequence:

Narrative: Hickey (1988, 2000) and Thomas (1996) identified development, especially land-use changes resulting from urban expansion, as a major threat to the species. (USFWS, 2003)

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:**Consequence:**

Narrative: Climate change may lead to increased frequency and duration of droughts (Rind et al., 1990; Seager et al., 2007; Rahel and Olden, 2008). Climate warming may increase the virulence of nonnative parasites and increased drought conditions may favor the establishment and spread of nonnative species (Rahel and Olden 2008). Extended droughts and an increase in soil and air temperatures could negatively impact seed set, germination, and overall fitness of *Physaria filiformis*. (USFWS, 2015)

Recovery**Reclassification Criteria:**

The bladderpod has already been reclassified from endangered to threatened based on discovery of new populations and reduced threats to large existing populations. (USFWS, 2003)

Delisting Criteria:

The Missouri bladderpod may be considered for delisting when there are thirty scattered, self-sustaining populations of *Lesquerella filiformis* that are maintained and protected. Fifteen of the thirty populations must be in secure ownership, occupy a minimum of one-half acre of habitat each, and show self-sustaining populations for at least seven years. (USFWS, 1988)

Recovery Actions:

- Existing populations need to be protected and managed. (USFWS, 1988)
- Suitable habitat needs to be surveyed for new populations. (USFWS, 1988)
- Populations need continuing monitoring; autecological and management research is needed on the species. (USFWS, 1988)
- Management programs need to be developed and then initiated on protected sites. (USFWS, 1988)
- New populations need to be established on public land. (USFWS, 1988)
- Programs need to be developed to enhance public awareness and support for conservation of the species. (USFWS, 1988)
- The establishment of measurable recovery criteria that address threats to the species should be developed and implemented before possible delisting is recommended. (USFWS, 2015)

Conservation Measures and Best Management Practices:

- A revision of the 1998 Missouri Bladderpod Recovery Plan is needed to develop measurable delisting criteria that reflect remaining threats to the species and to incorporate new information that has been obtained in the last 26 years. Development of such a plan should be done in cooperation with the appropriate experts and stakeholders in Missouri and Arkansas. (USFWS, 2015)
- Missouri bladderpod numbers and the results of ongoing conservation efforts need to be regularly monitored to assess recovery and ongoing management efforts. It may be appropriate to identify priority populations in Missouri and Arkansas for monitoring. Monitoring efforts should include populations that occur on the three different substrate types. (USFWS, 2015)
- Studies need to be initiated on the potential impacts of climate change on the Missouri bladderpod and its habitat. The species could be impacted from droughts and accompanying problems associated with climate change; further research is warranted. (USFWS, 2015)

- *Physaria filiformis* would benefit from additional genetic studies that evaluate genetic diversity across the range of the species, especially given the now known large geographic gaps between populations in southwest Missouri and scattered populations in Arkansas and the occurrence on three different soil substrates. (USFWS, 2015)
- Outreach efforts need to be made to private landowners in Missouri and Arkansas regarding best management practices that will maintain, and where necessary restore bladderpod habitat. (USFWS, 2015)
- Ongoing survey efforts should continue to search for new populations, especially in Arkansas. (USFWS, 2015)
- Viable sites should be protected and properly managed in all the outlying clusters within the species' range. (USFWS, 2015)

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SPECIES ACCOUNT: *Physaria globosa* (Short's bladderpod)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 8/1/2014

Physical Description

An erect, short-lived perennial (or biennial) herb with slender, leafy stems that spread from the base and are 3-5 dm tall, giving vigorous plants a bushy appearance. Leaves are densely hairy, grayish-green. Flowers are bright yellow to yellow-orange, cross-shaped, borne in elongated clusters of up to 50 flowers. Fruits are globe-shaped (NatureServe, 2015).

Taxonomy

A member of the mustard family (Brassicaceae), Short's bladderpod was first described as *Vesicaria globosa* by Desvaux (1814, p. 184). Because of several distinctive characters, Watson (1888, pp. 249-250) proposed that the American species of the genus *Vesicaria* be placed in the genus *Lesquerella*. This treatment was recognized as valid, until Al-Shehbaz and O'Kane (2002, entire) united most of the genus *Lesquerella* with the genus *Physaria*. Within the genus *Physaria*, and earlier treatments of *Lesquerella*, *P. globosa* has long been recognized as a geographically and evolutionarily distinct taxon (USFWS, 2017a).

Current Range

The species has a disjunct distribution, with populations known from Posey County, Indiana; Bourbon, Clark, Fayette, Franklin, Jessamine, Madison, Mercer, Nelson, Powell, Scott and Woodford Counties, Kentucky; and Cheatham, Davidson, Dickson, Jackson, Maury, Montgomery, Smith, Trousdale, and Williamson Counties, Tennessee (USFWS, 2017a).

Critical Habitat Designated

Yes; 8/26/2014.

Legal Description

On August 26, 2014, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Physaria globosa* (Short's bladderpod) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 20 critical habitat units (CHUs), in Indiana, Kentucky and Tennessee (79 FR 50990-51039).

Critical Habitat Designation

The critical habitat designation for *Physaria globosa* includes 20 CHUs in Posey County, Indiana; Clark, Franklin, and Woodford Counties, Kentucky; and Cheatham, Davidson, Dickson, Jackson, Montgomery, Smith, and Trousdale Counties, Tennessee. This species critical habitat encompasses approximately 925.5 acres (ac) (373 hectares (ha)) (79 FR 50990-51039).

Unit 1: Kings and Queens Bluff: Unit 1 consists of 7.6 ha (18.9 ac) of private land, but the U.S. Army Corps of Engineers (Corps of Engineers) holds flood easements on approximately 40 percent of this land. This unit is located in Montgomery County, Tennessee, on a bluff on the right descending bank of the Cumberland River within the city limits of Clarksville, approximately 0.16 km (0.10 mi) south of the intersection of State Route 12 (Ashland City Road) and Queens Bluff Way. Beginning approximately 0.28 km (0.18 mi) south of the easternmost intersection of

Ashland City Road (U.S.–41a Bypass) and Queens Bluff Road, this unit parallels the Cumberland River in a downstream direction for approximately 1.7 km (1.1 mi). The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to erosion or prolonged inundation due to water level manipulation; changes in land use, including residential or commercial construction, which could cause removal of forest vegetation or soils or soil loss due to erosion; and shading and competition due to encroachment of native and invasive, nonnative plants.

Unit 2: Lock B Road: Unit 2 consists of 10.1 ha (25.0 ac) of privately owned land, but the Corps of Engineers holds flood easements on approximately 3 percent of this land. This unit is located in Montgomery County, Tennessee, approximately 6.9 km (4.3 mi) south of the city limits of Clarksville, on a hillside that lies to the east and west of Lock B Road North, beginning approximately 0.8 km (0.5 mi) south of its junction with Gholson Road and continuing south for approximately 0.4 km (0.25 mi), at which point Lock B Road North veers to the southwest. From this point, this unit continues south for approximately 1.0 km (0.6 mi) along the hillside that is east of Lock B Road North. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to potential right-of-way construction or maintenance using herbicides or mechanized equipment along Lock B Road North or the Illinois Central Railroad, both of which traverse portions of the unit, and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 3: Jarrel Ridge Road: Unit 3 consists of 5.2 ha (12.8 ac) of privately owned lands, but the Corps of Engineers holds flood easements on approximately 8 percent of this land. This unit is located in Montgomery County, Tennessee, approximately 10 km south of the city limit of Clarksville, on a hillside that lies west and north of the southern terminus of Jarrel Ridge Road. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to erosion or prolonged inundation due to water level manipulation; changes in land use, including residential or commercial construction, which could cause removal of forest vegetation or soils or soil loss due to erosion; potential right-of-way construction or maintenance using herbicides or mechanized equipment along Jarrel Ridge Road at the unit boundary or the Illinois Central Railroad, which traverses the unit; and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 4: Cheatham Lake: Unit 4 consists of 27.3 ha (67.5 ac) of privately owned, local government, and Federal lands. This unit is located in Cheatham County, Tennessee, approximately 9.0 km (5.6 mi) westnorthwest of the city limits of the town of Ashland City, on a series of hillsides that begins approximately 0.8 km (0.5 mi) northeast of the junction of Beech Grove Road and Cheatham Dam Road and arcs in a southeasterly direction for approximately 2.2 km (1.4 mi). Here, the unit crosses Cheatham Dam Road, and continues for approximately 2.2 km in a southeasterly arc to its eastern boundary on the right descending bank of the Cumberland River, approximately 0.18 km (0.11 mi) south of Kimbrough Road. The land within this unit is approximately 70 percent privately owned, 12 percent owned by Ashland City, and 18 percent owned by the Corps of Engineers. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to erosion or prolonged inundation due to water level manipulation; changes in land use, including residential or commercial construction, which could cause removal of forest vegetation or soils or soil loss due to erosion; potential right-of-way construction or maintenance using herbicides or

mechanized equipment along the Illinois Central Railroad, which traverses the unit; and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 5: Harpeth River: Unit 5 consists of 25.5 ha (63.1 ac) of privately owned and federal land in Cheatham County, Tennessee. This unit is located approximately 5 km (3.1 mi) west of the city limits of the town of Ashland City, on the west slope of a hillside and associated bluffs that begin on the point of land formed by the confluence of Cumberland and Harpeth rivers and extend upstream along the right descending bank of the Harpeth River, reaching the unit's southernmost boundary approximately 0.6 km (0.4 mi) east of SR-49, where it crosses the Harpeth River. The land within this unit is approximately 32 percent privately owned, and 68 percent is owned by the Corps of Engineers. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to erosion or prolonged inundation due to water level manipulation; changes in land use, including residential or commercial construction, which could cause removal of forest vegetation or soils or soil loss due to erosion; and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 6: Montgomery Bell Bridge: Unit 6 consists of 11.2 ha (27.7 ac) of privately owned and federal land in Cheatham and Dickson Counties, Tennessee. This unit is located approximately 5.5 km (3.4 mi) west of the city limits of the town of Ashland City, on a hillside and bluffs on the left descending bank of the Harpeth River that begin approximately 0.4 km (0.27 mi) east of the Montgomery Bell Bridge, where SR-49 crosses the river and bisects the unit, and parallels the river in an upstream direction for approximately 1.8 km (1.1 mi). The land within this unit is approximately 19 percent privately owned, and 81 percent is owned by the Corps of Engineers. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to erosion or prolonged inundation due to water level manipulation; changes in land use, including residential or commercial construction, which could cause removal of forest vegetation or soils or soil loss due to erosion; and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 7: Nashville and Western Railroad: Unit 7 consists of 30.5 ha (75.3 ac) of privately owned, local government, and Federal land in Cheatham County, Tennessee. This unit is located along the southwest city limit of the town of Ashland City, on hillsides and bluffs that begin approximately 0.26 km (0.16 mi) east of the confluence of Marrowbone Creek and the Cumberland River and extend upstream on the right descending bank of the Cumberland River for approximately 2.3 km (1.4 mi). Here, the unit continues in a southeasterly direction for approximately 0.9 km (0.5 mi) from the point where the river veers away from the hillside and bluffs. The land within this unit is approximately 68 percent privately owned, 27 percent owned by the Cheatham County Rail Association, and 5 percent owned by the Corps of Engineers. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to erosion or prolonged inundation due to water level manipulation; changes in land use, including residential or commercial construction, which could cause removal of forest vegetation or soils or soil loss due to erosion; potential right-of-way construction or maintenance using herbicides or mechanized equipment along the Nashville and Western Railroad, which traverses the unit; and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 8: River Trace: Unit 8 consists of 42.8 ha (105.7 ac) of privately owned land, with the exception of the River Trace road right-of-way. The Corps of Engineers holds flood easements on approximately 13 percent of the lands within the unit. This unit is located in Davidson and Cheatham Counties, Tennessee, on hillsides and bluffs approximately 0.9 km (0.6 mi) southeast of the city limit of the town of Ashland City, beginning at the western extent of River Trace and extending along both sides of this road in a southeasterly direction for a distance of approximately 2.3 km (1.4 mi). Here, the unit leaves River Trace and continues along the hillside and bluffs on the right descending bank of the Cumberland River in an upstream direction for approximately 2.1 km (1.3 mi). The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to erosion or prolonged inundation due to water level manipulation; changes in land use, including residential or commercial construction, which could cause removal of forest vegetation or soils or soil loss due to erosion; potential right-of-way construction or maintenance using herbicides or mechanized equipment along River Trace or the Nashville and Western Railroad, both of which traverse the unit; and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 9: Old Hickory Lake: Unit 9 consists of 4.8 ha (11.9 ac) of privately owned and Federal lands in Trousdale County, Tennessee. This unit is located approximately 3.5 km (2.2 mi) west of the southern city limits of the town of Hartsville and 0.5 km (0.3 mi) south of Oldham Road, on a hillside and bluffs on the right descending bank of the Cumberland River. Beginning approximately 0.4 km (0.25 mi) downstream of the mouth of Second Creek, this unit parallels the Cumberland River in a downstream direction for approximately 0.7 km (0.4 mi). The land within this unit is approximately 40 percent privately owned, and 60 percent is owned by the Corps of Engineers. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to erosion or prolonged inundation due to water level manipulation; changes in land use, including residential or commercial construction, which could cause removal of forest vegetation or soils or soil loss due to erosion; and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 10: Coleman-Winston Bridge: Unit 10 consists of 7.4 ha (18.2 ac) of privately owned and Federal lands in Trousdale County, Tennessee. The unit is located at the southern city limit of the town of Hartsville, on a hillside and bluffs overlooking the Cumberland River. Beginning on the right descending bank approximately 0.5 km (0.3 mi) east of SR-141, which bisects the unit where it crosses the Cumberland River at the Coleman-Winston Bridge, this unit parallels the river in a downstream direction for approximately 1.1 km (0.7 mi). The land within this unit is approximately 55 percent privately owned, and 45 percent is owned by the Corps of Engineers. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to erosion or prolonged inundation due to water level manipulation; changes in land use, including residential or commercial construction, which could cause removal of forest vegetation or soils or soil loss due to erosion; potential right-of-way construction or maintenance using herbicides or mechanized equipment along SR-141, which bisects the unit; and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 11: Cordell Hull Reservoir: Unit 11 consists of 12.3 ha (34.2 ac) of Federal lands in Smith County, Tennessee. This unit is located approximately 4.3 km (2.7 mi) north of the city limits of

the town of Carthage, on hillsides and bluffs on the right descending bank of the Cumberland River. Beginning approximately 2.0 km (1.25 mi) upstream of the Cordell Hull Dam, this unit parallels the river in an upstream direction for approximately 0.6 km (0.4 mi), where it crosses a 0.3-km (0.2-mi) expanse of open water, and then continues paralleling the river for a distance of 1.2 km (0.7 mi). All of the land within this unit is owned by the Corps of Engineers, and the open water is not included in the area of the unit reported above. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to erosion or prolonged inundation due to water level manipulation; changes in land use, including residential or commercial construction, which could cause removal of forest vegetation or soils or soil loss due to erosion; and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 12: Funns Branch: Unit 12 consists of 20.8 ha (51.3 ac) of Federal lands in Jackson County, Tennessee. This unit is located approximately 12.1 km (7.5 mi) southwest of the city limits of the town of Gainesboro, on hillsides and bluffs on the right descending bank of the Cumberland River. Beginning approximately 0.4 km (0.2) mi upstream of the mouth of Funns Branch, this unit parallels the river in an upstream direction for approximately 1.0 km (0.65 mi) where it crosses a 0.3-km (0.2-mi) expanse of open water, and then continues paralleling the river for a distance of approximately 1.0 km (0.64 mi). All of the land within this unit is owned by the Corps of Engineers, and the open water is not included in the area of the unit reported above. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to erosion or prolonged inundation due to water level manipulation; changes in land use, including residential or commercial construction, which could cause removal of forest vegetation or soils or soil loss due to erosion; and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 13: Wartrace Creek: Unit 13 consists of 37.5 ha (92.6 ac) of Federal lands in Jackson County, Tennessee. This unit is located approximately 7.7 km (4.8 mi) west of the city limits of the town of Gainesboro, on hillsides and bluffs on the right descending bank of the Cumberland River. Beginning at the mouth of Indian Creek, this unit parallels the river in a downstream direction for approximately 1.6 km (1.0 mi), where it crosses the mouth of Wartrace Creek, and then continues paralleling the river for a distance of 2.5 km (1.5 mi). All of the land within this unit is owned by the Corps of Engineers, and areas of open water are not included in the area of the unit reported above. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to erosion or prolonged inundation due to water level manipulation; changes in land use, including residential or commercial construction, which could cause removal of forest vegetation or soils or soil loss due to erosion; and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 14: Camp Pleasant Branch: Unit 14 consists of 17.4 ha (42.9 ac) of privately owned lands in Franklin County, Kentucky. This unit is located approximately 8.3 km (5.8 mi) north of the city limits of Frankfort, on hillsides near Camp Pleasant Branch, a tributary to Elkhorn Creek. Beginning approximately 0.29 km (0.18 mi) west of the intersection of Indian Gap Road and Camp Pleasant Road, the unit begins in a hollow north of Indian Gap Road and extends to the east and north along hillsides above the right descending bank of Camp Pleasant Branch for approximately 0.75 km (0.5 mi) to the intersection of Camp Pleasant Road and Gregory Woods Road. Here the unit crosses Gregory Woods Road and extends north for a distance of

approximately 0.58 km (0.36 mi), encompassing the hillside to the east of the road. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to changes in land use, including residential or commercial construction, which could cause removal of forest vegetation or soils or soil loss due to erosion; potential right-of-way construction or maintenance using herbicides or mechanized equipment along Indian Gap Road, Camp Pleasant Road, or Gregory Woods Road, which are adjacent to the unit; and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 15: Kentucky River: This unit consists of 93.1 ha (230.0 ac) of privately owned and State land in Franklin County, Kentucky. This unit begins within the northwestern city limit of Frankfort, on a hillside that parallels U.S.–421 on its east side from approximately 0.21 km (0.13 mi) southeast of its junction with Clifty Drive to approximately 0.23 km (0.15 mi) northwest of its junction with U.S.–127. Here the unit follows the topography of the hillside as it turns away from the road to the east, leaving the city limits, and then arcs to the northeast, before abruptly turning back in a westerly direction. From this point, the hillside and this unit extend in a westerly direction for approximately 0.7 km (0.4 mi) and then parallel the Kentucky River in a downstream direction in an arc approximately 5.3 km (3.3 mi) in length on its left descending bank, encompassing hillsides in two hollows that extend from the river to the west. Approximately 90 percent of the land in this unit is privately owned, and the Commonwealth of Kentucky owns approximately 10 percent, which is part of a State nature preserve. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to erosion or prolonged inundation due to water level manipulation; changes in land use, including residential or commercial construction, which could cause removal of forest vegetation or soils or soil loss due to erosion; potential right-of-way construction or maintenance using herbicides or mechanized equipment along U.S.–421, where it parallels the unit; and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 16: Owenton Road: Unit 16 consists of 2.8 ha (7.0 acres) of privately owned and City of Frankfort municipal park lands in Franklin County, Kentucky. The unit is located approximately 0.1 km (0.08 mi) north of the city limits of Frankfort on a hill that is adjacent to and west of U.S.–127 (Owenton Road), approximately 0.6 km (0.4 mi) north of the intersection of U.S.–127 and U.S.–421. The land within this unit is approximately 46 percent privately owned, and 54 percent is owned by the City of Frankfort. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to changes in land use, including residential or commercial construction, which could cause removal of forest vegetation or soils or soil loss due to erosion; potential right-of-way construction or maintenance using herbicides or mechanized equipment on U.S.–127; and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 17: Little Benson Creek: Unit 17 consists of 9.4 ha (23.3 ac) of privately owned lands in Franklin County, Kentucky, located within the city limits of Frankfort. Beginning approximately 1.1 km (0.7 mi) south of the intersection of Mills Lane and Ninevah Road, this unit lies on a hillside on the east side of Ninevah Road and extends to the south for approximately 0.5 km (0.3 mi), where it crosses Ninevah Road and follows a hillside that parallels Ninevah Road for approximately 1.0 km (0.65 mi) on its west side. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to changes in land use, including residential or commercial construction, which

could cause removal of forest vegetation or soils or soil loss due to erosion; potential right-of-way construction or maintenance using herbicides or mechanized equipment on Ninevah Road; and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 18: Boone Creek: Unit 18 consists of 5.0 ha (12.4 ac) of privately owned lands in Clark County, Kentucky. This unit is located approximately 13.2 km (8.2 mi) southwest of the city limits of Winchester, and begins adjacent to Grimes Mill Road approximately 0.17 km north of the Fayette and Clark County line. From here, the unit extends on a hillside to the east for a distance of approximately 0.21 km (0.13 mi), where the unit and hillside then parallel a bend in Boone Creek on its left descending bank for a distance of approximately 0.68 km (0.42 mi). The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to changes in land use, including residential or commercial construction, which could cause removal of forest vegetation or soils or soil loss due to erosion; potential right-of-way construction or maintenance using herbicides or mechanized equipment on Grimes Road; and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 19: Delaney Ferry Road: Unit 19 consists of 0.6 ha (1.4 ac) of privately owned lands in Woodford County, Kentucky. This unit is located approximately 7.8 km (4.8 mi) south of the city of Versailles. Beginning approximately 2.1 km (1.3 mi) east of the intersection of Troy Pike and Delaney Ferry Road, this unit extends approximately 0.08 km (0.05 mi) northeast along Delaney Ferry Road, where the unit boundary turns to the northwest for approximately 0.08 km (0.05 mi). From this northeast corner of the unit, the boundary extends to the southwest approximately 0.05 km (0.03 mi), where it turns to the southeast, paralleling a driveway for 0.05 km (0.03 mi) before turning to the southwest for approximately 0.03 km (0.02 mi). From this point the unit boundary turns to the southeast for approximately 0.05 km (0.03 mi), returning to the starting point. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of shading or competition due to encroachment of native and invasive, nonnative plants. The current landowner manages encroaching vegetation to prevent shading and competition where Short's bladderpod occurs within the unit.

Unit 20: Bonebank Road: Unit 20 consists of 1.7 ha (4.3 ac) of lands in Posey County, Indiana, which are owned by the Indiana Department of Natural Resources. This unit is located approximately 13 km (8.1 mi) southwest of the city limits of Mt. Vernon, beginning at the intersection of Graddy Road and Bonebank Road and paralleling Bonebank Road on its west side for a distance 0.73 km (0.45 mi) north of the intersection. The surface geology at this site—Quaternary glacial outwash—and soils are markedly different from other sites on calcareous geology throughout the rest of the species' range. However, this site supports an occurrence that has numbered in the hundreds to more than a thousand individuals in the past, and the PCE of forest vegetation with canopy openings (PCE 3) is present at the road edge. The feature essential to the conservation of the species in this unit may require special management considerations or protection to address threats of shading or competition due to encroachment of native and invasive, nonnative plants.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Physaria globosa* critical habitat consists of four components (79 FR 50990-51039):

- (i) Bedrock formations and outcrops of calcareous limestone, sometimes with interbedded shale or siltstone, in close proximity to the mainstem or tributaries of the Kentucky and Cumberland rivers. These outcrop sites or areas of suitable bedrock geology should be located on steeply sloped hillsides or bluffs, typically on south- to west-facing aspects.
- (ii) Shallow or rocky, well-drained soils formed from the weathering of underlying calcareous bedrock formations, which are undisturbed or subjected to minimal disturbance, so as to retain habitat for ground-nesting pollinators and potential for maintenance of a soil seed bank.
- (iii) Forest communities with low levels of canopy closure or openings in the canopy to provide adequate sunlight for individual and population growth. Invasive, nonnative plants must be absent or present in sufficiently low numbers not to inhibit growth or reproduction of Short's bladderpod.

Special Management Considerations or Protections

The features essential to the conservation of Short's bladderpod may require special management considerations or protection to reduce the following threats: (1) Actions that would directly result in removal of soils or indirectly cause their loss due to increased rates of erosion; (2) building, paving, or grazing of livestock within or upslope of Short's bladderpod sites that alters water movement or causes soil erosion that results in sediment deposition in suitable habitat; (3) blasting or removal of hard rock and soil substrates; (4) dumping of trash and debris; (5) prolonged inundation of sites due to manipulation of regulated waters for flood control or other purposes; (6) indiscriminate maintenance of transportation rights-of-way, including grading, mowing, or herbicide application; and (8) shading and competition due to forest canopy closure and encroachment of invasive, nonnative plants. Management activities that could ameliorate these threats include, but are not limited to: (1) Avoiding areas located in or upslope of Short's bladderpod sites when planning for location of commercial or residential development; maintenance, construction, or expansion of utility and transportation infrastructure; and access for livestock; (2) removing trash and debris that are dumped onto or upslope of Short's bladderpod sites; (3) locating suitable habitat, determining presence or absence of Short's bladderpod, and protecting or restoring as many sites or complexes of sites as possible; (4) evaluating the effects of flow regulation on Short's bladderpod occurrences within the fluctuation zone of regulated river reaches and adjusting management to avoid or minimize prolonged periods of inundation; (5) reaching out to all landowners, including private, State, and Federal landowners, to raise awareness of the plant and its habitat; (5) providing technical or financial assistance to landowners to help in the design and implementation of management actions that protect the plant and its habitat; (6) managing, including reducing, canopy cover and competition from native and invasive, nonnative plants to maintain an intact native forest community with canopy openings or low levels of canopy closure.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Self-compatibility and self-incompatibility (USFWS, 2017a).

Breeding Season

Adult: Typically flowers and produces seed during the months of March through June. Timing of seed germination is not currently known, but it is possible that seeds could germinate in the fall and form rosettes over winter, germinate in spring when conditions become favorable, or exhibit either phenology depending upon the dormancy status of individual seeds and variation in seasonal climatic conditions (USFWS, 2017a).

Key Resources Needed for Breeding

Adult: Pollinators are likely native ground nesting bees and flies (USFWS, 2017a).

Reproduction Narrative

Adult: This species likely is self-incompatible, and nearly 50 percent of extant occurrences are threatened with adverse effects associated with small populations including loss of genetic variation, inbreeding depression, and reduced availability of compatible mates. Short's bladderpod is a biennial or perennial that typically flowers and produces seed during the months of March through June. Based on observations of an apparent biennial life history in at least some populations, the generation length is considered to be two years – i.e., the time between seed germination and next generation recruitment into the population would be a minimum of two years. Timing of seed germination is not currently known, but it is possible that seeds could germinate in the fall and form rosettes over winter, germinate in spring when conditions become favorable, or exhibit either phenology depending upon the dormancy status of individual seeds and variation in seasonal climatic conditions. Fitness of Short's bladderpod individuals is dependent on appropriate temperature, soil moisture and nutrients, and light regimes for seed germination; growth of seedling, juveniles, and adults; and reproduction. Availability of mate-compatible genotypes and abundance of pollinators are critical factors for production of viable seed (USFWS, 2017a). For this reason, it is essential that habitat for pollinators be conserved in close proximity to known occurrences to increase the likelihood of pollen exchange among compatible mates. Where possible, habitat patches should be protected that would reduce fragmentation between multiple occurrences among which pollinator dispersal could facilitate gene flow. Two species of dipterans (flies; *Nemotelus bruesii*, *Toxomerus geminatus*) and four species of hymenopterans (bees; *Lasioglossum illinoense*, *L. versatus*, *Halictus ligatus*, *Augochlorella striata*), from the family Halictidae, were determined to be effective pollinators for Short's bladderpod. Available data indicate that four species of hymenoptera (Pickering 2009) and *T. geminatus* (Hilty 2015) are generalist foragers. Sites where the species occurs should not be subjected to activities that would remove the soil seed bank. Moderate soil disturbance, however, could promote germination from the seed bank in locations where overstory shading and competition from herbaceous and shrub species have caused population declines (USFWS, 2014, USFWS, 2017a).

Habitat Type

Adult: Short's bladderpod typically grows on steep, rocky, wooded slopes and talus (sloping mass of rock fragments below a bluff or ledge) areas. It also occurs along tops, bases, and ledges of bluffs and infrequently on sites with little topographic relief. The species usually is found in these habitats on south- to southwest-facing steep heels or bluffs adjacent to the Cumberland River within the Highland Rim and Central Basin Sections of the Interior Low Plateaus Province .

The most stable and vigorous occurrences are found in sites with relatively open overstory canopy (USFWS, 2017a).

Habitat Vegetation or Surface Water Classification

Adult: Populations can include vegetation associated with both xeric and mesic conditions (USFWS, 2017a).

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits dry, open limestone ledges on river bluffs, talus of lower bluff slopes, and shale at cliff bases. These are usually south- to west-facing rocky slopes, and the tops, ledges, or bases of steep cliffs, often along major waterways, such as the Cumberland River (Pyne et al. 1995). Also on thin, calcareous soils in cedar glades. The plants should be sought on dry limestone rocks or open rock ledges. The species has also colonized artificial surfaces, especially roadcuts, downhill from natural or semi-natural bluffs (NatureServe, 2015). Short's bladderpod populations are most robust in sites where light availability is high due to low levels of shading from midstory and overstory vegetation (USFWS, 2017a).

Dispersal/Migration**Dispersal**

Adult: There is a lack of evident mechanisms for long-distance dispersal for Short's bladderpod but flowing water is needed for dispersal within watershed (USFWS, 2017a).

Population Information and Trends**Population Trends:**

Decreasing (USFWS, 2014)

Resiliency:

Low (USFWS, 2017a)

Representation:

Moderate (USFWS, 2017a)

Redundancy:

Moderate (USFWS, 2017a)

Number of Populations:

31 (USFWS, 2017a)

Population Size:

1 - 1,000 individuals (USFWS, 2017a)

Minimum Viable Population Size:

Unknown (USFWS 2017a)

Population Narrative:

Population numbers of this seed-banking mustard vary substantially from year to year, with maintenance of seed-bank diversity dependent on significant reproduction in at least some years. Shading from overtopping trees or invasive shrubs can deplete populations as well. Many sites are on roadsides, where they are no longer within natural ecosystems (USFWS, 2004). Species has a distjunct distribution where historically is was known from 55 occurrences, and as of 2016 there were 10 extant occurrences in Kentucky, 20 in Tennessee, and 1 in Posey County, Indiana, for a total of 31 extant occurrences range-wide (INHDC 2017, KNHP 2017, TNHID 2016). One of these (Tennessee EO 22) was not found when last visited, in 2013, and flood damage was observed at the site, but it is considered extant until such time as it is declared extirpated in the TNHID. Extant occurrences in Kentucky are distributed among Clark (1), Franklin (7), Madison (1), and Woodford (1) Counties, and in Tennessee among Cheatham (5), Davidson (3), Dickson (1), Jackson (3), Montgomery (3), Smith (2), and Trousdale (2) Counties. One Tennessee occurrence straddles the county line between Cheatham and Davidson Counties. This is an increase of 5 occurrences as compared to the 26 extant occurrences reported in the proposed listing rule for the species (78 FR 47111-47113; August 2, 2013). The rediscovery of Kentucky EO 10 in 2013 also adds Madison County to the species' current range. Of these occurrences, only 8 have greater than 100 individuals (USFWS, 2017a). The remaining populations are in many cases small, isolated, and have limited potential for recolonization should they be extirpated (USFWS, 2017b).

Threats and Stressors

Stressor: Soil Loss (USFWS, 2014)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The features essential to the conservation of Short's bladderpod may require special management considerations or protection to reduce the following threats: (1) Actions that would directly result in removal of soils or indirectly cause their loss due to increased rates of erosion (USFWS, 2014).

Stressor: Development/grazing (USFWS, 2014)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: (2) Building, paving, or grazing of livestock within or upslope of Short's bladderpod sites that alters water movement or causes soil erosion that results in sediment deposition in suitable habitat (USFWS, 2014).

Stressor: hard rock mining (USFWS, 2014)

Exposure:**Response:****Consequence:** Loss of habitat**Narrative:** 3) Blasting or removal of hard rock and soil substrates (USFWS, 2014).**Stressor:** Trash dumping (USFWS, 2014)**Exposure:****Response:****Consequence:** Habitat degradation**Narrative:** (4) Dumping of trash and debris (USFWS, 2014).**Stressor:** Prolonged inundation (USFWS, 2014)**Exposure:****Response:****Consequence:** Loss of habitat/Loss of individual plants**Narrative:** (5) Prolonged inundation of sites due to manipulation of regulated waters for flood control or other purposes (USFWS, 2014).**Stressor:** Right-of way maintenance (USFWS, 2014)**Exposure:****Response:****Consequence:** Loss of individuals**Narrative:** (6) Indiscriminate maintenance of transportation rights-of-way, including grading, mowing, or herbicide application**Stressor:** Invasive/non-native plants (USFWS, 2014)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** (8) Shading and competition due to forest canopy closure and encroachment of invasive, nonnative plants (USFWS, 2014).***Recovery*****Delisting Criteria:**

Agreements have been reached with key stakeholders to conserve, restore, and manage habitat to provide ecological conditions, as described in the Species Status Assessment for Short's bladderpod (SSA), that promote growth of individuals and support resilient populations (USFWS, 2017b).

Monitoring demonstrates stable or increasing population growth rates or an average population size for at least 25 populations that is equal to or above the minimum viable size. Populations are protected by a conservation mechanism. A minimum of 6 of these populations must be located in the Kentucky River watershed and 15 populations in the Cumberland River watershed, in addition to the population in the Wabash River watershed, in order to ensure adequate regional representation and intra-regional redundancy of resilient populations (USFWS, 2017b).

In lieu of satisfying criteria 1 and 2, the species could be considered for delisting if 50 resilient occurrences (as described in the SSA) are distributed among the physiographic regions where the species occurs (USFWS, 2017b).

Recovery Actions:

- Work with the Corps to develop and implement a conservation strategy for Short's bladderpod on lands that the Corps owns or controls (USFWS, 2017b). Includes: develop and implement an adaptive management framework to manage populations on Corps managed lands and implement annual monitoring of populations on Corps managed lands (USFWS, 2017c).
- Develop and implement management agreements with departments of transportation, local highway departments, railroad authorities, and utility companies to ensure protection of populations near rights-of-way (USFWS, 2017b). Includes: determine which populations are potentially impacted by right-of-way maintenance, assess potential impacts of rights-of-way maintenance on specific Short's bladderpod occurrences, and work with right-of-way stakeholders to develop and implement management agreements (USFWS, 2017c).
- Work with state agencies and private landowners in Kentucky, Tennessee, and Indiana to obtain protection for populations on privately owned lands and to develop and implement adaptive management strategies for protected sites (USFWS, 2017b).
- Establish standardized methods for monitoring of populations and habitat conditions, and initiate regular stage-specific monitoring at occurrences range-wide (USFWS, 2017b). Includes: develop a standardized rangewide population monitoring protocol and initiate regular stage-specific monitoring at occurrences range-wide (USFWS, 2017c).
- Conduct research that enhances knowledge of Short's Bladderpod to facilitate the development of scientifically sound management plans and models for conducting population viability analyses (USFWS, 2017b). Includes: conduct research to identify ecological conditions needed for germination, establishment, and reproduction of Short's bladderpod; conduct research to examine life history, seed bank longevity, breeding system, pollination, and dispersal for Short's bladderpod; determine germination and propagation requirements of Short's bladderpod; determine genetic diversity within populations and the genetic structure and distance between range-wide populations; determine the tolerance of Short's bladderpod to prolonged drought and inundation; and incorporate results from monitoring and research projects into development of models for estimating minimum viable size and demographic structure of populations and for evaluating extinction risk under various management scenarios (USFWS, 2017c).
- Facilitate and support surveys to identify new populations (USFWS, 2017b). Includes: develop a geospatial database to determine priority areas for surveys and conduct surveys to identify additional populations of Short's bladderpod (USFWS, 2017c).
- Increase the representation and genetic diversity of ex situ collections of Short's bladderpod in seedbanks to ensure the breadth of species diversity is conserved (USFWS, 2017b).
- Augment protected populations that are unable to grow in response to habitat management due to low population size, or introduce populations into suitable, but unoccupied, managed habitat on conservation lands (USFWS, 2017b).
- Continue to coordinate with Federal, State, County and City agencies to promote plant recovery and find innovative ways to increase public awareness of the need to protect this species and its habitats (USFWS, 2017b). Includes: develop a Short's bladderpod working group (USFWS, 2017c).

Conservation Measures and Best Management Practices:

- Management activities that could ameliorate these threats include, but are not limited to: (1) Avoiding areas located in or upslope of Short's bladderpod sites when planning for location of commercial or residential development; maintenance, construction, or expansion of utility and transportation infrastructure; and access for livestock (USFWS, 2014).
- (2) Removing trash and debris that are dumped onto or upslope of Short's bladderpod sites (USFWS, 2014).
- (3) Locating suitable habitat, determining presence or absence of Short's bladderpod, and protecting or restoring as many sites or complexes of sites as possible (USFWS, 2014).
- (4) Evaluating the effects of flow regulation on Short's bladderpod occurrences within the fluctuation zone of regulated river reaches and adjusting management to avoid or minimize prolonged periods of inundation (USFWS, 2014).
- (5) Reaching out to all landowners, including private, State, and Federal landowners, to raise awareness of the plant and its habitat (USFWS, 2014).
- (6) Providing technical or financial assistance to landowners to help in the design and implementation of management actions that protect the plant and its habitat (USFWS, 2014).
- (7) Managing, including reducing, canopy cover and competition from native and invasive, nonnative plants to maintain an intact native forest community with canopy openings or low levels of canopy closure (USFWS, 2014).

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Designation of Critical Habitat for *Physaria globosa* (Short's bladderpod), *Helianthus verticillatus* (whorled sunflower), and *Leavenworthia crassa* (fleshy-fruit Gladeceess)

Endangered and Threatened Wildlife and Plants

Endangered Status for *Physaria globosa* (Short's bladderpod), *Helianthus verticillatus* (whorled sunflower), and *Leavenworthia crassa* (fleshy-fruit glade cress)

Proposed Rules. Federal Register Vol. 78, No. 149. Pages 47060-47108

USFWS. 2017b. Draft Recovery Plan for Short's Bladderpod (*Physaria globosa*). U.S. Fish and Wildlife Service, Southeast Region, Atlanta, GA. 6 pp.

Proposed Rules. Federal Register Vol. 78, No. 149. Pages 47060-47108.

USFWS. 2017c. Recovery Implementation Strategy for Short's Bladderpod (*Physaria globosa*). U.S. Fish and Wildlife Service, Southeast Region, Atlanta, GA. 16 pp.

SPECIES ACCOUNT: *Physaria obcordata* (Dudley Bluffs twinpod)

Species Taxonomic and Listing Information

Listing Status: Threatened; 02/06/1990; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

A perennial herb with flowering stems, 1.2-1.8 dm tall, arising from a tuft of silvery, erect, basal leaves. Flowers are yellow and bloom in May and June. This species is recognized by its dense, silvery covering of dish-shaped hairs which completely encrust its stems, leaves, and heart-shaped fruits. (NatureServe, 2015)

Current Range

Endemic to Colorado; known from Rio Blanco County only along the Piceance and Yellow Creek drainages and at Clamity Ridge. Estimated range is 574 square kilometers, calculated in GIS by drawing a minimum convex polygon around the known occurrences.

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (USFWS, 2008)

Breeding Season

Adult: Flowers are yellow and bloom in May and June (NatureServe, 2015).

Reproduction Narrative

Adult: Flowers are yellow and bloom in May and June (NatureServe, 2015). These species rely exclusively on insect pollination (USFWS, 2008).

Habitat Type

Adult: Shale (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (natureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (NatureServe, 2015)

Site Fidelity

Adult: High (NatureServe, 2015)

Habitat Narrative

Adult: Species is found in white oil-shale, Parachute Creek Member of the Green River Formation. (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are based on the specific habitat requirements of this species.

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: No information found.

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Resiliency:

Low (NatureServe, 2015)

Representation:

Moderate (NatureServe, 2015)

Redundancy:

Moderate (NatureServe, 2015)

Population Growth Rate:

Unknown. There is insufficient data to characterize long-term trends. Unknown (NatureServe, 2015)

Number of Populations:

6 - 20 (NatureServe, 2015)

Population Size:

10,000 - 100,000 individuals (NatureServe, 2015)

Population Narrative:

Population trends are unknown. There is insufficient data to characterize long-term trends. Unknown Total estimated sum of individuals from the 10 documented occurrences is 34,400. There are 10 principal occurrences documented in the Colorado Natural Heritage Program database. All of the occurrences are in a restricted geographic area. Several occurrences are within approximately 1-2 km of one another, but have not been combined due to data complexity. (NatureServe, 2015). Low resiliency and moderate redundancy and representation are based on the relatively narrow geographic range this species is known to inhabit and the overall number of known populations and individuals.

Threats and Stressors

Stressor: Oil and Gas Development (USFWS, 2008)

Exposure:**Response:****Consequence:** Loss of habitat

Narrative: While not discussed in the recovery plan, ongoing oil and gas development is currently the primary threat to the bladderpod and the twinpod. Natural gas production is prolific from formations located stratigraphically below the oil shale. Four of the top 35 natural gas fields in the United States are located in the southern Piceance Basin (BLM 2007). This threat also is projected to increase significantly on the lands managed by the BLM-WRFO. Numerous projects are currently being planned and implemented to expand existing development and the associated infrastructure within the range of both plants. Along some pipeline routes, there is no room for additional pipelines without impacting occupied plant habitat (USFWS, 2008).

Stressor: Oil Shale Development (USFWS, 2008)**Exposure:****Response:****Consequence:** Loss of habitat

Narrative: The potential for oil shale development in the Piceance Basin was identified as the primary threat to both species in the 1993 recovery plan. In 2008, the threat is imminent (USFWS, 2008).

Stressor: Energy Corridors (USFWS, 2008)**Exposure:****Response:****Consequence:** Loss of habitat

Narrative: The potential designation of energy corridors is likely to impact energy development throughout the western United States, including commercial oil shale and tar sands development, because the location of energy corridors may facilitate development by removing administrative and planning barriers for potential pipelines, electric transmission lines, and associated infrastructure (BLM 2007) (USFWS, 2008).

Stressor: Summary of Energy Development (USFWS, 2008)**Exposure:****Response:****Consequence:** Loss of habitat

Narrative: Oil and gas development presents an imminent threat to the entire range of both species. BLM has managed to avoid oil and gas impacts on the species in most of the range, but further development in some areas may not be possible without disturbing suitable habitat for the species. The potential impacts from oil shale development depend on the alternative selected and the amount and distribution of leased areas. Potential impacts could be severe. New energy corridor designations may facilitate a larger volume of oil and gas activity and threats to the species, depending on the routes. As a listed species, consultation through Section 7 should minimize impacts. In the absence of the ESA's protections, we believe substantial threats would threaten both species range-wide (USFWS, 2008).

Stressor: Trampling (USFWS, 2008)**Exposure:****Response:****Consequence:** Loss of individuals

Narrative: information on cattle and wild horse trampling of plants shows only localized damage to plants in a few occurrences. The effect on plant numbers cannot be distinguished from population fluctuations during drought years (USFWS, 2008).

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2008)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Protection of habitat for both species depends on BLM management regulations. In the past year, BLM has worked with the Service to develop and apply more comprehensive conservation measures and larger avoidance buffers for oil and gas development. To date, all Section 7 consultations for the plants have resulted in findings of not likely to adversely affect. Increasing pressure on BLM to approve applications for more intensive oil and gas development is likely to result in formal consultations and more disturbance to potential if not occupied habitat. In the absence of the ESA's protections, we believe the situation would be considerably worse (USFWS, 2008).

Stressor: Secondary Impacts of Energy Development (USFWS, 2008)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Air pollution from diesel truck exhaust and from proposed coal-fired power plants for oil shale production could be a potential impact. Development of each new gas well requires between 375 and 1,375 round trips by large trucks to deliver materials, supplies and equipment, depending on the depth and location of the well. Operating wells require 0.25 truck trips per day (Kuhn 2006). Possible effects on the plants have not been predicted. Likewise, dust from heavy use of nearby roads may impede growth of the plants; information on likely impacts is not available. Conservation measures that are being implemented by BLM include dust abatement using water on roads, instead of magnesium chloride that could damage plants. Overspray from a produced-water evaporation pond on private land has reached an adjacent BLM plant occurrence; effects on the plants have yet to be determined. Accidental release of produced water from gas wells has been observed to kill sagebrush and associated vegetation near a few well pads. These species rely exclusively on insect pollination. As described above in section 2.3.1.1, Tepedino (1996) estimates that foraging bees may fly 4.8 km (3 mi) to obtain nesting materials. Increasing ground disturbance in the vicinity of occupied plant habitat may be curtailing nesting resources for ground nesting bee pollinators. Increasing vehicle traffic may cause mortality of pollinators. Available information regarding these potential threats is not sufficient to show that larger buffer areas would benefit the pollinators (USFWS, 2008).

Stressor: Climate Change (USFWS, 2008)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Changes in the global climate system during the 21st century are very likely to be larger than those observed during the 20th century (IPCC 2007). For the next two decades, a warming of about 0.2°C per decade is projected (IPCC 2007). Afterwards, temperature projections increasingly depend on specific emission scenarios (IPCC 2007). Various emissions scenarios suggest that by the end of the 21st century, average global temperatures are expected

to increase 0.6 to 4.0°C with the greatest warming expected over land (IPCC 2007). Localized projections suggest the southwest may experience the greatest temperature increase of any area in the lower 48 States (IPCC 2007). It is very likely that hot extremes, heat waves, and heavy precipitation will increase in frequency (IPCC 2007). There also is high confidence that many semi-arid areas like the western United States will suffer a decrease in water resources due to climate change (IPCC 2007). Milly et al. (2005) project a 10 to 30 percent decrease in precipitation in mid-latitude western North America by the year 2050 based on an ensemble of 12 climate models. Drought years result in a loss of plants. When occurrences also are impacted by other factors during drought years, they may require several years to recover. Dislodging of plants while monitoring during drought years has been cited as a factor in population decline at two ACEC sites (BLM-WRFO 1989; BLM-WRFO 2002b). Climate change may exacerbate the frequency and intensity of droughts in this area (USFWS, 2008).

Recovery

Reclassification Criteria:

Protect and/or enhance all known occurrences of *L. congesta*/*P. congesta* (bladderpod) and *P. obcordata* (twinpod) on public and private lands. Establish land management designations, and develop and implement habitat management programs (USFWS, 2008).

Protect both species from impacts via consultation under Section 7 and protection under Section 9 of the Endangered Species Act (ESA) (USFWS, 2008)

Minimum viable populations are defined and documented as being maintained for both species (USFWS, 2008).

Recovery Actions:

- **Inventory Remaining Potential Habitat** - Additional survey work has expanded the known distribution and abundance data for these species. Since 1993, bladderpod has been documented at two new occurrences on about 180 to 187 hectares (ha) (446 to 462 acres (ac)) (CNHP 2006b). During this same period, twinpod has been documented at five new occurrences on about 16 ha (40 ac) (CNHP 2006b, 2008). Most of the potential habitat on BLM land has been surveyed. Most of the potential habitat on private lands (primarily owned by energy companies) still needs to be surveyed. **Establish Land Management Designations on Federal Land** - Four Areas of Critical Environmental Concern (ACECs) were designated to protect the plants including about 177 ha (438 ac) (CNHP 2006a; BLM-CO 2004), or about 64 percent of known occupied habitat for both species on BLM land. Estimated occupied habitat on BLM land not protected by ACECs is 101 ha (250 ac) (CNHP 2006b), or 36 percent of known occupied habitat for both species on BLM land. Permanent protective land management designations are necessary on all, or nearly all, occupied BLM land in order to fully achieve recovery. **Protect Habitat on Private and State Land** – Ownership of one bladderpod occurrence at Duck Creek was transferred from State Division of Wildlife to a private energy company. A permanent conservation management and monitoring plan Memorandum of Agreement for the plants was attached to the land exchange. Similar agreements are needed for occurrences on other private parcels. **Create Habitat Management Plans** - Habitat management plans have not been developed for either species. **Apply No Surface Occupancy Stipulations on Federal Land** - No Surface Occupancy stipulations are applied to the four ACECs and to all known and potential habitat under BLM

- jurisdiction for endangered, threatened, and candidate plant species. Exceptions are allowed if surveys show there would be no direct impact or effects to the plants. Under this policy, developments including pipelines, roads and well pads have been approved by BLM within all four ACECs. In some cases, ground disturbance occurs within 30 meters (m) (98 feet (ft)) of plant habitat. No monitoring results are available to measure the effects of these actions on the plants. BLM is currently working with the Service to determine appropriate buffer distances to protect the plants and their habitat from direct and indirect effects of oil and gas development activities. The Service currently recommends a 200-m (656-ft) buffer to avoid adverse effects to plants and habitat for these listed plants. Implementation of buffers is an ongoing effort for BLM and the Service.
- Review Mining Claims – The Service has not reviewed plot records to determine the extent of historic mining claims, if any. Future claims require a plan of development and environmental analysis for mining. Current land management designations close all known and potential habitat to surface mineral materials development.
- Establish Off-highway Vehicle Designations – Within the ACECs, motorized vehicle travel is limited to designated roads and trails (BLM-WRFO 1997). The maps show about 26 segments of road that remain open within the ACECs, and about 19 that are closed. Off-highway vehicles on BLM land not in ACECs are limited to existing routes in areas with potential habitat for the plants. Additional fencing, signage, enforcement and education is needed to ensure compliance with existing road closures.
- Transfer Privately Owned Occurrences to BLM - Exchanges of private land into BLM management as recommended in the Recovery Plan have not occurred. Shell Oil acquired land in an exchange with the Colorado Division of Wildlife (CDOW) that includes approximately 28 ha (70 ac) of occupied bladderpod habitat adjacent to the Duck Creek ACEC and Natural Area. CDOW consulted with the Service and the Colorado Natural Areas Program to develop a Memorandum of Agreement that will protect the plant habitat acquired by Shell (CDOW 2007). The Memorandum of Agreement provided the basis for concurrence by the Service that the land exchange was not likely to adversely affect the species (USFWS, 2008).
- Process Project Clearances - BLM has ongoing informal Section 7 consultations with the Service regarding multiple gas pipelines, seismic survey projects, a large oil and gas Piceance Development Plan that covers an area including two of the ACECs, and five Oil Shale Research Development and Demonstration projects. The Service also is reviewing proposed oil shale lease areas described in the Draft Oil Shale and Tar Sands Resource Management Plan (RMP) Amendments Programmatic Environmental Impact Statement (BLM 2007). CDOW has informally consulted with the Service to avoid impacts to plant habitat on several projects involving gas pipelines, processing facilities and land exchanges. While Section 7 consultations are not considered recovery actions, they are the primary tool for implementing conservation measures to avoid or minimize disturbance of the habitat for both species (USFWS, 2008).
 - Conduct Soil Analyses, Life History Analyses and Monitoring - Detailed descriptions of the Thirteenmile Creek Tongue, the Parachute Creek Member, and the Garden Gulch Member of the Green River Formation are available, but the lack of finely mapped geology is still a limiting factor in modeling suitable habitat (Decker et al. 2006). Resources have not been available to conduct life history analyses. A minimum viable population analysis has not been performed. Because the habitat is limited and imminent threats encompass the entire range of both species (see five factor analysis, section 2.3.2, below), we are assuming that most, if not, all suitable habitat and occurrences are essential to the survival of the species. BLM has conducted sporadic monitoring on the ACEC occurrences of both species from 1985 to 2007. The Colorado Natural Areas Program and BLM have been monitoring the

bladderpod at two locations on the Duck Creek ACEC and Colorado Natural Area for 10 years (Rickey and Kurzel 2007). One site for each species has been monitored on the Dudley Bluffs ACEC (Kurzel 2006). Results are described below in section 2.3.1.2 (USFWS, 2008).

Conservation Measures and Best Management Practices:

- Publish a technical correction in the Federal Register noting the change in taxonomy from *Lesquerella congesta* to *Physaria congesta*, and correcting 50 CFR 17.12 (USFWS, 2008).
- Revise the recovery plan for both species so that it reflects the best scientific and commercial information available. The revised recovery plan should include objective, measurable criteria which, when met, will result in a determination that the species be removed from the Federal List of Endangered and Threatened Plants. Recovery criteria should address all threats meaningfully impacting the species. The recovery plan should also estimate the time required and the cost to carry out those measures needed to achieve the goal for recovery and delisting (USFWS, 2008).
- Designate critical habitat for both species. “Critical habitat” is defined as: (1) specific areas within the geographical area occupied by the species at the time of listing, if they contain physical or biological features essential to conservation, and those features may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species if the agency determines that the area itself is essential for conservation. This could be done concurrently, in a single rule, with other neighboring plant species (USFWS, 2008).
- Recommend at least a 200 m (656 ft) buffer between occupied or suitable habitat and ground disturbance or other activities that may affect the plants or their habitat (USFWS, 2008).
- Develop and implement consistent conservation measures in the WRFO RMP revision that will avoid and minimize impacts from all development, ORV, and grazing activities. Include protection for all occupied and suitable habitat in the conservation measures. Expand existing ACECs to include contiguous occupied and suitable habitat for the plants and their pollinators. Designate the Yellow Creek occurrence as an ACEC as was proposed in the recovery plan, plus contiguous occupied and suitable habitat (USFWS, 2008).
- Inventory remaining potential habitat on public and private lands. Report results to CNHP, BLM, and the Service (USFWS, 2008).
- Map all potential habitat, occupied habitat, and areas of existing and proposed leases, applications to drill, and development activities in GIS format (USFWS, 2008).
- Develop and implement permanent conservation agreements for occurrences on private lands (USFWS, 2008).
- Monitor the effects of development activities located within 200 m (656 ft) of plant occurrences on plants, pollinators, and habitat. Change buffers as determined by monitoring results (USFWS, 2008).
- Conduct annual status evaluations including estimates of mean density and population sizes at all Element Occurrences for the duration of intense energy activities within the range of both species (USFWS, 2008).
- Research the function of pollinators in the life history needs of the species, determine the habitat requirements of key pollinators, and adjust energy development best management practices accordingly (USFWS, 2008).

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U.S. Fish and Wildlife Service Western Colorado Field office Grand Junction, Colorado.

SPECIES ACCOUNT: *Pilosocereus robinii* (Key tree cactus)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/20/1984; Southeast Region (R4)

Physical Description

The Key tree-cactus is a large, tree-like cactus with erect columnar stems, reaching 10 m in height. At maturity, the plants are either much-branched (in variation *robinii*), or remaining few-branched (in variation *deeringii*). The stems of the tree-cactus are cylindrical, green, succulent, and 2 to 4 inches thick, with nine to 15 prominent ribs. Areoles bear 15 to 30 acicular spines that are up to 0.78 inches long and are thickly pubescent when young. Flowers are solitary in the Upper areoles, nocturnal, and 2.0 to 2.3 inches long. The outer perianth segments of the flowers are green, with tips pointed (in variation *robinii*) or rounded (in variation *deeringii*). The inner perianth segments of the flowers are white. The style is slightly exserted (in variation *robinii*) or included (in variation *deeringii*). The fruit of the Key tree cactus is globose, depressed, and 1.4 to 1.6 inches in diameter. The coat of this fruit is thin, leathery, bright red, and splits open at maturity. The seeds are small, hard, shiny black, and set in a soft, white pulp (Benson 1982, Britton and Rose 1937, Small 1931). (USFWS, 1999)

Taxonomy

The taxonomy of *Pilosocereus* in the Keys has been historically confusing and is not yet clearly resolved. Most recently both *P. robinii* and *P. bahamensis* have been grouped into the more widespread species *Pilosocereus polygonus* (Lem.) Byles & G.D.Rowley (Zappi 1994, Anderson 2001). Botanists who are familiar with the Key tree-cactus have not adopted this taxonomy, and *P. polygonus* is not recognized by the Integrated Taxonomic Information System (ITIS) (ITIS 2010a). The Flora of North America (1993) also states that this treatment is not supported by existing data. The ITIS accepts *Pilosocereus robinii* (Lem.) Byles & Rowley as a valid taxon. Two varieties are recognized, *P. robinii* var. *deeringii* (Small) Kartesz & Gandhi and *P. robinii* var. *robinii* (Lem.) Byles & Rowley (ITIS 2010b). The taxonomic position of *Pilosocereus* populations in Cuba is uncertain (Adams and Lima 1994). The Service will defer any decision to adopt the revised taxonomic scheme until the ongoing difficulties with classification in this group of taxa are settled. (USFWS, 2010)

Historical Range

The historical range of Key tree-cactus included the entire expanse of the Florida Keys, from Key West to Key Largo (Adams and Lima 1994), encompassing an area of about 80 miles (128 kilometers [km]) east to west, and 30 miles (48 km) north to south. (USFWS, 2010)

Current Range

The Florida Keys in Florida, an area 40 miles (114 km) east to west, and 15 miles (24 km) north to south. Records exist for populations on Key West, Boca Chica Key, Big Pine Key, Long Key, Lower Matecumbe Key, Upper Matecumbe Key, Windley Key, and Key Largo. (USFWS, 2010)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: The Key tree-cactus can flower year-round, but July, August, and September are peak flowering periods.

Reproduction Narrative

Adult: Long distance dispersal and establishment of new tree-cactus populations is dependent upon the production of seed. However, reproduction within a single population (a clump) is mostly, if not entirely, vegetative. This reproductive strategy (formation of clonal clumps from rooted wind-thrown branches) also accounts, in part, for the clumped distribution of the species (Adams and Lima 1994). Pollination agents are unknown, but may include sphingid moths (Adams and Lima 1994). Seed dispersal by birds (*Cardinalis cardinalis*, for example) is indicated for this species (Austin 1980). The effective dispersers would be those fruit-eating birds, which favor openings in the woods. The Key tree-cactus can flower year-round, but July, August, and September are peak flowering periods. Mature flowers develop in about 12-14 days, and many flowers may occur simultaneously on a single pseudocephalium (Adams and Lima 1994). Seed dispersal, based on one observation, occurs in August (Austin 1980; Avery [no date]).

Habitat Type

Adult: Tropical hardwood hammocks

Habitat Narrative

Adult: The Key tree-cactus grows in a narrow range of plant associations, which include tropical hardwood hammocks and a thorn-scrub association known locally as a “cactus hammock.” The major requirements for successful growth of Key tree-cactus are an open canopy and freedom from frequent floods or frequent fires. Hardwood hammocks inhabited by the species are typically in an early stage of succession following disturbance (Avery [no date], Small 1917, 1921). Dominant tree species include *Bumelia salicifolia*, *Bursera simaruba*, *Coccoloba diversifolia*, *Ficus aurea*, *Krugiodendron ferreum*, *Metopium toxiferum*, and *Piscidia piscipula*. The Lower story of the canopy typically contains small trees of the dominant species and plants of *Amyris elemifera*, *Ateramnus lucidus*, *Bumelia celastrina*, *Capparis flexuosa*, *Eugenia foetida*, *Guapira discolor*, *Pithecellobium guadelupense*, *Randia aculeata*, and *Zanthoxylum fagara* (Austin 1980, Weiner [no date]). These hardwood hammocks are upland communities which are flooded only rarely (during major storms) and are mesic in character (Weiner [no date]). The thorn-scrub, “cactus hammock” association occurs at relatively low elevations in the Keys and is prone to more flooding. Consequently, the canopy of this vegetative community is lower and more open than hardwood hammocks. *Conocarpus erectus* and *Ximenia americana* are the most typical dominant tree species (Weiner [no date]). *Cereus gracilis*, *Cereus pentagonus*, and *Opuntia dillenii* are common associates of Key tree-cactus in these habitats. Key tree-cactus exists on high sites within cactus hammocks that are rarely flooded. These sites support the hardwood hammock species listed above, but they are rarely extensive enough to allow typical development of hardwood hammocks. The hardwood hammocks and cactus hammocks where the Key tree-cactus grows are all on coral rock. Key tree-cactus grows well on well-drained upland sites with little or no soil development. Mineral soil is, if present at all, a very thin (less than 0.4 inches) layer of rock rubble, calcareous sands or calcareous marl (Austin 1980). A layer of leaf litter one to two cm thick is typically present (Austin 1980). Deeper accumulations of soil

may be found in pockets and crevices in the rock. These soils are classified as Histosols (Soil Conservation Service 1975). They are placed in the “catch-all” Rockland groups (Jones 1948). There is no detailed work on soil types in the Keys due to their small area, agricultural insignificance, and lack of well-developed soils. Hammocks on Key West and Boca Chica Key, where Key tree-cactus grew in the past, were developed on oolitic limestone. Soil conditions at these sites were not recorded, but were probably similar to those listed above. Key tree-cactus exists in small, isolated patches or clumps. The patches may consist of a single plant, or a group of plants may cover an area of tens of square meters (Austin 1980, Small 1917). When many plants occur in a clump, most, if not all, of the separate stems likely represent vegetative offshoots of one or a few founders. Vegetative reproduction is common because of old stems being knocked to the ground.

Dispersal/Migration

Population Information and Trends

Population Trends:

Decreasing

Number of Populations:

7 (USFWS, 2010)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

The species occurs only in Monroe County, Florida. The distribution of Key tree-cactus has decreased over the past 200 years as the Florida Keys have been transformed by commercial and residential development (Service 1999). The historical range of Key tree-cactus included the entire expanse of the Florida Keys, from Key West to Key Largo (Adams and Lima 1994), encompassing an area of about 80 miles (128 kilometers [km]) east to west, and 30 miles (48 km) north to south. The current range is approximately 50 percent of that area – 40 miles (114 km) east to west, and 15 miles (24 km) north to south. Records exist for populations on Key West, Boca Chica Key, Big Pine Key, Long Key, Lower Matecumbe Key, Upper Matecumbe Key, Windley Key, and Key Largo (Adams and Lima 1994). The number of islands now occupied by Key tree-cactus has been reduced by 50 percent. As of 2009, the distribution of this species is restricted to seven populations on four islands of the Florida Keys (Big Pine Key, Long Key, Lower Matecumbe Key, and Upper Matecumbe Key) (Adams and Lima 1994, Service 1999, Maschinski et al. 2009, FNAI 2009). Populations formerly found on Key West, Key Largo, Windley and Boca Chica keys, have been extirpated (Service 1999, FNAI 2009). It is reasonable to speculate that high mortality rates over the past 10 years have resulted in populations that are smaller in overall extent and have lower stem densities than in the past. Key tree-cactus may occur at an unknown number of sites in coastal thicket habitats in the provinces of Matanzas and Habana, in Cuba. Unconfirmed (and outdated) reports suggest that its distribution in Cuba has been reduced to a single population at Varadero Beach on the Icos peninsula, north of Matanzas (Adams 1997). As of 2009, the status of Key tree-cactus in Cuba is unknown. (USFWS, 2010)

Threats and Stressors

Stressor: Habitat destruction or modification

Exposure:

Response:

Consequence:

Narrative: The historic decline of Key tree-cactus was directly linked to the clearing of hardwood hammocks for development (Service 1999). Habitat destruction from development continues to occur and development pressure remains high; however, habitat loss currently occurs at substantially lower rates than in earlier periods (e.g., 1970s to 1990s). Clearing of hammocks for development is currently a threat to one population which remains unprotected on private land. Six of seven Key tree-cactus populations are protected from habitat loss to development. Four are protected on public conservation lands and two are protected by covenant or easement on private property. Development continues to fragment the remaining habitat, restricting gene flow between populations, and limiting the potential for expansion or shift in the species range in response to environmental changes. (USFWS, 2010)

Stressor: Overutilization for commercial, recreational, scientific, or educational purposes

Exposure:

Response:

Consequence:

Narrative: The threat of overutilization for commercial or recreational purposes was identified at the time of original listing in 1984 (49 FR 29234). Key treecactus is an attractive species with high horticultural value as landscape ornamentals. Cacti are regarded as one of the groups of plants that are most vulnerable to illegal collection due to their popularity with collectors worldwide (Anderson 2001). Laws prohibit the removal of cacti from State and Federal protected areas, but enforcement is difficult due to insufficient resources and the remoteness of the plants. There is recent evidence that the illegal trade in rare cacti includes Key tree-cactus. For example, a potted Key tree-cactus was sold across state lines on a well-known auction website in 2006 (Ebay 2006). The buyer subsequently surrendered this plant to Service law enforcement. Key tree-cactus is vulnerable to unlawful exploitation and collection and removal of plants from any of the protected areas for commercial or recreational reasons would be detrimental to the species. All sites with Key tree-cactus should be monitored for possible illegal collection activities

Stressor: Disease or predation

Exposure:

Response:

Consequence:

Narrative: There is no data to suggest that disease is the primary cause of the recent declines in Key tree-cactus populations. Tissue samples from several dying cacti were sent for analysis on more than one occasion. Results by Tropical Research & Education Center (TREC) of University of Florida – Institute of Food & Agricultural Sciences (UF-IFAS) (Aaron Palmateer; UF-IFAS, TREC Pathology Lab, Homestead) and Tim Schubert, Florida Department of Agriculture and Consumer Services [FDACS], Pathology, Gainesville) in January and April 2005, respectively reported no primary pathogens. A second test was conducted by TREC in 2008 and again, no primary pathogens were detected (P. Hughes, unpubl. data 2006, Goodman et al. 2008). Goodman et al. 2008 reported that a single cactus showed symptoms of basal rot that included ‘black goo’ leaking from the affected area. These are typical signs of bacterial necrosis in cacti. These bacteria are known to infect other large columnar cacti such as Saguaro (*Carnegiea gigantea*).

Since this symptom has only been observed in one individual Key tree-cactus, evidence is insufficient to connect this observation to the range-wide decline phenomenon. Goodman et al. (2008) observed that the surface of the soil just below the leaf litter at one site was entirely made up of frass from the introduced yellowbanded millipede (*Anadenobolus monilicornis*). While this organism is not known to be damaging to plants, they suggested that the predominance of frass could modify the soil structure or chemistry and possibly have an effect on plants. The native ant species, *Crematogaster ashmeadi* and *Solenopsis abdita* were observed removing the pulp and seeds from still-attached fruits and carrying them to ground level. In addition, the pulp and seeds of split fruits that had fallen were similarly removed by these two ant species (Adams and Lima 1994). There is no evidence suggesting seed predation by ants is a threat to Key tree-cactus. Ants may actually aid in seed dispersal. Hennessy and Habeck (1994) reported 'feeding damage' on plants in NKDR. Observed damage included complete girdling of woody trunks, uprooting, and chewing of stems. Maschinski et al. (2008) documented damage to cactus trunks at NKDR in which the fleshy tissue was removed down to the woody core of the plant. Damage occurred within 1.0 m of the ground and often on the exposed side of the plant that are more easily accessible to deer. Key deer are believed to damage Key tree-cactus through herbivory and antler polishing (Maschinski et al. 2008). Damage caused by herbivory or antler polishing by Key deer may weaken plants, making them more vulnerable to other stressors. (USFWS, 2010)

Stressor: Inadequacy of existing regulatory mechanisms:

Exposure:

Response:

Consequence:

Narrative: Key tree-cactus is listed as endangered by the State of Florida on the Regulated Plant Index (Florida Department of Agriculture and Consumer Services Rule 5B-40). This law regulates the taking, transport, and sale of listed plants. It does not prohibit private property owners from destroying populations of listed plants on their property nor require landowners to manage habitats to maintain populations. Existing Federal and State regulations prohibit the removal or destruction of listed plant species on public lands. However, such regulations afford no protection to listed plants on private lands. The ESA only protects populations from disturbances on Federal lands or when a 'Federal nexus' is involved for other lands, meaning any action that is authorized (e.g. permitted), funded or carried out by a Federal agency. In addition, State regulations are less stringent than Federal regulations toward land management practices that may adversely affect populations of listed plants on private land. Monroe County has adopted a point system of evaluation for building permit applications. Building permit applicants are required to replace listed plants and native vegetation removed from the construction site elsewhere on the property. Monroe County requires mitigation for impacts to rare plant species, including Key tree-cactus. If Key tree-cactus is found on a property to be developed, the property owner would be required to pay a mitigation fee to the County prior to development. Clearing is limited to 10 to 30 percent in high quality habitat. A conservation easement may then be placed on the remaining native habitat. These protections are limited, and populations can be still destroyed by private landowners. As such, existing regulatory mechanisms are adequate to protect Key tree-cactus, with exception of the single remaining unprotected population on private land. (USFWS, 2010)

Stressor: Hurricanes

Exposure:

Response:**Consequence:**

Narrative: Hurricanes have the potential to adversely affect tree-cactus populations. High winds can bring surrounding vegetation crashing down on top of individual cacti, injuring or killing them. However, hurricanes also open hammock canopies, allowing light to penetrate, thus providing conditions that may be favorable to cactus regeneration. Hurricane Georges made landfall on Big Pine Key in October 1998 and caused severe damage to the tree-cactus population on the NKDR. Maschinski et al. (2008) provides accounts by several individuals describing dramatic impacts to the lower Keys hammocks after Hurricane Georges. Many of the larger cacti were directly damaged by high winds or injured by airborne debris. A range of models suggest that due to global warming, future tropical cyclones (typhoons and hurricanes) will likely become more intense, with larger peak wind speeds and more heavy precipitation associated with ongoing increases of tropical sea-surface temperatures (IPCC 2007). The long-term impacts of hurricanes on tree-cactus are difficult to predict, but because the number of locations where Key tree-cactus occurs has been reduced, the potential threat of hurricanes is significant. (USFWS, 2010)

Stressor: Storm Surges**Exposure:****Response:****Consequence:**

Narrative: Hurricanes also cause storm surges, which inundate Key tree-cactus habitat with seawater. Maschinski et al. (2008) provides a local residents account which confirms that the area of NKDR where the cactus occurs was completely inundated during the storm surge produced by Hurricane Wilma in 2005. In a hammock where a Key tree-cactus population has decreased by about 90 percent, a past storm surge is evidenced by 'wrack line' of debris at that site (Maschinski et al. 2008). Storm surges during tropical storms and hurricanes have inundated areas where Key tree-cactus occurs on Big Pine and Long Keys (Maschinski et al. 2008). Storm surges can modify habitat by increasing soil salinity. Data suggest that high soil salinity may be the cause of the recent decline phenomenon in Key tree-cactus populations (Maschinski et al. 2009). The cause of the high salt levels is suspected to be salts deposited by storm surge events, from saltwater intrusion of groundwater, or both. Storm surges temporarily inundate large areas with seawater, which then drains off and percolates through the soil, leading to increased soil salinity. (USFWS, 2010)

Stressor: Sea Level Rise (SLR)**Exposure:****Response:****Consequence:**

Narrative: The projected global average sea level in 2100 will be 0.18 to 0.59 m higher than the average reported from 1980 to 1999 (IPCC 2007). SLR predictions do not take into account the full contribution of melting ice sheets, because existing data are inadequate to quantify these inputs. As a result, the predictions may underestimate SLR (IPCC 2007). SLR is the largest climate-driven challenge to refuges and other lands in the sub-tropical ecoregion of southern Florida (CCSP 2008). According to CCSP (2008), much of lowlying, coastal south Florida "will be underwater or inundated with salt water in the coming century". SLR is expected to exacerbate inundation, storm surge, erosion and other coastal hazards. Small islands, low-lying coastal areas and coastal systems such as mangroves and salt marshes are identified as areas that will be

especially affected. While habitat may be only partially inundated by 2100, it is likely that under any scenario, soil salinity will continue to increase, either by pulses as with successive storm surges, or incrementally due to saltwater intrusion. The Service anticipates that these processes will act separately or synergistically to cause ongoing mortality pulses of Key tree-cactus and eventually result in the conversion of their existing coastal hammock to transitional habitats and then tidal areas dominated by mangroves. (USFWS, 2010)

Recovery

Reclassification Criteria:

1. When further loss, fragmentation, or degradation of suitable, occupied habitat has been prevented (USFWS, 1999)
2. When native and non-native nuisance species have been reduced by 80 percent (USFWS, 1999)
3. When all suitable, occupied habitat on priority acquisition lists is protected either through land acquisition or cooperative agreements (USFWS, 1999)
4. When potential habitat on protected lands is restored or rehabilitated for the Key tree-cactus (USFWS, 1999)
5. When stable populations of the Key tree-cactus are distributed on secure sites within its historic range (including two on Upper Matecumbe, one on Lower Matecumbe, three on Long Key and two on Big Pine Key) (USFWS, 1999)
6. When three, additional, stable populations have been established on Windley Key, Boca Chica Key, and Key West. These populations will be considered demographically stable when they exhibit sexual reproduction and have a rate of increase equal to or greater than 0.0 as a 3-year running average for 6 years. (USFWS, 1999)

Delisting Criteria:

Delisting criteria have not been developed. (USFWS, 2010)

Recovery Actions:

- Conduct surveys to determine the distribution and status of *P. robinii*. Known *P. robinii* populations occur in coastal hammocks on Upper Matecumbe Key, Lower Matecumbe Key, Long Key, and Big Pine Key (Adams and Lima 1994), but other populations may exist. Survey historic range and determine distribution and status of *P. robinii*. Conduct surveys on private lands first since these are most likely to be vulnerable to disturbance. (USFWS, 1999)
- Protect and enhance existing populations. The remaining population sites must be protected as the first step toward recovery. These sites are currently the only ones which will offer assurance of supporting the species. Plant stocks for expansion of the population must come from the remaining specimens. (USFWS, 1999)
- Conduct research on the biology of *P. robinii*. Study the reproductive biology of *P. robinii*. Conduct genetic studies to document genetic variation within and between populations. Determine population size and viability of all populations. Study the response of *P. robinii* to

habitat management treatments. Characterize the habitat and identify suitable sites for experimental outplantings. (USFWS, 1999)

- Monitor *P. robinii* populations. Annual monitoring is the primary means to determine whether management practices are effective and what changes are needed. Inventories should detect changes in health, abundance, distribution, and threats. (USFWS, 1999)
- Increase public awareness and instill stewardship. Develop informational materials and host public workshops to increase awareness about *P. robinii* and instill a sense of stewardship for the protection of this endangered species. Conduct outreach efforts on national wildlife refuge properties and the State Recreation Area, through the Monroe County school system, and through press releases to emphasize the importance of the plant community, the conservation ethic, and Federal and State regulations and laws, including penalties for collection and vandalism. (USFWS, 1999)
- Establish reclassification and delisting criteria. Develop measurable reclassification criteria based on the factors that would produce a stable or increasing population, including total population size, number of subpopulations, habitat condition and availability, and level of threats. Evaluate and monitor *P. robinii*'s status in relation to reclassification criteria. Refine recovery goals. It is necessary to establish a realistic recovery objective for the species based on its biological characteristics. Recovery objectives should be re-evaluated and revised as necessary. Determine additional actions necessary to achieve the recovery objective. These actions must include legal protection, research, habitat protection, and other management strategies necessary to achieve recovery. (USFWS, 1999)
- Habitat-level Recovery Actions. Conserve existing habitats. Acquire habitat. Acquire and protect occupied habitat within historic range. Acquire the plant's suitable unoccupied sites that contain habitat associations important to *P. robinii*. Protect and manage *P. robinii* on private and public lands. Restore areas to suitable habitat. Conduct research on habitat-level ecological processes. Monitor the status of *P. robinii* habitat. Increase public awareness of *P. robinii* habitat and instill stewardship. (USFWS, 1999)

Conservation Measures and Best Management Practices:

- Continue to acquire privately owned parcels when there are willing sellers. (USFWS, 2010)
- Experiment with plant enclosures at NKDR to prevent potential damage to the plants by Key deer. (USFWS, 2010)
- Continue to monitor mature individuals for flowering/fruitletting and collect seed if found. (USFWS, 2010)
- Continue and increase monitoring for signs of disease. (USFWS, 2010)
- Attempt to increase seed set through hand pollination in selected plants to equalize representation in stock available for reintroduction projects. (USFWS, 2010)
- Maintain an aggressive program to salvage representative samples from dying cacti. (USFWS, 2010)
- Continue to monitor extant populations to confirm whether the rapidly declining populations have truly stabilized after 2007. (USFWS, 2010)
- Initiate genetic assessments to determine the genetic structure of the species at a range of spatial scales (clusters, populations, and species). Include the *P. bahamensis* population on Key Largo, and *Pilosocereus* in Cuba to determine the identity of these populations and relationship to *P. robinii*. (USFWS, 2010)
- Expand ex situ collections via cuttings from earlier collections and from seeds. Complete studies of soil to further test hypothesis that soil salinity is the main cause of the population decline. (USFWS, 2010)

- Conduct a greenhouse experiment to determine the range of salinity tolerance of Key tree-cactus. (USFWS, 2010)
- Determine the importance of specific elements and conditions that contribute to increased soil salinity – saltwater intrusion, storm surges, elevation, and drainage patterns. (USFWS, 2010)
- Continue to monitor soil salinity at all sites to provide early detection of rising salinity or evidence of declining salinity. (USFWS, 2010)
- Expand the scoring and evaluation of potential reintroduction sites. (USFWS, 2010)
- Develop an Emergency Response Plan for hurricanes and storm surges. (USFWS, 2010)
- Provide the Village of Islamorada ongoing technical support regarding cactus and site management in the newly acquired parcel. (USFWS, 2010)
- Reintroduce cactus in multiple, well dispersed sites, including those with raised elevation in the Lower Keys (e.g., NKDR; Key West Tropical Forest and Botanical Garden), and representing a range of percent canopy cover. (USFWS, 2010)

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SPECIES ACCOUNT: *Pinguicula ionantha* (Godfrey's butterwort)

Species Taxonomic and Listing Information

Listing Status: Threatened; 8/11/1993; Southeast Region (R4)

Physical Description

Pinguicula ionantha has a rosette of fleshy, oblong, bright green leaves that are rounded at their tips, with only the edges rolled upward. The rosette is about 15 cm (6 in) across. The upper surfaces of the leaves are covered with short glandular hairs that capture insects. The flowers are on leafless stalks (scapes) about 10-15 cm (4-6 in) tall. When a flower is fully open, its corolla is about 2 cm (almost 1 in) across. The five corolla lobes are pale violet to white. The throat of the corolla and the corolla tube are deeper violet with dark violet veins. The corolla has a spur 4-5 mm (0.2 in) long that is yellow to olive (Godfrey and Stripling 1961, Godfrey and Wooten 1981). (USFWS, 1994)

Taxonomy

Pinguicula ionantha Godfrey (Godfrey's butterwort or violet-flowered butterwort) is a member of the bladderwort family (Lentibulariaceae), a small family of carnivorous plants closely related to the snapdragon family (Scrophulariaceae) (USFWS, 1994).

Historical Range

See current range/distribution.

Current Range

Endemic to the central panhandle region of Florida with reported occurrences in Bay, Calhoun, Franklin, Gulf, Liberty, and Wakulla counties (USFWS, 2018).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Food/Nutrient Narrative

Adult: *Pinguicula* L., the second most diverse genus of the carnivorous Lentibulariaceae is monophyletic and composed of about 85 to 100 species native to Europe, North America, Asia, South and Central America, and southern Mexico (Cieslax et al. 2005, Degtjareva et al. 2006). Members of this genus use sticky, glandular leaves to trap and digest insects (USFWS, 2009). It is unclear what benefit the plant derives from this carnivory.

Breeding Season

Adult: The flowers rise from late February to April according to temperatures (USFWS, 2009).

Reproduction Narrative

Adult: *Pinguicula ionantha* has a rosette of fleshy, bright green-yellow leaves of up to 15 cm across that can be characterized by upward rolled leaf edges. The plants stay in rosette form all

year. The flowers rise from late February to April according to temperatures. The flowers, borne on stalks of about 10 to 15 cm in height, are about two centimeters across and possess five pale violet to white petals all of same shape corolla. The throat of the corolla and the corolla tube are deeper violet with dark violet veins. A yellow to olive spur 4 to 5 mm long is present on the corolla and the palate is yellow with a purple base and covered with yellow hairs (Godfrey and Stripling 1961, Godfrey and Wooten 1981) (USFWS, 2009). SEXUAL; ABIOTIC; Wind; (NatureServe, 2015)

Habitat Type

Adult: Bos/long leaf pine savannas (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits open, acidic soils of seepage bogs on gentle slopes, deep quagmire bogs, ditches, and depressions in grassy pine flatwoods and grassy savannas, often occurring in shallow standing water. "Pinguicula ionantha occurs in herb bog habitats embedded in longleaf pine savannas. Specifically, it is found between a lower elevation habitat dominated by pond cypress (*Taxodium ascendens*) overstory and a slightly higher elevation pine flatwoods dominated by an overstory of longleaf pine (*Pinus palustris*) (USFWS 2009) (NatureServe, 2015). High ecological integrity of the community and site fidelity and low tolerance ranges are inferred based on the species specific habitat needs.

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: No information found.

Population Information and Trends**Population Trends:**

Unknown (USFWS, 2018)

Species Trends:

Unknown (USFWS, 2018)

Population Growth Rate:

It is estimated that between 85 and 98% of herb bog/savanna habitats have been lost (Folkerts 1982 cited by Kesler et al. 2008). Decline of >70% (NatureServe, 2015)

Number of Populations:

92 sites (USFWS, 2018)

Population Size:

2500 - 100,000 individuals (NatureServe, 2015)

Additional Population-level Information:

Previously, 83 historical sites were documented between 1956 and 2009 (FNAI 2008). Based on information provided by FNAI (2017) and FWCC (2018) and recent surveys, the number of sites has increased to 92; technically representing 66 EOs. About 10,558 plants were present at 21 of the 23 EOs revisited in 2015 (Molano-Flores et al. 2014). A total of 52 sites were visited in 2006, 2008, and 2009 surveys: 33 sites were revisited by Kesler and Trusty (2008) during April 2006, and 19 sites were visited by Negrón-Ortiz during 2008 and 2009 surveys. Plants were present at 24 (46%) of these sites. Searches did not locate plants at 22 (42%) of the previously recorded sites. Additionally, high water or a dense woody midstory prevented access to six previously recorded sites in Gulf and Franklin counties (Kesler and Trusty 2008, Negrón-Ortiz, 2008 surveys). This species appears to be increasing in number of populations on public lands. However, overall trends in both abundance of individuals within each population and the total number of populations through the species range remain unknown. (USFWS, 2018)

Population Narrative:

Current survey information indicates an increase in the number of populations. Survey information shows 22 (33%) of the 66 EOs appear to be extirpated due to development and/or habitat modification. However, since surveys were conducted irregularly and based on either presence/absence and/or qualitative visual estimate (Jenkins et al. 2007); with most sites visited only once; and the actual counts of plants rarely provided, a comprehensive population survey is needed in order to better assess the current status of this species. Studies have demonstrated variation among the number of plants necessary for a population to survive risks of extinction (Given 1994, Matthies et al. 2004, Menges 1990). Matthies et al. (2004) study of 379 populations of eight threatened plant species in northern Germany demonstrated that very small populations face a considerable risk of extinction, while the risk for populations with more than 1000 individuals was very small. Because most of the *P. ionantha* populations have less than 1000 individuals, any impact to existing populations (specifically sites outside the ANF) could cause extirpation of these populations. Furthermore, the relatively low level of genetic diversity associated with this species is a concern as it may impair fitness and evolutionary adaptability in a changing environment (Zaya et. al 2016). (USFWS, 2018)

Threats and Stressors

Stressor: Logging and Pulpwood Production (USFWS, 2018)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Privately owned forests managed (clearcutting, mechanical site preparation, and bedding) for commercial timber production, is a primary threat to *P. ionantha* habitat. An active paper mill located in Panama City (Bay County) receives timber from thousands of acres of pine plantation. The commercial timber industry in North Florida became well established in the 1850's (FNAI 2005). It started in Franklin County in the 1870's and continued to be a prominent industry until the mid-1990's (Howell and Hartsell 1995). The Timberland Company had close to a

million acres in timber production in the eastern region of the Panhandle and they plan to continue to commercially harvest and replant off-site pine species. The Company also owned a paper mill in Port St. Joe until it was sold and shut down in 1999. In 2013, the Timberland Company sold more than 380,000 acres of its land to AgReserves, Inc.. The land sold included timberlands in Bay, Calhoun, Franklin, Gadsden, Gulf, Jefferson, Leon, Liberty and Wakulla counties. Within Gulf County, AgReserves, Inc. has repurposed timberlands into pasture lands for cattle (A. North, FDEP, 2/6/2018, pers. comm.). (USFWS, 2018)

Stressor: Coastal real estate and road development (USFWS, 2018)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Urban development continues to threaten Godfrey's butterwort. The Timberland Company is one of the largest private landowners in Florida, and one of the largest real estate operating companies in the Southeast. The Company develops both residential and commercial properties along roadways and near or within business districts in the region. More than a third of Florida's land is projected to be developed by 2070 along with a grow of about 33.7 million residents—almost 15 million more people than in 2010 (University of Florida GeoPlan Center 2017). Many *P. ionantha* locations are found along U.S. and state roads. Construction activity may directly kill individual plants or convert habitat to unsuitable habitat; widening may convert native habitat to managed road side; and culvert modification may change drainage patterns, which may change seasonal hydrology. Evidence suggests past road improvements have resulted in localized extirpation of Godfrey's butterwort in ANF (Kesler and Trusty 2008). Therefore, because they contribute to habitat loss, road widening and new roads continue to pose a threat to the species. (USFWS, 2018)

Stressor: Fire suppression (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Suppression of fire during the growing season continues to threaten the pineland and savanna's flora, as fire is an important factor in the maintenance of flatwoods (Abrahamson and Hartnett 1990). Fire influences community structure and composition (Abrahamson and Hartnett 1990), and with insufficient frequency in longleaf pine communities, a woody midstory quickly develops (Glitzenstein et al. 1995), negatively affecting the understory diversity. Several studies have shown that frequent, low intensity prescribed fire regimes are important for maintenance of flatwoods diversity (Hiers et al. 2007). Therefore, frequent prescribed burnings, i.e., < 3 yr interval, are needed to maintain optimal habitat for *P. ionantha* populations (Kesler et al. 2008). At present, the Apalachicola National Forest utilizes a 3- to 5-yr interval burn rotation (2-4 yr burn rotation at the burn units with *P. ionantha*, J. Drake, USFS, 02/21/2018, pers. comm.); Box-R WMA and SJBSBP utilize 2- to 3-yr interval; and Lathrop Bayou applies prescribed fire on a 2- to 7-yr interval. Thus, fire suppression continues to threaten to *P. ionantha* habitat and population numbers. Lack of fire, and subsequent growth of shrubs (particularly encroachment of *Cyrilla racemiflora* L., commonly known as swamp titi) and saplings in the understory, in addition to shading by planted pines, inhibits this species emergence (Negrón-Ortiz, 2008, pers. observ.; FNAI 2008, Kesler et al. 2008). Declining fire frequency reduces *P. ionantha* abundance in areas where it was previously observed in large quantities (FNAI 2008). Emergence of this species is prolific within one year of the fire event (Kesler and Trusty 2008). (USFWS, 2018)

Stressor: Over collection (USFWS, 2018)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: This factor is a threat, but the magnitude has been reduced. Butterworts are widely cultivated, grown and sold by plant enthusiasts and nurseries. *Pinguicula ionantha* was overcollected in the 1970s (58 FR 37440). Many thousands of plants propagated by tissue culture were sold without permits, but the plant is no longer commercially available in large quantities (D'Amato, California carnivores). In order to implement conservation measures and regulations, the Service granted a permit (TE061005-1) to the International Carnivorous Plant Society (ICPS) in 2003, which allows the society to sell seeds of endangered and threatened carnivorous plants only within the USA. Some restrictions apply to this permit (see <http://www.carnivorousplants.org/conservation/policies>); in addition, an annual report is required stipulating their selling activities. Collecting guidelines for live plants and seeds were developed by the ICPS: 1) they do not recommend collecting live plants unless it is for scientific purposes such as herbaria, the species has never been introduced to cultivation, or because a variant (a taxon exhibiting slight differences in form); 2) they will not accept field collected seed of listed plants, only seeds from cultivated plants will be accepted if they are donated in accordance with all relevant laws. The Nurseries Stock Restrictions manual summarizes the entry status of regulated plant material capable of or intended for propagation (USDA 2010). (USFWS, 2018)

Stressor: Hurricanes (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Saltwater inundation from storm surges caused by hurricanes represents a threat. Kesler and Trusty (2008) monitored one population in Franklin County, which was flooded during Hurricane Francis in 2004. In 2005, they observed that the plant number declined from about 100 to two individuals. (USFWS, 2018)

Stressor: Sea Level Rise (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Sea level rise (SLR) as a result of climate change is a growing concern for much of Florida's coastline and the endemic species that occur there because about 10% of Florida is less than 1 meter above current sea level. Being endemic to Florida, Godfrey's butterwort is threatened by climate change. Using the NOAA Sea Level Rise and Coastal Flooding Impacts Viewer (<https://coast.noaa.gov/slr/>), the projections indicated potential impacts to six known *P. ionantha* EOs (Bay Co.: 1 EO; Franklin Co.: 5 EOs) by intrusion of saltwater beginning at one foot SLR. (USFWS, 2018)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Section 7(b)(4) and 7(b)(2) of the Endangered Species Act (Act) generally do not apply to listed plant species. However, limited protection of listed plants from take is provided to the extent that the Act prohibits the removal and reduction to possession of Federally listed threatened and endangered plants or the malicious damage of such plants on areas under Federal jurisdiction, or the destruction of endangered plants on non-Federal areas in violation of State law or regulations or in the course of any violation of a State criminal trespass law. Seeds of both threatened and endangered species found on Federal land are regulated under the Act. However, the seeds of threatened species are not regulated if they come from cultivated plants (7 CFR 319.37.2, USDA 2008). Since *P. ionantha* is a threatened species, growers can obtain and sell seeds from other growers. Several populations of *P. ionantha* occur on private timberland and ROWs. While the Act requires Federal agencies to carry out programs for the conservation of endangered and threatened species, no such programs are stipulated for private landowners. The Act does not provide for protection of plants on private lands as long as the activity is permissible under state/local laws. The State requires permission of private landowners for collecting of State-listed plants from their property. *Pinguicula ionantha* is protected under Florida State Law, chapter 581.185: Preservation of native flora of Florida, which includes preventions of take, transport, and the sale of the plants listed under the State Law. The rule Chap. 5B-40, Florida Administrative Code, contains the "Regulated Plant Index" (5B-40.0055) and lists endangered, threatened, and commercially exploited plant species for Florida; defines the categories; lists instances where permits may be issued; and describes penalties for violations (Coile and Garland 2003). Bay County Comprehensive plan, under chapter 6, provides restrictions, constraints and requirements to protect and preserve designated habitat conservation areas for rare, threatened, or endangered species, and wetlands (<http://baycountyfl.gov/276/Planning-Zoning>). Calhoun, Gulf, Franklin, and Liberty Counties do not have such regulations. Highway ROW maintenance activities are not always reviewed for threatened and endangered species impact. However, if there is an activity (e.g., construction, mowing, or maintenance projects) affecting protected species, then the Service can recommend consultation to the FDOT under section 7 of the Act. The FDOT routinely consults with the Service on all major road construction activities. (USFWS, 2018)

Recovery

Reclassification Criteria:

Not relevant. (USFWS, 1994)

Delisting Criteria:

1. When 15 populations are adequately protected and managed throughout its historic range. Existing public land (mainly the Apalachicola National Forest) does not suffice for recovery). (USFWS, 1994)

Recovery Actions:

- Manage ROW Continue fostering conservation practices for utility and highway Right-of-Ways with the Forest Service, FDOT, and USFWS; a ROW Best Management Practices plan should be developed and implemented. (USFWS, 2018)
- Develop a stand-alone plan for managing listed plants at the Apalachicola National Forest and THSF, and integrate it to their Management Plan. (USFWS, 2018)
- Conduct a long-term study using 15 populations distributed throughout the species' historical range for 10 years to determine whether the observed declines in abundance

reflect acceptable stochasticity or if they are indicative of dangerously declining populations. This study could use the sites from Kesler and Trusty (2008) study, and will address the delisting criterion. (USFWS, 2018)

- Since habitat loss and degradation are leading causes of endangerment for *P. ionantha*, designating habitat that is critical for survival and recovery is recommended. (USFWS, 2018)
- Complete a comprehensive census (e.g., the total number of individuals, number of flowering vs. non-flowering plants, and whether seedling recruitment is occurring) throughout the present distribution including all the historical locations to determine the species' status. (USFWS, 2018)
- Conduct surveys/inventories on potentially new sites. This action can include the use of aerials and species distribution modeling methods to initially determine potential sites, with subsequent field inventory of the site using a consistent, statistically valid, repeatable inventory method. If new populations are discovered, protection should be sought, and identify sites for reintroductions such as areas that will not be affected by SLR and future development (USFWS, 2018)
- Establish (or continue) frequent growing-season fire regimes (i.e., 2-3 yr interval) on selected areas such as Apalachicola National Forest, SJBSBP, THSF, and Tyndall AFB to maintain optimal conditions of *P. ionantha* populations. Re-visit sites shortly after a burn event, and mark and count individual plants. Populations tend to be more evident after a fire event. (USFWS, 2018)
- Garden propagation and reintroduction. An ex-situ plant collection should be actively pursued and implemented with a botanical garden. (USFWS, 2018)
- Investigate if there is a soil seed bank persistence of *P. ionantha* seeds throughout the species geographic range. (USFWS, 2018)
- Conduct population biology studies at Apalachicola National Forest. Compare the demographic performance of *P. ionantha* in pinelands and road habitats. Survey for seedling recruitment and survival of tagged individuals (plant height and reproduction) for a period of 3-5 years in or near roadside populations of SR 65 and pinelands. (USFWS, 2018)
- The recovery plan should be updated to define objective measurable criteria and better address the five listing factors.(USFWS, 2018)

Conservation Measures and Best Management Practices:

- 1. Manage ROW
- 2. Since habitat loss and degradation are leading causes of endangerment for *P. ionantha*, designating habitat that is critical for survival and recovery is recommended (USFWS, 2009).
- 3. Evaluate the current species status (USFWS, 2009).
- 4. Conduct surveys/inventories on potentially new sites. This action can include the use of species distribution modeling methods to initially determine potential sites, with subsequent validation or inspection of the sites (USFWS, 2009).
- 5. Establish frequent growing-season fire regimes (i.e. 2-3 yr interval) on selected areas such as Tate's Hell State Forest, St. Joseph State Buffer Preserve, and ANF to maintain optimal conditions of *P. ionantha* populations. Re-visit sites shortly after burn event and mark individual plants. Populations tend to be more evident after a fire event (USFWS, 2009).
- 6. Garden propagation and reintroduction. An ex-situ plant collection should be actively pursued and implemented with a botanical garden. Studies on the viability of dry-stored seeds, the timing of the germination, and whether a persistent seed bank is present should be addressed (USFWS, 2009).
- 7. Conduct population studies at ANF (USFWS, 2009).

- 8. Conduct systematic studies to examine the current taxonomic classification (USFWS, 2009).
- 9. Conduct pollination studies (USFWS, 2009).
- 10. The recovery plan should be updated to define objective measurable criteria and better address the five listing factors (USFWS, 2009).

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SPECIES ACCOUNT: *Pittosporum halophilum* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (R1) (USFWS, 2017)

Physical Description

A shrub or small tree (USFWS, 2016).

Taxonomy

Kartesz 1999 does not recognize *Pittosporum halophilum* as distinct, but subsumes it in *P. confertiflorum*. In the Supplement of the Manual of the Flowering Plants of Hawai'i, Wagner and Herbst resurrect *P. halophilum* from synonymy of *P. confertiflorum* and say that 'recent collections have shown this taxon to be a distinct species' p. 1887. Also accepted as distinct by Wagner et al. (2012). (NatureServe, 2015) A member of the pittosporum family (Pittosporaceae) (USFWS, 2016).

Historical Range

See current range/distribution.

Current Range

Known only from Molokai (USFWS 2012). This species was reported from Huelo islet, Mokapu Island, Okala Island, and Kukaiwaa peninsula (USFWS, 2016).

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Pittosporum halophilum* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes seven detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Pittosporum halophilum* includes seven CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Molokai—Coastal—Unit 1 consists of 70 ac (28 ha) of privately owned land, and 54 ac (22 ha) of federally owned land (U.S. Coast Guard) at Laau Point, from Kahaiawa to Keawakalani, along the western coast of Molokai. This unit is occupied by the plant *Marsilea villosa*, and includes the mixed hermland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 1 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for

the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 2 consists of 263 ac (106 ha) of State land, and 710 ac (287 ha) of privately owned land, from Ilio Point to Kaa Gulch, along the northwestern coast of Molokai. This unit is occupied by the plant *Marsilea villosa* and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 2 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 3 consists of 794 ac (321 ha) of State land, and 3 ac (1 ha) of federally owned land (Kalaupapa National Historical Park), from Kahu Point to Wainene, along the north-central coast of Molokai. This unit is occupied by the plants *Pittosporum halophilum*, *Schenkia sebaeoides*, and *Tetramolopium rockii*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 3 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Marsilea villosa*, *Peucedanum sandwicense*, or *Sesbania tomentosa*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 4 consists of 10 ac (4 ha) on Mokapu Island on the northern coast of Molokai. This area is State-owned, and is classified as a State Seabird Sanctuary. This unit is occupied by the plants *Peucedanum sandwicense* and *Pittosporum halophilum*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 4 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Marsilea villosa*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and

recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 5 consists of 1 ac (0.5 ha) on Huelo islet on the northern coast of Molokai. This area is State-owned, and is classified as a State Seabird Sanctuary. This unit is occupied by the plants *Brighamia rockii*, *Peucedanum sandwicense*, and *Pittosporum halophilum*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 5 is not known to be occupied by *Bidens wiebkei*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrnone*, *Marsilea villosa*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 6 consists of 190 ac (77 ha) of State land, and 1,685 ac (682 ha) of privately owned land, from Kaholaiki Bay to Halawa Bay, on the northeastern coast of Molokai. This unit is occupied by the plants *Bidens wiebkei*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, and *Ischaemum byrnone*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 6 is not known to be occupied by *Brighamia rockii*, *Hibiscus brackenridgei*, *Marsilea villosa*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 7 consists of 49 ac (20 ha) of privately owned land from Alanuihipaka Ridge to Kalanikaula, on the northeastern coast of Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). Although Molokai—Coastal—Unit 7 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrnone*, *Marsilea villosa*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their

small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Pittosporum halophilum* critical habitat consists of one component. Coastal (Molokai) (81 FR 17790-18110):

Ecosystem: Coastal. Elevation: <980 ft (<300 m). Annual precipitation: <20 in (<50 cm). Substrate: Well-drained, calcareous, talus slopes; dunes; weathered clay soils; ephemeral pools; mudflats. Canopy: Hibiscus, Myoporum, Santalum, Scaevola. Subcanopy: Gossypium, Sida, Vitex. Understory: Eragrostis, Jacquemontia, Lyceum, Nama, Sesuvium, Sporobolus, Vigna.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's

tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylothea* ssp. *pentamera*, *B. campylothea* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Lifespan

Adult: < 10 years (inferred from USFWS, 2016)

Reproduction Narrative

Adult: It is a short-lived perennial (USFWS, 2016).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Coastal ecosystem (NatureServe, 2015)

Habitat Narrative

Adult: Coastal ecosystem on Molokai (USFWS 2012). (NatureServe, 2015).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Decreasing (USFWS, 2016)

Resiliency:

Low (inferred from current range/distribution)

Redundancy:

Low (inferred from USFWS, 2016)

Number of Populations:

3 (USFWS, 2016)

Population Size:

5 wild, 17+ outplants (USFWS, 2016)

Population Narrative:

There are three individuals on Mokapu Island, one individual on Okala Island, and one individual on Kukaiwaa peninsula (Bakutis 2010; Hobdy 2010; Perlman 2010 cited by USFWS 2012.). At Huelo islet, one individual was last seen in 2001 but its current status is unknown (USFWS 2012). There have been at least 17 individuals outplanted on the Kalaupapa peninsula (Garnett 2010 cited by USFWS 2012). As of 2010, there are three occurrences known: Mokapu Island, Okala Island, and Kukaiwaa peninsula (Bakutis 2010; Hobdy 2010; Perlman 2010 cited by USFWS 2012.). (NatureServe, 2015). On Mokapu Island, there were 15 individuals in the coastal ecosystem in 2001, and in 2005, 10 individuals remained. On Okala Island, there were two individuals in 2005, and one individual on the sea cliff at Kukaiwaa peninsula (Wainene) (Wood 2005, pp. 2, 41). As of 2010, there were three occurrences totaling five individuals: three individuals on Mokapu Island, one individual on Okala Island, and one individual on Kukaiwaa peninsula (Bakutis 2010, in litt.; Hobdy 2010, in litt.; Perlman 2010, in litt.). At least 17

individuals have been outplanted at 3 sites on the coastline of the nearby Kalaupapa peninsula (Garnett 2010a, in litt.) (USFWS, 2016).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs), nonnative plants, fire, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Fire can destroy dormant seeds and plants, even in steep and inaccessible areas. Successive fires can remove habitat for native species by altering microclimate conditions favorable to alien plants. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, rats, and slugs) is considered an ongoing threat to *Pittosporum halophilum* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor: Small populations (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: *Pittosporum halophilum* faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). *Pittosporum halophilum* is known from three disparate locations, each with one to three individuals, on Molokai and its offshore islets. These individuals are not protected from predation by feral pigs or rats, or from the threat of fire (USFWS, 2013).

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Recovery**Recovery Actions:**

- A recovery plan has not been completed for this species.

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

Final Rule . 81 FR 17790-18110 (March 30, 2016).

USFWS. 2013. Determination of Endangered Status for 38 Species on Molokai, Lanai, and Maui

Final Rule. 78 Federal Register 102, May 28, 2013. Pages 32014 - 32065.

SPECIES ACCOUNT: *Pittosporum hawaiiense* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Historical Range

See current range/distribution.

Current Range

Endemic to leeward Hawaii Island (NatureServe, 2015)

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Habitat Type**

Adult: Lowland mesic, montane mesic, and montane wet ecosystems (USFWS, 2013)

Habitat Narrative

Adult: Currently, there are 14 known occurrences totaling fewer than 175 individuals, from HVNP to Puu O Umi NAR, and south Kona, in the lowland mesic, montane mesic, and montane wet ecosystems: 1 occurrence in Puu O Umi NAR (several scattered individuals) (Perlman 1995b, in litt.); 1 occurrence (with a least one individual) in TNC's Kona Hema PR (Oppenheimer et al. 1998, in litt.); 1 occurrence with 50 to 100 individuals at Kukuipoe in the South Kona FR (Perlman and Perry 2002, in litt.; Perry 2012, in litt.); 1 occurrence (with a few individuals) in the Manuka NAR (Perry 2011, in litt.); 8 occurrences (totaling fewer than 58 individuals) scattered within the Kahuku unit of HVNP; 1 occurrence in the Olaa FR (at least one individual), just adjacent to the Olaa Tract in HVNP; and 1 occurrence (with fewer than 6 individuals) at the Volcano solid waste transfer station (Wood and Perlman 1991, in litt.; McDaniel 2011a, in litt.; McDaniel 2011b, in litt.; Pratt 2011d, in litt.) (USFWS, 2013).

Dispersal/Migration***Population Information and Trends*****Population Trends:**

No information found.

Population Size:

~175 (USFWS, 2013)

Population Narrative:

Currently, there are 14 known occurrences totaling fewer than 175 individuals, from HVNP to Puu O Umi NAR, and south Kona, in the lowland mesic, montane mesic, and montane wet

ecosystems: 1 occurrence in Puu O Umi NAR (several scattered individuals) (Perlman 1995b, in litt.); 1 occurrence (with a least one individual) in TNC's Kona Hema PR (Oppenheimer et al. 1998, in litt.); 1 occurrence with 50 to 100 individuals at Kukuipae in the South Kona FR (Perlman and Perry 2002, in litt.; Perry 2012, in litt.); 1 occurrence (with a few individuals) in the Manuka NAR (Perry 2011, in litt.); 8 occurrences (totaling fewer than 58 individuals) scattered within the Kahuku unit of HVNP; 1 occurrence in the Olaa FR (at least one individual), just adjacent to the Olaa Tract in HVNP; and 1 occurrence (with fewer than 6 individuals) at the Volcano solid waste transfer station (Wood and Perlman 1991, in litt.; McDaniel 2011a, in litt.; McDaniel 2011b, in litt.; Pratt 2011d, in litt.) (USFWS, 2013).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs, cattle, and mouflon), nonnative plants, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Lack of regeneration and hybridization (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Lack of, or low levels of, regeneration (reproduction and recruitment) in the wild has been observed, and is a threat to, *Pittosporum hawaiiense*. Hybridization is a potential threat, since native species can hybridize with related nonnative species. Native species of *Pittosporum*, including *P. hawaiiense*, are known to exhibit high levels of gene flow, and hybridization between native *Pittosporum* and nonnative species of *Pittosporum* may occur when they occupy similar habitat and elevation (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, cattle, mouflon, and rats) is considered an ongoing threat to *Pittosporum hawaiiense* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor:
Exposure:
Response:
Consequence:
Narrative:

Stressor:
Exposure:
Response:
Consequence:
Narrative:

Stressor:
Exposure:
Response:
Consequence:
Narrative:

Recovery

Recovery Actions:

- A recovery plan has not been completed for this species.

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Determination of Endangered Species Status for 15 Species on Hawaii Island

Final Rule. FR Vol. 78, No. 209. Pages 64638-64690.

USFWS. 2013. Determination of Endangered Species Status for 15 Species on Hawaii Island

Final Rule. 78 Federal Register 209, October 29, 2013. Pages 64638 - 64690.

SPECIES ACCOUNT: *Pittosporum napaliense* (Ho`awa)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (R1) (USFWS, 2016)

Physical Description

A small tree, 5 - 11 m tall. Flowers are unisexual, 8 - 20 in axillary or terminal, simple, corymbose, umbellate inflorescences. Petals are cream-colored (NatureServe, 2015).

Taxonomy

A member of the pittosporum family (Pittosporaceae) (USFWS, 2010b). The genus is of tropical and subtropical Africa, Asia, Australia, New Zealand, and a number of Pacific Islands; this species is endemic to Na Pali Coast, Kauai (NatureServe, 2015).

Historical Range

Historically, *P. napaliense* was known from northwestern Kauai (Wagner et al. 1999, p. 1047; HBMP 2007) (USFWS, 2010b).

Current Range

Currently, this species is known from the Hono o Na Pali NAR in Waiahuakua and Hoolulu valleys, and upper Kalalau Valley in the Na Pali Coast State Park (Kauai) (HBMP 2007) (USFWS, 2010b).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Pittosporum napaliense* (Ho`awa) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes five critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Pittosporum napaliense* includes five CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Lowland Mesic—Section 1: Lowland Mesic—Section 1 consists of 2,006 ac (812 ha) in the lowland mesic ecosystem, including mesic forest extending from Awaawapuhi Trail south to Makaha Ridge, in the Na Pali Kona Forest Reserve and the Kuia NAR (Figure 1-A). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plants *Doryopteris angelica*, *Labordia helleri*, *Platydesma rostrata* and *Psychotria hobbdi*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these four species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic—Section 1 is not known to be occupied by the species *Canavalia napaliensis*, *Chamaesyce*

eleanoriae, *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Dubautia kenwoodii*, *Pittosporum napaliense*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 2: Lowland Mesic—Section 2 consists of 379 ac (154 ha) in the lowland mesic ecosystem, including mesic forest extending from Keanapuka to Kahuamaa Flat along the rim and cliffs of the Kalalau Valley, in the Na Pali Coast State Park (Figure 1-A, above). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plants *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Pittosporum napaliense*, and *Psychotria hobdyi*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these six species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic—Section 2 is not known to be occupied by the species *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Platydesma rostrata*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 3: Lowland Mesic—Section 3 consists of 124 ac (50 ha) in the lowland mesic ecosystem, including mesic forest extending from Manono Ridge, Pohakuao Valley, to Kanakuu, within the Na Pali Coast State Park (Figure 1- A, above). The entire section is Stateowned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plants *Canavalia napaliensis*, *Chamaesyce eleanoriae*, and *Charpentiera densiflora*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these three species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic— Section 3 is not known to be occupied by the species *Chamaesyce remyi* var. *remyi*, *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Pittosporum napaliense*, *Platydesma rostrata*, *Psychotria hobdyi*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 4: Lowland Mesic—Section 4 consists of 81 ac (33 ha) in the lowland mesic ecosystem, including mesic forest at the head of the Hanakapiai Valley, in the Na Pali Coast State Park (Figure 1-A, above). The entire section is Stateowned and within previously

designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plant *Charpentiera densiflora* and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. Although Lowland Mesic—Section 4 is not known to be occupied by the species *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *Chamaesyce remyi* var. *remyi*, *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Pittosporum napaliense*, *Platydesma rostrata*, *Psychotria hobdyi*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 5: Lowland Mesic—Section 5 consists of 37 ac (15 ha) in the lowland mesic ecosystem, including mesic forest on the slopes of Mt. Haupu, on privately owned land (Figure 1-B). The entire section is within previously designated critical habitat, and falls within Critical Habitat Unit 7 of 50 CFR 17.99(a)(1), Map 23a. This section is occupied by the plants *Chamaesyce remyi* var. *remyi* and *Tetraplasandra bisattenuata*, and includes mesic forest and shrubland, the moisture regime, and subcanopy and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these two species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic—Section 5 is not known to be occupied by the species *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *Charpentiera densiflora*, *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Pittosporum napaliense*, *Platydesma rostrata*, and *Psychotria hobdyi*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Pittosporum napaliense* critical habitat consists of one component (Lowland mesic) (75 FR 18960-19165):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<914 m). Annual precipitation: 50–75 in (127–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations

or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to

further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Pandanus and lowland mesic forest (USFWS, 2010b)

Geographic or Habitat Restraints or Barriers

Adult: 400 - 2,100 ft. elevation (USFWS, 2010b)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits moist forests on ridges and in gulches. The environmental specificity is unknown (NatureServe, 2015). It is typically found in Pandanus and lowland mesic forest in the lowland mesic ecosystem, at elevations between 400 and 2,100 ft. (122 and 640 m) (Wagner et al. 1999, pp. 1045–1047; HBMP 2007; TNCH 2007) (USFWS, 2010b).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Species Trends:

Declining (NatureServe, 2015)

Resiliency:

Very low (inferred from USFWS, 2010b; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2010a)

Number of Populations:

3 (USFWS, 2010a)

Population Size:

~200 (USFWS, 2017)

Population Narrative:

The long term population trend is unknown. It is known to be declining due to numerous threats, exact percentage is unknown (HBMP 2007) (NatureServe, 2015). There are three populations totaling 160 - 200 individuals (USFWS, 2010a). There are currently about 200 wild individuals of *Pittosporum napaliense* along the Na Pali coast and at Limahuli (USFWS, 2017).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from non-native plants, deer, hurricanes, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species.

Stressor: Predation and herbivory (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species present an immediate and significant threat to *Pittosporum napaliense* throughout its range due to documented browsing and trampling by pigs, goats, and deer, and documented mechanical damage by rats (USFWS, 2010).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Pittosporum napaliense* is highly vulnerable to the impacts of climate change with a vulnerability score of 0.906 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Stressor: Hurricanes—Loss and degradation of habitat

Exposure:

Response:

Consequence:

Narrative: In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013) (USFWS, 2017).

Recovery

Reclassification Criteria:

In addition to achieving 5 to 10 populations with 400 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats (USFWS, 2017).

Delisting Criteria:

In addition to achieving 5 to 10 populations with 400 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is

available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis (USFWS, 2017).

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys (USFWS, 2010a).
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units (USFWS, 2010a).
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys (USFWS, 2010a).
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range (USFWS, 2010a).
- Conduct research on control methods for introduced slugs and avian malaria (USFWS, 2010a).
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction (USFWS, 2010a).
- Identify threats and prioritize which ones to address first for the two birds (USFWS, 2010a).
- Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program (USFWS, 2010a).
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security (USFWS, 2010a).
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems (USFWS, 2010a).
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations (USFWS, 2010a).
- Current Management Actions: • Surveys and inventories—Surveys are ongoing in Hoolulu (PEPP 2014). • Captive propagation for genetic storage and reintroduction—Seeds are being collected for storage and propagation at NTBG, but longterm storage potential in this genus is questionable (NTBG 2013, 2014b, 2015b; Keir and Weisenberger 2014). There are 20 plants from one bulk collection of the Hoolulu population at the Kokee Rare Plant Facility (DOFAW 2016). There are over 200 plants planted at the NTBG gardens from 12 different collections, and there are several hundreds of plants in the NTBG nursery from 11 different

- collections (NTBG 2017). • Reintroduction and translocation—NTBG has outplanted individuals in lower Limahuli Preserve (NTBG 2013, 2014b, 2015b, 2017) (USFWS, 2017).
- **RECOMMENDATIONS FOR FUTURE ACTIONS** • Surveys and inventories—Continue to survey for populations of *Pittosporum napaliense* in areas of potentially suitable habitat. • Ungulate monitoring and control—Protect all occurrences against browsing and disturbances from feral ungulates. Construct and maintain fenced exclosures around existing populations to prevent imminent extinction. • Invasive plant monitoring and control
 - o Control established ecosystem-altering nonnative invasive plant species around all populations.
 - o Control invasive nonnative plant species around all populations that compete with the species.
 - Rodent predation or herbivory control—Implement effective measures to control rodents around all populations.
 - Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock.
 - Reintroduction and translocation—Continue reintroduction of individuals into suitable habitat within historic range that is being managed for known threats to this species.
 - Population biology research—Study *Pittosporum napaliense* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats.
 - Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms.
 - Based on the recovery criteria above, consider development of a recovery plan (USFWS, 2017).

Conservation Measures and Best Management Practices:

- This species is currently in controlled propagation for genetic storage and/or reintroduction efforts (USFWS, 2010a).

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SPECIES ACCOUNT: *Pityopsis ruthii* (Ruth's golden aster)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 7/18/1985

Physical Description

A perennial herb, 1-3 dm tall. The stems are leafy with grass-like leaves. Bright yellow flower heads bloom in late summer and fall (NatureServe, 2015).

Taxonomy

Past taxonomic treatments of Ruth's golden aster, and golden asters in general, have involved frequent shifting of species among genera. Small (1897) described the species as *Chrysopsis ruthii* but subsequently transferred it to the genus *Pityopsis* (Small 1933), a genus characterized as those golden asters with graminiform (grass-like) leaves. This concept was rejected by Fernald (1942) who described the recognition of *Pityopsis* as "hardly worthwhile" and retained the species in *Chrysopsis*. Later, Shinnars (1951) included *Chrysopsis* in his concept of the genus *Heterotheca*. His treatment generally was accepted by Harms (1969), who published the combination *Heterotheca ruthii*, and by Bowers (1972b) and Cronquist (1980). Dress (1953), in his study of the eastern *Chrysopsis*, continued to follow Small's 1933 nomenclature (except in the case of the *Pityopsis graminifolia* complex). Semple (1977), Semple et al. (1980), and Semple and Bowers (1985) reaffirmed *Heterotheca*, *Chrysopsis*, and *Pityopsis* as distinct genera. Semple's work is widely accepted, and Ruth's golden aster will be referred to here as *Pityopsis ruthii* (Small) Small. It is instructive to note that no student of the genus has questioned the validity of the species, only the proper generic designation (USFWS, 1990).

Historical Range

See current range/distribution.

Current Range

Known only to occur along short reaches of the Ocoee and Hiwassee River, Polk County, Tennessee (USFWS, 2018).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Reproduction in natural populations is attributed to stem regeneration or tillering of the subaerial root-rhizome crown (Wofford and Smith 1980). This agrees with White (1977), who stated that the chief method of reproduction is by existing rhizomes. White observed no seedlings in the field and concluded that *P. ruthii* has difficulty becoming established on the phyllite boulders. His comparison of plants from the Hiwassee River population with those grown for his greenhouse studies showed an average of 50 achenes and 58 achenes per flowering head, respectively. Typically, 18 percent of those achenes from the wild population

were filled (i.e., viable) compared to 19 percent from the greenhouse populations. Although White (1977) presented no figures on percentage germination of the filled achenes he sowed during his greenhouse study, he indicated that 62 percent of the *P. ruthii* seedlings resulting from the 960 filled achenes sown survived their first 3 weeks. It is suggested that a combination of wind and nonselective foraging by insects could account for the low percentage of filled achenes (Wofford and Smith 1980). No studies of pollinators or of pollination in *P. ruthii* have been performed. However, in the field, Bowers (1972a) noted several kinds of bees visiting the flowers of various members of the section *Pityopsis* (including *P. ruthii*), and in the greenhouse he observed occasional visits by flies to the flowers of the same species. He determined that members of the section *Pityopsis* are obligate outcrossers and that self-fertilization and apomixis seldom, if ever, occur. He also concluded that wind is of little importance in pollination. White (1977), while collecting soil samples in the field, observed numerous ant colonies sharing the same crevices with *P. ruthii*. He suggested there may be a relationship between the presence of the ants and the establishment of *P. ruthii* but made no further investigation of this potential relationship. Production of low numbers of viable seeds could easily contribute to difficulties in the establishment of new plants. Ineffective dispersal methods also could be a contributing factor. While Wofford and Smith (1980) stated that “age class determinations indicate only mature individuals are present,” there was evidence that regeneration from seeds is occurring. In an ongoing study of *P. ruthii*, Collins and Gunn (1986) observed one subpopulation on the Hiwassee River comprising 1,149 individual plants. Relative to other subpopulations measured in 1986 and 1987, a greater preponderance of those plants were small and single-stemmed and were not located near enough other larger plants to have come from rhizomes. The same subpopulation was measured the next year (Collins and Gunn 1987), and 307 fewer individuals were found, perhaps the victims of stress from severe drought. Apparently many of the absent individuals were the small, single-stemmed plants recorded the prior year. It is possible that many of those plants were young seedlings, not yet vigorous enough to withstand the extreme conditions at the time. Furthermore, a great many more individuals not producing flowering heads were seen than were found by Wofford and Smith (1980). The extent and significance of predation upon *P. ruthii* are not known. White (1977) observed predation by the larvae of three moth species on plants in the greenhouse. In the field, Collins and Gunn (1986) also have observed insect larvae apparently feeding on the achenes in the maturing heads of some plants (USFWS, 1990).

Habitat Type

Adult: The species is restricted to outcrops of phyllite (rarely greywacke) within 5.7 km (3.5 mi) and 4.6 km (2.9 mi) reaches of the Hiwassee and Ocoee Rivers, respectively (USFWS, 2018).

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (NatureServe, 2015)

Site Fidelity

Adult: High (NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits soil-filled cracks in phyllite boulders along river banks and in rivers, within 5.7 km (3.5 mi) and 4.6 km (2.9 mi) reaches of the Hiwassee and Ocoee Rivers, respectively (USFWS, 2018). Shade intolerant but adapted to annual high water flows; requires periodic flooding and scouring to remove competing vegetation (NatureServe, 2015). High ecological integrity of the community and site fidelity along with low tolerance ranges are noted based on the species specific habitat requirements and the relatively low number of populations (NatureServe, 2015).

Dispersal/Migration**Motility/Mobility**

Adult: Low (inferred from USFWS, 1990)

Dispersal

Adult: Low (inferred from USFWS, 1990)

Dispersal/Migration Narrative

Adult: No study of fruit dispersal has been made, but the pappus is disposed to dissemination by wind. According to Wofford and Smith (1980), dispersal also is achieved by water. They regarded effective dispersal as rare, based on the paucity of observations of seedlings in nature, but provided no supportive data (USFWS, 1990). Low mobility and dispersal are inferred based on rare effective dispersal of the species.

Population Information and Trends**Population Trends:**

Stable to decreasing (USFWS, 2018)

Species Trends:

Decreasing (USFWS, 2018)

Resiliency:

Low (inferred from NatureServe, 2015)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1000 - 10,000 individuals (NatureServe, 2015)

Population Narrative:

As of 2017, the population from the Ocoee River was relatively stable from 2011 through 2017 ranging from a low of 1,140 during 2011 to a high of 1,299 individuals in 2015. As of 2017, there were 1,232 individuals, an overall increase of 82 individuals (7.2 percent) compared to the baseline census in 2011. Data collection on the Hiwassee River has occurred at a total of 57 sites, but only 27 sites have been counted annually. These 27 sites account for more than 90 percent of all plants counted in each year from 2011 through 2017, thus are representative of trends for the population on this river. Data from the Hiwassee demonstrate that a period of increase occurred from 2011 through 2014, followed by decreases through 2017. Using data from the 27 sites counted annually, as of 2017 there has been a decrease of 1,676 individuals (17.6 percent) compared to the 2011 baseline and a decrease of 4,125 individuals (34.5 percent) since 2014, when the population peaked (USFWS, 2018). A study from 2013 showed moderate genetic diversity in three populations sampled and a study from 2018 determined that gene flow levels among populations within each river were sufficient to reduce risk of divergence due to genetic drift.

Threats and Stressors

Stressor: Encroachment of competing vegetation (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: There are concerns about the loss of habitat in the Hiwassee drainage to encroachment of competing herbaceous and woody vegetation. A Biological Assessment prepared by TVA (2002) discussed the threat posed to the Hiwassee population by vegetation encroachment onto the phyllite boulders due to altered flows in the river below Apalachia Dam since its construction in 1943. They identified this threat as the cause for the observed decline of *P. ruthii* since monitoring began in 1986. Several lines of evidence support this conclusion, including the general declining trend in the Hiwassee population since monitoring began, the finding of Thomson and Schwarz (2006) that all Hiwassee populations suffered mean negative growth rates except for one plot from which vegetation had been removed in the past, and Cruzan's (2000) observation that vegetative cover in the Hiwassee floodplain has increased approximately 50 percent since the late 1940s (USFWS, 2012). Continued encroachment and habitat reduction contributes to decreases in *P. ruthii* in some sites. As abundance decreases, pollinator attraction could decrease, potentially creating a negative feedback loop reducing reproductive output and contributing to further declines (USFWS, 2018).

Stressor: Altered flow regimes (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Altered flow regimes (due to the Apalachia dam) and encroachment of competing vegetation into suitable habitat in the Hiwassee drainage remain the greatest active threats for *P. ruthii*. Because the process of vegetation encroachment has occurred over a period of several decades, riparian communities have become established on the phyllite boulders to the extent that periodic high flows alone would not be enough to remove this threat and restore *P. ruthii* habitat (USFWS, 2012). Maintenance work in 2015-2016 on the Apalachia powerhouse and switchyard caused elevated flows for 132 days in the Hiwassee River where *P. ruthii* occurs and a

decline in this population was observed. Drought conditions also occurred during part of 2016, which could also account for the decline in the observed Ocoee River population (USFWS, 2018).

Stressor: Recreation (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of individual plants

Narrative: The development of a whitewater recreation facility on the Ocoee River and hosting of whitewater events during the 1996 Olympics elevated concerns about recreation-related impacts to *P. ruthii*, both from whitewater paddlers and spectators. The USFS-CNF recommended corrective measures to reduce recreation-related impacts at two sites (Doublesuck and Tablesaw) where they were found to be greatest (Herrig and Wyrick 1996). The threat of trampling by spectators at the Tablesaw site was reduced by the extension of a guardrail on the nearby highway, eliminating parking access in close vicinity to this population. However, no billboard or kiosk has been constructed at the access point for paddlers upstream of Doublesuck, to inform paddlers of the presence of *P. ruthii* and biologically sensitive areas near particular whitewater features (USFWS, 2012). No adverse effects from whitewater recreationists or observers have been reported since 2015 (USFWS, 2018).

Stressor: Road construction (USFWS, 2018)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The Tennessee Department of Transportation is currently analyzing transportation alternatives for Corridor K, which passes through the Ocoee River Gorge and based on a preliminary map of targeted spot improvements, some of the road construction would occur along US HWY 64 where it parallels sites on the Ocoee River that *P. ruthii* occupies. A Section 7 consultation has not been completed and therefore the potential for adverse effects to *P. ruthii* that could result from implementing the Targeted Approach have not been analyzed (USFWS, 2018).

Stressor: Disease or predation (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Five potential invertebrate herbivores have been observed on *P. ruthii* in situ and ex situ plants and can damage flower buds and developing seeds (USFWS, 2018).

Stressor: Hybridization (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: The potential for hybridization to occur between *Heterotheca ruthii* (= *P. ruthii*) and *H. graminifolia* (= *P. graminifolia* var. *latifolia*) was first documented by Bowers (1972), in a cross that produced only two seeds, one of which germinated and died within a week. Moore et al. (2016) report that P.A. Wadl (unpublished data) produced viable offspring from controlled crosses between these species. Recent evidence (Bogges 2013, Hatmaker et al. 2018, P. Wadl 2018,

pers. comm.) indicates that wild hybrids may be formed where these two species co-occur. Hybridization could present a threat to reproductive output and genetic variation (USFWS, 2018).

Stressor: Climate change (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Using NatureServe's Climate Change Vulnerability Index (CCVI) to assess *P. ruthii*'s predicted exposure to climate change, the species was ranged as highly to extremely vulnerable indicating that abundance and/or range extent or are either likely to decrease significantly (highly vulnerable), or extremely likely to substantially decrease or disappear (extremely vulnerable), by 2050 (Young et al., 2015)(USFWS, 2018). Drought experienced in 2016 and 2017 contributed to declines of this species and very likely reduced seedling establishment given that seedling emergence has been observed to occur beginning in November (USFWS, 2018).

Recovery

Delisting Criteria:

The Ocoee River population, under the criteria described in or to be established by implementation of Task 7, is deemed recovered and the rate of natural succession on the phyllite boulders on the Hiwassee River is determined to not be detrimental to the survival of *P. ruthii* (USFWS, 1990).

The Hiwassee River population, under the criteria described in or to be established by implementation of Task 6, is deemed recovered and Tasks 7.2, 7.3, 7.4, and 7.6 are accomplished for the Ocoee River population.

Pityopsis ruthii shall be considered recovered when the full set of recovery goals (Tasks 6 and 7) for each population is fulfilled (USFWS, 1990).

Recovery Actions:

- 1. Maintain formal agreements among the appropriate concerned agencies on the preservation of *Pityopsis ruthii*.
- 2. Maintain permanent plots.
- 3. Determine what is necessary for effective and successful achene dispersal. seed germination, and seedling establishment. 3.1 Study achene dispersal. 3.2 Determine life history. seed germination, and seedling establishment requirements. 3.3 Determine the role of interspecific and intraspecific competition.
- 4. Determine what constitutes suitable habitat.
- 5. Search for *Pityopsis ruthii* on other rivers.
- 6. Determine and implement for the Hiwassee River population the management necessary for long-term reproduction, maintenance, and vigor. 6.1 Determine and compare Past and present stream flow regimes. 6.2 Determine the nature and role of natural succession on the phyllite boulders. 6.3 Determine whether or not the population is self-sustaining. 6.4 Establish *P. ruthii* on unoccupied suitable habitat. 6.5 Establish a cultivated population of plants descended from the Hiwassee River population and provide for long-term seed

- storage. 6.6 Determine feasibility and/or necessity of water releases and hand-clearing of phyllite boulders (USFWS, 1990).
- 7. Determine and implement for the Ocoee River population the management necessary for long-term reproduction, maintenance, and vigor. 7.1 Study the relationship of the river to *P. ruthii*. 7.2 Determine impacts of river recreational users and implement required management actions. 7.3 Ensure that highway construction will not damage or destroy plants or suitable habitat. 7.4 Determine whether the population is self-sustaining. 7.5 Establish *P. ruthii* on unoccupied suitable habitat. 7.6 Establish a cultivated population of plants descended from the Ocoee River population and provide for long-term seed storage (USFWS, 1990).
 - 8. Variability in population trends among sites in the Hiwassee River suggests that demographic monitoring of selected sites would be useful in understanding which life history stages are most affected by threats to the species and its habitat. Demographic monitoring will be necessary for evaluating effectiveness of any future efforts to reintroduce the species into suitable unoccupied habitat (USFWS, 2018).
 - 9. Future restoration projects should explore effects of planting season and importance of mycorrhizal associations on establishment, survival, growth, and reproduction of introduced plants. Additionally, if restoration into suitable habitat is to be successful, multiple outplantings over time likely will be necessary at any given site (USFWS, 2018).
 - 10. For each mapped location on the Hiwassee River, record data on apparent vulnerability to vegetation encroachment, including observations on substrate composition (e.g., bedrock, boulder, cobble, gravel, degree of sediment deposition), landform and aspect. Use these data to map risk of local extinction and assess whether and where management is needed to control vegetation encroachment (USFWS, 2018).
 - 11. Incorporate observations on presence and relative abundance of *Pityopsis graminifolia* var. *latifolia* at monitoring sites, to document locations where potential threat of hybridization is greatest (USFWS, 2018).
 - 12. Coordinate with TDOT to avoid potential adverse effects to *P. ruthii* from road construction activities on US HWY 64 (USFWS, 2018).

Conservation Measures and Best Management Practices:

- The primary actions needed to move *P. ruthii* towards a status at which downlisting or delisting could be considered, include: 1. Determining effective methods for controlling vegetation encroachment and restoring degraded habitat in the Hiwassee drainage (USFWS, 2012).
- 2. Implementing a vegetation control and habitat restoration program to restore suitable habitat conditions across the occupied range in the Hiwassee drainage. For long-term prevention of repeated vegetation encroachment, altering flows to provide sufficient frequency and duration of scouring of phyllite boulders will likely be necessary (USFWS, 2012).
- 3. Analyzing and comparing contemporary flow regimes (i.e., since 1943) on the Hiwassee River to pre-impoundment flow regimes (USFWS, 2012).
- 4. Conducting future surveys of *P. ruthii* populations in the Hiwassee drainage in order to assess (1) the degree to which suitable habitat for the species declines due to vegetation encroachment and (2) whether the species' linear distribution along the Hiwassee River changes over time (USFWS, 2012).
- 5. Developing effective reintroduction methods for establishing *P. ruthii* in suitable habitat, in order to fulfill recovery tasks 6.4 and 7.5 (USFWS, 2012).

- 6. Ensuring that recommendations for controlling whitewater recreation-related threats to the Ocoee population are implemented (USFWS, 2012).
- 7. Continuing long-term monitoring effort that has been implemented by TVA, USFS-CNF, and TDEC (USFWS, 2012).
- 8. Continuing annual meetings of the RCWG to coordinate recovery efforts (USFWS, 2012).

References

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SPECIES ACCOUNT: *Plagiobothrys hirtus* (rough popcornflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

A stout, hairy (on the upper part of the stems) annual, 3-6 dm tall, with long, narrow leaves and white flowers. Blooms primarily from mid to late June. (NatureServe, 2015)

Current Range

At present, 36 distinct patches, within 14 extant popcornflower occurrences, are distributed discontinuously from Yoncalla Creek, near Rice Hill, Oregon, south to the Sutherlin Creek, near Wilbur, in the Umpqua River watershed (Maddux and Meyers 2008, USFWS 2010) (USFWS, 2016).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Popcornflower can be a perennial, growing to 70 cm tall (27.5 inches), with dozens of flowering stems and hundreds of flowers, or can be a diminutive annual with only a few flowers (Amsberry and Meinke 2001). At Popcorn Swale Preserve, rough popcornflower generally reaches peak growth and flowering by mid-June. By July 1, many plants have dropped seed and are senescing. By July 15, rough popcornflower generally appears gray-brown and crispy although a rare flower or two may be found low to the ground in moister, shaded areas. Although most plants are dormant by mid-July, perhaps around 1% of individuals may still be green and actively growing and flowering. Rough popcornflower, like most borages, can potentially produce four nutlets per flower. In most sites, copious numbers of mature seeds were observed from mid-June through early September, but plants in a few wetter habitats delayed seed maturation until the beginning of August. The number of seeds produced by individual plants is largely controlled by the number of flowers produced, and correspondingly, large plants produce more flowers (USFWS, 2016).

Habitat Type

Adult: River valley wetlands (USFWS, 2016)

Spatial Arrangements of the Population

Adult: Clumped (inferred from USFWS, 2016)

Environmental Specificity

Adult: Very narrow to narrow. (NatureServe, 2015)

Habitat Narrative

Adult: Open, moist, poorly drained clay soils at 100-150 m elevation. Associated vegetation is dominated by tufted hairgrass (*Deschampsia cespitosa*), meadow barley (*Hordeum brachyantherum*), and various sedges. Found only in seasonal wetlands that are inundated by water from late fall to early spring (vernal pools) at lower elevations (approximately 300 to 500 ft or 100 to 150 m) (Guerrant, no date). (NatureServe, 2015). Popcornflower is endemic to seasonal wetlands in the interior valley of the Umpqua River in southwestern Oregon between Yoncalla and Wilbur in Douglas County (USFWS 2000). The wetland plant community at rough popcornflower habitats may include red-root yampa, a Federal species of concern, great camas (*Camassia leichtlinii* var. *leichtlinii*), Douglas meadowfoam (*Limnanthes douglasii*), California oatgrass, one-sided sedge (*Carex unilateralis*), pointed rush (*Juncus oxymersis*), meadow barley (*Hordeum brachyantherum*), and Cusick's checkermallow (*Sidalcea cusickii*). Known occurrences for the plant are associated with North Umpqua drainage. Rough popcornflower is found in open seasonal wetlands at elevations ranging from 30 to 270 m (98 to 886 feet). Suitable habitat for rough popcornflower includes open vernal wet meadows, seasonally-ponding mud-flats, or Oregon ash-swale openings dominated by native wetland-associated herbs and graminoids in valley lowlands. Populations are known to occur on six different soil types (Conser silty clay loam, Bashaw silty clay loam, Brand silty clay loam, Nonpareil loam, Oakland silt loam, and Sibold fine sandy loam) but there is a positive correlation only for Conser silty clay loam (USFWS 2000). The taxon depends on seasonal flooding and/or fire to maintain open habitat and to limit competition with invasive native and non-native plant species (USFWS 2010) (USFWS, 2016).

Dispersal/Migration

Population Information and Trends

Population Trends:

Decreasing (USFWS, 2016)

Population Growth Rate:

Decline of 50-70% (NatureServe, 2015)

Number of Populations:

14 (USFWS, 2016)

Population Size:

2500 - 100,000 individuals (NatureServe, 2015)

Population Narrative:

Decline of 50-70% Estimated population fluctuations between 7,000 and 16,000 individuals. 7 extant EOs using 1 km separation distance, all in Oregon. Falsely reported from Michigan, Illinois, North Carolina, Arkansas, Washington, and British Columbia. All of these falsely reported occurrences have been determined to be *Plagiobothrys figuratus* ssp. *figuratus*. (NatureServe, 2015). At the time of its final listing (USFWS 2000), popcornflower was known from 17 naturally-occurring habitat patches and two successfully established populations. These habitat patches occurred in 8 extant Element Occurrences (or occurrences or EOs) at that time. A "habitat patch", "patch" or "sub-population" as described in the final listing rule, represents a patch. A "reserve" is a habitat patch that occurs on protected property and is not likely to be

developed in the near future. At present, 36 distinct patches, within 14 extant popcornflower occurrences, are distributed discontinuously from Yoncalla Creek, near Rice Hill, Oregon, south to the Sutherlin Creek, near Wilbur, in the Umpqua River watershed (Maddux and Meyers 2008, USFWS 2010). Of the 14 occurrences, five introduced populations have been established in the southern range of the population; two of these populations may exceed 5,000 plants in the next 5 years. Two naturally occurring populations have also been augmented with additional popcornflower. The average population size for 10 known occurrences as of 2014 was 8,480 plants; 8 estimates were in excess of 1,600 plants (K. Amsberry, Oregon Department of Agriculture, pers. comm. 2014). At present, six protected popcornflower reserves have approximately 5,000 plants or more. TNC owns property with a popcornflower occurrence in Wilbur (the Popcorn Swale Preserve). This population has been declining for several years for unknown reasons, but believed to be attributed to invasive non-native and native plant invasion. In 2003, TNC counted 13,065 plants at the Popcorn Swale Preserve, but by June 2012 the number was down to about 1,000 plants and has continued to decline. Apart from the TNC population in Wilbur, most popcornflower populations are fairly abundant and stable throughout its range (Sam Friedman, USFWS, pers. comm. 2015) (USFWS, 2016).

Threats and Stressors

Stressor: Competition (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Competition from native and non-native plant species is listed as a threat to this species (USFWS, 2016).

Stressor: Development (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Most of the mapped historic occurrences of the species have been destroyed or deteriorated by development in the vicinity of the town of Sutherlin in the last twenty years (USFWS, 2016).

Stressor: Agriculture (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Destruction of wetlands due to drainage for agricultural uses is listed as a threat to this species (USFWS, 2016).

Stressor: Fire suppression (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Fire suppression resulting in encroaching native oaks and ash trees that shade popcornflower and reduced gene flow due to habitat fragmentation are considered to be other threat factors (USFWS 2010).

Recovery**Recovery Actions:**

- Recovery Measures for Popcornflower: Of the eleven populations of popcornflower currently protected from development, six meet recovery criteria (K. Amsberry, Oregon Department of Agriculture, pers. comm. 2014). One robust plant population is on land owned and managed by Douglas Soil and Water Conservation District. Two occur on ODOT right-of-ways, and two occur on land managed by TNC at the Popcorn Swale Preserve. One population, estimated to have nearly 8,000 plants, occurs on the City of Sutherlin's Red Rock Park (USFWS 2009). Two populations were reintroduced on Roseburg BLM land prior to listing; two additional populations were reintroduced on ODOT land, and one was reintroduced on County land at the Orenco Ponds mitigation site in 2013. Inventories for new and known populations of popcornflower were conducted throughout the species range in 2005 and 2014 by ODA (K. Amsberry, Oregon Department of Agriculture, pers. comm. 2014). Documentation of the distribution and abundance of popcornflower began in 1995 and has continued annually at most sites in most years; the exceptions are 2001 for BLM populations and 2008 to 2011 for TNC populations (USFWS, 2016).

Conservation Measures and Best Management Practices:

- All of the General Plant Conservation Measures (Section 3.13.1) apply for popcornflower. In addition, livestock grazing will not be used to control or remove invasive and non-native vegetation at project sites occupied by popcornflower, unless approved by the local Service office (USFWS, 2016).

References

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SPECIES ACCOUNT: *Plagiobothrys strictus* (Calistoga allocarya)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An annual herb, 1-4 dm tall. White flowers appear March-April in a slender, curved inflorescence. (NatureServe, 2015)

Historical Range

Historically, three populations of *Plagiobothrys strictus* were documented within a 3-kilometer (2-mile) radius of Calistoga, Napa County, California. Prior to listing one population had been extirpated due to urbanization and agricultural land conversion (California Native Plant Society 2008a). (USFWS, 2010)

Current Range

The range extent covers a small area in Napa County, near Calistoga. The total range is only about 14 sq mi. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: *Plagiobothrys strictus* is an annual herb in the Boraginaceae (borage family) (USFWS, 2010).

Habitat Type

Adult: Vernal pools (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (NatureServe, 2015)

Site Fidelity

Adult: High (NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits geyser- and hot spring-fed vernal pools and swales in meadows at 90-160 m elevation. Soils are clay or gravelly-clay loams. These pools contain high concentrations of boron and sulfates - substances that are toxic to most plants. Associated species include the rare Napa blue grass (*Poa napensis*). (NatureServe, 2015)

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Decreasing (NatureServe, 2015)

Resiliency:

Low (NatureServe, 2015)

Representation:

Low (NatureServe, 2015)

Redundancy:

Low (NatureServe, 2015)

Population Growth Rate:

Decline of 30-50% (NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

2500 - 10,000 individuals (NatureServe, 2015)

Adaptability:

Highly vulnerable due to annual habit and location in wetlands. (NatureServe, 2015)

Population Narrative:

Highly vulnerable due to annual habit and location in wetlands. Decline of 30-50% .Population size of this annual fluctuates from year to year. In some good years, as many as 6000 plants were reported. There are only 2 extant EO's ;there is a third, historical EO. (NatureServe, 2015). Low resiliency, representation and redundancy are based on the low number of known populations and individuals.

Threats and Stressors

Stressor: Commerical/Residential Development (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The two *Plagiobothrys strictus* and *Poa napensis* populations exist on private land and could be developed. The airport property will be required by the City of Calistoga to be evaluated

under the California Environmental Quality Act for the environmental effects to these species, and the evaluation reviewed by the California Department of Fish and Game, if and when any development should ever be proposed. According to the City of Calistoga Zoning Map, one property is zoned as Rural-residential and the former airport property is zoned Commercialairport (City of Calistoga 2003). Given that both species' population sizes are very small and restricted to two locations, development of these parcels could lead to the extinction of both species. The occurrences of the two species on the second private parcel (Myrtledale Hot Springs) in the City of Calistoga had been proposed for a new hospital (USFWS, 2010).

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: the California and Federal Endangered Species Acts are the primary State and Federal laws, respectively, that provide protection for this species since its listing as endangered in 1997. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act. Therefore, we continue to believe other laws and regulations have limited ability to protect the species in absence of the Endangered Species Act (USFWS, 2010).

Stressor: Human activities (USFWS, 201)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: *Poa napensis* individuals within the Myrtledale Hot Springs population could be lost to trampling should the number of hikers increase to the hot spring, the paved road is widened, or the property owner decides to alter the landscape causing the alteration of hydrology. Because the most recent observation of six *Poa napensis* individuals was in 2007 and conducted from outside the property boundary (Occurrence #1, CNDDDB 2009b), the risk of human activities may be even greater since a more accurate count of individuals does not exist currently. The former Calistoga airport parcel could be mowed or its hydrology could be altered presenting unknown magnitude of risk to the populations of either species since neither population has been thoroughly surveyed since 1996 (*P. napensis* Occurrence #3 and *Plagiobothrys strictus* Occurrence #3, CNDDDB 2009a) (USFWS, 2010).

Stressor: Restricted Habitat, Range, and Few Numbers of Populations (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of genetic variability/extinction

Narrative: Species in natural habitats face threats both from deterministic factors such as habitat loss, overexploitation, pollution, introduced species, and stochastic events associated with small population size. Such events may be of a demographic genetic or environmental nature, including catastrophes (World Conservation Monitoring Centre 1992). The estimated population size for *Plagiobothrys strictus* was over 5,000 individuals in 1994 (Occurrence # 3, CNDDDB 2009a) and six plants in 2007 as observed from the edge of the second property boundary for *Poa napensis* (Occurrence #1, CNDDDB 2009b). Both species' populations could be susceptible to extirpation from random events due to their restricted range. Increased homozygosity resulting

from genetic drift and inbreeding may lead to a loss of fitness (ability of individuals to survive and reproduce) in small populations (Menges 1991; Ellstrand and Elam 1993)

Stressor: Invasive plant species (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Competition from invasive plant species poses a potential threat to both species. Exotic and/or invasive, weedy plant species reduce native plant diversity and diminish the habitat suitability for native species; this is particularly the case in sensitive habitats (G. Cooley, California Department of Fish and Game, pers. comm. 2008). The consistent pattern of heavy growth of nonnative grasses when not controlled by grazing or other management can 'smother' native plants, resulting in the subsequent crowding out, outcompeting, or overshadowing of native annuals. A common consequence of such heavy annual grass growth is development of thatch, which adds to the strong smothering effect by inhibiting annuals' germination and growth (Weiss et al. 2007) (USFWS, 2010).

Stressor: Climate Change and Drought (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: A modeling study completed by Loarie et al. (2008) provides an evaluation of potential trends to California's floristic communities under climate change scenarios. In general, plant diversity will shift in two divergent directions: along the coast and northwards at higher elevations; and southwards at higher elevations of the Sierra Nevada. The models suggest that climate change has the potential to break up local floras, resulting in new species combinations, with new patterns of competition and biotic interactions (Loarie et al. 2008). Based on these modeling results, *Plagiobothrys strictus* and *Poa napensis* plants could be unable to shift their range because of their isolated, small populations, whose growth depend upon particular hydrological regimes, and the limited available, suitable habitat surrounding the two private parcels (USFWS, 2010).

Recovery

Recovery Actions:

- No final recovery plan has been completed for these species (USFWS, 2010).

Conservation Measures and Best Management Practices:

- Work with the landowners, the California Department of Fish and Game, the City of Calistoga, and California Native Plant Society to ensure the protection of all known populations of *Plagiobothrys strictus* and *Poa napensis* (USFWS, 2010).
- Work with the landowners, the California Department of Fish and Game, the City of Calistoga, and California Native Plant Society to ameliorate or eliminate any threats to *Plagiobothrys strictus* and *Poa napensis* from hydrological changes and from competition from nonnative plants (USFWS, 2010).
- Collect seeds from both species from both parcel sites and store them in Center for Plant Conservation certified botanic gardens to guard against extirpation of populations from chance catastrophic events (USFWS, 2010).

- Follow conservation measures and policies as stated in the 2007 Napa County General Plan Update (USFWS, 2010).
- Follow conservation measures and policies as stated in the 2003 City of Calistoga General Plan for sensitive plant species (USFWS, 2010).
- Conduct a population assessment for each species and continue monitoring over the next 5 years (USFWS, 2010).

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NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.”

SPECIES ACCOUNT: *Plantago hawaiiensis* (Kuahiwi laukahi)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/04/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

A perennial herb with a short stem that is several centimeters long and has red-brown woolly hairs (Wagner et al. 1990). Thick leathery basal leaves are narrowly elliptic, 3-8.7 in (7.5-22 cm) long and 0.6-1.3 in (1.5-3.2 cm) wide, usually with five to seven almost parallel nerves. Sessile, ascending flowers are moderately crowded into a spike about 5.9-9 in (15-23 cm) long. The spike of flowers is subtended by a flowering stalk (scape) 7.9-35 in (20-90 cm) long. Each flower has an ovate-elliptic bract at its base, 0.08-0.1 in (2.1-2.6 mm) long. The calyx consists of four subequal, elliptic to oval lobes with thin, translucent margins. The petals are trumpet-shaped with four reflexed lobes, about 0.04 in (1 mm) long. The fruit is longer than the calyx, 0.1-0.2 in (2.6-4 mm) long, dry, and splits apart to release four to six dull black, winged (at one end) seeds, 0.4 in (1 mm) long (USFWS, 1996).

Taxonomy

A member of the plantain family (Plantaginaceae). Other synonyms for this species include *P. gaudichaudiana* H. Lév., *P. hawaiiensis* var. *laxa* Pilg., and *P. pachyphylla* var. *hawaiiensis* subvar. *gracilis* A. Gray (Wagner et al. 1999) (USFWS, 2012).

Historical Range

Plantago hawaiiensis is known only from the Big Island. It occurred on the southern slope of Mauna Kea, northeastern, southeastern and southern slopes of Mauna Loa, and the western slope of Hualalai (HELP 199 lrl-r6) (USFWS, 1996).

Current Range

Since 1975, eight populations have been identified on Hawaii island, in North and South Hilo, Waiakea Forest Reserve, Hawaii Volcanoes National Park, Kapapala and Puu Waawaa (USFWS, 1996).

Critical Habitat Designated

Yes; 7/2/2003.

Legal Description

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Plantago hawaiiensis* on the island of Hawaii (68 FR 39623 - 39722).

Critical Habitat Designation

The critical habitat designation for *Plantago hawaiiensis* includes three units totaling 10,103 acres in Hawaii County, Hawaii. The units are Hawaii 24—*Plantago hawaiiensis*—a, Hawaii 25—*Plantago hawaiiensis*—b, and Hawaii 30—*Plantago hawaiiensis*—c. All three units are currently occupied by the species. Each unit is geographically separated from other critical habitat for this island-endemic species within its historical range in order to reduce the likelihood of all recovery populations being destroyed by one naturally occurring catastrophic event. The three units

designated for this species on the island of Hawaii provide habitat for a total of 10 populations, each with 300 mature, reproducing individuals.

Hawaii 24—*Plantago hawaiiensis*—a [1,348 ha (3,330 ac)]: This unit contains no named natural features; the northern portion is in the Kapapala watershed, and the southern portion is in the Pahala watershed, and the unit is completely within the Kapapala Forest Reserve; provides habitat for 3 populations of 300 individuals of *P. hawaiiensis*; and is currently occupied by 5,000 individuals. This unit is essential to the conservation of *P. hawaiiensis* because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population. This unit provides the southwesternmost critical habitat within the species' historical range.

Hawaii 25—*Plantago hawaiiensis*—b [1,522 ha (3,761 ac)]: This unit contains a portion of Kipuka Kulalio, it is completely within the Kapapala watershed. This unit is completely within HVNP; provides habitat for 4 populations of 300 individuals of *P. hawaiiensis*; and is currently occupied by more than 630 individuals. This unit is essential to the conservation of *P. hawaiiensis* because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population.

Hawaii 30—*Plantago hawaiiensis*—c [1,219 ha (3,012 ac)]: This unit contains no named natural features and is mostly in the Wailoa watershed, but it is bordered in the south by the Kaahakini watershed. This unit is completely within Olaa-Kilauea Partnership lands. The unit provides habitat for 3 populations of 300 individuals of *P. hawaiiensis* and is currently occupied by 50 to 100 individuals. This unit is essential to the conservation of *P. hawaiiensis* because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable.

Primary Constituent Elements/Physical or Biological Features

Habitat features that are essential for this species include, but are not limited to, montane wet sedge land with mixed sedges and grasses, montane mesic forest, dry subalpine woodland, or *Metrosideros* and native shrub.

Special Management Considerations or Protections

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for this species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Lifespan**

Adult: < 10 years (USFWS, 2012)

Key Resources Needed for Breeding

Adult: Wind - based on closely related species (USFWS, 2012)

Reproduction Narrative

Adult: It is a short-lived perennial (fewer than ten years). Members of the genus have very small, inconspicuous flowers with widely exerted stamens, which is associated with wind pollination (USFWS, 2012).

Habitat Type

Adult: Terrestrial, wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Moist and dry shrublands and forests, bog (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Periodic water-flow channels (USFWS, 2012)

Geographic or Habitat Restraints or Barriers

Adult: 5,198 - 8,243 ft. elevation (USFWS, 2012)

Habitat Narrative

Adult: Inhabits moist and dry shrublands and forests, and in bogs. In ash deposits and in lava cracks (NatureServe, 2015). *Plantago hawaiensis* is typically found in dry shrubland habitats on the leeward side of Hawaii Island, often in cracks in lava (Rock 1920; Wagner et al. 1999), between 1,584 and 2,513 meters (5,198 to 8,243 feet) elevation (USFWS 2003). However, Belfield and Pratt (2002) determined that periodic water-flow channels are evidently required by the species, and indicated that the report for dry lava fields by Rock (1920) was probably incorrect. However, Dunbar-Co et al. (2008) reported the species as occurring in bogs and alpine shrublands (USFWS, 2012).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Low (inferred from USFWS, 1996; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2012)

Number of Populations:

5 (USFWS, 2012)

Population Size:

300 - 400 wild, 303 outplants (NatureServe, 2015)

Population Narrative:

The most current information reports, five populations of *Plantago hawaiiensis* containing several hundred individuals (USFWS 2010). There are 303 outplanted individuals (USFWS, 2012).

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Ungulates: feral pigs (*Sus scrofa*), goats (*Capra hircus*), mouflon sheep (*Ovis gmelini musimon*); invasive plants: *Passiflora tarminiana* (banana poka) (USFWS, 2012).

Stressor: Herbivory and competition (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: The sharp decline in the population at Kipuka Kulalio was feared, at one point, to be caused by grazing by feral mouflon sheep or feral goats (Dunbar 2005). However, Belfield and Pratt (2002) had stated earlier that a decline due to mouflon sheep was less likely after finding evident signs of feral sheep (*Ovis aries*) instead, including droppings, around relatively healthy individuals of *P. hawaiiensis*. Evidence of Kalij pheasants (*Lophura leucomelanos*) (such as footprints and egg shells, indicating possible nest sites) were found in association with the population from Kipuka Kulalio (Belfield and Pratt 2002). Although pheasants are known to eat tender leaves, the authors felt it was unlikely that the pheasants would be uprooting larger individuals (Belfield and Pratt 2002). Competition with *Verbascum thapsus* (common mullein) (USFWS, 2012).

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species (USFWS, 2012).

Recovery**Reclassification Criteria:**

1. A total of five to seven populations should be documented on the Big Island (USFWS, 1996).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1996).
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1996).

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on the Big Island (USFWS, 1996).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1996).
3. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1996).

Recovery Actions:

- Protect current populations and manage threats (USFWS, 1996).
- Conduct essential research (USFWS, 1996).
- Expand existing wild populations, as necessary (USFWS, 1996).
- Create new populations within historical range, as necessary (USFWS, 1996).
- Evaluate and validate recovery objectives (USFWS, 1996).
- Steps should be taken to fence known populations to protect them from ungulates and encourage regeneration (USFWS, 1996).
- Research as to additional causes for decline may also be necessary (USFWS, 1996).
- Ownership of the large population at Kapapala should be determined and the site protected (USFWS, 1996).

Conservation Measures and Best Management Practices:

- Captive propagation for genetic storage and reintroduction: Collect cuttings or seed from tagged individuals, keeping close track of the maternal source for use in ex situ propagation. Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation (USFWS, 2012).
- Reintroduction / translocation implementation – Continue to reintroduce the species back into its known historical range (USFWS, 2012).
- Reintroduction / translocation protocol development – Maximize the genetic variation among individuals at each reintroduction site, based on microsatellite data and detailed information from crossing records (USFWS, 2012).
- Reintroduction / translocation site identification – While surveying for new populations or reintroduced populations, determine which sites are least invaded by invasive introduced plant

species and which appear to have the highest likelihood of maintaining new reintroductions (USFWS, 2012).

- Ungulate exclosures: Monitor the condition of fenced exclosures at Hawaii Volcanoes National Park to prevent breaching by feral ungulates. Continue to construct fenced exclosures for all known populations (USFWS, 2012).
- Ungulate control – Protect all populations against disturbances from feral ungulates (USFWS, 2012).
- Ecosystem-altering invasive plant species control – Control invasive introduced plant species around all populations (USFWS, 2012).
- Surveys / inventories – Survey areas of suitable habitat for the species that have not been surveyed, or which have not been surveyed for over ten years (USFWS, 2012).
- Threat monitoring and control: Monitor newly established reintroduced and wild populations for evidence of plant disease and insect predation. If threats are found implement effective control methods. Monitor the remaining wild populations, taking close notice of factors that may be responsible for senescence among individuals (USFWS, 2012).
- Threats research – Study populations of *Plantago hawaiiensis* with regard to nonnative bird predation (USFWS, 2012).
- Population biology research – Study the reproductive biology of the species in the field to determine the pollinators of the species and what factors aid in seed dispersal (USFWS, 2012).
- Alliance and partnership development – Work with Hawaii Division of Forestry and Wildlife, Hawaii Volcanoes National Park, and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2012).
- Threats research – Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2012).

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SPECIES ACCOUNT: *Plantago princeps* (Kuahiwi laukahi)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

Plantago princeps is a short-lived woody perennial of the Plantaginaceae (plantain) family. It is a shrub at least 1 m (3.3 ft) tall that is single-stemmed or sparingly branched at the base. The leathery, oblong leaves are up to 20 cm (7.8 in) long and clustered at the branch tips. The stem tips usually bear several erect inflorescences, each of which consists of a single stem of small, densely arranged flowers on the upper portion. The small capsules contain three to four black seeds that are 1.5 to 2.1 mm (0.06 to 0.08 in) long. Seed surfaces are covered by a sticky mucilaginous membrane (Wagner et al 1999; Makua Implementation Team 2003) (USFWS, 2016).

Historical Range

Historically, *Plantago princeps* was found on Kauai, Oahu, Molokai, Maui, and Hawaii (where it no longer exists) (USFWS, 2016).

Current Range

Survey data indicate *P. princeps* var. *princeps*, a woody variety, is currently the only variety extant on Oahu. *Plantago princeps* var. *princeps* has been recorded from three general areas on Oahu, including the leeward Waianae Mountains, windward Waianae Mountains, and southeastern Koolau Mountains (Kalihi, Nuuanu, and Manoa valleys) (USFWS, 2016).

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Plantago princeps* (Kuahiwi laukahi) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 15 detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

On September 18, 2012, the U.S. Fish and Wildlife Service (Service), designated revised critical habitat under the Endangered Species Act of 1973, as amended (Act), for *Plantago princeps* on the island of Oahu. Critical habitat on Oahu was originally designated on June 17, 2003 (68 FR 25934).

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Plantago princeps* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Plantago princeps* (both var. *longibracteata* and var. *princeps*) (Kuahiwi laukahi) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Plantago princeps* (77 FR 57648-57862). The critical habitat designation includes 34 critical habitat units, which encompass approximately 25,112 acres for var. *longibracteata* and 35,382 acres for var. *princeps* on the Island of Oahu, Hawaii.

The critical habitat designation for *Plantago princeps* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Plantago princeps* includes 15 CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Molokai—Lowland Wet—Unit 1 (and) *Palmeria dolei*—Unit 38—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 38— Lowland Wet This area consists of 2,195 ac (888 ha) of State land, and 754 ac (305 ha) of privately owned land (partly within The Nature Conservancy's Pelekunu Preserve), from Pelekunu Valley to Wailau Valley, in north-central Molokai. These units are occupied by the plant *Cyrtandra filipes*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Wet—Unit 1 is not known to be occupied by *Asplenium dielerectum*, *Bidens wiebkiei*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Lysimachia maxima*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 2 (and) *Palmeria dolei*—Unit 39—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 39— Lowland Wet This area consists of 1,356 ac (549 ha) of State land and 594 ac (241 ha) of privately owned land, from Kahanui to Pelekunu Valley, in north-central Molokai. These units are occupied by the plant *Lysimachia maxima*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Wet—Unit 2 is not known to be occupied by *Asplenium dielerectum*, *Bidens wiebkiei*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Cyrtandra filipes*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 3 consists of 94 ac (38 ha) of State land, and 3,125 ac (1,265 ha) of privately owned land, from Waiahookalo gulch to Moaula stream and Puniuohua, on eastern Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Molokai—Lowland Wet—Unit 3 is not known to be occupied by *Asplenium dielerectum*, *Bidens wiebkei*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Cyrtandra filipes*, *Lysimachia maxima*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Mesic—Unit 1 (and) *Palmeria dolei*—Unit 42—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 42— Montane Mesic This area consists of 257 ac (104 ha) of State land, and 559 ac (226 ha) of privately owned land from Kamiloloa to Makolelau in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Bidens wiebkei*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Montane Mesic—Unit 1 is not known to be occupied by *Asplenium dielerectum*, *Cyanea dunbariae*, *C. mannii*, *C. procera*, *C. solanacea*, *Cyperus fauriei*, *Kadua laxiflora*, *Melicope mucronulata*, *Neraudia sericea*, *Plantago princeps*, or *Stenogyne bifida*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 1 (and) *Palmeria dolei*—Unit 26—Dry Cliff (and) *Pseudonestor xanthophrys*—Unit 26— Dry Cliff This area consists of 755 ac (305 ha) of federally owned land (Haleakala National Park), from Pakaoao to Koolau Gap on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). Although Maui—Dry Cliff— Unit 1 is not known to be occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Diplazium molokaiense*, *Geranium multiflorum*, *Plantago princeps*, or *Schiedea haleakalensis*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 2 consists of 688 ac (279 ha) of federally owned land (Haleakala National Park) from Haupaakea Peak to Kaupo Gap on east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). It is occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Geranium multiflorum*, *Plantago princeps*, and *Schiedea haleakalensis*, and contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Dry Cliff—Unit 2 is not known to be occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, or *Diplazium molokaiense*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 3 (and) *Palmeria dolei*—Unit 27—Dry Cliff (and) *Pseudonestor xanthophrys*—Unit 27— Dry Cliff This area consists of 200 ac (81 ha) of federally owned land (Haleakala National Park) near Papaanui on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). It is occupied by the plant *Plantago princeps*, and contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Dry Cliff—Unit 3 is not currently occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Diplazium molokaiense*, *Geranium multiflorum*, or *Schiedea haleakalensis*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 4 (and) *Palmeria dolei*—Unit 28—Dry Cliff (and) *Pseudonestor xanthophrys*—Unit 28— Dry Cliff This area consists of 315 ac (127 ha) federally owned land (Haleakala National Park), along Kalapawili Ridge on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). Although Maui—Dry Cliff— Unit 4 is not currently occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Diplazium molokaiense*, *Geranium multiflorum*, *Plantago princeps*, or *Schiedea haleakalensis*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 1 (and) *Palmeria dolei*—Unit 30—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 30— Wet Cliff This area consists of 290 ac (117 ha) of privately owned land along the wall of Keanae Valley on the northern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff— Unit 1 is not currently occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *Cyanea horrida*, *Melicope ovalis*, *Phyllostegia bracteata*, *P. haliakalae*, or *Plantago princeps*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 2 (and) *Palmeria dolei*—Unit 31—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 31— Wet Cliff This area consists of 475 ac (192 ha) of State land, 20 ac (8 ha) of privately owned land, and 912 ac (369 ha) of federally owned land (Haleakala National Park), from Kalapawili Ridge along Kipahulu Valley and north to Puuhoolio, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plants *Bidens campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *Melicope ovalis*, *Phyllostegia bracteata*, and *Plantago princeps*. These units also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 2 is not known to be occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Cyanea horrida*, or *Phyllostegia haliakalae*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 3 (and) *Palmeria dolei*—Unit 32—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 32— Wet Cliff This area consists of 5 ac (2 ha) of State land and 433 ac (175 ha) federally owned land (Haleakala National Park) along the south rim of Kipahulu Valley on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff— Unit 3 is not currently occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. horrida*, *Melicope ovalis*, *Phyllostegia bracteata*, *P. haliakalae*, or *Plantago princeps*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 4 (and) *Palmeria dolei*—Unit 33—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 33—Wet Cliff This area consists of 184 ac (75 ha) of State land along the north wall of Waihoi Valley, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plant *Bidens campylotheca* ssp. *pentamera* and *B. campylotheca* ssp. *waihoiensis*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 4 is not known to be occupied by the plants *Cyanea copelandii* ssp. *haleakalaensis*, *C. horrida*, *Melicope ovalis*, *Phyllostegia bracteata*, *P. haliakalae*, or *Plantago princeps*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 6 (and) *Palmeria dolei*—Unit 35—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 35—Wet Cliff This area consists of 1,858 ac (752 ha) of State land, and 253 ac (102 ha) of privately owned land, at the summit ridges of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plants *Alectryon macrococcus*, *B. conjuncta*, *Ctenitis squamigera*, *Cyrtandra munroi*, *Remya mauiensis*, and *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 6 is not known to be occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Bonamia menziesii*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendrion pyriformis*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, or *Tetramolopium capillare*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 7 (and) *Palmeria dolei*—Unit 36—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 36—Wet Cliff This area consists of 556 ac (225 ha) of State land along Honokowai ridge on the northwestern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units are occupied by the plants *Cyrtandra filipes* and *C. munroi*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 7 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*,

Dubautia plantaginea ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 8 consists of 337 ac (137 ha) of State land along Kahakuloa ridge on the north side of west Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff—Unit 8 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat designation for *Plantago princeps* includes 34 units totaling 60,494 acres in Hawaii County, Hawaii. The units are Oahu—Lowland Mesic—Unit 1, 2, 3, 4, 5, 6, 7, Oahu—Lowland Wet—Unit 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, Oahu—Dry Cliff—Unit 1, 2, 3, 4, 6, 7a, 7b, 8, Oahu—Wet Cliff—Unit 6, 7, 8.

Oahu—Lowland Mesic—Unit 1 consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Although this unit is not known to be occupied by *Plantago princeps*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Mesic—Unit 2 consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Although this unit is not known to be occupied by *Plantago princeps*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could

achieve recovery. Oahu—Lowland Mesic—Unit 3 consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit is occupied by *Plantago princeps* and includes the mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations.

Oahu—Lowland Mesic—Unit 4 consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. This unit includes the lowland mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem. Although this unit is not known to be occupied by *Plantago princeps*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Mesic—Unit 5 consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. This unit includes the mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem. Although this unit is not known to be occupied by *Plantago princeps*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Mesic—Unit 6 consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Although this unit is not known to be occupied by *Plantago princeps*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Mesic—Unit 7 consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge. Although this unit is not known to be occupied by *Plantago princeps*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Wet—Unit 1 consists of 428 ac (173 ha) of State land and 112 ac (46 ha) of City and County of Honolulu land in the lowland wet ecosystem on the windward side of the Waianae Mountains, and partially within the Mokuleia and Waianae Kai Forest Reserves. Although this

unit is not known to be occupied by *Plantago princeps*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Wet—Unit 2 consists of 19 ac (8 ha) of State land in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puuhapapa. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Although this unit is not known to be occupied by *Plantago princeps*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Wet—Unit 3 consists of 29 ac (12 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puukanehoa. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Although this unit is not known to be occupied by *Plantago princeps*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Wet—Unit 4 consists of 27 ac (11 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains on State land at Puukaua. A portion of this area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Although this unit is not known to be occupied by *Plantago princeps*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Wet—Unit 5 consists of 74 ac (30 ha) of State land in the lowland wet ecosystem, on the windward side of the Waianae Mountains at Palikea. A portion of this area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Although this unit is not known to be occupied by *Plantago princeps*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Wet—Unit 6 consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Although this unit is not known to be occupied by *Plantago princeps*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Wet—Unit 7 consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet

ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Hauila Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Although this unit is not known to be occupied by *Plantago princeps*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Wet—Unit 8 consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikēē, and Uwao streams. Although this unit is not known to be occupied by *Plantago princeps*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Wet—Unit 9 consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream, and is occupied by *Plantago princeps*. This area includes the wet forest and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. This area also contains unoccupied habitat that is essential to the conservation of the species by providing the PCEs necessary for the expansion of the existing wild populations.

Oahu—Lowland Wet—Unit 10 consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Although this unit is not known to be occupied by *Plantago princeps*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Wet—Unit 11 consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Although this unit is not known to be occupied by *Plantago princeps*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Wet—Unit 12 consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Although this unit is not known to be occupied by *Plantago princeps*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

recovery. Oahu—Lowland Wet—Unit 13 consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Although this unit is not known to be occupied by *Plantago princeps*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Wet—Unit 14 consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Although this unit is not known to be occupied by *Plantago princeps*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Wet—Unit 15 consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Although this unit is not known to be occupied by *Plantago princeps*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Wet—Unit 16 consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamoa Ridge. Although this unit is not known to be occupied by *Plantago princeps*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 1 consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. This unit is on State land within the Pahole Natural Area Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. This unit is occupied by *Plantago princeps* var. *princeps* and contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Oahu—Dry Cliff—Unit 2 consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. This unit is almost entirely within the Makua Keaau Forest Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. Although this unit is not known to be occupied by

Plantago princeps, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Dry Cliff—Unit 3 consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. This unit is partially within the Waianae Kai Forest Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. Although this unit is not known to be occupied by *Plantago princeps*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Dry Cliff—Unit 4 consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. This unit is partially within the Waianae Kai Forest Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. Although this unit is not known to be occupied by *Plantago princeps*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Dry Cliff—Unit 6 consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. The unit is occupied by *Plantago princeps* and contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Oahu—Dry Cliff—Unit 7a consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem, and is occupied by *Plantago princeps*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Oahu—Dry Cliff—Unit 7b consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. Although this unit is not known to be occupied by *Plantago princeps*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations

within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Dry Cliff—Unit 8 consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve. A small portion of this area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. Although this unit is not known to be occupied by *Plantago princeps*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Wet Cliff—Unit 6 consists of 151 ac (61 ha) in the wet cliff ecosystem on State land on the windward side of the Koolau Mountains in Kaipapau Gulch, entirely within the Kaipapau Forest Reserve. This area includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem. Although this unit is not known to be occupied by *Plantago princeps*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Wet Cliff—Unit 7 consists of 144 ac (58 ha) in the wet cliff ecosystem in State land on the windward side of the Koolau Mountains in Hauula Gulch, entirely within the Hauula Forest Reserve. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem. Although this unit is not known to be occupied by *Plantago princeps*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Wet Cliff—Unit 8 consists of 1,479 ac (598 ha) of State land, 1,281 ac (519 ha) of City and County of Honolulu land, 5 ac (2 ha) of Federal land, and 1,884 ac (762 ha) of privately owned land, in the wet cliff ecosystem along the summit of the Koolau Mountains, overlapping portions of Sacred Falls State Park, the Waiahole FR (Waiahole and Iolekaa sections), the Kaneohe and Honolulu Watershed FRs, and the Nuuanu Pali State Wayside. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem. This unit is occupied by *Plantago princeps* and contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations.

The critical habitat designation for *Plantago princeps* includes four units totaling 1,787 acres in Kauai. The units are Kauai 10—*Plantago princeps*—a and Kauai 11—*Plantago princeps*—b, c, d.

Kauai 10—*Plantago princeps*—a: This unit is critical habitat for *Plantago princeps* and is 277 ha (682 ac) on State (Halelea and Lihue-Koloa Forest Reserves) and private land. This unit contains Kuaohukini Summit. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Plantago princeps* and is currently occupied with 350 to 400 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population,. It provides habitat for the westernmost range of the species that is unique to Kauai. The habitat features contained in this unit that are essential for this species include, but are not limited to, windswept areas near waterfalls in *Metrosideros polymorpha* *Cheirodendron montane* wet forest with riparian vegetation or *Metrosideros polymorpha* lowland to montane transitional wet forest on cliffs and ridges, growing on rocky basalt outcrops. This unit provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Kauai 11—*Plantago princeps*—b: This unit is critical habitat for *Plantago princeps* and is 126 ha (312 ac) on State land (Kokee and Na Pali Coast State Park), containing Kalalau Lookout. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Plantago princeps* and is currently occupied with 18 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. It provides habitat for the westernmost range of the species that is unique to Kauai. The habitat features contained in this unit that are essential for this species include, but are not limited to, windswept areas near waterfalls in *Metrosideros polymorpha* *Cheirodendron montane* wet forest with riparian vegetation or *Metrosideros polymorpha* lowland to montane transitional wet forest on cliffs and ridges, growing on rocky basalt outcrops. This unit provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Kauai 11—*Plantago princeps*—c: This unit is critical habitat for *Plantago princeps* and is 244 ha (603 ac) on State land (Halelea Forest Reserve). This unit contains Kaliko and Puu Manu Summits. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Plantago princeps* and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is important to the establishment of additional populations on Kauai in order to reach recovery goals. It provides habitat for the westernmost range of the species that is unique to Kauai. The habitat features contained in this unit that are essential for this species include, but are not limited to, windswept areas near waterfalls in *Metrosideros polymorpha* *Cheirodendron montane* wet forest with riparian vegetation or *Metrosideros polymorpha* lowland to montane transitional wet forest on cliffs and ridges, growing on rocky basalt outcrops.

Kauai 11—*Plantago princeps*—d This unit is critical habitat for *Plantago princeps* and is 77 ha (189 ac) on State land (Hono o Na Pali NAR and Na Pali Coast State Park). This unit contains Alealau and Puu Ki Summits, and Kaaalahina Ridge. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Plantago princeps* and is currently occupied with 20 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the

expansion of the present population, which is currently considered non-viable. It provides habitat for the westernmost range of the species that is unique to Kauai. The habitat features contained in this unit that are essential for this species include, but are not limited to, windswept areas near waterfalls in *Metrosideros polymorpha* Cheirodendron montane wet forest with riparian vegetation or *Metrosideros polymorpha* lowland to montane transitional wet forest on cliffs and ridges, growing on rocky basalt outcrops. This unit provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

The critical habitat designation for *Plantago princeps* includes 34 critical habitat units, covering four ecosystem types for var. *princeps* and one ecosystem type for var. *longibracteata*, which encompasses approximately 25,112 acres for var. *longibracteata* and 35,382 acres for var. *princeps* on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7; Oahu—Lowland Wet—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8; Oahu—Wet Cliff—Units 6, 7, 8.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

Oahu—Lowland Wet—Unit 1 [541 ac (219 ha)]. This area consists of 428 ac (173 ha) of State land and 112 ac (46 ha) of City and County of Honolulu land in the lowland wet ecosystem on the windward side of the Waianae Mountains, and partially within the Mokuleia and Waianae Kai Forest Reserves. Oahu—Lowland Wet—Unit 2 [20 ac (8 ha)]. This area consists of 19 ac (8 ha) of State land in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puuhapapa. Oahu—Lowland Wet—Unit 3 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puukanehoa. Oahu—Lowland Wet—Unit 4 [27 ac (11 ha)]. This area consists of 27 ac (11 ha) in the lowland wet

ecosystem on the windward side of the Waianae Mountains on State land at Puukaua. Oahu—Lowland Wet—Unit 5 [74 ac (30 ha)]. This area consists of 74 ac (30 ha) of State land in the lowland wet ecosystem, on the windward side of the Waianae Mountains at Palikea. Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihihi, Wailele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Haula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikeekee, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet—Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet—Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu—Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamoa Ridge.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450

ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac (105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

Oahu—Wet Cliff—Unit 6 [151 ac (61 ha)]. This area consists of 151 ac (61 ha) in the wet cliff ecosystem on State land on the windward side of the Koolau Mountains in Kaipapau Gulch, entirely within the Kaipapau Forest Reserve. Oahu—Wet Cliff—Unit 7 [144 ac (58 ha)]. This area consists of 144 ac (58 ha) in the wet cliff ecosystem in State land on the windward side of the Koolau Mountains in Hauula Gulch, entirely within the Hauula Forest Reserve. Oahu—Wet Cliff—Unit 8 [4,649 ac (1,881 ha)]. This area consists of 1,479 ac (598 ha) of State land, 1,281 ac (519 ha) of City and County of Honolulu land, 5 ac (2 ha) of Federal land, and 1,884 ac (762 ha) of privately owned land, in the wet cliff ecosystem along the summit of the Koolau Mountains, overlapping portions of Sacred Falls State Park, the Waiahole FR (Waiahole and Iolekaa sections), the Kaneohe and Honolulu Watershed FRs, and the Nuuana Pali State Wayside.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Plantago princeps* critical habitat consists of four components. Lowland wet (Molokai), Montane mesic (Molokai), Dry cliff (east Maui) and Wet cliff (east Maui and west Maui) (81 FR 17790-18110):

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: *Acacia*, *Ilex*, *Metrosideros*, *Myrsine*, *Nestegis*, *Nothocestrum*, *Pisonia*, *Pittosporum*, *Psychotria*, *Sophora*, *Zanthoxylum*. Subcanopy: *Alyxia*, *Charpentiera*, *Coprosma*, *Dodonaea*, *Kadua*, *Labordia*, *Leptecophylla*, *Phyllostegia*, *Vaccinium*. Understory: Ferns, *Carex*, *Peperomia*.

Ecosystem: Dry Cliff. Elevation: unrestricted. Annual precipitation: <75 in (<190 cm). Substrate: >65 degree slope, rocky talus. Canopy: None. Subcanopy: *Antidesma*, *Chamaesyce*, *Diospyros*, *Dodonaea*. Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Schiedea*.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: Broussaia, Cheirodendron, Leptecophylla, Metrosideros. Understory: Bryophytes, Ferns, Coprosma, Dubautia, Kadua, Peperomia.

(i) In units Oahu—Lowland Mesic— Unit 1, Oahu—Lowland Mesic—Unit 2, Oahu—Lowland Mesic—Unit 3, Oahu— Lowland Mesic—Unit 4, Oahu— Lowland Mesic—Unit 5, Oahu— Lowland Mesic—Unit 6, and Oahu— Lowland Mesic—Unit 7, the physical and biological features of critical habitat for *Plantago princeps* var. *princeps* are: (A) Elevation: Less than 3,300 ft (1,000 m). (B) Annual precipitation: 50 to 75 in (130 to 190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (F) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

(ii) In units Oahu—Lowland Wet— Unit 6, Oahu—Lowland Wet—Unit 7, Oahu—Lowland Wet—Unit 8, Oahu— Lowland Wet—Unit 9, Oahu—Lowland Wet—Unit 10, Oahu—Lowland Wet— Unit 11, Oahu—Lowland Wet—Unit 12, Oahu—Lowland Wet—Unit 13, Oahu— Lowland Wet—Unit 14, Oahu— Lowland Wet—Unit 15, and Oahu— Lowland Wet—Unit 16, the physical and biological features of critical habitat for *Plantago princeps* var. *longibracteata* are: (A) Elevation: Less than 3,300 ft (1,000 m). (B) Annual precipitation: Greater than 75 in (190 cm). (C) Substrate: Clays; ashbeds; deep, well-drained soils; lowland bogs. (D) Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. (E) Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. (F) Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepidia.

(iii) In units Oahu—Lowland Wet— Unit 1, Oahu—Lowland Wet—Unit 2, Oahu—Lowland Wet—Unit 3, Oahu— Lowland Wet—Unit 4, Oahu—Lowland Wet—Unit 5, Oahu—Lowland Wet— Unit 6, Oahu—Lowland Wet—Unit 7, Oahu—Lowland Wet—Unit 8, Oahu— Lowland Wet—Unit 9, Oahu—Lowland Wet—Unit 10, Oahu—Lowland Wet— Unit 11, Oahu—Lowland Wet—Unit 12, Oahu—Lowland Wet—Unit 13, Oahu— Lowland Wet—Unit 14, Oahu— Lowland Wet—Unit 15, and Oahu— Lowland Wet—Unit 16, the physical and biological features of critical habitat for *Plantago princeps* var. *princeps* are: (A) Elevation: Less than 3,300 ft (1,000 m). (B) Annual precipitation: Greater than 75 in (190 cm). (C) Substrate: Clays; ashbeds; deep, well-drained soils; lowland bogs. (D) Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. (E) Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. (F) Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepidia.

(iv) In units Oahu—Dry Cliff—Unit 1, Oahu—Dry Cliff—Unit 2, Oahu—Dry Cliff—Unit 3, Oahu—Dry Cliff—Unit 4, Oahu—Dry Cliff—Unit 6, Oahu—Dry Cliff—Unit 7a, Oahu—Dry Cliff—Unit 7b, and Oahu—Dry Cliff—Unit 8, the physical and biological features of critical habitat for *Plantago princeps* var. *princeps* are: (A) Elevation: Unrestricted. (B) Annual precipitation: Less than 75 in (190 cm). (C) Substrate: Greater than 65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. (F) Understory: Bidens, Eragrostis, Melanthera, Schiedea.

(v) In units Oahu—Wet Cliff—Unit 6, Oahu—Wet Cliff—Unit 7, and Oahu— Wet Cliff—Unit 8, the physical and biological features of critical habitat for *Plantago princeps* var. *princeps* are: (A) Elevation: Unrestricted. (B) Annual precipitation: Greater than 75 in (190 cm). (C) Substrate: Greater than 65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy:

Broussaisia, Cheirodendron, Leptecophylla, Metrosideros. (F) Understory: Bryophytes, Ferns, Coprosma, Dubautia, Kadua, Peperomia.

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Windswept areas near waterfalls in Metrosideros polymorpha/Cheirodendron montane wet forest with riparian vegetation or Metrosideros polymorpha lowland to montane transitional wet forest on cliffs and ridges, growing on basalt rocky outcrops, and containing one or more of the following associated native plant species: Antidesma platyphyllum var. hillebrandii, Bidens forbesii, Bidens sandwicensis, Bobea elatior, Boehmeria grandis, Carex meyenii, Carex wahuensis, Charpentiera elliptica, Cyrtandra spp., Diplazium sandwichianum, Freycinetia arborea, Gunnera kauaiensis, Hedyotis spp., Huperzia spp. Isachne pallens, Lipochaeta connata, Lysimachia glutinosa, Lysimachia kalalauensis, Machaerina angustifolia, Melicope spp., Myrsine linearifolia, Perrottetia sandwicensis, Pilea peploides, Pipturus spp., Poa mannii, Sadleria cyatheoides, Tetraplasandra spp., or Wilkesia gymnoxiphium; and

(ii) Elevations between 434 and 1,563 m (1,424 and 5,128 ft).

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Plantago princeps* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Plantago princeps* var. *princeps* occurs within the Lowland mesic, Lowland wet and Dry cliff ecosystems in the Waianae Mountain caldera complex, is also known from Lowland wet and wet cliff ecosystems in the Koolau caldera complex, and was known historically (last observed > 20 yrs ago) from the Lowland mesic ecosystem in the Koolau Mountain caldera complex. In addition var. *longibracteata* was known historically (last observed > 20 yrs ago) from the Lowland wet ecosystem in the Koolau Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (F) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Oahu—Lowland Wet—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. (E) Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. (F) Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. (F) Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Oahu—Wet Cliff—Units 6, 7, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: >65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E)

Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. (F) Understory: Bryophytes, Ferns, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into

native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkii*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

All critical habitat, except in the coastal ecosystem on Oahu, requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs and goats). Feral ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required during nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat posed by fire to 25 of the designated ecosystem critical habitat units in particular: Oahu—Lowland Mesic—Unit 2, Oahu—Lowland Mesic—Unit 3, Oahu—Lowland Mesic—Unit 7, Oahu—Dry Cliff—Unit 2, Oahu—Dry Cliff—Unit 3, Oahu—Dry Cliff—Unit 4, Oahu—Dry Cliff—Unit 6, Oahu—Dry Cliff—Unit 7 (Oahu—Dry Cliff—Unit 7a and Oahu—Dry Cliff—Unit 7b), and Oahu—Dry Cliff—Unit 8. Oahu—Lowland Mesic—Unit 1,

Oahu—Lowland Mesic—Unit 2, Oahu—Lowland Mesic—Unit 3, Oahu—Lowland Mesic—Unit 4, Oahu—Lowland Mesic—Unit 5, Oahu—Lowland Mesic—Unit 7, Oahu—Lowland Wet—Unit 1, Oahu—Lowland Wet—Unit 2, Oahu—Lowland Wet—Unit 3, Oahu—Lowland Wet—Unit 4, Oahu—Lowland Wet—Unit 7, Oahu—Lowland Wet—Unit 8, Oahu—Lowland Wet—Unit 9, Oahu—Lowland Wet—Unit 10, Oahu—Lowland Wet—Unit 11, Oahu—Lowland Wet—Unit 12, Oahu—Lowland Wet—Unit 13, Oahu—Lowland Wet—Unit 14, Oahu—Lowland Wet—Unit 15, Oahu—Lowland Wet—Unit 16, Oahu—Dry Cliff—Unit 1, Oahu—Dry Cliff—Unit 2, Oahu—Dry Cliff—Unit 3, Oahu—Dry Cliff—Unit 4, Oahu—Dry Cliff—Unit 6, Oahu—Dry Cliff—Unit 7 (Oahu—Dry Cliff—Unit 7a and Oahu—Dry Cliff—Unit 7b), Oahu—Wet Cliff—Unit 3, Oahu—Wet Cliff—Unit 5, Oahu—Wet Cliff—Unit 6, Oahu—Wet Cliff—Unit 7, and Oahu—Wet Cliff—Unit 8 may require special management to reduce the threat of landslides, rockfalls, and flooding.

The following management actions are important: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Plantago princeps* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Lifespan

Adult: <10 years (USFWS, 2016)

Breeding Season

Adult: *Plantago princeps* var. *princeps* appears to produce flowers and fruits throughout the year (Wagner et al 1999), with increased fruiting in the spring (U.S. Army Garrison 2005b) (USFWS, 2016).

Reproduction Narrative

Adult: *Plantago princeps* var. *princeps* appears to produce flowers and fruits throughout the year (Wagner et al 1999), with increased fruiting in the spring (U.S. Army Garrison 2005b). The sticky seeds may have once been dispersed by now-extinct species of flightless birds (Carlquist 1980; Makua Implementation Team 2003). Plant longevity probably is similar to that of other

small, semi-woody shrubs that live less than 10 years (i.e., short-lived perennials) (Makua Implementation Team 2003). Other demographic information for *P. princeps* var. *princeps* in the wild is unknown, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, timing of reproductive output, pollination and seed dispersal, vegetative reproduction and specific environmental requirements (USFWS, 2016). Some *Plantago* (eg *P. media*) may be secondarily insect pollinated. Seed are mucilaginous and adhere to animals. Birds and rodents eat seeds. Wind may also disperse seed.; ABIOTIC; BIOTIC; Wind; ABIOTIC; Wind; (NatureServe, 2015)

Habitat Type

Adult: Cliff faces (USFWS, 2016)

Habitat Narrative

Adult: Steep slopes in mesic and wet forests. (NatureServe, 2015). *Plantago princeps* var. *princeps* occurs in two different habitat types, at elevations of 480 to 1,100 m (1,580 to 3,600 ft) (Service 1999a). In the Waianae Mountains, this variety is found on cliff faces, ledges, and bases, in mesic vegetation consisting predominantly of native grasses, sedges, herbs, and shrubs. Historical occurrences in the southeastern Koolau Mountains also were found in mesic cliff habitats. In contrast, the Waiawa population unit occurs on a streamside embankment in wet, rainforest habitat close to the Koolau summit ridge, an area with the highest precipitation on Oahu (Service 2003a) (USFWS, 2016).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: The sticky seeds may have once been dispersed by now-extinct species of flightless birds (Carlquist 1980; Makua Implementation Team 2003) (USFWS, 2016).

Population Information and Trends**Population Trends:**

Increasing (USFWS, 2016)

Number of Populations:

9 (USFWS, 2016)

Population Size:

354 (USFWS, 2016)

Population Narrative:

When the species was listed, there were five occurrences totaling about 20 individuals on Oahu. *Plantago princeps* var. *princeps* is currently known from nine population units totaling 354 individuals on Oahu, located on Federal, State, and private lands (68 FR 35950). Because all currently known population units of this species were discovered relatively recently, trends in abundance and distribution are difficult to determine. A rapid decline from 20 to 5 individuals of *P. princeps* var. *princeps* was documented in the North Palawai population unit over 1987 to 2003, attributed to competition with daisy fleabane (*Erigeron karvinskianus*), a highly invasive

non-native plant (Makua Implementation Team 2003). Trends in abundance and distribution on Oahu indicate that *P. princeps* var. *princeps* has increased since 2003, from eight population units totaling up to 253 individuals to nine population units totaling 354 individuals. None of the currently known population units contains more than fifty mature, reproducing individuals (the minimum number required for stabilized populations as defined in the Makua Implementation Plan) (Makua Implementation Team 2003; U.S. Army Garrison 2005b). *Plantago princeps* var. *princeps* is present in both the Makua and Schofield Barracks action areas in the Ohikilolo, Pahole, and North Mokiakea population units, in areas at risk from training-related wildfire (Service 2003a).

Threats and Stressors

Stressor: Rats (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Rats are a threat to this species (USFWS, 2016)

Stressor: Fire (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Fire is a threat to population units in Army action areas (Ohikilolo, Pahole, and North Mokiakea) and to areas vulnerable to non-military related fire. For example, fire burned native vegetation in parts of the Ekahanui Management Unit and near the Halona population unit during summer 2005 (U.S. Army Garrison 2005b) (USFWS, 2016).

Stressor: Stochastic events (USFWS, 2016)

Exposure:

Response:

Consequence: Extinction

Narrative: Occurrences of *P. princeps* var. *princeps* are vulnerable to extirpation from naturally occurring events such as rockslides and/or reduced reproductive vigor due to small population size and limited distribution (59 FR 56333; 68 FR 35950; Service 1999a). Thus, *P. princeps* var. *princeps* has a high background risk of species extinction, and any additional threats could reduce expectation of its long-term persistence (USFWS, 2016).

Recovery

Delisting Criteria:

Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1999a). The Army has noted that a re-evaluation of stabilization population units may be needed to account for the recently discovered population unit on the Kaneohe side of Puu Konahuanui (currently the largest population unit at 45 total individuals) (U.S. Army Garrison 2005b). A pig-proof fence is needed for the Ekahanui population unit and is planned for 2007. A fence is also needed for the Waiawa

population unit and is planned as part of the Army's Oahu Implementation Plan (U.S. Army Garrison 2005b).

Conservation Measures and Best Management Practices:

- The Makua Implementation Team (2003) has developed stabilization protocols for *Plantago princeps* var. *princeps*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). The Ohikilolo, Pahole, and Ekahanui population units are fenced and protected by cliffs and steep terrain. In addition, about 271 individuals (77 percent of all remaining individuals on Oahu) of this species occur in five management units where they will benefit from population unit and/or ecosystem-level protection. The management units include Palikea and Waiawa, which are not fenced; and Ekahanui, Ohikilolo, and Pahole, which are fenced. The Nature Conservancy of Hawaii's long-range management plan for Honouliuli Preserve includes management actions to control non-native plants, feral ungulates, and fire, and to recover rare species and restore native habitats; this plan will benefit *P. princeps* in the Ekahanui and Palawai population units within the preserve. This species is also included in the Army's stabilization plan for species impacted by military training at other areas on Oahu associated with Schofield Barracks Military Reservation (Service 2003a). Seed collection from this taxon is difficult because it inhabits inaccessible cliffs. Plants fruit year-round, with peak production in the spring, and germination rate of fresh seed is about 60 percent. Cuttings can be successfully propagated, but the plants do not survive well in the greenhouse (U.S. Army Garrison 2005b). *Plantago princeps* is represented in ex situ collections, including four cuttings in a nursery (Army Environmental Division, Oahu), 81 plants in a nursery (Haleakala National Park), 39 ungerminated seeds in a nursery (Harold L. Lyon Arboretum), and 5,900 seeds in seed storage (Lyon Arboretum Seed Storage Facility) (Service 2005b) (USFWS, 2016).

References

USFWS 2016. Status of the Species and Critical Habitat: *Plantago princeps* var. *princeps* (Ale, Laukahi kuahiwi). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016

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Final Rule . 81 FR 17790-18110 (March 30, 2016).

U.S. Fish and Wildlife Service. 2012. Endangered and Threatened Wildlife and Plants

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USFWS. 2016. Status of the Species and Critical Habitat: *Plantago princeps* var. *princeps* (Ale, Laukahi kuahiwi). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016.

SPECIES ACCOUNT: *Platydesma cornuta cornuta* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/18/2012; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Shrubs, 1-2 m or (rarely) up to 7 m tall. Branches few, with leaves clustered near the stem tips. Leaves 12-40 cm long. Inflorescences axillary, on lower stems below the leaves, with 9-15 flowers (or rarely as few as 3 flowers). Petals white or cream. (NatureServe, 2015)

Taxonomy

The genus is endemic to the Hawaiian Islands; the species is endemic to Oahu. The two varieties are weakly distinguished by leaf morphology. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Endemic to the Koolau Mountains on the island of Oahu, state of Hawaii. (NatureServe, 2015)

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On September 18, 2012, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Platydesma cornuta cornuta* under the Endangered Species Act of 1973, as amended (Act) (77 FR 57648-57862). The critical habitat designation includes 11 critical habitat units, which encompass approximately 25,112 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Platydesma cornuta cornuta* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Platydesma cornuta cornuta* includes 11 critical habitat units, covering one ecosystem type, which encompasses approximately 25,112 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16.

Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Haula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231

ha]]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikēkee, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet— Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet— Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu— Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamo Ridge.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Platydesma cornuta cornuta* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Platydesma cornuta cornuta* occurs within the indicated ecosystem in the Koolau Mountain caldera complex:

Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (F) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Platydesma cornuta cornuta* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland, shrubland/chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 1,900 and 2,500 feet (USFWS, 2012)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: This species occurs in wet forest, shrubland, and gulches in the lowland wet ecosystem of the Koolau Mountains, at elevations between 1,900 and 2,500 ft (580 and 760 m) (U.S. Army 2006; TNC 2007; HBMP 2008). (USFWS, 2012)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Long-term trends are unknown, whereas short-term trends indicate declines of 10-30% (NatureServe, 2015)

Resiliency:

Low (inferred from USFWS, 2012)

Redundancy:

Medium (USFWS, 2012)

Number of Populations:

9 (USFWS, 2012)

Population Size:

~50 (USFWS, 2012)

Population Narrative:

Long-term population trends are unknown, whereas short-term trends indicate declines of 10-30%. Currently, 9 occurrences (totaling 32 individuals) are restricted to the summit area of the northern Koolau Mountains, with only 1 occurrence (16 individuals) near the summit of the southern Koolau Mountains (HBMP 2008). (USFWS, 2012; NatureServe, 2015)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative plants, animals (pigs), hurricanes, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. The projected effects of climate change will likely exacerbate the effects of the other threats to the species (USFWS, 2012).

Stressor: Predation and herbivory (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs and goats) is considered an ongoing threat to *Platydesma cornuta* var. *decurrens* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2012).

Stressor: Small populations (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: *Platydesma cornuta* var. *cornuta* faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). *P. cornuta* var. *cornuta* individuals are widely scattered in the Koolau Mountains, and are susceptible to reduced reproductive vigor (USFWS, 2012).

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

References

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Final Rule. 77 Federal Register 181, September 18, 2012. Pages 57648 - 57862.

SPECIES ACCOUNT: *Platydesma cornuta decurrens* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 9/18/2012; Pacific Region (R1) (USFWS, 2016)

Physical Description

A shrub, 1-2 m or (rarely) up to 7 m tall, with few branches. The leaves are clustered near the stem tips, and are 12-40 cm long. The inflorescences is axillary, on lower stems below the leaves, with 9-15 flowers (or rarely as few as 3 flowers). The flower petals are white or cream (NatureServe, 2015).

Taxonomy

In the rue family (Rutaceae) (USFWS, 2012).

Historical Range

On the island of Oahu in the state of Hawaii, in the Waianae Mountains, from the Mokuleia Forest Reserve south to Kaluaa (USFWS, 2012).

Current Range

On the island of Oahu in the state of Hawaii, scattered from Pahole to Palawai Gulch in the Waianae Mountains (USFWS, 2012).

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On September 18, 2012, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Platydesma cornuta decurrens* under the Endangered Species Act of 1973, as amended (Act) (77 FR 57648-57862). The critical habitat designation includes 11 critical habitat units, which encompass approximately 7,332 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Platydesma cornuta decurrens* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Platydesma cornuta decurrens* includes 11 critical habitat units, covering two ecosystem types, which encompass approximately 7,332 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3, Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland

Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac (105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Platydesma cornuta decurrens* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Platydesma cornuta decurrens* occurs within the Lowland mesic and Dry cliff ecosystems in the Waianae Mountain caldera complex:

Oahu—Lowland Mesic—Units 1,2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (F) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. (F) Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Platydesma cornuta decurrens* to avoid further degradation or destruction

of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Potential pollinators are insects (EPA, 2016).

Habitat Type

Adult: Terrestrial (USFWS, 2012)

Habitat Vegetation or Surface Water Classification

Adult: Lowland mesic and dry cliff ecosystems (USFWS, 2012)

Geographic or Habitat Restraints or Barriers

Adult: Elevations generally between 1,990 and 3,000 ft (USFWS, 2012)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: Occurs in the lowland mesic and dry cliff ecosystems of the Waianae Mountains, at elevations between 1,990 and 3,000 ft (USFWS, 2012). In the understory of moist forests, primarily on gulch slopes (NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Potential dispersal mechanisms are abiotic and insect (EPA, 2016).

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Species Trends:

Decline of 10 - 30% (NatureServe, 2015)

Resiliency:

Medium (inferred from USFWS, 2012)

Representation:

Medium (inferred from USFWS, 2012)

Redundancy:

Medium (inferred from USFWS, 2012)

Population Growth Rate:

Unknown (NatureServe, 2015)

Number of Populations:

15 (USFWS, 2012)

Population Size:

259 - 309 individuals (USFWS, 2012)

Population Narrative:

Currently, *P. cornuta* var. *decurrans* is found in 15 occurrences scattered from Pahole to Palawai Gulch, totaling 259 to 309 individuals (USFWS, 2012). Long-term trend is unknown, and short-term trend is a decline of 10 - 30%; population growth rate is unknown (NatureServe, 2015).

Threats and Stressors

Stressor: Habitat modification by ungulates (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: The threat posed by introduced ungulates (pigs and goats) to *Platydesma cornuta decurrans* and its habitat is serious, because they cause: (1) Trampling and grazing that directly impact the plant communities; (2) increased soil disturbance, leading to mechanical damage to individuals of the plant species; and (3) creation of open, disturbed areas conducive to weedy plant invasion and establishment of alien plants from dispersed fruits and seeds, which results over time in the conversion of a community dominated by native vegetation to one dominated by nonnative vegetation. These threats are expected to continue or increase without ungulate control or eradication (USFWS, 2012).

Stressor: Habitat modification by non-native plants (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Nonnative plants represent a serious and ongoing threat to the habitat of *Platydesma cornuta decurrans* through habitat destruction and modification because they: (1) Adversely impact microhabitat by modifying the availability of light; (2) alter soil-water regimes; (3) modify nutrient cycling processes; (4) alter fire characteristics of native plant habitat, leading to incursions of fire-tolerant nonnative plant species into native habitat; and (5) outcompete, and possibly directly inhibit the growth of, native plant species. Each of these threats can convert native-dominated plant communities to nonnative plant communities (USFWS, 2012).

Stressor: Habitat modification by stochastic events (USFWS, 2012)

Exposure:

Response:**Consequence:**

Narrative: Landslides, rockfalls, and flooding adversely impact the habitat of *Platydesma cornuta decurrens* by destabilizing substrates, damaging and destroying individual plants, and altering hydrological patterns. These threats result in habitat destruction or modification, and changes to native plant and animal communities. These threats are significant and have the potential to occur at any time, although their incidence is not predictable (USFWS, 2012).

Stressor: Habitat modification by climate change (USFWS, 2012)

Exposure:**Response:****Consequence:**

Narrative: The projected effects of global climate change and increasing temperatures on the habitat of *Platydesma cornuta decurrens* are related to changes in microclimatic conditions in their habitats. These changes may lead to the loss of native species due to direct physiological stress, the loss or alteration of habitat, increased competition from nonnative species, and changes in disturbance regimes (e.g., fire, storms, and hurricanes). Because the specific and cumulative effects of climate change on these 23 species are presently unknown, we are not able to determine the magnitude of this possible threat with confidence (USFWS, 2012).

Stressor: Predation (USFWS, 2012)

Exposure:**Response:****Consequence:**

Narrative: Feral pigs and goats pose a threat based on several studies conducted in Hawaii and elsewhere. Feral goats and pigs forage on native vegetation (USFWS, 2012).

Stressor: Inadequate existing regulatory mechanisms (USFWS, 2012)

Exposure:**Response:****Consequence:**

Narrative: Existing State and Federal regulatory mechanisms are not preventing the introduction into Hawaii of nonnative species or the spread of nonnative species between islands and watersheds. Habitat-altering nonnative plant species and predation by nonnative animal species pose a major ongoing threat to *Platydesma cornuta decurrens*. Because these regulatory mechanisms are inadequate to maintain habitat for the species, and to prevent the spread of nonnative species, the inadequacy of existing regulatory mechanisms is considered to be a serious threat, both now and in the foreseeable future (USFWS, 2012).

Recovery**Reclassification Criteria:**

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

References

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NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Accessed September, 2016.

SPECIES ACCOUNT: *Platydesma remyi* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/29/2013; Pacific Region (R1) (USFWS, 2016)

Physical Description

A shrub or shrubby tree, 1 - 3 m tall, with spreading branches leafy toward the apex. Flowers are 1 - 3(-5?) in axillary cymes. Petals are white or cream (NatureServe, 2015).

Taxonomy

A member of the rue family (Rutaceae) (USFWS, 2013). The genus is endemic to the Hawaiian islands, this species is endemic to Kohala-hamakua, Hawaii (NatureServe, 2015).

Historical Range

Endemic to the island of Hawaii, state of Hawaii. It is known only from the Kohala Mountains and the eastern slope of Mauna Kea (NatureServe, 2015). Historically, *P. remyi* was known from a few scattered individuals on the windward slopes of the Kohala Mountains and several small populations on the windward slopes of Mauna Kea, in the lowland wet and montane wet ecosystems (Stone et al. 1999, p. 1210; HBMP 2010i) (USFWS, 2013).

Current Range

All current occurrences are found in the Laupahoehoe NAR or in closely surrounding areas (USFWS, 2013).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Lowland wet and montane wet forest (NatureServe, 2015; USFWS, 2013)

Geographic or Habitat Restraints or Barriers

Adult: 0 - 6,600 ft. elevation (USFWS, 2012)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits wet forests on old volcanic slopes. The environmental specificity is unknown (NatureServe, 2015). It occurs in the lowland wet and montane wet ecosystems (USFWS, 2013). The montane wet ecosystem is composed of natural communities (grasslands, shrublands, forests, and bogs) found at elevations between 3,300 and 6,600 ft. (1,000 and 2,000 m); the lowland wet ecosystem is generally found below 3,300 ft. (1,000 m) elevation (USFWS, 2012).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

The long term population trend is unknown (NatureServe, 2015)

Species Trends:

Declining (USFWS, 2013)

Resiliency:

Low (inferred from USFWS, 2013; see current range/distribution)

Redundancy:

Low (USFWS, 2013)

Number of Populations:

8 (USFWS, 2013)

Population Size:

< 40 wild, 29 outplanted (USFWS, 2013)

Population Narrative:

The long term population trend is unknown (NatureServe, 2015). Currently, *P. remyi* is known from 8 occurrences totaling fewer than 40 individuals. According to field biologists, this species appears to be declining with no regeneration believed to be caused, in part, by rat predation on the seeds (Bio 2011, pers. comm.). In 2009, 29 individuals of *P. remyi* were outplanted in Laupahoehoe NAR (Bio 2008, in litt.). Their current status is unknown (USFWS, 2013).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs), nonnative plants, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the

spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs) is considered an ongoing threat to *Platydesma remyi* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor: Small populations and lack of regeneration (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: *Platydesma remyi* faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). This species is known from fewer than 40 scattered individuals (Stone et al. 1999, p. 1210; HBMP 2010i). Declining or lack of regeneration in the wild appears to threaten this species. Lack of, or low levels of, regeneration (reproduction and recruitment) in the wild has been observed, and is also a threat (USFWS, 2013).

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- The State of Hawaii's Plant Extinction Prevention (PEP) Program supports conservation of plant species by securing seeds or cuttings (with permission from the State, Federal, or private landowners) from the rarest and most critically endangered native species for propagation and outplanting (<http://pepphi.org>). The PEP Program collects, propagates, or outplants this species (USFWS, 2013).

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Final Rule. 78 Federal Register 209. October 29, 2013. Pages 64637 - 64690

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Listing 15 Species on Hawaii Island as Endangered and Designating Critical Habitat for 3 Species

Proposed Rule. 77 Federal Register 201. October 17, 2012. Pages 63927 - 64018.

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Final Rule. 78 Federal Register 209, October 29, 2013. Pages 64638 - 64690.

SPECIES ACCOUNT: *Platydesma rostrata* (Pilo kea lau li'i)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (R1) (USFWS, 2016)

Physical Description

A shrub, few-branched, 1 - 3 m tall. Branches are ascending, leafy toward the apex. Leaves are usually 20 - 42 cm long. Cymes are axillary, in the leaf axils or below the leaves, with 3 - 9 flowers. Sometimes 2 - 3 cymes are clustered in fascicles up to 2 cm long. Petals are white or cream (NatureServe, 2015).

Taxonomy

A member of the rue family (Rutaceae) (USFWS, 2010b). The genus endemic to Hawaiian Islands; this species is endemic to Kauai (NatureServe, 2015).

Historical Range

Platydesma rostrata was historically known from Makaha and Milolii ridge in the Na Pali Kona Forest Reserve, and Kaunuohua ridge and Nualolo trail in Kokee State Park, on the island of Kauai (HBMP 2007) (USFWS, 2010b).

Current Range

Currently, this species is found in the Na Pali Kona Forest Reserve on the Awaawapuhi and Honopu trails; in Halelea Forest Reserve at Lumahai; in Hono o Na Pali NAR at Pihea; in Kunia NAR on the Nualolo Trail; in Mahanaloa and Kuia valleys; and in the Lihue-Koloa Forest Reserve at Pohakupele, Hulua, Kapalaoa, and Iliiliula Valley (Kauai) (HBMP 2007) (USFWS, 2010b).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Platydesma rostrata* (Pilo kea lau li'i) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 20 critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Platydesma rostrata* includes 20 CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Lowland Mesic—Section 1: Lowland Mesic—Section 1 consists of 2,006 ac (812 ha) in the lowland mesic ecosystem, including mesic forest extending from Awaawapuhi Trail south to Makaha Ridge, in the Na Pali Kona Forest Reserve and the Kuia NAR (Figure 1-A). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plants *Doryopteris angelica*, *Labordia helleri*, *Platydesma rostrata* and *Psychotria hobbdi*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that

is essential to the conservation of these four species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic—Section 1 is not known to be occupied by the species *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Dubautia kenwoodii*, *Pittosporum napaliense*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 2: Lowland Mesic—Section 2 consists of 379 ac (154 ha) in the lowland mesic ecosystem, including mesic forest extending from Keanapuka to Kahuamaa Flat along the rim and cliffs of the Kalalau Valley, in the Na Pali Coast State Park (Figure 1-A, above). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plants *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Pittosporum napaliense*, and *Psychotria hobdyi*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these six species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic—Section 2 is not known to be occupied by the species *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Platydesma rostrata*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 3: Lowland Mesic—Section 3 consists of 124 ac (50 ha) in the lowland mesic ecosystem, including mesic forest extending from Manono Ridge, Pohakuao Valley, to Kanakuu, within the Na Pali Coast State Park (Figure 1- A, above). The entire section is Stateowned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plants *Canavalia napaliensis*, *Chamaesyce eleanoriae*, and *Charpentiera densiflora*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these three species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic—Section 3 is not known to be occupied by the species *Chamaesyce remyi* var. *remyi*, *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Pittosporum napaliense*, *Platydesma rostrata*, *Psychotria hobdyi*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 4: Lowland Mesic—Section 4 consists of 81 ac (33 ha) in the lowland mesic ecosystem, including mesic forest at the head of the Hanakapiʻai Valley, in the Na Pali Coast State Park (Figure 1-A, above). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plant *Charpentiera densiflora* and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. Although Lowland Mesic—Section 4 is not known to be occupied by the species *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *Chamaesyce remyi* var. *remyi*, *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Pittosporum napaliense*, *Platydesma rostrata*, *Psychotria hobdyi*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 5: Lowland Mesic—Section 5 consists of 37 ac (15 ha) in the lowland mesic ecosystem, including mesic forest on the slopes of Mt. Haupu, on privately owned land (Figure 1-B). The entire section is within previously designated critical habitat, and falls within Critical Habitat Unit 7 of 50 CFR 17.99(a)(1), Map 23a. This section is occupied by the plants *Chamaesyce remyi* var. *remyi* and *Tetraplasandra bisattenuata*, and includes mesic forest and shrubland, the moisture regime, and subcanopy and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these two species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic—Section 5 is not known to be occupied by the species *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *Charpentiera densiflora*, *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Pittosporum napaliense*, *Platydesma rostrata*, and *Psychotria hobdyi*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 1: Lowland Wet—Section 1 consists of 1,164 ac (471 ha) in the lowland wet ecosystem (117 ac (47.4 ha) on State land; 1,047 ac (424 ha) on private land), including wet forest extending from Kulanalilia into Limahuli Valley to Hoonoanapali, in the Halelea Forest Reserve (Figure 2-A). The section includes 1,099 ac (445 ha) of State and privately owned land within previously designated critical habitat and 65 ac (26 ha) of newly designated critical habitat on private land. The area that falls within designated critical habitat lies within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and newly designated Critical Habitat Unit 20, Map 217c. This section is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Labordia helleri*, and *Phyllostegia renovans*. This section also contains unoccupied habitat that is essential to the conservation of these four species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory

plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet–Section 1 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Melicope paniculata*, *M. puberula*, *Platydesma rostrata*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 2: Lowland Wet–Section 2 consists of 172 ac (70 ha) in the lowland wet ecosystem, including wet forest extending from Alealau to Pohakea, within the Hono o Na Pali NAR and the Na Pali Coast State Park (Figure 2-A, above). The entire section is Stateowned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plant *Melicope puberula*. This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet–Section 2 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope paniculata*, *Phyllostegia renovans*, *Platydesma rostrata*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 3: Lowland Wet–Section 3 consists of 756 ac (306 ha) in the lowland wet ecosystem, including wet forest in upper Wainiha Valley, on privately owned land in the Halelea Forest Reserve (Figure 2-B). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyrtandra oenobarba*, *Melicope puberula*, *Phyllostegia renovans*, and *Stenogyne kealiae*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet–Section 3 is not known to be occupied by the species *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope paniculata*, *Platydesma rostrata*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 4: Lowland Wet—Section 4 consists of 591 ac (239 ha) in the lowland wet ecosystem, including wet forest at the head of Lumahai Valley, on State (10 ac, 4.1 ha) and privately owned (581 ac, 235 ha) land in the Halelea Forest Reserve (Figure 2-B, above). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyrtandra oenobarba*, *Melicope paniculata*, *Phyllostegia renovans*, and *Platydesma rostrata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 4 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope puberula*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population numbers of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 5: Lowland Wet—Section 5 consists of 1,541 ac (624 ha) in the lowland wet ecosystem, including wet forest extending from the headwaters of the Wailua River at “Blue Hole” south to Iole, on State (442 ac, 179 ha) and privately owned (1,099 ac, 445 ha) land in the Lihue-Koloa Forest Reserve (Figure 2-C). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36a, and is occupied by the plants *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Melicope paniculata*, *Phyllostegia renovans*, and *Platydesma rostrata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 5 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Labordia helleri*, *Melicope puberula*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 6: Lowland Wet—Section 6 consists of 789 ac (319 ha) in the lowland wet ecosystem, including wet forest extending from Kapalaoa to Kanaele Bog and Lauahihaihai in the Wahiawa Mountains, on State (134 ac, 54 ha) and privately owned (655 ac, 265 ha) land in the Lihue-Koloa Forest Reserve (Figure 2-D). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36a, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Platydesma rostrata*, and *Tetraplasandra bisattenuata*. This section also contains unoccupied habitat that is essential to the conservation of these five

species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 6 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Labordia helleri*, *Melicope paniculata*, *M. puberula*, *Phyllostegia renovans*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Montane Mesic—Section 1: Montane Mesic—Section 1 consists of 2,423 ac (980 ha) in the montane mesic ecosystem, including the area above Honopu Valley to Mahanaloa Valley, on State owned land in Kokee State Park, the Na Pali-Kona Forest Reserve, and Kuia NAR (Figure 3-A). The entire section is within previously designated critical habitat for the plant species, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70c, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Labordia helleri*, *Myrsine knudsenii*, *Platydesma rostrata*, *Psychotria grandiflora*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*. This section is also occupied by the akekee and the picture-wing fly; maps of critical habitat for these species can be found at 50 CFR 17.95(b) for the akekee and akikiki (Unit 1—Montane Mesic), and at 50 CFR 17.95(i) for the picture-wing fly (Unit 1—Montane Mesic). This section also contains unoccupied habitat that is essential to the conservation of these nine species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the montane mesic forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane mesic ecosystem (Table 3), as well as species-specific PCEs for the akekee and akikiki (arthropod prey) and picture-wing fly (the larval-stage host plants, *Cheirodendron* sp. and *Tetraplasandra* sp.). Although Montane Mesic—Section 1 is not known to be occupied by the species *Diellia mannii*, *Myrsine mezii*, and the akikiki, we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Montane Mesic—Section 2: Montane Mesic—Section 2 consists of 376 ac (152 ha) in the montane mesic ecosystem and includes a portion of the area surrounding a tributary of Nawaimaka Stream east to Kumuwela Ridge (Figure 3-A, above). The entire section is State-owned within Kokee State Park, and includes 8 ac (3 ha) of newly designated critical habitat. This section is occupied by *Diellia mannii* and the picture-wing fly *Drosophila sharpi*, and includes the montane mesic forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane mesic ecosystem (Table 3), as well as the larval-stage host plants (*Cheirodendron* sp. and *Tetraplasandra* sp.) associated with the picture-wing fly. This section also contains unoccupied habitat that is essential to the conservation of these two species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Montane Mesic—Section 2 is not known to be occupied by the plants *Chamaesyce remyi* var. *remyi*, *Labordia helleri*, *Myrsine knudsenii*, *Myrsine mezii*,

Platydesma rostrata, *Psychotria grandiflora*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*, or by the birds the akekee and akikiki, we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range, as well as species-specific PCEs for the akekee and akikiki (arthropod prey). Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, that portion of the section that overlies previously designated critical habitat falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70c. The previously undesignated land comprises Critical Habitat Unit 21 of 50 CFR 17.99(a)(1), Map 217d. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 2—Montane Mesic), and for the picture-wing fly at 50 CFR 17.95(i) (Unit 2—Montane Mesic).

Kauai—Montane Mesic—Section 3: Montane Mesic—Section 3 consists of 139 ac (56 ha) in the montane mesic ecosystem, including the upper portion of the Nawaimaka Valley up to Kapukapaia Ridge, on State-owned land in the Na Pali-Kona Forest Reserve (Figure 3-B). This section is not in previously designated critical habitat and includes the only montane mesic forest occupied by the plant *Myrsine mezii*, and the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. Although Montane Mesic—Section 3 is not known to be occupied by the plants *Chamaesyce remyi* var. *remyi*, *Labordia helleri*, *Myrsine knudsenii*, *Myrsine mezii*, *Platydesma rostrata*, *Psychotria grandiflora*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*; by the birds the akekee and akikiki; or by the picturewing fly *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. It also provides for the species-specific PCEs for the akekee and akikiki (arthropod prey) and the larval-stage host plants (*Cheirodendron* sp. and *Tetraplasandra* sp.) associated with *D. sharpi*. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, this section comprises Critical Habitat Unit 22 of 50 CFR 17.99(a)(1), Map 217e. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 3—Montane Mesic), and for the picturewing fly at 50 CFR 17.95(i) (Unit 3—Montane Mesic).

Kauai—Montane Wet—Section 1: Montane Wet—Section 1 consists of 13,055 ac (5,257 ha) in the montane wet ecosystem, extending across the Alakai Plateau from Hanakoa to Mount Waialeale, on State (12,628 ac, 5,110 ha) and privately owned (427 ac, 173 ha) land in the Na Pali Coast State Park, the Alakai Wilderness Preserve, the Na Pali-Kona and Halelea forest reserves, and Hono o Na Pali NAR (Figure 4). It is occupied by the plants *Astelia waialealae*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *K. helenae*, *Labordia helleri*, *L. pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, and *Platydesma rostrata*; by the akekee and akikiki; and by the picture-wing fly. This section also contains unoccupied habitat that is essential to the conservation of these 18 species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the montane wet forest, the moisture regime, and canopy, subcanopy, and understory plant species

identified as PCEs in the montane wet ecosystem (Table 3), and the species-specific PCEs including (1) bogs (identified as PCEs for *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*) (2) bog hummocks (identified as PCEs for *Astelia waialealae* and *Lysimachia daphnoides*); (3) arthropod prey (identified as PCEs for the akekee and the akikiki); and (4) larval-stage host plants, *Cheirodendron* and *Tetraplasandra* sp., (identified as a PCE for the picture-wing fly). Although Montane Wet–Section 1 is not known to be occupied by the plants *Dubautia kalalauensis*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, those portions of the section that overlies previously designated critical habitat fall within two existing Critical Habitat Units of 50 CFR 17.99(a)(1): Unit 10, Map 35a; and Unit 11, Map 64a. The previously undesignated land comprises Unit 23, Map 217f; and Unit 24, Map 217g. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 4–Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 4–Montane Wet).

Kauai—Montane Wet—Section 2: Montane Wet–Section 2 consists of 790 ac (320 ha) in the montane wet ecosystem, extending from Kahuamaa Flat south to the edge of Waimea Canyon, on State-owned land in Kokee State Park (Figure 4, above). The entire section is within previously designated critical habitat, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Dubautia kalalauensis*, *Labordia helleri*, *Melicope puberula*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*, and by the akekee. This section includes montane wet forest, potentially some small-scale boggy areas, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and arthropod prey (identified as a species-specific PCE for the akekee). Although Montane Wet–Section 2 is not known to be occupied by the plants *Astelia waialeale*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialeale*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *Myrsine mezii*, and *Phyllostegia renovans*; by the akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. This area also supports the arthropod prey identified as a PCE for the akikiki, and the larval-stage host plants (*Cheirodendron* and *Tetraplasandra* spp.) identified as a PCE for the picturewing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within previously designated Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 5–Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 5–Montane Wet).

Kauai—Montane Wet—Section 3: Montane Wet–Section 3 consists of 413 ac (167 ha) in the montane wet ecosystem, encompasses the summit of Namolokama, on State (156 ac, 63 ha) and privately owned (257 ac, 104 ha) land in the Halelea Forest Reserve (Figure 4, above). It is entirely within previously designated critical habitat, and is occupied by the plants *Keysseria erici* and *Labordia pumila*. This section includes the montane wet forest, the moisture regime, and the canopy, subcanopy, and understory plant species identified as PCEs in the montane wet

ecosystem (Table 3), and bogs (identified as a species-specific PCE for *K. erici*). Although Montane Wet–Section 3 is not known to be occupied by the plants *Astelia waialeale*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia kalalauensis*, *D. waialeale*, *Geranium kauaiense*, *Keysseria helenae*, *Labordia helleri*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*; by the akekee and akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. It also supports the arthropod prey identified as a PCE for the akekee and akikiki, and the larval-stage host plants (*Cheirodendron* and *Tetraplasandra* spp.) identified as a PCE for the picture-wing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 6–Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 6–Montane Wet).

Kauai—Wet Cliff—Section 1: Wet Cliff–Section 1 consists of 190 ac (77 ha) in the wet cliff ecosystem, including cliffs along the rim of Kalalau Valley from Alealeau to Pihea, on State-owned land in the Na Pali Coast State Park and the Hono o Na Pali NAR (Figure 6-A). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70b, and is occupied by the plant *Chamaesyce remyi* var. *remyi*. This section includes the wet cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the wet cliff ecosystem (Table 3). Although Wet Cliff–Section 1 is not known to be occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyanea dolichopoda*, *Cyrtandra oenobarbara*, *C. paliku*, *Dubautia plantaginea* ssp. *magnifolia*, *Lysimachia iniki*, *L. pendens*, *L. venosa*, and *Platydesma rostrata*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Wet Cliff—Section 2: Wet Cliff–Section 2 consists of 784 ac (317 ha) in the wet cliff ecosystem, and includes the cliffs at the headwaters of the Wailua River or “Blue Hole,” on State (778 ac, 315 ha) and privately owned (6 ac, 3 ha) land in the LihueKoloa Forest Reserve (Figure 6-B). There are 489 ac (198 ha) within previously designated critical habitat and 296 ac (120 ha) of newly designated critical habitat on State-owned land. The portion of the section that is in previously designated critical habitat falls within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36b. The newly designated portion of the section comprises Critical Habitat Unit 18 of 50 CFR 17.99(a)(1), Map 217a. This section is occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyrtandra oenobarba*, *Dubautia plantaginea* ssp. *magnifolia*, *Lysimachia iniki*, *L. pendens*, and *Platydesma rostrata*. The section includes the wet cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the wet cliff ecosystem (Table 3). Although Wet Cliff–Section 2 is not known to be occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyanea dolichopoda*, *Cyrtandra paliku*, and *Lysimachia venosa*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population

sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Wet Cliff—Section 3: Wet Cliff—Section 3 consists of 61 ac (24 ha) in the wet cliff ecosystem, including cliffs below Kekoiki, on State (8 ac, 3 ha) and privately owned (53 ac, 22 ha) land in the Halelea, Moloaa and Kealia forest reserves (Figure 6-C). There are 23 ac (9 ha) of newly designated critical habitat on privately owned land within this section. That portion of the section that falls within previously designated critical habitat is within Critical Habitat Unit 4 of 50 CFR 17.99(a)(1), Map 5a. The newly designated portion of the section comprises Critical Habitat Unit 19 of 50 CFR 17.99(a)(1), Map 217b. This section is occupied by the plant *Cyrtandra paliku*, and includes the wet cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the wet cliff ecosystem (Table 3). Although Wet Cliff—Section 3 is not known to be occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Cyanea dolichopoda*, *Cyrtandra oenobarbara*, *Dubautia plantaginea* ssp. *magnifolia*, *Lysimachia iniki*, *L. pendens*, *L. venosa*, and *Platydesma rostrata*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Platydesma rostrata* critical habitat consists of five components (Lowland mesic, Lowland wet, Montane mesic, Montane wet and Wet Cliff)) (75 FR 18960-19165):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<914 m). Annual precipitation: 50–75 in (127–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Ecosystem: Lowland Wet. Elevation: <3,000 ft (<914 m). Annual precipitation: >75 in (>190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepis*.

Ecosystem: Montane Mesic. Elevation: 3,300–5,243 ft (914–1,598 m). Annual precipitation: 50–75 in (127–190 cm). Substrate: weathered aa lava, rocky mucks, thin silty loams, deep volcanic ash soils. Canopy: *Acacia*, *Metrosideros*, *Psychotria*, *Tetraplasandra*, *Zanthoxylum*. Subcanopy: *Cheirodendron*, *Coprosma*, *Kadua*, *Ilex*, *Myoporum*, *Myrsine*. Understory: *Bidens*, *Dryopteris*, *Leptecophylla*, *Poa*, *Scaevola*, *Sophora*.

Ecosystem: Montane Wet. Elevation: 3,000–5,243 ft (914–1,598 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: *Ferns*, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: Broussaisia, Cheirodendron, Leptecophylla, Metrosideros. Understory: Bryophytes, Ferns, Coprosma, Dubautia, Kadua, Peperomia. There are also an unknown number of units on Lanai that contain this species (number of units is unknown because detailed unit descriptions for Lanai are not available)

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the

course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: *Acacia koa* and *Metrosideros polymorpha* lowland and montane mesic to wet forest (USFWS, 2010b)

Geographic or Habitat Restraints or Barriers

Adult: 2,500 - 4,000 ft. elevation (USFWS, 2010b)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits moist forests or, less often, in wet forests; on ridges and in gulches. The environmental specificity is unknown (NatureServe, 2015). It occurs in the lowland mesic, lowland wet, wet cliff, montane mesic, and montane wet ecosystems, in forest dominated by *Acacia koa* and *Metrosideros polymorpha*, at elevations between 2,500 and 4,000 ft. (760 and 1,220 m) (Stone et al. 1999, p. 1210; HBMP 2007; TNCH 2007) (USFWS, 2010b).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Species Trends:

Declining (NatureServe, 2015)

Resiliency:

Very low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from USFWS, 2010a)

Number of Populations:

12 subpopulations (USFWS, 2017)

Population Size:

~110 (USFWS, 2017)

Population Narrative:

The long term population trend is unknown. It is presumed declining because of continued presence of alien animals and plants. The range of current, known populations is about 770 square km (NatureServe, 2015). There are six populations totaling 100 individuals (USFWS, 2010a). There are currently about 112 wild individuals of *Platydesma rostrata* in 12 subpopulations (USFWS, 2017)..

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from non-native plants, pigs, goats, deer, hurricanes, landslides, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species.

Landslides destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities.

Stressor: Predation and herbivory (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species present an immediate and significant threat to *Platydesma rostrata* throughout its range due to documented browsing and trampling by pigs, goats, and deer, and documented mechanical damage by rats and the two-spotted leafhopper (*Sophonia rufofascia*) (USFWS, 2010).

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor: Hurricanes—Loss and degradation of habitat

Exposure:

Response:

Consequence:

Narrative: In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013) (USFWS, 2017).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Platydesma rostrata* is vulnerable to the impacts of climate change with a vulnerability score of 0.448 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery

Reclassification Criteria:

In addition to achieving 5 to 10 populations with 200 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats (USFWS, 2017).

Delisting Criteria:

In addition to achieving 5 to 10 populations with 200 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis (USFWS, 2017).

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys (USFWS, 2010a).
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units (USFWS, 2010a).
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys (USFWS, 2010a).
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range (USFWS, 2010a).
- Conduct research on control methods for introduced slugs and avian malaria (USFWS, 2010a).

- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction (USFWS, 2010a).
- Identify threats and prioritize which ones to address first for the two birds (USFWS, 2010a).
- Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program (USFWS, 2010a).
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security (USFWS, 2010a).
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems (USFWS, 2010a).
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations (USFWS, 2010a).
- **RECOMMENDATIONS FOR FUTURE ACTIONS**
 - Surveys and inventories—Continue to survey for populations of *Platydesma rostrata* in areas of potentially suitable habitat.
 - Ungulate monitoring and control—Protect all occurrences against browsing and disturbances from feral ungulates. Construct and maintain fenced exclosures around existing populations to prevent imminent extinction.
 - Invasive plant monitoring and control
 - o Control established ecosystem-altering nonnative invasive plant species around all populations.
 - o Control invasive nonnative plant species around all populations that compete with the species.
 - Rodent predation or herbivory control—Implement effective measures to control rodents around all populations.
 - Invertebrate predation or herbivory control—Study *Platydesma rostrata* populations to determine level of threat from invertebrate herbivory and effective control actions.
 - Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock.
 - Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.
 - Population biology research—Study *Platydesma rostrata* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats.
 - Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered throughout historic range to reduce impacts from landslides and storms.
 - Based on the recovery criteria above, consider development of a recovery plan (USFWS, 2017).
- **Current Management Actions:**
 - Surveys and inventories—PEPP has upgraded this species to POP (Potential PEP) and surveys and monitors individuals at Nualolo and Koaie (PEPP 2015, 2016).
 - Captive propagation for genetic storage and reintroduction— Hundreds of seeds have been brought into the NTBG seed bank and nursery for storage and propagation in 2017 (NTBG 2017). Two seeds were brought to Kokee Rare Plant Facility for propagation (DOFAW 2016). A few individuals have been outplanted as living collections.
 - Reintroduction and translocation—A few individuals have been outplanted at the Limahuli and McBryde facilities as living collections (NTBG 2013f, 2014b, 2015c) (USFWS, 2017).

Conservation Measures and Best Management Practices:

- This species is currently in controlled propagation for genetic storage and/or reintroduction efforts (USFWS, 2010a).

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SPECIES ACCOUNT: *Pleodendron macranthum* (Chupacallos)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 11/25/1994

Physical Description

A small to medium size aromatic evergreen tree reaching 10 meters (33 feet) in height, 20 centimeters (8 inches) in diameter with brownish twigs that are slender and hairless. Leaves are alternate, simple, leathery, entire, measuring 8.5 - 12.5 centimeters (3.5 - 5.0 inches) long and 4.5 - 5.0 centimeters (1.7 - 2 inches) wide. The blades are elliptic with the upper surface dark shiny green and the mid-vein sunken. The lower surface is pale green with a prominent mid-vein and with fine, parallel side veins. The leafstalks are about 7 millimeters (.25 inches) long and canal-shaped (Vivaldi et al. 1981). The solitary flowers, whitish in color and bisexual, are axillary and are subtended by a long flower stalk 2.5 centimeters (1 inch) long. The flowers are 2 centimeters (.8 inches) wide with 3 sepals, 12 petals and many united stamens. The cup-shaped calyx is persistent in the fruit. The aromatic purplish black fruit measures 2 centimeters (.8 inches) in diameter and contains many rounded, shiny brownish black seeds. The wood is described as nearly white, hard, and heavy (Little et al. 1974) (USFWS, 1998).

Taxonomy

There are no recent taxonomic or nomenclatural changes for *P. macranthum*, which was originally described as *Cinnamodendron macranthum*. Its closest relative, *P. ekmanii*, is a very rare tree from Haiti (Little et al., 1974) whose present status is unknown. The other member of the Canellaceae family in Puerto Rico is *Canella winterana*, a dry forest species (USFWS, 2014).

Historical Range

See current range/distribution.

Current Range

Known from the Caribbean National Forest and the Rio Abajo Commonwealth Forest, which are administered by the USDA Forest Service and the Department of Natural and Environmental Resources (USFWS, 1998). The populations at El Yunque National Forest (EYNF) consisted of nine trees at the Jimenez Ward and two separated trees at Mameyes II Ward in Rio Grande. However, none of these populations were located during the latest surveys conducted by University of Puerto Rico at Mayagüez personnel in March 2011. (USFWS, 2019).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Breeding Season

Adult: *Plethodendron macranthum* has been collected with flowers in February, April-June, and with fruits in June-August (Little et al. 1974) (USFWS, 1998).

Reproduction Narrative

Adult: Very little is known about the reproductive biology of *Plethodendron macranthum* and *Eugenia haematocarpa* due to their extremely low population numbers and isolated locations. *Plethodendron macranthum* has been collected with flowers in February, April-June, and with fruits in June-August (Little et al. 1974). This species is known to reproduce successfully on the forest; specimens with fruit have been encountered in July (USDA Forest Service 1993) (USFWS, 1998).

Habitat Type

Adult: Forest (USFWS, 1998)

Spatial Arrangements of the Population

Adult: Clumped (inferred from USFWS, 1998)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1998)

Site Fidelity

Adult: High (inferred from USFWS, 1998)

Habitat Narrative

Adult: *Plethodendron macranthum* is known to exist in the subtropical wet (tabonuco forest type) and the subtropical lower montane wet (palo colorado forest type) forest life zones (USFWS, 1998). High ecological integrity of the population and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species and the low number of known populations.

Dispersal/Migration***Population Information and Trends*****Resiliency:**

Low (inferred from USFWS, 2014)

Representation:

Low (inferred from USFWS, 2014)

Redundancy:

Low (inferred from USFWS, 2014)

Number of Populations:

~10 (USFWS, 2014)

Population Size:

~97 total individuals (USFWS, 2014)

Population Narrative:

Overall, the majority of the known individuals of Chupacallos are planted trees. There are 97 known individuals in the wild, and 70 percent have been planted (Table 1). Of the 21 naturally occurring individuals, none have been observed during the last decade. The 97 individuals occur in 10 populations, 6 of which are experimental populations consisting of planted individuals (USFWS, 2014). Low representation, resiliency and redundancy are inferred based on the low number of populations and individuals as well as the specific habitat needs of the species.

Threats and Stressors

Stressor: Deforestation (USFWS, 2014)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: At the time of listing, forest management practices such as the establishment and maintenance of plantations, selective cutting, trails maintenance, and shelter construction were identified as threats to both Chupacallos and Uvillo. Based on the available information, the core of the known populations of Chupacallos and Uvillo occurs within the boundaries of Federal, State, or other protected areas. Within these areas, there is no direct evidence of populations or individuals being affected by forest management practices. Therefore, USFWS no longer considers forest management practices a threat to Chupacallos or Uvillo. However, the largest known population of Uvillo lies within Las Robledas along a ridge that marks the boundary of several private properties and some clusters of individuals lie within neighboring properties that are not managed by the PRCT. Boundary management practices (clearing and fencing) may affect individuals along these areas. Similarly, land clearing for agricultural purposes and urban development may affect the small populations of Uvillo within private properties at the Sierra de Cayey, including the private properties adjacent to Las Robledas. Undetected populations of Chupacallos and Uvillo might be affected by deforestation for urban development on the periphery of El Yunque National Forest. In the northern Karst 13 region, suitable habitat for these species may be affected by rock quarries, particularly in the Quebradillas and Isabela area. The present or threatened destruction, modification, or curtailment of the species habitat or range remains a threat to Chupacallos and Uvillo. However, since the majority of the known populations lie within properties managed for conservation and there is no direct evidence of populations being affected by habitat destruction or modification, we consider this threat to be low in magnitude and non-imminent (USFWS, 2014).

Stressor: Storms (USFWS, 2014)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Hurricanes and landslides are listed as a threat to this species (USFWS, 2014).

Stressor: Climate change (USFWS, 2014)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Climate change is predicted to increase the frequency and strength of tropical storms and can cause severe droughts (Hopkinson et al. 2008). Vulnerability to climate change impacts is a function of sensitivity to those changes, exposure to those changes, and the adaptive capacity

of the species (Glick et al. 2011). Shifts of vegetation communities are expected as temperatures and moisture regimes are altered by climate change. Under this scenario populations of Chupacallos and Uvillo may be displaced or outcompeted by native or exotic species with wider environmental plasticity. Climate change may also compromise natural recruitment by affecting the survival of seedlings. Despite the low number of populations and individuals (particularly for Chupacallos), at this time the USFWS considers hurricanes, landslides and climate change a moderate and non-imminent threat to both species. Climate change is occurring gradually and the frequency of severe hurricanes is low (USFWS, 2014).

Stressor: Decreased genetic variation (USFWS, 2014)

Exposure:

Response:

Consequence: Lack of genetic variability

Narrative: Along with a decreasing population size, negative impacts of habitat fragmentation may result in erosion of genetic variation through the loss of alleles by random genetic drift (Honney and Jacquemyn 2007), and may also limit the ability of a species to respond to a changing environment (Booy et al. 2000). Given the extremely small population size and low number of known natural populations of Chupacallos, it is likely that their genetic variability is low. As previously indicated, all reported populations consist of less than 10 individuals, and in some cases they are represented by a single individual. Despite the reports of new populations of Uvillo, this species may be affected by genetic depression due to the low number of individuals in some populations, as it is evident that the species was severely affected by former habitat fragmentation due primarily to extensive deforestation for agriculture. However, the wide distribution and geographical isolation of the species, from the eastern to the northwestern side of the Island (i.e., El Yunque National Forest, Sierra de Cayey, and Guajataca Commonwealth Forest), with different environmental conditions, suggests that the species may show high interpopulation genetic variability. In order to safeguard the remaining genetic diversity, the origin and survival of reintroduced individuals needs to be monitored as well as their development into mature individuals. The protection and monitoring of known adult individuals should be considered a high priority for the conservation of Chupacallos and Uvillo. Based on the above, we consider the lack of genetic variation is a high and imminent threat to Chupacallos, and a low and non-imminent threat for Uvillo (USFWS, 2014).

Stressor: Lack of natural recruitment (USFWS, 2014)

Exposure:

Response:

Consequence: Loss of genetic variability

Narrative: Without natural recruitment or successful augmentation from captive propagated individuals, populations (natural and reintroduced) of Chupacallos are likely to become extirpated as older individuals naturally die. Despite future efforts to enhance natural populations by planting seedlings and saplings, it is unknown if planted individuals will develop into mature plants capable of reproducing. Therefore, we consider the lack of natural recruitment a high and imminent threat to Chupacallos (USFWS, 2014).

Recovery

Reclassification Criteria:

The two species will be considered for down listing when the following criteria are met: 1. An agreement between the USFWS and the USFS concerning the protection of Chupacallos and Uvillo within the Caribbean National Forest property has been prepared and implemented (USFWS, 2014).

2. An agreement between the USFWS and the PRDNER concerning the protection of these two species in Commonwealth Forests, specifically Río Abajo, for Chupacallos, has been prepared and implemented (USFWS, 2014).

3. New populations (the number of which will be determined by appropriate scientific studies) capable of self-perpetuation have been established within protected areas (USFWS, 2014).

Delisting Criteria:

1. Three (3) natural populations of uvillo and two (2) populations of chupacallos exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes, and populations extending onto private lands are protected through a conservation mechanism (addresses Factors A and E). (USFWS, 2019).

2. Establish or discover two (2) new populations of uvillo and seven (7) new populations of chupacallos within the historic range of the species that exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes, and populations extending onto private lands are protected through a conservation mechanism (addresses Factors A and E). (USFWS, 2019).

3. Threat reduction and management activities (e.g., trail maintenance) have been implemented to a degree that the species will remain viable into the foreseeable future (addresses Factor A). (USFWS, 2019).

Recovery Actions:

- Criterion 1 has been partially initiated. There is no formal agreement between the USFS and USFWS for the implementation of a management plan to protect Chupacallos and Uvillo. Nonetheless, under Section 7 of the Endangered Species Act (ESA), Federal agencies are mandated to carry out programs for the conservation of endangered species. Under the ESA, it must be ensured that any action authorized, funded, or carried out by a Federal agency is not likely to jeopardize the continued existence of an endangered species. The USFS and USFWS have developed a good communication relationship, and USFS always consults with USFWS to avoid and minimize impacts to listed species and their habitat at El Yunque National Forest. Further coordination is needed for the long term monitoring of natural populations and propagation of Chupacallos and Uvillo (USFWS, 2014)
- Criterion 2 has been partially met. The Río Abajo Commonwealth Forest has an approved management plan that recognizes the presence of Chupacallos within the forest. Furthermore, PRDNER has listed Chupacallos as endangered, and as part of their list of critical elements. Species on the list of critical elements receive special consideration when evaluating development actions within suitable habitat. However, there is no formal agreement in place between USFWS and the PRDNER to protect Chupacallos populations within the Río Abajo Commonwealth Forest. Further coordination is needed for the long term monitoring of natural populations and the propagation of Chupacallos. Because the species is not monitored on the forest, adverse impacts to the populations could be

occurring due to forest management practices (e.g., opening of new trails and research projects) (USFWS, 2014).

- Criterion 3 has been initiated. Several natural populations of Uvillo have been reported since the species was listed in 1994. The Puerto Rico Conservation Trust (PRCT) has conducted an exhaustive evaluation of two recently discovered population in the municipality of Cayey in two properties known as Las Robledas, and Sotomayor del Toro and have consulted with the USFWS about adequate management practices for these populations. USFWS biologists visited the population at Las Robledas and it seems to be healthy and may set the standards to establish further viable populations within these areas (Las Robledas and Sotomayor del Toro) and other Commonwealth protected areas. Furthermore, a germination experiment with Uvillo is being conducted by the PRCT in their greenhouse at Río Piedras, which is expected to improve our knowledge on the propagation of this species (USFWS, 2014). Despite the lack of available information about the natural populations of Chupacallos, this species was successfully propagated by Dr. Eugenio Santiago (professor at UPRRP). The material produced in this effort has been used to establish a new experimental population of Chupacallos in an area adjacent to the aviary of the Puerto Rican parrot at El Yunque National Forest. However, more information on the reproductive biology and ecology of this species is needed in order to establish what constitute a viable population. Thus, further research and monitoring of planted individuals of Chupacallos is needed (USFWS, 2014).
- Refined recovery action for 2019: Monitoring should be conducted on both species' phenology and reproductive biology to address other limiting factors affecting these species (e.g., natural recruitment, lack of pollinators or seed dispersers). This recovery action should be coordinated with Puerto Rico Department of Natural and Environmental Resources and United States Forest Service and be included within Task 121,212,323, 324: Monitor all known populations, Assess periodicity of flower production and pollination activity, Assess seed viability and Evaluate seedling establishment and growth of the approved recovery plan. (USFWS, 2019).

Conservation Measures and Best Management Practices:

- 1. Studies should be conducted on both species' phenology and reproductive biology to address other limiting factors affecting these species (e.g., lack of pollinators or seed dispersers) (USFWS, 2014).
- 2. All known populations should be marked and monitored on a regular basis, and additional visits should be made after hurricanes or other major disturbances to determine any possible adverse effects on the populations (USFWS, 2014).
- 3. The previous ex situ conservation efforts (individuals reintroduced to the wild) should be monitored and further similar efforts should be undertaken to enhance the status of both species (USFWS, 2014).
- 4. The USFS and USFWS should develop a comprehensive survey program to inventory areas with potential habitat. This program should include training to field biologists of both agencies so these personnel is able to recognize listed species on the field (USFWS, 2014).
- 5. The populations that are actively producing seeds need to be identified and monitored to collect seed material for recovery purposes. A protocol to collect seed material should be developed and implemented to avoid altering the natural recruitment of the species. Enhancement of natural populations should be considered particularly for Chupacallos. The development of adequate propagation techniques is essential for the recovery of these species (USFWS, 2014).

- 6. The recovery plan should be revised to establish measurable down listing and delisting criteria, including how many individuals constitute a self-sustainable population and how many populations would be needed to delist these species (USFWS, 2014),
- 7. Studies should be conducted to determine the patterns of genetic variation within and among populations in order to develop a plan to preserve the species genetic variability (USFWS, 2014).

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5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Southeast Region, Caribbean Ecological Services Field Office, Boquerón, Puerto Rico

SPECIES ACCOUNT: *Pogogyne abramsii* (San Diego mesa-mint)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An aromatic annual herb, 1-3 dm tall, covered dense, curved hairs. Flowers (April-June) are lavender, 11-14 mm long. (NatureServe, 2015)

Taxonomy

There has been some debate whether *Pogogyne abramsii* is taxonomically distinct from *Pogogyne nudiuscula*. Abrams (1951) recognized this species but considered it possibly not distinct from *Pogogyne nudiuscula*. Current work (Jokerst 1993; McMillan unpublished data 1995) supports taxonomic distinction. Not only do the two species differ in the calyx pubescence (hairiness) and bract morphology, but also in the number of flowers per stem node. All of the current *Pogogyne* populations north of Mission Valley and south of Del Mar Mesa are still considered to be *Pogogyne abramsii*. The populations from the central (San Diego) mesas were probably *Pogogyne abramsii*, but with such limited herbaria records, this question will probably never be fully resolved (USFWS, 1998).

Historical Range

Historically, outside of *Pogogyne abramsii*'s current range, it is thought to have occurred around Linda Vista, the vicinity of Balboa Park, Normal Heights, and the area surrounding San Diego State University (USFWS 1998a, p. 12; Zedler et al. 1979), however some confusion has existed regarding *P. abramsii*'s historical range due to misidentified herbarium specimens (identified as *Pogogyne nudiuscula*) and vague references regarding collection sites. (USFWS, 2010)

Current Range

California endemic. San Diego Co., mesas from San Diego to Miramar. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (NatureServe, 2015)

Breeding Season

Adult: May and June (USFWS, 2010)

Reproduction Narrative

Adult: The family is primarily bee pollinated (Proctor & Yeo, 1973, p. 219).; (NatureServe, 2015). *Pogogyne abramsii* usually blooms in May and June when water is absent from the vernal pool (Munz 1974, p. 531). The plants produce fruit, dry out, and senesce in the hot, dry summer

months. Pollination of *P. abramsii* was described by Schiller et al. (2000, p. 392) by monitoring insect visitors to individual plants on Del Mar Mesa. They found the Eurasian honey bee (*Apis mellifera*) and two anthophorid bees (*Exomalopsis nitens* and *E. torticornis*) to be the most common and likely pollinators of *P. abramsii*. They also documented that *P. abramsii* is self-fertile but has greater seed set when cross-pollinated (Schiller et al. 2000, p. 393) (USFWS, 2010).

Habitat Type

Adult: Vernal pool (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits vernal pools on coastal terraces (mesas) at 100-200 m elevation. (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species and the low number of known populations

Dispersal/Migration**Dispersal**

Adult: Moderate (USFWS, 2010)

Dispersal/Migration Narrative

Adult: Zedler and Black (1992, p. 4) found that *Pogogyne abramsii* seeds germinated and grew from pellets of brush rabbits and Audubon's cottontail rabbits (*Sylvilagus bachmani* and *S. auduboni*), which were collected from vernal pools on Del Mar Mesa and Miramar Mesa. They postulated that rabbit movement may be a potential mechanism for dispersal and genetic mixing of vernal pool obligate species. In addition *P. abramsii* seeds float, which may result in limited dispersal opportunities when pools interconnect or lakes fill their basins in years of greater than average precipitation (Scheidlinger 1981, p. 54) (USFWS, 2010).

Population Information and Trends**Population Trends:**

Decreasing (USFWS, 2010)

Resiliency:

Low (inferred from NatureServe, 2015 and USFWS, 2010)

Representation:

Low (inferred from NatureServe, 2015 and USFWS, 2010)

Redundancy:

Low (inferred from NatureServe, 2015 and USFWS, 2010)

Number of Populations:

21 - 80 (NatureServe, 2015).

Population Narrative:

About 36 populations believed extant (NatureServe, 2015). USFWS (2010) indicates that the species population levels are decreasing. Low resiliency, representation and redundancy are inferred based on the low number of known populations and decreasing population trends.

Threats and Stressors

Stressor: Road widening (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Since listing, road projects have continued to impact *Pogogyne abramsii* occurrences. Though future work on Highway 163, Highway 52, Interstate 15, or Miramar Road could impact *P. abramsii* habitat, we don't currently consider road widening projects a direct threat. Camino Del Sur is being extended through vernal pool habitat in Del Mar Mesa (EO 38, H18-23) and while no direct impacts from the road are expected to impact *P. abramsii*, indirect impacts such as edge effects are possible (S. Wynn, 2010, pers. obs.). Edge effects to *P. abramsii* are evident as a result of road widening projects, creating outer bands of habitat distant from the center but immediately proximal to a different type of habitat, thus providing a different species composition and abundance divergent from the interior of the habitat (Forman and Gordon 1986, p. 108). These edges may allow *P. abramsii* to be in closer proximity to disturbed areas, which may facilitate the incursion of invasive, nonnative plants. Edge effects degrade extant interior habitat and create an island of the protected habitat/reserve through isolation and decrease the effective size and serviceability of a conservation area (Diamond and May 1976, pp. 228–252). Characteristics of habitat islands include less resistant habitat, more disturbed habitat, areas more susceptible to invasive species, areas with native species less resistant to disturbance, and higher seed immigration (Meyers and Bazely 2003, pp. 34-50). Further development of the roads mentioned above and surrounding areas would exacerbate these impacts (USFWS, 2010).

Stressor: Urban Development (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Since listing, many *Pogogyne abramsii* occurrences impacted by approved development have been restored, partially restored (may include reshaping the basin, transplantation of inoculum containing *P. abramsii* seeds), or pools have been created to mitigate unavoidable losses (Appendix 1). These mitigation efforts are designed to help offset impacts from development of vernal pool habitat and are required under the MSCP; however, the long-term viability of such efforts remains unclear (Black and Zedler 1998). While restructured and inoculated pools (which represents the most intensive of restoration treatments) present a much more "natural" appearance than disturbed pools, the degree to which these pools resembles the

original pools is unknown (Black and Zedler 1998, p. 197). Black and Zedler (1998, p. 205) also state that “there is no assurance of success, and restored pools, unless restored from only minor disturbance, do not have the same historic and scientific interest as undisturbed pools.” Successful restoration must include long-term maintenance and monitoring to ensure that the *P. abramsii* and other vernal pool species persist. Development continues to threaten *Pogogyne abramsii*, and will not, in the foreseeable future, be reduced as a threat until sufficient private land supporting vernal pools has been conserved or purchased for reserves (USFWS, 2010).

Stressor: Off-Highway Vehicles (OHVs) (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: OHV use remains a threat to at least eight EOs including (11 vernal pool complexes), and is a predominant threat on Del Mar Mesa (Appendix 1). Installation and maintenance of fencing and signage are needed to help protect *P. abramsii* habitat from the impact of OHV users (USFWS, 2010).

Stressor: Military Activities (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of individuals/loss of habitat

Narrative: Provisions under the Integrated Natural Resources Management Plan (INRMP) guide conservation and management of *Pogogyne abramsii* habitat on MCAS Miramar (see Factor D for further discussion). The military must maintain the flexibility to adapt the defense mission to political and technological developments (Department of Defense Instruction 4715.3 para. F.1. i(4)). For this reason, vernal pool sites on military lands are not considered fully protected, though threats to *P. abramsii* habitat are ameliorated under the INRMP. As of July 2010, no training activities or military maneuvers are planned that are expected to negatively impact *P. abramsii* in the near future (Kassebaum pers. comm. 2010); however military activities are considered a potential threat to all extant occurrences found on MCAS Miramar in the event that unforeseen circumstances necessitate changes in vernal pool management (USFWS, 2010).

Stressor: Alteration of Hydrology (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Although altered hydrology continues to impact this species at six EOs (six vernal pool complexes), the Service has been successful in ensuring implementation of measures to reduce this threat through section 7 consultations. For example, the use of best management practices reduces the amount of runoff entering vernal pool watersheds, and restoration projects are designed to minimize water draining off impervious surfaces into vernal pool watersheds. However, the specific impact runoff has on *Pogogyne abramsii* is unknown because site specific monitoring has not been conducted. Preserved pools should be monitored for these runoff impacts to identify remediation where feasible and prevent further damage to vernal pool systems (USFWS, 2010).

Stressor: Illegal Dumping (USFWS, 2010)

Exposure:

Response:**Consequence:** Loss of habitat

Narrative: Illegal dumping was identified as a threat at listing and continues to impact *Pogogyne abramsii* habitat at Carroll Canyon (EO 27), Del Mar Mesa - Deer Canyon (EO 38, 41; H 17), and Rose Canyon (EO 1) (Appendix 1). Additionally, pool complexes in Murphy Canyon (EO 3) have served as dump sites for domestic refuse in the past (Black and Zedler 1998, p. 203). Trash and other materials can decrease the amount of space available to vernal pool species, disturb the soils, and release toxic substances and pollutants which may make vernal pools inhospitable to *P. abramsii*. Fencing and monitoring may decrease the impact of this threat on protected lands, however illegal dumping and deterrence on private lands are difficult to control making this a continuing threat to *P. abramsii* (USFWS, 2010).

Stressor: Nonnative Plants (USFWS, 2010)**Exposure:****Response:****Consequence:** Loss of habitat

Narrative: Development and other threats that disturb vernal pool habitat allow certain invasive nonnative plants, such as those discussed above, to invade and replace *Pogogyne abramsii*. Invasive nonnatives pose the biggest threat to *P. abramsii* and other vernal pool obligates on MCAS Miramar (Kassebaum pers. comm. 2010), specifically, invasive grasses and bromes (e.g. *Agrostis* spp. and *Bromus* spp.) which outcompete *P. abramsii* at the drier edges of vernal pools. Therefore, we consider invasive nonnative plants to be a continuing threat to *P. abramsii* (USFWS, 2011).

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2010)**Exposure:****Response:****Consequence:** Loss of habitat

Narrative: In summary, the Act provides the greatest regulatory protection to *Pogogyne abramsii*. Habitat conservation plans, and the related conservation actions arising from the Act have contributed to short and long term conservation of *P. abramsii*. The INRMP at MCAS Miramar has created policy mechanisms and partnerships that have restored and conserved vernal pool habitat. Additional potential protection provided by other Federal, State, and local laws and ordinances is discretionary, incomplete, subject to funding availability and changing missions, and largely dependent on the federally listed status of *P. abramsii*. As a result, regulatory mechanisms provided by other Federal, State, and local laws and ordinances do not independently or collectively provide adequate regulatory protection to *P. abramsii* (USFWS, 2010).

Stressor: Human Access and Disturbance (USFWS, 2010)**Exposure:****Response:****Consequence:** Loss of individuals

Narrative: Separation of *Pogogyne abramsii* occurrences through habitat loss and fragmentation is often accompanied by effects associated with human access or disturbance associated with adjacent development. These include trampling, OHV-activity, pedestrian introduction of nonnatives, and trash dumping. This can directly impact *P. abramsii* by crushing, shading, or releasing toxic substances that harm individual plants. Human access and disturbance has been

identified as a threat to seven EOs containing nine vernal pool complexes. Trampling by pedestrians and OHVs may damage or kill plants. Pool complex C28 (EO 36) on Mira Mesa was extirpated partly as a result of human access and disturbance, more specifically OHV damage and trampling (City of San Diego 2004). Pool complex H 39 (Greystone Highlands, EO 41) on Del Mar Mesa is vulnerable to human trampling from adults and children trespassing from the nearby residential development (City of San Diego, 2006, p. 34). Protective fencing is used in many conserved occurrence areas to protect vernal pool complexes (Appendix 1). Though implementing this protective measure has lessened the impacts of human access and disturbance, such effects still threaten *Pogogyne abramsii*. Occurrences on private, non-conserved lands remain vulnerable to this threat (USFWS, 2010).

Stressor: Drought and Climate Change (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to particular species (including *Pogogyne abramsii*) or sites at this time. Although we cannot predict the exact effects of climate change on *P. abramsii*, it is likely that it will exacerbate identified threats and may introduce new additional threats. A changing climate with spatial and temporal shifting of temperature and precipitation may cause this species specific adaptations to climate to work against its survival. A changing climate may also provide advantages to other native and nonnative plant species. Sharing information between scientists, land managers, and decision makers will increase our ability to address these threats. Increasing the success with which we address current threats to *P. abramsii* will increase our success of handling the uncertain effects of future climate change (USFWS, 2010).

Stressor: Small Population Size (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of genetic variability/extinction

Narrative: The restricted range and small population of *Pogogyne abramsii* pose a threat as it increases the possibility that urban development or other activities near remnant pool ecosystems could destroy a significant portion of the species' remaining population and habitat (USFWS 1993, p. 41390). *Pogogyne abramsii* is distributed on approximately 19.2 ac (7.8 ha) of vernal pool habitat on MCAS Miramar, and approximately 0.8 ac (0.3 ha) outside the boundary of MCAS Miramar (U.S Marine Corp 2006, p. 5-4; City of San Diego 2004, p. 11). Stochastic events outside the natural range of frequency and severity, such as floods, fires, contamination, or drought, can substantially reduce or eliminate species, such as *P. abramsii* with a restricted range and small population, and increase the likelihood of extinction (Lande 1993, p. 912). Genetic effects may further influence population demography via inbreeding depression and genetic drift (Barrett and Kohn 1991, pp. 3-30; Menges 1991, pp. 58 – 61). Allee (1931, pp. 17- 50) suggested small, single populations are vulnerable to extirpation when opportunities for reproduction diminish because of reduced opportunity of individuals to reproduce (Allee effect or depensation) (Courchamp et al. 2008, pp. vi – 216). Stephens et al. (1999, pp. 185 -190), Dennis (2002, pp. 389 - 401) and Courchamp et al. (2008, pp. vi – 216) suggest that the Allee effect is a density-dependent event that is inversely related to population size. The isolated vernal pool complex on Los Pensamientos Canyon (EO 54, complex B5-8) and on Mira Mesa (EO 36, complex

B11) are all that remain in both of these areas making *P. abramsii* susceptible to random events here (USFWS, 2010).

Stressor: Fire control (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Fire control has been identified as a potential threat to *Pogogyne abramsii* at two of the 28 extant EOs (four vernal pool complexes) listed in Appendix 1. The ecological effects of fire exclusion in the habitat of southern California has not been specifically detailed for vernal pool habitat, however the processes and structure of fire ecology is comparable to other ecosystems (Keane et al. 2002, pp. 3–11; D’Antonio and Vitousek 1992, pp. 63 - 87). Fire exclusion may affect the natural regulation of succession via selecting and regenerating plants. Species that are adapted to light fire (such as *P. abramsii* during the dry season) are replaced by species that are able to out compete for growing resources in the absence of fire (Keane et al. 2002, pp. 3 - 11). While complete fire exclusion may result in *Pogogyne abramsii* being outcompeted for space, the alternative may pose an equal threat as fires at critical times can eliminate populations of *P. abramsii* by killing individual plants, overheating soil to create hydrophobic conditions, or intense heat which kills or eliminates the seed bank (Agee 1993, pp. 1–493; Keane et al. 2002, pp. 3–11; Keeley 2001, pp. 81–94; Arno and Fiedler 2005, pp. 7–38). The severity of fires may be exacerbated by a greater fuel load provided by nonnatives (Bauder 1996, p. 3), and a higher density of established native upland species that have not been disturbed by fires in the past (MALGBC 2007, p. 7). Fire suppression has been identified as a threat at Del Mar Mesa which could act as a staging ground for fire control activities if a fire began (City of San Diego 2006, pp. 37, 42). Currently a burn study is being conducted on MCAS Miramar to determine how fire impacts vernal pool species. Initial observations show that there is no difference between species composition between burned and unburned vernal pools (Kassebaum pers. comm. 2010) (USFWS, 2010).

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Recovery

Reclassification Criteria:

“Existing vernal pools and their associated watersheds...should be secured from further loss and degradation. Habitat functions and species viability... must be ensured... Maintaining habitat function and species viability (as determined by prescribed research tasks)” (USFWS, 2010)

The existing vernal pools and their associated watersheds contained within the complexes...are secured in a configuration that maintains habitat function and species viability (as determined by recommended research); (USFWS, 2010)

Secured vernal pools are enhanced or restored such that population levels of existing species are stabilized or increased; (USFWS, 2010)

Population trends must be shown to be stable or increasing for a minimum of 10 consecutive years prior to consideration for reclassification. Monitoring should continue for a period of at least 10 years following reclassification to ensure population stability” (USFWS 1998a, p. iv-vi). (USFWS, 2010)

Recovery Actions:

- “Conduct surveys and research essential to the conservation of these species; (USFWS, 2010)
- Secure the existing vernal pools and their associated watersheds; (USFWS, 2010)
- Where necessary reestablish vernal pool habitat to the historical structure; (USFWS, 2010)
- Manage and monitor habitat and listed species”(USFWS 1998a, p. vi). (USFWS, 2010)

Conservation Measures and Best Management Practices:

- Support continued conservation, management and monitoring of *Pogogyne abramsii* habitat to include acquisition of occupied sites (USFWS, 2010)
- Develop a coordinated interagency invasive species prevention and eradication program for all vernal pool habitat where *Pogogyne abramsii* is extant (USFWS, 2010).
- Identify the conditions and areas necessary to support all of the necessary biotic interactions (e.g. pollination, seed dispersal, population movement) for *Pogogyne abramsii* (USFWS, 2010).
- Monitor restored/enhanced habitat to determine their suitability and impact in furtherance of recovery of *Pogogyne abramsii* (USFWS, 2010).

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SPECIES ACCOUNT: *Pogogyne nudiuscula* (Otay mesa-mint)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A small aromatic annual to 3 dm tall. Leaves are dark green, opposite, ovate to oblong and hairless. There are both axillary flowers and flowers at the top of the plant. The flowers are two-lipped, lavender and 11-14mm long. The fruit consists of small nutlets. Blooming is May-July. (NatureServe, 2015)

Taxonomy

Pogogyne nudiuscula is an annual herb in the mint family (Lamiaceae). As was mentioned in the description for *Pogogyne abramsii*, Howell (1931) considered all *Pogogyne* populations on Otay Mesa to be *Pogogyne nudiuscula*. Many of the older herbarium specimens that might be from the central mesas are labeled as *Pogogyne nudiuscula*, but are likely *Pogogyne abramsii*. Howell considered *Pogogyne nudiuscula* to be diagnosable from *Pogogyne abramsii* by having a glabrous (smooth) calyx and bract with a different morphology. This distinction is supported by current work (Jokerst 1993; McMillan unpublished data 1995), and the species is also diagnosable by usually having at least six flowers per node on the stem (USFWS, 1998).

Historical Range

Historically *P. nudiuscula* was found beyond Otay Mesa and occurred at 10 locations in southern San Diego County (Appendix 1). Herbarium records indicate that *P. nudiuscula* historically occurred further north near University Heights, Balboa Park, and Mission Valley (CNDDDB 2010, Element Occurrence (EOs) 4, 9, and 10, respectively). Also, *P. nudiuscula* occurred in Mexico at the eastern edge of the city of Tijuana; however, it was believed to be extirpated from its Mexican locations prior to listing (Bauder and McMillan 1998, p. 65; USFWS 1993, p. 41385). Currently, *P. nudiuscula* is found at three locations on Otay Mesa: Otay Mesa West, Otay Mesa East, and Otay Mesa Northeast (Appendix 1). (USFWS, 2010)

Current Range

San Diego County, California; adjacent Baja California, Mexico. The range extent covers approximately 370 sq mi. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (NatureServe, 2015)

Reproduction Narrative

Adult: The family is primarily bee pollinated (Proctor & Yeo, 1973, p. 219).; (NatureServe, 2015). There is little documented information regarding pollination and seed dispersal mechanisms of *P. nudiusscula*. Observations in the field suggest that native syrphid flies (Syrphidae) and bee flies (Bombyliidae) are the most common pollinators (S. McMillan, EDAW pers. comm. 2010). Eurasian honeybees (Apidae) have also been seen pollinating *P. nudiusscula* (McMillan, pers. comm. 2010). Research on the similar species *Pogogyne abramsii* show that it is self-fertile but has greater seed set when cross-pollinated (Schiller et al. 2000, p. 393); further research is necessary to determine if this is the case for *P. nudiusscula* (USFWS, 2010).

Habitat Type

Adult: Vernal pools (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist

Habitat Narrative

Adult: Vernal pools (Smith & Berg, 1988). Moist flats in chaparral and coastal sage scrub (Munz, 1959). (NatureServe, 2015)

Dispersal/Migration**Dispersal**

Adult: Moderate (USFWS, 2010)

Dispersal/Migration Narrative

Adult: Zedler and Black (1992, p. 4) found that *Pogogyne abramsii* seeds germinated and grew from pellets of brush rabbits (*Sylvilagus bachmani*) and Audubon's cottontail rabbits (*S. auduboni*) that were collected from vernal pools on Del Mar Mesa and Miramar Mesa. Zedler and Black (1992, p. 2) postulated that rabbit movement may be a potential vector for seed dispersal and genetic mixing of vernal pool obligate species including *P. abramsii*. They concluded that rabbit dispersal explains the "anomalous occurrence of vernal pool plants in newly excavated artificial pools (1992, p. 8)." Additionally, *P. abramsii* seeds float, which may result in limited dispersal opportunities when pools interconnect or lakes fill their basins in years of greater than average precipitation (Scheidlinger 1981, p. 54). It is possible that these dispersal mechanisms also apply to *P. nudiusscula*; however, data do not exist to support this assumption (USFWS, 2010).

Population Information and Trends**Population Trends:**

Decreasing (NatureServe, 2015)

Resiliency:

Low (NatureServe, 2015)

Representation:

Low (NatureServe, 2015)

Redundancy:

Low (NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1000 - 2500 individuals (NatureServe, 2015)

Population Narrative:

This wetland annual endemic is highly vulnerable. The long term trend is one of very rapid decline. Decline of >90% Population numbers for this annual are mostly unknown. CNDDDB records only record a total of 1700 plants from all currently known vernal pools. This is likely wildly off from reality. Of 9 EOs, at least five may be extirpated, and all but a few are severely threatened. (NatureServe, 2015)

Threats and Stressors

Stressor: Urban development (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Planned and ongoing development projects throughout *Pogogyne nudiuscula*'s range were described as a primary threat in the listing rule (USFWS 1993, p. 41387). Urban development may result in: (1) the loss or damage of vernal pools by filling, grading, discing, leveling, and other activities; and (2) destruction of watersheds and the hydrology that support vernal pools; (3) isolation of vernal pools; (4) fragmentation of vernal pool systems. Destruction of watersheds and disruption of hydrological systems can create further impacts by creating barriers to dispersal, such that pollination and reproductive output may be inhibited (Schiller et al. 2000, p. 395). Potential means of seed dispersal (e.g., rabbits, floating seeds) (Zedler and Black 1992, p. 2) may also be impacted. Whenever development impacts vernal pools in a complex, some degree of fragmentation occurs within and among complexes. Because *P. nudiuscula* has specific habitat requirements (e.g., soil type, water depth), habitat degradation and alteration likely result in population decline (USFWS, 2010).

Stressor: Road projects (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Road projects are a type of development that pose a threat to *Pogogyne nudiuscula* habitat at Otay Mesa West, Otay Mesa South, and Otay Mesa Northeast (Appendix 1). First, the listing rule identified State Route 125 construction on Otay Mesa as a project that could impact *P. nudiuscula* habitat. This project was completed and directly impacted vernal pool basins on the Otay Mesa Northeast occurrence (i.e., J29–30); however, vernal pools containing *P. nudiuscula* were avoided in one pool and seeds were collected and used to reestablish populations within their mitigation site which encompass J29–30 (Wynn, pers. obs. 2010). Second, the construction associated with Interstate 905 and Otay Mesa Road (J14) did not directly impact *P. nudiuscula*; however, indirect impacts in the future in the form of edge effects (see below) are possible.

Third, State Route 11 (associated with a new U.S./Mexico border crossing) is planned southeast of State Route 125 on Otay Mesa. Though habitat is present, *P. nudiusscula* was not detected and Caltrans anticipates future potential edge effects to vernal pools if they are discovered in the area (USDOT and Caltrans 2008, p. 3.20-11–3.20-15). Edge effects to *Pogogyne nudiusscula* are evident as a result of road widening projects, creating outer bands of habitat distant from the center but immediately proximal to a different type of habitat, thus providing a different species composition and abundance divergent from the interior of the habitat (Forman and Gordon 1986, p. 108). These edges may allow *P. nudiusscula* to be in closer proximity to disturbed areas, which may facilitate the incursion of invasive, nonnative plants that can outcompete *P. nudiusscula* for space (see also Factor E discussion). Edge effects degrade extant interior habitat and create an island of the protected habitat/reserve through isolation and decrease the effective size and serviceability of a conservation area (Diamond and May 1976, pp. 228–252). Characteristics of habitat islands include less resistant habitat, more disturbed habitat, areas more susceptible to invasive species, areas with native species less resistant to disturbance, and higher seed immigration (Meyers and Bazely 2003, pp. 34-50). Further development of the roads mentioned above and surrounding areas would exacerbate these impacts (USFWS, 2010).

Stressor: Alteration of watershed (Hydrology) (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Although altered hydrology continues to be a threat to the species, the Service has been successful in ensuring implementation of measures to reduce this threat through section 7 consultations. For example, best management practices reduce the amount of runoff entering vernal pool watersheds, and restoration projects are designed to minimize water draining off impervious surfaces into vernal pool watersheds. However, the specific impact runoff has on *Pogogyne nudiusscula* is unknown because site specific monitoring has not been conducted. Preserved pools should be monitored for these runoff impacts to identify remediation where feasible and prevent further damage to vernal pool systems (USFWS, 2010).

Stressor: Compaction of erosion of soil (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Recent studies suggest that trampling associated with limited livestock grazing in the watershed may benefit some vernal pool species by increasing the inundation period of the pools through reduction of vegetation (particularly nonnative grass) in the watershed and compaction of the soil, which reduces infiltration (Marty 2005, p. 1630). Grazing may also increase the duration of vernal pool inundation by altering soil properties and modifying the rate of evapotranspiration from plants, thus counteracting the potential decrease in precipitation brought about by climate change to some degree (Pyke and Marty 2005, p. 1623). However, it is unknown if *Pogogyne nudiusscula* or vernal pool habitat in San Diego County benefit from low levels of trampling (USFWS, 2010)

Stressor: Off-Highway Vehicles (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Since listing, OHV continues to threaten *Pogogyne nudiuscula*, especially from recreational and Border Patrol activities (see Appendix 1). Installation and maintenance of fencing and signage are needed to help protect *P. nudiuscula* habitat from these impacts (USFWS, 2010).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Since listing in 1993, the Act is the primary law that provides protection for *Pogogyne nudiuscula* on Federal lands or in instances where there is a Federal nexus. Nearly all occurrences of *P. nudiuscula* are conserved under the San Diego's MSCP; however, coverage for this species and six other vernal pool species was removed from the City of San Diego Subarea Plan in April 2010. The Service accepted the City's relinquishment of coverage for vernal pool species; thus, *P. nudiuscula* is no longer a covered species under the subarea plan. However, the City of San Diego is currently working with the Service to revise and improve the management plan for *P. nudiuscula* under the MSCP. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act. However, once a revised subarea plan is completed that provides coverage for *P. nudiuscula*, the Act will likely provide the most effective protection for the species (USFWS, 2010).

Stressor: Competition with invasive, nonnative plants (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Depending upon conditions, certain invasive, nonnative plants (such as the grasses discussed above) may replace *Pogogyne nudiuscula*. Therefore, we consider invasive, nonnative plants to be a continuing rangewide threat to all extant occurrences of *P. nudiuscula* (USFWS, 2010).

Stressor: Human access and disturbance effects (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Protective fencing is used in several conserved areas to protect vernal pool complexes and has been successful in significantly decreasing the impact of trampling and OHV use in the J29–30 vernal pool complex at Otay Mesa Northeast and J2 N/W/S vernal pool complex at Otay Mesa West (City of San Diego 1997, p. 299, 316). Though implementing this protective measure has lessened the impacts of human access and disturbance, such effects still threaten *Pogogyne nudiuscula* occurrences. The J32 complex in the Otay Mesa West occurrence may be the most severely impacted by trampling due to foot traffic by immigrants, transients, Border Patrol, and OHV use (City of San Diego 1997, p. 236). Fencing was installed and stolen (City of San Diego 1997, p. 236) indicating that monitoring is critical in reducing the impacts of human access and disturbance (USFWS, 2010).

Stressor: Fire and fire suppression activity (USFWS, 2010)

Exposure:

Response:**Consequence:** Loss of habitat

Narrative: Fire and fire suppression have been identified as a current potential threat at three of the four occurrences (vernal pool complexes J2, J2 N/W/S, J28, J14, and J29–30), with the exception of the Otay Mesa East occurrence. These areas may serve as a staging area in the event of a fire if defensible structures are developed in the vicinity (City of San Diego 1997) (USFWS, 2011).

Stressor: Drought and climate change (USFWS, 2010)**Exposure:****Response:****Consequence:** Loss of habitat

Narrative: While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to particular species, including *Pogogyne nudiuscula* or sites at this time. However, it is likely that impacts from existing threats could increase and new threats may arise. Sharing information between scientists, land managers, and decision makers will increase our ability to address and manage these threats (USFWS, 2010).

Stressor: Small population size (USFWS, 2010)**Exposure:****Response:****Consequence:** Lack of genetic variability/extinction

Narrative: Since listing, *Pogogyne nudiuscula*'s range has decreased and there have been no new occurrences of the species. Therefore, restricted range and small population size continue to threaten *P. nudiuscula* at all of its occurrences (USFWS, 2010).

Recovery**Delisting Criteria:**

All the existing vernal pools and their watersheds identified in Appendix F and G of the Recovery Plan should be secured from further loss and degradation in a configuration that maintains habitat function and viability (as determined by prescribed research tasks) (USFWS, 2010).

Secured vernal pools must be enhanced or restored such that population levels of existing species are stabilized or increased (USFWS, 2010).

Population trends must be shown to be stable or increasing for a minimum of 10 consecutive years prior to consideration for reclassification (USFWS, 2010).

Recovery Actions:

- This recovery criterion does not explicitly address any of the threat factors identified in the five factor analysis in the listing rule or in the above discussion. Moreover, achievement of this criterion as written is complicated by the fact that some pool basins within the complexes identified in Appendices F and G have been developed or preserved in accordance with provisions of regional HCPs since the completion of the Recovery Plan. However, working toward the goals in this criterion will reduce the threats discussed above under Factors A and E. Securing vernal pool complexes physically, legally, and ecologically

would reduce threats posed by development (e.g., habitat loss and alterations of hydrology) and discussed under Factor A and E above. As discussed in Factor A, all of the extant occurrences of *Pogogyne nudiuscula*, are partially or completely conserved and those that are only partial conserved have been mitigated in another area of suitable habitat (Appendix 1). These protections generally extend to direct loss and not necessarily indirect loss of habitat through degradation. These lands are under conservation easements or protected in perpetuity, conserved through mitigation, or have some sort of protection from development (Appendix 1). Pools within these areas meet the criterion in the Recovery Plan as “secured legally” from further habitat loss. In the Recovery Plan, Appendix F lists the vernal pool occurrences that are necessary to stabilize the proposed and listed vernal pool species (USFWS 1998, p. F1). Appendix G of the Recovery Plan lists vernal pool occurrences identified as necessary to secure in order to reclassify the proposed and listed vernal pool species (USFWS 1998, p. G1). Appendix G broadly lists complex J (undescribed) and J–3 and J–22. *Pogogyne nudiuscula* is found throughout the J complex and portions of this complex have been conserved partially or fully and other areas have been extirpated and mitigated. Although some of these occurrences are considered secure from development, they are not all guaranteed monitoring or maintenance in perpetuity. Although it is not possible to specifically identify every complex in Appendices F and G of the Recovery Plan, development and impacts on complexes listed in Appendices F and G that contain *P. nudiuscula* should be avoided. Additionally, the Service is working towards conserving these complexes (USFWS, 2010).

- This criterion does not directly address any of the threats discussed above in the five-factor analysis. Rather, it uses a measure of stability that is not easily assessed for *Pogogyne nudiuscula*. As discussed in the abundance section of this 5-year review, the population numbers for *P. nudiuscula* are not easily measured. Because methods of measurement are not standardized and *P. nudiuscula* does not germinate every year, population abundance is not a good indicator for the species. However, restoration and management do provide a measure of protection against threats to the species. Additionally, the CFWO issues biological opinions associated with consultations under section 7 of the Act for *Pogogyne nudiuscula*. These opinions detail avoidance and minimization measures to prevent jeopardizing the species’ continued existence and can include restoration of *P. nudiuscula* habitat. Many of these opinions lead to successful restoration and protected populations of *P. nudiuscula*. Some pools are being restored and therefore meet the outlined goals of Criterion 3 in the Recovery Plan (USFWS, 2010).
- This criterion does not directly address any threats outlined in the five-factor analysis. In order to stabilize or increase the population, threats would have to be reduced. Reducing the threats discussed above in Factors A and E would help us provide the conditions needed to work toward the goal in this criterion, but vernal pool habitat has been reduced by human-induced conversion (Bauder and McMillan 1998, p. 66). As yet, however, it is difficult to assess the abundance of *Pogogyne nudiuscula* in the absence of standardized sampling methods and population trends for vernal pool annuals are often difficult to detect. Therefore, we are unable to address this criterion (USFWS, 2010).

Conservation Measures and Best Management Practices:

- Support continued conservation, management, and monitoring of vernal pool habitat that supports *Pogogyne nudiuscula*, including monitoring of restored/enhanced habitat to determine if vernal pool restoration projects continue to be viable through time (e.g., artificial clay layer remains stable and supports adequate ponding) (USFWS, 2010).

- Work with the Otay Mesa Water District to address inundation of pools in J26 from the Otay Mesa water pump. Implement measures to ensure that water does not flow over the road and into the pools (USFWS, 2010).
- Conduct research to determine life history traits most vulnerable to threats discussed in the five factor analysis (USFWS, 2010).
- Develop a dynamic, threats based, species-specific recovery plan based on analysis of current knowledge of the species (USFWS, 2010).
- Establish a seed bank for *Pogogyne nudiuscula* according to Center for Plant Conservation guidelines (USFWS, 2010).

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SPECIES ACCOUNT: *Polygala lewtonii* (Lewton's polygala)

Species Taxonomic and Listing Information

Listing Status: Endangered; 5/27/1993; Southeast Region (R4) (USFWS, 2015)

Physical Description

Polygala lewtonii is a relatively short-lived (5 to 10 year) perennial herb. Each plant produces one to several annual stems, which are spreading, upward-curving or erect, and are often branched. The leaves are small, sessile, rather succulent, broader toward the tip, and are borne upright, tending to overlap along the stem, like shingles. The normally opening flowers are in erect, loosely flowered racemes about 1.5 cm (Wunderlin et al. 1981) or 3.3 cm (Weekley 1996) long. The flowers are about 0.5 cm long and bright pink (Wunderlin et al. 1981) or purplish-red (Ward and Godfrey 1979). Two of the five sepals are enlarged and wing-like, between which the largest of the three petals forms a keel that ends in a tuft of finger-like projections (Ward and Godfrey 1979). The plant also produces two types of small, cleistogamous (non-sexual) flowers (L. Miller, Ocala NF, personal communication 1996, Weekley 1996). This species is closely related to the widespread *P. polygama*, which forms larger clumps and has a longer root, narrower leaves, and differently shaped wing sepals. It also has short branches that hug the ground, bearing inconspicuous self-pollinating flowers. (USFWS, 1999)

Taxonomy

This small herb was first collected near Frostproof, Florida by F. L. Lewton in 1894, and was named by J.K. Small (1898). The status of *P. lewtonii* as a distinct species was affirmed by Blake (1924) and James (1957). There have been no other taxonomic treatments of this species. (USFWS, 1999)

Historical Range

See current range.

Current Range

Lewton's polygala occurs in sandhill (high pine) vegetation and Florida scrub of the Lake Wales and Mount Dora ridges in Highlands, Polk, Osceola, Orange, Lake, and Marion Counties of central Florida. (USFWS, 1999)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollination/self-fertilization

Lifespan

Adult: relatively short-lived (5-10 year) (USFWS, 2019)

Other Reproductive Information

Adult: Lewton's polygala is amphicarpic, producing flowers and fruits above and below ground at different times (Menges and Weekley 2002). Lewton's polygala is one of only a few dozen amphicarpic angiosperms known worldwide. Amphicarpy is viewed as an adaptation for reproduction in uncertain habitats, for example, producing seeds underground where they have better chances of surviving fire (Cheplick and Quinn 1982) and are protected from herbivory (Menges and Weekley 2003). While self-fertilization occurs in Lewton's polygala, it appears to be a less-reliable mechanism for seed production than insect pollination. (USFWS, 2019)

Reproduction Narrative

Adult: Confusion has existed about whether *P. lewtonii* has cleistogamous flowers (James 1957, Wunderlin et al. 1981, Ward and Godfrey 1979, FWS 1996). More recently, Weekley (1996) and Miller (Ocala NF, personal communication 1996) confirmed the presence of two types of cleistogamous flowers. The first are solitary flowers in the axils of the lower leaves and the second are few-flowered racemes on underground rhizomes that are usually 5 to 15 cm long (Weekley 1996). *Polygala lewtonii* blooms from February to May with chasmogamous flowers dominating from February to April. Chasmogamous flowers have an average of four to six racemes per plant, though one extreme individual had 30 racemes (Weekley 1996). Each raceme has 20 to 25 flowers 85 to 100 percent of these set fruit. This high percentage of fruit set suggests that flowers self-pollinate when insect pollinators are not present. (USFWS, 1999).

Habitat Type

Adult: high pine and turkey oak barrens and transitional areas (USFWS, 1999)

Habitat Narrative

Adult: *Polygala lewtonii* is not strictly a scrub species and is found in widely scattered populations that frequently occur in transitional habitats between high pine and turkey oak barrens. *P. lewtonii* also occurs in both habitats (Wunderlin et al. 1981, Christman 1988). *P. lewtonii* depends on fire to maintain its habitat. It is found in sunny openings and often colonizes disturbed sites, such as roadsides and fire lanes. *P. lewtonii*'s preference for transitional habitats between high pine and turkey oak barrens suggests a preference for a burn frequency that is less frequent than high pine, but more frequent than turkey oak barrens. (USFWS, 1999)

Dispersal/Migration***Population Information and Trends*****Number of Populations:**

44 known occurrences (USFWS, 2019)

Population Narrative:

The species is known from Marion, Lake, Orange, Osceola, Polk, and Highlands counties on the Lake Wales and Mount Dora ridges. The most recent FNAI Element Tracking Summary (FNAI 2015) reported 44 known occurrences for Lewton's polygala, of which 28 were on 12 managed areas. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat destruction or modification

Exposure:

Response:

Consequence:

Narrative: This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 million persons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

Stressor: Lack of adequate fire management

Exposure:

Response:

Consequence:

Narrative: Fire is necessary to maintain the scrub habitats upon which this species depends. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time (Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species. (USFWS, 2019)

Stressor: Limited geographic range

Exposure:

Response:

Consequence:

Narrative: This species occurs occur within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic

groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

Recovery

Reclassification Criteria:

1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to assure 20 to 90 percent probability of persistence for 100 years (USFWS, 1999)
2. When these sites, within the historic range of *P. lewtonii*, are adequately protected from further habitat loss, degradation, and fragmentation (USFWS, 1999)
3. When these sites are managed to maintain the seral stages of high pine and xeric oak scrub to support *P. lewtonii* (USFWS, 1999)
4. When monitoring programs demonstrate that these sites support the appropriate numbers of self-sustaining populations, and those populations are stable throughout the historic range of the species. (USFWS, 1999)

Delisting Criteria:

1. At least 40 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)
2. Populations (as defined in criterion 1) in yellow sand scrub or sand hill habitats are distributed across the known range of the species. (USFWS, 2019)
3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

Recovery Actions:

- Determine current distribution and status of *P. lewtonii*. This species' distribution is somewhat questionable since individuals are easily overlooked. A thorough survey is needed to determine the distribution for this species. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, has become isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Conduct research on life history characteristics. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species, more specific biological information is needed. (USFWS, 1999)

- Monitor existing populations of *P. lewtonii*. (USFWS, 1999)
- Provide public information about *P. lewtonii*. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Care is needed, though, to avoid revealing specific locality information about *P. lewtonii*. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of *P. lewtonii* and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)

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USFWS. 2019. Amendment 1. Recovery Plan for *Conradina brevifolia* (short-leaved rosemary), *Crotalaria avonensis* (Avon Park harebells), *Dicerandra christmanii* (Garrett's mint), *Dicerandra frutescens* (scrub mint), *Eryngium cuneifolium* (snakeroot), *Hypericum cumulicola* (Highlands scrub hypericum), *Liatris ohlingerae* (scrub blazing star), *Polygala lewtonii* (Lewton's polygala), *Polygonella basiramia* (wireweed), *Polygonella myriophylla* (sandlace), *Warea carteri* (Carter's mustard), and *Ziziphus celata* (Florida ziziphus). U.S. Fish and Wildlife Service, Atlanta, Georgia. 23 pp. September 24, 2019.

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SPECIES ACCOUNT: *Polygala smallii* (Tiny polygala)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/19/1985; Southeast Region (R4)

Physical Description

Tiny polygala is an erect short-lived herbaceous species. Most plants germinate and die within one year. It forms a rosette and grows no more than 8 cm tall (Kennedy 1998). It has one to four, short, usually unbranched stems, and a well-developed, scented taproot. Its leaves are oblanceolate to lanceolate, from 1.5 to 5 cm long and 0.2 to 1.4 cm broad and occur in a basal rosette. The inflorescence is a cylindric raceme from 0.4 to 7 cm long and 0.5 to 1.8 cm thick and usually surpassed by the basal leaves (Kennedy 1998). The flowers have both functional stamens and pistils (perfect) and are not radially symmetrical (zygomorphic). The calyx has five sepals. The lateral pair is decurrent, large and petaloid. The corolla is a greenish-yellow color with three petals. The fruit is a thin-walled, two-celled capsule that splits down the center of the compartment. The seed is 1.2 to 1.4 mm long, with sparse rather short, stiff, appressed hairs (strigose). It also has a pair of aril-like outgrowths about half the length of the capsule (Gann and Bradley 1995, Smith and Ward 1976). (USFWS, 1999)

Taxonomy

J.K. Small first described tiny polygala as *Polygala arenicola* (Small 1905; type specimen at New York Botanical Garden, Small #1276). The specific epithet was later found to be invalid due to its prior use in 1903 by Gurke in describing another species of *Polygala* from southeast Africa (Smith and Ward 1976). In 1933, Small revived the segregate genus *Pilostaxis* Raf., and renamed tiny polygala *Pilostaxis arenicola* (Small) Small. The genus *Pilostaxis* has since fallen out of use, but represents the series *Decurrentes*, a natural group of seven species of *Polygala* found only in the southeastern U.S. (Smith and Ward 1976). Long and Lakela (1971) considered tiny polygala to be conspecific with *Polygala nana* (Michx.) DC., a species widely distributed in the southeastern U.S., but in 1976, Smith and Ward defended the specific status of tiny polygala, recognizing distinct characters of the seeds, lateral sepals, flower color, and leaves, and proposed *Polygala smallii* Smith and Ward as a nomen novum. Synonyms: *Polygala arenicola* Small, non Gurke; *Pilostaxis arenicola* (Small) Small; *Polygala nana* auct., non (Michx.) DC. (USFWS, 1999)

Historical Range

See Current Range. The historic distribution of tiny polygala to the north is uncertain; it possibly ranged as far north as central Brevard County, Florida. (USFWS, 1999)

Current Range

This species is known to occur on the Atlantic Coastal Ridge of southeast Florida, in Miami-Dade, Palm Beach, St. Lucie, and Martin Counties. (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources**Lifespan**

Adult: ~ 180 days

Other Reproductive Information

Adult: Pollination in tiny polygala has not been observed in 2.5 years of monitoring (Kennedy 1998), or in 3 years of monthly life history monitoring (DERM 1994). Zomlefer (1991) reports that self-pollination may occur in species of Polygala which have a tuft of hairs on the sterile apical lobe of the stigma. These hairs catch pollen when the anthers dehisce, and, as the flower develops, these hairs may touch the receptive lobes of the stigma, transferring pollen. Tiny polygala has these hairs (Smith and Ward 1976) and may be selfpollinating. (USFWS, 1999)

Reproduction Narrative

Adult: Tiny polygala seedlings can be observed from late October through April, but are most typically seen from December to February (DERM 1996). Populations in Miami-Dade County appear to have two germination periods, a short one in June and a longer one between September and January (Kennedy 1998). Thus, seedlings can be germinating for 6 months out of the year, resulting in plants maturing at different times of the year, and overlapping generations within years. In populations, flowers appear throughout the year with a peak during summer. Also, seeds are produced year-round. Approximately one year following appearance of seedlings, plants show a marked reduction in condition, apparently allocating resources to flowering instead of growth or self-maintenance. By July, approximately 18 months after the first seedlings are observed, remaining plants senesce and die (DERM 1994). (USFWS, 1999)

Habitat Type

Adult: pine rockland, scrub, high pine, and open coastal spoil (USFWS, 1999)

Habitat Vegetation or Surface Water Classification

Adult: Terrestrial

Habitat Narrative

Adult: Tiny polygala occurs in four distinct habitats with similar characteristics: pine rockland, scrub, high pine, and open coastal spoil (Gann and Bradley 1995). All of these habitats are pyrogenic-extremely dry and prone to periodic natural fire. Pine rocklands historically burned every 2 to 15 years (Snyder et al. 1991). Sand pine scrub and sandhill burn less frequently, possibly every 10 to 50 years. (USFWS, 1999)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Tiny polygala seeds have paired, fleshy outgrowths, a typical adaptation to ant dispersal. ostermeijer (1989) reports that a similar species Polygala vulgaris L. is a specialist in ant dispersal. Also, ants have been observed carrying tiny polygala seeds to their nests on several occasions in Miami-Dade County (K. Bradley, Institute for Regional Conservation, personal communication 1996). The seeds have a bilobed aril attached to the caruncle. This bilobed aril was suggested by some to be an elaisome, a structure that contains lipids that are attractive to ants. Kennedy (1998) reports observing ants going into the flowers and removing and

transporting seeds by the arils. After applying Sudan IV stain to the arils, she determined that they do not contain lipids; rather the arils appear to be hollow sacs. It is unclear why the ants are moving the seeds. (USFWS, 1999)

Additional Life History Information

Adult: *Polygala smallii* seeds are able to float in water for extended periods (over three weeks) (Kennedy 1998). The hairs on the seed coat appear to provide most of the buoyancy by trapping air. Since many of the sites where tiny polygala occurs are riparian or riverine and the seeds are buoyant, water may be the primary means of dispersal. After Hurricane Andrew, tiny polygala was found growing in areas where the soil was turned over or disturbed (ie. around uprooted fallen trees). A response to soil turnover may indicate a good seed bank. The seed banks probably occur in more habitat types than previously thought. (USFWS, 1999)

Population Information and Trends

Number of Populations:

9 sites (USFWS, 2019)

Population Narrative:

Polygala smallii is extant on a total of nine sites in Miami-Dade, Palm Beach, St. Lucie, and Martin Counties, with the highest density of sites located in southern Miami-Dade County (Wendelberger and Frances 2004; Woodmansee et al. 2007; Maschinski, pers. comm. 2010; Florida Natural Areas Inventory [FNAI] 2010a; Lange, pers. comm. 2017; Possley, pers. comm. 2017a). Clusters of sites are separated by an average of 38 miles (61 km). Eight of nine known occurrences are on publicly owned lands, and all the sites are currently being managed for conservation of *P. smallii*. The species is known to have been extirpated from at least five historical locations, including three in Miami-Dade County and single populations in Broward and St. Lucie Counties. Five sites are known from Miami-Dade County. These include the publicly owned Zoo Miami and adjacent U.S. Coast Guard (USCG) property, both located within the 2,100-acre Richmond pinelands (Lange, pers. comm. 2017; Possley, pers. comm. 2017). Possley pers. comm. (2017a) indicates the *P. smallii* population size within Zoo Miami has fluctuated from 13 to over 1,000 individuals in the past decade. The USCG site contains the largest population, which was estimated at over 10,000 plants during a 2008 survey (Lange, pers. comm. 2017; Possley, pers. comm. 2017a); no recent estimates are available for the species at this site. The three remaining *P. smallii* sites within Miami-Dade County each retain populations of ten individuals or less (Lange, pers. comm. 2017; Possley, pers. comm. 2017a). In Palm Beach County, the *P. smallii* abundance at two known locations fluctuates dramatically from year to year (Woodmansee et al. 2007). At Jupiter Ridge Natural Area, *P. smallii* abundance has fluctuated from 86 (2005) to 8 (2017) (Buck, pers. comm. 2017). The Limestone Creek Natural Area population has ranged from 3 to 60 since being discovered in 2002, with 5 encountered during 2017 (Woodmansee et al. 2007; Shearer, pers. comm. 2017). In southern Martin County, *P. smallii* is known to occur in Jonathan Dickinson State Park (JDSP). Surveys of the site have recorded between 6 and 64 individuals (Woodmansee et al. 2007; FNAI 2010a). Woodmansee et al. (2007) indicated that while the species appears to be in decline at JDSP, it is expected that plant numbers will increase in the long run, provided fires are administered. In St. Lucie County, a small population (14 plants) of *P. smallii* occurs at the privately owned Lynn University (Woodmansee et al. 2007). (USFWS, 2019)

Threats and Stressors

Stressor: Habitat loss and fragmentation

Exposure:

Response:

Consequence:

Narrative: The pine rockland community of south Florida is critically imperiled globally (FNAI 2010b). In Miami-Dade County, development and agriculture have reduced pine rockland habitat by 90 percent. Continued habitat loss (Factor A) and fragmentation threaten the existence of this species, and less than 1 percent of the original acreage of pine rockland habitat remains outside of Everglades National Park (Herndon 1998). Populations on private sites remain threatened with destruction or habitat modification due to improper or lack of management (Factors A and E). (USFWS, 2019)

Stressor: Inadequacy of existing regulatory mechanisms

Exposure:

Response:

Consequence:

Narrative: Currently, regulatory mechanisms (Factor D) provide limited protections for this species. The Florida Department of Agriculture and Consumer Services designated these species as endangered under Chapter 5B-40, Florida Administrative Code. This law regulates the taking, transport, and sale of listed plants. This law does not prohibit private property owners from destroying listed plants, nor does it require them to manage habitats to maintain populations. The Natural Forest Communities (NFC) program was established by Miami-Dade County to encourage but not require private landowners to protect forested lands by making it necessary to apply for a permit with the County prior to working in designated NFCs (i.e., pinelands, hammocks). (USFWS, 2019)

Stressor: Inadequate fire management

Exposure:

Response:

Consequence:

Narrative: Fire suppression continues to affect *Amorpha crenulata* (Factor E). Historically, frequent (approximately twice per decade), lightning-induced fires were a vital component in maintaining native vegetation and ecosystem functioning within south Florida pine rocklands. A period of just 10 years without fire may result in a marked decrease in the number of herbaceous species due to the effects of shading and litter accumulation (FNAI 2010b). The majority of extant populations of this species is affected by some degree of inadequate fire management, with the primary threat being shading by hardwoods (Bradley and Gann 1999; Bradley and Gann 2005). (USFWS, 2019)

Stressor: Nonnative invasive plants

Exposure:

Response:

Consequence:

Narrative: Invasion by exotic plant species continue to affect *Amorpha crenulata* (Factor E). Nonnative invasive plants compete with native plants for space, light, water, and nutrients, and make habitat conditions unsuitable for this species, which prefers open conditions (Factor E).

Bradley and Gann (1999) indicated that the control of nonnative plants is one of the most important conservation actions for the pine rockland species and a critical part of habitat maintenance. Nonnative plants have significantly affected pine rocklands and negatively impacted all occurrences of this species to some degree (Bradley and Gann 1999; Bradley 2006; Bradley and Saha 2009; Bradley and van der Heiden 2013). (USFWS, 2019)

Recovery

Reclassification Criteria:

Not developed (USFWS, 1999; USFWS, 2010)

Delisting Criteria:

1. Existing natural populations achieve and maintain a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (addresses Factors A and E) (USFWS, 2019)
2. A network of 6 new populations are either discovered or reintroduced that exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (addresses Factors A and E) (USFWS, 2019)
3. All populations (criteria 1 and 2) are protected by a conservation mechanism. (addresses Factors A, D, and E) (USFWS, 2019)
4. Threats have been reduced or eliminated to the degree that this species will remain viable for the foreseeable future. (addresses Factors A, D, and E) (USFWS, 2019)

Recovery Actions:

- Conduct surveys to determine distribution and status of *Polygala smallii*. Pine rocklands have been thoroughly surveyed in Miami-Dade County. Additional surveys in the historic range of this plant should be performed in the scrub, sandhill, and open coastal spoil of Broward, Palm Beach, Martin, and St. Lucie counties. Fire eliminates litter concealing species, it may kill seeds in the litter or soil surface, or it may enable seeds in the seed bank to germinate. For that reason, suitable habitats which did not contain listed species when unmanaged should be resurveyed after fire events. (USFWS, 1999)
- Protect and enhance existing populations. It is imperative for the recovery of this species that populations not be lost. (USFWS, 1999)
- Collect biological information important to species recovery. Determine population size and viability of all populations. Investigate the genetic relationship of distinct *Polygala* populations. (USFWS, 1999)
- Develop standardized monitoring. Collect existing and historical data, and place in a central location. Convene a meeting of all researchers. Monitor status and success of all populations; change management practices if so indicated. Monitor reintroduction success and modify procedures as necessary. (USFWS, 1999)
- Continue to provide public information about scrub, sandhill, and open coastal spoil habitat and its unique flora. (USFWS, 1999)
- Habitat-Level Recovery Actions: Continue to protect existing pine rockland, scrub, sandhill, and open coastal spoil plant habitats. Restore areas to suitable habitat. Research additional habitat relationships. Monitor sites with pine restoration programs to determine success.

Continue implementation of the fire education program and modify as necessary, any fire management education program that has been developed. (USFWS, 1999)

References

USFWS. 2019. Amendment 1. Recovery Plan for the endangered *Arnorpha crenulata* (crenulate lead-plant), *C'hamaesyce dettoidea* ssp. *dettoidea* (deltoid spurge), *Galactia smallii* (Small's milkpea), and *Polygala smallii* (tiny polygala). U.S. Fish and Wildlife Service, Atlanta, Georgia. 10 pp. September 26, 2019.

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USFWS. 2010. Tiny Polygala (*Polygala smallii*), 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, South Florida Ecological Services Field Office. 18 pp.

SPECIES ACCOUNT: *Polygonella basiramia* (Wireweed)

Species Taxonomic and Listing Information

Listing Status: Endangered; 2/20/1987; Southeast Region (R4)

Physical Description

P. basiramia is a short-lived, perennial herb (Hawkes, University of Pennsylvania, personal communication 1995). When vegetative, the plant consists entirely of basal, compressed stems with narrow, alternate leaves. Ocreae, the sheaths formed at stem nodes, are ciliate. Stems and leaves range in color from green to dark red; red coloration in the stems and leaves appears to be associated with individuals more exposed to sunlight and with older vegetative parts (although even seedlings are often red). As basal stems elongate, plants develop 1 to 46 slender, flowering, spike-like panicles as tall as 0.8 m (Hawkes and Menges 1995). This species is gynodioecious and plants have either only female flowers or hermaphroditic flowers. Individual flowers are small, white to slightly pink with 5 sepals (no petals), pink pistils, and black anthers. The gynoecium consists of 3 united carpels, 1-ovuled, ovary superior. Flowering occurs from the top spikelet downward on each stem. The fruit is a three-sided achene 1 to 3 mm in length. (USFWS, 1999) Wireweed *Polygonella basiramia* (= *ciliata* var. *b.*) (Small) Nesom and Bates Page 4-1149 Federal Status: Endangered (January 21, 1987) Critical Habitat: None Designated Florida Status: Endangered Figure 1. County distribution of wireweed. Recovery Plan Status: Revision (May 18, 1999) Geographic Coverage: Rangewide

Taxonomy

Originally named *Delopyrum basiramia* by Small in 1924 (Nesom and Bates 1984), this species was later thought to be a variety of *Polygonella ciliata* by Horton (1963). In 1984 Nesom and Bates recognized *P. basiramia* as a separate species. This species is commonly known as hairy or tufted wireweed. *Polygonella basiramia* is most closely related to *P. ciliata* and *P. gracilis* (Lewis and Crawford 1995). *P. basiramia* and *P. ciliata* are believed to have originated from *P. gracilis*, but whether they did so independently or from a single intermediate ancestral species is unknown. (USFWS, 1999)

Historical Range

See current range.

Current Range

Lake Wales, Winter Haven, and Bombing Range ridges in central peninsular Florida. It ranges from Lake Pierce in Polk County southward to Venus near the southern tip of the Lake Wales Ridge in Highlands County (USFWS, 1999)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: short-lived (average 0.31 years) (USFWS, 2019)

Breeding Season

Adult: September to December (USFWS, 1999)

Other Reproductive Information

Adult: Wireweed is an obligate seeder: no adult plants survive fire, and all post-fire recruits derive from seed. Flowering begins in September and achenes are produced in late November and early December. Because flowering is sequential, beginning at the top of each spike-like panicle and moving downwards, flowers and achenes are present at the same time mid-autumn. Achenes drop readily from the plant and most fall by mid-January. (USFWS, 2019)

Reproduction Narrative

Adult: *Polygonella basiramia* is gynodioecious, with individual plants producing either pistillate (female) or perfect flowers (both sexes in a single flower). The ratio of female to hermaphroditic plants is 1:1 at Archbold Biological Station (Hawkes and Menges 1995). Pollinators of *P. basiramia* include small halictid bees, *Perdita polygonellae* (a bee specific to the genus *Polygonella*), Eumenidae wasps, and potentially *Glabellula* spp. (Bombyliidae) (M. Deyrup, Archbold Biological Station, personal communication 1995). Seed production by female plants greatly exceeds that of perfect plants, with an average of 217.8 seeds per stem for females, but only 32.1 for perfect plants. *P. basiramia* is an obligate seeder which means that no adult plants survive a fire event and all new growth is from seedlings. On a population level, the number of seeds produced by *P. basiramia* in one reproductive season is more than 30 times the average plant density, sufficient to replace existing populations if only 3 percent of seeds were able to germinate and survive. (USFWS, 1999)

Habitat Type

Adult: scrub/scrubby flatwoods

Habitat Narrative

Adult: *Polygonella basiramia* is most commonly found in rosemary scrub, also known as rosemary phase of sand pine scrub (Abrahamson et al. 1984, Menges and Kohfeldt 1995). At Archbold Biological Station, rosemary scrubs are found only on the higher ridges and knolls at 40 to 50 m in elevation, and are largely restricted to St. Lucie and Archbold soil types (Abrahamson et al. 1984), both well drained white sands (Carter et al. 1989). Outside Archbold Biological Station, rosemary scrubs are generally found on white sands and higher elevations (Hawkes, University of Pennsylvania, personal communication 1998). The fire cycle in rosemary scrub can range from 10 to as long as 100 years (Johnson 1982, Myers 1990). *Polygonella basiramia* occupies open spaces or gaps between shrubs and can be found in abundance along sandy fire lanes, which provide similar habitat. (USFWS, 1999)

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Declining (inferred) (USFWS, 2019)

Population Narrative:

The last FNAI Element Tracking Summary (FNAI 2015) reported 71 extant occurrences, 47 of which were on managed lands. This was a significant decrease (approximately 40 percent) from the 119 reported occurrences in the last 5-year status review (Service 2010d). At a larger scale, regional persistence of this species is dependent on landscape features and disturbance effects on metapopulation dynamics. Fire may expand or create the open sand gaps within a shrub matrix that support wireweed, but fire also kills established plants. Patchy fires may provide a balance, both creating suitable habitats and providing a fine-grained spatial landscape structure so wireweed can colonize those habitats. (USFWS, 2019).

Threats and Stressors

Stressor: Habitat destruction or modification

Exposure:

Response:

Consequence:

Narrative: This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggest that Florida's 2070 population will be early 15 million persons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

Stressor: Lack of adequate fire management

Exposure:

Response:

Consequence:

Narrative: Fire is necessary to maintain the scrub habitats upon which this species depends. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time (Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species. (USFWS, 2019)

Stressor: Limited geographic range.

Exposure:

Response:

Consequence:

Narrative: This species occurs occur within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

Recovery

Reclassification Criteria:

1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to assure 20 to 90 percent probability of persistence for 100 years (USFWS, 1999)
2. When these sites, within the historic range of *P. basiramia*, are adequately protected from further habitat loss, degradation, and fragmentation (USFWS, 1999)
3. When these sites are managed to maintain the rosemary phase of xeric oak scrub communities to support *P. basiramia* (USFWS, 1999)
4. When monitoring programs demonstrate that populations of *P. basiramia* on these sites support the appropriate numbers of self-sustaining populations, and those populations are stable throughout the historic range of the species. Individuals growing opportunistically in unnatural areas, for example fire lanes, should be excluded from consideration when determining the status of this species. (USFWS, 1999)

Delisting Criteria:

1. At least 40 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)
2. Populations (as defined in criterion 1) in rosemary scrub or scrubby flatwoods habitats are distributed across the known range of the species. (USFWS, 2019)
3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

Recovery Actions:

- Determine current distribution status of *Polygonella basiramia*. This species' distribution is somewhat questionable for taxonomic reasons. A thorough survey is needed to determine the distribution for this species. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Conduct research on life history characteristics. Though much of the basic biology and ecology of this species is understood, to effectively recover this species additional biological information is needed. (USFWS, 1999)
- Monitor existing populations of *Polygonella basiramia*. (USFWS, 1999)
- Provide public information about *P. basiramia*. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. (USFWS, 1999)
- Habitat-level Recovery Actions: Prevent degradation of existing habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

References

USFWS. 2019. Amendment 1. Recovery Plan for *Conradina brevifolia* (short-leaved rosemary), *Crotalaria avonensis* (Avon Park harebells), *Dicerandra christmanii* (Garrett's mint), *Dicerandra frutescens* (scrub mint), *Eryngium cuneifolium* (snakeroot), *Hypericum cumulicola* (Highlands scrub hypericum), *Liatris ohlingerae* (scrub blazing star), *Polygala lewtonii* (Lewton's polygala), *Polygonella basiramia* (wireweed), *Polygonella myriophylla* (sandlace), *Warea carteri* (Carter's mustard), and *Ziziphus celata* (Florida ziziphus). U.S. Fish and Wildlife Service, Atlanta, Georgia. 23 pp. September 24, 2019.

USFWS. 1999. Wireweed. Revised Recovery Plan (May 18, 1999). Pages 4-1149 to 4-1161, In: South Florida Multi-Species Recovery Plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. URL: <https://www.fws.gov/verobeach/MSRPPDFs/ScrubBlazing.pdf>

USFWS. 2019. Amendment 1. Recovery Plan for *Conradina brevifolia* (short-leaved rosemary), *Crotalaria avonensis* (Avon Park harebells), *Dicerandra christmanii* (Garrett's mint), *Dicerandra frutescens* (scrub mint), *Eryngium cuneifolium* (snakeroot), *Hypericum cumulicola* (Highlands scrub hypericum), *Liatris ohlingerae* (scrub blazing star), *Polygala lewtonii* (Lewton's polygala), *Polygonella basiramia* (wireweed), *Polygonella myriophylla* (sandlace), *Warea carteri* (Carter's mustard), and *Ziziphus celata* (Florida ziziphus). U.S. Fish and Wildlife Service, Atlanta, Georgia. 23 pp. September 24, 2019.

SPECIES ACCOUNT: *Polygonella myriophylla* (Sandlace)

Species Taxonomic and Listing Information

Listing Status: Endangered; 5/27/1993; Southeast Region (R4)

Physical Description

Polygonella myriophylla is a sprawling shrub that looks somewhat like the ornamental creeping juniper (*Juniperus horizontalis*). Its many branches zigzag along the ground and root at the nodes, forming low mats. The lower parts of the creeping branches have bark that cracks and partly separates in long, flat, interlacing strips. The short lateral branches end in flowering racemes. *P. myriophylla* has the sheathing leaf stipules (ocreae and ocreolae) typical of the jointweed family. The leaves are needle-like and are from 0.3 to 10.0 mm long. The small, white or cream colored flowers have white petallike sepals up to 3.4 mm long (Kral 1983). (USFWS, 1999)

Taxonomy

Sandlace is one of 11 species of North American *Polygonella* and one of three species of *Polygonella* that occur in scrub habitat in south Florida (Lewis and Crawford 1995). The sandlace was first collected in the early 1920s and was subsequently identified and named by Small (1924) as *Dentoceras myriophylla*. Horton (1963) combined two of Small's genera with the genus *Polygonella*. *P. myriophylla* has been commonly called sandlace (Christman 1988), Small's jointweed and woody wireweed (Wunderlin 1982). (USFWS, 1999)

Historical Range

See current range/distribution.

Current Range

In the Florida Counties of Orange, Osceola, Polk (Lake Wales Ridge), and Highlands (Lake Wales Ridge). (USFWS, 1999)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual; Vegetative (USFWS, 2019)

Other Reproductive Information

Adult: Sandlace reproduces sexually and vegetatively through the rooting of prostrate branches. Sandlace is killed by fire and will recolonize burned areas by seedling recruitment or clonal growth. Most obligate seeders in Florida scrub and sandhill, including both herbs (e.g., Highlands scrub hypericum, snakeroot, Lewton's polygala) and sub-shrubs (e.g., several species in the genus *Dicerandra*), recover quickly post-fire via seedling recruitment and often show dramatic aboveground population booms. In sandlace's preferred habitats, recommended FRIs range

from 8 to 16 years for xeric scrubby flatwoods to 15 to 30 years for Florida rosemary scrub (Menges 2007). (USFWS, 2019)

Reproduction Narrative

Adult: Weekley and Menges (2003) confirmed that sandlace does not resprout after fire, but recolonizes burned areas from seed arriving from unburned areas, and perhaps by spreading from unburned areas. Pollinators of sandlace are genus-specific bees and likely a few varieties of wasps. Little is known about seed production and germination for this species, but seedlings do not survive in the vicinity of the mature plants, which are allelopathic, meaning they produce chemicals that inhibit the growth and survival of other nearby plants (Weidenhamer et al.1989). The major allelochemicals are gallic acid and hydroquinone (Weidenhamer and Romeo 2004).

Habitat Type

Adult: Scrub

Habitat Narrative

Adult: Sandlace occupies open, sandy areas within the scrub vegetation, and it appears to require fire or other disturbances that create or maintain these sandy gaps. This species is killed by fire, and reoccupies burned sites from seed (Pedro Quintana-Ascencio, University of Central Florida, pers. comm. 2004). Its abundance can easily be overestimated, because it tends to colonize disturbed areas along easily accessible road cuts and rights-of-way.

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Declining (USFWS, 2019)

Number of Populations:

72 extant occurrences (USFWS, 2019)

Population Size:

2500 - 10,000 individuals (NatureServe, 2015)

Population Narrative:

The previous FNAI Element Tracking Summary (FNAI 2015) reported 72 extant occurrences, 39 of which occurred on managed land. Thirty-three of 72 extant sandlace occurrences were located on private property where they had no protection from development and were unlikely to be appropriately managed. This was a significant decrease (approximately 36 percent) from the previous 5-year status review, which reported 113 extant occurrences. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat destruction or modification

Exposure:

Response:

Consequence:

Narrative: This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 million persons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

Stressor: Lack of adequate fire management

Exposure:

Response:

Consequence:

Narrative: Fire is necessary to maintain the scrub habitats upon which this species depends. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time (Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species. (USFWS, 2019)

Stressor: Limited geographic range

Exposure:

Response:

Consequence:

Narrative: This species occurs occur within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation

seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

Recovery

Reclassification Criteria:

1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to assure 20 to 90 percent probability of persistence for 100 years (USFWS, 1999)
2. When these sites, within the historic range of *P. myriophylla*, are adequately protected from further habitat loss, degradation, and fragmentation (USFWS, 1999)
3. When these sites are managed to maintain the seral stage of xeric oak scrub communities to support *P. myriophylla* (USFWS, 1999)
4. When monitoring programs demonstrate that populations of *P. myriophylla* on these sites support the appropriate numbers of self-sustaining populations, and those populations are stable throughout the historic range of the species. (USFWS, 1999)

Delisting Criteria:

1. At least 40 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)
2. Populations (as defined in criterion 1) in yellow sand scrub or sand hill habitats are distributed across the known range of the species. (USFWS, 2019)
3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

Recovery Actions:

- Determine current distribution of *P. myriophylla*. A thorough survey is needed to determine the distribution for this species. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Conduct research on life history characteristics. Though much of the basic biology and ecology of this species is understood, to recover this species more specific biological information is needed. (USFWS, 1999)
- Monitor existing populations of *P. myriophylla*. (USFWS, 1999)
- Provide public information about *P. myriophylla*. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Care is needed, though, to avoid revealing specific locality information about where *P. myriophylla* is found. Public outreach efforts must also continue to address the increasing concern that

horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of *P. myriophylla* and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)

References

USFWS. 1999. Sandlace. Revised Recovery Plan (May 18, 1999). Pages 4-1163 to 4-1172, In: South Florida Multi-Species Recovery Plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. URL: <https://www.fws.gov/verobeach/MSRPPDFs/Sandlace>.

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NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

USFWS. 2019. Amendment 1. Recovery Plan for *Conradina brevifolia* (short-leaved rosemary), *Crotalaria avonensis* (Avon Park harebells), *Dicerandra christmanii* (Garrett's mint), *Dicerandra frutescens* (scrub mint), *Eryngium cuneifolium* (snakeroot), *Hypericum cumulicola* (Highlands scrub hypericum), *Liatris ohlingerae* (scrub blazing star), *Polygala lewtonii* (Lewton's polygala), *Polygonella basiramia* (wireweed), *Polygonella myriophylla* (sandlace), *Warea carteri* (Carter's mustard), and *Ziziphus celata* (Florida ziziphus). U.S. Fish and Wildlife Service, Atlanta, Georgia. 23 pp. September 24, 2019.

USFWS. 1999. Sandlace. Revised Recovery Plan (May 18, 1999). Pages 4-1163 to 4-1172, In: South Florida Multi-Species Recovery Plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. URL: <https://www.fws.gov/verobeach/MSRPPDFs/Sandlace.pdf>

SPECIES ACCOUNT: *Polygonum hickmanii* (Scotts Valley Polygonum)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

a small, annual plant, 2 to 5 centimeters tall (1 to 2 inches) in the buckwheat family (Polygonaceae). The leaves are linear and pointed, and the single white flower is in the axil of bracteal leaves. (USFWS, 2009)

Taxonomy

We are not aware of any changes or proposed changes in taxonomic classification or nomenclature since listing. However, prior to listing, the following names were used in unpublished historical documents: a "draft" scientific name, *Polygonum muripes* pro. sp. (Morgan 1990a, b; Habitat Restoration Group 1992); and a common name, Hickman's smartweed (Denise Duffy and Associates 1997b). Hinds and Morgan (1995) used the common name Hickman's knotweed. (USFWS, 2009)

Current Range

Endemic to Santa Cruz County, California (Fish and Wildlife Service 2000). (NatureServe, 2015)

Critical Habitat Designated

Yes; 4/8/2003.

Legal Description

On April 8, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Polygonum hickmanii* (Scotts Valley Polygonum) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in California (68 FR 16970-16990).

Critical Habitat Designation

The critical habitat designation for *Polygonum hickmanii* includes two CHUs in Santa Cruz County, California. This species critical habitat encompasses approximately 287 acres (ac) (116 hectares (ha)) (68 FR 16970-16990).

Unit 1: Glenwood Site: Unit 1 consists of approximately 87 ha (214 acres) to the west of Glenwood Drive and north and northwest of Casa Way, in the city of Scotts Valley. This unit includes land owned and managed by the Salvation Army and by the Scotts Valley High School District as a preserve, but excludes the rest of the High School, and land to the east of Glenwood Drive, encompassing the parcel known as the Glenwood Development. Most of the land being designated within this unit is privately owned, with a small portion (4 ha (9 ac)) owned by a local agency (High School District). This unit is essential because it supports approximately 25 to 50 percent of the known above-ground numbers of individuals of *Polygonum hickmanii*, as well as other suitable patches of wildflower field habitat that could be colonized by the species naturally, or used as introduction sites as part of a recovery effort. Much of this suitable, but unoccupied habitat, is slated to be dedicated as "open space" as part of the housing development on the Glenwood parcel; therefore, an opportunity may exist to pursue such a recovery effort. The unit

also supports intervening habitat that includes the grassland community that supports the pollinators and seed dispersers that are important to the survival and conservation of *P. hickmanii*. Additional habitat that is unsuitable for *P. hickmanii* is also included on the slopes above the wildflower field patches; this additional habitat is necessary to maintain the slope stability and therefore the hydrologic and soil conditions suitable for *P. hickmanii* and the wildflower field habitat.

Unit 2: Polo Ranch Site: The Polo Ranch site consists of approximately 30 ha (73 ac) to the east of Carbonera Creek on the east side of Highway 17 and north and northeast of Navarra Drive, in the city of Scotts Valley, in Santa Cruz County, California. All land being designated as critical habitat is privately owned. This unit is essential because it supports approximately 50 to 75 percent of the known above-ground numbers of individuals of *Polygonum hickmanii*, as well as other suitable patches of wildflower field habitat that could be colonized by the species naturally, or used as introduction sites as part of a recovery effort. The unit also supports intervening habitat that includes the grassland community necessary for pollinators and seed dispersers that are responsible for maintaining genetic variability within the species. Additional habitat that is unsuitable for the growth of *P. hickmanii* is also included on the slopes above the wildflower field patches; this additional habitat is necessary to maintain the slope stability and therefore the hydrologic and soil conditions suitable for *P. hickmanii*. Much of the unsuitable habitat will be set aside as "open space" as part of the pending housing development, because these slopes are too steep to safely support housing construction.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Polygonum hickmanii* critical habitat consists of five components (68 FR 16970-16990):

- (i) Thin soils in the Bonnydoon series that have developed over outcrops of Santa Cruz mudstone and Purisima sandstone;
- (ii) "Wildflower field" habitat that has developed on these thin-soiled sites;
- (iii) A grassland plant community that supports the "wildflower field" habitat and that supports the pollinator activity and seed dispersal mechanisms that typically occur within the grassland plant community;
- (iv) Areas around each colony to allow for recolonization to adjacent suitable microhabitat sites; and
- (v) Habitat within the subwatersheds upslope to the ridgelines to maintain the edaphic and hydrologic conditions and slope stability that provide the seasonally wet substrate for growth and reproduction of *Polygonum hickmanii*.

Special Management Considerations or Protections

Special management considerations or protections may be needed to maintain the primary constituent elements for *Polygonum hickmanii* within the units being designated as critical habitat. In some cases, protection of existing habitat and current ecologic processes may be sufficient to ensure that populations of *P. hickmanii* are maintained at those sites and have the

ability to reproduce and disperse in surrounding habitat. In other cases, however, active management may be needed to maintain the primary constituent elements for *P. hickmanii*. We have outlined below the most likely kinds of special management and protection that *P. hickmanii* may require. (1) The soils on which *Polygonum hickmanii* is found should be maintained to optimize conditions for its persistence. Physical properties of the soil, such as its chemical composition, surface crust, and drainage capabilities, would best be maintained by limiting or restricting the use or application of herbicides, fertilizers, or other soil amendments. (2) Overspray from irrigation or saturation of soils beyond the normal rainfall season should also be avoided, as this may alter the structure and composition of the grassland community or render the native species more vulnerable to pathogens found in wetter soil regimes. (3) The associated plant communities must be maintained to ensure that the habitat needs of pollinators and seed dispersal agents are maintained. The use of pesticides should be limited or restricted so that healthy populations of pollinators are present to effect pollination and, therefore, seed set in *Polygonum hickmanii*. The fragmentation of habitat through construction of roads and certain types of fencing should be limited so that dispersal agents may disperse seed of *P. hickmanii* throughout the unit. (4) Invasive, nonnative species such as brome grasses and other species may need to be actively managed within the grassland community to maintain the patches of open habitat that *Polygonum hickmanii* needs. (5) Certain areas where *Polygonum hickmanii* occurs may need to be fenced to protect it from accidental or intentional trampling by humans and livestock. While *P. hickmanii* appears to withstand light to moderate disturbance, heavy disturbance may be detrimental to its persistence. Seasonal exclusions may work in certain areas to protect *P. hickmanii* during its critical season of growth and reproduction.

Life History**Food/Nutrient Resources****Breeding Season**

Adult: Plant flowers in May (USFWS, 2009)

Reproduction Narrative

Adult: Very little is known regarding the species' biology, and there is no new information since listing. Germination is in the fall or early winter in response to seasonal rains. The plants grow slowly over the next few months, remaining inconspicuous until flowering begins in May. New flowers are produced until climate or microhabitat conditions are no longer favorable. Consequently, seed production ranges from several dozen in a typical individual to several hundred in a robust individual (Morgan, pers. comm. 1998b), while depauperate plants produce few or no seeds (Morgan in California Department of Fish and Game 2003) (USFWS, 2009).

Habitat Type

Adult: Grasslands (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (NatureServe, 2015)

Site Fidelity

Adult: High (NatureServe, 2015)

Habitat Narrative

Adult: Species occurs with other small annual herbs in patches within annual grasslands. These "wildflower field" patches are generally underlain by shallow, well-drained soils; this species occurs on gently sloping to nearly level shallow soils over outcrops of Santa Cruz mudstone and Purisima sandstone. It is found near the center of the patches where the soil is shallowest and often has a consolidated, crusty surface texture; other species are sparse in patch centers. Associated species include the native herbs *Chorizanthe robusta* var. *hartwegii*, *Lasthenia californica*, *Minuartia douglasii*, *Minuartia californica*, *Gilia clivorum*, *Castilleja densiflora*, *Lupinus nanus*, *Brodiaea terrestris*, *Stylocline amphibola*, *Trifolium grayii*, and *Hemizonia corymbosa*, as well as the non-natives *Filago gallica* and *Vulpia myuros*. In many cases, the habitat also supports a crust of mosses and lichens. 200 - 250 m elevation. (NatureServe, 2015)

Dispersal/Migration***Population Information and Trends*****Resiliency:**

Low (NatureServe, 2015)

Representation:

Low (NatureServe, 2015)

Redundancy:

Low (NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Narrative:

Restricted to 2 sites (Fish and Wildlife Service 2000). (NatureServe, 2015). Low resiliency, representation and redundancy are inferred based on the low number of known populations.

Threats and Stressors

Stressor: Urban development/road construction (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat/extirpation

Narrative: On Salvation Army land and the Scotts Valley High School Preserve, the five colonies of this population are now being substantially affected by the indirect impacts of development. These five colonies are at risk of extirpation because of the highly disturbed and fragmented

nature of the ecosystem, the isolation from other colonies, the proximity to developed areas, and invasive plant species (USFWS, 2009).

Stressor: Recreational use (USFWS, 2009).

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Although the preserve is fenced, Lyons (2004) observed minor disturbance by students traversing to and from the high school in 2003. Gogul-Prokurat (2004) observed a number of golf balls within the preserve. Lyons (2002) previously reported residents using the preserve for golf practice (USFWS, 2009).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Since listing under the Endangered Species Act, *Polygonum hickmanii* has become listed under the California Endangered Species Act. However, because none of the colonies are on Federal or State lands, the combination of all Federal and State laws has only limited ability to protect this plant species. The inadequacy of existing regulatory mechanisms remains a threat in 2009 (USFWS, 2009).

Stressor: Inadequate preserve design (USFWS, 2009)

Exposure:

Response:

Consequence: Lack of protection

Narrative: A preserve should be large enough to maintain the ecological functions upon which the target species depends, and it should have a ratio of edge to total area that minimizes edge effects and fragmentation. To increase the certainty that the target species will persist over the long term, land uses adjacent to a preserve should be compatible with maintaining the integrity of the preserve (Service 2003). The Scotts Valley High School Preserve (3.2 hectares; 8 acres) is not large enough to maintain the ecosystem supporting *Polygonum hickmanii*, and edge effects are present because the single colony is near the preserve boundary (within approximately 18 meters; 60 feet). In addition, adjacent land uses to the immediate north (in particular, athletic fields and parking lot), and east and south of the preserve (residences) are not compatible with maintaining its integrity. Because of this, the preserve has been used for non-compatible purposes, including recreation (Lyons 2002, Gogul-Prokurat 2004), a walking short-cut to and from the school (Lyons 2004), and disposal of waste (Cheap, in litt. 2008). Prior to construction of the high school and the recycled water distribution system, the California Department of Fish and Game (in litt. 1991) recommended the two areas with *Polygonum hickmanii* be designated as one larger preserve. They stated "Our experiences with small plant preserves have demonstrated that high density residential developments next to small preserves result in significant declines in preserve quality and effectiveness from incompatible land uses if buffer areas between the preserve boundary and the rare plant habitats are too narrow. A 100- foot wide buffer between the plant populations and adjacent development is considered to be the minimum required." See Factor A for additional discussion about alteration and loss of habitat due to proximity to urban areas (USFWS, 2009).

Stressor: Random extinction (USFWS, 2009)

Exposure:

Response:

Consequence: Extinction

Narrative: Species with few populations and/or individuals are vulnerable to random extinction. In this situation, naturally occurring events can cause extinction through mechanisms operating at the genetic level (e.g., decrease in genetic variability), the population level (e.g., lack of ability to attract pollinators because of few individuals), or the landscape level (e.g., storms, drought, fire) (Service 2003). *Polygonum hickmanii* is at high risk of random extinction. The species is known from only two populations approximately 1.6 kilometers (1 mile) apart. The total occupied area comprises less than 0.4 hectare (1 acre). The most-recent surveys reported 0 individuals on the Polo Ranch in 2006 (Morgan, pers. comm. 2009), “several dozen” individuals on Salvation Army land in 2008 (Morgan, pers. comm. 2009), and 88 individuals on the Scotts Valley High School Preserve in 2003 (Lyons 2004) (USFWS, 2009).

Stressor: Invasive species and competitive native species (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Non-native annual grasses are now a threat to *Polygonum hickmanii* on all three properties. In particular, much of the habitat on the Scotts Valley High School Preserve and adjacent Salvation Army land is now occupied by non-native grasses, which must be mowed to reduce adverse effects to this species and *Chorizanthe robusta* var. *hartwegii*. On the Polo Ranch, competitive native species are also threatening *Polygonum hickmanii* and its habitat. See Factor A for additional discussion about invasive species and competitive native species (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, Intergovernmental Panel on Climate Change 2007). The potential impacts of climate change on the flora of California were discussed recently by Loarie et al. (2008). Based on modeling, they predicted that species’ distributions will shift in response to climate change and that species will move to higher elevations and northward, depending on the ability of each species to do so. Increases in species diversity in higher elevations and northern locations due to climate change have the potential to result “...in new species mixes, with consequent novel patterns of competition and other biotic interactions...” with unknown consequences to the species which currently exist there (Loarie et al. 2008). While we lack adequate information to make specific and accurate predictions regarding how climate change in combination with other factors such as small population size will affect *Polygonum hickmanii*, small-ranged species are more vulnerable to extinction due to these changing conditions (Loarie et al. 2008) (USFWS, 2009).

Recovery

Reclassification Criteria:

Interim recovery objective: Establishing permanent conservation easements over or acquisition of the three properties in Scotts Valley (USFWS, 2009).

Interim recovery objective: ddressing conservation measures for this species in a habitat conservation plan with the City of Scotts Valley (USFWS, 2009).

Recovery Actions:

- Protect habitat for Santa Cruz Mountains species on private land through habitat conservation plans and landowner agreements. Little to no progress has been achieved. Because the habitat on Salvation Army land and the Scotts Valley High School Preserve is now highly degraded, the Polo Ranch is the only property where the ecosystem may be intact (USFWS, 2009).
- 2. Manage habitat for Santa Cruz Mountains species. Little progress has been achieved regarding this recommended recovery action as it pertains to *Polygonum hickmanii*. The only beneficial actions we are aware of is the mowing of invasive grasses in the vicinity of the colonies on Salvation Army land and the Scotts Valley High School Preserve, and possibly the placing of a fence around colonies on the Polo Ranch (HuffmanBroadway Group 2008) (USFWS, 2009).
- 3. Conduct research on the life history, ecology, and population dynamics of these species that will contribute to appropriate management strategies. No research has been conducted on *Polygonum hickmanii*. Monitoring has been conducted only on an irregular basis, and the data have not been used to modify management actions (USFWS, 2009).
- 4. Locate additional habitat/populations within the historic range of the species. Gogul-Prokurat (2004) reported the following. "Surveys of most remaining potentially suitable habitat throughout Scotts Valley and surrounding areas have been conducted by local botanists, and to date, no additional populations...have been discovered. Because the rock outcrop areas in which Scotts Valley polygonum occurs are also home to two other Federally-listed endangered species, the Scotts Valley spineflower...and the Ohlone tiger beetle..., these areas have been thoroughly surveyed. Although the individual Scotts Valley polygonum plants are small and only visible during the growing season, populations should be relatively easy to locate because the rock outcrops on which they grow are...readily identifiable in the field. It is possible that some privately-owned areas of potentially suitable habitat have not been surveyed.... However, Mr. Randall Morgan, a long-time resident ecologist who is intimately familiar with the area, has thoroughly searched for suitable areas based on topographic maps and on-the-ground surveys. According to Mr. Morgan, most of the habitat likely to support Scotts Valley polygonum in this area has been developed, and it is highly unlikely that additional undeveloped areas with the potential to support the species exist.... The Department searched nine U.S. herbaria for historical records.... A literature search was also conducted. To date, no references to any...populations other than the known localities in Scotts Valley have been located." In sum, no additional habitat or populations have been located, and it now seems unlikely that any more exist (USFWS, 2009).
- 5. Develop and implement a public outreach program. A public outreach program has not been developed. The only beneficial action is Hayes and Taylor (2007) producing a fact sheet with color photos in 2006, which the Elkhorn Slough National Estuarine Research Reserve has posted on its website (USFWS, 2009).

- 6. Evaluate progress of recovery effectiveness of management and recovery actions and revise management plans. The efforts to date for *Polygonum hickmanii* have not been effective, and management plans have not been appropriately revised (USFWS, 2009).

Conservation Measures and Best Management Practices:

- Polo Ranch. The Polo Ranch contains the only potentially intact ecosystem with *Polygonum hickmanii* (and *Chorizanthe robusta* var. *hartwegii*). Therefore, we recommend pursuing opportunities for acquisition of the Polo Ranch by a conservation organization to appropriately manage it as a preserve for sensitive plant species (USFWS, 2009).
- Salvation Army land. We recommend pursuing a conservation easement over the area with *Polygonum hickmanii* (and *Chorizanthe robusta* var. *hartwegii*) and that the area be appropriately managed by a conservation organization as a preserve for the plants (USFWS, 2009).
- Scotts Valley High School Preserve. We recommend the preserve and the grassland and revegetation area be protected by a conservation easement with appropriate management by a conservation organization. In addition, we recommend the Scotts Valley High School implement an education program (with assistance from the Ventura Fish and Wildlife Office) for its students and the community that includes conservation of *Polygonum hickmanii* and *Chorizanthe robusta* var. *hartwegii* (USFWS, 2009).
- Because of the high degree of threat and low potential for recovery in the wild, a botanical seed bank for *Polygonum hickmanii* should be established, with the collections stored at several institutions allied with the Center for Plant Conservation. This would provide for a genetic representation of the species in case of extinction in the wild and also a subsequent source for future re-introductions (USFWS, 2009).
- Because of the high degree of threat and low potential for recovery in the wild, living colonies of *Polygonum hickmanii* should be established at several botanical gardens allied with the Center for Plant Conservation. This would insure that living specimens of the species could be seen somewhere and also insure there is a living population through time (USFWS, 2009).

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SPECIES ACCOUNT: *Polyscias (=Tetraplasandra) bisattenuata* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (R1) (USFWS, 2016)

Physical Description

Tetraplasandra bisattenuata (ohe ohe) is a tree in the ginseng family (Araliaceae). (USFWS, 2010)

Current Range

This species is known only from the Haupu and Kahili regions of Kauai. (USFWS, 2010)

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Tetraplasandra bisattenuata* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 11 critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Tetraplasandra bisattenuata* includes 11 CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Lowland Mesic—Section 1: Lowland Mesic—Section 1 consists of 2,006 ac (812 ha) in the lowland mesic ecosystem, including mesic forest extending from Awaawapuhi Trail south to Makaha Ridge, in the Na Pali Kona Forest Reserve and the Kuia NAR (Figure 1-A). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plants *Doryopteris angelica*, *Labordia helleri*, *Platydesma rostrata* and *Psychotria hobbdi*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these four species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic—Section 1 is not known to be occupied by the species *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Dubautia kenwoodii*, *Pittosporum napaliense*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 2: Lowland Mesic—Section 2 consists of 379 ac (154 ha) in the lowland mesic ecosystem, including mesic forest extending from Keanapuka to Kahuamaa Flat along the rim and cliffs of the Kalalau Valley, in the Na Pali Coast State Park (Figure 1-A, above). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plants *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Pittosporum napaliense*, and *Psychotria hobdyi*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these six species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic—Section 2 is not known to be occupied by the species *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Platydesma rostrata*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 3: Lowland Mesic—Section 3 consists of 124 ac (50 ha) in the lowland mesic ecosystem, including mesic forest extending from Manono Ridge, Pohakuao Valley, to Kanakuu, within the Na Pali Coast State Park (Figure 1- A, above). The entire section is Stateowned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plants *Canavalia napaliensis*, *Chamaesyce eleanoriae*, and *Charpentiera densiflora*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these three species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic— Section 3 is not known to be occupied by the species *Chamaesyce remyi* var. *remyi*, *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Pittosporum napaliense*, *Platydesma rostrata*, *Psychotria hobdyi*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 4: Lowland Mesic—Section 4 consists of 81 ac (33 ha) in the lowland mesic ecosystem, including mesic forest at the head of the Hanakapiai Valley, in the Na Pali Coast State Park (Figure 1-A, above). The entire section is Stateowned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plant *Charpentiera densiflora* and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. Although Lowland Mesic—Section 4 is not known to be occupied by the species *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *Chamaesyce remyi* var. *remyi*, *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*,

Pittosporum napaliense, *Platydesma rostrata*, *Psychotria hobbdi*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 5: Lowland Mesic—Section 5 consists of 37 ac (15 ha) in the lowland mesic ecosystem, including mesic forest on the slopes of Mt. Haupu, on privately owned land (Figure 1-B). The entire section is within previously designated critical habitat, and falls within Critical Habitat Unit 7 of 50 CFR 17.99(a)(1), Map 23a. This section is occupied by the plants *Chamaesyce remyi* var. *remyi* and *Tetraplasandra bisattenuata*, and includes mesic forest and shrubland, the moisture regime, and subcanopy and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these two species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic—Section 5 is not known to be occupied by the species *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *Charpentiera densiflora*, *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Pittosporum napaliense*, *Platydesma rostrata*, and *Psychotria hobbdi*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 1: Lowland Wet—Section 1 consists of 1,164 ac (471 ha) in the lowland wet ecosystem (117 ac (47.4 ha) on State land; 1,047 ac (424 ha) on private land), including wet forest extending from Kulanalilia into Limahuli Valley to Honoanapali, in the Halelea Forest Reserve (Figure 2-A). The section includes 1,099 ac (445 ha) of State and privately owned land within previously designated critical habitat and 65 ac (26 ha) of newly designated critical habitat on private land. The area that falls within designated critical habitat lies within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and newly designated Critical Habitat Unit 20, Map 217c. This section is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Labordia helleri*, and *Phyllostegia renovans*. This section also contains unoccupied habitat that is essential to the conservation of these four species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 1 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Melicope paniculata*, *M. puberula*, *Platydesma rostrata*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 2: Lowland Wet—Section 2 consists of 172 ac (70 ha) in the lowland wet ecosystem, including wet forest extending from Alealau to Pohakea, within the Hono o Na Pali NAR and the Na Pali Coast State Park (Figure 2-A, above). The entire section is Stateowned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plant *Melicope puberula*. This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 2 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope paniculata*, *Phyllostegia renovans*, *Platydesma rostrata*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 3: Lowland Wet—Section 3 consists of 756 ac (306 ha) in the lowland wet ecosystem, including wet forest in upper Wainiha Valley, on privately owned land in the Halelea Forest Reserve (Figure 2-B). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyrtandra oenobarba*, *Melicope puberula*, *Phyllostegia renovans*, and *Stenogyne kealiae*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 3 is not known to be occupied by the species *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope paniculata*, *Platydesma rostrata*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 4: Lowland Wet—Section 4 consists of 591 ac (239 ha) in the lowland wet ecosystem, including wet forest at the head of Lumahai Valley, on State (10 ac, 4.1 ha) and privately owned (581 ac, 235 ha) land in the Halelea Forest Reserve (Figure 2-B, above). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyrtandra oenobarba*, *Melicope paniculata*, *Phyllostegia renovans*, and *Platydesma rostrata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet

ecosystem (Table 3). Although Lowland Wet—Section 4 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Charpentiera densiflora*, *Cyanea eleeeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope puberula*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population numbers of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 5: Lowland Wet—Section 5 consists of 1,541 ac (624 ha) in the lowland wet ecosystem, including wet forest extending from the headwaters of the Wailua River at “Blue Hole” south to Iole, on State (442 ac, 179 ha) and privately owned (1,099 ac, 445 ha) land in the Lihue-Koloa Forest Reserve (Figure 2-C). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36a, and is occupied by the plants *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Melicope paniculata*, *Phyllostegia renovans*, and *Platydesma rostrata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 5 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Labordia helleri*, *Melicope puberula*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 6: Lowland Wet—Section 6 consists of 789 ac (319 ha) in the lowland wet ecosystem, including wet forest extending from Kapalaoa to Kanaele Bog and Lauahihaihai in the Wahiawa Mountains, on State (134 ac, 54 ha) and privately owned (655 ac, 265 ha) land in the Lihue-Koloa Forest Reserve (Figure 2-D). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36a, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Platydesma rostrata*, and *Tetraplasandra bisattenuata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 6 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Charpentiera densiflora*, *Cyanea eleeeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Labordia helleri*, *Melicope paniculata*, *M. puberula*, *Phyllostegia renovans*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of

these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Tetraplasandra bisattenuata* critical habitat consists of two components (Lowland mesic and Lowland wet) (75 FR 18960-19165):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<914 m). Annual precipitation: 50–75 in (127–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Ecosystem: Lowland Wet. Elevation: <3,000 ft (<914 m). Annual precipitation: >75 in (>190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas

(DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland, shrubland/chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 1,800 and 2,000 feet (550 and 610 meters) (USFWS, 2010)

Environmental Specificity

Adult: Low, with few key requirements (USFWS, 2010)

Habitat Narrative

Adult: Tetraplasandra bisattenuata (ohe ohe) is a tree in the ginseng family (Araliaceae), which occurs in lowland mesic to wet forest in Dicranopteris (fern)-covered slopes and shrubland in the lowland mesic and lowland wet ecosystems at elevations between 1,800 and 2,000 ft (550 and 610 m) (TNCH 2007; Wood 2007f, pp. 1–5). (USFWS, 2010; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2010)

Redundancy:

Very low (inferred from USFWS, 2010)

Number of Populations:

4 (USFWS, 2017)

Population Size:

26 (USFWS, 2017)

Population Narrative:

Currently, 35 individuals are found at Mt. Haupū and 2 individuals are at Mt. Kahili (Wood 2007f, p. 1). (USFWS, 2010). There are currently about 26 wild individuals of Polyscias bisattenuata in four populations, with the largest population containing 20 individuals (USFWS, 2017).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from non-native plants, pigs, hurricanes, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds, and through

the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species.

Stressor: Predation and herbivory (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species present an immediate and significant threat to *Tetraplasandra bisattenuata* throughout its range due to documented browsing and trampling by pigs, goats, and deer, and documented mechanical damage by rats (USFWS, 2010).

Stressor: Small populations (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: *Tetraplasandra bisattenuata* is threatened by the effects of small population size (fewer than 50 wild individuals). Research on *Pittosporum* species suggests that small populations are susceptible to loss of genetic variation through inbreeding and drift (USFWS, 2010).

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Recovery

Reclassification Criteria:

Downlisting Criteria In addition to achieving 5 to 10 populations with 400 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats (USFWS, 2017).

Delisting Criteria:

Delisting Criteria In addition to achieving 5 to 10 populations with 400 mature individuals per population and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVA for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis (USFWS, 2017).

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys. (USFWS, 2010)
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units. (USFWS, 2010)
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys. (USFWS, 2010)
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range. (USFWS, 2010)
- Conduct research on control methods for introduced slugs and avian malaria. (USFWS, 2010)

- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction. (USFWS, 2010)
- Identify threats and prioritize which ones to address first for the two birds. (USFWS, 2010)
- Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program. (USFWS, 2010)
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security. (USFWS, 2010)
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems. (USFWS, 2010)
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations. (USFWS, 2010)

Conservation Measures and Best Management Practices:

- Current Management Actions: • Surveys and inventories—PEPP and NTBG monitor this species (PEPP 2013, 2014, 2015, 2016). • Captive propagation for genetic storage and reintroduction—Lyon Arboretum Micropropagation Lab is currently germinating seeds from 20 individuals and establishing explants in their inventory (Lyon Arboretum 2017). NTBG and Lyon Arboretum seed banks have hundreds of seeds in storage from the majority of wild plants, however long-term seed banking potential for this species remains questionable and has yet to be determined (Keir and Weisenberger, 2014, Lyon Arboretum 2017; NTBG 2014d). There are hundreds of plants at the NTBG gardens and nursery with hundreds of seeds currently being propagated (NTBG 2017). • Reintroduction and translocation—Seven individuals have been outplanted (PEPP 2014).
- RECOMMENDATIONS FOR FUTURE ACTIONS • Surveys and inventories—Continue to survey for populations of *Polyscias bisattenuata* in areas of potentially suitable habitat. • Ungulate monitoring and control—Protect all occurrences against browsing and disturbances from feral ungulates. Construct and maintain fenced exclosures around existing populations to prevent imminent extinction. • Invasive plant monitoring and control o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative plant species around all populations that compete with the species. • Fire monitoring and control—Develop and implement fire prevention management plans. • Rodent predation or herbivory control—Implement effective measures to control rodents around all populations. • Invertebrate predation or herbivory control—Study *Polyscias bisattenuata* populations to determine level of threat from insect predation and effective control actions. • Captive propagation for genetic storage and reintroduction— Continue to secure ex-situ stocks with complete representation of remaining individuals. • Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered throughout historic range to reduce impacts from landslides and storms. • Based on the recovery criteria above, consider development of a recovery plan (USFWS, 2017).

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SPECIES ACCOUNT: *Polyscias (=Tetraplasandra) flynnii* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (R1) (USFWS, 2016)

Physical Description

Tetraplasandra flynnii (ohe ohe) is a tree in the ginseng family (Araliaceae). (USFWS, 2010)

Historical Range

See current range/distribution.

Current Range

This species is known only from Hawaii, and specifically is known from the island of Kaua'i. (NatureServe, 2015)

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Tetraplasandra flynnii* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes five critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Tetraplasandra flynnii* includes five CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Lowland Wet—Section 1: Lowland Wet—Section 1 consists of 1,164 ac (471 ha) in the lowland wet ecosystem (117 ac (47.4 ha) on State land; 1,047 ac (424 ha) on private land), including wet forest extending from Kulanalilia into Limahuli Valley to Honoonapali, in the Halelea Forest Reserve (Figure 2-A). The section includes 1,099 ac (445 ha) of State and privately owned land within previously designated critical habitat and 65 ac (26 ha) of newly designated critical habitat on private land. The area that falls within designated critical habitat lies within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and newly designated Critical Habitat Unit 20, Map 217c. This section is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Labordia helleri*, and *Phyllostegia renovans*. This section also contains unoccupied habitat that is essential to the conservation of these four species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 1 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Melicope paniculata*, *M. puberula*, *Platydesma rostrata*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and

biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Montane Mesic—Section 2: Montane Mesic—Section 2 consists of 376 ac (152 ha) in the montane mesic ecosystem and includes a portion of the area surrounding a tributary of Nawaimaka Stream east to Kumuwela Ridge (Figure 3-A, above). The entire section is State-owned within Kokee State Park, and includes 8 ac (3 ha) of newly designated critical habitat. This section is occupied by *Diellia mannii* and the picture-wing fly *Drosophila sharpi*, and includes the montane mesic forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane mesic ecosystem (Table 3), as well as the larval-stage host plants (*Cheirodendron* sp. and *Tetraplasandra* sp.) associated with the picture-wing fly. This section also contains unoccupied habitat that is essential to the conservation of these two species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Montane Mesic—Section 2 is not known to be occupied by the plants *Chamaesyce remyi* var. *remyi*, *Labordia helleri*, *Myrsine knudsenii*, *Myrsine mezii*, *Platydesma rostrata*, *Psychotria grandiflora*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*, or by the birds the akekee and akikiki, we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range, as well as species-specific PCEs for the akekee and akikiki (arthropod prey). Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, that portion of the section that overlies previously designated critical habitat falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70c. The previously undesignated land comprises Critical Habitat Unit 21 of 50 CFR 17.99(a)(1), Map 217d. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 2—Montane Mesic), and for the picture-wing fly at 50 CFR 17.95(i) (Unit 2—Montane Mesic).

Kauai—Montane Mesic—Section 3: Montane Mesic—Section 3 consists of 139 ac (56 ha) in the montane mesic ecosystem, including the upper portion of the Nawaimaka Valley up to Kapukapaia Ridge, on State-owned land in the Na Pali-Kona Forest Reserve (Figure 3-B). This section is not in previously designated critical habitat and includes the only montane mesic forest occupied by the plant *Myrsine mezii*, and the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. Although Montane Mesic—Section 3 is not known to be occupied by the plants *Chamaesyce remyi* var. *remyi*, *Labordia helleri*, *Myrsine knudsenii*, *Myrsine mezii*, *Platydesma rostrata*, *Psychotria grandiflora*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*; by the birds the akekee and akikiki; or by the picturewing fly *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. It also provides for the species-specific PCEs for the akekee and akikiki (arthropod prey) and the larval-stage host plants (*Cheirodendron* sp. and *Tetraplasandra* sp.) associated with *D. sharpi*. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, this section comprises Critical Habitat Unit

22 of 50 CFR 17.99(a)(1), Map 217e. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 3– Montane Mesic), and for the picturewing fly at 50 CFR 17.95(i) (Unit 3– Montane Mesic).

Kauai—Montane Wet—Section 1: Montane Wet—Section 1 consists of 13,055 ac (5,257 ha) in the montane wet ecosystem, extending across the Alakai Plateau from Hanakoa to Mount Waialeale, on State (12,628 ac, 5,110 ha) and privately owned (427 ac, 173 ha) land in the Na Pali Coast State Park, the Alakai Wilderness Preserve, the Na PaliKona and Halelea forest reserves, and Hono o Na Pali NAR (Figure 4). It is occupied by the plants *Astelia waialealae*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *K. helenae*, *Labordia helleri*, *L. pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, and *Platydesma rostrata*; by the akekee and akikiki; and by the picture-wing fly. This section also contains unoccupied habitat that is essential to the conservation of these 18 species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the montane wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and the species-specific PCEs including (1) bogs (identified as PCEs for *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*) (2) bog hummocks (identified as PCEs for *Astelia waialealae* and *Lysimachia daphnoides*); (3) arthropod prey (identified as PCEs for the akekee and the akikiki); and (4) larval-stage host plants, *Cheirodendron* and *Tetraplasandra* sp., (identified as a PCE for the picture-wing fly). Although Montane Wet—Section 1 is not known to be occupied by the plants *Dubautia kalalauensis*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, those portions of the section that overlie previously designated critical habitat fall within two existing Critical Habitat Units of 50 CFR 17.99(a)(1): Unit 10, Map 35a; and Unit 11, Map 64a. The previously undesignated land comprises Unit 23, Map 217f; and Unit 24, Map 217g. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 4–Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 4–Montane Wet).

Kauai—Montane Wet—Section 3: Montane Wet—Section 3 consists of 413 ac (167 ha) in the montane wet ecosystem, encompasses the summit of Namolokama, on State (156 ac, 63 ha) and privately owned (257 ac, 104 ha) land in the Halelea Forest Reserve (Figure 4, above). It is entirely within previously designated critical habitat, and is occupied by the plants *Keysseria erici* and *Labordia pumila*. This section includes the montane wet forest, the moisture regime, and the canopy, subcanopy, and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and bogs (identified as a species-specific PCE for *K. erici*). Although Montane Wet—Section 3 is not known to be occupied by the plants *Astelia waialeale*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia kalalauensis*, *D. waialeale*, *Geranium kauaiense*, *Keysseria helenae*, *Labordia helleri*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*; by the akekee and akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the

reestablishment of wild populations within their historic range. It also supports the arthropod prey identified as a PCE for the akekee and akikiki, and the larval-stage host plants (Cheirodendron and Tetraplasandra spp.) identified as a PCE for the picture-wing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 6–Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 6–Montane Wet).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Tetraplasandra flynnii* critical habitat consists of three components (Lowland wet, Montane mesic and Montane wet) (75 FR 18960-19165):

Ecosystem: Lowland Wet. Elevation: <3,000 ft (<914 m). Annual precipitation: >75 in (>190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

Ecosystem: Montane Mesic. Elevation: 3,300–5,243 ft (914–1,598 m). Annual precipitation: 50–75 in (127–190 cm). Substrate: weathered aa lava, rocky mucks, thin silty loams, deep volcanic ash soils. Canopy: Acacia, Metrosideros, Psychotria, Tetraplasandra, Zanthoxylum. Subcanopy: Cheirodendron, Coprosma, Kadua, Ilex, Myoporum, Myrsine. Understory: Bidens, Dryopteris, Leptecophylla, Poa, Scaevola, Sophora.

Ecosystem: Montane Mesic. Elevation: 3,300–5,243 ft (914–1,598 m). Annual precipitation: 50–75 in (127–190 cm). Substrate: weathered aa lava, rocky mucks, thin silty loams, deep volcanic ash soils. Canopy: Acacia, Metrosideros, Psychotria, Tetraplasandra, Zanthoxylum. Subcanopy: Cheirodendron, Coprosma, Kadua, Ilex, Myoporum, Myrsine. Understory: Bidens, Dryopteris, Leptecophylla, Poa, Scaevola, Sophora.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species,

competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 2,600 and 4,000 feet (793 to 1,225 m) (USFWS, 2010)

Habitat Narrative

Adult: Tetraplasandra flynnii (ohe ohe) is a tree in the ginseng family (Araliaceae) found in Metrosideros polymorpha (ohia) montane mesic to wet forest in the lowland wet, montane mesic, and montane wet ecosystems, at elevations between 2,600 and 4,000 ft (793 and 1,225 m) (Lowry and Wood 2000, p. 42; HBMP 2007; TNCH 2007). Current population occurs on a steep north-facing montane mesic to wet ohia forest with a mostly open canopy that is approximately 10-15 m tall (Lowry and Wood, 2000). (USFWS, 2010; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from NatureServe, 2015)

Redundancy:

Very low (inferred from NatureServe, 2015)

Number of Populations:

7 subpopulations (USFWS, 2017)

Population Size:

~30 (USFWS, 2017)

Population Narrative:

It is similar to the more widespread species *T. kawaiensis*, however, this species is only known from a single population consisting at present, of only three individuals. (NatureServe, 2015). There are currently about 30 individuals of *Polyscias flynnii* in seven subpopulations, with only five individuals in the largest subpopulation. Seed collection efforts are ongoing (USFWS, 2017).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from non-native plants, pigs, goats, hurricanes, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species.

Stressor: Predation and herbivory (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species present an immediate and significant threat to *Tetraplasandra flynnii* throughout its range due to documented browsing and trampling by pigs, goats, and deer (USFWS, 2010).

Stressor: Small populations (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: *Tetraplasandra flynnii* is known only from a single population with fewer than 50 individuals. Research on *Pittosporum* species suggests that small populations are susceptible to loss of genetic variation through inbreeding and drift (USFWS, 2010).

Recovery

Reclassification Criteria:

Downlisting Criteria In addition to achieving 5 to 10 populations with 400 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Multi-island species should be represented by at least three populations on each of the islands from which they were known historically, but considered on a species-by-species basis. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats (USFWS, 2017).

Delisting Criteria:

Delisting Criteria In addition to achieving 5 to 10 populations with 400 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. Multi-island species should be represented by at least three populations on each of the islands from which they were known historically, but considered on a species-by-species basis. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis. This recovery objective has not been met (see Table 1) (USFWS, 2017).

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys. (USFWS, 2010)
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units. (USFWS, 2010)
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys. (USFWS, 2010)
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range. (USFWS, 2010)
- Conduct research on control methods for introduced slugs and avian malaria. (USFWS, 2010)
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction. (USFWS, 2010)
- Identify threats and prioritize which ones to address first for the two birds. (USFWS, 2010)
- Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program. (USFWS, 2010)
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security. (USFWS, 2010)
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems. (USFWS, 2010)
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these

species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations. (USFWS, 2010)

Conservation Measures and Best Management Practices:

- **RECOMMENDATIONS FOR FUTURE ACTIONS** • Surveys and inventories—Continue to survey for populations of *Polyscias flynnii* in areas of potentially suitable habitat. • Ungulate monitoring and control—Construct small-scale ungulate exclosures to protect all populations from feral ungulates to prevent imminent extinction. Protect all occurrences against browsing and disturbances from feral ungulates. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative plant species around all populations that compete with the species. • Rodent predation or herbivory control—Implement effective measures to control rodents around all populations. • Invertebrate predation or herbivory control—Study *Polyscias flynnii* populations to determine level of threat from insect predation and effective control actions. • Captive propagation for genetic storage and reintroduction—Continue to secure ex-situ stocks with complete representation of remaining individuals. • Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Human disturbance—Develop and implement effective measures to reduce the threat of malicious injury. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered throughout historic range to reduce impacts from landslides and storms. • Based on the recovery criteria above, consider development of a recovery plan (USFWS, 2017).
- **Current Management Actions:** • Surveys and inventories—PEPP monitors this species at Kalalau, Honopu, and Wahiawa (PEPP 2010, 2011, 2012, 2013, 2014, 2015, 2016). • Captive propagation for genetic storage and reintroduction—One founder from the Kalalau Rim population is represented at Lyon Arboretum Seed Bank by 24 seeds (Lyon Arboretum 2017). Another founder from this population is also represented at NTBG Seed Bank (NTBG 2017). It remains uncertain the long-term storage potential of this species in conventional seed storage (Keir and Weisenberger 2014). There are three trees representing a third founder from the Kalalau population at the NTBG gardens, and over a hundred seeds currently being propagated at the NTBG nursery (NTBG 2017) (USFWS, 2017).

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SPECIES ACCOUNT: *Polyscias* (= *Tetraplasandra*) *gymnocarpa* (*`ohe`ohe*)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/28/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

Tetraplasandra gymnocarpa is a member of the Auraliaceae (ginseng family). This tree species ranges in height from 2.5 to 10.0 m (8.2 to 32.8 ft) and has odd-pinnate compound leaves which are 30 to 55 cm (11.8 to 21.7 in) long. Flowers are perfect (both anthers and stamens) and found in terminal compound-umbellate or racemose-umbellate inflorescences. The fruit is a drupe and purple at maturity (Wagner et al. 1999).

Historical Range

See current range/distribution

Current Range

Tetraplasandra gymnocarpa was historically known from Punaluu, Waikakalaua Gulch, Mount Olympus, and the region between Niu and Wailupe in the Koolau Mountains of Oahu. This species was also observed in the Waianae Range at Palikea in 1954. Currently, *T. gymnocarpa* is restricted to 16 occurrences totaling at least 176 individuals in the summit regions of the Koolau Mountains (Wagner et al. 1999; K. Kawelo, pers. comm. 2003; J. Lau, pers. comm. 2003). Specifically, these occurrences are found at Paumalu and Kaunala Gulches (4 individuals), lower Peahinaia trail (2), lower Kawai Iki (8), Peahinaia trail (midreach; 1), Kawai Iki trail (1), upper Kawai Iki (1), south Kaukonahua summit (1), Waimano to south Kaukonahua Gulch (at least 25), Waikakalaua (1), Kaipapapa to Kaluanui (at least 25), Kawalao to Waiau (25), Aiea trail (2), Halawa-Haiku Ridge to Moanalua-Haiku Ridge (at least 25), Puu Keahiakahoe (21), Konahuanui (9), and East Honolulu-Wiliwili Nui to Kulioouou (at least 25) (Wagner et al. 1999; J. Lau, HINHP, pers. comm. 2003; K. Kawelo, U.S. Army, pers. comm. 2003).

Critical Habitat Designated

Yes; 6/16/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Polyscias* (= *Tetraplasandra*) *gymnocarpa* (*`ohe`ohe*) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Polyscias* (= *Tetraplasandra*) *gymnocarpa* (77 FR 57648-57862). The critical habitat designation includes 18 critical habitat units, which encompass approximately 31,995 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Polyscias* (= *Tetraplasandra*) *gymnocarpa* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Polyscias (=Tetraplasandra) gymnocarpa* includes 18 critical habitat units, covering three ecosystem types, which encompass approximately 31,995 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 4, 5, 6, 7; Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; Oahu—Wet Cliff—Units 6, 7, 8.

Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Hauula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikeekee, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet—Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet—Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu

land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu—Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamo Ridge.

Oahu—Wet Cliff—Unit 6 [151 ac (61 ha)]. This area consists of 151 ac (61 ha) in the wet cliff ecosystem on State land on the windward side of the Koolau Mountains in Kaipapau Gulch, entirely within the Kaipapau Forest Reserve. Oahu—Wet Cliff—Unit 7 [144 ac (58 ha)]. This area consists of 144 ac (58 ha) in the wet cliff ecosystem in State land on the windward side of the Koolau Mountains in Hauula Gulch, entirely within the Hauula Forest Reserve. Oahu—Wet Cliff—Unit 8 [4,649 ac (1,881 ha)]. This area consists of 1,479 ac (598 ha) of State land, 1,281 ac (519 ha) of City and County of Honolulu land, 5 ac (2 ha) of Federal land, and 1,884 ac (762 ha) of privately owned land, in the wet cliff ecosystem along the summit of the Koolau Mountains, overlapping portions of Sacred Falls State Park, the Waiahole FR (Waiahole and Iolekaa sections), the Kaneohe and Honolulu Watershed FRs, and the Nuana Pali State Wayside.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Polyscias (=Tetraplasandra) gymnocarpa* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Polyscias (=Tetraplasandra) gymnocarpa* occurs within the Lowland mesic, Lowland wet and Wet cliff ecosystems in the Koolau Mountain caldera complex:

Oahu—Lowland Mesic—Units 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (F) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Oahu—Wet Cliff—Units 6, 7, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: >65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. (F) Understory: Bryophytes, Ferns, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Polyscias* (=Tetraplasandra) *gymnocarpa* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: *T. gymnocarpa* has been observed flowering and fruiting in November (Service 1996) and Colonel David L. Anderson 140 fruiting in May and September (Service 1998a). There is little other information on its reproductive cycles, longevity, specific environmental requirements, or limiting factors.

Habitat Type

Adult: Wet forest

Habitat Narrative

Adult: Usually in wet forests (often in the cloud zone) near the spine of the Koolau Mountains and, less often, in moist-wet forests. On ridgecrests, on gulch slopes, and in gulch bottoms. (NatureServe, 2015). *Tetraplasandra gymnocarpa* is typically found on windswept summit ridges, slopes, or gullies in wet or sometimes mesic lowland forests and shrublands between elevations of 93 and 959 m (305 and 3,146 ft). Associated native plant species include *Acacia koa*, *Antidesma platyphyllum*, *Bidens* spp., *Bobea elatior*, *Broussaisia arguta*, *Cheirodendron* spp., *Cibotium chamissoi*, *Cibotium glaucum*, *Cyanea humboldtiana*, *Dicranopteris linearis*, *Diplopterygium pinnatum*, *Dubautia laxa*, *Freycinetia arborea*, *Hedyotis fosbergii*, *Hedyotis terminalis*, *Labordia* sp., *Lobelia hypoleuca*, *Machaerina angustifolia*, *Melicope* sp., *Metrosideros polymorpha*, *Myrsine fosbergii*, *Pouteria sandwicensis*, *Psychotria* spp., *Sadleria* sp., *Syzygium sandwicensis*, *Tetraplasandra oahuensis*, and *Wikstroemia* sp. (HINHP Database 2001; Service 1998a).

Dispersal/Migration

Population Information and Trends

Resiliency:

No evidence of regeneration. (NatureServe, 2015)

Representation:

No evidence of regeneration. (NatureServe, 2015)

Redundancy:

No evidence of regeneration. (NatureServe, 2015)

Number of Populations:

6 - 20 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Adaptability:

No evidence of regeneration. (NatureServe, 2015)

Population Narrative:

No evidence of regeneration. Currently 24 plants observed, estimate less than 1000 plants. Ten current and twelve historical occurrences. (NatureServe, 2015)

Threats and Stressors**Stressor:****Exposure:****Response:****Consequence:**

Narrative: The major threats to *Tetraplasandra gymnocarpa* are similar to those of other wet forest plants. Feral pigs root soil and destroy habitat. The two-spotted leafhopper causes a systemic infection that defoliates the plant. Non-native plant species such as *Aleurites moluccana*, *Araucaria columnaris*, *Ardisia elliptica*, *Axonopus fissifolius*, *Clidemia hirta*, *Erigeron karvinskianus*, *Eucalyptus* sp., *Paspalum conjugatum*, *Psidium cattleianum*, *Pterolepis glomerata*, *Sacciolepis indica*, and *Setaria palmifolia* compete for light, space, and nutrients. The small size of occurrences results in reduced reproductive vigor and the risk of extinction from stochastic events (HINHP Database 2001; Service 1998a; 59 FR 14482). Conservation Needs of the Species A State-wide management plan should be developed and implemented for the long-term conservation of all known occurrences of *Tetraplasandra gymnocarpa*. This plan should also include broader landscape actions that are needed for the recovery of this plant throughout its range. The recovery plan for this species identifies the following important conservation actions. Fenced exclosures need to be constructed around all known occurrences of *T. gymnocarpa*. Emphasis should be placed on those occurrences with five or less individuals (e.g., Paumalu and Kaunala Gulches, Kawailoa trail). Feral pigs and competitive nonnative plant species should be removed or controlled from exclosures and from the greater landscape needed to recovery this plant. Monitoring should be conducted at each occurrence to determine the presence, and effect of, the two-spotted leafhopper on *T. gymnocarpa*. If this leafhopper is detected and its presence is adversely affecting seedlings or trees, the insect should be controlled using approved pest management methods.

Recovery**Conservation Measures and Best Management Practices:**

- Both the Lyon Arboretum and Waimea Arboretum have genetic material of *Tetraplasandra gymnocarpa* in genetic storage. The Lyon Arboretum houses 10 plants/seeds from two sources and Waimea Arboretum houses two plants from one source (Service 2002). Seed germination attempts

at Lyon Arboretum have not been successful (Service 1998a). The Service is currently not aware of any other conservation efforts for this species.

References

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SPECIES ACCOUNT: *Polyscias* (=Tetraplasandra) *lydgatei* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/18/2012; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Tetraplasandra lydgatei (NCN), a tree in the ginseng family (Araliaceae). (USFWS, 2012)

Taxonomy

Kartesz (1999) included *Tetraplasandra lydgatei* in *T. oahuensis*. Motley (2005) presents evidence that *T. lydgatei* deserves formal taxonomic recognition as a distinct species. In 2011, the U.S. FWS recognized it, proposing Endangered status under the Endangered Species Act. As of 2015, U.S. FWS recognizes this taxon as *Polyscias lydgatei* following Lowry and Plunkett (2010) and Wagner et al. (2012). (NatureServe, 2015)

Historical Range

Endemic to the Koolau Mountains, island of Oahu, state of Hawaii. (NatureServe, 2015)

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On September 18, 2012, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Polyscias* (=Tetraplasandra) *lydgatei* under the Endangered Species Act of 1973, as amended (Act) (77 FR 57648-57862). The critical habitat designation includes 4 critical habitat units, which encompass approximately 1,939 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Polyscias* (=Tetraplasandra) *lydgatei* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Polyscias* (=Tetraplasandra) *lydgatei* includes 4 critical habitat units, covering one ecosystem type, which encompasses approximately 1,939 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 4, 5, 6, 7.

Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on

the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Polyscias* (=Tetraplasandra) *lydgatei* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Polyscias* (=Tetraplasandra) *lydgatei* occurs within the indicated ecosystem in the Koolau Mountain caldera complex:

Oahu—Lowland Mesic—Units 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Polyscias* (=Tetraplasandra) *lydgatei* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (USFWS, 2012)

Habitat Vegetation or Surface Water Classification

Adult: Forests (USFWS, 2012)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 800 and 1,600 feet (240 and 490 meters) (USFWS, 2012)

Habitat Narrative

Adult: *Tetraplasandra lydgatei* (NCN), a tree in the ginseng family (Araliaceae), is found in mesic forest in the lowland mesic ecosystem at elevations between 800 and 1,600 ft (240 and 490 m) in the Koolau Mountains (Motley 2005, p. 107; TNC 2007). (USFWS, 2012)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Resiliency:

Very low (inferred from NatureServe, 2015)

Redundancy:

Very low (inferred from NatureServe, 2015)

Number of Populations:

2 (USFWS, 2012)

Population Size:

42 (8 wild, 34 outplanted) (USFWS, 2012; NatureServe, 2015)

Population Narrative:

Formerly found from Niu Valley to the Halawa Ridge Trail, its distribution is now limited to two wild occurrences: one on the eastern slope of Hawaii Loa Ridge and another on Kulepeamo Ridge. These occurrences total 8 individuals (HBMP 2008). Additionally, 34 individuals have been outplanted in a fenced area at Kulepeamo Ridge (PEP Program 2007 cited by USFWS 2011). (USFWS, 2012; NatureServe, 2015)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative plants, animals (pigs), and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The projected effects of climate change will likely exacerbate the effects of the other threats to the species (USFWS, 2012).

Stressor: Predation and herbivory (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs) is considered an ongoing threat to *Tetraplasandra lydgatei* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2012).

Stressor: Small populations (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: *Tetraplasandra lydgatei* faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). The range of known occurrences of *T. lydgatei* has been reduced from 10 mi (16 km) to 2 mi (3 km) since 2005, and consists of 2 occurrences totaling 8 individuals. These individuals are showing a decline in health (USFWS, 2012).

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

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SPECIES ACCOUNT: *Polyscias racemosum* (=Munroidendron racemosum) (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/25/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

A tree up to 7 m tall with a straight trunk and spreading branches. The bark is grey and smooth. The flowers are borne along a hanging stalk 25 - 60 cm long (NatureServe, 2015).

Taxonomy

A member of the ginseng family (Araliaceae) (USFWS, 2003). The Araliaceae family is composed of 55 genera totaling about 1,500 species worldwide, with most distributed in the tropics and sub-tropics (Wood 2008). Hawaiian Araliaceae includes four genera with 15 endemic species (USFWS, 2010). Monotypic genus, restricted to Kauai. First described by Forbes, 1917, as *Tetraplasandra racemosa*. Sherff described new genus *Munroidendron* based on Forbes' name. Wagner et al are not recognizing any of Sherff's varieties (NatureServe, 2015).

Historical Range

Historically, *Munroidendron racemosum* was known from scattered locations throughout the island of Kauai (USFWS, 2010).

Current Range

Occurrences are now known from Waiahuakua, Pohakuao, the left and right branches of Kalalau Valley, Nakeikionaiwi Valley, Awaawapuhi Valley spring, Honopu Valley, Nualolo Valley, Poomau Valley, Kawaiiki Valley, Koaie Canyon, Nonou, Haupu, and Keopaweo (USFWS, 2003).

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Polyscias racemosum* (=Munroidendron racemosum) on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Polyscias racemosum* (=Munroidendron racemosum) includes four units totaling 5,469 acres in Kauai County, Hawaii. The units are Kauai 5—Munroidendron racemosum—a, Kauai 7—Munroidendron racemosum—b, and Kauai 11—Munroidendron racemosum—c, d.

Kauai 5—Munroidendron racemosum— a: This unit is critical habitat for *Munroidendron racemosum* and is 60 ha (148 ac) on State land (Nonou Forest Reserve). This unit contains Nonou Summit and the Sleeping Giant. This unit provides habitat for one population of 100 mature, reproducing individuals of the long-lived perennial *Munroidendron racemosum* and is currently occupied with six plants. This unit is essential to the conservation of the taxon because it

supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep exposed cliffs or ridge slopes in coastal or lowland mesic forest. This unit is geographically separated from the other three units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 7—*Munroidendron racemosum*— b: This unit is critical habitat for *Munroidendron racemosum* and is 50 ha (123 ac) on private land, containing Naluakeina Summit and Queen Victoria's Profile. This unit provides habitat for one population of 100 mature, reproducing individuals of the long-lived perennial *Munroidendron racemosum* and is currently occupied with two plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep exposed cliffs or ridge slopes in coastal or lowland mesic forest. This unit is geographically separated from the other three units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 11—*Munroidendron racemosum*—c: This unit is critical habitat for *Munroidendron racemosum* and is 1,952 ha (4,824 ac) on State (Hono o Na Pali NAR, Haena and Na Pali Coast State Parks) and private land. This unit contains Hanakapiai, Hanakoa, and Kalalau Valleys, Kanakou Summit, Kaaalahina and Kalepa Ridges, Nualolo Kai, and Pohakuao. This unit provides habitat for six populations of 100 mature, reproducing individuals of the long-lived perennial *Munroidendron racemosum* and is currently occupied with 46 to 86 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep exposed cliffs or ridge slopes in coastal or lowland mesic forest. This unit is geographically separated from the other three units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Munroidendron racemosum*—d: This unit is critical habitat for *Munroidendron racemosum* and is 153 ha (379 ac) on State land (Alakai Wilderness Preserve). This unit contains portions of Kawaiiki and Kipalau Valleys. This unit provides habitat for two populations of 100 mature, reproducing individuals of the long lived perennial *Munroidendron racemosum* and is currently occupied with three plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep exposed cliffs or ridge slopes in coastal or lowland mesic forest. This unit is geographically separated from the other three units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Primary Constituent Elements/Physical or Biological Features

Within these units the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Steep exposed cliffs or ridge slopes in coastal or lowland mesic forest and containing one or more of the following associated plant species: *Bobea brevipes*, *Brighamia insignis*, *Canavalia napaliensis*, *Diospyros sandwicensis*, *Diospyros hillebrandii*, *Nestegis sandwicensis*, *Pisonia sandwicensis*, *Pisonia umbellifera*, *Pleomele aurea*, *Pouteria sandwicensis*, *Psychotria* spp., *Psydrax odorata*, *Rauvolfia sandwicensis*, *Schiedea* spp., *Sida fallax*, or *Tetraplasandra* spp.; and

(ii) Elevations between 11 and 938 m (37 and 3,077 ft).

Special Management Considerations or Protections

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species in paragraph (b) of this section and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: self-pollination, cross-pollination (USFWS, 2003)

Lifespan

Adult: > 10 years (USFWS, 2010)

Breeding Season

Adult: Year round (USFWS, 2003)

Key Resources Needed for Breeding

Adult: Likely insects (USFWS, 2003)

Reproduction Narrative

Adult: It is a long-lived perennial (USFWS, 2010). Reproduction occurs year-round, with flowers and fruits found throughout the year. Self-pollination is assumed to occur since viable seeds have been produced by isolated individuals. Pollinators have not been observed, but insect pollination is likely (USFWS, 2003).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Moist forests (NatureServe, 2015); dry to mesic regions (USFWS, 2010); coastal to lowland mesic forest (USFWS, 2003)

Geographic or Habitat Restraints or Barriers

Adult: 19 - 3,213 ft. elevation (USFWS, 2003)

Habitat Narrative

Adult: Moist forests on cliffs, ridges, and steep slopes. (NatureServe, 2015). Munroidendron racemosum trees usually grow on vertical basalt cliffs in dry to mesic regions, as well as on moderately steep slopes or talus terraces, and are occasionally seen among basalt boulders near drainages (Wood 2008) (USFWS, 2010). Munroidendron racemosum is typically found on steep exposed cliffs or on ridge slopes in coastal to lowland mesic forests at elevations between 6 and 979 m (19 and 3,213 ft.) (USFWS, 2003).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Dispersal mechanisms are unknown (Service 1995) (USFWS, 2003).

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Increasing (USFWS, 2010)

Resiliency:

Low (inferred from USFWS, 2003; see current range/distribution)

Redundancy:

Moderate (inferred from USFWS, 2010)

Number of Populations:

14 subpopulations (USFWS, 2017)

Population Size:

110-170 (USFWS, 2017)

Population Narrative:

In 2003, 17 populations were known on Kauai with approximately 59 to 99 individuals. Currently, *Munroidendron racemosum* has approximately 114 naturally occurring individuals surviving in the wild and over 400 outplanted individuals (USFWS, 2010). At the time of the last 5-year review in 2010 there were 14 populations totaling 114 individuals, in four locations on Kauai. Surveys conducted after the last 5-year review have confirmed individuals in the same locations at Hoolulu (three individuals), Kalalau (two individuals), Waiahuakua (two to five individuals), Hipalau (four individuals), Kawaiiki (one individual), Koaie (four individuals), Kipu Kai (one individual), and Nonou (four individuals) (NTBG 2011, 2012a-d, 2013a-f, 2015a, c, 2017b-c, e-f). Populations at Hanakoa (eight individuals), Honopu (three individuals), Nakeikianaiwi (four individuals), Kalepa (50 individuals), Nualolo Kai (19 individuals), and Pohakuao (23 individuals) have not been observed since 2002 to 2008 and the current status of individuals at these locations is unknown; however, this species continues to slowly decline at the more frequently visited populations. Adams (2016) reports individuals at four locations, within 14 “subpopulations” (considered “populations” by USFWS) totaling 110 to 170 individuals, with the largest population consisting of 45 individuals (USFWS, 2017).

Threats and Stressors

Stressor: Feral ungulates (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Feral goats degrade the habitat of *Munroidendron*, and cattle were formerly present in areas where the trees grow (USFWS, 1995).

Stressor: Invasive plants (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The major threat to *Munroidendron racemosum* is competition with alien plant species (kukui, ti, Chinaberry, common guava, firetree, koa haole, lantana, and *Triumfetta semitriloba* (Sacramento bur)) (USFWS, 1995).

Stressor: Predation (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Fruit predation by rats; an introduced insect of the longhorned beetle family (Cerambycidae) killed a mature, cultivated tree and has the potential of affecting wild trees (USFWS, 1995).

Stressor: Stochastic events/small population size (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Species like *Munroidendron racemosum* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding, and disease outbreaks (USFWS, 2010).

Stressor: Human disturbance (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Not available

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Polyscias racemosa* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.727 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery**Reclassification Criteria:**

1. A total of five to seven populations should be documented on Kauai and at least one other island where they now occur or occurred historically (USFWS, 1995).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population (for long-lived perennials) (USFWS, 1995).
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 1995).

Delisting Criteria:

1. A total of 8 to 10 populations should be documented on Kauai and at least one other island where they now occur or occurred historically (USFWS, 1995).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population (for long-lived perennials) (USFWS, 1995).

3. Each population should persist at this level for a minimum of five consecutive years (USFWS, 1995).

Recovery Actions:

- Protect current populations, control threats and monitor (USFWS, 1995).
- Expand current populations (USFWS, 1995).
- Conduct research essential to conservation of the species (USFWS, 1995).
- Establish new populations as needed to reach recovery objectives (USFWS, 1995).
- Validate and revise recovery objectives (USFWS, 1995).
- Devise and implement a public education program (USFWS, 1995).

Conservation Measures and Best Management Practices:

- Collect seed between November and February, for best quality and availability, from all known populations (USFWS, 2010).
- Fence all populations possible to exclude negative impacts from ungulates (USFWS, 2010).
- Propagate individuals representing all populations for reintroduction (USFWS, 2010).
- Reintroduce new populations in protected areas within suitable habitat (USFWS, 2010).
- Control invasive introduced species at as many populations as possible (USFWS, 2010).
- Work with Hawaii Division of Forestry and Wildlife and Hawaii State Parks to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2010).
- New Management Actions: • NTBG continues to collect thousands of seeds for storage and propagation from populations of *Polyscias racemosa* at Hipalau, Kalalau, Hoolulu, Nonou, Kipu Kai, Koaie, Kawaiiki, Pohakuao, and Nakeikianaiwi, but it is uncertain how many founders are represented (NTBG 2017g). Some individuals are planted in NTBG gardens as living collections. Lyon Arboretum has several founders represented in their seed bank (Lyon Arboretum 2017). Waimea Valley Arboretum (2016) has five plants in their living collection. Kokee rare Plant Facility has two founders and 15 total plants in the nursery (DOFAW 2016) (USFWS, 2017).
- Recommendations for Future Actions: No new threats and no other significant new information regarding the species' biological status have been reported since the last 5-year review in 2010. The following recommendations for future actions are reiterated for the 5-year review for 2017. • Surveys and inventories—Survey for populations of *Polyscias racemosa* in areas of potentially suitable habitat. • Ungulate monitoring and control—Protect all populations against browsing and disturbances from feral ungulates. Continue to construct fenced exclosures to protect populations from ungulates. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative species that compete with the species around all populations. • Predator and herbivore monitoring and control—Implement effective measures to control rodents around all known populations. • Predator and herbivore control research—Study *Polyscias racemosa* populations to determine level of threat from invertebrate herbivory and any additional needed recovery actions. • Fire monitoring and control—Develop and implement fire management plans for all wild and reintroduced populations. • Captive propagation for genetic storage and reintroduction—Continue to collect seeds between November and February, for best quality and availability, from all known populations. Continue to propagate individuals representing all populations for reintroduction. • Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Human interaction monitoring and management—Develop and implement effective measures to reduce the impacts of

hikers and trail maintenance. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and hurricanes (USFWS, 2017).

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SPECIES ACCOUNT: *Portulaca sclerocarpa* (Po`e)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/04/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

Portulaca sclerocarpa is in the Portulacaceae, or purslane family. It is a short, generally herbaceous perennial that has a fleshy tuberous taproot that becomes woody. Its stems are up to 20 centimeters (7.9 inches) long. The species has stalkless, succulent, grayish-green leaves that are almost circular in cross-section. Dense tufts of hairs are located in each leaf axial and underneath the tight clusters of three to six stalkless flowers. The flowers are grouped at the end of the stalk and petals are white, pink, or pink with a white base. The sepals are 5 millimeters (0.2 inch) long with membranous edges. The hardened capsules are 5 millimeter (0.2 inch) long, and have thick walls that open late or not at all. The species is closely related to *P. villosa*, differing in the thickness of the capsule wall, the length of the capsule, and the capsule of *P. sclerocarpa* is indehiscent or tardily indehiscent (U.S. Army 2003a).

Historical Range

See current range/distribution

Current Range

The historic and current locations of *Portulaca sclerocarpa* are limited to the islands of Lanai and Hawaii. On the island of Lanai, plants are found on the Poopoo Islet. On the island of Hawaii, the species occurs in the Nohonaohae area, at Puu Anahulu, near Puu Keani and Lehua, and at PTA (see Figure 43 in the Transformation Biological Assessment). At PTA, the species occurs in Kipuka Kalawamauna Endangered Plant Habitat, north and west of Kipuka Alala, and on the 1859 Mauna Kea lava flow (U.S. Army 2003a).

Critical Habitat Designated

Yes; 7/2/2003.

Legal Description

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Portulaca sclerocarpa* on the island of Hawaii (68 FR 39623 - 39722).

On January 9, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Portulaca sclerocarpa* on the island of Lanai, Hawaii.

Critical Habitat Designation

The critical habitat designation for *Portulaca sclerocarpa* includes one unit totaling 10,848 acres on the island of Hawaii. The unit is Hawaii 27—*Portulaca sclerocarpa*—a. This contains the Keanakakoi, Kokoolau, and Puhimau craters; Lele o Kalihipaa Pali; and a portion of the lava flow of 1921. The unit lies completely within HVNP; provides habitat for 5 populations of 300 individuals of the *P. sclerocarpa*; and is currently occupied by more than 900 individuals. This unit is essential to the conservation of *P. sclerocarpa* because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population. This

unit provides the southeasternmost critical habitat within the species' historical range. This unit is geographically separated from other critical habitat for this multi-island species within its historical range in order to reduce the likelihood of all recovery populations being destroyed by one naturally occurring catastrophic event.

Hawaii 27—*Portulaca sclerocarpa*—a [4,390 ha (10,848 ac)]:

The critical habitat designation for *Portulaca sclerocarpa* includes two units totaling 19 acres on the island of Lanai. The units are Lanai 5—*Portulaca sclerocarpa*—Coast and Lanai 6—*Portulaca sclerocarpa*—Isle.

Lanai 5—*Portulaca sclerocarpa*—Coast [7 ha; 17 ac]: This unit is critical habitat for *Portulaca sclerocarpa* and is 7 ha (17 ac) on privately owned land. This unit lies along the shore between Anapuka in the west and Huawai Bay in the east. This unit provides habitat for one population (combined with Lanai 6—*Portulaca sclerocarpa*—Isle) of 300 mature, reproducing individuals of this shortlived perennial and is currently unoccupied. The habitat features contained in this unit that are important for this species include, but are not limited to, exposed ledges in thin soil in coastal communities. This coastal habitat is unique to Lanai for this species; on the island of Hawaii, this species grows on weathered soils, cinder cones, or geologically young lava; in montane dry shrubland; often on bare cinder; near steam vents; or in open *Metrosideros polymorpha*-dominated woodlands, away from coastal areas. This critical habitat unit provides area for one recovery population within the historical range of this multi-island species and is adjacent to the currently occupied habitat in Unit 6—*Portulaca sclerocarpa*—Isle. It is geographically separated from other designated critical habitat on the island of Hawaii in order to avoid all populations from being destroyed by one naturally occurring catastrophic event.

Lanai 6—*Portulaca sclerocarpa*—Isle [1 ha; 2 ac]: This unit is critical habitat for *Portulaca sclerocarpa* and is 1 ha (2 ac) on privately owned land. This unit comprises all of Poopoo Islet. This unit provides habitat for one population (combined with Lanai 5—*Portulaca sclerocarpa*—Coast) of 300 mature, reproducing individuals of this shortlived perennial and is currently occupied by about 10 plants. This unit is important to the conservation of the species because it supports the one extant colony of this species on Lanai. This unit also includes habitat that is important for the expansion (combined with Lanai 5—*Portulaca sclerocarpa*—Coast) of the present population. The habitat features contained in this unit that are important for this species include, but are not limited to, exposed ledges in thin soil in coastal communities. This coastal habitat is unique to Lanai for this species; on the island of Hawaii, this species grows on weathered soils, cinder cones, or geologically young lava; in montane dry shrubland; often on bare cinder; near steam vents; or in open *Metrosideros polymorpha*-dominated woodlands, away from coastal areas. This critical habitat unit provides area for one population within the historical range of this multi-island species. It is geographically separated from other designated critical habitat units on the island of Hawaii to prevent all populations from being destroyed by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Habitat features that are essential for this species include, but are not limited to, weathered Mauna Kea soils, cinder cones, or geologically young lavas in montane dry shrubland, often on bare cinder, near steam vents, and in open *Metrosideros polymorpha* dominated woodlands.

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

- (i) Exposed ledges in thin soil in coastal communities; and
- (ii) Elevations between 0 and 30 m (0 and 98 ft).

Special Management Considerations or Protections

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for this species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

In addition to monitoring the plant populations, management actions include, but are not limited to: (1) Feral ungulate control; (2) nonnative plant control; (3) rodent control; (4) invertebrate pest control; (5) fire management; (6) maintenance of genetic material of the endangered and threatened plant species; (7) propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; (8) ongoing management of the wild, outplanted, and augmented populations; and (9) habitat management and restoration in areas deemed essential for the recovery of the species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Little is known about the life history of the species. Flowers have been observed in March, June, and December. Juveniles are present in some locations, indicating reproduction is taking place (U.S. Army 2003a).

Habitat Type

Adult: Montane dry shrublands

Habitat Narrative

Adult: *Portulaca sclerocarpa* is found in montane dry shrublands, often on bare cinder, near steam vents, and in open *Metrosideros polymorpha* woodlands from 1,030 to 1,630 meters (3,379 to 5,348 feet) in elevation. At PTA, the species is found on barren lava and in the Sparse

Metrosideros Treeland, Open Metrosideros Treeland with sparse shrubs understory, Open Metrosideros Treeland with dense shrub understory, Intermediate Metrosideros Mixed Treeland, and the Myoporum Shrubland vegetation types.

Dispersal/Migration***Population Information and Trends*****Resiliency:**

Fragility unknown. (NatureServe, 2015)

Representation:

Fragility unknown. (NatureServe, 2015)

Redundancy:

Fragility unknown. (NatureServe, 2015)

Number of Populations:

6 - 20 (NatureServe, 2015)

Population Size:

1000 - 2500 individuals (NatureServe, 2015)

Adaptability:

Fragility unknown. (NatureServe, 2015)

Population Narrative:

Fragility unknown. Total of over 1000 plants. 10 current (between 1982 and 1997) and 7 historical occurrences. (NatureServe, 2015)

Threats and Stressors**Stressor:****Exposure:****Response:****Consequence:**

Narrative: The major threats to *Portulaca sclerocarpa* are competition from non-native grasses, such as *Pennisetum setaceum* and *Andropogon virginicus*; trampling and habitat disturbance from feral sheep, goats, and pigs; habitat disturbance associated with military exercises; and fire. Plant grazing has not been observed, but it has been suggested that trampling by feral animals may damage the understory, destroy plants, and open sites to non-native species (U.S. Army 2003a).

Recovery***Conservation Measures and Best Management Practices:***

- The following important conservation actions are needed: continued propagation and maintenance of ex situ genetic stock of *Portulaca sclerocarpa*, protection of habitat from feral ungulates, and

control of non-native grasses. Efforts should be made to ensure that both the Lanai and island of Hawaii populations remain viable. Outplanting of propagated plants may be necessary in order to augment populations (Service 1996a). In addition, a State-wide management plan that identifies areas and landscapes for the long-term conservation of all known occurrences of *P. sclerocarpa* is needed. As part of this management plan, landowners and managers should delineate management units to conserve this species and other native species through threat control and habitat restoration.

References

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SPECIES ACCOUNT: *Portulaca villosa* (Ihi)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2017)

Physical Description

Perennial herbs from a fleshy, tuberous, but becoming woody taproot. Stems prostrate to weakly ascending, up to ca. 3 dm long. Leaves narrowly oblanceolate to linear, subterete, 5-25 mm long, 1.5-3 mm wide. Flowers usually 3-6 in dense, terminal, head-like cymes. Petals white, pink, or pink with a white base, obovate, 8-10 mm long. Capsules broadly ovoid, 3-5 mm long. (NatureServe, 2015)

Taxonomy

Genus cosmopolitan, chiefly tropical America, species endemic to Hawaiian Islands. (NatureServe, 2015) A member of the purslane family (Portulacaceae) (Wagner et al. 1999, p. 1074) (USFWS, 2016).

Historical Range

Portulaca villosa is historically known from all the main Hawaiian Islands except Niihau and Kauai (Wagner et al. 1999, p. 1074). This species has not been observed on Oahu since the 1960s, when it was locally abundant at Kaohikaipu Island (HBMP 2010). Historically, on the island of Hawaii, this species occurred in the coastal area of Hawaii Volcanoes National Park west of Kamoamoa, but was extirpated in 1993 by lava flows (Orlando 2015, in litt.). On the island of Lanai, two individuals were last observed in 1996 (HBMP 2010) (USFWS, 2016).

Current Range

Portulaca villosa is endemic to the Hawaiian Islands. In the Northwestern Hawaiian Islands it occurs on the island of Nihoa. In the main islands, it has been documented from Kaula (a little island south of Niihau), Oahu, Molokai, Maui, Lanai, Kahoolawe, and Hawaii. It is unrecorded on Niihau and Kauai. (NatureServe, 2015) *Portulaca villosa* has been observed on the small islets of Kaula and Lehua (west of Kauai and Niihau), and on Nihoa (NWHI); however, the current status of these occurrences is unknown (USFWS, 2016).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Habitat Type

Adult: Terrestrial (USFWS, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Dry, rocky, clay, lava, or coralline reef sites (USFWS, 2015)

Dependencies on Specific Environmental Elements

Adult: Coastal, lowland dry, and montane dry ecosystems (USFWS, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 0 - 1,600 ft. elevation (USFWS, 2015)

Habitat Narrative

Adult: *Portulaca villosa* occurs on dry, rocky, clay, lava, or coralline reef sites, from sea level to 1,600 ft (490 m), in the coastal (Lehua, Kaula, Oahu, Kahoolawe, Maui, and Hawaii Island) and lowland dry (Oahu, Molokai, Lanai, Kahoolawe, Maui, and Hawaii Island) ecosystems, and one reported occurrence in the montane dry (Hawaii Island) ecosystem (Wagner et al. 1999, p. 1074; TNCH 2007; HBMP 2010) (USFWS, 2015).

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Not available

Resiliency:

Moderate (inferred from USFWS, 2016)

Redundancy:

Low (inferred from USFWS, 2016)

Number of Populations:

Molokai: 1, Maui: 2, Kahoolawe: 1, Hawaii: 5 (USFWS, 2016)

Population Size:

Molokai: ~3, Maui: 26, Kahoolawe: < 15, Hawaii: 10 (USFWS, 2016)

Population Narrative:

Currently, *P. villosa* is known from a few individuals on Molokai, 2 individuals on east Maui and 24 individuals on west Maui, fewer than 15 individuals on Kahoolawe, and five occurrences totaling 10 individuals on Hawaii Island (MNTF 2010, in litt.; Evans 2015a, in litt.) (USFWS, 2016).

Threats and Stressors

Stressor: Nonnative ungulates (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Axis deer (Maui and Lanai), mouflon, sheep, and goats (Lanai), and cattle (Hawaii Island) modify and destroy the habitat of *Portulaca villosa* (HBMP 2010). These animals may also forage directly on this species (USFWS, 2015).

Stressor: Nonnative plants (USFWS, 2015)

Exposure:

Response:**Consequence:** Loss of habitat**Narrative:** Nonnative plants compete with and modify and destroy native habitat of *P. villosa*; displace this species and other native Hawaiian plants; and pose a threat to the known occurrences on Hawaii Island, Maui, Kahoolawe, Lanai, and Molokai (Smith 1985, pp. 180–250; Vitousek et al. 1987 in Cuddihy and Stone 1990, p. 74) (USFWS, 2015).**Stressor:** Stochastic events (USFWS, 2015)**Exposure:****Response:****Consequence:** Loss of habitat/loss of individuals**Narrative:** *Portulaca villosa* occurs in drier coastal and lowland habitats, all of which are at risk from wildfires. Some coastal habitat includes exposed cliffs, which erode and cause rockfalls in areas where *P. villosa* occurs (Kahoolawe), posing a threat to this species (HBMP 2010) (USFWS, 2015).**Stressor:** Reduced vegetative vigor (USFWS, 2015)**Exposure:****Response:****Consequence:** Extinction**Narrative:** This species may experience reduced reproductive vigor due to low levels of genetic variability, leading to diminished capacity to adapt to environmental changes, and thereby lessening the probability of long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361) (USFWS, 2015).**Stressor:** Climate change (USFWS, 2015)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** Climate change may result in alteration of the environmental conditions and ecosystems that support this species. *Portulaca villosa* may be unable to tolerate or respond to changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini et al. 2013, p. 86) (USFWS, 2015).**Recovery****Recovery Actions:**

- A recovery plan has not been completed for this species.

References

U.S. Fish and Wildlife Service. 2015. Endangered and Threatened Wildlife and Plants

Endangered Status for 49 Species From the Hawaiian Islands

Proposed Rule. FR Vol. 80, No. 189. Pages 58820-58909

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Endangered Status for 49 Species From the Hawaiian Islands. Final rule. 81 FR 67786 67860 (September 30, 2016).

Proposed Rule. FR Vol. 80, No. 189. Pages 58820-58909.

SPECIES ACCOUNT: *Potentilla hickmanii* (Hickman's potentilla)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial herb from a woody taproot. Leaves are basal, with 4-7 pairs of deeply cleft leaflets. Stems are prostrate or decumbent, mostly 8-15 cm long. Slender flowering stems, 4-25 mm long, bearing yellow flowers arise from each stem. Blooms April-August. (NatureServe, 2015)

Taxonomy

Astragalus tener var. *titi* (Figure 4) was first collected by Mrs. Joseph Clemens in 1904. It was first described by Alice Eastwood as *Astragalus titi* based on those specimens collected by Clemens near Moss Beach, Monterey (Eastwood 1905). Eastwood named the plant *A. titi* in honor of Dr. F. H. Titus, who also collected specimens of this plant. Jepson (1936) considered these two taxa synonymous. Howell (1938) compared type specimens of *A. tener* and *A. tener* var. *titi* and confirmed two different plants, based on the low decumbent habit and smaller flowers of *A. tener* var. *titi*. Barneby (1950) published the name *A. tener* var. *titi*, noting differences from *A. tener* var. *tener* (alkali milk-vetch) in size of various flower parts, habitat, and geographic range. *Astragalus tener* var. *tener* is native to alkaline grass flats in the Central Valley, San Francisco Bay region, and the lower Salinas Valley (Barneby 1950). Additionally, crossing studies and enzyme electrophoresis concluded that *A. tener* var. *titi* is a valid taxon (Liston 1992) (USFWS, 2004).

Historical Range

Potentilla hickmanii was historically known from two general areas along the central coast of California: on the Monterey Peninsula in Monterey County, and in the Half Moon Bay area in San Mateo County. The type specimen was collected from the Monterey Peninsula “near the reservoir which supplies Pacific Grove” and described by Alice Eastwood in 1902. Several other collections were made from the Monterey Peninsula during the 1930s, but detail on specific locations is lacking. (USFWS, 2009)

Current Range

California endemic. One extant population in Monterey County. One large population exists in San Mateo County. The total range extent consists of 3 areas and about 9 sq. mi. (NatureServe, 2015)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (USFWS, 2004)

Breeding Season

Adult: Seeds are produced late in the season (USFWS, 2004).

Reproduction Narrative

Adult: *Potentilla hickmanii* has protogynous flowers with a stigma that is receptive to pollen before the pollen-bearing anthers open within the same flower (Jones and Stokes Associates 1996). This mechanism can reduce self-pollination and increase the possibility of outcrossing. It is also likely that some level of interpopulational genetic diversity exists (B. Ertter in litt. 1997). Seeds are produced late in the season. Plants may produce little to no seeds in drier years, especially among early-blooming flowers (Jones and Stokes Associates 1996, B. Ertter in litt. 1997). This lack of seed set might be due to the observed absence of pollinators during blooming time of dry years. Natural population increases appear during wet years, although these population increases may not occur during dry years (Doak et al. 2000). Additionally, recent greenhouse research indicates that some plants previously counted as up to five individuals may have been one single plant with a branched caudex (V. Yadon in litt. 2002). Research was conducted during 1998 and 1999 to explore environmental factors that limit seed production and establishment, and how a limitation might vary through the plants' flowering season (Doak et al. 2000). Evidence for pollen limitation of seed set was apparent and pollen augmentation also significantly reduced the probability of reproductive failure (Doak et al. 2000). Reproductive failure may exist if both pollinator visitation and pollen dispersal is low. Doak et al. (2000) observed only one pollinator in the 2-year study (i.e., a small beetle). Additionally, this research discovered that developed, mature seed was found significantly more frequently in plants that were within at least 50 centimeters (20 inches) of each other than in isolated plants (Doak et al. 2000). *Potentilla hickmanii* will grow and bloom year-round under cultivated conditions. However, cultivated flowers that bloom later in the year tend not to set seed (V. Yadon in litt. 2002). Plants with early flowers that were grown in a hot house set seed apparently without benefit of pollinators (V. Yadon in litt. 2002) (USFWS, 2004).

Habitat Type

Adult: coastal scrub/forest (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits coastal bluff scrub and closed-cone pine forest (Smith & Berg 1988). Freshwater marshes, seeps and streamlets in open forested areas near the coast, 0-75 m. (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species and the low number of known populations.

Dispersal/Migration

Population Information and Trends**Population Trends:**

Decreasing (NatureServe, 2015)

Resiliency:

Low (NatureServe, 2015)

Population Growth Rate:

Decline of 70-90% (NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

250 - 2500 individuals (NatureServe, 2015). As of 2019: In San Mateo County, a population of between 2,000 and 3,000 individuals is scattered over a half square mile (sq mi) (130 hectares (ha)). In Monterey County, one population comprised of less than 20 plants occurs on less than one quarter of an acre (0.1 ha). (USFWS, 2019).

Population Narrative:

Highly vulnerable due to lack of appeal and to sensitivity of its wetland habitat. Decline of 70-90% The largest population with perhaps 2000 plants (?) is known from Devils Slide area in San Mateo Co., California. At least one population in Monterey Co. has plants (about 15) as well. 9 total EO's are known, but at least 4-5 are historic or extirpated. (NatureServe, 2015)

Threats and Stressors

Stressor: Development (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: current threats to the population at Pebble Beach, Monterey County, are relatively the same as at the time of listing. Because a second population has been discovered since the time of listing (Montara population in San Mateo County) and threats to the population are less than they are for the Pebble Beach, Monterey County, population, the threats to the species overall are less than they were at the time of listing. In addition, the Montara population has been transferred from private ownership to state and local agency ownership (CalTrans and Peninsula Open Space Trust), and long-term plans are to transfer these lands to California State Parks and Golden Gate National Recreation Area, respectively. However, threats to the habitat remain at both locations, and include conversion of coastal terrace prairie habitat by native and nonnative species, alteration in hydrology, and recreation. The Pebble Beach population is threatened with extirpation from alteration and destruction of habitat because the size of coastal prairie where *Potentilla hickmanii* occurs is less than 0.25 ac (0.1 ha) and the number of individuals is so few; therefore, the remaining individuals may not be able to persist if the condition of the habitat continues to decline (USFWS, 2009).

Stressor: Predation (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Predation on *Potentilla hickmanii* by mule deer (*Odocoileus hemionus*) on the Pebble Beach population in Monterey County has been observed by Yadon (in litt. 1997) and others (Jones and Stokes Associates 1996). Since the time of listing, herbivory by voles (*Microtus* spp.), snails (various species), and slugs (various species) has also been observed on both vegetative and reproductive structures (Doak et al. 2000). As recently as 2008, Staub (in litt. 2008) noted that gophers (*Thomomys* sp.) and mice (various species) are likely affecting the population. With so few individuals comprising this population (11 individuals as of 2008), predation exacerbates the threat of stochastic extinction (see Factor E). We have also become aware that the Montara population in San Mateo County is within an area being grazed by cattle (CNDDDB 2008). Cattle grazing may be either beneficial or deleterious to the species, depending on the intensity and duration. Cattle grazing may benefit the species by reducing competition from nonnative species. Too little grazing may allow nonnative species to outcompete *Potentilla hickmanii*, while too much grazing may result in predation or trampling of *Potentilla hickmanii*. We do not have specific information concerning the intensity or the overall impact of grazing that is occurring within this area (USFWS, 2009).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: This species occurs within a portion of the Monterey Peninsula included in the California Coastal Zone. The Del Monte Forest Land Use Plan of 1984 was developed to comply with the Coastal Act's requirement that all counties prepare a plan for those portions of the Coastal Zone within their jurisdiction. Once the Del Monte Forest Land Use Plan was certified by the Coastal Commission, development permits within the Del Monte Forest coastal zone became the responsibility of the County of Monterey. The County of Monterey also has designated certain areas, including where *Potentilla hickmanii* grows, as Environmentally Sensitive Habitat Areas. Protection of listed species through the California Coastal Act and local land use designations is dependent upon the discretion of the lead agency involved. Although no projects have been proposed for the site where *Potentilla hickmanii* grows, these state and local regulations may not protect the species from secondary impacts that occur from such threats as changes in hydrology in adjacent areas and the spread of nonnative species (USFWS, 2009).

Stressor: Competition with nonnative species (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: At the Monterey Peninsula site, at least five nonnative plant species occur within *Potentilla hickmanii* habitat. These include: hairgrass, various bromes, tall fescue, and ryegrass (Ferreira 1995, Yadon pers. comm. 2008). Nonnative grasses including Harding grass (*Phalaris aquaticus*) also occur at the Montara site. Several of these nonnative taxa are known to outcompete and displace native species in general (Bossard et al. 2000). To determine the effects of competition on *Potentilla hickmanii*, Doak compared the number of inflorescences and the number of flowers on *Potentilla hickmanii* seedlings within plots where surrounding vegetation

was either clipped or unclipped; *Potentilla hickmanii* seedlings in the clipped plots produced more flowers and inflorescences than those in the unclipped plots (Doak et al. 2000). At the Montara site, pampasgrass was noted as being a potential threat to one colony of *Potentilla hickmanii* (Kramer 2008) (USFWS, 2009).

Stressor: Reproductive failure (USFWS, 2009)

Exposure:

Response:

Consequence: Reduced number of new plants

Narrative: At the time of listing, we discussed that reproductive failure was a concern, primarily because the Monterey Peninsula population had a very low number of new seedlings established over a 2- year period (Morosco 1997). In addition, low seed set had been observed by several biologists (Ertter in litt. 1997, Yadon in litt. 1997). Since the time of listing, Doak et al. (2000) compared seed set in flowers that were cross-pollinated by hand with those in a control group. Based on number of ovules, each flower has the potential to produce approximately 10 seeds; the researchers found that hand-pollinated flowers achieved a higher seed set than the control group (4.8 per flower compared to 3.2) (Doak et al. 2000). The lack of pollinators observed in the field has been put forth as a potential cause for low seed set by several observers (Yadon in litt. 1997, Ertter in litt. 1997, Doak et al. 2000) (USFWS, 2009).

Stressor: Small numbers of individuals and populations (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of genetic variability/extinction

Narrative: Conservation biology literature discusses that small populations are threatened by inbreeding depression (Ellstrand and Elam 1993). Small populations can have significantly lower germination rates than larger populations of the same species due to high levels of homozygosity (Menges 1991). Based on historical records, we believe that urban development and secondary impacts associated with such development has already reduced the distribution of this species in the two areas where it occurs. Indirect effects from urbanization in the watersheds include changes in hydrology, changes in vegetation, and an increase in nonnative species. The effects of competition with nonnative species is most problematic immediately adjacent to urban areas and in habitat that has been isolated or fragmented by development (Alberts et al. 1993). While any one of these factors may not be enough to threaten the survival of *Potentilla hickmanii* independently, its limited range, the cumulative and synergistic effects of all of these factors combined could be a threat to the survival and recovery of *Potentilla hickmanii* (USFWS, 2009).

Stressor: Alteration of fire frequency (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: At the time of listing, we discussed that alteration of fire frequency was a potential threat to all five taxa in the listing rule, due to fire suppression activities that increased on the Monterey Peninsula as development increased over time; we did not discuss specifically how reducing the frequency of fires in the area would affect *Potentilla hickmanii*. Although *Potentilla hickmanii* itself is associated with grassland habitats, the small meadow where it occurs is within an opening of Monterey pine forest. Without periodic fire, the pine forest would tend to expand in range over time and eventually shade out the habitat where *Potentilla hickmanii* occurs.

Shading by Monterey pine was also noted as a threat to several colonies of *Potentilla hickmanii* at the Montara population (Kramer 2008). Based on current information, alteration of fire frequency may continue to be a threat to *Potentilla hickmanii* at both sites (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). Recently, the potential impacts of climate change on the flora of California were discussed by Loarie et al. (2008). Based on modeling, they predicted that species' distributions will shift in response to climate change, specifically that the species will "move" or disperse to higher elevations and northward, depending on the ability of each species to do so. Species diversity will also shift in response to these changes with a general trend of diversity increases shifting towards the coast and northwards with these areas becoming de facto future refugia. However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to *Potentilla hickmanii* at this time (USFWS, 2009).

Recovery

Reclassification Criteria:

At least five viable populations (i.e., populations that are stable or increasing based on a minimum of 10 years monitoring) occur in suitable habitat (addresses Listing Factors A and E). This criterion is relevant and up-to-date. This criterion has not been met. In addition to the two populations known at the time of listing, one outplanting effort is underway at Point Lobos State Park (USFWS, 2009).

All five of the sites are on land that is protected from human-induced disturbance. Funds must be available for appropriate long-term management. As determined by research, protected habitat must be of adequate size (large enough to support a functioning ecosystem; e.g., species present to support seed dispersal and pollination, areas that support fluctuating distributions, areas that harbor suitable unoccupied habitat for population expansion) and configuration to ensure that ecosystem and community processes and associated species (e.g., hydrologic regime, food webs, pollinator fauna, forest meadow communities) are maintained, and that an adequate diversity of sites exist for population expansion and for colonization of new areas as microhabitat conditions change. One of these protected sites should be the Indian Village (Pebble Beach) population; another should be the Montara population in San Mateo County (addresses Listing Factors A and E). This criterion is relevant and up-to-date. This criterion has not been met (USFWS, 2009).

Surrounding vegetation has been managed for a reduction of nonnative plant species and nonnative snails and slugs. The populations should be adequately maintained, such that

encroachments by nonnative plants and herbivorous predators (including deer) are not negatively affecting *Potentilla hickmanii* directly or indirectly (addresses Listing Factor C). Individuals have been caged at the Pebble Beach population, and this has reduced deer browse. However, additional management is needed to control nonnative species. This criterion is relevant and up-to-date. This criterion has been partially met for one population (USFWS, 2009).

The populations have been appropriately managed to such a degree that monitoring has determined the populations are of adequate size, density, and number that the trend for each of the populations is projected to be stable or increasing in the future (addresses Listing Factors A and E). Population censusing and demographic studies have been conducted for the Pebble Beach population, but not in a manner that is able to detect long-term trends. This criterion is relevant and up-to-date. This criterion has not been met (USFWS, 2009).

A seed bank has been established at a recognized institution certified by the Center for Plant Conservation (addresses Listing Factor E). This criterion is relevant and up-to-date. This criterion has been partially met in the following way: a portion of seed from the Pebble Beach population that was previously collected for research is being stored at the University of California, Santa Cruz (UCSC); UCSC is not a Center for Plant Conservation affiliate. A small amount of seed was collected from the Montara population in 1995 by staff from the University of California, Berkeley (Jones and Stokes 1996); its current disposition is unknown (USFWS, 2009).

Delisting Criteria:

Delisting Criterion 1) threats are reduced or eliminated so that protected populations are capable of persisting without significant human intervention or perpetual endowments are secured for management necessary to maintain the continued existence of the species. The most outstanding management needs currently are: a) maintaining and restoring habitat through control of nonnative grass species, and b) control of herbivory by deer and small mammals. (USFWS, 2019).

Delisting Criterion 2) unoccupied habitat in the area has been assessed for its suitability for reintroduction efforts; the Monterey Peninsula area should be further assessed for potential sites. Two additional, new populations are established and protected where appropriate. (USFWS, 2019).

Delisting Criterion 3) all protected populations remain viable for at least 10 years to demonstrate long-term viability under a range of environmental conditions. We expect above-ground population size to fluctuate annually, based on response to amount and timing of rainfall (e.g. see Fox et al. 2006). Even though this is a perennial species, the aboveground portion is herbaceous and dies back each year, and thus responds to some extent like an annual species. Therefore, a period of 10 years should be long enough to include most of the variability in rainfall that occurs in this region (Zedler & Black 1989; NOAA 2018). (USFWS, 2019).

Conservation Measures and Best Management Practices:

- Work with Pebble Beach Company to evaluate current conditions and improve habitat conditions at the Pebble Beach site. Determine if additional measures can be taken to reduce threats from overwatering, invasive nonnative species, and herbivores (a portion of recovery tasks 1.4.3 and 2.3) (USFWS, 2009).

- Continue pollination ecology research initiated by Doak to determine if lack of pollinators is limiting seed set at the Pebble Beach site. Conduct research to identify pollinators at the Montara site and compare with those at Pebble Beach (a portion of recovery task 3.2.3) (USFWS, 2009).
- Seek additional sites for outplanting additional populations in Monterey and San Mateo Counties. State Park lands (aside from Point Lobos) may offer opportunities for outplanting (a portion of recovery task 4.2.3) (USFWS, 2009).
- Coordinate with Peninsula Open Space Trust to determine if management actions need to be taken to protect or enhance habitat for the species on lands they manage prior to transfer to Golden Gate National Recreation Area (GGNRA). Seek assurance from GGNRA that necessary management actions be continued (USFWS, 2009).

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SPECIES ACCOUNT: *Primula maguirei* (Maguire primrose)

Species Taxonomic and Listing Information

Listing Status: Threatened; 08/21/1985; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

A perennial herb with stems approximately 4-10 cm tall, each bearing 1-3 showy, conspicuous lavender-colored flowers. Blooms May-June. (NatureServe, 2015)

Taxonomy

Primula maguirei was recently determined to be one of four varieties of *Primula cusickiana* A. Gray (Holmgren and Kelso 2001). The classification is described as *Primula cusickiana* var. *maguirei* L.O. Williams (Holmgren and Kelso 2001). The physical features of the plant are as they were when originally classified and this taxonomic reclassification does not change its limited range and geographic restrictions. *Primula maguirei* is an endemic with unique ecological and physical characteristics; however, the features that distinguish *Primula cusickiana* var. *maguirei* from other varieties within *Primula cusickiana* are not substantial enough to warrant *P. maguirei* being classified at the species level (Holmgren and Kelso 2001). We recognize the synonymy (same identity) of *P. maguirei* = *P. cusickiana* var. *maguirei* and find this taxonomic change does not affect the listing or protection of the *P. maguirei* under the ESA. We recommend that the taxonomy be amended through a technical revision to the list at 50 CFR 17.12 (see section 4). Until that time, we will continue to refer to this species as *Primula maguirei* (USFWS, 2011).

Current Range

Limited area of Logan Canyon in Cache county, Utah (Tilley et al. 2011).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: insect and hummingbird pollinated. Also able to reproduce asexually (USFWS, 2011)

Breeding Season

Adult: Flowering mid-April to mid-May (USFWS, 2011).

Reproduction Narrative

Adult: *Primula maguirei* is a perennial, herbaceous plant 50-100 millimeters (mm) (2-4 inches (in.) high, with showy reddish-lavender flowers. Leaves are oblong and 50 mm (2 in. long and 12 mm (0.5 in.) wide. *P. maguirei* has two types of flowers, the pin and thrum—this is referred to as heterostyly (Davidson and Wolf 2009). On the pin form flower, the female reproductive organs (pistil—produces ovules which become seeds) are higher than the male reproductive organs (stamen—produces pollen). The thrum form is the opposite (Davidson and Wolf 2009). The different lengths of the pin and thrum flowers are adapted for pollination by different

pollinators or different body parts of the same pollinator (Davidson 2010). These flower forms thus promote outcrossing (reproducing with non-related individuals) through sexual reproduction (Darwin 1877 in Bjerregaard and Wolf 2008). Bees, moths, and hummingbirds pollinate *Primula maguirei* flowers (Davidson 2010). *Primula maguirei* also can reproduce asexually, using underground rhizomes or horizontal plant stems to produce new shoots. Rhizomes allow storage of water in times of drought. This clonal growth pattern (genetically identical individuals growing together) allows recovery after periods of dormancy, such as during drought conditions (Kelso et al. 2009). The clonal nature of this species also makes it difficult to identify individual plants in the field (Sibul 2006). *Primula maguirei* is distributed across a linear reach (ca. 16.5 kilometers (km) (10 miles (mi)) of Logan Canyon, with occurrences aggregated in upper and lower portions of the canyon that are separated by some 9.6 km (6 mi) of unoccupied habitat (see section 2.3.1.2). The upper and lower portions of the canyon are characterized by differences in several environmental parameters likely to influence the species' life history. The average temperature over the flowering period is 5°C (9°F) warmer in the lower canyon than it is in the upper canyon (Torti 2008; Davidson and Wolf 2009; Torti and Schen 2009). The average relative humidity also is lower (15-20%) in the lower canyon than in the upper canyon (Torti 2008; Davidson and Wolf 2009; Torti and Schen 2009). Generally, flowering occurs between mid-April and early June, but due to these environmental differences, plants in the lower canyon may begin blooming 2 to 3 weeks earlier and tend to dry out faster than those in the upper canyon (Bjerregaard and Wolf 2008; Torti 2008; Davidson and Wolf 2009; Torti and Schen 2009). It is unknown if there is sufficient cross pollination between the lower and upper canyon sites (Wolf and Sinclair 1997; Bjerregaard and Wolf 2008) (see section 2.3.1.3 for genetic discussion). Some investigators have noted a period of overlap (10–17 days) where both the lower and upper canyon sites are in flower, but the number of flowering individuals is low during this period (Bjerregaard and Wolf 2008; Davidson and Wolf 2009). However, observations since 2006 have revealed little to no period of overlap, suggesting a very limited potential for gene flow between these two portions of the species' very limited geographic range (Torti 2011b) (USFWS, 2011). Flowering mid-April to mid-May. Plant associates include pink alumroot (*Huechera rubescens*), mat rockspirea (*Petrophytum caespitosum*), tadpole buttercup (*Ranunculus ranunculinus*), and narrowleaf wildparsley (*Musineon lineare*) (Tilley et al. 2011) (NatureServe, 2015).

Habitat Type

Adult: cliff ledge (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits damp ledges, crevices, and over-hanging rocks along canyon walls.

Almost always on north-facing, moss covered limestone cliffs at or near the canyon bottom in shallow dolomitic soils of the Laketown and Fish Haven geologic formations (Tilley et al. 2011). 1350-1700 m elevation. (NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seed dispersal from May to June (England 1990) (NatureServe, 2015)

Population Information and Trends**Population Trends:**

Unknown

Resiliency:

Low (NatureServe, 2015)

Representation:

Low (NatureServe, 2015)

Redundancy:

Low (NatureServe, 2015)

Number of Populations:

6 - 20 (NatureServe, 2015)

Population Size:

250 - 2500 individuals (NatureServe, 2015); 4000 - 20000 (USFWS, 2011)

Additional Population-level Information:

Our evaluation of the 1990 recovery plan (USFWS 1990), and the original 1985 listing rule (50 FR 33731) indicated that we did not present how we defined a population for Maguire primrose. For this amendment and managing for Maguire primrose in the future, we use NatureServe guidelines for delimiting plant populations (NatureServe 2004) which are based on the proximity of occupied habitat areas to one another. We consider locations within 2 kilometer (km) (1.24 miles (mi)) of each other and suitable habitat in between them to be a single population. Plant locations that are greater than 2 km (1.24 mi) from each other with unsuitable habitat in between them, are considered separate populations (NatureServe 2004). Based on this criterion, there are two populations of Maguire primrose (Lower Canyon and Upper Canyon), and the number of populations has not changed since the time of our listing decision (USFWS 2019).

Population Narrative:

It is estimated that 3000 individuals exist across all 6 populations (Tilley et al. 2011). Past surveys have produced estimates around 1000. 6 known populations (Tilley et al. 2011). (NatureServe, 2015). Low resiliency, representation and redundancy are based on the relatively low number of populations and the relatively restricted geography this species inhabits.

Threats and Stressors

Stressor: Rock Climbing (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: The USFS has funded a number of studies to look at the interactions between rock climbing and *Primula maguirei* (Sibul 2006; Torti 2008; Torti and Schen 2009; Torti 2010, 2011a). These studies have examined climbing-related impacts at 11 of the 12 EO locations mapped for *P. maguirei* by the UNHP, and have consistently concluded that climbing-related impacts are not occurring at these sites (TABLE 2). The explanations for the apparent lack of conflict varied by site--at 3 sites, *P. maguirei* is not (and may never have been) present; of the remaining 8 sites, 1 was assessed as unsuitable for climbing; 2 have been formally closed to climbing by the USFS; another lacked any evidence of impacts despite the presence of *P. maguirei* within a few meters of climbing routes; and at the remaining 4 sites, plants are not located along or near climbing routes (Sibul 2006; Torti 2010, 2011a, 2011b; summarized in TABLE 2 this document). Short-term monitoring (1-3 years in duration) at 5 of the 9 EOs where *P. maguirei* still occurs has indicated that plants are relatively stable, showing no significant mortality or decreased growth at any monitored location (Torti 2011a). These studies have recommended that existing climbing closures remain in effect, but have not recommended additional closures based upon the apparent lack of conflict from existing patterns and levels of climbing activity (Sibul 2006; Torti 2008; Torti and Schen 2009; Torti 2010, 2011a). Instead, these authors recommend that monitoring of both *Primula maguirei* and climbing use continue in order to gain increased confidence in apparent trends as well as to verify the assumption that climbing routes and/or pressures will not change. We believe that the threats posed by rock climbing may be less than previously assessed, based on the preliminary data and short-term monitoring that has occurred so far, and we concur with the recommendations to continue monitoring to ensure that the species is adequately protected from habitat loss from climbing-related activities. Monitoring should include an adaptive management approach that utilizes the monitoring data to determine the necessity of continued monitoring and management actions. This recommendation is reflected in section 4 (USFWS, 2011).

Stressor: Highway Improvements (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: At the time of listing, transportation and utility construction from the mouth of Logan Canyon to the Right Fork of Logan Canyon were considered threats to the species (50 FR 33733, August 21, 1985). Highway and utility construction had the potential to change the geomorphology of the canyon; we believed that construction could result in altered air patterns and the removal of vegetation to an extent that the microclimate habitat of the cliffs would become less suitable for *Primula maguirei*. Since the time of listing, one highway resurfacing and bridge replacement (Burnt Bridge) project has occurred near the upper canyon *Primula maguirei* sites, from the Right Fork of Logan Canyon to Garden City (Federal Highway Administration 1995). *P. maguirei* occurrences along this stretch of highway are about 40-50 feet above the highway. Conservation measures were used to protect the species, such as avoiding construction activity in *P. maguirei* habitat, limiting removal of canyon-bottom trees (preserving microhabitat conditions of the cliff face), avoiding blasting during the flowering period, and minimizing dust during the flowering period (Federal Highway Administration 1995). Highway widening projects have the potential to impact the species. However, the Utah Department of Transportation (UDOT) does not have plans to improve the highway through at least 2030 (UDOT 2007). Therefore, we do not consider highway projects to be a threat to the species in the foreseeable future (USFWS, 2011).

Stressor: Campground Development (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: At the time of listing, we determined that campground and trail development within Logan Canyon area may impact the species (50 FR 33733, August 21, 1985). Furthermore, we were concerned with the indirect effects of altering the microenvironment of Logan Canyon by removing canyon-bottom trees for campgrounds (50 FR 33732, August 21, 1985). Two small campgrounds are currently within 0.25 mi of three known *Primula maguirei* locations. We are not aware of any loss of plants from campground activities. No major campground improvements have occurred since we listed *P. maguirei* and further campground development is now seen as unlikely given the limited space available in the canyon (Duncan 2010, pers. comm.). We no longer consider campground activities as a threat (USFWS, 2011).

Stressor: Maintenance and Improvement to Water Development (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: At the time of listing, we determined that utility construction was a threat. More specifically, the Recovery Plan stated that water development and maintenance or improvements of facilities such as reservoirs and water pipelines were threats to the species (FWS 1990). However, the only water facility in the canyon is the DeWitt Pipeline, which supplies 70% of Logan City's water (CH2MHILL 2007). We are not aware of any *Primula maguirei* occurrences within the DeWitt pipeline route (CH2MHILL 2007). The final biological assessment for the project also included best management practices and mitigation measures to reduce the likelihood negative impacts to the species would occur as a result of the project (CH2MHILL 2007). We are not aware of any additional water improvement projects planned within the vicinity of habitats occupied by *P. maguirei*. Therefore, we do not currently consider water development to be a threat (USFWS, 2011).

Stressor: Climate Change (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Reliable projections of climate change in the West are particularly difficult due largely to its complex topography (Smith et al. 2001). It is thus difficult to predict the long-term effects of climate change on a species such as *Primula maguirei* that occurs in a relatively small area (Wolf 2010, pers. comm.). At least one location (Right Fork, EO #007 in TABLE 2) has decreased in the number of individuals and area of coverage in apparent response to dry winter and spring conditions (Shultz 1987 in IHI 1995). Another occurrence (Lower Logan Canyon North, EO #003 in TABLE 2) was located in 1982 during a wet year, but has not been observed again since (Sibul 2006). Although rhizomes may allow *P. maguirei* to store water in times of drought (see section 2.3.1.1), extreme weather events, such as persistent or prolonged drought conditions, could ultimately exceed the drought tolerance of *P. maguirei*. In 2008, HOBO data loggers were placed at 10 sites throughout Logan Canyon and programmed to record temperature and humidity every 30 minutes (Torti 2008). Torti also established 124 permanent quadrats over the course of 2 years (2008 and 2009) to record the approximate size of clumps of *P. maguirei*, the number of

stems per clump, the number of flowers per stem, the pin or thrum form of the flower, as well as the general state of the flower's phenology (Torti 2008). Follow-up surveys in 2009 and 2011 suggest that plants within permanent quadrats have been relatively stable, with no significant mortality or reductions in vegetative growth (stems) or reproduction (flowers) (Torti and Schen 2009; Torti 2011a). We recommend that this long-term monitoring effort continue in conjunction with data collection from the HOBO data loggers, so that a climate vulnerability assessment can be completed for this species (see section 4) (USFWS, 2011).

Stressor: Disease or predation (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: In the listing document and Recovery Plan for *Primula maguirei*, disease and predation were not considered threats to the species (50 FR 33733, August 21, 1985; FWS 1990). Herbivory from rodents is regularly encountered (Sibul 2006; Bjerregaard and Wolf 2008; Torti 2008; Davidson and Wolf 2009; Torti and Schen 2009), primarily from bushy-tailed woodrats (*Neotoma cinerea*) and similar species (Bjerregaard and Wolf 2008). Snails of the *Oreohelix* genus were observed directly on plant leaves (Davidson 2010). Insects also may damage fruits of the plants (Sibul 2006). The magnitude of herbivory of a single individual ranges from the single flower being eaten to the entire plant being devoured (Davidson 2010). Herbivory from rodents, snails and insects appears to affect plants; however, we do not have information indicating that it is occurring at unnatural or unsustainable levels. We have no evidence to indicate that this factor is a threat to this species now or for the foreseeable future (USFWS, 2011).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Prior to listing, *Primula maguirei* was afforded some protection because the USFS designated it as a sensitive species under the NFMA. This designation requires the USFS to analyze the effects of actions they fund, authorize, or carry out that may affect *P. maguirei*. In the event that ESA protections are removed, the USFS has expressed the intention to once again designate *P. maguirei* as a sensitive species, thereby reinstating these protections. The USFS also has designated substantial parts of Logan Canyon as a Botanical Special Interest Area, a designation which directs the agency to protect and manage (in part) for the unique botanical resources present, including *P. maguirei*. This designation also will remain in effect regardless of the ESA status of *P. maguirei*. In addition, the USFS has funded numerous research projects to better understand the status of this species and its vulnerability to threats, and has closed certain areas to climbing activity as a result of concerns stemming from the perceived threats. If these existing regulatory mechanisms continue to be adequately implemented, as they have been in recent years, we regard them as likely to be sufficient to provide for the long-term protection of the species in the event that it is de-listed (USFWS, 2011).

Stressor: Invasive Species (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Weed infestation is a possible threat to *Primula maguirei*. Dyer's woad (*Isatis tinctoria*) is found near 8 of the 9 sites where *P. maguirei* is found (CH2MHILL 2007). Dyer's woad is primarily found in disturbed sites, such as pastures, rangeland, cropland, woodlands, and areas of disturbed soils such as housing developments (Weber County 2004). Dyer's woad also could invade lands disturbed by fire, roads, and areas associated with grazing. Because *P. maguirei* grows within the cliff face, in cracks and crevices, we do not anticipate that this infestation will directly affect *P. maguirei*. It is possible that rockslides could occur in sites occupied by *P. maguirei*, allowing Dyer's woad to gain a foothold; however, these events are rare and would not occur with great frequency. Efforts to control Dyer's woad or other invasive exotics using herbicides and/or biocontrol agents could affect *P. maguirei*; however, conservation measures contained in the Forest Plan are adequate to avoid direct and indirect effects associated with these management activities (USDA 2003). We have no evidence to suggest that invasive exotic species are currently impacting *P. maguirei*. However, because future infestations of invasive species can be difficult to predict, this threat represents a perpetual challenge that must be periodically assessed and managed appropriately. The Forest Plan directs the USFS to manage the threat of invasive species to the sensitive botanical resources in Logan Canyon Botanical Special Interest Area (USDA 2003). At the present time, we regard this threat as foreseeable, but adequately addressed by existing regulatory mechanisms (USFWS, 2011).

Stressor: Small Population Risks (USFWS, 2011)

Exposure:

Response:

Consequence: Extinction

Narrative: Smaller numbers of plant individuals are more likely to succumb to natural catastrophes (e.g., drought, fire, and flood), environmental stochasticity (e.g., changes in weather, available pollinators, amount of predation), and demographic stochasticity (e.g., fluctuations in survival and fitness). We acknowledge that *Primula maguirei* is found in a single canyon and this limited range increases the potential for some threats to affect all known populations simultaneously. However, several factors suggest that *P. maguirei* may be less vulnerable to these risks than its limited geographic distribution otherwise suggests: • Estimates of the total number of plants in the wild have increased from 350 (at listing) to between 4,000-20,000 clumps (see section 2.3.1.2); • The number of locations known to support the species also has increased since the time of listing (also see section 2.3.1.2); • The rugged and isolated habitat (i.e., moist cliff tops, notches and boulders) in which *P. maguirei* occurs appears generally unsuitable for rock climbing routes, suggesting that although climbing occurs in Logan Canyon, this threat may have less of an effect than previously thought on the habitats in which *P. maguirei* occurs; and, • Preliminary monitoring data indicates that existing populations have been stable (low rates of mortality over the past 3 years). These increases in abundance and the number of known locations should reduce the risk of extirpation or extinction from stochastic events. However, as noted above (section 2.3.1.2), recent estimates of abundance in *Primula maguirei* populations are either imprecise (ranging from 4,000-20,000 clumps) or speculative (the presumption of additional locations in areas that have yet to be surveyed). These estimates and assumptions need verification through additional surveys before threats from small population risk can be effectively dismissed (USFWS, 2011).

Recovery

Reclassification Criteria:

Maintain at least two populations (Lower Canyon and Upper Canyon) at a level that demonstrates stable or increasing trend in plant abundance over a consecutive ten-year period. Plant abundance (measured by the number of ramets) may fluctuate within individual sites, but the defined populations should have a stable or increasing growth rate (λ equal to or greater than 1) over a consecutive ten-year period. The ten-year period may start retroactively (USFWS 2019).

Maintain an estimated range-wide total population size at or greater than 4,000 individuals for a five-year minimum period. This population estimate will be based on a measure of the number of ramets identified in criterion 1, above. The five-year period may start retroactively (USFWS 2019).

The two populations (Lower Canyon and Upper Canyon) demonstrate sexual reproduction by pollinators over a consecutive ten-year period. Sexual reproduction (recorded as the presence of mature fruits that contain viable seeds) should be documented at all eight extant sites within the two populations. This measure does not need to be recorded on an annual basis, but should be recorded every two or three years over a ten-year period. The ten-year period may start retroactively (USFWS 2019).

Long-term habitat protections are in place for the two populations (Lower Canyon and Upper Canyon) to protect Maguire primrose from rock climbing and other potential threats with the U.S. Forest Service via long-term management agreements, conservation agreements, or memoranda of understanding (MOU). Species management would include outreach and education efforts to climbing audiences that would continue to build community support for long-term protections (USFWS 2019).

The two populations (Lower Canyon and Upper Canyon) are represented in an ex-situ seed collection that is managed according to the Center for Plant Conservation guidelines (Guerrant et al. 2004). The ex-situ seed collection should contain existing levels of genetic diversity (or representation) of the two populations (USFWS 2019).

Recovery Actions:

- The majority of known locations of *Primula maguirei* have been mapped in databases maintained by the Utah Natural Heritage Program (UNHP), a program of the Utah Division of Wildlife Resources (UDWR). Therefore, the UNHP has historically provided the primary mechanism for managing and distributing location and trend data for rare species throughout the State, including *P. maguirei*. However, in June 2011 the UDWR reorganized, in the process eliminating its sole botanist position and, therefore, the botany data management functions formerly provided by the UNHP. At present there is no established mechanism for maintaining or distributing location data for rare plant species in the State of Utah, including *P. maguirei*. The FWS is engaged in conversations with other partners about assuming this function; however, to date no mechanism has been agreed upon. This data management challenge represents not just the mere maintenance and distribution of historical data, but rather a need to amend older data with more recent information gathered through additional survey and monitoring efforts. With respect to *Primula maguirei*, new data do exist that have yet to be incorporated into the databases of the UNHP. Specifically, in recent years, additional locations of the species have been discovered by persons not affiliated with or funded by the USFS, FWS, or UNHP; these locations have

- not yet been provided to these agencies nor have they been captured in the existing UNHP databases. The USFS also is funding ongoing monitoring activities at previously known locations; these activities also provide new information regarding the status of the species at known sites. Because *P. maguirei* occurs in such close (within a few meters) proximity to established and popular climbing routes, and because of the potential for climbing activities to change in the future (either in location, intensity or both), there is a continual need for periodic monitoring of *P. maguirei* populations. Therefore, the lack of an established repository to manage and distribute updated data represents a significant barrier to effective communications among relevant management interests as well as the ability of these entities to protect *P. maguirei*. This criterion has not been met (USFWS, 2011).
- The primary threat at the time of listing and writing the Recovery Plan was rock climbing and rappelling (see section 2.3.2.1). Since listing, the USFS has worked to address these threats through a combination of efforts including education, physical barricades and site-specific climbing closures (U.S. Department of Agriculture (USDA) 2003). Subsequent field observations also have revealed that *Primula maguirei* tends to occupy moist to perennially saturated habitats that are typically avoided along preferred climbing routes, suggesting that climbing activities may pose less of a threat to this species than previously assessed. Since 2006, the USFS has funded a monitoring program to assess the proximity of *P. maguirei* plants to climbing routes and apparent correlations between plant survival or growth and climbing activities (Sibul 2006; Torti 2008, Torti and Schen 2009; Torti 2010, 2011a). To date, this monitoring effort has failed to detect climbing-related impacts to the species. This primarily appears due to the degree of spatial separation between plants and climbing routes, the effectiveness of existing climbing closures at deterring entry into occupied habitats, or some combination of these factors. However, at one location, *P. maguirei* has been found to persist in close proximity (2–3 meters (m)) to well-known climbing routes within a larger area visited by thousands of climbers per year (Torti 2010). These preliminary results suggest that climbers may be avoiding the specific microsites occupied by *P. maguirei*. To the extent that this is true, this pattern of recreational use may pose even less of a threat than currently believed. However, verification of this assumption would require additional, and more detailed, data collection than is occurring at the present time. Additional protections to *Primula maguirei* and its habitat are afforded by the designation of substantial parts of Logan Canyon as a Botanical Special Interest Area (USDA 2003). This designation directs the USFS to manage the habitat of *P. maguirei* in a manner consistent with the needs of that species and other sensitive botanical resources (see section 2.3.2.4). The USFS' combined program of education, physical barriers, selective use of climbing closures and the designation of Logan Canyon Botanical Special Interest Area have collectively and substantively reduced threats to *Primula maguirei* and its habitat from rock climbing. However, as discussed below, continued monitoring is needed to verify that patterns of climbing use (location and intensity of routes) are stable, and that *P. maguirei* is persisting in areas not subject to formal site closures. In addition, additional threats unrelated to rock climbing remain in the form of accelerated climate change. The magnitude and intensity of these threats is poorly understood, and would be informed by additional analyses (e.g., climate vulnerability analyses) recommended later in this document. Therefore, this criterion has been partially met (USFWS, 2011).
 - We no longer believe over-collection and commercial exploitation is a threat to the species (see section 2.3.2.3). This recovery objective is obsolete (USFWS, 2011).

Conservation Measures and Best Management Practices:

- Revise the species' taxonomy in the FR to reflect the best available scientific information (USFWS, 2011).
- Federal agencies should work with partners to resurrect the UNHP and ensure the plant portion of the database is populated and maintained (USFWS, 2011).
- Continue monitoring plant survivorship, growth and reproduction in *Primula maguirei* in conjunction with assessments of climbing patterns and intensities. Iteratively assess the need for changes in climbing closures and monitoring efforts (USFWS, 2011).
- Encourage and implement standardized and quantitative reporting of population parameters (clumps, rosettes, stems) in monitoring reports, and strengthen the use of quantitative measures to assess population (or site-specific) trends (USFWS, 2011).
- Conduct additional surveys in areas of potentially suitable habitat to refine and narrow the range of available estimates of total population size (USFWS, 2011).
- Continue collecting precipitation and humidity data (using HOBO sensors or comparable field equipment) in conjunction with monitoring plant survivorship, growth, and reproduction. Use this information to prepare a climate vulnerability assessment for this species to assess its relative vulnerability to accelerated climate change (USFWS, 2011).
- Encourage the USFS to iteratively assess and manage the potential for invasive exotic species to threaten sensitive botanical resources (species and habitats) in Logan Canyon, including *P. maguirei*. These activities should specifically ensure that existing infestations of Dyer's woad (*Isatis tinctoria*) have not expanded or encroached into botanically sensitive habitats (USFWS, 2011).
- Continue and expand prior research regarding the identity and availability of pollinators (USFWS, 2011).

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SPECIES ACCOUNT: *Prunus geniculata* (Scrub plum)

Species Taxonomic and Listing Information

Listing Status: Endangered; 2/20/1987; Southeast Region (R4)

Physical Description

The scrub plum is a heavily branched, broad-crowned shrub that can reach 2 m in height, although 0.5 m may be more typical at sites with frequent fires. It grows from gnarled, half-buried trunks and spreads by sucker shoots. Its young twigs are strongly geniculate (zig-zag shaped), while its lateral branches are either short, stubby, spur shoots bearing leaves and flowers, or are strongly tapering and spine-like. The bark of old stems is thin, gray, usually lichen-encrusted, and forms small rectangular or square plates. The bark of new shoots is lustrous reddish-brown or purplish and smooth. The scrub plum's leaves are crowded on the spur shoots (an arrangement typical of the Rosaceae family) and are widely spaced on the normal shoots. The stipules are linear-subulate, roughly 5 mm long, green, and pectinately fringed at the margins with reddish glands. The leaf blades are ovate to obovate or elliptic, 1 to 3 cm long, short-acuminate, and serrulate with gland-tipped teeth. The leaf base is rounded or broadly cuneate. The leaf stalk is a third to half as long as the blade. The scrub plum has small, fragrant flowers that are 11 to 13 mm across when open. Like the leaves, flowers found on the spur shoots are rather crowded, while those found on the regular shoots or the spine bases are spaced further apart. The pedicels extend only slightly beyond the bud scales, so the flowers give the appearance of being sessile. The flowers are radially symmetrical with a 3 mm long hypanthium (the cup-shaped structure formed by the united portions of the bases of the sepals, petals, and stamens). The 5 calyx lobes are radially symmetrical, spreading to ascending triangular with acute apices, sparsely ciliate on the margins, reddish or green, with the bottom surfaces smooth and the upper surfaces white-tomentose. The 5 petals are white, spreading, and about 5 mm long. The petal blades are ovate to obovate with rounded tips and attenuated bases ending in short, ciliate-margined claws. The stamens are numerous, roughly 0.5 mm long, and borne on the rim of the hypanthium. The fruit of the scrub plum is an ovoid or ellipsoidal drupe, 12 to 25 mm long, and dull reddish in color. It has a thin, bitter flesh and a slightly flattened seed. (USFWS, 1999)

Taxonomy

Prunus geniculata was first described by Roland M. Harper in 1911 (Harper 1911). There has been no additional treatment of this species. The common name "scrub plum" was first used by Small (Small 1933). (USFWS, 1999)

Historical Range

See current range/distribution.

Current Range

In Florida, the range includes Lake County, west and southwest of Lake Apopka; the southwest and northwest corners of Orange and Osceola counties, respectively; and Polk and Highlands counties, from the City of Lake Wales south to the Highlands County/Glades County border. (USFWS, 2009)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Scrub plum is a rare plant with a very narrow range and small, widely scattered populations. It frequently forms small colonies of several plants but may grow as solitary individuals (unpublished FNAI data). It prefers fairly open areas without a dense canopy, but older plants are able to survive in dense shade (Schultz, pers. obs.). Scrub plum's life history has not been reported in the literature. Many birds, rodents and other mammals are known to be fond of plum fruit and are probably responsible for the dissemination of the species (Van Dersal, 1938). Gopher tortoise (*Gopherus polyphemus*) could also be a vector. Kral (1983) states that *P. geniculata* respond vigorously to fire disturbance and historically was probably fire maintained due to its presence in frequently burned sandhills.; ASEXUAL; Perfect; Predominantly outcrossing; SEXUAL; BIOTIC; Birds; Mammals; BIOTIC; Hymenoptera; Insects, other; (NatureServe, 2015). From the various research efforts, we now know that scrub plum: (1) has a rare breeding system characterized by the presence of male and bisexual flowers on the same plant, (2) is partially self-incompatible and that inbreeding depression is high in self-compatible individuals, and (3) experiences high rates of fruit loss due to abortion and pre-dispersal predation. Recent research has also confirmed that scrub plum is long-lived and experiences low mortality, and populations persist for long periods in the absence of fire (Pace-Aldana et al. 2006; Menges et al. 2008; C. Weekley, Archbold Biological Station, personal communication, 2009). Current information also supports previous reports that this species is a strong postburn resprouter (Weekley et al. 2007, Weekley and Menges 2003, Menges et al. 2007) and that recruitment is low (Service 1999; Weekley and Menges 2003, 2007). Weekley and Menges (2008) are currently evaluating the effects of various land management treatments on a number scrubendemic plants, including scrub plum (USFWS, 2009).

Habitat Type

Adult: Turkey oak sandhill and evergreen oak-sand pine (USFWS, 2009)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 2009)

Environmental Specificity

Adult: Narrow/specialist (USFWS, 2009)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 2009)

Site Fidelity

Adult: High (inferred from USFWS, 2009)

Habitat Narrative

Adult: Species inhabits deep, yellow sands of longleaf pine-turkey oak sandhill and white, excessively leached, wind-deposited soils of evergreen scrub oak-sand pine scrub (NatureServe,

2015). High site fidelity and ecological integrity of the population as well as low tolerance range are inferred based on the specific habitat requirements of this species.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Scrub plum's life history has not been reported in the literature. Many birds, rodents and other mammals are known to be fond of plum fruit and are probably responsible for the dissemination of the species (Van Dersal, 1938). Gopher tortoise (*Gopherus polyphemus*) could also be a vector (USFWS, 2009).

Population Information and Trends

Number of Populations:

83 (USFWS, 2009)

Population Size:

2500 - 10,000 individuals (USFWS, 2009)

Population Narrative:

Responds vigorously to fire disturbance; cannot withstand soil disturbance of shade. Sometimes common, but usually only a few individuals at a site (NatureServe, 2015). FNAI updated its records for scrub plum in the 6 summer of 2008 and confirmed 83 extant populations. These 83 populations contained from 1 to 10,200 plants (A. Johnson, Florida Natural Areas Inventory, personal communication, 2009). Forty-five populations contained 10 or more plants (USFWS, 2009).

Threats and Stressors

Stressor: Fire Suppression (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The most pervasive threat to scrub plum on public land is habitat degradation due to fire suppression. Most land managing agencies in Florida are not able to use prescribed fire at the rates, frequency, and/or intensity needed to restore and maintain most of Florida's fire-adapted ecosystems (R. Mulholland, Florida Department of Environmental Protection, personal communication, 2007; Service 2006). Consequently, the difficulties land managing agencies currently face in implementing prescribed fires probably have resulted in the degradation of scrub plum habitat in some areas (USFWS, 2009).

Stressor: Urban development (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Scrub plum that occur on non-conservation private lands also are vulnerable to destruction due to urban development, such as construction of roads; installation of utilities and other infrastructure; and residential, commercial, and industrial construction. Scrub plum on

each private parcel is vulnerable to this threat at any time. Several populations are located in areas previously platted for residential development and these populations are at greatest risk, especially when economic conditions improve and residential construction resumes at its historic pace. One small population is imminently threatened by land clearing for commercial development. In 2006, the Service issued an incidental take permit for two fossorial skinks on about 45 acres in west-central Lake County. Several hundred scrub plum plants were also found on this parcel along with six other federally listed plants (Service 2005). The entire parcel has not yet been developed but as land clearing proceeds individual plants will be destroyed (USFWS, 2009).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: On private properties, Federal or State laws provide little protection for scrub plum. Since the majority of extant scrub plum populations occur on unprotected private lands, we conclude that existing regulatory mechanisms are inadequate to protect this species (USFWS, 2009).

Stressor: Low seed viability (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of genetic diversity

Narrative: Scrub plum produce few viable seeds and recruitment is extremely low (Weekley et al. 2007; B. Pace-Aldana, TNC, personal communication, 2008). Loss of seeds due to inbreeding depression reduces the number of germinable seeds. These effects may be exacerbated by habitat fragmentation and fire exclusion (C. Weekley, Archbold Biological Station, personal communication, 2009) (USFWS, 2009).

Recovery

Reclassification Criteria:

Applicable to the South Florida populations: 1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations required to ensure 20 to 90 percent probability of persistence for 100 years. (USFWS, 1999)

Applicable to the South Florida populations: 2. When these populations, within the historic range of *P. geniculata* are adequately protected from further habitat loss, degradation, and fire suppression. (USFWS, 1999)

Applicable to the South Florida populations: 3. When these sites are managed to maintain the high pine and xeric oak scrub communities to support *P. geniculata*; (USFWS, 1999)

Applicable to the South Florida populations: 4. When monitoring programs demonstrate that these sites support sufficient population sizes, are distributed throughout the historic range, and are sexually or vegetatively reproducing at sufficient rates to maintain the population. (USFWS, 1999)

Applicable to the entire species range: The 1996 recovery plan lists four criteria necessary to reclassify the scrub plum from endangered to threatened status: (1) there are eight populations at four sites; (2) at least 10 years of demographic monitoring is conducted at one of these locations; (3) scrub plum is monitored at all locations; and (4) there must be protected locations in Highlands, Polk, and Lake counties. (USFWS, 1996)

Delisting Criteria:

Applicable to the entire species range: To delist the scrub plum, 20 populations must be present at 5 sites and there must be 10 additional years of monitoring. (USFWS, 1996).

Recovery Actions:

- S1. Determine current distribution of *P. geniculata*. Conduct surveys for *P. geniculata*. Conduct surveys for *P. geniculata*. Maintain distribution of known populations and suitable habitat in GIS database. (USFWS, 1999)
- S2. Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties has been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- S3. Conduct research on life history characteristics of *P. geniculata*. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species more specific biological information is needed. (USFWS, 1999)
- S4. Monitor existing populations of *P. geniculata*. Develop monitoring protocol to assess population trends for *P. geniculata*. Develop a quantitative description of the population structure of *P. geniculata*. (USFWS, 1999)
- S5. Provide public information about *P. geniculata*. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of *P. geniculata* and other rare species requires a self sustaining, secure number of natural populations. (USFWS, 1999)
- H1. Prevent degradation of existing habitat. Extensive habitat loss, degradation, and fragmentation have already occurred throughout the range of this species. Both urbanization and fire suppression have decreased the available habitat. To date, there are six protected sites for *P. geniculata* in Polk and Highlands counties. (USFWS, 1999)
- H2. Restore areas to suitable habitat. Native habitats that have been disturbed or that have experienced a long history of fire suppression may be good candidates for future reserves. (USFWS, 1999)
- H3. Conduct habitat-level research projects. Study the response of *P. geniculata* to various land management practices, such as prescribed fire regimes, vegetative thinning, and control of exotic/invasive vegetation. (USFWS, 1999)
- H4. Monitor habitat/ecological processes. Monitor the effects of land management actions, such as prescribed fire, exotic plant control, etc., on the habitats where *P. geniculata* occurs. (USFWS, 1999)

- H5. Provide public information about scrub and its unique biota. Educational efforts, especially those conducted by Archbold Biological Station, have been successful. Without these successful efforts, the Lake Wales Ridge NWR would not have been created. Florida's system of biological preserves depends on a broad base of public understanding and support for its funding and future success. In addition to past and ongoing educational efforts by The Nature Conservancy, Bok Tower Gardens, and Archbold Biological Station, future efforts by these organizations, and the Florida Park Service, the Florida Division of Forestry, the South Florida Water Management District, the Florida Native Plant Society, and local garden clubs are crucial in increasing public appreciation of scrub and high pine communities, and their associated plant species. The Arbuckle Appreciation Day sponsored by the Florida Division of Forestry has been especially successful. (USFWS, 1999)
- Recommendation for Future Action from 2009 5-Year Review: Revise the recovery criteria to establish measurable goals for demographic monitoring, including but not limited to: the number of populations that should be monitored, the demographic parameters that should be measured, the demographic performance levels/rates that should be met, and the timeframe within which these levels/rates should be attained/maintained (USFWS, 2009).
- Recommendation for Future Action from 2009 5-Year Review: Continue demographic monitoring on the Carter Creek tract of the LWRNWR and reinitiate demographic monitoring on TNC's Tiger Creek and Longleaf Pine Preserves. Conduct Level 2 (see Menges and Gordon 1996) monitoring on multiple sites using populations in different habitats and with different management regimes (USFWS, 2009).
- Recommendation for Future Action from 2009 5-Year Review: Conduct a rangewide survey of genetic diversity in scrub plum. Such a survey could help in identifying populations that might be targeted for acquisition or included as a propagule source for creation of new populations on sites undergoing restoration (USFWS, 2009).
- Recommendation for Future Action from 2009 5-Year Review: Evaluate breeding system to identify S-locus and assay S-allele diversity within populations to assess the degree of self-incompatibility and role of inbreeding depression in seed viability (USFWS, 2009).
- Recommendation for Future Action from 2009 5-Year Review: Implement management activities on public lands that contain scrub plum, including prescribed fire at return intervals and intensities necessary to restore and/or maintain the various xeric vegetative communities that support this species (USFWS, 2009).
- Recommendation for Future Action from 2009 5-Year Review: Purchase or otherwise protect large scrub plum populations on unprotected lands. Protection should target scrub plum populations that are sufficiently large, or could be large if adequately managed, as to be self-sustaining and viable long-term (USFWS, 2009).
- Recommendation for Future Action from 2009 5-Year Review: Explore opportunities to encourage landowners to conserve and manage property known to contain this species (USFWS, 2009).

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SPECIES ACCOUNT: *Pseudobahia bahiifolia* (Hartweg's golden sunburst)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An annual herb, about 6-15 cm tall, covered throughout with white, wooly hairs. Flower heads (March or April) are bright yellow, and are borne singly at the ends of the branches. (NatureServe, 2015)

Historical Range

The historical distribution of *Pseudobahia bahiifolia* is not known specifically but is thought to have spread approximately 200 miles along the eastern San Joaquin valley and foothills from Stanislaus County in the south to Yuba County in the Sacramento Valley to the north (Stebbins 1991). The distribution once extended north to Yuba County in the Sacramento Valley, based on the 1847 type collections of Karl Hartweg; however, these occurrences are now extirpated (Stebbins 1991). (USFWS 2007)

Current Range

The current distribution of the majority of *P. bahiifolia* occurs in two isolated clusters, including six extant occurrences near Friant along both sides of the San Joaquin River in high pumice content soils (Fresno and Madera Counties) and six occurrences near Cooperstown in Stanislaus County. *Pseudobahia bahiifolia* grows in loam or sandy loam soil associated with Amador and Pentz series (Stanislaus County), Rocklin series (Fresno and Madera County), Amador and Hornitos soils (Merced County) (Stebbins 1991). (USFWS, 2007)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Flowering and fruiting occur in March-April (NatureServe, 2015).

Reproduction Narrative

Adult: Grazing levels must be reduced during flowering and fruiting (March-April). Overgrazing during this period has been documented to be detrimental. The greatest threat to this species is destruction of habitat by ag, development and heavy grazing (NatureServe, 2015).

Habitat Type

Adult: Grasslands/woodlands (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits non-native grasslands and occasionally grassland-blue oak woodland community ecotones in the Central Valley of California. The composition of the prehistoric grassland communities in this area is unknown; the communities have long-since become dominated by exotic grasses. *P. bahiifolia* generally occurs in areas with Mima mound topography: small mounds (30 cm to 2 m in height) interspersed with shallow basins that may form vernal pools. The plants nearly always occur on north-northeast facing mound slopes, preferentially on the upper slopes where grass cover is minimal. Plant can also occur along shady creeks or the margins of vernal pools. Plant distribution is closely correlated with certain soil types; prefers highly acidic, shallow soils derived from rhyolitic tuff. (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species and the low number of known populations.

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Not available

Number of Populations:

6 - 20 (NatureServe, 2015)

Population Size:

10,000 to >1,000,000 individuals (NatureServe, 2015)

Population Narrative:

About 32,000 total plants in 1990 (Stebbins 1991 Status Survey, cited in USFWS 1997). 16 Populations (USFWS 1997). (NatureServe, 2015)

Threats and Stressors

Stressor: Residential development (USFWS, 2007)

Exposure:

Response:

Consequence: Loss of habitat

Narrative:**Stressor:** Agricultural conversion (USFWS, 2007)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:****Stressor:** Flooding (USFWS, 2007)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:****Stressor:** Protected occurrences (USFWS, 2007)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:****Stressor:** Overgrazing and trampling (USFWS, 2007)**Exposure:****Response:****Consequence:** Loss of individuals**Narrative:****Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2007)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:****Stressor:** Non-native plants (USFWS, 2007)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:****Stressor:** Road maintenance and widening (USFWS, 2007)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:****Stressor:** Transmission line maintenance (USFWS, 2007)**Exposure:****Response:****Consequence:** Loss of individuals

Narrative:**Stressor:** Drought (USFWS, 2007)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:****Stressor:** Small population size (USFWS, 2007)**Exposure:****Response:****Consequence:** Loss of genetic variability**Narrative:****Recovery****Recovery Actions:**

- The draft recovery plan is currently under development

Conservation Measures and Best Management Practices:

- Protect lands with known occurrences of either species of *Pseudobahia*, particularly those occurrences with the largest and most dense populations, through conservation easements, acquisition in title, or other methods. Manage these properties to protect and enhance growth of *P. bahiaefolia* and *P. peirsonii* (USFWS, 2007).
- Work with landowners to gain access to their property for surveying and monitoring populations of both *Pseudobahia* species (USFWS, 2007).
- Conduct coordinated surveys of all recorded occurrences of both species of *Pseudobahia*. Establish systematic periodic surveys where possible of known occurrences. Begin surveys in potentially suitable habitat of both species of *Pseudobahia* based on soil type and habitat characteristics (USFWS, 2007).
- Complete and publish the draft recovery plan and ultimately finalize the recovery plan. Much of the information contained in Stebbins' two studies (1989, 1991) is still valid and is directly applicable to a recovery plan (USFWS, 2007).
- Maintain a viable, protected seed collection for both species of *Pseudobahia*. Ensure sufficient seeds (approximately 5,000 per site, USFWS 2006a) are taken from as many sites as possible to maintain genetic heterogeneity (USFWS, 2007).

References

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SPECIES ACCOUNT: *Pseudobahia peirsonii* (San Joaquin adobe sunburst)

Species Taxonomic and Listing Information

Listing Status: Threatened; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An annual herb, about 1-6 dm tall, and loosely covered with white, wooly hairs. Flower heads (March or April) have bright yellow rays and are borne singly at the ends of the branches. (NatureServe, 2015)

Taxonomy

Pseudobahia peirsonii has had no changes in its scientific name or to its taxonomic classification since it was first described in 1949 by the California botanist Phillip A. Munz. Common names used for *P. peirsonii* include San Joaquin adobe sunburst, Tulare pseudobahia, and San Joaquin adobe sunflower (Stebbins 1991). The San Joaquin adobe sunburst is the preferred common name since it was used in the original listing notice (62 FR 5542)

Historical Range

The historical distribution of *Pseudobahia peirsonii* is not known because when the species was first described in 1949, extensive areas with suitable habitat for this species in the lower San Joaquin Valley were already converted to agriculture. This extensive land conversion precluded establishing a meaningful baseline survey of *P. peirsonii* (Stebbins 1991). (USFWS, 2007)

Current Range

Three major population concentrations of *P. peirsonii* now include: east of Fresno in Fresno County, west of Lake Success in Tulare County, and northeast of Bakersfield in Kern County (CNDDB 2007). (USFWS, 2007)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Habitat Type

Adult: Grasslands/woodlands (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (NatureServe, 2015)

Site Fidelity

Adult: High (NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits non-native grasslands and occasionally grassland-blue oak woodland community ecotones in the Central Valley of California. The composition of the prehistoric grassland communities in this area is unknown; the communities have long-since become dominated by exotic grasses. *P. peirsonii* occurs only on heavy adobe clay soils which retain moisture into the summer dry season (NatureServe, 2015).

Dispersal/Migration

Population Information and Trends

Population Trends:

Not available

Number of Populations:

32 (USFWS, 2007)

Population Narrative:

The plant is found at 32 extant occurrences distributed in Fresno, Tulare and Kern Counties. Population numbers can fluctuate widely from one year to another. This fluctuation is believed to depend on annual climatic conditions, specifically the amount of seasonal rainfall, and also on competition from non-native plants (Stebbins 1989, 1991; E. Cypher, CDFG, pers. comm. 2007). Because of these annual fluctuations, population trends for these species are difficult to deduce and can not be reliably completed in a few years of surveys (Stebbins 1989). Actual plant numbers are not as useful an index of population health as is the condition of occupied habitat and general population condition (62 FR 5542) (USFWS, 2007).

Threats and Stressors

Stressor: Residential development (USFWS, 2007)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: At the time of listing, the threat to *P. peirsonii* was primarily due to the planned 462-acre combined Quail Lakes housing development and recreational lake in Fresno County that would affect the large occurrence (CNDDDB occurrence number 31) of 5,000 plants surveyed in 1990. Completion of this project included compensation for environmental impacts which involved off-site wetland construction, transplantation of *P. peirsonii* and top soil translocation to a protected area within the development site, and preservation of two high density sub-populations of *P. peirsonii* within the protected site (EIP Associates 1994). During post-construction monitoring of these sub-populations, *P. peirsonii* at this location were not seen for four years; however, large numbers were observed in a single season during the fifth year of monitoring (Halstead in litt. 2007). In the 2003 season John Stebbins did not observe any plants at this location (J. Stebbins in litt. 2007). Residential development still remains a threat to *P. peirsonii* at the following locations (two occurrences): 1. A proposed parcel split of a privately owned 65-acre parcel in Fresno County near the city of Clovis, and the proposed residential development of these sub-parcels, is located within the area described to contain *Pseudobahia peirsonii* occurrence number 36 (Halstead and Associates 2006, CNDDDB 2007). Surveys for *P. peirsonii* were performed on this property in 2004 and 2005 and no plants were found (Halstead

in litt. 2007). We lack adequate information on the reproductive ecology and seed bank dynamics of this species to determine whether or not it may reappear at this site in the future. 2. The proposed Round Mountain Estates project would develop a 600-acre parcel at Round Mountain in Fresno County, an area occupied by about 40 acres of *Pseudobahia peirsonii*. Surveys in 1993 and 1996 revealed the 40 acres support an apparently stable *P. peirsonii* population and that current land use continues to be moderate cattle grazing (J. Gurule, Live Oak Associates, pers. comm. 2007). Compensation recommended for this project by the consultant is to protect in perpetuity the 40 acres that contain the *P. peirsonii* occurrence (Hartesveldt Ecological Consulting Services [now Live Oak Associates] 1996) (USFWS, 2007).

Stressor: Agricultural conversion (USFWS, 2007)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: When federally listed in 1997, conversion of habitat to agricultural use was considered a significant but secondary threat to *Pseudobahia peirsonii*. Eight of the original recorded occurrences of *P. peirsonii* had already been extirpated from their locale due to various agricultural conversions by the time Stebbins (1991) surveyed the sites. We do not believe that agricultural conversion presents a serious threat to *P. peirsonii* at this time since occurrences are now on either public land or private land used for cattle ranching (E. Cypher pers. comm. 2007). However, *P. bahiifolia* is still threatened by agricultural development, as it was at the time of listing, because of the pressure to convert ranch lands with occurrences of *P. bahiifolia* to orchards and vineyards (E. Cypher pers. comm. 2007) (USFWS, 2007).

Stressor: Flooding (USFWS, 2007)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Inundation of *Pseudobahia peirsonii* plants caused by the creation of Lake Success in Tulare County extirpated two of the originally recorded occurrences of *P. peirsonii* before the species was listed (Stebbins 1989, CNDDDB 2007). Three occurrences of *P. peirsonii* are now found at the Lake Success Recreation Area which is managed by the U.S. Army Corps of Engineers. Two of these occurrences are historically recorded and one occurrence is believed to be a relict of one of the original occurrences that were documented as extirpated when Lake Success was first filled (EDAW 2006a). Flooding at Lake Success continues to be a threat to the three local occurrences of *P. peirsonii* (E. Cypher in litt. 2007). Excessive rainfall during an exceptionally wet year could raise the level of Lake Success and cause inundation of at least one of the occurrences (E. Cypher in litt. 2007). In addition, two proposals for the improvement of the Lake Success dam could affect at least one other occurrence of *P. peirsonii*. The U.S. Army Corps of Engineers plans to move the dam 300 feet downstream of its current location and then increase the size of the new spillway (E. Cypher in litt. 2007). Compensation by transplanting was addressed, but is not considered a reliable option for saving the affected populations of *P. peirsonii* owing to the limited success of previous transplanting efforts (E. Cypher in litt. 2007). As a result of the creation of Lake Success, one population was subjected to the additional threat of adverse recreational activity, since that population was located on the highly impacted shoreline (Stebbins 1989, 62 FR 5542, CNDDDB 2007 The Fancher Creek flood control project, completed in the mid-1990s, impacted about 40 percent of the second largest population of *Pseudobahia peirsonii* (CNDDDB occurrence number 30, 62 FR 5542). However, *P. peirsonii* are still found at the

Fancher Creek site and surveys are conducted on a regular basis (P. Bryan in litt. 2007). The possible inundation of at least part of the existing local occurrence during an exceptionally heavy rainfall season remains a threat to this occurrence because no flood control system can protect against all conceivable flood events (Stebbins 1991, Fresno Metropolitan Flood Control District 2007) (USFWS, 2007).

Stressor: Protected occurrences (USFWS, 2007)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Two occurrences of *Pseudobahia peirsonii* are located on public, nonFederal land in Fresno County owned and managed by the Fresno Metropolitan Flood Control District (CNDDDB occurrence numbers 16 and 30). Although these occurrences are monitored by surveys and protected by fencing, flooding remains a possible threat to these occurrences. Lake Success was created when the Tule River was dammed by the earthen Success Dam, which was constructed by the U.S. Army Corps of Engineers in 1961. The property around Lake Success, owned and managed by the U.S. Army Corps of Engineers, located just east of Porterville in Tulare County, contains three occurrences of *Pseudobahia peirsonii*. Two of these occurrences were previously recorded in the CNDDDB as occurrence numbers 10 and 19; however, a new occurrence was also discovered and may be the continuation of a population that was covered by the lake when the Success Dam was first built (EDAW 2006a). The sizes of these populations were recorded as 120 individuals for occurrence 10, 30 individuals for occurrence 19, and 45 individuals for the new occurrence (EDAW 2006a). The population numbers from this recent survey appear to indicate these occurrences are somewhat stable when compared with population numbers recorded in previous surveys (1985, 1986, 1988, 2003) (EDAW 2006a; T. Beyerl, EDAW, pers.comm. 2007). These occurrences receive a certain amount of protection because they are on federally operated public land; however, flooding from this dam remains a viable threat to the local occurrences. Lewis Hill Preserve consists of 110 acres of grass-covered hills with rock outcrops located north of Porterville in Tulare County. This preserve, owned and managed by the Sequoia Riverlands Trust, contains *Pseudobahia peirsonii* occurrence number 28, as well as the rare wildflower, *Fritillaria striata* (striped adobe lily) (Sequoia Riverlands Trust 2007). This preserve is not open to the public. Although formal surveys for the listed plant species have not been conducted since 1990, the presence of *P. peirsonii* was confirmed by preserve personnel during the 2006 flowering season (H. Destin, Sequoia Riverlands Trust, pers. comm. 2007). Currently the Lewis Hill preserve is not actively managed, but future management activities such as prescribed burns and grazing are being planned to control invasive weedy plants (H. Destin pers. comm. 2007). Before *Pseudobahia peirsonii* was listed in 1997, as compensation for impacts to the four subpopulations of occurrence number 31 by construction of the Quail Lake residential development in Fresno County (see above), two of the highest-density sub-populations were protected and a new sub-population was created by trans-locating soil from the two impacted sub-populations and seeding the soil with seeds collected earlier (completed in 1993) (62 FR 5542, EIP Associates 1994). This compensation was done in compliance with the California Endangered Species Act and California Environmental Quality Act. The area, south of Clovis in Fresno County, containing these sub-populations is protected as natural habitat in perpetuity (EIP Associates 1994). Subsequent monitoring revealed that individuals originating from seeds sewn into the trans-located soil, as well as the individual plants in the original two dense populations, were numerous, healthy, and reproducing in 1998 (J. Halstead in litt. 2007). However, *P. peirsonii* is not clearly present at Quail Lakes every year and the habitat in the area of the translocated soil

appeared to be significantly degraded in 2006 (J. Halstead in litt. 2007, J. Stebbins in litt. 2007) (USFWS, 2007).

Stressor: Overgrazing and trampling (USFWS, 2007)

Exposure:

Response:

Consequence: Loss of individual plants

Narrative: Cattle ranching was recognized as a threat to the *Pseudobahia* species in the original listing rule (62 FR 5542) because of the possibility of excessive grazing and trampling by cattle, which could destroy many individuals of the two species (Stebbins 1989). In 1997, when first listed, about 50 percent of known occurrences of *P. peirsonii* were found on private property that was used primarily for cattle grazing. Moderate grazing regimes are not believed to seriously affect either of the plant species, and may actually enhance their growth due to the removal of nonnative, aggressive, invasive grasses and forbs (Stebbins 1989, Marty 2005). Cattle do not preferentially target either of the *Pseudobahia* species while grazing (E. Cypher pers. comm. 2007). In addition, profitable cattle ranching may indirectly benefit the two *Pseudobahia* species by discouraging residential development of ranch land (E. Cypher pers. comm. 2007). Cattle grazing and trampling are no longer considered a serious threat to either species unless the grazing times are extended, leading to excessive trampling and consumption (USFWS, 2007).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2007)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: When listed in 1997, we noted that most of the occurrences of both the *Pseudobahia* species were located on private land and, thus, State and Federal laws were limited in their ability to regulate potentially detrimental human activity at these locations (62 FR 5542). No significant changes to the Federal or State laws have provided increased protection for these species (USFWS, 2007).

Stressor: Non-native plants (USFWS, 2007)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The final listing rule noted that the intrusive and aggressive characteristics of herbaceous weedy species appear to be detrimental to habitat quality of the two *Pseudobahia* species. Plants mentioned as being common non-native associates of *P. bahiifolia* include *Erodium cicutarium* (red-stem filaree), *E. botrys* (longbeak stork's bill), *Bromus mollis* (soft brome or soft chess), and *Bromus madritensis ssp rubens* (foxtail chess). Plants mentioned as being common non-native associates of *P. peirsonii* include *Avena fatua* (wild oats), *Brassica kaber* (wild mustard), *Bromus mollis* (soft brome or soft chess), *Bromus madritensis ssp rubens* (foxtail chess), and *Erodium cicutarium* (red-stem filaree) (62 FR 5542). Non-native grasses and forbs continue to proliferate throughout the range of the two *Pseudobahia* species and these non-native species continue to invade locations that the two species occupy. Thus, non-native plants remain a significant threat to the two *Pseudobahia* species (E. Cypher pers. comm. 2007) (USFWS, 2007).

Stressor: Road maintenance and widening (USFWS, 2007)

Exposure:**Response:****Consequence:** Loss of habitat

Narrative: Stebbins (1991) lists several road maintenance projects that would affect populations of *Pseudobahia peirsonii*. The most extensive project was the proposed widening of State Route 180 in Fresno County that may destroy plants on both sides of the road. Six other occurrences were also determined to be threatened by road maintenance activities conducted by the California Department of Transportation (CALTRANS) which include spraying herbicides, grading, scraping, slope stabilization, road widening, and road alignment. The listing rule noted that road maintenance activities were a threat to *P. peirsonii* (62 FR 5542). However, subsequent CALTRANS maintenance activities and road alignment did not appear to directly affect the occurrences of *P. peirsonii*; rather, the disturbance created from the maintenance appears to indirectly and moderately threaten both species of *Pseudobahia* by encouraging the growth of non-native weedy vegetation which competes with the two listed species of *Pseudobahia* (J. Stebbins in litt. 2007) (USFWS, 2007).

Stressor: Transmission line maintenance (USFWS, 2007)**Exposure:****Response:****Consequence:** Loss of individuals

Narrative: Two occurrences of *Pseudobahia peirsonii* (CNDDDB occurrence numbers 23 and 24) inhabit areas beneath two transmission lines supported by Southern California Edison (SCE). The properties where the transmission lines are located are considered "rights of way", and are mostly within privately owned lands. Stebbins (1991) recognized that these populations would need to be protected from the machinery and traffic (human and vehicular) that would impact the area when maintenance actions were performed on the transmission lines, and this was considered a threat when the species was listed (62 FR 5542). Routine maintenance activities include patrol road maintenance, line maintenance, and overhead canopy maintenance. Routine maintenance actions are scheduled by SCE annually, avoid the active time periods for local listed plants, and require a minimum of off-road activities (Entrix, Inc. 1997). A more substantial threat to *P. peirsonii* is from emergency repairs to the power lines due to catastrophic failure, natural disasters, or vandalism where the need to conduct repairs expeditiously would increase the chances of incidental damage to the plants during the repair effort. Entrix, Inc. (1997) conducted a survey for *P. peirsonii* and found only one occurrence along one of the two transmission lines where the species was thought to occur. SCE maintenance personnel are provided with environmental and endangered species training to ensure they avoid impacting listed species (Entrix, Inc. 1997) (USFWS, 2007).

Stressor: Drought (USFWS, 2007)**Exposure:****Response:****Consequence:** Loss of habitat

Narrative: At the time of listing drought was considered a threat to small and marginal populations of either *Pseudobahia* species (62 FR 5542). Natural cycles of drought are not likely to threaten the larger occurrences of either of the *Pseudobahia* species owing to the drought-adaptive nature of the plants (E. Cypher pers. comm. 2007). However, where populations persist on only marginal habitat, the addition of prolonged drought conditions is likely to result in higher rates of mortality in the short term, with the effects of low reproductive output and survivorship

persisting after the drought has ceased (E. Cypher pers. comm. 2007). It is unknown how quickly the *Pseudobahia* populations may rebound after severe climatic conditions (USFWS, 2007).

Stressor: Small population size (USFWS, 2007)

Exposure:

Response:

Consequence: Loss of genetic variability

Narrative: The two species of *Pseudobahia* each require separate and specific soil conditions for successful germination and growth, so that the distribution of these plants is limited to the occurrences of these soil types (Stebbins 1991). The conversion to agricultural use of the geographic areas where these soil types are found began before a baseline survey of either plant could be performed, so the historic distribution can only be assumed based on a variety of factors, including soil type. The conversion to agriculture and to other land uses (discussed above) which are adverse to the proliferation of the two species have resulted in fragmented populations, many of which are of extremely limited population size (E. Cypher pers. comm. 2007). For example, about 67 percent of the *P. bahiifolia* and 62 percent of the *P. peirsonii* populations with known counts have less than 100 plants from the last surveys that were recorded (CNDDDB 2007). In addition, some of the sites are questionable as to whether they are still producing any plants at all; for example, two of the presumed extant occurrences of *P. bahiifolia* are single sightings of unknown numbers of plants that have not been verified since 1937 and 1939, respectively (CNDDDB 2007). At the time of listing it was recognized that such small populations may be highly susceptible to extirpation due to chance events, inbreeding depression, or additional environmental disturbance (Gilpin and Soule 1988; Goodman 1987, 62 FR 5542). The conservation biology literature commonly notes the vulnerability of species known from one or very few locations and/or from small populations (e.g., Shaffer 1981 and 1987, Primack 1998, Dunning et al. 2006). In particular, small population size makes it difficult for such species to persist while sustaining the impacts of habitat loss, competition with non-native plants, and other impacts such as prolonged drought. If an extirpation event occurs in a population that has been fragmented, the opportunities for re-colonization will be greatly reduced due to physical isolation from other source populations. The small size of populations, along with the geographic isolation of the separate populations of both *Pseudobahia* species remains a threat (E. Cypher pers. comm. 2007) (USFWS, 2007).

Recovery

Recovery Actions:

- The draft recovery plan is currently under development (USFWS, 2007).

Conservation Measures and Best Management Practices:

- Protect lands with known occurrences of either species of *Pseudobahia*, particularly those occurrences with the largest and most dense populations, through conservation easements, acquisition in title, or other methods. Manage these properties to protect and enhance growth of *P. bahiifolia* and *P. peirsonii* (USFWS, 2007).
- Work with landowners to gain access to their property for surveying and monitoring populations of both *Pseudobahia* species (USFWS, 2007).
- Conduct coordinated surveys of all recorded occurrences of both species of *Pseudobahia*. Establish systematic periodic surveys where possible of known occurrences. Begin surveys in potentially

suitable habitat of both species of *Pseudobahia* based on soil type and habitat characteristics (USFWS, 2007).

- Complete and publish the draft recovery plan and ultimately finalize the recovery plan. Much of the information contained in Stebbins' two studies (1989, 1991) is still valid and is directly applicable to a recovery plan (USFWS, 2007).
- Maintain a viable, protected seed collection for both species of *Pseudobahia*. Ensure sufficient seeds (approximately 5,000 per site, USFWS 2006a) are taken from as many sites as possible to maintain genetic heterogeneity (USFWS, 2007).

References

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5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California.

SPECIES ACCOUNT: *Pseudognaphalium (=Gnaphalium) sandwicensium* var. *molokaiense* (`Ena`ena)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/30/2016; Pacific Region (R1) (USFWS, 2016a)

Physical Description

Pseudognaphalium sandwicensium var. *molokaiense* is a perennial herb found in strand vegetation in dry consolidated dunes on the islands of Molokai and Maui, Hawaii.

Taxonomy

Family: Asteraceae.

Historical Range

Historically, this variety was found on the Hawaiian islands of Molokai and Maui, as well as on Oahu and Lanai (USFWS, 2016).

Current Range

Currently this variety is found on the Hawaiian islands of Molokai and Maui (USFWS, 2016).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Habitat Type

Adult: The species is found in strand vegetation in dry, consolidated dunes (USFWS, 2016).

Habitat Vegetation or Surface Water Classification

Adult: Strand vegetation (USFWS, 2016)

Environmental Specificity

Adult: Unknown

Habitat Narrative

Adult: Typical habitat for this variety is strand vegetation in dry consolidated dunes, in the coastal ecosystem (Wagner et al. 1999, p. 321; TNCH 2007; HBMP 2010). Historically, this variety was known from Molokai, Oahu, Maui, and Lanai (HBMP 2010; MNTF 2010, in litt.) (USFWS, 2016). *Pseudognaphalium sandwicensium* var. *molokaiense* is a perennial herb found in strand vegetation in dry consolidated dunes on the islands of Molokai and Maui, Hawaii. Historically, this variety was also found on Oahu and Lanai. This variety is known from five populations collectively totaling approximately 200 to 20,000 individuals (depending upon rainfall) in the Moomomi area on the island of Molokai, and from 2 populations of a few individuals at Waiehu dunes and at Puu Kahulianapa on west Maui (USFWS, 2014).

Dispersal/Migration***Population Information and Trends*****Number of Populations:**

3 populations: Molokai (2) and Maui (1) (USFWS, 2016)

Population Size:

200 to 20,000 individuals, depending on rainfall

Population Narrative:

Currently, *P. sandwicense* var. *molokaiense* is known only from two locations on Molokai (as many as 20,000 individuals, depending on rainfall), and from fewer than 25 individuals on the northwest coast of Maui (Moses 2006, in litt.; Starr 2006, in litt.; Kallstrom 2008, in litt.; Oppenheimer 2015, in litt.). This variety was last observed on Lanai in 1960, and on Oahu (5 individuals) in the 1980s (HBMP 2010) (USFWS, 2016).

Threats and Stressors

Stressor: Feral goats and axis deer (USFWS, 2016b; USFWS, 2014)

Exposure: Habitat degradation and destruction, predation

Response:

Consequence:

Narrative: *Pseudognaphalium* s. var. *molokaiense* is threatened by feral goats (*Capra hircus*) and axis deer (*Axis axis*) that degrade and destroy habitat and possibly browse upon it (USFWS, 2016b; USFWS, 2014).

Stressor: Nonnative plants (USFWS, 2016b; USFWS, 2014).

Exposure: Competition

Response:

Consequence:

Narrative: Nonnative plants compete for light and nutrients (USFWS, 2016; USFWS, 2014).

Stressor: Climate change (USFWS, 2016b)

Exposure:

Response:

Consequence:

Narrative: The effects of climate change are likely to further exacerbate these threats (Non-native plants and herbivory). Because of these threats, we find that this variety is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range (USFWS, 2016b).

Stressor: Low genetic variability (USFWS, 2016b)

Exposure:

Response:

Consequence:

Narrative: This variety experiences reduced reproductive vigor due to low levels of genetic variability, leading to diminished capacity to adapt to environmental changes, and thereby lessening the probability of long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361) (USFWS, 2016b).

Stressor: Stochastic events (USFWS, 2016b)

Exposure:

Response:

Consequence:

Narrative: Rockfalls and landslides are a threat to the occurrence of this variety on a sea cliff on west Maui (HBMP 2010) (USFWS, 2016b).

Stressor: Climate change (USFWS, 2016b)

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013, p. 86) found that, as environmental conditions are altered by climate change, *P. sandwicensium* var. *molokaiense* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions (USFWS, 2016b).

Recovery

Recovery Actions:

- Weed control is conducted for one population on Molokai.

Conservation Measures and Best Management Practices:

- Weed control

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Endangered Status for 49 Species From the Hawaiian Islands

Final Rule. Federal Register 81(190) pp. 67786-67860

USFWS 2014. Review of Native Species That Are Candidates for Listing as Endangered or Threatened

Annual Notice of Findings on Resubmitted Petitions

Annual Description of Progress on Listing Actions

Proposed Rule. Federal Register 79(234) pp. 72450-92497

USFWS. 2016a. Environmental Conservation Online System (ECOS) – Species Profile.
<http://ecos.fws.gov/ecp0/>. Accessed September 2016.

Proposed Rule. Federal Register 79(234) pp. 72450-92497.

USFWS 2016. Endangered and Threatened Wildlife and Plants

Final Rule. 81 Federal Register 190. September 30, 2016. Pages 67786 - 67860.

SPECIES ACCOUNT: *Psychotria grandiflora* (Kopiko)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (R1) (USFWS, 2016)

Physical Description

A tree or shrub, up to five m tall. Corollas are tubular and white (NatureServe, 2015).

Taxonomy

A member of the coffee family (Rubiaceae) (USFWS, 2010b). The genus is widespread in the tropics; this species is endemic to northwestern Kawai (NatureServe, 2015).

Historical Range

Historically, this species was known from collections at Waimea, Kokee, and Kalalau, all from the northwestern area of Kauai (Fosberg 1964, p. 258) (USFWS, 2010b).

Current Range

Currently, populations of *P. grandiflora* are found only within Kokee State Park (USFWS, 2010b).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Psychotria grandiflora* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Psychotria grandiflora* includes six CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Montane Mesic—Section 1: Montane Mesic—Section 1 consists of 2,423 ac (980 ha) in the montane mesic ecosystem, including the area above Honopu Valley to Mahanaloa Valley, on State owned land in Kokee State Park, the Na Pali-Kona Forest Reserve, and Kuia NAR (Figure 3-A). The entire section is within previously designated critical habitat for the plant species, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70c, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Labordia helleri*, *Myrsine knudsenii*, *Platydesma rostrata*, *Psychotria grandiflora*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*. This section is also occupied by the akekee and the picture-wing fly; maps of critical habitat for these species can be found at 50 CFR 17.95(b) for the akekee and akikiki (Unit 1—Montane Mesic), and at 50 CFR 17.95(i) for the picture-wing fly (Unit 1—Montane Mesic). This section also contains unoccupied habitat that is essential to the conservation of these nine species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the montane mesic forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane mesic ecosystem (Table 3), as well as species-specific PCEs for the akekee and akikiki (arthropod prey) and picture-wing fly (the larval-stage host plants, *Cheirodendron* sp. and *Tetraplasandra* sp.). Although Montane Mesic—Section 1 is not

known to be occupied by the species *Diellia mannii*, *Myrsine mezii*, and the akikiki, we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Montane Mesic—Section 2: Montane Mesic—Section 2 consists of 376 ac (152 ha) in the montane mesic ecosystem and includes a portion of the area surrounding a tributary of Nawaimaka Stream east to Kumuwela Ridge (Figure 3-A, above). The entire section is State-owned within Kokee State Park, and includes 8 ac (3 ha) of newly designated critical habitat. This section is occupied by *Diellia mannii* and the picture-wing fly *Drosophila sharpi*, and includes the montane mesic forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane mesic ecosystem (Table 3), as well as the larval-stage host plants (*Cheirodendron* sp. and *Tetraplasandra* sp.) associated with the picture-wing fly. This section also contains unoccupied habitat that is essential to the conservation of these two species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Montane Mesic—Section 2 is not known to be occupied by the plants *Chamaesyce remyi* var. *remyi*, *Labordia helleri*, *Myrsine knudsenii*, *Myrsine mezii*, *Platydesma rostrata*, *Psychotria grandiflora*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*, or by the birds the akekee and akikiki, we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range, as well as species-specific PCEs for the akekee and akikiki (arthropod prey). Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, that portion of the section that overlies previously designated critical habitat falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70c. The previously undesignated land comprises Critical Habitat Unit 21 of 50 CFR 17.99(a)(1), Map 217d. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 2—Montane Mesic), and for the picture-wing fly at 50 CFR 17.95(i) (Unit 2—Montane Mesic).

Kauai—Montane Mesic—Section 3: Montane Mesic—Section 3 consists of 139 ac (56 ha) in the montane mesic ecosystem, including the upper portion of the Nawaimaka Valley up to Kapukapaia Ridge, on State-owned land in the Na Pali-Kona Forest Reserve (Figure 3-B). This section is not in previously designated critical habitat and includes the only montane mesic forest occupied by the plant *Myrsine mezii*, and the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. Although Montane Mesic—Section 3 is not known to be occupied by the plants *Chamaesyce remyi* var. *remyi*, *Labordia helleri*, *Myrsine knudsenii*, *Myrsine mezii*, *Platydesma rostrata*, *Psychotria grandiflora*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*; by the birds the akekee and akikiki; or by the picturewing fly *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. It also provides for the species-specific PCEs for the akekee and akikiki (arthropod prey) and the larval-stage host plants (*Cheirodendron* sp. and

Tetraplasandra sp.) associated with *D. sharpi*. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, this section comprises Critical Habitat Unit 22 of 50 CFR 17.99(a)(1), Map 217e. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 3– Montane Mesic), and for the picturewing fly at 50 CFR 17.95(i) (Unit 3– Montane Mesic).

Kauai—Montane Wet—Section 1: Montane Wet—Section 1 consists of 13,055 ac (5,257 ha) in the montane wet ecosystem, extending across the Alakai Plateau from Hanakoa to Mount Waialeale, on State (12,628 ac, 5,110 ha) and privately owned (427 ac, 173 ha) land in the Na Pali Coast State Park, the Alakai Wilderness Preserve, the Na PaliKona and Halelea forest reserves, and Hono o Na Pali NAR (Figure 4). It is occupied by the plants *Astelia waialealae*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *K. helenae*, *Labordia helleri*, *L. pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, and *Platydesma rostrata*; by the akekee and akikiki; and by the picture-wing fly. This section also contains unoccupied habitat that is essential to the conservation of these 18 species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the montane wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and the species-specific PCEs including (1) bogs (identified as PCEs for *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*) (2) bog hummocks (identified as PCEs for *Astelia waialealae* and *Lysimachia daphnoides*); (3) arthropod prey (identified as PCEs for the akekee and the akikiki); and (4) larval-stage host plants, *Cheirodendron* and *Tetraplasandra* sp., (identified as a PCE for the picture-wing fly). Although Montane Wet—Section 1 is not known to be occupied by the plants *Dubautia kalalauensis*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, those portions of the section that overlie previously designated critical habitat fall within two existing Critical Habitat Units of 50 CFR 17.99(a)(1): Unit 10, Map 35a; and Unit 11, Map 64a. The previously undesignated land comprises Unit 23, Map 217f; and Unit 24, Map 217g. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 4–Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 4–Montane Wet).

Kauai—Montane Wet—Section 2: Montane Wet—Section 2 consists of 790 ac (320 ha) in the montane wet ecosystem, extending from Kahuamaa Flat south to the edge of Waimea Canyon, on State-owned land in Kokee State Park (Figure 4, above). The entire section is within previously designated critical habitat, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Dubautia kalalauensis*, *Labordia helleri*, *Melicope puberula*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*, and by the akekee. This section includes montane wet forest, potentially some small-scale boggy areas, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and arthropod prey (identified as a species-specific PCE for the akekee). Although Montane Wet—Section 2 is not known to be occupied by the plants *Astelia waialeale*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialeale*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia*

pumila, *Lysimachia daphnoides*, *Melicope degeneri*, *Myrsine mezii*, and *Phyllostegia renovans*; by the akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. This area also supports the arthropod prey identified as a PCE for the akikiki, and the larval-stage host plants (*Cheirodendron* and *Tetraplasandra* spp.) identified as a PCE for the picturewing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within previously designated Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 5—Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 5—Montane Wet).

Kauai—Montane Wet—Section 3: Montane Wet—Section 3 consists of 413 ac (167 ha) in the montane wet ecosystem, encompasses the summit of Namolokama, on State (156 ac, 63 ha) and privately owned (257 ac, 104 ha) land in the Halelea Forest Reserve (Figure 4, above). It is entirely within previously designated critical habitat, and is occupied by the plants *Keysseria erici* and *Labordia pumila*. This section includes the montane wet forest, the moisture regime, and the canopy, subcanopy, and understory plant species identified as PCEs in the montane wet ecosystem (Table 3), and bogs (identified as a species-specific PCE for *K. erici*). Although Montane Wet—Section 3 is not known to be occupied by the plants *Astelia waialeale*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia kalalauensis*, *D. waialeale*, *Geranium kauaiense*, *Keysseria helenae*, *Labordia helleri*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*; by the akekee and akikiki; or by the picture-wing fly, *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. It also supports the arthropod prey identified as a PCE for the akekee and akikiki, and the larval-stage host plants (*Cheirodendron* and *Tetraplasandra* spp.) identified as a PCE for the picture-wing fly. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, critical habitat falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 64a. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 6—Montane Wet), and for the picture-wing fly *Drosophila sharpi* at 50 CFR 17.95(i) (Unit 6—Montane Wet).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Psychotria grandiflora* critical habitat consists of two components (Montane mesic and Montane wet) (75 FR 18960-19165):

Ecosystem: Montane Mesic. Elevation: 3,300–5,243 ft (914–1,598 m). Annual precipitation: 50–75 in (127–190 cm). Substrate: weathered aa lava, rocky mucks, thin silty loams, deep volcanic ash soils. Canopy: *Acacia*, *Metrosideros*, *Psychotria*, *Tetraplasandra*, *Zanthoxylum*. Subcanopy: *Cheirodendron*, *Coprosma*, *Kadua*, *Ilex*, *Myoporum*, *Myrsine*. Understory: *Bidens*, *Dryopteris*, *Leptecophylla*, *Poa*, *Scaevola*, *Sophora*.

Ecosystem: Montane Wet. Elevation: 3,000–5,243 ft (914-1,598 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: Acacia, Charpentiera, Cheirodendron, Metrosideros. Subcanopy: Broussaisia, Cibotium, Eurya, Ilex, Myrsine. Understory: Ferns, Carex, Coprosma, Leptecophylla, Oreobolus, Rhynchospora, Vaccinium.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland

Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Acacia-Metrosideros montane mesic to wet forest (USFWS, 2010b)

Geographic or Habitat Restraints or Barriers

Adult: 3,400 - 4,100 ft. elevation (USFWS, 2010b)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: Moist and wet forests in gulches, on ridges, or on flats. The environmental specificity is unknown (NatureServe, 2015). It occurs in the montane mesic and montane wet ecosystems (K. Wood 2007a; TNCH 2007). It is found in Acacia-Metrosideros mesic to wet forest between the elevations of 3,400 and 4,100 ft. (1,128 and 1,250 m) (HBMP 2007) (USFWS, 2010b).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Resiliency:

Very low (inferred from USFWS, 2010b; see current range/distribution)

Redundancy:

Low to moderate (inferred from USFWS, 2010a)

Number of Populations:

42 (USFWS, 2017)

Population Size:

10 subpopulations (USFWS, 2017)

Population Narrative:

There are currently 42 wild individuals of *Psychotria grandiflora* in 10 subpopulations or sites in the Kokee region of Kauai. Seed collection efforts and pesticide treatments are ongoing. Two small exclosures have been constructed to protect a few individuals (USFWS, 2017).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from non-native plants, pigs, goats, deer, hurricanes, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species.

Stressor: Predation and herbivory (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species present an immediate and significant threat to *Psychotria grandiflora* throughout its range due to documented browsing and trampling by pigs, goats, and deer, and documented mechanical damage by rats (USFWS, 2010).

Stressor: Small populations and lack of reproduction (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: *Psychotria grandiflora* is threatened by the effects of small population size (fewer than 50 wild individuals). No viable seeds or reproduction have been observed. Research on *Pittosporum* species suggests that small populations are susceptible to loss of genetic variation through inbreeding and drift (USFWS, 2010).

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Recovery

Reclassification Criteria:

In addition to achieving 5 to 10 populations with 400 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats (USFWS, 2017).

Delisting Criteria:

In addition to achieving 5 to 10 populations with 400 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis (USFWS, 2017).

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data

- to better understand species distributions and priority ecosystem areas for targeting future surveys (USFWS, 2010a).
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units (USFWS, 2010a).
 - Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys (USFWS, 2010a).
 - Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range (USFWS, 2010a).
 - Conduct research on control methods for introduced slugs and avian malaria (USFWS, 2010a).
 - Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction (USFWS, 2010a).
 - Identify threats and prioritize which ones to address first for the two birds (USFWS, 2010a).
 - Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program (USFWS, 2010a).
 - Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security (USFWS, 2010a).
 - Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems (USFWS, 2010a).
 - Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations (USFWS, 2010a).

Conservation Measures and Best Management Practices:

- This species is monitored by the Plant Extinction Prevention Program. The Plant Extinction Prevention Program focuses on those plant species with fewer than 50 individuals remaining in the wild. The goal of the program is to achieve the general interim recovery guidelines set by the Hawaii and Pacific Plants Recovery Coordinating Committee (1994), which are: 3 populations of 25 (long-lived species), 50 (short-lived), or 100 (annual) mature, reproducing individuals; all threats to those populations being managed; and all individuals are represented in genetic storage (USFWS, 2010a).
- This species is currently in controlled propagation for genetic storage and/or reintroduction efforts (USFWS, 2010a).
- Current Management Actions: • Surveys and inventories—Surveys are ongoing to locate additional individuals of this species (PEPP 2010, 2011, 2012, 2014, 2015). • Ungulate monitoring and control—DOFAW has constructed a 0.008 hectare (0.02 acre) and a 0.02 hectare (0.6 acre) fence around two groups of individuals of *Psychotria grandiflora* at Kahuamaa Flats in Kokee SP (DOFAW 2005). • Captive propagation for genetic storage and reintroduction— Collection of seeds and cuttings is ongoing (PEPP 2016). A large hand pollination effort in 2016, under the guidance of Kenta Watanabe, a professor at Okinawa College studying breeding systems in Rubiaceae, produced dozens of seeds that have been given to NTBG nursery, Lyon Arboretum Micropropagation Lab, and

Kokee Rare Plant Facility (DOFAW 2016, Lyon Arboretum 2017, NTBG 2017). This effort continues in 2017 (Kishida 2017, pers. comm.). • Stochastic events—Reduced viability due to low numbers—PEPP continues to monitor populations (PEPP 2010, 2011, 2012, 2014, 2016). Research was conducted to determine pollinators for this species (PEPP 2016) (USFWS, 2017).

- RECOMMENDATIONS FOR FUTURE ACTIONS • Surveys and inventories—Continue to survey for populations of *Psychotria grandiflora* in areas of potentially suitable habitat. • Ungulate monitoring and control—Protect all occurrences against browsing and disturbances from feral ungulates. Continue to construct and maintain fenced exclosures around existing populations to prevent imminent extinction. • Invasive plant monitoring and control o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative plant species around all populations that compete with the species. • Rodent predation or herbivory control—Implement effective measures to control rodents around all populations. • Invertebrate predation or herbivory control—Study *Psychotria grandiflora* populations to determine level of threat from invertebrate predation or herbivory and effective control actions. • Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Population biology research—Study *Psychotria grandiflora* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. • Stochastic events—Build resilience and redundancy— o Increase numbers of populations and individuals scattered throughout historic range to reduce impacts from lack of pollination. o Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms. • Human disturbance—Protect occurrences along hiking trails and popular fruit collection sites. • Based on the recovery criteria above, consider development of a recovery plan (USFWS, 2017).

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SPECIES ACCOUNT: *Psychotria hexandra* ssp. *oahuensis* (Oahu wild coffee (=kopiko))

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/18/2012; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Tree or shrub up to 6 m tall. Flowers unisexual, usually 6-merous, corolla white, apex acute in bud. (NatureServe, 2015)

Taxonomy

A member of the coffee family (Rubiaceae). Two varieties of this subspecies, var. *hosakana* and var. *oahuensis*, were historically known only from the northern Koolau Mountains, while var. *rockii* was known only from the southern Koolau Mountains (Lau 2011, in litt.). (USFWS, 2012)

Historical Range

See current range/distribution.

Current Range

Recorded from north-central Koolau Mountains, island of Oahu, state of Hawaii. (NatureServe, 2015)

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On September 18, 2012, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Psychotria hexandra* ssp. *oahuensis* (Oahu wild coffee (=kopiko)) under the Endangered Species Act of 1973, as amended (Act) (77 FR 57648-57862). The critical habitat designation includes 14 critical habitat units, which encompass approximately 30,056 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Psychotria hexandra* ssp. *oahuensis* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Psychotria hexandra* ssp. *oahuensis* includes 14 critical habitat units, covering two ecosystem types, which encompass approximately 30,056 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; Oahu—Wet Cliff—Units 6, 7, 8.

Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Waialele, and Koloa gulches. Oahu—Lowland

Wet— Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Hauula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu— Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikēē, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet— Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet— Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu— Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamo Ridge.

Oahu—Wet Cliff—Unit 6 [151 ac (61 ha)]. This area consists of 151 ac (61 ha) in the wet cliff ecosystem on State land on the windward side of the Koolau Mountains in Kaipapau Gulch, entirely within the Kaipapau Forest Reserve. Oahu—Wet Cliff—Unit 7 [144 ac (58 ha)]. This area consists of 144 ac (58 ha) in the wet cliff ecosystem in State land on the windward side of the Koolau Mountains in Hauula Gulch, entirely within the Hauula Forest Reserve. Oahu—Wet Cliff—Unit 8 [4,649 ac (1,881 ha)]. This area consists of 1,479 ac (598 ha) of State land, 1,281 ac (519 ha) of City and County of Honolulu land, 5 ac (2 ha) of Federal land, and 1,884 ac (762 ha) of privately owned land, in the wet cliff ecosystem along the summit of the Koolau Mountains, overlapping portions of Sacred Falls State Park, the Waiahole FR (Waiahole and Iolekaa sections), the Kaneohe and Honolulu Watershed FRs, and the Nuuna Pali State Wayside.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Psychotria hexandra* ssp. *oahuensis* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Psychotria hexandra* ssp. *oahuensis* occurs within the Lowland wet and Wet cliff ecosystems in the Koolau Mountain caldera complex:

Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (F) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Oahu—Wet Cliff—Units 6, 7, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: >65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. (F) Understory: Bryophytes, Ferns, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Psychotria hexandra* ssp. *oahuensis* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (USFWS, 2012)

Habitat Vegetation or Surface Water Classification

Adult: Wet forest and shrubland (USFWS, 2012)

Dependencies on Specific Environmental Elements

Adult: Lowland wet and wet cliff ecosystems (USFWS, 2012)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 1,080 and 2,000 feet (330 and 600 meters) (USFWS, 2012)

Environmental Specificity

Adult: Low (inferred from USFWS, 2012)

Habitat Narrative

Adult: *Psychotria hexandra* ssp. *oahuensis* (kopiko) occurs in wet forest and shrubland in the lowland wet and wet cliff ecosystems of the Koolau Mountains, at elevations between 1,080 and 2,000 ft (330 and 600 m) (Wagner et al. 1999, p. 1,166; TNC 2007; HBMP 2008). (USFWS, 2012)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Short-term trends suggest declines of 10-30% (NatureServe, 2015)

Resiliency:

Very low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

3 (NatureServe, 2015)

Population Size:

<20 (NatureServe, 2015)

Population Narrative:

Short-term population trends suggest declines of 10-30%. There are 8 to 9 individuals in Maakua Gulch, 1 individual at Opauala Gulch, and fewer than 10 individuals south of Maakua Gulch (A. Bakutis, in litt. 2005; U.S. Army 2006; PEP Program 2007; HBMP 2008 cited by USFWS 2011).

One individual was outplanted in a fenced area in Makaua Valley in February 2007 (PEP Program 2007 cited by USFWS 2011). There are three extant occurrences (A. Bakutis, in litt. 2005; U.S. Army 2006; PEP Program 2007; HBMP 2008 cited by USFWS 2011). (NatureServe, 2015)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative plants, animals (pigs), hurricanes, rockfalls, landslides, floods, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants

and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Rockfalls, landslides, and floods destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. The projected effects of climate change will likely exacerbate the effects of the other threats to the species (USFWS, 2012).

Stressor: Predation and herbivory (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs and rats) is considered an ongoing threat to *Psychotria hexandra* ssp. *oahuensis* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2012).

Stressor: Small populations (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: *Psychotria hexandra* ssp. *oahuensis* faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). The only known wild populations are facing imminent threats from flooding, landslides, and rock falls because of their locations in steep gulches (USFWS, 2012).

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor:

Exposure:

Response:
Consequence:
Narrative:

Recovery

Reclassification Criteria:
Not available.

Delisting Criteria:
Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

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Final Rule. 77 Federal Register 181, September 18, 2012. Pages 57648 - 57862.

SPECIES ACCOUNT: *Psychotria hobbdi* (Kopiko)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (R1) (USFWS, 2016)

Physical Description

A tree, up to eight m tall. Corollas are white (NatureServe, 2015).

Taxonomy

A member of the coffee family (Rubiaceae) (USFWS, 2010b). The genus is widespread in tropics, and this species is endemic to northwestern Kauai (NatureServe, 2015).

Historical Range

The first collection of *P. hobbdi* was made in Mahanaloa Valley on Kauai in 1970 (St. John 1975, p. 59) (USFWS, 2010b).

Current Range

Currently, this species is known from Kawaiula Valley, the junction of Mahanaloa Valley and Kuia Valley, Mahanaloa Valley, Paaiki Valley, Poopooiki Valley, and upper Kalalau Valley (Kauai) (HBMP 2007) (USFWS, 2010b).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Psychotria hobbdi* (Kopiko) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes five critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Psychotria hobbdi* includes five CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Lowland Mesic—Section 1: Lowland Mesic—Section 1 consists of 2,006 ac (812 ha) in the lowland mesic ecosystem, including mesic forest extending from Awaawapuhi Trail south to Makaha Ridge, in the Na Pali Kona Forest Reserve and the Kuia NAR (Figure 1-A). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plants *Doryopteris angelica*, *Labordia helleri*, *Platydesma rostrata* and *Psychotria hobbdi*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these four species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic—Section 1 is not known to be occupied by the species *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Dubautia kenwoodii*, *Pittosporum napaliense*, and *Tetraplasandra bisattenuata*, we have determined this area to be

essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 2: Lowland Mesic—Section 2 consists of 379 ac (154 ha) in the lowland mesic ecosystem, including mesic forest extending from Keanapuka to Kahuamaa Flat along the rim and cliffs of the Kalalau Valley, in the Na Pali Coast State Park (Figure 1-A, above). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plants *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Pittosporum napaliense*, and *Psychotria hobdyi*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these six species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic—Section 2 is not known to be occupied by the species *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Platydesma rostrata*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 3: Lowland Mesic—Section 3 consists of 124 ac (50 ha) in the lowland mesic ecosystem, including mesic forest extending from Manono Ridge, Pohakuao Valley, to Kanakuu, within the Na Pali Coast State Park (Figure 1- A, above). The entire section is Stateowned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plants *Canavalia napaliensis*, *Chamaesyce eleanoriae*, and *Charpentiera densiflora*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these three species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic—Section 3 is not known to be occupied by the species *Chamaesyce remyi* var. *remyi*, *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Pittosporum napaliense*, *Platydesma rostrata*, *Psychotria hobdyi*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 4: Lowland Mesic—Section 4 consists of 81 ac (33 ha) in the lowland mesic ecosystem, including mesic forest at the head of the Hanakapiai Valley, in the Na Pali Coast State Park (Figure 1-A, above). The entire section is Stateowned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plant *Charpentiera densiflora* and includes mesic forest, the

moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. Although Lowland Mesic—Section 4 is not known to be occupied by the species *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *Chamaesyce remyi* var. *remyi*, *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Pittosporum napaliense*, *Platydesma rostrata*, *Psychotria hobdyi*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 5: Lowland Mesic—Section 5 consists of 37 ac (15 ha) in the lowland mesic ecosystem, including mesic forest on the slopes of Mt. Haupū, on privately owned land (Figure 1-B). The entire section is within previously designated critical habitat, and falls within Critical Habitat Unit 7 of 50 CFR 17.99(a)(1), Map 23a. This section is occupied by the plants *Chamaesyce remyi* var. *remyi* and *Tetraplasandra bisattenuata*, and includes mesic forest and shrubland, the moisture regime, and subcanopy and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these two species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic—Section 5 is not known to be occupied by the species *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *Charpentiera densiflora*, *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Pittosporum napaliense*, *Platydesma rostrata*, and *Psychotria hobdyi*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Psychotria hobdyi* critical habitat consists of one component (Lowland mesic) (75 FR 18960-19165):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<914 m). Annual precipitation: 50–75 in (127–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed

throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are

designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Lowland Acacia koa-Metrosideros polymorpha mesic forest (USFWS, 2010b)

Geographic or Habitat Restraints or Barriers

Adult: 1,700 - 2,700 ft. elevation (USFWS, 2010b)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits mesic forests on gulch slopes and in gulch bottoms. The environmental specificity is unknown (NatureServe, 2015). It occurs in lowland Acacia koa-Metrosideros polymorpha mesic forest in the lowland mesic ecosystem at elevations between 1,700 and 2,700 ft. (520 and 825 m) (Wagner et al. 1999, pp. 1166–1168; HBMP 2007; TNCH 2007) (USFWS, 2010b).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Species Trends:

Declining (NatureServe, 2015)

Resiliency:

Very low (inferred from USFWS, 2010b; see current range/distribution)

Redundancy:

Low to moderate (inferred from USFWS, 2010a)

Number of Populations:

10 (USFWS, 2017)

Population Size:

89-110 (USFWS, 2017)

Population Narrative:

The first collection of *Psychotria hobbdi* was made by Hobdy in Mahanaloa Valley on Kauai in 1970 (St. John 1975). At the time of listing, this species was known from 10 populations totaling approximately 120 individuals in Kawaiula Valley, at the junction of Mahanaloa Valley and Kuia Valley, in Mahanaloa Valley, in Paaiki Valley, in Poopooiki Valley; and in upper Kalalau Valley (HBMP 2010). Currently, *P. hobbdi* occurs in the same locations, and including Nualolo and Kaahole, totaling from 89 to possibly 100 individuals (HBMP, NTBG 2009, 2011a-b, 2012a-d, 2013, 2014a-b, 2015a-g, 2016; PEPP 2010, 2011, 2013, 2014, 2015, 2016) (USFWS, 2017).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from non-native plants, pigs, goats, deer, fire, hurricanes, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Fire can destroy dormant seeds and plants, even in steep in inaccessible areas. Successive fires can remove habitat for native species by altering microclimate conditions favorable to alien plants.

Stressor: Predation and herbivory (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species present an immediate and significant threat to *Psychotria hobbdi* throughout its range due to documented browsing and trampling by pigs, goats, and deer, and documented mechanical damage by rats and the two-spotted leafhopper (*Sophonia rufofascia*) (USFWS, 2010).

Stressor:

Exposure:
Response:
Consequence:
Narrative:

Stressor:
Exposure:
Response:
Consequence:
Narrative:

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys (USFWS, 2010a).
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units (USFWS, 2010a).
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys (USFWS, 2010a).
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range (USFWS, 2010a).
- Conduct research on control methods for introduced slugs and avian malaria (USFWS, 2010a).
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction (USFWS, 2010a).
- Identify threats and prioritize which ones to address first for the two birds (USFWS, 2010a).
- Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program (USFWS, 2010a).
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security (USFWS, 2010a).
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems (USFWS, 2010a).

- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations (USFWS, 2010a).

Conservation Measures and Best Management Practices:

- This species is currently in controlled propagation for genetic storage and/or reintroduction efforts (USFWS, 2010a).
 - The Hawaii Division of Forestry and Wildlife has established over 20 small-scale exclosures, largely in lowland and montane mesic ecosystems, and continues to control invasive introduced plants within them. While these fenced areas are extremely small, they have allowed for small-scale protection of remaining wild populations and reintroductions of this species, preventing its extinction (Hawaii Division of Forestry and Wildlife 2005, The National Tropical Botanical Garden 2007) (USFWS, 2010a).
 - To prevent extinction, which is the first step in recovering the species, the taxon must be managed to control threats (e.g., fenced) and have 50 individuals (or the total number of individuals in a population if fewer than 50) from each of three populations represented in an ex situ (at other than the plant's natural location, such as a nursery or seed bank) collection. In addition, a minimum of three populations should be documented on Kauai where they now occur or occurred historically and each of these populations must be naturally reproducing (i.e., viable seeds or seedlings), with a minimum of 50 mature individuals per population (USFWS, 2017).
 - RECOMMENDATIONS FOR FUTURE ACTIONS:
 - Surveys and inventories—Continue to survey for populations of *Psychotria hobbnyi* in areas of potentially suitable habitat.
 - Ungulate monitoring and control—Protect all occurrences against browsing and disturbances from feral ungulates. Continue to construct and maintain fenced exclosures around existing populations to prevent imminent extinction.
 - Invasive plant monitoring and control o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative plant species around all populations that compete with the species.
 - Rodent predation or herbivory control—Implement effective measures to control rodents around all populations.
 - Invertebrate predation or herbivory control—Study *Psychotria hobbnyi* populations to determine level of threat from invertebrate predation or herbivory, effective control actions, and any additional needed recovery actions.
 - Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock.
 - Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.
 - Population biology research—Study *Psychotria hobbnyi* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats.
 - Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms.
- Based on the recovery criteria above, consider development of a recovery plan (USFWS, 2017).

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SPECIES ACCOUNT: *Psychotria malaspinae* (Aplokating-palaoan)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/02/2015; Pacific Region (R1) (USFWS, 2016)

Physical Description

Psychotria malaspinae (aplokating palaoan), a shrub or small tree in the coffee family (Rubiaceae), is known only from Guam. (USFWS, 2015)

Historical Range

Historically, *P. malaspinae* was known from scattered occurrences on the northeast and southwest sides of Guam, in the forest ecosystem (Merrill 1914, pp. 148–149; Stone 1970, pp. 554– 555; Raulerson and Rinehart 1991, p. 83; Fosberg et al. 1993, pp. 111–112; Costion and Lorence 2012, pp. 54, 85– 86; Bishop Museum 2014—Online Database; Wagner 2012—Flora of Micronesia; WCSP 2012c—Online Database). (USFWS, 2015)

Current Range

It currently occurs on Guam (Mariana Islands) (USFWS, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (USFWS, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forests (USFWS, 2015)

Habitat Narrative

Adult: *P. malaspinae* was known from scattered occurrences on the northeast and southwest sides of Guam, in the forest ecosystem (Merrill 1914, pp. 148–149; Stone 1970, pp. 554– 555; Raulerson and Rinehart 1991, p. 83; Fosberg et al. 1993, pp. 111–112; Costion and Lorence 2012, pp. 54, 85– 86; Bishop Museum 2014—Online Database; Wagner 2012—Flora of Micronesia; WCSP 2012c—Online Database). (USFWS, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2015)

Redundancy:

Very low (inferred from USFWS, 2015)

Number of Populations:

4 (USFWS, 2015)

Population Size:

5 (USFWS, 2015)

Population Narrative:

Currently, *P. malaspinae* is known from only four occurrences, three with only a single individual each (M and E Pacific, Inc. 1998, pp. 67, 79; Grimm 2012, in litt.), none of which have been observed for at least 5 years; and a fourth recently discovered occurrence with three individuals (Guam Plant Extinction Prevention Program 2015, in litt.). In summary, the species *Psychotria malaspinae*, a single island endemic, has been reduced to an estimated five individuals in the wild, and possibly fewer since several of these individuals have not been observed for several years, rendering this species vulnerable to extinction. (USFWS, 2015)

Threats and Stressors

Stressor: Habitat loss from agriculture, urban development, non-native animals and plants, and typhoons (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: There are likely a few scattered individuals or small occurrences such as that recently discovered; however, these remaining individuals are at risk, due to continued habitat loss and destruction from agriculture, urban development, nonnative animals and plants, and typhoons. (USFWS, 2015)

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: The Service anticipates the effects of climate change will further exacerbate many of these threats in the future. (USFWS, 2015)

Stressor: Herbivory (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Herbivory by pigs and deer, damage by ordnance and live-fire training, combined with the effects of low numbers of individuals, which results in loss of vigor and genetic representation, and limits its ability to compete with other species and adapt to changes in environmental conditions, contribute to the decline of *P. malaspinae*. (USFWS, 2015)

Stressor: Small population size (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: In summary, the species *Psychotria malaspinae*, a single island endemic, has been reduced to an estimated five individuals in the wild, and possibly fewer since several of these individuals have not been observed for several years, rendering this species vulnerable to extinction. (USFWS, 2015)

Recovery**Reclassification Criteria:**

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

References

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SPECIES ACCOUNT: *Pteralyxia kauaiensis* (Kaulu)

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/25/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

A 3 - 8 m tall tree with milky sap and thick branches. Flowers are pale yellow. Fruits are large, and bright red (NatureServe, 2015).

Taxonomy

A member of the dogbane family (Apocynaceae) (USFWS, 2003). The genus is endemic to Kauai and Oahu, this species is endemic to Kauai (NatureServe, 2015).

Historical Range

Pteralyxia kauaiensis was first known from the Wahiawa Mountains in the southern portion of Kauai. Fossil seeds from Makauwahi Cave, at Mahaulepu on Kauai's south shore, show that *P. kauaiensis* occurred in coastal forests before human arrival (Burney et al. 2001) (USFWS, 2010).

Current Range

Since 2003, it has been observed in Limahuli Valley, Mt. Kahili, Hanakapiai Valley, Mahanaloa Valley, Hipalau Valley, two locations in Kalalau Valley, Koaie, Kawaiiki, and Makaha (Kauai) (USFWS, 2003).

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Pteralyxia kauaiensis* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Pteralyxia kauaiensis* includes seven units totaling 5,687 acres in Kauai County, Hawaii. The units are Kauai 7—*Pteralyxia kauaiensis*—a, Kauai 10—*Pteralyxia kauaiensis*—b, Kauai 11—*Pteralyxia kauaiensis*—c, d, e, f, g.

Kauai 7—*Pteralyxia kauaiensis*—a: This unit is critical habitat for *Pteralyxia kauaiensis* and is 345 ha (854 ac) on private land. This unit contains Hokulei Peak, Haupu and Naluakeina Summits, and Queen Victoria's Profile. This unit provides habitat for one population of 100 mature, reproducing individuals of the long-lived perennial *Pteralyxia kauaiensis* and is currently occupied with 10 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, diverse mesic or *Diospyros sandwicensis* mixed mesic forests with *Pisonia* spp. This unit is geographically separated from the other six units designated as critical habitat for this island-endemic species, in

order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 10—*Pteralyxia kauaiensis*—b: This unit is critical habitat for *Pteralyxia kauaiensis* and is 304 ha (752 ac) on State (Halelea and Lihue-Koloa Forest Reserves) and private land, containing Kuaohukini Summit. This unit provides habitat for one population of 100 mature, reproducing individuals of the long-lived perennial *Pteralyxia kauaiensis* and is currently occupied with two plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, diverse mesic or *Diospyros sandwichensis* mixed mesic forests with *Pisonia* spp. This unit is geographically separated from the other six units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 11—*Pteralyxia kauaiensis*—c: This unit is critical habitat for *Pteralyxia kauaiensis* and is 209 ha (516 ac) on State land (Hono o Na Pali NAR and Na Pali Coast State Park). This unit contains Alealau, Kanakou, and Puu Ki Summits and Kaaalahina Ridge. This unit provides habitat for one population of 100 mature, reproducing individuals of the long-lived perennial *Pteralyxia kauaiensis* and is currently occupied with 24 to 33 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, diverse mesic or *Diospyros sandwichensis* mixed mesic forests with *Pisonia* spp. This unit is geographically separated from the other six units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Pteralyxia kauaiensis*—d: This unit is critical habitat for *Pteralyxia kauaiensis* and is 57 ha (141 ac) on State land within Makaha Valley. This unit provides habitat for one population of 100 mature, reproducing individuals of the long-lived perennial *Pteralyxia kauaiensis* and is currently occupied with 300 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population,. The habitat features contained in this unit that are essential for this species include, but are not limited to, diverse mesic or *Diospyros sandwichensis* mixed mesic forests with *Pisonia* spp. This unit is geographically separated from the other six units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Pteralyxia kauaiensis*—e: This unit is critical habitat for *Pteralyxia kauaiensis* and is 353 ha (873 ac) on State land (Na Pali Coast State Park) within Kalalau Valley. This unit provides habitat for one population of 100 mature, reproducing individuals of the long-lived perennial *Pteralyxia kauaiensis* and is currently occupied with 332 to 337 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population. The habitat features contained in this unit that are essential for this species include, but are not limited to, diverse mesic or *Diospyros sandwichensis* mixed mesic forests with *Pisonia* spp. This unit is geographically separated from the other six units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Pteralyxia kauaiensis*—f: This unit is critical habitat for *Pteralyxia kauaiensis* and is 588 ha (1,445 ac) on State (Alakai Wilderness Preserve

and Puu Ka Pele Forest Reserve) and private land. This unit contains Hipalau, Kawaiiki, Kipalau, and Oneopaewa Valleys and portions of Kaluahaulu Ridge. This unit provides habitat for two populations of 100 mature, reproducing individuals of the long-lived perennial *Pteralyxia kauaiensis* and is currently occupied with 70 to 82 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, diverse mesic or *Diospyros sandwicensis* mixed mesic forests with *Pisonia* spp. This unit is geographically separated from the other six units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 11—*Pteralyxia kauaiensis*—g: This unit is critical habitat for *Pteralyxia kauaiensis* and is 445 ha (1,100 ac) on State land (Kuia NAR, Na Pali Coast State Park, and Puu Ka Pele Forest Reserve). This unit contains Kawaiula, Kuia, Mahanaloa, Paaiki, and Poopooiki Valleys and Milolii Ridge. This unit provides habitat for two populations of 100 mature, reproducing individuals of the long-lived perennial *Pteralyxia kauaiensis* and is currently occupied with 335 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population. The habitat features contained in this unit that are essential for this species include, but are not limited to, diverse mesic or *Diospyros sandwicensis* mixed mesic forests with *Pisonia* spp. This unit is geographically separated from the other six units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Diverse mesic or *Diospyros sandwicensis* mixed mesic forests with *Pisonia* spp. and containing one or more of the following associated plant species: *Acacia koa*, *Alectryon macrococcus*, *Alphitonia ponderosa*, *Antidesma platyphyllum* var. *hillebrandii*, *Bobea brevipes*, *Carex* spp., *Charpentiera elliptica*, *Claoxylon sandwicense*, *Cyanea* spp., *Dianella sandwicensis*, *Diospyros* spp., *Dodonaea viscosa*, *Diplazium sandwichianum*, *Euphorbia haeleeleana*, *Freycinetia arborea*, *Gahnia* spp., *Gardenia remyi*, *Hedyotis terminalis*, *Hibiscus kokio*, *Kokia kauaiensis*, *Leptecophylla tameiameia*, *Metrosideros polymorpha*, *Myrsine lanaiensis*, *Neraudia* spp., *Nesoluma polynesianum*, *Nestegis sandwicensis*, *Peperomia* spp., *Pisonia sandwicensis*, *Pipturus* spp., *Pleomele aurea*, *Poa sandwicensis*, *Pouteria sandwicensis*, *Pritchardia* spp., *Psydrax odorata*, *Psychotria* spp., *Rauvolfia sandwicensis*, *Santalum freycinetianum* var. *pyrularium*, *Schiedea* spp., *Syzygium sandwicensis*, *Tetraplasandra* spp., *Xylosma hawaiiense*, or *Zanthoxylum dipetalum*; and

(ii) Elevations between 127 and 1,563 m (418 and 5,128 ft).

Special Management Considerations or Protections

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites;

existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species in paragraph (b) of this section and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Lifespan

Adult: > 10 years (USFWS, 2010)

Breeding Season

Adult: Unknown (USFWS, 2003)

Key Resources Needed for Breeding

Adult: Unknown (USFWS, 2003)

Reproduction Narrative

Adult: It is a long-lived perennial (USFWS, 2010). Flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown (Service 1995) (USFWS, 2003).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Diverse mesic or Diospyros sandwicensis mixed mesic forests (USFWS, 2003)

Geographic or Habitat Restraints or Barriers

Adult: 418 - 5,128 ft. elevation (USFWS, 2003)

Environmental Specificity

Adult: Moderate to broad (inferred from USFWS, 2010)

Habitat Narrative

Adult: Inhabits moist forests, or sometimes wet forests on gulch slopes and gulch bottoms (NatureServe, 2015). *Pteralyxia kauaiensis* occurs in a range of elevations and habitat types around Kauai (USFWS, 2010). This species is typically found in diverse mesic or *Diospyros sandwicensis* mixed mesic forests with *Pisonia* spp. between elevations of 127 and 1,563 m (418 and 5,128 ft.) (USFWS, 2003).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Declining (USFWS, 2010)

Resiliency:

Low (inferred from USFWS, 2003; see current range/distribution)

Redundancy:

Moderate (inferred from USFWS, 2010)

Number of Populations:

16 (USFWS, 2017)

Population Size:

300 - 400 (USFWS, 2017)

Population Narrative:

New Status Information: In addition to those populations cited in the previous 5-year review, new observations include the following: • At the time of the last 5-year review in 2010 there were 10 populations totaling between 330 and 700 individuals on Kauai. Surveys confirm previously known individuals at seven locations: Kaluahaulu to Hipalau, Haeleele, Makaha to Mahanaloa, Mohihi, Kalalau, Keanapuka, Hanakapiai, and lower Limahuli (NTBG 2011c-d, 2012, 2013a, 2014a-d, 2015a-c, 2016a-b; PEPP 2017). The current status of individuals at Haupu, Wahiawa, Blue Hole, Makaleha, and Poomau is unknown. New populations were found at Waiahi and Kawaiumakua (NTBG 2011a-b, 2013c). The current populations total between 300 and 400 individuals (USFWS, 2017).

Threats and Stressors

Stressor: Ungulates (USFWS, 2010)

Exposure:

Response:**Consequence:**

Narrative: The forest floor in Hanakapiai and elsewhere is at times highly disturbed with pig (*Sus scrofa*) and goat damage (Tangalin 2008) (USFWS, 2010).

Stressor: Invasive plants (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: Invasive introduced plants including *Axonopus fissifolius* (narrow-leaved carpet grass), *Bryophyllum pinnatum* (airplant), *Clidemia hirta* (Koster's curse), *Erigeron karvinskianus* (daisy fleabane), *Grevillea robusta* (silk oak), *Lantana camara* (lantana), *Melia azedarach* (pride-of-India), *Pluchea* sp. (fleabane), *Psidium guajava* (common guava), *P. cattleianum* (strawberry guava), *Rubus rosifolius* (thimbleberry), and *Setaria parviflora* (yellow foxtail), are species which compete with *P. kauaiensis* and degrade habitat quality (National Tropical Botanical Garden 2008b; Perlman 2008; Tangalin 2008) (USFWS, 2010).

Stressor: Predation (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: Larvae of an unknown invertebrate species have been observed eating seeds in Koaie Canyon (Hawaii Biodiversity and Mapping Program 2008) (USFWS, 2010). Animals affecting the survival of this species include feral goats and pigs, and possibly rats, which may eat the fruit (USFWS, 2003).

Stressor: Falling boulders (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: Not available

Stressor: Fire (USFWS, 2003)

Exposure:**Response:****Consequence:**

Narrative: Fire could threaten some populations (USFWS, 2003).

Stressor: Climate change loss or degradation of habitat

Exposure:**Response:****Consequence:**

Narrative: —Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Pteralyxia kauaiensis* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.558 (on a scale of 0

being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Stressor: Hurricanes—Loss and degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Hurricanes were omitted in the last five year review. In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event, and 70 percent of all listed plant species on Kauai are only found on Kauai. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013) (USFWS, 2017).

Recovery

Reclassification Criteria:

1. A total of five to seven populations should be documented on Kauai and at least one other island where they now occur or occurred historically (USFWS, 1995).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials (USFWS, 1995).
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 1995).

Delisting Criteria:

1. A total of eight to ten populations should be documented on Kauai and at least one other island where they now occur or occurred historically (USFWS, 1995).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials (USFWS, 1995).
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 1995).

Recovery Actions:

- Protect current populations, control threats and monitor (USFWS, 1995).
- Expand current populations (USFWS, 1995).
- Conduct research essential to conservation of the species (USFWS, 1995).
- Establish new populations as needed to reach recovery objectives (USFWS, 1995).
- Validate and revise recovery objectives (USFWS, 1995).
- Devise and implement a public education program (USFWS, 1995).

Conservation Measures and Best Management Practices:

- Continue collecting seed from all populations for genetic storage and reintroduction (USFWS, 2010).
- Propagate plants for reintroduction (USFWS, 2010).
- Fence wild populations to exclude the negative impacts from ungulates (USFWS, 2010).
- Control invasive introduced species around wild plants (USFWS, 2010).
- Survey historical locations to the species' current status (USFWS, 2010).
- Work with Hawaii Division of Forestry and Wildlife and Hawaii State Parks to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2010).
- New Management Actions: • There are three plants from a fruit collection from the Mohihi population at the Kokee Rare Plant Facility (DOFAW 2016). There are a dozen plants planted at the NTBG grounds as a living collection from six different collections from Waimea, Hanakapiai, and Kalalau (NTBG 2017). • PEPP is monitoring a population of *Pteralyxia kauaiensis* at Kawaiiki (PEPP 2015) (USFWS, 2017).
- Recommendations for Future Actions: No new threats and no other significant new information regarding the species' biological status have been reported since the last 5-year review in 2010. Therefore, the following recommendations for future actions are reiterated for the 5-year review for 2017. • Surveys and inventories—Survey for populations of *Pteralyxia kauaiensis* in areas of potentially suitable habitat • Ungulate monitoring and control—Protect all populations against browsing and disturbances from feral ungulates. Continue to construct and maintain fenced exclosures to protect all known wild populations from ungulates. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative species that compete with the species around all populations. • Fire monitoring and control—Develop and implement fire management plans for all wild and reintroduced populations. • Predator and herbivore monitoring and control— o Implement effective control measures for rodents. o Determine and implement effective control methods for the black twig borer. • Predator and herbivore control research—Study *Pteralyxia kauaiensis* populations to determine level of threat from invertebrate herbivory and any additional needed recovery actions. • Captive propagation for genetic storage and reintroduction—Continue collecting seed from all populations. • Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Population biology research—Study *Pteralyxia kauaiensis* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides (USFWS, 2017)

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SPECIES ACCOUNT: *Pteralyxia macrocarpa* (Kaulu)

Species Taxonomic and Listing Information

Listing Status: Endangered; 9/18/2012; Pacific Region (R1) (USFWS, 2016)

Physical Description

A tree, 8-15 m tall, with milky sap and dark green leaves that are shiny on the upper surfaces. The lower leaf surfaces are paler and dull; the cymes are congested and terminal. The corolla lobes are pale yellow; fruits are ellipsoid to obovoid, 5.5-7 cm long, and bright red at maturity (NatureServe, 2015).

Taxonomy

In the dogbane family (Apocynaceae). (USFWS, 2012).

Historical Range

On island of Oahu in the state of Hawaii, along the entire length of the Koolau range and on the summit ridges of the Waianae Mountains (USFWS, 2012).

Current Range

On island of Oahu in the state of Hawaii, found from Kapuhi Gulch to North Palawai Gulch in the Waianae Mountains (USFWS, 2012).

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On September 18, 2012, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Pteralyxia macrocarpa* (Kaulu) under the Endangered Species Act of 1973, as amended (Act) (77 FR 57648-57862). The critical habitat designation includes 39 critical habitat units, which encompass approximately 40,326 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Pteralyxia macrocarpa* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Pteralyxia macrocarpa* includes 39 critical habitat units, covering four ecosystem types, which encompass approximately 40,326 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7; Oahu—Lowland Wet—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8; Oahu—Wet Cliff—Units 1, 2, 3, 4, 5, 6, 7, 8.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole

NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

Oahu—Lowland Wet—Unit 1 [541 ac (219 ha)]. This area consists of 428 ac (173 ha) of State land and 112 ac (46 ha) of City and County of Honolulu land in the lowland wet ecosystem on the windward side of the Waianae Mountains, and partially within the Mokuleia and Waianae Kai Forest Reserves. Oahu—Lowland Wet—Unit 2 [20 ac (8 ha)]. This area consists of 19 ac (8 ha) of State land in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puuhapapa. Oahu—Lowland Wet—Unit 3 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puukanehoa. Oahu—Lowland Wet—Unit 4 [27 ac (11 ha)]. This area consists of 27 ac (11 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains on State land at Puukaua. Oahu—Lowland Wet—Unit 5 [74 ac (30 ha)]. This area consists of 74 ac (30 ha) of State land in the lowland wet ecosystem, on the windward side of the Waianae Mountains at Palikea. Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihihi, Wailele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Hauula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikēēē, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet—Unit 11 [124 ac (50 ha)]. This area

consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet—Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu—Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamo Ridge.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac (105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawana, and partially within the Nanakuli Forest Reserve.

Oahu—Wet Cliff—Unit 1 [235 ac (95 ha)]. This area consists of 167 ac (68 ha) of State land, 68 ac (28 ha) of City and County of Honolulu land, and less than 1 ac (less than 1 ha) of privately owned land in the wet cliff ecosystem in the Waianae Mountains, near the summit of Kaala, and partially within the Mokuleia and Waianae Kai FRs and the Kaala Natural Area Reserve. Oahu—Wet Cliff—Unit 2 [3 ac (1 ha)]. This area consists of 3 ac (1 ha) of State land in the wet cliff ecosystem in the Waianae Mountains at Puuhapapa, within a small area that was part of the Honouliuli Preserve,

managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Oahu—Wet Cliff—Unit 3 [16 ac (6 ha)]. This area consists of 16 ac (6 ha) in the wet cliff ecosystem on State land in the Waianae Mountains at Puukanehoa, partially within an area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Oahu—Wet Cliff—Unit 4 [23 ac (9 ha)]. This area consists of 23 ac (9 ha) in the wet cliff ecosystem on State land in the Waianae Mountains at Puukaua, partially overlapping an area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and recently acquired by the State. Oahu—Wet Cliff—Unit 5 [31 ac (13 ha)]. This area consists of 31 ac (13 ha) of State land in the wet cliff ecosystem in the Waianae Mountains, at Palikea and north of Palikea. Oahu—Wet Cliff—Unit 6 [151 ac (61 ha)]. This area consists of 151 ac (61 ha) in the wet cliff ecosystem on State land on the windward side of the Koolau Mountains in Kaipapau Gulch, entirely within the Kaipapau Forest Reserve. Oahu—Wet Cliff—Unit 7 [144 ac (58 ha)]. This area consists of 144 ac (58 ha) in the wet cliff ecosystem in State land on the windward side of the Koolau Mountains in Hauula Gulch, entirely within the Hauula Forest Reserve. Oahu—Wet Cliff—Unit 8 [4,649 ac (1,881 ha)]. This area consists of 1,479 ac (598 ha) of State land, 1,281 ac (519 ha) of City and County of Honolulu land, 5 ac (2 ha) of Federal land, and 1,884 ac (762 ha) of privately owned land, in the wet cliff ecosystem along the summit of the Koolau Mountains, overlapping portions of Sacred Falls State Park, the Waiahole FR (Waiahole and Iolekaa sections), the Kaneohe and Honolulu Watershed FRs, and the Nuana Pali State Wayside.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Pteralyxia macrocarpa* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Pteralyxia macrocarpa* occurs within the Lowland mesic, Lowland wet, Dry cliff and Wet cliff ecosystems in the Waianae Mountain caldera complex and the Lowland mesic, Lowland wet and Wet cliff ecosystems in the Koolau Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Oahu—Lowland Wet—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (F) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: *Antidesma*, *Chamaesyce*, *Diospyros*, *Dodonaea*. (F) Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Schiedea*.

Oahu—Wet Cliff—Units 1, 2, 3, 4, 5, 6, 7, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: >65 degree slope, shallow soils, weathered lava. (D) Canopy:

None. (E) Subcanopy: Broussaisia, Cheirodendron, Leptecophylla, Metrosideros. (F) Understory: Bryophytes, Ferns, Coprosma, Dubautia, Kadua, Peperomia.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for Pteralyxia macrocarpa to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Potential pollinators are insects are birds (EPA, 2016).

Habitat Type

Adult: Terrestrial (USFWS, 2012)

Habitat Vegetation or Surface Water Classification

Adult: Lowland mesic, lowland wet, dry cliff, and wet cliff ecosystems (USFWS, 2012). Mostly in moist forests (or sometimes in the lower wet forests in the Koolau Mountains). On gulch slopes and in gulch bottoms. (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Elevations between 1,100 and 2,800 ft (USFWS, 2012)

Environmental Specificity

Adult: Unknown (Natureserve, 2015)

Habitat Narrative

Adult: This species occurs in the Waianae and Koolau Mountains, in the lowland mesic, lowland wet, dry cliff, and wet cliff ecosystems, at elevations between 1,100 and 2,800 ft (340 and 850 m) (USFWS, 2012). Mostly in moist forests (or sometimes in the lower wet forests in the Koolau Mountains) on gulch slopes and in gulch bottoms (NatureServe, 2015).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Potential dispersal mechanism is abiotic (EPA, 2016).

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Species Trends:

Unknown (NatureServe, 2015)

Redundancy:

Low (inferred from USFWS, 2012)

Population Growth Rate:

Unknown (NatureServe, 2015)

Number of Populations:

40 (USFWS, 2012)

Population Size:

291 - 347 individuals (USFWS, 2012)

Population Narrative:

Unknown In the Waianae Mountains, there are approximately 233-289 individuals and in the Koolau Mountains, there are approximately 58 individuals (U.S. Army 2006; HBMP 2008 cited by USFWS 2011). In the Waianae Mountains, there are approximately 31 extant occurrences and in the Koolau Mountains, there are approximately 9 extant occurrences (U.S. Army 2006; HBMP 2008 cited by USFWS 2011). (NatureServe, 2015)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative plants, animals (pigs and goats), fire, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The projected effects of climate change will likely exacerbate the effects of the other threats to the species (USFWS, 2012).

Stressor: Predation and herbivory (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, goats, and two-spotted leafhopper) is considered an ongoing threat to *Pteralyxia macrocarpa* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2012).

Stressor:
Exposure:
Response:
Consequence:
Narrative:

Stressor:
Exposure:
Response:
Consequence:
Narrative:

Stressor:
Exposure:
Response:
Consequence:
Narrative:

Stressor:
Exposure:
Response:
Consequence:
Narrative:

Recovery

Reclassification Criteria:
Not available.

Delisting Criteria:
Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

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SPECIES ACCOUNT: *Ptilimnium nodosum* (Harperella)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/28/1988; Northeast Region (Region 5) (USFWS, 2015)

Physical Description

An annual herb with slender, erect stems, up to 12 dm high. The roots are shallow, diffuse-fibrous, and the plants have a faint scent of dill. Unlike those of the more common members of this genus, the leaves of *P. nodosum* are reduced to hollow, quill-like structures. Broad clusters of small white flowers bloom mostly in July and August. (NatureServe, 2015)

Taxonomy

As of 2008, the U.S. FWS treatment includes *P. fluviatile* (AR, AL; river form, does not produce asexual buds), *P. viviparum* (MD, WV, VA, NC; river form, produces asexual buds), and *P. nodosum sensu stricto* (GA, SC; pond form) in *P. nodosum*, as does Kartesz (1994 and 1999); this is the treatment followed here. However, recent information suggests they may be tentatively treated as distinct entities, although not necessarily as distinct species (David Maddox pers. comm. to Alan Weakley and to Larry Morse). Specifically, a 1994 isozyme study found that there was substantial genetic differentiation among rather than within these three groups, supporting designation as distinct entities (Kress et al. 1994 cited in Douglas 2008). A 2008 DNA study (nuclear rDNA ITS sequences) found that "viviparum" accessions formed a monophyletic group, but "nodosum sensu stricto" accessions did not, with South Carolina populations forming a monophyletic group, but Georgia populations falling at the base of the clade alongside "fluviatile" accessions (Feist and Downie 2008). In summary, although there is clearly more than one distinct entity within the current broad-sense circumscription of *P. nodosum*, there is not yet a clear consensus on how to divide the material and at what taxonomic level entities should be distinguished. (NatureServe, 2015)

Current Range

Currently known from scattered sites in western Maryland, eastern West Virginia, northeastern Virginia, north-central North Carolina, central South Carolina, central Georgia, northeastern Alabama, and west-central Arkansas. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual (vegetatively) and sexual (NatureServe, 2015)

Lifespan

Adult: 1 year (USFWS, 2015)

Breeding Season

Adult: July to August (USFWS, 1990)

Reproduction Narrative

Adult: *Ptilimnium nodosum* is an annual that reproduces both vegetatively and via seed; it is thought that established patches may persist over the long-term primarily by vegetative reproduction, while novel habitat colonization may occur primarily via seed. These multiple reproduction modes also appear to provide a survival mechanism for variable water levels; since sexual reproduction becomes more difficult within increasing water depth, the plants produce seeds and reproduce sexually in dry years, while in wet years they produce plantlets and reproduce vegetatively. It appears that both forms of reproduction contribute to overall population size in most years, with the contribution of each dependent upon hydrological patterns (Douglas 2008). Marcinko and Randall (2008) studied the mating system of *P. nodosum*, with the following findings. Flowers were self-compatible, but strong intrafloral protandry essentially prevented autonomous selfing. (NatureServe, 2015)

Habitat Type

Adult: Riverine, and palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Spring/spring brook, herbaceous wetland, riparian, temporary pool (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Saturated sites; flooding; water fluctuations (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Prefers saturated habitat, periodic flooding, sunny areas. Restricted to intermediate water depths (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Patches (USFWS, 1990)

Tolerance Ranges/Thresholds

Adult: Moderate (USFWS, 1990)

Site Fidelity

Adult: High (USFWS, 1990)

Habitat Narrative

Adult: *Ptilimnium nodosum* occurs in three habitat types: rocky/gravelly shoals or cracks in bedrock outcrops beneath the water surface in clear, swift-flowing streams (usually in microsites that are sheltered from rapidly moving water); edges of intermittent pineland ponds or low, wet savannah meadows on the Coastal Plain; and granite outcrop seeps. In all habitat-types, the species occurs in a narrow range of water depths; it is intolerant of deep water and of conditions that are too dry. However, the plants readily tolerate periodic, moderate flooding - something to which few potential competitors are adapted. *P. nodosum* seeds generally germinate during short-duration spring floods and the plants have completed their life cycle by late summer or fall, just as water levels are lowest and competing species are moving in. The dominant species at *P. nodosum* sites is often *Panicum hemitimon*. Other species may include

many sedges in the genera *Rhynchospora* (e.g., *B. perplexa*, *R. microcarpa*), *Carex* (e.g., *C. walteri*, *C. lupulina*), *Eleocharis* (e.g., *E. tricostrata*, *E. melanocarpa*), *Psilocarpha*, *Dichromena colorata*, and *Fimbristylis*. Dicot associates include *Hypericum fasciculatum*, *H. denticulatum*, *H. myrtifolium*, *Rhexia virginica*, *R. mariana*, *B. aristosa*, *Proserpinaca pectinata*, several *Ludwigia* species, and *Sclerolepis uniflora* (Kral 1983). (USFWS, 1990; NatureServe, 2015)

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 1990)

Dispersal/Migration Narrative

Adult: Seeds readily float, so dispersal probably is mediated by water flow; however, safe sites downstream are infrequently and haphazardly found. Further, seeds have no structures to facilitate aerial dispersal and drop quickly to the ground, with many seeds germinating directly under the parent plant. The natural founding of new pond populations is probably very rare because of the plant's (apparently) poor capacity for long distance dispersal and the fragmented dispersion of appropriate habitat. Thus, seed dispersal to new sites is probably a rare event. (USFWS, 1990)

Population Information and Trends

Population Trends:

Long-term trends suggest a decline of 30 to 70%, whereas short-term trends indicate a decline of >50% (NatureServe, 2015)

Species Trends:

Declining (NatureServe, 2015)

Resiliency:

Low (inferred from USFWS, 1990)

Representation:

Low (inferred from USFWS, 1990)

Number of Populations:

24 (NatureServe, 2015)

Population Size:

~500,000 (NatureServe, 2015)

Population Narrative:

This species may be somewhat resistant, but is sensitive to dry conditions and dependent on narrowly defined hydrologic conditions. Vulnerable to upstream development. Many sites have been lost. Approximately 25% of mapped occurrences are ranked historical or extirpated. Long-term population trends suggest a decline of 30 to 70%, whereas short-term trends indicate a decline of greater than 50%. The total number of known individuals appears to be approximately 500,000. One population (drainage/watershed) in West Virginia is estimated to

contain 400,000 plants, and all populations in Arkansas are estimated to total 50,000-100,000 plants in a good year (Douglas 2008). Many of the other extant populations are small; nine of the populations (drainages/watersheds) are estimated to contain less than 400 plants (Douglas 2008). Approximately 45 occurrences are believed extant, about half of which are in Arkansas with the other states in the range having 1-5 each. Thirteen occurrences are considered historical (predominantly in Alabama and South Carolina) and 1 (in Georgia) has been extirpated. The U.S. Fish and Wildlife Service (Douglas 2008) regards 24 "populations" as extant, with "population" defined as "sites located within one drainage or watershed... each may have a number of discrete sites (element occurrences)." Under this view, there are 9 extant populations in Arkansas and 1-3 in each of the other states. (NatureServe, 2015)

Threats and Stressors

Stressor: Water fluctuations (USFWS, 1990)

Exposure:

Response:

Consequence:

Narrative: Fluvatile tends to occupy a narrow range of water depths, manipulations of water flow upstream from populations can easily destroy suitable habitat by inundation or persistent desiccation. Dams, reservoirs, or other water impoundments or diversions would almost certainly threaten any *P. nodosum* downstream. Natural fluctuation in water flow causes significant yearly variation in subpopulation persistence. Small subpopulations are particularly susceptible to loss during normal high water events. Thus, small populations such as those in North Carolina or Maryland's Fifteen Mile Creek are at significant yearly risk. Hydrological manipulations on rivers with small populations should be strictly avoided or controlled. *Nodosum*, like *Fluvatile*, depends on intermediate water levels and is threatened by either dry conditions or total inundation. Thus, the primary threats to *Nodosum* populations are hydrological manipulation and physical destruction of their pond habitats. (USFWS, 1990)

Stressor: Water quality (USFWS, 1990)

Exposure:

Response:

Consequence:

Narrative: *Fluvatile* is apparently also sensitive to reductions in water quality. Siltation caused by heavy construction, residential development, and agriculture has been cited as detrimental to the plant. The negative effect of sediment on *Fluvatile* was substantiated in a greenhouse experiment: turbidity equal to that near a bridge construction site reduced *Fluvatile* growth rate by 40% (Maddox and Bartgis 1990b). (USFWS, 1990)

Stressor: Stream acidification (USFWS, 1990)

Exposure:

Response:

Consequence:

Narrative: Another greenhouse experiment indicates that stream acidification (especially pH ~ 5.0) may cause significant plant mortality (Maddox and Bartgis 1990b). Plants growing in water with pH approximately equal to 3.4 had a 70% mortality rate; in water with pH = 4.6 plants grew at a significantly lower rate than controls. This is potentially important in Alabama, where the extant population has historically experienced low pH due to mining. At Maryland and West

Virginia sites, the pH is typically 7.0. However, the acid neutralizing capacity is very low, suggesting that minor acid inputs could significantly lower pH. Other water quality variables, such as increased sewage or nitrate concentration, may also be detrimental. (USFWS, 1990)

Stressor: Alterations in hydrology (USFWS, 1990)

Exposure:

Response:

Consequence:

Narrative: Coastal plain ponds everywhere are threatened by active drainage for conversion to pine plantations or row crops (Godfrey and Wooten 1979). Lowered water tables are probably detrimental to *Nodosum* through increased competitive and physiological stress. While hydrological manipulations directly to the pond are clearly detrimental, ditching and other manipulations of the water table from some distance away may affect coastal plain ponds, although the exact area of effect is not known (Pat Phillips, U.S. Geological Survey, pers. comm. 1989). The effective distance of such manipulations clearly is important in determining the zone around a population needed to ensure protection of the hydrological resource. (USFWS, 1990)

Stressor: Dredging (USFWS, 1990)

Exposure:

Response:

Consequence:

Narrative: Occasionally ponds are dredged to create deep ponds for livestock; these deeper water levels probably disrupt the life cycle of *Nodosum*, a small plant. (USFWS, 1990)

Recovery

Reclassification Criteria:

1. Thirteen populations (the number of currently extant populations) have been relatively stable in population size for five years. (USFWS, 1990)
2. All thirteen populations are permanently protected. (USFWS, 1990)

Delisting Criteria:

1. Thirteen populations (the number of currently extant populations) have been relatively stable in population size for five years. (USFWS, 1990)
2. All thirteen populations are permanently protected. (USFWS, 1990)
3. There are at least 26 self-sustaining populations in existence. To reach this level, at least thirteen new populations will have to be discovered or established. This is the total number of current and historically known populations. (USFWS, 1990)
4. The populations are distributed throughout the historical range from Arkansas to Maryland. (USFWS, 1990)
5. All 26 populations are permanently protected. (USFWS, 1990)

Recovery Actions:

- Protect plants and their habitat through landowner cooperation, land protection, and regulatory authorities. (USFWS, 1990)
- Where needed, seek conservation of watersheds to protect populations. (USFWS, 1990)
- Search for additional populations. (USFWS, 1990)
- Study species and habitat characteristics. (USFWS, 1990)
- Develop a cultivated sources of plants and provide for seed storage. (USFWS, 1990)
- Implement appropriate management techniques, particularly for pond populations. (USFWS, 1990)
- Re-establish populations within the species' historical range. (USFWS, 1990)
- Inform the public about the plant's status and recovery needs. (USFWS, 1990)

Conservation Measures and Best Management Practices:

- Population surveys and inventories have been performed at all current sites by State Heritage Programs or botanists from various universities. Active population monitoring occurs only in Maryland and West Virginia. (USFWS, 1990)
- Surveys for new populations have been undertaken in all states containing extant populations, except Arkansas. New populations were verified in Maryland in 1988 and Arkansas in 1990. Significant potential habitat or recent unconfirmed records remain to be investigated in Alabama, Georgia, North and South Carolina, Arkansas, southern Missouri, and eastern Oklahoma. (USFWS, 1990)
- The Nature Conservancy, Western Pennsylvania Conservancy, and Maryland Department of Natural Resources have begun a comprehensive program to protect Sideling Hill Creek, including upstream areas as buffer. To date, a number of tracts have been registered in Maryland and Pennsylvania, a tract has been acquired on the border of Maryland and Pennsylvania, and the potential purchase of the most significant tract supporting *p. nodosum* is being negotiated by the State of Maryland and The Nature Conservancy. (USFWS, 1990)
- The Nature Conservancy has acquired an easement on one Cacapon River subpopulation. Additional subpopulations in West Virginia have been added to the Conservancy's registry program. The U.S. Fish and Wildlife Service contracted with The Nature Conservancy in 1990 to expand landowner contact efforts on the Cacapon River. (USFWS, 1990)
- The Maryland Natural Heritage Program has conducted an extensive two—year investigation of the ecology and life history of *Fluviatile* (Maddox and Bartgis 1989, 1990a, 1990b). (USFWS, 1990)
- The Maryland Natural Heritage Program has collaborated with the Smithsonian Institution on a study of electrophoretically detectable genetic variation throughout the range of *P. nodosum*. This study is expected to be completed in spring of 1991. (USFWS, 1990)
- The Maryland Natural Heritage Program has produced and distributed several information brochures on the biology of *P. nodosum* and its habitat. (USFWS, 1990)
- In a 1988 survey conducted by the Center for Plant Conservation to determine the plant taxa in most imminent danger of extinction, *P. nodosum* was identified by botanists as a "B" priority taxon, i.e., one which could go extinct in the wild within the next ten years. The Center has assisted in the recovery of the plant: 7,500 seeds have been collected as part of the National Collection of Endangered Plants and are housed at the North Carolina Botanical Garden (NCBG), one of the Center's participating institutions in the region. All seeds were collected from the Tar River area in Granville County, North Carolina. Although not currently being propagated at NCBG, these seeds provide a valuable conservation resource. (USFWS, 1990)

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SPECIES ACCOUNT: *Purshia (=Cowania) subintegra* (Arizona Cliff-rose)

Species Taxonomic and Listing Information

Listing Status: Endangered; 5/29/1984; Southwest Region

Physical Description

Arizona cliffrose is a member of the Rose Family (Rosaceae). It is a low, straggling woody perennial usually 1 - 2 meters (in) (3 - 6 feet) high and generally wider than tall. In the Cottonwood population, plants can reach a maximum of 2.4 m (8 feet) tall and 3.7 m (12 feet) in diameter. The horizontal lower branches are spreading, and the central branches are irregularly ascending (Denham and Fobes 1992b). New shoots tend to be red-brown and pubescent with a red dot below the fascicle. The older branches have light gray bark that becomes shreddy. The herbage is not viscid (sticky), although some resin glands may be present, causing slight stickiness. The shape of *Purshia subintegra* leaves is variable. The leaves are very narrow and short: averaging about 8 millimeters (mm) (0.3 inch) long (Denham and Fobes 1992b) and 3 mm (0.1 inch) wide. Leaves usually have no lobes, but occasionally have 1 or 2 rounded, shallow lobes or teeth just below the leaf tip. The margins (edges) of the leaves are curled towards the underside (revolute). The upper leaf surface is bright or dark green and usually has no punctate glands. The upper leaf surface is usually loosely arachnoidpubescent (having a few long hairs) on the upper surface, but sometimes it is hairless. The lower surface is densely white-lanate (wooly) and usually has no punctate glands. Each flower is born on a single stalk (peduncle). The end of the peduncle gradually merges with the beginning of the narrowly funnelform hypanthium, the flower part bearing the sepals, petals, and stamens. The average length of the hypanthium plus peduncle is 5.1 mm (< 0.3 inch) (Reichenbacher 1993). The hypanthium has no stipitate (stalked) glands or has few glands. The typical flower has 3 - 7 pistils and 5 white or pale yellow petals that are about 10 mm (0.4 inch) long, slightly smaller than *P. stansburiana* flowers. Occasionally, flowers have 8 - 12 petals per flower (Denham and Fobes 1992a). As the achenes (fruits) develop, the style remains attached and forms a short, white, feathery plume. (USFWS, 1995)

Taxonomy

Purshia subintegra genetic variability, phenotypic plasticity, and past and recent hybridization with *P. stansburiana* have complicated taxonomic identification. Phenotypic and genetic variability among populations has been studied using morphometrics and molecular (DNA) analysis. Schaack (1987) described the San Carlos Basin (i.e., Bylas) population of *P. subintegra* as *P. pinkavae*, and designated *P. subintegra* to be of hybrid origin involving a cross between *P. stansburiana* and *P. pinkavae*. Kartesz (1994) treats *P. subintegra* as a hybrid. Reichenbacher (1994) states that although there is some character variation between the four populations of *P. subintegra*, multivariate analysis clearly indicates they exhibit a coherent syndrome of characters, and the taxonomy developed by Schaack is not supported by the analysis. The Recovery Plan concludes that *P. subintegra* is distinct from the more common *P. stansburiana*, despite sometimes overlapping plant characteristics (USFWS 1995). Travis et al. (2008) re-examined the genetic variation within *P. subintegra* and state that molecular evidence indicates a distinct classification for the Bylas population in support of the hypothesis that this population represents a separate species per Schaack (1987). However, the authors conclude that a broader taxonomic analysis of the genus is necessary to confirm such a distinction. Henrickson's unpublished description of *P. subintegra* notes considerable variation in key characteristics

within the species. Characteristics used for identification, such as occasionally lobed (or toothed) leaves, exhibit a continuum of variability between and within individuals, change seasonally (e.g., as leaves are shed during drier periods sometimes leaving only unlobed leaves), and sort out independently from other key characteristics. The demarcation between Schaack's pinkavae and *P. subintegra* is not discrete (Henrickson, pers. comm., 2013). Pending further studies, the USFWS continues to recognize that the four described populations of *P. subintegra* comprise one distinct species. Regarding nomenclature, Travis et al. (2008) present strong evidence for a hybrid origin of *P. subintegra*. Based on their molecular data and hypothesized pre-historic biogeography of the region (Anderson 1993), hybridization occurred during the late Pleistocene (11,000 to 13,000 years before the present). There has been a growing consensus for this explanation and increased use of the following nomenclature indicating a hybrid origin: *Purshia* \times *subintegra* (Kartesz 2013; Integrated Taxonomic Information System, 2013). However, such a designation for a species believed to be of hybrid origin is discretionary (International Code of Botanical Nomenclature (Article H:3.3) 2012). (USFWS, 1995))

Historical Range

See Current Range.

Current Range

In Arizona, in Graham, Maricopa, Mohave, and Yavapai counties. All known occurrences of *P. subintegra* are located in four disjunct populations, which occur along the sub-Mogollon region of central Arizona over a distance of 320 kilometers (200 miles) (Rutman 1992). (USFWS, 2013)

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Food Source**

Adult: sunlight

Competition

Adult: yes, especially creasote

Food/Nutrient Narrative

Adult: This species acquires its energy from sunlight via photosynthesis.

Reproductive Strategy

Adult: Flowering plant that attracts pollinators

Lifespan

Adult: many years

Dependency on Other Individuals or Species

Adult: lepidopterans, dipterans, and bees

Breeding Season

Adult: late March through early May

Reproduction Narrative

Adult: *Purshia subintegra* generally flowers from late March through early May and is visited by a wide variety of insects, including lepidopterans, dipterans, and bees. Typically, hundreds of flowers are produced on each mature plant, which can reproduce for many years (USFWS 1995). Flower and seed production varies between years based on climatic conditions, plant vigor, browsing, and other factors. Native wild bees and introduced honeybees (*Apis mellifera*) are the most important pollinators, the latter becoming the predominant pollinator later in the flowering season (Fitts et al. 1993). Fruit dispersal occurs when summer rains dislodge seeds from plants (USFWS 1995). Experiments have shown that this species is partially self-compatible, but sets significantly more seeds and produces fruit more often when outcrossed (Fitts et al. 1993).

Habitat Type

Adult: desert

Habitat Vegetation or Surface Water Classification

Adult: limestone soils

Geographic or Habitat Restraints or Barriers

Adult: Restricted by competition with other plants

Spatial Arrangements of the Population

Adult: Clumped according to suitable resources

Environmental Specificity

Adult: specialist; narrow habitat requirements

Tolerance Ranges/Thresholds

Adult: unknown

Site Fidelity

Adult: high

Habitat Narrative

Adult: This species has narrow habitat requirements and occurs at four widely separated areas across central Arizona. These sites differ slightly in elevation and associated vegetation, but all sites have limestone soils (generally white but also reddish in color) derived from Tertiary lacustrine (lakebed) deposits. At each site *P. subintegra* is part of a locally unique vegetative community (Anderson 1993). The geographic and local distribution of *P. subintegra* appears to be limited by competition from other plant species rather than a requirement for a specific soil type. These soils are relatively infertile and have significantly lower amounts of phosphorus and organic matter compared with surrounding areas where *P. subintegra* is absent (Anderson 1986, 1993). These surrounding areas are typically dominated by creosotebush (*Larrea tridentata*), which is thought to have a competitive advantage over *P. subintegra* due to its aggressive seedling establishment (Anderson 1993). Creosotebush is unable to grow on the relatively

infertile lacustrine soils. However, it has been found growing together with *P. subintegra* in the Verde Valley, in areas with higher amounts of organic matter and phosphorus. This suggests that the distribution of *P. subintegra* within these limestone soil conditions is limited primarily by competition from creosotebush, rather than a requirement for specific soil properties (Anderson 1986, 1993, 1996).

Dispersal/Migration**Motility/Mobility**

Adult: not mobile

Dispersal

Adult: only the seeds

Dispersal/Migration Narrative

Adult: Fruit dispersal occurs when summer rains dislodge seeds from plants (USFWS 1995).

Population Information and Trends**Population Trends:**

Declining

Species Trends:

Declining

Population Growth Rate:

unknown

Number of Populations:

4

Population Size:

Unknown, estimated to exceed 40,000

Minimum Viable Population Size:

unknown

Resistance to Disease:

unknown

Population Narrative:

The total number of plants in the four *P. subintegra* populations is not known, but has been estimated. Not all areas of potential habitat have been surveyed, and in some areas, such as Cottonwood, the presence of hybrids between *P. subintegra* and *P. stansburiana*, or introgressed forms, has complicated population estimates (USFWS 2001). Despite the potential conservation significance of hybrids, the USFWS considers these plants to be outside the definition of the species (USFWS 1995) and are not included in population estimates. In 1988, a total number for all four populations (i.e., recovery units) was estimated to exceed 40,000

plants, although a large percentage may have included hybrids (USFWS 1988). About 10,000 plants are thought to currently occur in the predominant subpopulation at Burro Creek (USFWS 2004). At the time of listing, the USFWS estimated 243 ha (600 ac) of habitat at Burro Creek, and 40 ha (100 ac) at Bylas with an estimated 700 plants (USDI 1984). The Horseshoe Lake population is estimated to include 750 plants (USFWS 1987) over an unspecified area. The Cottonwood population covers the largest area, estimated at over 405 ha (1,000 ac) (USFWS 1995), with the amount of occupied habitat recently calculated to be 78 ha (194 ac) (Goodwin 2012). Total Cottonwood population numbers were previously not known, but were conservatively estimated to include tens of thousands of plants (USFWS 2007). The most recent, intensive survey places this number considerably lower, at a total of 8,272 *P. subintegra* plants within the Cottonwood population (Goodwin 2012). Acceptance of this figure would result in a downward adjustment of the estimated total numbers of known plants in the four populations by one-half, or to about 20,000. This adjustment may be the result of a more intensive survey as opposed to a large scale decline in numbers. We have no demographic trend information from monitoring the four populations, but population viability modeling suggests that *P. subintegra* will slowly decline in the Cottonwood population under more arid scenarios (Maschinski et al. 2006). *Purshia subintegra* populations are genetically variable, exhibit phenotypic plasticity in response to environmental conditions, and hybridize with *P. stansburiana*. Gene exchange through backcrossing hybrids (introgression) of *P. subintegra* and the more common *P. stansburiana* has resulted in hybrid swarms in the Cottonwood and Horseshoe Lake populations (USFWS 1995). A hybrid swarm is a “hybrid population,” maintained by backcrossing and/or crossing with other hybrids, which may be stable or spread. The proliferation of hybrids has the potential to negatively affect long-term population dynamics of *P. subintegra* through interference competition and loss of genetic integrity (Fitts et al. 1993; Baggs and Maschinski 2001b). At the same time, hybridization may act as a mechanism to increase genetic diversity in a population, enhancing adaptation and survival, therefore potentially benefiting conservation of *P. subintegra* (Baggs and Maschinski, 2001b). Hybrid swarms illustrate the migratory and dynamic nature of evolving plant populations, and may provide the key to the future of the genus and species. For this reason, conservation of these hybrid swarms is important (USFWS 1995). A recent study by Travis et al. (2008) confirmed the presence of a hybrid swarm in the Verde Valley and emphasized its conservation significance. Because introgressed forms appear to possess potential fitness advantages under hotter, drier conditions, they may provide a viable refuge for *P. subintegra* genome in the face of climate change (Travis et al. 2008). The paper also identified three distinct genetic lineages of *P. subintegra*: the Cottonwood (Verde Valley) population, which is currently undergoing introgression; the Burro Creek and Horseshoe Lake populations, which exhibit an ancient natural hybrid origin; and the Bylas population, which is genetically distinct from the others. These findings underscore the complex genetics of this species and the importance of conserving all four populations. (USFWS, 2013)

Threats and Stressors

Stressor: Urbanization (USFWS, 1995)

Exposure:

Response:

Consequence:

Narrative: Habitat loss due to urbanization is a serious threat for the Cottonwood Arizona cliffrose population. Urbanization does not appear to be a threat to the other three populations, which are either on Federal land, which precludes urbanization, or they occur where

development is unlikely. A significant amount of Arizona cliffrose habitat has already been lost due to development in the Cottonwood area, but the amount of habitat loss has not been estimated. The threat of urbanization continues, because some occupied habitat remains on private lands that could be developed and a substantial amount of habitat is on State Trust land. The transfers of land from Federal ownership into private or State ownership is an indirect threat to Arizona cliffrose. These land exchanges significantly reduce the protections offered by the Endangered Species Act and may contribute to urbanization or other actions causing habitat loss or degradation. These types of transfers would be subject to section 7 consultation procedures. (USFWS, 1995)

Stressor: Mineral Exploration and Development (USFWS, 1995)

Exposure:

Response:

Consequence:

Narrative: Mining and mining-related activities are a serious threat to the long-term survival of this species, particularly in the Burro Creek area. The soils supporting Arizona cliffrose populations are known to contain high quality bentonite (BLM 1993), a type of clay used for cosmetics and pharmaceuticals. Drilling and bulk sample procurement have reduced the number of plants and amount of available or undisturbed habitat in the Burro Creek area. (USFWS, 1995)

Stressor: Cattle and Feral Burro Browsing Effects (USFWS, 1995)

Exposure:

Response:

Consequence:

Narrative: In 1987, the BLM- Kingman Resource Area began monitoring the effects of livestock browsing on Arizona cliffrose near Burro Creek with the objective of determining the amount of utilization. Internode distances on five branches were measured on each of 50 Arizona cliffrose plants. Cages were constructed around 25 Arizona cliffrose plants to prevent browsing by livestock, wild burros, and mule deer. Twenty-five plants were left uncaged to serve as a control. Their results showed that browsing activity resulted in 65% utilization of Arizona cliffrose (BLM 1993). This high level of utilization can reduce plant vigor and fecundity, cause lack of seedling establishment, and change the form class of Arizona cliffrose plants, causing them to look hedged. Under this level of utilization, more palatable, associated plant species may be overutilized, resulting in disturbed ecosystem functions and degraded ecological values. The BLM continued monitoring Arizona cliffrose utilization after a fence was constructed in 1989 to exclude cattle and burros from an approximately one square mile area. This large enclosure included the caged and uncaged plants that had been monitored since 1987. After the fence was built, utilization of the Arizona cliffrose plants dropped to 16% in 1989 and 18% in 1990 (BLM 1993). Utilization of caged plants was similar to uncaged plants. These results indicate that livestock and burros were responsible for most of the browsing activity on Arizona cliffrose. Some browsing continues within the enclosure, probably from mule deer and other wildlife. Livestock and burros may occasionally enter the enclosure if the fence is not maintained. Most plants appear to be responding favorably to the lower levels of browsing. However, it appears that some plants that were very heavily browsed over a long period of time may never recover. Only observational data are available regarding the effects of livestock grazing on the Bylas Arizona cliffrose population. At the Graham County population, Bingham (1977) noted that no young plants were observed during a one hour search in the grazed open area, whereas juvenile plants were present along an adjacent fenced ungrazed highway right-of-way. In 1986, the BIA

(/n litt. 1986) noted that the absence of quantities of dried manure and lack of hoofprints to the north of Highway 70 indicated low grazing pressure. They also noted that Arizona cliff rose plants south of Highway 70 were browsed, probably because nearby Poison Spring offers a source of water for livestock and wildlife. (USFWS, 1995)

Stressor: Roads and Utilities (USFWS, 1995)

Exposure:

Response:

Consequence:

Narrative: All of the Arizona cliffrose populations have roads and/or utility right-of-ways within or near them. The Burro Creek population is divided by a graded dirt road paralleled by the Southern Union Gas Company pipeline and Arizona Electric Power Cooperative Incorporated high voltage power line. The gas pipeline has been in existence since at least 1969 (Butterwick 1979). No estimate of the amount of habitat lost to these developments in the Burro Creek area has been made. The Kingman Resource Management Plan (Kingman RMP) (BLM 1993) proposed a one-mile wide utilities corridor that overlies Arizona cliffrose habitat. The BLM may grant right-of-ways through this utility corridor (BLM 1993). A graded dirt road (Forest Road 205) and a gated road (Forest Road 530) passes near one of the three Horseshoe Lake subpopulations. Forest Road 479 passes near a second subpopulation. U.S. Highway 70, a two-lane paved road, bisects the population near Bylas. Numerous paved and dirt roads pass through the Cottonwood population. Highway 89A nearly forms the eastern border and Rocking Chair Road passes through the Arizona cliffrose habitat. Its expansion is being planned. Other roads to access housing or for recreational purposes create a network through the habitat. Roads and trails have direct and indirect effects. Road surfaces constitute lost habitat. The amount of habitat and number of plants lost to roads have not been estimated. Roads can change the local hydrology, affecting the amount of precipitation received and absorbed in a local area, changing the direction and speed of runoff, and perhaps changing erosion rates and patterns. These changes can adversely or beneficially affect survivorship and fecundity of individuals. Soil compaction occurs in areas of moderate to heavy vehicle use. Roads can provide access to ORV and other users that may adversely affect Arizona cliffrose and its habitat. ORVs can destroy young plants, harm mature plants, prevent seedling establishment or seed germination, cause soil compaction, and otherwise disrupt the soil surface. Arizona cliffrose plants have colonized a lightly used vehicle trail on the Coconino National Forest. These plants indicate that Arizona cliffrose in the actively reproducing Verde Valley population can recover after light soil surface disturbance. Unknowingly, local residents of the Verde Valley have been using Arizona cliffrose habitat as a parking lot. The parking area is located at the intersection of Rocking Chair Road and U.S. Highway 89A. The area of impact has been expanding during recent years, increasing the number of plants and amount of habitat already lost. The Coconino Forest Plan (U.S. Forest Service 1987) states that the Forest will manage roads adjacent to the Verde Valley Botanical Area to prevent vehicular intrusion." In the same document, the Forest committed to blocking and obliterating existing roads entering the area within the first ten years of plan implementation. To date, road blocking and obliteration has not yet occurred. (USFWS, 1995)

Stressor: Recreation (USFWS, 1995)

Exposure:

Response:

Consequence:

Narrative: The Cottonwood population is adversely affected by recreation of several types. An unofficial shooting range near the eastern portion of this population on the Coconino National Forest has caused the loss of an unknown number of plants and acres of habitat. Shooters park within an Arizona cliffrose population at the base of a small hill and shoot into the population on the hill. The soil at the well-used parking area and roads leading to the shooting range is compacted and eroding, devoid of vegetation, and probably incapable of supporting cliffrose plants unless restored. The area is used not only by shooters, but also by nighttime recreationists. In addition to the shooting range, other spots in the Arizona cliffrose Cottonwood population are frequented by night-time recreationists. These “party spots” are generally severely impacted by vehicles, devoid of vegetation, and littered with trash. ORV recreationists drive through the Cottonwood population, in some cases ignoring signs or cutting fences to gain access to prohibited areas. A fence completely surrounds a section of Arizona State Trust land, which was used by ORV users despite trespass notices. The primary damage to Arizona cliff rose habitat in the Cottonwood area has occurred in Township 16 North, Range 3 East, section 36 by vehicles entering the section from the west. The State Land Department has been successful at notifying the offenders and eliminating this use (Denham /n I/U. 1994). Denham and Fobes (1992d) also noted ORV damage in the southeast corner of Township 16 North, Range 3 East, section 22 and the northeast corner of section 27. The ORV users entered a parcel of private land via the Coconino National Forest and rode across the property. ORVs are not currently a problem at Horseshoe Lake. The Tonto National Forest Plan (U.S. Forest Service 1985) closed the area to ORV use except where posted as open but has minimally enforced the closure. Despite the presence of a nearby lake and campground, ORV use has not yet been reported within the subpopulations. The amount of recreational activity occurring within the core Burro Creek subpopulation is poorly known. Increased recreational activity may occur within the Clay Hills Area of Critical Environmental Concern (ACEC) when the Burro Creek campground is developed (BLM 1993). The Burro Creek site is a wellknown destination for rock collecting enthusiasts. These visitors may affect Arizona cliffrose by turning over rocks and disturbing seedling establishment microsites. They also may occasionally drive short distances across country to reach collecting sites and crush plants. Whether or not these visitors adversely affect Arizona cliffrose is unknown. (USFWS, 1995)

Stressor: Control of Insect Pests (USFWS, 1995)

Exposure:

Response:

Consequence:

Narrative: General pesticides are often used to control cropland insect pests and sometimes used to control rangeland insect pests. Two Arizona cliffrose populations (Horseshoe Lake and Cottonwood) occur very close to lands under cultivation. A private parcel of land near Horseshoe Dam is being cultivated to provide food for livestock. We do not know if pesticides are currently being applied on the cultivated lands near Arizona cliffrose populations. Four Arizona cliffrose populations occur in areas that are grazed. High densities of rangeland pests have never been reported within Arizona cliffrose populations. If problem densities develop, however, they may be accompanied by proposals from Federal and State agencies to apply chemical controls, including general pesticides. General pesticides such as malathion, a commonly used rangeland and cropland pesticide, can drastically decrease target and non-target insect populations. Insect population sizes are regulated by a number of variables, including weather, inter-and intra-specific competition, vertebrate predators, and insect predators and parasitoids (Belovsky 1989, Wang and Walgenbach 1989, Hostetter et al. 1989, Dysart and Onsager 1989, Lockwood 1993).

General pesticides will kill target herbivorous insects as well as the insect predators and parasitoids that regulate the herbivores. Herbivorous insects and their predators and parasitoids are usually in a dynamic balance, rarely reaching high, damaging densities except in unnatural circumstances such as the introduction of nonnative pests or in association with various agricultural practices including livestock grazing (Auerbach 1991, Brusven and Fielding 1989, Belovsky 1989). For a review of the field experiments and models of arthropod predator-prey systems that demonstrate this dynamic ecosystem balance, see Hassell (1978). Herbivorous insects recover more quickly after pesticide applications than do their predators and parasitoids because herbivores tend to have a higher fecundity and shorter generation time. Consequently, herbivorous species will more quickly become resistant to chemicals, and their populations will rebound faster and typically at higher densities because predator/parasitoid controls are lost or reduced. Thus, general pesticide applications tend to exacerbate insect population imbalances rather than resolve them. Concern about applying chemical pesticides within or near endangered plant populations has tended to focus on the adverse effects of pesticides on pollinators. For plants that depend on insects for pollination, seed set may be drastically reduced when pollinator populations are reduced by pesticides (Tepedino and Griswold 1989). Avoiding the blooming period of endangered plants may not remove these adverse effects. Fitts et al. (1993) provide the following explanation: It is obvious that, for the plant, the most dangerous time to spray is during the blooming period. It is less obvious that it may also be risky to spray when bloom is past; many important pollinators are either eusocial, or multivoltine species, i.e., adults are present throughout the growing season, foraging on other plants. These adults are the progenitors of the next years' pollinator crop; removing them will eliminate progeny and, thus the number of pollinators flying in the following year. Information needed to effectively manage insects as part of the ecosystem containing Arizona cliffrose includes the Identification of all insects beneficial to Arizona cliffrose, including pollinators, and an understanding of their life histories and habitat needs. Until such information is obtained, the U.S. Department of Agriculture, Animal and Plant Health Inspection Service has agreed to restrict certain pesticides within a 4.8 km (three-mile) radius of Arizona cliffrose populations. (USFWS, 1995)

Stressor: Herbicides (USFWS, 1995)

Exposure:

Response:

Consequence:

Narrative: Herbicides are sometimes used to control plant growth along paved roads. Although paved roads pass through the Verde Valley and Bylas Arizona cliffrose populations, we do not know if herbicides are used there. Herbicides should not be used along roadsides within Arizona cliffrose populations because treated plants are destroyed. (USFWS, 1995)

Stressor: Inundation (USFWS, 1995)

Exposure:

Response:

Consequence:

Narrative: Arizona cliff rose plants and habitat were probably inundated when Horseshoe Dam and its spillway were built on the Verde River in 1944-1946 (FraserDesign 1991). Additional plants and habitat were probably lost when the conservation pool level of Horseshoe Lake was raised in the 1950's to the current elevation of 618 in (2,026 feet). Habitat inundation most likely occurred in the Chalk Mountain area. If the height of the conservation elevation is increased further, the action would probably inundate additional plants and habitat. The Salt River Project,

a utility company, operates the reservoir on a daily basis without specific approvals from Reclamation (Project Manager, Arizona Projects Office, Bureau of Reclamation, in litt. 1994). (USFWS, 1995)

Recovery

Reclassification Criteria:

We will consider Arizona cliffrose for downlisting when: (USFWS, 2019)

1. A single, long-term monitoring plan for all Arizona cliffrose populations and habitat is developed and implemented. (USFWS, 2019)
2. Land managers conserve existing habitat, in each recovery unit, in perpetuity to prevent further habitat loss and/or degradation. (USFWS, 2019)
3. Each of the four recovery units contains a population of Arizona cliffrose that is stable or increasing over a period of at least 10 years. (USFWS, 2019)

Delisting Criteria:

In addition to meeting downlisting criteria 1 and 2, we will consider Arizona cliffrose for delisting when: (USFWS, 2019)

1. Each of the four recovery units contains a population of Arizona cliffrose that is stable or increasing over a period of at least 20 years. (USFWS, 2019)

Recovery Actions:

- Produce and implement management plans for each of the four recovery units. This recovery task must be completed before recovery criterion 3 can be met. Commitment of the appropriate Federal and State land management agencies and the San Carlos Indian Community towards managing this sensitive habitat is critical to the recovery and survival of Arizona cliffrose. If new populations are found, management plans covering those populations should be produced and implemented. (USFWS, 1995)
- Initiate research and other actions needed to monitor the species' status and guide recovery efforts. Best management efforts are guided by good biological and ecological information. Currently, too little is known about Arizona cliffrose to determine the most appropriate management actions to effect recovery and determine population stability. Research, studies, and other actions are needed to provide a sound basis for management. (USFWS, 1995)
- Eliminate or minimize threats to the species. Threats which prevent the recovery of Arizona cliffrose should be eliminated. The most important current threats to Arizona cliffrose are habitat loss due to mineral exploration and development, urbanization, recreation, roads, and utilities, and habitat degradation due to livestock grazing and recreation. Reducing or eliminating these and all other threats will lead to the recovery of Arizona cliffrose. (USFWS, 1995)
- Enforce and apply existing laws and regulations. Full use of all Endangered Species Act regulatory control should be used to manage and protect Arizona cliffrose populations. Arizona State law should also be applied and enforced. (USFWS, 1995)

- Information and education. Exchange of information and ideas among private landowners, the scientific community, the public, and Federal, State and local agencies is essential to a successful recovery program. Scientific information, including results of field and greenhouse research, monitoring data, trip reports, agency reports, and scientific literature should be readily available to all parties interested in the management and survival of Arizona cliffrose. Ideas should be freely exchanged so that optimal recovery strategies can be outlined and implemented. Meetings of interested parties to discuss new information or management issues or strategies should be encouraged. Preliminary or refined research or monitoring data should be presented at local, regional, and national gatherings of professional scientists so that a broad professional audience may have opportunities to comment on, and potentially enhance, recovery of Arizona cliffrose. (USFWS, 1995)
- Recommendations for Future Actions from 2013 5-Year Review: 1) We recommend the development or completion of management plans for the Cottonwood population (including the VVBA), the Horseshoe Lake population, and the Bylas population. The plans for each of these populations would be developed by the respective land managing agency (CNF, TNF, and the San Carlos Apache Tribe) with the offered assistance of the USFWS. These management plans should address newly understood or emerging threats such as climate change and invasive weeds. (USFWS, 2013)
- Recommendations for Future Actions from 2013 5-Year Review: 2) We recommend the appropriate agencies analyze the monitoring data they have collected to date to determine demographic trends in their respective *P. subintegra* populations. This will allow the USFWS to determine whether a given population is viable or on a trend toward viability, in support of downlisting criteria one. The USFWS can assist in coordinating this effort to facilitate consistency and comparability between the various monitoring methods employed by each agency. (USFWS, 2013)
- Recommendations for Future Actions from 2013 5-Year Review: 3) We recommend the modification or addition of standardized long-term demography monitoring techniques to existing monitoring schemes, or the establishment of standardized long-term monitoring protocols within all four populations. The USFWS can facilitate this process and assist in monitoring design and coordinating standardization between agencies. (USFWS, 2013)
- Recommendations for Future Actions from 2013 5-Year Review: 5) We recommend that the terms “viability” and “significant upward trend towards viability,” as used in the first downlisting criterion, be defined or described for *P. subintegra* for the purpose of developing an objective and measurable criterion. The USFWS will lead this effort in coordination with land managing agencies and subject matter experts. (USFWS, 2013)

Conservation Measures and Best Management Practices:

- Since 1989, when a fence was set around the main Burro Creek subpopulation, the BLM has continued to monitor grazing on *P. subintegra* in the main population as well as the two subpopulations. Herbivory of *P. subintegra* has been low within the ACEC, recorded at 3 to 9.4 percent utilization for the past six years (Peck 2009b; Peck 2012). Grazing use in the two outlier populations has also been low, ranging from 2.5 to 8 percent. The BLM had predicted livestock grazing at these sites would be light because cattle would be less likely to travel in the area due to the rugged terrain and distance from water. Evidence of herbivory at all sites has been attributed to wildlife, and is well below the trigger of 20 percent for determining if reinitiation of formal consultation is necessary (Hall 1993). The ACEC fence is inspected annually and repaired as needed. The VVBA is within the Windmill Allotment. Section 7 consultations with the CNF were conducted in

1992 and 1997 for the Windmill Allotment Management Plan. Grazing has been excluded from the Rocking Chair and Cornville pastures since 1992, while seasonal grazing has continued in the Gyberg pasture under a deferred rest rotation system (USFWS 1995). Range inspection memoranda, from 2001 to 2006, state that there was light to no use of *P. subintegra* within the North Gyberg Pasture. The Horseshoe Lake *P. subintegra* population on the TNF is contained within three grazing allotments. Current management in the Sears Club/Chalk and the St. Clair allotments is non-use due to the allotments being vacant (Willard, pers. comm., 2012). The Sears Club/Chalk Allotment, which contains most of the population, is scheduled for evaluation, under the National Environmental Policy Act, in 2013. The three pastures in the Cartwright Allotment (Lime Creek, Professor, and Long Canyon) have been removed from grazing (USFS 2008). Currently, the threat from grazing appears to be at a low level at three of the populations; the level of grazing effects at the Bylas population is not quantified to our knowledge.

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SPECIES ACCOUNT: *Quercus hinckleyi* (Hinckley oak)

Species Taxonomic and Listing Information

Listing Status: Threatened; 08/26/1988; Southwest Region (Region 2) (USFWS, 2016)

Physical Description

Quercus hinckleyi is an evergreen shrub, most often forming patchy thickets that grow to a maximum height of 0.75 m. The plant usually has multiple stems, with relatively thin light brown twigs that may become waxy on second year growth. The buds are less than 1 mm long, and reddish brown with short hairs on the margins. The leaves have rose-colored petioles 1-2 mm long, and hairy stipules at the base, 2 mm long, that fall off later in the season. The leaf blades are very characteristic. They are thickened, gray-green, almost rounded, 5-15 mm long and broad, with a spiny tip and 2-3 spiny teeth on each margin. The flowers are unisexual, with the male flowers in 3-5 mm long catkins of only a few flowers each. The female flowers are tiny, inconspicuous, and densely hairy. Acorns are formed annually. They are oval, 8-12 mm broad, and usually only included in the cup at the base. The cup is shallow, up to 3 mm deep, and saucer-shaped. (USFWS, 1992)

Taxonomy

The first known collection was made in 1950 from the Solitario (Presidio County, Texas), and is attributed to Dr. L. C. Hinckley. Dr. C. H. Muller collected specimens from the same location a month later, and eventually described it as a new species, named in honor of Dr. Hinckley (Muller 1951). He placed the species within his series *Glaucoideae*. The most notable features of this species are its leaves, which are small, smooth, broadly oval, noticeably thickened, and markedly spiny on the margins (superficially holly-like). This, combined with its small stature, thicket-forming habit with intricate, multiple-branched stems, and gray-green color make it easily recognizable and distinctive within its group (series *Glaucoideae*). (USFWS, 1992)

Current Range

Known from the Chihuahuan Desert of West Texas. All of the populations known are in Presidio County. Other reports exist of additional populations in the area of Shafter, Texas, but these localities have not been recently verified. (USFWS, 1992)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual (vegetative) (USFWS, 1992)

Reproduction Narrative

Adult: All reproduction appears to be vegetative. (USFWS, 1992)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Desert (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Arid climate with large fluctuations in temperature and low rainfall (USFWS, 1992)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at elevations between 1066.8 and 1372 m (3,500 to 4,500 ft) (USFWS, 1992)

Spatial Arrangements of the Population

Adult: Patchy (USFWS, 1992)

Environmental Specificity

Adult: Moderate, with some key requirements (USFWS, 1992)

Tolerance Ranges/Thresholds

Adult: Moderate to high (inferred from USFWS, 1992)

Habitat Narrative

Adult: *Quercus hinckleyi* prefers arid, rocky, limestone-derived soils or limestone outcrops at mid-elevations in Chihuahuan Desert shrublands. The development of more arid climates is postulated to have resulted in restriction of the species to a few sites within its old range of distribution, resulting in a patchy distribution of a few populations with relatively few individuals. *Quercus hinckleyi* occurs in an arid subtropical climate. Climatologists place it in the Trans—Pecos climatic area of Texas, which is extremely variable because of topographic differences. The area generally has great daily temperature fluctuations and an arid profile where evaporation exceeds precipitation. The average temperature is 30.4 C (86.8 F), with 178 days of 32.2 C (90 F) and above temperatures, and 44 days of temperatures below 0 C (32 F). The frost free season is 238 days. The average precipitation is 23.4 cm (9.2 inches). *Quercus hinckleyi* grows on dry limestone slopes between 1066.8 m and 1372 m (3,500 — 4,500 feet) elevation. Slopes where the species occurs are mostly north and west-facing. The plants are found growing in cracks of solid rocks or extremely rocky soils (Poole 1988a). (USFWS, 1992; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Low (inferred from USFWS, 1992)

Representation:

Moderate (inferred from USFWS, 1992)

Redundancy:

Low (inferred from USFWS, 1992)

Number of Populations:

10 (USFWS, 1992)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Most populations have less than 100 trees. Currently, only ten populations of *Quercus hinckleyi* are known. (USFWS, 1992; NatureServe, 2015)

Threats and Stressors

Stressor: Climate change (USFWS, 1992)

Exposure:

Response:

Consequence:

Narrative: Climatic changes of the last 8,000-11,000 years, have resulted in the reduction of suitable habitat and fragmentation of populations. These are the primary reason the plant is rare today (Miller and Powell 1982). (USFWS, 1992)

Stressor: Small population size (USFWS, 1992)

Exposure:

Response:

Consequence:

Narrative: The species is vulnerable today because few populations are known, and each has a small number of individuals. The population centers are relatively widespread, limiting any potential gene flow. These conditions make the species vulnerable to catastrophic destruction and loss of genetic viability. (USFWS, 1992)

Stressor: Genetic variability (USFWS, 1992)

Exposure:

Response:

Consequence:

Narrative: All observers report a very low level of regeneration in the stands of *Quercus hinckleyi*, with no juveniles reported, though in some years there have been heavy acorn yields (Bacon 1989, 1990). All reproduction appears to be vegetative. Populations may already have become so isolated, and the numbers of individuals fallen so low, that low genetic diversity has developed in the populations, reducing both fertility and the genetic ability to adapt evolutionarily to the changing environment (Hilsenbeck 1989). (USFWS, 1992)

Stressor: Herbivory (USFWS, 1992)

Exposure:**Response:****Consequence:**

Narrative: Native deer are known to browse the plants and eat the acorns (Miller and Powell 1982). Small mammals and birds are also known to eat the acorns, and some epidermal damage caused by disease or insect predation (webs have been found on the branches) has been noted at the type locality (Miller and Powell 1982, U.S. Fish and Wildlife Service 1987, Poole 1988a). (USFWS, 1992)

Stressor: Roads (USFWS, 1992)

Exposure:**Response:****Consequence:**

Narrative: One of the populations is very near a highway and roadway maintenance activities, or any further highway expansion or realignment, could constitute a threat to the species (Poole 1988a). (USFWS, 1992)

Stressor: Grazing (USFWS, 1992)

Exposure:**Response:****Consequence:**

Narrative: In the past, all of the populations were on private land. At least nine of these populations were subject to browsing and acorn consumption by livestock and wildlife, and the possible introduction of exotic game species. Overstocking of cattle or sheep and the introduction of goats or other browsing animals represented a potential threat to the small populations of plants (U.S. Fish and Wildlife Service, 1988). With the 1988 acquisition by the Texas Parks and Wildlife Department, 9 of the 10 known populations are now in the Big Bend Ranch State Natural Area where the species is protected by State Law. Although a specific management plan for Hinckley oak that addresses policies governing cattle grazing or the introduction of exotic species is not yet in place, the Texas Parks and Wildlife Department is currently developing a plan for the Natural Area that should include considerations for this species. (USFWS, 1992)

Stressor: Collectors (USFWS, 1992)

Exposure:**Response:****Consequence:**

Narrative: The rarity of the plant and its distinctive leaves have attracted the attention of collectors and horticulturists. Some taking of acorns in violation of State permit requirements and trespass laws has been reported (U.S. Fish and Wildlife Service 1988). In addition, acorns are reportedly collected legally every year at the Shafter population, reducing the possible recruitment to the natural population (Poole 1988a). (USFWS, 1992)

Stressor: Hybridization (USFWS, 1992)

Exposure:**Response:****Consequence:**

Narrative: Oak species are known to hybridize freely, and hybridization with *Quercus pungens* var. *vasevana* (Vasey oak) has been reported at one population of *Quercus hinckleyi* (U.S. Fish and Wildlife Service 1988). Genetic swamping by nearby native or introduced oak species is a potential problem, both for populations in the wild and any plants maintained under cultivation (Poole 1988a). (USFWS, 1992)

Recovery

Reclassification Criteria:

Reclassification criteria are not available.

Delisting Criteria:

1. Attain at least 20 viable self-sustaining populations in at least 4 geographically distinct population centers and attain a total of at least 10,000 individual plants. (USFWS, 1992)
2. Demonstrate population viability at recovery levels for 10 consecutive years. (USFWS, 1992)

Recovery Actions:

- Protect populations from present and future threats. (USFWS, 1992)
- Establish a reserve seed bank and cultivated population. (USFWS, 1992)
- Gather biological data necessary for management decisions. (USFWS, 1992)
- Search for new populations. (USFWS, 1992)
- Develop plans for reintroducing plants into suitable habitat. (USFWS, 1992)

Conservation Measures and Best Management Practices:

- Determine exact habitat requirements. (USFWS, 2009)
- Develop a model, based on soil types and other appropriate habitat attributes for Hinckley oak, to predict areas of potentially suitable habitat and then survey those areas for the species. (USFWS, 2009)
- Establish a reserve germ bank/cultivated population with a responsible agency/institution. (USFWS, 2009)
- Evaluate present conditions and determine stability requirements for populations. (USFWS, 2009)
- Assess incidence of (and potential threat from) hybridization with nearby oak (*Quercus*) species and develop management strategies to address any threats associated with hybridization. (USFWS, 2009)
- Assess potential threats to the species associated with climate change and develop management strategies to address these threats. (USFWS, 2009)

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SPECIES ACCOUNT: *Ranunculus aestivalis* (= *acriformis*) (Autumn Buttercup)

Species Taxonomic and Listing Information

Listing Status: Endangered; 07/21/1989; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

A perennial herb, 3-6 dm tall that bears 6-10 bright yellow flowers, usually high above most of the deeply divided leaves. The late summer-early fall flowering season gives the plant its common name. A recent study by Van Buren et al. (1994) concluded that this is a distinct species, rather than a variety of *R. acriformis*. The taxon is probably a relict of the moister Pleistocene Era and is now severely limited to the little suitable habitat remaining in what is now a semi-arid region. (NatureServe, 2015)

Taxonomy

The phylogenetic relationship of the autumn buttercup with closely related taxa has been studied since the completion of the Recovery Plan, but its taxonomic treatment continues to be disputed. The autumn buttercup was recommended to be a separate species based upon a genetic analysis of molecular markers that showed a clear separation of the autumn buttercup from other varieties of *Ranunculus acriformis* (Van Buren 1994; Van Buren et al. 1994). Environmental characteristics of the occupied habitat also clearly separated autumn buttercup habitat from habitat occupied by closely related taxa (Van Buren and Harper 1996); however, morphological characteristics were not so clear (Van Buren 1994). Due to genetic separation, Van Buren et al. (1994) recommended reclassifying the variety *R. acriformis* var. *aestivalis* to a full species *R. aestivalis*. A taxonomic review was later published in 1997 in the Flora of North America, and the author retained the varietal rank of *R. acriformis* var. *aestivalis* (Whittemore and Parfitt 1997). It must be noted that the author states it was his preference to retain the varietal rank and that the molecular results of Van Buren et al. "are consistent with either interpretation." The 4th edition of A Utah Flora, published in 2008, disagrees with both treatments, and considers it a variety of *R. acris* based upon morphological characteristics (Welsh et al. 2008). The latest taxonomic review was published in 2012 for the Intermountain Flora, and the authors accepted the species rank, *R. aestivalis*, recommended by Van Buren et al. (Holmgren et al. 2012). Two online plant databases accept the species rank, *R. aestivalis*, the USDA PLANTS Database (USDA PLANTS Database 2012) and The Biota of North America Program (Kartesz 2011). Given the recent taxonomic evaluation which accepts the autumn buttercup as a valid species rank, we recommend updating the synonymy (same identity) of *R. acriformis* var. *aestivalis* = *R. aestivalis* and find this taxonomic change does not affect the listing or protection of the autumn buttercup under the Act. The recovery priority number will change from 6 to 5 when the full species rank is accepted. We recommend the taxonomy be amended through a technical revision to the list at 50 CFR 17.12 (see section 4). We also will formally request the name be changed in ITIS database. Until the name can be changed in the Federal Register, we will continue to refer to this species as *R. acriformis* var. *aestivalis* (USFWS, 2013).

Current Range

"The autumn buttercup is probably the rarest and most restricted plant in Utah. Marcus E. Jones first collected it during 1894 in a wet meadow near Panguitch, 38 km northwest of Bryce Canyon

National Park. Named for its late-summer flowering habit, the autumn buttercup was not formally described until 1948. It is among the most graceful and showy members of the genus in the western United States." (Spence, Van Pelt and Franklin 1991: 1). The General Federation of Womens Clubs Sevier River Valley Preserve was purchased in 1989 to protect the only known buttercup plants in the wild, chiefly through exclusion of livestock grazing. The Great Basin Field Office is responsible for stewardship of the 44-acre property. GENERAL ELEMENT OCCURRENCE LOCATION INFORMATION. *R. acriformis* var. *aestivalis*'s only known occurrence is in Garfield County, Utah. Due to the sensitivity of the site, directions may be obtained by contacting the Utah land steward of the Conservancy in Salt Lake City.

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Wind and insect pollinated (NatureServe, 2015)

Lifespan

Adult: Life expectancy of *R. acris* is about 3.8 years (NatureServe, 2015).

Breeding Season

Adult: Vegetative plants and reproductive plants with buds, flowers, fruits, or dehiscent achenes have all been observed between late August and early September. During this same time period, well-developed seedlings, with up to several leaves, have also been surveyed (Mutz 1984) and counted (Spence 1991) (NatureServe, 2015).

Reproduction Narrative

Adult: Phenotypic Patterns: *R. acriformis* var. *aestivalis* appears to reproduce sexually. To date, the only field observations have been in late summer or early fall. Vegetative plants and reproductive plants with buds, flowers, fruits, or dehiscent achenes have all been observed between late August and early September. During this same time period, well-developed seedlings, with up to several leaves, have also been surveyed (Mutz 1984) and counted (Spence 1991). The riparian environment may be instrumental in extending the bloom for this population; however, it is still curious that autumn buttercup blooms as late as it does (late July to early October). Its closest relatives flower in June and July. Floral initiation does not apparently occur in the first year of life. The age at which it does occur is unknown (Mutz 1984). According to Sarukhan and Harper (1973) the life expectancy of *R. acris* is about 3.8 years. The autumn buttercup is similar to this species in many respects. The *Ranunculus* genus includes species which reproduce through self-fertilization, out-crossing, and apomixis. To date, autumn buttercup has not exhibited any observed asexual reproductive strategies (Mutz 1984). Pollination: Pollination mechanisms for autumn buttercup probably include wind and insects. The only documented pollinators are unidentified bees, and various flies and moths (Schelz, personal communication). Ants inhabit several mounds in the area, but none have been observed on the flowers (Mutz 1984). Harper (1957) reports that the flowers of *Ranunculus* are visited by a great number of insect species including the honey bee. Seed Dispersal: Mutz (1984)

speculates that autumn buttercup's seeds dehisce independently, since both partially bare and completely bare receptacles have been observed (NatureServe, 2015). Seed Biology: Germination Strategies. Nothing of significance is known about autumn buttercup's seed longevity, dormancy, viability, germination, or seedling establishment and maintenance requirements. However, Sarukhan's (1974) study of *Ranunculus acris*, a closely related plant with very similar environmental requirements, indicate that the seeds may be depleted by the next seed producing season. In his study, after predation and germination had occurred *R. acris* showed a reduction of c. 90% in the living seed population. Leck (1989) indicates that wetland seed banks typically contain seed with one of four germination strategies. Types 1 and 2 are represented by large seed output with total volumes greater than 10 cubic mm. Type 3 is represented by seed with total volumes greater than 1 cubic mm and less than 10 cubic mm. The majority of Type 3 seed, in a wetland seed bank, is a transient component with a relatively smaller persistent component. The fourth germination strategy is represented by seed with a seed volume less than 0.1 cubic mm. These seeds provide a relatively large persistent seed bank with little annual recruitment. Type 4 seeds are more abundant in subsurface than surface samples (Leck 1989). *R. acrifolius* var. *aestivalis* seed can therefore be classified as either Type 2 or Type 3. England (1990) feels its seed volume is greater than 10 cubic mm and would therefore be Type 2. Type 2 seeds typically function as transient winter or summer seed bank components (Leck 1989). If, however, autumn buttercup's seed strategy is similar to that of Type 3, Leck's (1989) observations from studies of both Type 3 and Type 4 strategies could be useful. Seed distribution and establishment: Wetland seed bank studies revealed that seeds in bogs, swamps, and prairie marshes were deeply buried, with only 20 to 50 percent occurring in the top 5 cm (Leck 1989). Leck (1989) further states that seed distribution patterns are primarily related to variations in seed rain; that variable soil compression, seed survival, and seed bank strategies may also be related to distribution patterns; and that graminoids typically comprise more than 50 percent of seed in wetland seed banks. Seed ecology: Seedlings have been observed in small vegetative openings in friable soil on the mounds. The increased available light and solar radiation might be conducive for seed germination and seedling establishment in these clearings. However, unobserved seedlings may also be present but difficult to locate in more densely vegetated localities (NatureServe, 2015).

Habitat Type

Adult: Seeps/bogs (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Seeps/bogs

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (NatureServe, 2015)

Site Fidelity

Adult: High (NatureServe, 2015)

Habitat Narrative

Adult: Species is found in the Sevier River Valley, where fresh water seeps and springs surface, creating marshy or bog-like conditions. Within this wet environment, are slightly drier, peaty hummocks upon which most of the plants grow. In addition, plants have been found on a somewhat drier site not associated with hummocks. The surrounding region is semi-arid and sagebrush-dominated. The elevation is 1938-1965 m. BIOLOGICAL HABITAT: The autumn buttercup has only been found along the west slope of the Sevier River Valley where fresh water seeps and springs surface and create marsh\ bog conditions. Within this marshy environment are mesic islands of peaty hummocks upon which most of the autumn buttercups grow. However, in 1990 about 30 plants were found together on a drier site that does not contain the mounds. Spence (1991) provides a detailed, current description of the habitat at the more recently discovered site. The biological habitat is a low growing herbaceous community. It is characterized by the dominant species, *Juncus articus* var. *balticus* (Spence 1991). Forb-dominated mounds occur throughout the marsh, and the inter-mound areas are primarily graminoid. *R. acriformis* var. *aestivalis*'s frequently associated species are *Achillea millefolium* (infrequently found elsewhere in the studied area), *Juncus articus* var. *Balticus*, *Carex nebrascensis*, *Aster occidentalis*, *Plantago eriopoda*, *Glaux maritima*, *Trifolium* spp., *Carex aquatilis*, *Hordeum Jubatum* (Mutz 1984), *Dodecatheon* spp., and *Eleocharis* spp. (USFWS 1992). In addition, moss is frequently found between plants. Other forb-dominated mounds occur throughout the meadow which appear comparable to autumn buttercup's habitat, except that some of the inter-mound areas are persistently pooled with water. *R. cymbalaria*, an aquatic species, replaces *R. acriformis* var. *aestivalis* on these more saturated mounds (Mutz 1984). PHYSICAL HABITAT Climate: The dry semi-arid climate has an average annual temperature of 64.4 degrees F. This middle latitude, cold desert has a growing season of about 100 days. The mean January temperature for Panguitch is 23.5 degrees F and the mean July temperature is 64.6 degrees F. Recorded August temperatures range from 44.7 to 83.0 degrees F, September temperatures range from 38.8 to 76.9 degrees F, and October temperatures are between 27.8 and 60.1 degrees F (Mutz 1984). The regional climatological data also indicates 9.9 inches annual precipitation for Panguitch (6625 feet elevation) most of which (70%) is received between April and September (Mutz 1984). Air and Water Quality. Field tests indicate good quality water present at the site (Mutz 1984). The pH was tested at 7.6. There was less than 0.2 gm/l iron, and the moderate hardness of 395 mg/l is probably due to calcium. Mutz (1984) speculates that additional mounds which are similar to autumn buttercup in wetness may differ in water quality. The water originates from seeps and springs both on and off of the western edge of the property near the highway. The direction of water flow from the various sources is northeast through the wet areas of the preserve (Baird 1988). Since there is little traffic and no major industrial polluters in the area, the air quality is also presumed good (Mutz 1984). Topography and Physiography: The autumn buttercup habitat occurs in a transition zone between a well-developed, *Carex*-dominated bog community and a dry upland sagebrush area (USFWS 1992). The Sevier River Valley bottom is Quaternary alluvium which supports sagebrush communities as close as 24 yards from the river (Mutz 1984). Multiple springs occur along the river valley, and it is speculated that mesic areas near these springs could provide suitable habitat for the autumn buttercup (Baird 1988). Observations of the habitat indicate as much as 100% vegetation coverage (little rock or wood cover), a friable soil surface (perhaps a key factor in seed germination), and underlying sandy or gravelly layers which may be indicative of active stream beds of the past (Mutz 1984). Slope: The two known populations are located on a very gentle east-facing slope above the bottom of the Sevier River Valley. The plants and the

hummocks have various subtle exposures, but the general relief of autumn buttercup's habitat is relatively flat. Because the topography is rather level, the extant population has full exposure to the sun and wind throughout the growing season. Substrate: The peaty hummocks are about seven inches high, less than two feet in diameter, and probably are a result of long-term habitat alteration by livestock grazing. The soil is compacted between them. Near the base of these little hummocks is a band of lighter brown, loamy soil, approximately two inches thick (Mutz 1984). The knoll upon which the hummocks occur at one population may be a result of a raised peat bog uplifted by the up-welling waters of the surrounding spring (England 1989a). Schelz (personal communication) questions whether the uplifting action of the extensive vole and/or ant activity in the area may be the source of the mounds. The soil's composition is a very dark, clay loam which is high in organic matter (Spence 1991). The roots of the plants can reach up to and beyond 17 inches. The soil ranges from dry to saturated, and the low area surrounding the plants is not generally pooled with water, unlike the mounds which support *R. cymbalaria*. The absence of the autumn buttercups on these comparable forb-dominated mounds in more boggy areas may infer that a mesic soil is preferable to a constantly wet one (Mutz 1984). To date, there has been no known technical soil analysis, nor government soil surveys, conducted on the extant population's substrate. Spence (1991) lacked time and funds for a survey, and wished to minimize disturbance (NatureServe, 2015). High ecological of the community and site fidelity as well as low tolerance ranges are based on the specific habitat needs of the species and the need for a relatively pristine habitat (no grazing/trampling).

Dispersal/Migration

Dispersal

Adult: Wind/water/livestock (NatureServe, 2015)

Dispersal/Migration Narrative

Adult: Dispersal mechanisms are presumed to be wind, which can effectively whip the long pedicels; water, which can only transport the seed short distances due to its slow movement in the bog; and possibly livestock, through consumption and defecation of viable seeds (Mutz 1984). With *Ranunculus acris*, many seeds are eaten by birds but it is doubtful if much of this is still viable when voided (Harper, 1957) (NatureServe, 2015).

Population Information and Trends

Population Trends:

Unknown

Resiliency:

Low (NatureServe, 2015)

Representation:

Low (NatureServe, 2015)

Redundancy:

Low (NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Narrative:

Two known occurrences. Additional but as-yet unsurveyed potential habitat exists. (NatureServe, 2015). POPULATION TRENDS Summary: *Ranunculus acrifolius* var. *aestivalis* developed over the eons with two vital conditions that it seemingly requires for survival. The first is the historic availability of fresh water seeps and springs and the resulting marsh/bog habitat that was always there along the Sevier river (this water is what drives the whole system for the autumn buttercup). The second is the lack of intensive grazing by large animals such as cows and horses. When white people moved into the area these two vital conditions disappeared. Settlers immediately diverted the water from the seeps and springs to ponds and irrigation ditches, effectively changing the habitat drastically. And, they unleashed untold numbers of large domestic grazing animals into the area. Thus the autumn buttercup was getting hit from both ends; no suitable habitat for its roots to sink into and draw nourishment, and constant flower and stem decapitation by the grazers (NatureServe, 2015). Low representation, resiliency and redundancy are based on the low number of known populations and individuals.

Threats and Stressors

Stressor: Livestock grazing (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of individuals/habitat degradation

Narrative: We assign a high overall threat level for livestock grazing practices at the present time, not because grazing and trampling are inherently detrimental to autumn buttercup, but because an appropriate grazing regime is not currently implemented on the Preserve and we do not have sufficient population trend data to assess the suitability of the grazing regime at the Dale Ranch population. We will re-evaluate this threat level when we have more information regarding appropriate grazing practices (USFWS, 2013).

Stressor: Water Diversion for Agricultural Development (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: We do not have data on the hydrology of the wet meadow on the Preserve and no documentation to suggest the spring is affected by nearby agricultural water use. If water development commences in the future that may affect the autumn buttercup populations, or we have hydrologic data which suggests agricultural water use is affecting autumn buttercup habitat, we will re-evaluate the degree of threat this poses to the species (USFWS, 2013).

Stressor: Development of Buildings and Structures in Habitat (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: In the Recovery Plan, we identified construction of corrals and outbuildings associated with agricultural land use to be a threat to the autumn buttercup. We believed that structures would lead to an increased use of the immediate area around them and would likely degrade the

wet meadow habitat. However, there have been no corrals or outbuildings built within the known habitat for the two extant populations. There is no concern of these structures being built on the Preserve, and there are no new structures on the Dale Ranch property. Given the high water table and periodic flooding that occurs in the wet meadows, it is unlikely that large structures will be built on the habitat. Therefore, we no longer believe this to be a threat because this threat is presently not occurring, nor has it occurred in the past 21 years. However, if future development does occur, we will re-evaluate the degree of threat this poses to the species (USFWS, 2013).

Stressor: Invasive Species (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Invasive species were not considered a threat to autumn buttercup in the Recovery Plan. However, in the years following livestock removal from the Preserve, a noxious weed, Scotch thistle (*Onopordum acanthium*) increased ten-fold and completely occupied some areas where autumn buttercup originally occurred (Spence 1996). The Nature Conservancy developed a weed management plan and began controlling the Scotch thistle in 1995 and the spread of Scotch thistle continues to be controlled as per their weed management plan (TNC 1995). Scotch thistle was not documented to be a threat to autumn buttercup on the Dale Ranch (USFWS 2011; USFWS 2012). We conclude that invasive species are a low threat since weeds are being controlled on the Preserve, and are negligible on Dale Ranch. The intensity of this threat is presently low as well and the exposure of this threat is low (USFWS, 2013).

Stressor: Predation (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Herbivory occurs at high intensity levels at one of the two extant populations. Small rodents may have devastating consequences for individual plants and populations. Therefore, we conclude the threat posed by small mammal herbivory is high, and is greater than previously assessed (USFWS, 2013).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: In summary, prior to listing, autumn buttercup had no significant State or Federal protections. Under the Act's protection, a review of Federal actions potentially impacting the species can be performed. Because the species occurs on private land, two of the three high threats to the species cannot be addressed by regulatory mechanisms (small mammal herbivory and inappropriate grazing practices). As documented in section 2.3.2.5, climate change is a high threat to the species that can be addressed by regulatory mechanisms, but the Clean Air Act of 1970 presently does not regulate greenhouse gas emission levels. We assign an overall threat level to this factor as high because climate change is a high threat to the species and is not adequately addressed by the existing Federal regulatory mechanisms (USFWS, 2013).

Stressor: Vulnerability due to Small Population Sizes (USFWs, 2013)

Exposure:**Response:****Consequence:** Extinction

Narrative: The threat posed by small population size and small range of autumn buttercup is high when evaluated cumulatively with small mammal herbivory, invasive weed species, and climate change. We have attempted to alleviate this threat through three separate reintroduction efforts (see section 2.2.3.(6) after acknowledging that the greatest impediment to recovery was small population size (USFWS 2007)). However, these reintroduction efforts have not been successful (USFWS, 2013).

Stressor: Lack of Scientific Knowledge/Monitoring (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: The lack of scientific knowledge to identify the meaningful threats contributing to the population decline of autumn buttercup has caused the species to be managed ineffectively. While not a threat in and of itself, lack of scientific knowledge and monitoring information affects our ability to manage and recover the species. We acknowledge the complexity of biotic interactions directly and indirectly affecting autumn buttercup. We could promote population growth on the Preserve if we could better quantify the threats the species faces and better understand how the threats could be alleviated. We consider this factor to have a high level of impact to the species because we believe that beneficial management is crucial to preventing the extinction of autumn buttercup by providing the essential ecological processes necessary to recover the species (USFWS, 2013).

Stressor: Climate change (USFWS, 2013)

Exposure:**Response:****Consequence:** Loss of habitat

Narrative: Our current understanding is that the habitat of autumn buttercup was sensitive to historic climate change in the region, and the restricted range of the species can be explained by the prolonged period of aridity during the Holocene post-glacial epoch (12,000 years before present). Autumn buttercup has not been able to maintain a large range or robust population under current climate conditions, and therefore does not appear to have the adaptive capacity (Glick et al. 2011; Dawson et al. 2011) to adjust to a future climate change scenario of prolonged arid conditions. Extinction risk from climate change is predicted to be higher for species such as autumn buttercup with small ranges, particularly for those species whose current distributions are constrained by climate variables (Schwartz et al. 2006). We conclude that autumn buttercup is vulnerable to climate change, and that the threat of climate change to autumn buttercup is high, mainly due to the range-wide scope, the imminent and future immediacy, and the high exposure of the threat. There are uncertainties in our threat evaluation since downscaled climate projections are not available for our specific location and aquifer, and a vulnerability assessment has not been performed for autumn buttercup. We will re-assess the degree of threat climate change poses on autumn buttercup when more information becomes available (USFWS, 2013).

Recovery**Reclassification Criteria:**

Reclassification criteria have not been established.

Delisting Criteria:

Delisting criteria have not been established.

Conservation Measures and Best Management Practices:

- Taxonomy: We recommend revising the species' taxonomy in the Federal Register to reflect the best available scientific information (USFWS, 2013).
- Taxonomy: We recommend formally requesting the name be changed in the ITIS plant database (USFWS, 2013).
- Surveys: We recommend the Utah Heritage Program identify potential habitat and survey for autumn buttercup (USFWS, 2013).
- Research & Monitoring: We recommend that qualified scientists monitor and evaluate threats to autumn buttercup in conjunction with population monitoring of both extant and reintroduced autumn buttercup plants on the Preserve (USFWS, 2013).
- Research & Monitoring: Since there is a complex web of processes that occur within grazed wet meadow habitat (small mammal herbivory, vegetative competition, livestock trampling, weed suppression, litter removal), we recommend qualified scientists assess the relative importance of each process with regard to autumn buttercup abundance and distribution on the Preserve (USFWS, 2013).
- Research & Monitoring: We recommend qualified scientists assess whether small mammal herbivory is reduced when livestock grazing is reintroduced and to monitor their population levels in tandem with the autumn buttercup on the Preserve. We recommend the scientists identify measures to reduce small mammal populations and that The Nature Conservancy implement these measures on the Preserve at least in the near-term to reduce the threat of herbivory and encourage the recovery of autumn buttercup (USFWS, 2013).
- Research & Monitoring: We recommend initiating discussions with landowners about land use practices (stocking rates and seasonality of grazing) the ranchers believe would benefit the autumn buttercup (USFWS, 2013).
- Research & Monitoring: We recommend qualified scientists reinstate a multi-year demography study of subpopulations both on the Preserve and other available populations to study survivorship, growth, and reproduction. This study should include a seedbank component to determine seed longevity in soil, and seedling recruitment patterns at different microsites (USFWS, 2013).
- Research & Monitoring: We recommend qualified scientists perform a minimum viable population analysis for the species based upon data collected from the demography study (USFWS, 2013).
- Research & Monitoring: We recommend qualified scientists document the identity and availability of pollinators, and determine the breeding system of autumn buttercup (USFWS, 2013).
- Research & Monitoring: We recommend qualified scientists perform a climate change vulnerability assessment of autumn buttercup (USFWS, 2013).
- Research & Monitoring: We recommend qualified scientists implement long-term monitoring of the hydrology in the wet meadow habitat on the Preserve to document water table fluctuations on a regular basis (USFWS, 2013).
- Research & Monitoring: We recommend The Arboretum at Flagstaff, or another qualified and permitted botanic garden, assess the drought tolerance and plant response to drought by evaluating plant establishment, growth and reproduction of autumn buttercup under different water regimes in a greenhouse setting (USFWS, 2013).

- Ex-situ Conservation: We recommend The Arboretum at Flagstaff, or another qualified and permitted botanic garden, collect seed annually of wild (not reintroduced) autumn buttercup plants (USFWS, 2013).
- Administrative Actions: We recommend the USFWS host an annual workshop to prioritize, assess, and fulfill recovery actions (USFWS, 2013).
- Administrative Actions: Once we have new survey and research data, we recommend that the USFWS revise the Recovery Plan to explicitly address the relevant listing factors. The number of plants and populations referenced in the current recovery plan that are required for long-term viability of autumn buttercup are unsupported by our current understanding of the population status. The revised Recovery Plan will include objective, measurable criteria which, when met, will result in a determination that the species be removed from the Federal List of Endangered and Threatened Plants. The Recovery Plan also will estimate the time required and cost to carry out those measures needed to achieve the goal for recovery and delisting (USFWS, 2013).
- Administrative Actions: We recommend that the USFWS support autumn buttercup recovery by providing personnel and fiscal resources yearly to implement recovery actions (USFWS, 2013).
- Administrative Actions: We recommend that the USFWS and The Nature Conservancy write a management plan for the Preserve (USFWS, 2013).

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SPECIES ACCOUNT: *Ranunculus hawaiiensis* (Hawaii buttercup (Makou))

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2016a)

Physical Description

Ranunculus hawaiiensis is an erect or ascending perennial herb 20 to 79 inches (in) (50 to 200 centimeters (cm)) tall with fibrous roots. Stems are densely covered with golden or whitish hairs. Basal leaves are twice compound, with leaflets lanceolate with the terminal one largest and irregularly toothed and lobed. The yellow, glossy flowers are numerous in branched open cymes and contain a scale-covered nectary at the base. Achenes are numerous in an ovoid head and are margined with a narrow wing (Wagner et al. 1999, p. 1,088).

Taxonomy

Phylum Anthophyta; Class Dicotyledoneae; Order Ranunculaceae; Genus *Ranunculus*. *Ranunculus hawaiiensis* is a member of the buttercup family. It was described by Asa Gray (1854). This species is recognized as a distinct taxon in Wagner et al. (1999, p. 1,088), the most recently accepted Hawaiian plant taxonomy.

Historical Range

Historically, *Ranunculus hawaiiensis* was wide-ranging on the island of Hawaii, from Kona, Hualalai, Mauna Kea, and Kau. On Maui, this species was known from Haleakala National Park (Hawaii Biodiversity Mapping Program (HBMP) 2008).

Current Range

Ranunculus hawaiiensis is found on the island of Hawaii on unencumbered State land adjacent to Kipahoe Natural Area Reserve (NAR), in Hawaii Volcanoes National Park Kahuku section, at Kapapala FR, and Mauna Kea FR at Puu Kanakaleonui and north Kolekole Gulch. On Maui, this species is known from one sighting on a cliff in the Waikamoi Preserve (Bio, in litt. 2008; Pratt, in litt. 2008; Oppenheimer, in litt. 2006; Agorastos, in litt. 2011).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Habitat Type

Adult: Forest - Hardwood, Forest/Woodland, Grassland/herbaceous, Shrubland/chaparral

Environmental Specificity

Adult: Unknown

Habitat Narrative

Adult: Typical habitat is mesic to wet forests dominated by *Metrosideros polymorpha* and *Acacia koa* with scree substrate at elevations between 6,000 and 6,700 feet (ft) (1,820 and 2,040 meters (m)) (Medeiros 2007, pers. comm.; Pratt, in litt. 2007; Wagner et al. 1999, p. 1,088); moist to dry subalpine forests and shrublands, grassy habitats including open pastures and subalpine grassy slopes, and sparsely vegetated (2015)

Dispersal/Migration

Population Information and Trends

Population Trends:

Decreasing

Species Trends:

Decreasing

Number of Populations:

Six: Three on State land (Mauna Kea and Kapapala Forest Reserves (FR) on the island of Hawaii); two populations on Federal land (Hawaii Volcanoes National Park and Hakalau NWR on the island of Hawaii); and one population on State land on Maui (Waikamoi Preserve).

Population Size:

<100

Population Narrative:

In the 1980s and 1990s, *Ranunculus hawaiiensis* numbered several hundred individuals on both Maui and the island of Hawaii observed during surveys conducted as recently as 2010. We are unaware of additional surveys conducted to date. Currently, there are six populations totaling 14 individuals on the island of Hawaii. On the island of Hawaii there are two individuals on State land above Hakalau National Wildlife Refuge (NWR), one to three fenced-enclosed individuals at Puu Kanakaleonui in Hakalau NWR (last observed in 2005), one individual at Kolekole gulch, six individuals on Federal land at Kahuku (part of Hawaii Volcanoes National Park), one individual at Kapapala FR on State Land, and one individual on unencumbered State land adjacent to Kipahoehoe NAR (HBMP 2008; Bio, in litt. 2008; Pratt, in litt. 2008; Plant Extinction Prevention Program (PEPP) 2008, p. 108; Agorastos, in litt. 2011; Imoto, in litt. 2013). The eight individuals previously reported at Kapapala FR (also referenced as Kau FR and Kahuku) are now down to one individual and this population remains threatened by feral cattle and drought (Pratt, in litt. 2011; Imoto, in litt. 2013). Five individuals were outplanted at Kahuku, on the island of Hawaii in 2007 (Pratt, in litt. 2007); however, Pratt (in litt. 2011) confirmed these as dead in 2010. On Maui, the last observation was in 1995 of a few individuals on a cliff in the Waikamoi Preserve (Oppenheimer, in litt. 2007), and as of 2012, the status of this population remains uncertain (PEPP, in litt. 2012). None were found on a survey of Kuiki planeze in Haleakala National Park in 2006; however, the area will be surveyed again (DLNR 2006).

Threats and Stressors

Stressor: Feral pigs

Exposure:

Response:**Consequence:**

Narrative: Feral pigs (*sus scrofa*) are known to degrade and destroy habitat and to feed on *R. hawaiiensis*. Rooting by feral pigs has deleterious effects on native forest ecosystems; they have been observed to be related to root in search of earthworms to depths averaging 8 inches (20 centimeters) greatly disrupting the leaf litter and topsoil layers and contributing to erosion and changes in ground topography. The feeding habits of pigs were observed to create seed beds, enabling the establishment and spread of weedy species such as *Psidium cattleianum* (strawberry guava). The study concluded that all aspects of the food habits of pigs are damaging to the structure and function of the Hawaiian forest ecosystem (Diong 1982). Feral pigs are a threat to *R. hawaiiensis* on both Hawaii and Maui.

Stressor: Feral goats, sheep, and mouflon

Exposure:**Response:****Consequence:**

Narrative: Feral goats (*Capra hircus*), sheep (*Ovis aries*), and mouflon (*Ovis musimon*) are known to degrade and destroy habitat and to feed on *R. hawaiiensis*. Goats browse on introduced grasses and native plants, trample roots and seedlings, cause erosion, and promote the invasion of alien plants. Goats, sheep and mouflon are able to forage in extremely rugged terrain and have a high reproductive capacity (Clarke and Cuddihy 1980; van Riper and van Riper 1982; Scott et al. 1986; Tomich 1986; Culliney 1988; Cuddihy and Stone 1990). Mouflon are both grazers and browsers. *R. hawaiiensis* is threatened by predation by goats on both Hawaii and Maui and by feral sheep and mouflon on Hawaii.

Stressor: Feral cattle

Exposure:**Response:****Consequence:**

Narrative: Feral cattle (*Bos taurus*) are known to degrade and destroy habitat. Cattle eat native vegetation, trample roots and seedlings, cause erosion, create disturbed areas into which alien plants invade, and spread seeds of alien plants in their feces and on their bodies. The forest in areas grazed by cattle becomes degraded to grassland pasture, and plant cover is reduced for many years following removal of cattle from an area. Several alien grasses and legumes purposely introduced for cattle forage have become noxious weeds (Tomich 1986; Cuddihy and Stone 1990). Feral cattle are a threat to *R. hawaiiensis* on Maui.

Stressor: Introduced grasses and plants

Exposure:**Response:****Consequence:**

Narrative: *Ranunculus hawaiiensis* is threatened by introduced pasture grasses that degrade and destroy habitat and outcompete native plants (HBMP 2008). The nonnative grasses that are reported to be the greatest threats to *R. hawaiiensis* on the island of Hawaii are *Anthoxanthum odoratum* (sweet vernalgrass), *Ehrharta stipoides* (meadow rice grass), *Holcus lantanus* (common velvet grass), and *Pennisetum clandestinum* (kikuyu grass) (HBMP 2008; PEPP 2008, p. 108). Nonnative plants which pose the greatest threats to *R. hawaiiensis* on the island of Maui are:

Cymbopogon refractus (barbwire grass), *Holcus lantanus*, and *Pennisetum clandestinum* (Medeiros, in litt. 1995).

Stressor: Introduced slugs

Exposure:

Response:

Consequence:

Narrative: Slug predation has been observed on *R. hawaiiensis* in cultivation and in the wild (Medeiros 2007, pers. comm.). The effect of slugs on the decline of this and related species is unclear, although slugs may pose a threat by feeding on the stems and fruit thereby reducing the vigor of the plants and limiting regeneration (Mehrhoff, in litt. 1994). Currently, there is no known control method for this threat.

Stressor: Stochastic events (USFWS, 2016b)

Exposure:

Response:

Consequence:

Narrative: Drought and erosion pose a threat in the areas of the last known occurrences of *R. hawaiiensis* on Maui (PEPP 2013, p. 177) (USFWS, 2016b).

Stressor: Low genetic variability (USFWS, 2016b)

Exposure:

Response:

Consequence:

Narrative: This species experiences reduced reproductive vigor due to low levels of genetic variability, leading to diminished capacity to adapt to environmental changes, and thereby lessening the probability of long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361) (USFWS, 2016b).

Stressor: Climate change (USFWS, 2016b)

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013, p. 86) found that, as environmental conditions are altered by climate change, *R. hawaiiensis* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions (USFWS, 2016b).

Recovery

Recovery Actions:

- Protect all individuals from feral pigs, goats, sheep, mouflon, and cattle by removing these species from areas where *Ranunculus hawaiiensis* populations exist and preventing reinvasion through the use of exclosures.
- Control alien plants through physical, mechanical, and biological control methods, as well as herbicides when necessary. Continue to conduct research into potential biocontrol species.
- Develop and implement control methods for slugs.

- Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.

Conservation Measures and Best Management Practices:

- Remove feral ungulates from areas where *Ranunculus hawaiensis* populations exist and prevent reinvasion through the use of exclosures.
- Control nonnative plants through physical, mechanical, and biological control methods, as well as herbicides when necessary.
- Conduct research into potential biocontrol species.
- Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.
- Propagate and maintain genetic stock.
- Conduct/update field surveys at known locations and potential habitat.
- Develop and implement control methods for slugs.

References

USFWS. 2014. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for *Ranunculus hawaiensis* (makou), Pacific Region (Region 1), 16 p.

USFWS. 2016a. Environmental Conservation Online System (ECOS) – Species Profile. <http://ecos.fws.gov/ecp0/>. Accessed October 2016.

(1) USFWS 2014. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for *Ranunculus hawaiensis* (makou), Pacific Region (Region 1), 16 p. (2) NatureServe 2015. NatureServe Species Explorer, *Ranunculus hawaiensis*, Ecology and Life History, updated 2015.

USFWS 2014. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for *Ranunculus hawaiensis* (makou), Pacific Region (Region 1), 16 p.

USFWS. 2016b. Endangered and Threatened Wildlife and Plants

Endangered Status for 49 Species From the Hawaiian Islands

Final rule. 81 Federal Register 190. September 30, 2016. Pages 67786 - 67860.

SPECIES ACCOUNT: *Ranunculus mauiensis* (Maui buttercup (Makou))

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2016a)

Physical Description

Ranunculus mauiensis is an erect to weakly ascending perennial herb 20 to 79 inches (in) (50 to 200 centimeters) tall with fibrous roots. Stems are sparsely to densely pubescent with scattered whitish hairs. Basal leaves are compound with ovate leaflets with the terminal leaflet being the largest and irregularly serrate. Flowers are few, in branched loose cymes. Petals are yellow and glossy on the upper surface. Achenes are numerous in a globose head and have smooth faces (Wagner et al. 1999).

Taxonomy

Phylum Anthophyta; Class Dicotyledoneae; Order Ranunculales; Family Ranunculaceae; Genus *Ranunculus*. *Ranunculus mauiensis* was described by Asa Gray (1854). This species is recognized as a distinct taxon in Wagner et al. (1999, p. 1,089)

Historical Range

Historically, *Ranunculus mauiensis* was known from five islands. On the island of Hawaii it was found at Kealakekua. On Kauai, *R. mauiensis* occurred at Kuia, Kokee, and Na Pali Kona. On west Maui this species was known from Puu Kukui, Kapunakea, and Pohakea; and on east Maui it could be found at Olinda, Kipahulu, Waikamoi, and Puu Alaea. On Molokai, it occurred at Kamakou, Kalae, Waikolu, and Kaluaaha Valley; and on Oahu, *R. mauiensis* was known from the Waianae Mountains (HBMP 2008).

Current Range

Currently, *Ranunculus mauiensis* is known from three islands, Kauai (Kokee State Park and Na Pali Kona); Maui, both east (Waikamoi Preserve, Makawao Forest Reserve, and Manawainui) and west (Kapunakea Preserve, West Maui Forest Reserve, and West Maui Natural Area Reserve); and Molokai (Kamakou Preserve) (Wood, in litt. 2007; HBMP 2008; Oppenheimer, in litt. 2008).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Habitat Type

Adult: Open sites in mesic to wet forests and along streams.

Habitat Vegetation or Surface Water Classification

Adult: Palustrine Habitat: Forested wetland, herbaceous wetland, riparian. Terrestrial Habitat: Forest - Hardwood, Forest/Woodland

Dependencies on Specific Environmental Elements

Adult: Montane wet, montane mesic, and wet cliff ecosystems (USFWS, 2016b)

Environmental Specificity

Adult: Unknown

Habitat Narrative

Adult: There is limited information available on the habitat and life history of this species. Typical habitat is open sites in mesic to wet forest and along streams at elevations around 3,500 to 5,600 feet (ft) (1,060 to 1,710 meters (m)) (Wagner et al. 1999, p. 1,089). It occurs in the montane wet (Kauai, Oahu, Molokai, and Maui), montane mesic (Kauai, Molokai, Maui, and Hawaii Island), and wet cliff (Molokai and Maui) ecosystems (Duncan 1999, p. 1089; TNCH 2007; HBMP 2010) (USFWS, 2016b).

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Unknown

Species Trends:

Unknown

Resiliency:

Low to moderate (inferred from USFWS, 2016b)

Redundancy:

Low (inferred from USFWS, 2016b)

Number of Populations:

14 on the islands of Maui, Molokai, and Kauai

Population Size:

Kauai: 53, Maui: 112, Molokai: 2 (USFWS, 2016b)

Population Narrative:

Ranunculus mauiensis is currently known from 14 populations on Maui, Molokai, and Kauai observed during surveys conducted as recently as 2007. (Wood, in litt. 2007; Perlman, in litt. 2007; Oppenheimer, in litt. 2008; HBMP 2008), totaling 198 individuals. We are unaware of additional surveys conducted to date. Nine populations are known from the island of Maui. Five populations occur on west Maui (one population at Kapunakea Preserve of five individuals, one population of five individuals at Pohakea gulch, one population of five individuals at Lihau, one population of one individual at Kauaula Valley, and one population of 34 individuals at Puehuhunui); and four populations of approximately 90 plants are found on east Maui (20 individuals at Waikamoi Preserve, 30 individuals at Makawao Forest Reserve, one population of 10 individuals within Kahikinui, and 10 individuals at Manawainui (Nakula Natural Area Reserve also within Kahikinui)) (Perlman, in litt. 2007; Wood, in litt. 2007; Bily 2007, pers. comm.; Plant

Extinction Prevention Program (PEPP), in litt. 2011). Five populations occur on the island of Kauai: Kalalau-Honopu (34 individuals), Nualolo (12 individuals), Kawaiiki ridge (four individuals), Nawaimaka (one individual), and Nawaimaka stream (two individuals) (Perlman, in litt. 2007; Wood, in litt. 2007; HBMP 2008; PEPP, in litt. 2011). Two populations of one individual each were known to occur in Kamakou Preserve on Molokai (HBMP 2008); however, recent surveys have been unable to relocate these individuals (PEPP 2010, p. 105; Bakutis, in litt. 2011). Currently, *R. mauiensis* is known from Kauai (53 individuals) and east Maui (112 individuals). Two individuals formerly known from Molokai have not been observed on recent surveys (Bily 2007, in litt.; Perlman 2007a, in litt.; Wood 2007b, in litt.; HBMP 2010; PEPP 2010, p. 105; Bakutis 2011, in litt.; PEPP 2011, p. 161; PEPP 2013, p. 177; Oppenheimer 2015, in litt.) (USFWS, 2016b).

Threats and Stressors

Stressor: Feral pigs

Exposure:

Response:

Consequence:

Narrative: Hawaiian ecosystems, having evolved without hooved or grazing mammals, are susceptible to large-scale disturbance and predation by introduced ungulates (Loope et al. 1991). Feral pigs (*sus scrofa*) are known to degrade and destroy habitat and to feed on *R. hawaiensis*. Rooting by feral pigs has deleterious effects on native forest ecosystems; they have been observed to be related to root in search of earthworms to depths averaging 8 inches (20 centimeters) greatly disrupting the leaf litter and topsoil layers and contributing to erosion and changes in ground topography. The feeding habits of pigs were observed to create seed beds, enabling the establishment and spread of weedy species such as *Psidium cattleianum* (strawberry guava). The study concluded that all aspects of the food habits of pigs are damaging to the structure and function of the Hawaiian forest ecosystem (Diong 1982). Feral pigs are a threat to *R. hawaiensis* on both Hawaii and Maui.

Stressor: Feral goats

Exposure:

Response:

Consequence:

Narrative: Currently, populations of feral goats (*Capra hircus*) exist on Kauai, Oahu, Maui, Molokai, and Hawaii. Hawaiian ecosystems, having evolved without hooved or grazing mammals, are susceptible to large-scale disturbance and predation by introduced ungulates (Loope et al. 1991). Feral goats are known to degrade and destroy habitat and to feed on *R. mauiensis*. Goats browse on introduced grasses and native plants, trample roots and seedlings, cause erosion, and promote the invasion of alien plants. Goats are able to forage in extremely rugged terrain and have a high reproductive capacity (Clarke and Cuddihy 1980; van Riper and van Riper 1982; Scott et al. 1986; Tomich 1986; Culliney 1988; Cuddihy and Stone 1990). *R. mauiensis* is threatened by predation by goats on both Hawaii and Maui.

Stressor: Introduced mule deer

Exposure:

Response:

Consequence:

Narrative: Hawaiian ecosystems, having evolved without hoofed or grazing mammals, are susceptible to large-scale disturbance by introduced deer species (Loope et al. 1991). Mule deer trample native vegetation and cause erosion by creating trails and removing vegetation (Hawaii Department of Land and Natural Resources 1985; Tomich 1986; Cuddihy and Stone 1990).

Stressor: Introduced axis deer

Exposure:

Response:

Consequence:

Narrative: Hawaiian ecosystems, having evolved without hoofed mammals, are susceptible to large-scale disturbance by introduced deer species (Loope et al. 1991). Axis deer are primarily grazers, but also browse numerous plant species including those grown as commercial crops (Waring 1996; Simpson, in litt. 2001).

Stressor: Nonnative slugs

Exposure:

Response:

Consequence:

Narrative: Nonnative slugs are generalist herbivores (Rathke 1985) that feed principally on plant seedlings and low-lying herbs, yet they are not completely indiscriminate in their choices of foods (Dirzo 1980; Joe 2006). While native Hawaiian plants have had to defend themselves against avian, insect and possibly snail herbivory, the defense mechanisms evolved by Hawaiian plants may not be very effective against nonnative slugs (Joe 2006). In the Kahanahaiki Management Unit on Oahu, nonnative slugs were found to be responsible for substantial seedling mortality of certain native plant species. Of three native species studied, two had significantly higher seedling mortality (50 percent) when exposed to slugs (Joe 2006). Slug damage has been observed on *R. mauianus* in cultivation and in the wild (Medeiros 2007, pers. comm.). The effect of slugs on the decline of this and related species is unclear, although slugs may pose a threat by feeding on the stems and fruit, thereby reducing the vigor of the plants and limiting regeneration (Mehrhoff, in litt. 1994; Perlman, in litt. 1994). Currently, there is no effective control method for this threat.

Stressor: Nonnative plants

Exposure:

Response:

Consequence:

Narrative: *Ranunculus mauianus* is threatened by alien plant species that degrade and destroy habitat and outcompete native plants (HBMP 2008). The nonnative plants that are reported to be the greatest threats to *R. mauianus* on the island of Maui are *Agerantia adenophora* (Maui pamakani), *Andropogon virginicus* (broomsedge), *Clidemia hirta* (Kosters curse), *Hedychium gardnerianum* (kahili ginger), *Holcus lantanus* (common velvetgrass), *Rubus argutus* (prickly Florida blackberry), *R. rosifolius* (thimbleberry), and *Tibouchina herbacea* (glorybush). Nonnative plants which pose the greatest threats to *R. mauianus* on the island of Kauai are: *C. hirta*, *Erigeron karvinskianus* (daisy fleabane), *H. gardnerianum*, *Kalanchoe pinnata* (air plant), *Lantana camara* (lantana), *Lonicera japonica* (Japanese honeysuckle), *Passiflora tarminiana* (banana poka), *Psidium cattleianum*, *R. argutus*, and *R. rosifolius* (HBMP 2008). The nonnative plants reported to be the greatest threats to *R. mauianus* on the island of Molokai are *C. hirta*, *Passiflora edulis* (passion fruit, lilikoi), *R. argutus*, and *T. herbacea* (Moses, in litt. 2009).

Stressor: Climate change

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to the ecosystem that supports this species. Fortini et al. (2013, pp. 1134) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013, p. 87) concluded that *Ranunculus mauianus* is vulnerable to the impacts of climate change. Therefore, additional management actions may be needed to conserve this taxon into the future.

Stressor: Rats (USFWS, 2016b)

Exposure:

Response:

Consequence:

Narrative: Seed predation by rats (Maui, Kauai) is reported as a threat to *R. mauianus* (HBMP 2010; PEPP 2014, pp. 154–155) (USFWS, 2016b).

Stressor: Stochastic events (USFWS, 2016b)

Exposure:

Response:

Consequence:

Narrative: Stochastic events such as drought (Maui), landslides (Kauai), and fire (Maui) are also reported as threats to *R. mauianus* (HBMP 2010). Erosion is a threat to occurrences on Maui and Kauai (PEPP 2014, pp. 155–156) (USFWS, 2016b).

Stressor: Low genetic variability (USFWS, 2016b)

Exposure:

Response:

Consequence:

Narrative: This species experiences reduced reproductive vigor due to low levels of genetic variability, leading to diminished capacity to adapt to environmental changes, thereby lessening the probability of its long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361) (USFWS, 2016b).

Recovery

Recovery Actions:

- Protect all individuals from feral pigs, goats, and deer by removing these species from areas where *R. mauianus* populations exist and preventing reinvasion through the use of exclosures.
- Control alien plants through physical, mechanical, and biological control methods, as well as herbicides when necessary. Continue to conduct research into potential biocontrol species.
- Develop and implement control methods for slugs.
- Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.

Conservation Measures and Best Management Practices:

- Removing all individuals of feral goats, pigs, and deer from areas where *R. mauiensis* populations exist and prevent reinvasion through the use of exclosures.
- Control alien plants through physical, mechanical, and biological control methods, as well as herbicides when necessary.
- Conduct research into potential biocontrol species to control alien plants.
- Develop and implement control methods for slugs.
- Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.
- Propagate and maintain genetic stock.

References

USFWS. 2014. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for *Ranunculus mauiensis* (makou)

Pacific Region (Region 1), 19 p.

USFWS. 2016b. Environmental Conservation Online System (ECOS) – Species Profile.
<http://ecos.fws.gov/ecp0/>. Accessed October 2016.

USFWS 2014. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for *Ranunculus mauiensis* (makou)

USFWS. 2016b. Endangered and Threatened Wildlife and Plants

Endangered Status for 49 Species From the Hawaiian Islands

Final rule. 81 Federal Register 190. September 30, 2016. Pages 67786 - 67860.

SPECIES ACCOUNT: *Remya kauaiensis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 01/14/1991; Pacific Region (R1) (USFWS, 2016)

Physical Description

A weakly erect to sprawling shrub 1 - 4 m tall. Leaf undersides are covered with white woolly hairs. Flower heads are borne in panicles (NatureServe, 2015).

Taxonomy

A member of the aster family (Asteraceae) (USFWS, 2003). It belongs to an endemic genus of 3 species, this species is endemic to Kauai (NatureServe, 2015).

Historical Range

Historically, this species was found at Koaie, Mohihi, Kalalau, Makaha, Nualolo, Kawaiula, Kuia, Honopu, Awaawapuhi, Kopakaka, and Kauhao on Kauai (USFWS, 2003).

Current Range

As of 2003, the species was located in Hipalau Valley, Awini Valley, Koaie Canyon, Mohihi Stream, the left branch of Kalalau Valley, Kalalau Valley Rim, Awaawapuhi and Nualolo Valleys, Kuia and Kawaiula Valleys, Makaha Valley and Makaha Ridge, Poopooiki Valley, Kauhao Valley, Waialae Valley, and Kaulaula Valley (Kauai) (USFWS 2003; 2010).

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Remya kauaiensis* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Remya kauaiensis* includes six units totaling 3,185 acres in Kauai County, Hawaii. The units are Kauai 11—*Remya kauaiensis*—a, b, c, d, e, and Kauai 12—*Remya kauaiensis*—f.

Kauai 11—*Remya kauaiensis*—a This unit is critical habitat for *Remya kauaiensis* and is 172 ha (426 ac) on State land (Alakai Wilderness Preserve), containing portions of Kipalau Valley. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Remya kauaiensis* and is currently occupied with five to 10 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in

Kauai 11—*Remya kauaiensis*—a: This unit is critical habitat for *Remya kauaiensis* and is 172 ha (426 ac) on State land (Alakai Wilderness Preserve), containing portions of Kipalau Valley. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived

perennial *Remya kauaiensis* and is currently occupied with five to 10 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep, north- or northeast-facing slopes in *Acacia koa*-*Metrosideros polymorpha* lowland mesic forest. This unit is geographically separated from the other five units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Remya kauaiensis*—b: This unit is critical habitat for *Remya kauaiensis* and is 66 ha (163 ac) on State land (Na Pali Coast State Park) within Kalalau Valley. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Remya kauaiensis* and is currently occupied with three plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep, north- or northeast-facing slopes in *Acacia koa*-*Metrosideros polymorpha* lowland mesic forest. This unit is geographically separated from the other five units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Remya kauaiensis*—c: This unit is critical habitat for *Remya kauaiensis* and is 886 ha (2,190 ac) on State land (Kuia NAR and Kokee State Park). This unit contains portions of Awaawapuhi, Honopu, and Nualolo Trails and Kainamanu Summit. This unit provides habitat for five populations of 300 mature, reproducing individuals of the short-lived perennial *Remya kauaiensis* and is currently occupied with 73 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep, north- or northeast-facing slopes in *Acacia koa*-*Metrosideros polymorpha* lowland mesic forest. This unit is geographically separated from the other five units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Remya kauaiensis*—d: This unit is critical habitat for *Remya kauaiensis* and is 47 ha (115 ac) on State land, containing portions of Kaluahaulu Ridge. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Remya kauaiensis* and is currently occupied with 10 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep, north- or northeast-facing slopes in *Acacia koa*-*Metrosideros polymorpha* lowland mesic forest. This unit is geographically separated from the other five units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Remya kauaiensis*—e: This unit is critical habitat for *Remya kauaiensis* and is 66 ha (163 ac) on State land (Alakai Wilderness Preserve) and contains portions of Kohua Ridge and the Mohihi Waialai Trail. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Remya kauaiensis* and is currently occupied with one plant. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are

essential for this species include, but are not limited to, steep, north- or northeast-facing slopes in *Acacia koa*-*Metrosideros polymorpha* lowland mesic forest. This unit is geographically separated from the other five units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 12—*Remya kauaiensis*—f: This unit is critical habitat for *Remya kauaiensis* and is 52 ha (128 ac) on State land (Waimea Canyon State Park) near Lapa Picnic Area and Lua Reservoir. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Remya kauaiensis* and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is important to the establishment of additional populations on Kauai in order to reach recovery goals. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep, north- or northeast-facing slopes in *Acacia koa*-*Metrosideros polymorpha* lowland mesic forest. This unit is geographically separated from the other five units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

- (i) Steep, north or northeast-facing slopes in *Acacia koa*-*Metrosideros polymorpha* lowland mesic forest and containing one or more of the following associated native plant species: *Chamaesyce* spp., *Claoxylon sandwicense*, *Dianella sandwicensis*, *Diospyros* spp., *Dodonaea viscosa*, *Hedyotis terminalis*, *Melicope* spp., *Nestegis sandwicensis*, *Pouteria sandwicensis*, *Psychotria* spp., *Schiedea* spp., or *Tetraplasandra* spp.; and
- (ii) Elevations between 560 and 1,249 m (1,836 and 4,097 ft).

Special Management Considerations or Protections

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species in paragraph (b) of this section and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and

augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (inferred from USFWS, 2003)

Lifespan

Adult: < 10 years (USFWS, 2010)

Breeding Season

Adult: April - August (USFWS, 2003)

Key Resources Needed for Breeding

Adult: Probably insects (USFWS, 2003)

Reproduction Narrative

Adult: It is a short-lived perennial (fewer than 10 years) (USFWS, 2010). Flowers have been observed in April, May, June, and August, and are probably insect-pollinated. *Remya kauaiensis* may be self-incompatible (Herbst 1988; Service 1995; 56 FR 1450) (USFWS, 2003).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Koa-ohia lowland mesic forest (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: 1,836 - 4,090 ft. elevation (USFWS, 2010)

Habitat Narrative

Adult: Inhabits moist forests on gulch slopes and in gulch bottoms (NatureServe, 2015). *Remya kauaiensis* grows chiefly on steep, north- or northeast-facing slopes between 560 and 1,247 meters (1,836 and 4,090 feet) elevations. It is found primarily, but not exclusively, in *Acacia koa* (*koa*) – *Metrosideros polymorpha* (*ohia*) lowland mesic forest (USFWS, 2010).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Seeds are probably wind or water-dispersed (USFWS, 2003).

Population Information and Trends**Population Trends:**

Rediscovered in 1983 (USFWS, 2010)

Resiliency:

Low (inferred from USFWS, 2010; see current range/distribution)

Redundancy:

Moderate (inferred from USFWS, 2010)

Number of Populations:

10 to 11 (USFWS, 2017)

Population Size:

175 to 335 (USFWS, 2017)

Population Narrative:

New Status Information: In addition to those populations cited in the previous 5-year review, new observations include the following: • At the time of the last 5-year review in 2010 there were nine populations totaling between 119 and 224 individuals on Kauai. Surveys confirm previously known individuals at eight locations: Waialae, Hipalau, Makaha, Poopooiki, Kawaiula, Kuia, Nualolo, and Awaawapuhi (NTBG 2011a-b, d, 2012b, f, 2013a-d, e, 2014a-b, 2015a-e, h, 2016a, g, 2017; PEPP 2010, 2011, 2013, 2014, 2015). The current status of individuals at Kauaula, Honopu, Kalalau, Mohihi, and upper Koaie is unknown. New populations were found at Kohua, Kumuwela, and Haeleele (NTBG 2012c-e, h; PEPP 2012). The current populations total approximately 175 individuals. Clark (2016) estimated 10 'subpopulations' (considered as 'populations' by USFWS) totaling 335 individuals, with the largest population totaling 70 individuals (USFWS, 2017).

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The primary threats to *Remya kauaiensis* include habitat degradation by feral goats (*Capris hircus*), pigs (*Sus scrofa*), cattle (*Bos taurus*), and deer (*Odocoileus hemionus*). Other threats include erosion and fire (USFWS, 2010).

Stressor: Invasive plants (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Competition from invasive introduced plant species including *Axonopus fissifolius* (narrow-leaved carpetgrass), *Blechnum appendiculatum* (hammock fern), *Bryophyllum pinnatum* (airplant), *Erigeron karvinskianus* (daisy fleabane), *Rubus argutus* (blackberry), *Grevillea robusta* (silk oak), *Lantana camara* (lantana), *Passiflora tarminiana* (banana poka), *P. ligularis* (sweet

granadilla), *Hedychium gardnerianum* (Kahili ginger), *Psidium cattleianum* (strawberry guava), *Pluchea carolinensis* (sourbush), *Rubus rosifolius* (thimbleberry), *Psidium guajava* (common guava), *Oplismenus hirtellus* (basketgrass), and *Nasturtium microphyllum* (watercress) (Perlman 2009; Wood 2009) (USFWS, 2010).

Stressor: Small population size (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: This species is at risk of extinction from naturally occurring events, such as landslides or hurricanes, and/or reduced reproductive vigor due to the small number of remaining populations and individuals (USFWS 2003). In addition to all of the other threats, species like *Remya kauaiensis* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding, and disease outbreaks (USFWS, 2010).

Stressor: Herbivory (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Herbivory by feral goats, pigs, cattle, and deer has been frequently noted and regeneration in the wild is not observed (Perlman 2009; Wood 2009) (USFWS, 2010).

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to *Remya kauaiensis*. However, current climate change models do not allow us to predict specifically what those effects, and their extent, would be for this species (USFWS, 2010).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Remya kauaiensis* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.764 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Stressor: Rodent predation or herbivory

Exposure:

Response:

Consequence:

Narrative: Herbivory by rats is noted to be a threat to *Remya kauaiensis* at the Nualolo, Awaawapuhi, Kohua, Kuia, Kumuwela, Makaha, and Poopooiki populations (NTBG 2011a-d, 2012c-h, 2013a-d, f, 2014a, c, 2015a-e, 2016a, 2017a). Rats eat virtually every part of plants and at every stage: fleshy fruits, seeds, flowers, stems, leaves, shoot, seedlings, and roots (Russell 1980; Cuddihy and Stone 1990). The effects on plants range from reduced vigor and decreased reproduction to mortality of individuals and complete lack of recruitment (USFWS, 2017).

Recovery**Reclassification Criteria:**

1. A total of five to seven populations should be documented on Kauai and at least one other island where they now occur or occurred historically (USFWS, 1995).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials (USFWS, 1995).
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 1995).

Delisting Criteria:

1. A total of eight to ten populations should be documented on Kauai and at least one other island where they now occur or occurred historically (USFWS, 1995).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials (USFWS, 1995).
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 1995).

Recovery Actions:

- Protect current populations, control threats and monitor (USFWS, 1995).
- Expand current populations (USFWS, 1995).
- Conduct research essential to conservation of the species (USFWS, 1995).
- Establish new populations as needed to reach recovery objectives (USFWS, 1995).
- Validate and revise recovery objectives (USFWS, 1995).
- Devise and implement a public education program (USFWS, 1995).

Conservation Measures and Best Management Practices:

- Fence wild occurrences of *Remya kauaiensis* to prevent further disturbance and browsing by feral ungulates (USFWS, 2010).
- Control invasive introduced species within enclosure fences (USFWS, 2010).
- Survey locations where *Remya kauaiensis* was previously seen but not recorded in the last ten years: Awini Valley, Koaie Canyon, Mohihi, Kauhao Valley, and Kaulaula (USFWS, 2010).
- Collect seeds from all remaining populations for storage and propagation (USFWS, 2010).

- Conduct research to determine genetic diversity in and between populations (USFWS, 2010).
- Propagate for reintroduction (USFWS, 2010).
- Work with Hawaii Division of Forestry and Wildlife and Hawaii State Parks to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2010).
- New Management Actions: • NTBG has collected thousands of seeds and placed them in the NTBG seed bank from populations at Kuia, Kohua, Awaawapuhi, Makaha, Hipalau, Waialae, and Nualolo for storage. It is uncertain how many founders are represented. There are five plants total from four different collections from Awaawapuhi and Kuia as living collections (NTBG 2017b). There is one research collection, three bulk collections from Kuia, Makaha, and Awaawapuhi, and one individual founder collected from the Awaawapuhi population at the Lyon Arboretum seed bank (Lyon Arboretum 2017). • PEPP is monitoring occurrences (23 individuals) of *Remya kauaiensis* at Awaawapuhi, Kuia, Haeleele, Nualolo, Kawaiula, Poopooiki, and Makaha (PEPP 2010, 2011, 2012, 2013, 2014 2015). • A few wild individuals occur in fenced exclosures at Kuia (three) and Kawaiula (three) (PEPP 2013, 2014) (USFWS, 2017).
- Recommendations for Future Actions: No new threats and no other significant new information regarding the species' biological status have been reported since the last 5-year review in 2010. Therefore, the following recommendations for future actions are reiterated for the 5-year review for 2017. • Surveys and inventories—Survey locations where *Remya kauaiensis* was previously seen but not recorded in the last ten years: Kauaula, Honopu, Kalalau, Mohihi, and upper Koaie. • Ungulate monitoring and control—Continue to construct small-scale fenced exclosures to exclude feral ungulates from wild populations to prevent imminent extinction. Protect all occurrences against browsing and disturbances from feral ungulates. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative species that compete with the species around all populations. • Fire monitoring and control—Develop and implement fire management plans for all wild and reintroduced populations. • Predator and herbivore monitoring and control—Implement effective control measures for rodents. • Captive propagation for genetic storage and reintroduction—Continue collecting seeds and cuttings from all populations for storage and propagation. • Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Population biology research—Study *Remya kauaiensis* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides (USFWS, 2017).

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SPECIES ACCOUNT: *Remya mauiensis* (Maui remya)

Species Taxonomic and Listing Information

Listing Status: Endangered; 01/14/1991; Pacific Region (R1) (USFWS, 2016)

Physical Description

A sprawling, many-branched shrub 1 - 2 m tall, forming loosely tangled clumps that sprawl on or among the branches of other vegetation. The flower heads are dark yellow (NatureServe, 2015).

Taxonomy

A member of the sunflower family (Asteraceae) (USFWS, 2016). The genus is endemic to Maui & Kauai, this species is restricted to west Maui (NatureServe, 2015).

Historical Range

It is known from west Maui (Wagner et al. 1999m, p. 353). Historically, this species also occurred in Maui's lowland wet ecosystem (TNC 2007; HBMP 2010) (USFWS, 2016).

Current Range

Current range includes West Maui (NatureServe, 2015). It occurs in Kauaula, Puehuhunui, Ukumehame, Papalaua, Pohakea, and Manawainui (USFWS 2012; 2014).

Critical Habitat Designated

Yes; 5/14/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Remya mauiensis* (Maui remya) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 18 detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Remya mauiensis* includes 18 CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Lowland Dry—Unit 5 consists of 3,615 ac (1,463 ha) of State land, and 43 ac (17 ha) of privately owned land, from Panaewa to Manawainui on the western and southern slopes of west Maui. This unit is occupied by the plants *Asplenium dielirectum*, *Bidens campylotheca* ssp. pentamera, *Cenchrus agrimonioides*, *Gouania hillebrandii*, *Kadua coriacea*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and *Tetramolopium capillare*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 5 is not known to be occupied by *Ctenitis squamigera*, *Cyanea obtusa*, *Hesperomannia arbuscula*, *Hibiscus brackenridgei*, *Lysimachia lydgatei*, *Neraudia sericea*, *Schiedea salicaria*, *Sesbania tomentosa*, or *T. remyi*, we have determined this area to be essential for the conservation and recovery of these lowland dry

species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 6 consists of 3 ac (1 ha) of State land, and 237 ac (96 ha) of privately owned land, from Paleaahu Gulch to Puu Hona on the southern slopes of west Maui. This unit is occupied by the plants *Hibiscus brackenridgei* and *Schiedea salicaria*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 6 is not known to be occupied by *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, *Cenchrus agrimonoides*, *Ctenitis squamigera*, *Cyanea obtusa*, *Gouania hillebrandii*, *Hesperomannia arbuscula*, *Kadua coriacea*, *Lysimachia lydgatei*, *Neraudia sericea*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Spermolepis hawaiiensis*, *Tetramolopium capillare*, or *T. remyi*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Mesic—Unit 2 consists of 1,034 ac (419 ha) of State land, and 113 ac (46 ha) of privately owned land, from Honokohau to Launiupoko on the western slopes of west Maui. This unit is occupied by the plants *Ctenitis squamigera*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, and *Zanthoxylum hawaiiense*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Mesic—Unit 2 is not known to be occupied by *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, or *Colubrina oppositifolia*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within its historical range. Due to its small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could approach recovery.

Maui—Lowland Mesic—Unit 3 (and) *Palmeria dolei*—Unit 1—Lowland Mesic (and) *Pseudonestor xanthophrys*—Unit 1—Lowland Mesic This area consists of 477 ac (193 ha) of State land at Ukumehame on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). Although Maui—Lowland Mesic—Unit 3 is not currently occupied by the plants *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Zanthoxylum hawaiiense*, or by the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs for the reestablishment of wild populations within the historical ranges of the

species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 2 (and) *Palmeria dolei*—Unit 3—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 3— Lowland Wet (and) *Newcombia cumingi*—Unit 1—Lowland Wet This area consists of 65 ac (26 ha) of State land at Moomoku, on the northwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. Although Maui—Lowland Wet—Unit 2 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), or by the Newcomb's tree snail (*Newcombia cumingi*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 3 (and) *Palmeria dolei*—Unit 4—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 4— Lowland Wet This area consists of 1,247 ac (505 ha) of State land at Honanana Gulch on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta*, *Cyanea asplenifolia*, and *Pteris lidgatei*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 3 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 4 (and) *Palmeria dolei*—Unit 5—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 5— Lowland Wet This area consists of 864 ac (350 ha) of State land at Kahakuloa Valley on the northeastern slopes of west Maui. These units include the mixed

herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta* and *Cyanea asplenifolia*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 4 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 5 (and) *Palmeria dolei*—Unit 6—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 6—Lowland Wet This area consists of 30 ac (12 ha) of State land at Iao Valley on the eastern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 5 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 6 (and) *Palmeria dolei*—Unit 7—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 7—Lowland Wet This area consists of 136 ac (55 ha) of State land at Honokowai and Wahikuli valleys on the western slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 6 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H.*

arbuscula, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 7 (and) *Palmeria dolei*—Unit 8—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 8—Lowland Wet This area consists of 898 ac (364 ha) of State land at Olowalu Valley, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Alectryon macrococcus*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 7 is not currently occupied by the plants *Asplenium dielerectionis*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 8 (and) *Palmeria dolei*—Unit 9—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 9—Lowland Wet This area consists of 230 ac (93 ha) of State land at upper Ukumehame Gulch, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 8 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectionis*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 2 (and) *Palmeria dolei*—Unit 19—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 19— Montane Mesic This area consists of 124 ac (50 ha) of State land at Helu and the upper reaches of Puehuhunui on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Lysimachia lydgatei*, *Remya mauiensis*, and *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 2 is not known to be occupied by the plants *Geranium hillebrandii*, *Huperzia mannii*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 3 (and) *Palmeria dolei*—Unit 20—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 20— Montane Mesic This area consists of 174 ac (70 ha) of State land at Lihau on the southwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plant *Geranium hillebrandii*, and contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 3 is not known to be occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Huperzia mannii*, *Lysimachia lydgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 4 (and) *Palmeria dolei*—Unit 21—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 21— Montane Mesic This area consists of 72 ac (29 ha) of State land at Halepohaku on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). Although Maui—Montane Mesic—Unit 4 is not known to be occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Geranium hillebrandii*, *Huperzia mannii*, *Lysimachia lydgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their

small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 5 (and) *Palmeria dolei*—Unit 22—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 22— Montane Mesic This area consists of 170 ac (69 ha) of State land at the upper reaches of Manawainui Gulch on the southeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants *Remya mauiensis* and *Santalum haleakalae* var. *lanaiense*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 5 is not known to be occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Geranium hillebrandii*, *Huperzia mannii*, *Lysimachia lydgatei*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 6 (and) *Palmeria dolei*—Unit 35—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 35— Wet Cliff This area consists of 1,858 ac (752 ha) of State land, and 253 ac (102 ha) of privately owned land, at the summit ridges of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plants *Alectryon macrococcus*, *B. conjuncta*, *Ctenitis squamigera*, *Cyrtandra munroi*, *Remya mauiensis*, and *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 6 is not known to be occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Bonamia menziesii*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyriformis*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, or *Tetramolopium capillare*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 7 (and) *Palmeria dolei*—Unit 36—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 36— Wet Cliff This area consists of 556 ac (225 ha) of State land along Honokowai ridge on the northwestern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units are occupied by the plants *Cyrtandra filipes* and *C. munroi*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the

expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 7 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 8 consists of 337 ac (137 ha) of State land along Kahakuloa ridge on the north side of west Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff—Unit 8 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Remya mauiensis* critical habitat consists of five components. Lowland dry (west Maui), Lowland mesic (west Maui), Lowland wet (west Maui), Montane mesic (west Maui) and Wet cliff (west Maui) (81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*. Subcanopy: *Chamaesyce*, *Dodonaea*, *Leptecophylla*, *Osteomeles*, *Psydrax*, *Scaevola*, *Wikstroemia*. Understory: *Alyxia*, *Artemisia*, *Bidens*, *Chenopodium*, *Nephrolepis*, *Peperomia*, *Sicyos*.

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freyinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*,

Metrosideros, Myrsine, Pisonia, Psychotria. Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: Acacia, Ilex, Metrosideros, Myrsine, Nestegis, Nothocestrum, Pisonia, Pittosporum, Psychotria, Sophora, Zanthoxylum. Subcanopy: Alyxia, Charpentiera, Coprosma, Dodonaea, Kadua, Labordia, Leptecophylla, Phyllostegia, Vaccinium. Understory: Ferns, Carex, Peperomia.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: Broussaisia, Cheirodendron, Leptecophylla, Metrosideros. Understory: Bryophytes, Ferns, Coprosma, Dubautia, Kadua, Peperomia.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire,

drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Lifespan

Adult: < 10 years (USFWS, 2010)

Reproduction Narrative

Adult: It is a short-lived perennial (fewer than 10 years) (USFWS, 2014).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Moist forests (NatureServe, 2015); mixed mesophytic forests (USFWS, 1997)

Geographic or Habitat Restraints or Barriers

Adult: 2,790 - 4,100 ft. elevation (USFWS, 1997)

Environmental Specificity

Adult: Moderate (inferred from USFWS 2016; 1997)

Habitat Narrative

Adult: Inhabits moist forests on gulch slopes (NatureServe, 2015). *Remya mautensis* grows chiefly on steep, north or northeast-facing slopes at 850-1,250 meters (2,790-4,100 feet) elevation and is found primarily in mixed mesophytic forests, or the remnants of such forests (Herbst 1988) (USFWS, 1997). It occurs in the lowland mesic, montane mesic, wet cliff, and lowland dry ecosystems (USFWS, 2016).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Presumed extinct until rediscovery in 1971 (USFWS, 1997)

Species Trends:

Increasing (USFWS, 2014)

Resiliency:

Very low (inferred from NatureServe, 2015; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2014)

Number of Populations:

6 (USFWS, 2014)

Population Size:

500 (USFWS, 2014)

Population Narrative:

Overall, *Remya mauiensis* has increased from 156 individuals reported in the last 5-year review to approximately 500 individuals in 6 locations (USFWS 2012; 2014). The species was thought to be extinct until its rediscovery on the slopes of Manawainui Gulch, West Maui, in 1971 by L.E. Bishop, W. Gagnand, and S. Montgomery (USFWS, 1997). New Status Information: • There are three populations at one location, Kaua'ula, west Maui, totaling approximately 400 individuals (PEPP 2017; Oppenheimer 2018, in litt.) and one population at Pāpalaua-Manawainui Gulches (undetermined number of individuals) (PEPP 2017). There is no new information regarding the status of populations at Lihau, Pōhākea, and Ukumehame. • In 2016, 18 critical habitat units in five ecosystems (lowland dry, lowland mesic, lowland wet, montane mesic, and wet cliff) were designated on west Maui for *Remya mauiensis* (12,536 ac; 5,074 ha) (81 FR 17790, March 30, 2016) (USFWS, 2018).

Threats and Stressors

Stressor: Ungulates (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: It is clear that habitat well-suited for *Remya mautensis* and likely within its former range has been destroyed or degraded by cattle, goats, and pigs, and that the remaining extant individuals are found growing only in areas relatively inaccessible to these animals. Browsing and grazing by feral and domesticated livestock have impacted *Remya mautensis* and its habitat through outright destruction of the plants and secondarily through erosion that results from the loss of vegetation, trampling and rooting by these animals (Herbst 1988) (USFWS, 1997).

Stressor: Invasive plants (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Browsing and associated habitat disturbance caused by feral ungulates have favored the invasion and spread of numerous aggressive, alien plant species that may compete for space, light, water, or nutrients. Such alien species have replaced *Remya mautensis* throughout its presumed former habitat (Herbst 1988). Competition from alien plants may also be the reason for the low number of *Remya mautensis* in areas such as Manawainui Plant Sanctuary, where populations have been protected from ungulates (R. Hobdy, personal communication 1995) (USFWS, 1997).

Stressor: Invertebrate herbivory (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Not available

Stressor: Fire (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: *Remya mautensis* occurs in a fire-prone area (dry much of the year), and is jeopardized with extinction by brush fires set accidentally or intentionally (Herbst 1988) (USFWS, 1997).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: We previously reported that climate change may pose a threat to this species, anticipating an analysis by 2013. The assessment conducted by Fortini et al. (2013) concluded that *Remya mauensis* is extremely vulnerable to the impacts of climate change, with a vulnerability score of 0.889 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this species has no overlap between current and future climate envelopes, and is unlikely to tolerate expected changes in climate at its current location. This means that this species must persist within suitable microrefugia, or move to newly available climate-compatible areas to avoid extinction. Therefore, additional management actions, including the possibility of assisted translocations, are needed to conserve this taxon into the future (USFWS, 2018)

Recovery**Reclassification Criteria:**

1. A total of five to seven populations should be documented on Maui and at least one other island where they now occur or occurred historically (USFWS, 1997).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1997).
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 1997).

Delisting Criteria:

1. A total of 8 to 10 populations should be documented on Maui and at least one other island where they now occur or occurred historically (USFWS, 1997).
2. Each population must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1997).
3. Each population should persist at this level for a minimum of five consecutive years (USFWS, 1997).

Recovery Actions:

- Protect current populations, manage threats and monitor (USFWS, 1997).
- Conduct research essential to conservation of the species (USFWS, 1997).
- Expand current populations (USFWS, 1997).

- Establish new populations as needed to reach recovery objectives (USFWS, 1997).
- Validate and revise recovery objectives (USFWS, 1997).
- Evaluate the status of *Remya mauiensis* in the Manawainui Plant Sanctuary enclosure; if warranted, initiate alien plant control (USFWS, 1997).
- Using seeds from existing populations, establish and maintain outplanted populations within the Manawainui Plant Sanctuary enclosure (USFWS, 1997).

Conservation Measures and Best Management Practices:

- Captive propagation for genetic storage and reintroduction: Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change (USFWS, 2014).
- Reintroduction / translocation – Augment current natural populations to increase numbers of individuals (USFWS, 2014).
- Ungulate monitoring and control – Fence remaining populations to protect them from the impacts of feral ungulates (USFWS, 2014).
- Invasive plant monitoring and control – Control invasive introduced plant species within the vicinity of all known populations of *R. mauiensis* (USFWS, 2014).
- Population viability monitoring and analysis – Continue monitoring activities for all known populations of *R. mauiensis* (USFWS, 2014).
- Climate change adaptation strategy – Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change (USFWS, 2014).
- Alliance and partnership development – Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2014).
- New Management Actions: • Surveys and inventories—In 2016, the Plant Extinction Prevention Program (PEPP) noted that additional surveys of known populations on west Maui were needed to determine if elevation to PEPP status (fewer than 50 wild individuals) of this species was necessary (PEPP 2016). • Captive propagation for genetic storage and reintroduction—In 2017, Lyon Arboretum Micropropagation Laboratory reported three containers of propagules of *Remya mauiensis* from collections made in 2012 in storage. The Lyon Seed Conservation Laboratory reports over 99,000 seeds in storage from collections representing multiple individuals from populations at Kaua'ula and Pōhākea (Lyon Arboretum 2017).
- Recommendations for Future Actions: We are not aware of any new threats or significant new information regarding the species' biological status since the last 5-year review in 2014. Thus, the following recommendations for future actions are reiterated for 5-year review for 2018. • Surveys and inventories—Continue to survey for additional populations of *Remya mauiensis* in areas of potentially suitable habitat on west Maui. Reassess the status of populations at Lihau, Pōhākea, and Ukumehame. • Ungulate monitoring and control—Construct enclosure fences to protect currently unfenced populations from the negative impacts of feral pigs, goats, cattle, and axis deer. • Invasive plant monitoring and control—Control established ecosystemaltering nonnative invasive plant species around all populations of *R. mauiensis*. • Captive propagation for genetic storage and reintroduction— o Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. o Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change. • Reintroduction and translocation— Augment known populations and reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Climate change adaptation strategy—

Research the suitability of habitat for reintroducing this species in the future due to impacts of climate change. • Alliance and partnership development—Work with the West Maui Mountains Watershed Partnership to continue ecosystem-level restoration and management to benefit this species (USFWS, 2018).

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SPECIES ACCOUNT: *Remya montgomeryi* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 01/14/1991; Pacific Region (R1) (USFWS, 2016)

Physical Description

A weakly erect shrub up to 1 m tall. Stems are leafy toward the apex. The flower heads are borne in open panicles (NatureServe, 2015).

Taxonomy

A member the aster family (Asteraceae) (USFWS, 2003). Belongs to a genus of 3 species endemic to the Hawaiian Islands, this species is endemic to Kauai (NatureServe, 2015).

Historical Range

Endemic to Kauai, from Kalalau and Koaie Canyon (NatureServe, 2015).

Current Range

It currently occurs in the left and right branches of Kalalau Valley, Koaie Canyon, and Kuia Valley within the Alakai Wilderness Preserve and Na Pali Coast State Park (GDSI 2000; HINHP Database 2000; Herbst 1988; K. Wood, in litt. 1999) (USFWS, 2003).

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designate critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Remya montgomeryi* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Remya montgomeryi* includes three units totaling 3,743 acres in Kauai County, Hawaii. The units are Kauai 11—*Remya montgomeryi*—a, b, c.

Kauai 11—*Remya montgomeryi*—a: This unit is critical habitat for *Remya montgomeryi* and is 69 ha (171 ac) on State land (Kuia NAR) within portions of the Kuia and Mahanaloa Valleys. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Remya montgomeryi* and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is important to the establishment of additional populations on Kauai in order to reach recovery goals. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep, north- or northeast-facing slopes or cliffs in transitional wet or *Metrosideros polymorpha*-dominated mixed mesic forest. This unit is geographically separated from the other two units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Although the Service does not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is at an appropriate distance from the other unit to avoid their destruction by one naturally occurring catastrophic event. Kauai 11—*Remya montgomeryi*—b: This unit is

critical habitat for *Remya montgomeryi* and is 1,010 ha (2,496 ac) on State land (Alakai Wilderness Preserve and Halelea Forest Reserve), containing portions of the Alakai Swamp. This unit provides habitat for four populations of 300 mature, reproducing individuals of the shortlived perennial *Remya montgomeryi* and is currently occupied with nine plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep, north- or northeast-facing slopes or cliffs in transitional wet or *Metrosideros polymorpha*-dominated mixed mesic forest. This unit is geographically separated from the other two units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Although the Service does not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is at an appropriate distance from the other unit to avoid their destruction by one naturally occurring catastrophic event.

Kauai 11—*Remya montgomeryi*—c: This unit is critical habitat for *Remya montgomeryi* and is 436 ha (1,077 ac) on State land (Kokee and Na Pali Coast State Parks). This unit contains Kahuamaa Flat, and Kalahu, Pihea, and Puu o Kila Summits, and Kalalau Lookout. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial *Remya montgomeryi* and is currently occupied with 134 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep, north- or northeast-facing slopes or cliffs in transitional wet or *Metrosideros polymorpha*-dominated mixed mesic forest. This unit is geographically separated from the other two units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Although the Service does not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is at an appropriate distance from the other unit to avoid their destruction by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Steep, north or northeast-facing slopes or cliffs in transitional wet or *Metrosideros polymorpha*-dominated mixed mesic forest and containing one or more of the following associated native plant species: *Artemisia australis*, *Bobea* spp., *Boehmeria grandis*, *Cheirodendron* spp., *Claoxylon sandwicense*, *Cyrtandra* spp., *Dubautia* spp., *Ilex anomala*, *Lepidium serra*, *Lysimachia* spp., *Myrsine linearifolia*, *Nototrichium* spp., *Pleomele aurea*, *Poa mannii*, *Sadleria* spp., *Scaevola* spp., *Stenogyne campanulata*, *Tetraplasandra* spp., or *Zanthoxylum dipetalum*; and

(ii) Elevations between 336 and 1,345 m (1,102 and 4,411 ft).

Special Management Considerations or Protections

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to

pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species in paragraph (b) of this section and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (inferred from USFWS, 2003)

Lifespan

Adult: < 10 years (USFWS, 2010)

Breeding Season

Adult: April - August (USFWS, 2003)

Reproduction Narrative

Adult: It is a short-lived perennial (fewer than 10 years) (USFWS, 2010). Flowers have been observed in April through August and are probably insect-pollinated. *Remya montgomeryi* may be self-incompatible (Herbst 1988; 56 FR 1450) (USFWS, 2003).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Transitional wet or *Metrosideros polymorpha*-dominated mixed mesic forest (USFWS, 2003)

Geographic or Habitat Restraints or Barriers

Adult: 1,102 - 4,411 ft. elevation (USFWS, 2003)

Habitat Narrative

Adult: Inhabits moist shrublands on cliffs (NatureServe, 2015). *Remya montgomeryi* grows at elevations between 336 and 1,344 m (1,102 and 4,411 ft.), primarily on steep, north or northeast-facing slopes or cliffs in transitional wet or *Metrosideros polymorpha*-dominated mixed mesic forest (USFWS, 2003).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Seeds are probably wind or water-dispersed (USFWS, 2003).

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Declining (USFWS, 2010)

Resiliency:

Very low (inferred from USFWS, 2010)

Redundancy:

Low (inferred from USFWS, 2010)

Number of Populations:

6 (USFWS, 2010)

Population Size:

<15 (USFWS, 2017)

Population Narrative:

New Status Information: In addition to those populations cited in the previous 5-year review, new observations include the following: • At the time of the last 5-year review in 2010 there were six populations totaling 18 individuals on Kauai. Recent surveys have been unable to locate any individuals at Koaie (PEPP 2012). The current population at Kalalau was reported to have fewer than ten individuals in 2016, and only five individuals in 2017 (Clark 2016, PEPP 2017) (USFWS, 2017).

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The primary threats to *Remya montgomeryi* are habitat degradation by feral goats (*Capra hircus*), pigs (*Sus scrofa*), and mule deer (*Odocoileus hemionus*). Fire is also a threat (USFWS, 2010).

Stressor: Invasive plants (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: competition from invasive introduced plant species including *Bryophyllum pinnatum* (airplant), *Christella dentata* (downy wood fern), *Cyperus meyenianus* (NCN), *Erigeron karvinskianus* (daisy fleabane), *Holcus lanatus* (common velvet grass), *Lantana camara* (lantana), *Lonicera japonica* (honeysuckle), *Lythrum maritimum* (loosestrife), *Paspalum urvillei* (vasey grass), *Passiflora tarminiana* (banana poka), *Rubus argutus* (blackberry), *R. rosifolius* (thimbleberry), and *Setaria parviflora* (yellow foxtail) (USFWS 2003; Wood 2009). No regeneration has been observed (Wood 2009) (USFWS, 2010).

Stressor: Predation (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Seed predation by rats (*Rattus* spp.). The area above the Kalalau Valley cliffs was observed to be severely degraded by goats and pigs as early as 1992 (Wood 2009). No regeneration was observed near these plants, most likely due to habitat disturbance and herbivory by feral ungulates, and competition with invasive introduced plant species (Wood 2009) (USFWS, 2010).

Stressor: Small population size (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: This species is at increased risk of extinction from naturally occurring events (e.g., landslides or hurricanes) because of the small size of the populations and their limited distribution (USFWS 2003; Wood 2009). Species like *Remya montgomeryi* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding, and disease outbreaks (USFWS, 2010).

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to *Remya montgomeryi*. However, current climate change models do not allow specific predictions as to what those effects, and their extent, would be for this species (USFWS, 2010).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:**Consequence:**

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Remya montgomeryi* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.725 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery**Reclassification Criteria:**

1. A total of five to seven populations should be documented on Kauai and at least one other island where they now occur or occurred historically (USFWS, 1995).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population for short-lived perennials (USFWS, 1995).
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 1995).

Delisting Criteria:

1. A total of eight to ten populations should be documented on Kauai and at least one other island where they now occur or occurred historically (USFWS, 1995).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population for short-lived perennials (USFWS, 1995).
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 1995).

Recovery Actions:

- Protect current populations, control threats and monitor (USFWS, 1995).
- Expand current populations (USFWS, 1995).
- Conduct research essential to conservation of the species (USFWS, 1995).
- Establish new populations as needed to reach recovery objectives (USFWS, 1995).
- Validate and revise recovery objectives (USFWS, 1995).
- Devise and implement a public education program (USFWS, 1995).
- In order to prevent this taxon from going extinct, propagation efforts and the maintenance of adequate genetic stock ex situ should be undertaken immediately, as well as the protection of remaining wild individuals from feral ungulates and alien weed threats (USFWS, 1995).

Conservation Measures and Best Management Practices:

- Continue to collect cuttings or seeds from all known populations (USFWS, 2010).
- Propagate for reintroduced into protected habitat (USFWS, 2010).
- Fence existing plants to exclude feral ungulates (USFWS, 2010).
- Control introduced invasive plants around existing plants (USFWS, 2010).
- Work with Hawaii Division of Forestry and Wildlife to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2010).
- New Management Actions: • NTBG collected seeds and cuttings of the last known individuals at Kalalau in 2015 (NTBG 2017). • Lyon Arboretum seed bank stores seeds from four founders from Kalalau (Lyon Arboretum 2017). • PEPP is monitoring of the Kalalau occurrence (PEPP 2010, 2011, 2012, 2014, 2015). • PEPP surveyed for individuals at the last known occurrence in Koaie, but none were relocated (PEPP 2013). • PEPP has outplanted 14 individuals in a fenced exclosure at Kalalau and is monitoring the area (PEPP 2013, 2014).
- Recommendations for Future Actions: No new threats and no other significant new information regarding the species' biological status have been reported since the last 5-year review in 2010. Therefore, the following recommendations for future actions are reiterated for the 5-year review for 2017. • Surveys and inventories—Survey for populations of *Remya montgomeryi* in areas of potentially suitable habitat. • Ungulate monitoring and control—Continue to construct small-scale fenced exclosures to exclude feral ungulates from wild populations to prevent imminent extinction. Protect all occurrences against browsing and disturbances from feral ungulates. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative species that compete with the species around all populations. • Fire monitoring and control—Develop and implement fire management plans for all wild and reintroduced populations. • Predator and herbivore monitoring and control—Implement effective control measures for rodents. • Captive propagation for genetic storage and reintroduction—Continue collecting seeds and cuttings from all populations for storage and propagation. • Captive propagation protocol development—Study the use of hand-pollination techniques to produce viable seeds and augment genetic diversity among populations. • Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Population biology research—Study *Remya montgomeryi* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides.

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SPECIES ACCOUNT: *Rhodiola integrifolia* ssp. *leedyi* (Leedy's roseroot)

Species Taxonomic and Listing Information

Listing Status: Threatened; 04/22/1992; Great Lakes-Big Rivers Region (R3) (USFWS, 1992)

Physical Description

Leedy's Roseroot is a perennial herb with multiple leafy stems from a scaly root crown that is usually visible in the rock crevices where the plants are growing. Leaves are glaucous, oblong, blue-green, and thick-succulent, with irregularly toothed to entire margins. The dark red and yellow flowers (May-August) are arranged in rounded clusters at the ends of the stems. (NatureServe, 2015)

Taxonomy

Listed as a subspecies of *Sedum integrifolium*, a revised scientific name of *Rhodiola integrifolia* ssp. *leedyi*, as treated by Kartesz (1999) was accepted by the USFWS in 2010 (USFWS, 2010).

Historical Range

Apparently the Leedy's roseroot is not known to have occurred in historical times in other locations than present. (USFWS, 2015)

Current Range

Leedy's roseroot is found today in only six locations in two widely separated states. Four populations of several thousand plants each are found in Fillmore and Olmsted Counties, Minnesota. The other two are in upstate New York, a large population on the shores of Seneca Lake and a single plant at Watkins Glen. (USFWS, 2015). Also occurs at Harney Peak, Black Hills National Forest, South Dakota (Olfelt and Freyman 2014, p. 908). (USFWS, 2015b).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Usually sexual reproduction; some vegetative (USFWS, 1998)

Dependency on Other Individuals or Species

Adult: Bees and syrphus flies as pollinators (USFWS, 1998)

Breeding Season

Adult: Flowers in June (USFWS, 1998)

Other Reproductive Information

Adult: Olfelt (1998, p. 16) found a seed germination rate for Leedy's roseroot of 77% and described this as high for a rare plant, but lower than that of related subspecies. (USFWS, 2015b).

Reproduction Narrative

Adult: Flowering occurs in early June. Clausen (1975) reports bees and syrphus flies as pollinators; Sather (1993a) observed bees on New York plants. Seeds are winged and adapted for wind dispersal. Seeds produced by plants at Glenora Cliff, New York, sometimes germinate in their follicles and produce seedlings on the parent plant (Clausen 1975). Plants grown in a Minnesota greenhouse from seed flowered their first season after germination (Joel P. Olfelt, University of Minnesota, pers. comm. 1996). Although, newer growth on the long-lived rootstocks breaks off to form clones, which have lived at least 36 years in cultivation (Clausen 1975), Olfelt and Luby (in press) report finding little clonal reproduction. Of 81 stems they assayed, 75 had unique markers, indicating those 75 stems had not been produced by cloning. (USFWS, 1998)

Habitat Type

Adult: Cliff ledges and talus slopes (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Ground water or cool air (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (inferred from USFWS, 1998)

Environmental Specificity

Adult: Very narrow specialist (USFWS, 1998)

Habitat Narrative

Adult: The habitat is limited to north or east-facing talus slopes or cliff ledges where ground water (primarily in New York) or cool air (primarily in Minnesota) constantly seep through the strata or between the rocks, maintaining a cool, wet environment throughout the summer. (NatureServe, 2015; USFWS, 1998)

Dispersal/Migration**Motility/Mobility**

Adult: Low (inferred from USFWS, 1998)

Dispersal

Adult: Wind dispersal of seeds (USFWS, 1998)

Dispersal/Migration Narrative

Adult: Plants are specific to a particular habitat which limits dispersal. The preferred cold air cliff faces with seepages are rare. (USFWS, 1998)

Population Information and Trends**Population Trends:**

Unable to assess (NatureServe, 2015)

Resiliency:

Moderate (inferred from NatureServe, 2015)

Representation:

Low (NatureServe, 2015)

Redundancy:

Low (NatureServe, 2015)

Number of Populations:

6 (USFWS, 2015)

Population Size:

2500 - 10,000 individuals (NatureServe, 2015)

Adaptability:

Low (inferred from NatureServe, 2015)

Population Narrative:

Populations may be increasing or decreasing (NatureServe, 2015). USFWS (2015) indicates that the four Minnesota populations have several thousand plants each, but NatureServe (2015) indicates only 1500-2000 plants in all Minnesota populations. The New York population at Seneca Falls consists of "a large population" (USFWS, 2015) or "several thousand plants" (NatureServe, 2015). There is one plant at Watkins Glen, NY; it is likely introduced. (USFWS, 2015; NatureServe, 2015). The South Dakota population of Leedy's roseroot occurs on Black Hills National Forest on a cliff at approximately 7,000 feet above sea level. White spruce (*Picea glauca*) is the dominant overstory species on the north-northeast facing slope directly below the cliff; and ponderosa pine (*Pinus ponderosa*) is the dominant tree species in the general vicinity (U.S. Forest Service, in litt.). About seven patches of Leedy's roseroot may inhabit only a total of 10-50 square meters of the cliff face (Fig. 4; U.S. Forest Service, in litt. 2001; 2011). (USFWS, 2015b).

Threats and Stressors

Stressor: Ground water contamination (USFWS, 1992)

Exposure:

Response:

Consequence:

Narrative: Contamination of ground water is likely through filling or dumping in sink holes adjacent to the cliffs. Sink holes are highly vulnerable because they provide direct access to the ground water and are the main source of seepage on the cliffs. (USFWS, 1992)

Stressor: Agricultural pesticides (USFWS, 1992)

Exposure:

Response:

Consequence:

Narrative: The use of agricultural pesticides in adjacent upland farmland (cropland in Minnesota and vineyards in New York) may directly affect the quality of the ground water. (USFWS, 1992)

Stressor: Residential development (USFWS, 1992)

Exposure:

Response:

Consequence:

Narrative: In New York, homes are being built above the cliffs. Many homeowners have built stairs down the cliffs to Seneca Lake and some have cleared vegetation from the cliff or cut trees at the top of the cliff to enhance the view. Some trees have been simply dumped over the cliffs. (USFWS, 1992)

Stressor: Road building and quarrying (USFWS, 1992)

Exposure:

Response:

Consequence:

Narrative: Road building and quarrying in the karst region of Minnesota would affect the subsurface water flow in an area and change the required groundwater seepage at a cliff face. (USFWS, 1992)

Stressor: Erosion and rock slides (USFWS, 1992)

Exposure:

Response:

Consequence:

Narrative: The slopes where the roseroot occurs are unstable. Natural erosion of the cliffs occurs and may denude the vegetation. Heavy runoff may directly dislodge plants from cliffs or may result in gullies being cut into a population site. Logging above some of the Minnesota sites may also cause erosion affecting the cliffs. (USFWS, 1992)

Stressor: Grazing (USFWS, 1992)

Exposure:

Response:

Consequence:

Narrative: Grazing may damage plants on the lower, gentler slopes of the cliffs where dislodged plants have again taken root.

Stressor: Climate change and catastrophic wildfire (USFWS, 2015b).

Exposure:

Response:

Consequence:

Narrative: Leedy's roseroot already inhabits the highest elevation habitat available in the ecoregion and would not be able to move to higher – and presumably cooler and moister – habitats if climate change rendered its current habitat unsuitable. In addition, as ponderosa pines succumb to mountain pine beetle, drop needles, and fall the risk of a wildfire in forest around the Leedy's roseroot population is likely to increase (C. Monks, pers. comm. 2014). (USFWS, 2015b).

Recovery

Delisting Criteria:

All three privately owned Minnesota populations must be protected by conservation easements or fee acquisition by a public agency or private conservation organization. (USFWS, 1998)

The Whitewater Wildlife Management Area, Minnesota, population must be protected from or removed from any confirmed contamination threat. (USFWS, 1998)

The Glenora Falls, New York, population must be protected. (USFWS, 1998)

Habitat for 4,000 plants in multiple sites, evenly distributed along a 2-mile stretch of Glenora Cliff, New York, must be protected. The two most-distant subpopulations protected at Glenora Cliff must be at least 1.5 miles apart. (USFWS, 1998)

Protected populations must be geographically distinct, self-sustaining, and have been protected for five consecutive years by measures that will remain effective following delisting. (USFWS, 1998)

Recovery Actions:

- Map all populations, and identify all affected landowners. (USFWS, 1998)
- Determine hydrologic relationships between upland areas and *S. integrifolium* ssp. *leedyi* populations. (USFWS, 1998)
- Establish and administer a permanent infrastructure for Leedy's roseroot site protection and secure funding for that protection. (USFWS, 1998)
- Contact landowners, landowner associations, and land trusts; secure their involvement in conservation strategies; compensate them for costs of fee acquisition, enrollment in conservation easements or other programs; prepare management plans for public and private protected areas. (USFWS, 1998)
- Establish, implement, and review a monitoring program. (USFWS, 1998)
- Provide public education, including advance landowner contact. (USFWS, 1998)
- Develop and maintain a genetic bank. (USFWS, 1998)
- 2015 recommended actions - 1. Review threats to the species, beginning with the information in this review, to ensure that recovery criteria are revised appropriately to address all significant threats to the species. Prepare a list of threats based on this assessment and have it reviewed by species' experts to ensure that it is complete and accurate. Finally, revise the recovery criteria, as appropriate. (USFWS, 2015b).
- 2015 - 1.1: Determine whether and to what degree any Leedy's roseroot populations are threatened by the instability of their cliff side habitats and whether heavy rains are likely to pose a threat any population. Use this information to determine whether the recovery criteria should be revised to address specific related threats and revise the criteria, if appropriate. (USFWS, 2015b).
- 2015 - 1.2: Determine whether and to what degree any Leedy's roseroot populations are threatened by gully formation or by poor soil conservation practices. Revise the recovery criteria to address this factor if it poses a threat. This potential threat may currently be most relevant to the population at Whitewater Wildlife Management Area in Minnesota. (USFWS, 2015b).
- 2015 - 1.3: Determine whether grazing or logging poses a direct or indirect threat to any Leedy's roseroot population. If they do, revise the recovery criteria to ensure that no site is considered to be protected unless the threats are adequately minimized. (USFWS, 2015b).

- 2015 - 1.4. Consider revising the recovery criteria to clarify that the protections required for each Leedy's roseroot population must preclude the following: 1.4.1. Filling or dumping material into any sink holes where that activity could result in exposure of Leedy's roseroot to harmful contaminants or alteration of groundwater flows to cliffs where Leedy's roseroot occurs; 1.4.2. The use of any pesticides or herbicides where it would result in the exposure of Leedy's roseroot to harmful compounds; and, 1.4.3. Road building or quarrying that would affect groundwater flows in any Leedy's roseroot cliff side habitats. (USFWS, 2015b).
- 2015 - 1.5: Consider revising the recovery criteria to require that protection of Leedy's roseroot habitat at the Glenora Cliff site in New York would preclude the construction of stairs, vegetation clearing (except for invasive species), laying of pipes, and dropping felled trees where these activities would likely cause adverse effects to Leedy's roseroot. (USFWS, 2015b).
- 2015 - 1.6. Consider revising the recovery criteria to further clarify that the populations around Seneca Lake must be protected from residential development, cliff-face alteration, and hydraulic fracturing (fracking) that could affect ground water quality and flow. (USFWS, 2015b).
- 2015 - 1.7. Review the preliminary hydrogeological assessment prepared for Leedy's roseroot in Minnesota (Spetzman and Cremers 1999) and develop a plan to assess the risk of groundwater contamination for each of the four Minnesota populations and measures that would protect the taxon from this threat. Consider engaging the appropriate regional hydrologist with the Minnesota Department of Natural Resources, Division of Ecological and Water Resources to help develop this plan. Ensure that the plan is sufficient to determine the following: 1.7.1. The extent to which transport of agricultural chemicals into sinkholes poses a risk of exposing Leedy's roseroot to contaminated groundwater. 1.7.2. The locations of sinkholes – or the areas in which they may occur – that should be protected to ensure that each Leedy's roseroot population is safe from effects to groundwater flows or groundwater contamination. 1.7.3. The area in which road building or quarrying may expose Leedy's roseroot to the effects of any changes in groundwater discharge. 1.7.4. The specific practices that would need to be implemented to mitigate any specific threats of exposing Leedy's roseroot to changes in groundwater discharge or to contaminated groundwater and to alleviate any ongoing exposure. It may also be prudent to carry out similar actions in New York. (USFWS, 2015b).
- 2015 - 2. Revise the recovery plan to address the Leedy's roseroot population that is now confirmed in South Dakota. (USFWS, 2015b).
- 2015 - 3. It may still be unclear whether the taxon may be conserved by relying only on the protection of the seven known extant populations. The seven populations include four in Minnesota; two in New York; and, one in South Dakota. Consider developing a range wide viability assessment that assesses the species' recovery criteria and determines whether extant populations would ensure sufficient redundancy and representation for the subspecies; and to develop criteria that may be used to determine whether or not the populations that are essential to recovery are sufficiently resilient. (USFWS, 2015b).
- 2015 - 4. Define "self-sustaining" per the recovery criteria or eliminate it from revised criteria. (USFWS, 2015b).
- 2015 - 5. Ensure that an adequate seed banking program is established for Leedy's roseroot. (USFWS, 2015b).

Conservation Measures and Best Management Practices:

- Enrollment in permanent conservation easements, private land trusts, or landowner associations with effective land management plans to minimize impacts on *S. integrifolium* ssp. *leedyi* populations. (USFWS, 1998)
- Acquisition of fees to provide tax relief or other compensation to landowners. (USFWS, 1998)

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SPECIES ACCOUNT: *Rhododendron chapmanii* (Chapman rhododendron)

Species Taxonomic and Listing Information

Listing Status: Endangered; 5/23/1979; Southeast Region (R4)

Physical Description

Chapman's rhododendron is a small (0.5 - 2m in height), evergreen shrub with stiffly ascending branches. Leaves are alternate, 3 to 6cm long, obovate with tapered bases, obtuse or rounded apices, somewhat wrinkled, and with entire but curled undermargins. Shade leaves are less wrinkled and curled. Petioles are from 2 to 6mm long. New stems, petioles and under surface of leaves are usually scurfy, dotted reddish brown. Flowers, borne in terminal clusters, have light pink, funnel-shaped corollas about 3cm long with 5 fused petals. Fruit capsules, about 1cm long, are borne in clusters which persist several years and are present on almost all plants. It blooms prolifically with large clusters in late March to early April. (USFWS, 1983)

Taxonomy

Asa Gray (1877) described *R. chapmanii* and credited Chapman (1860) with recognizing the taxon as a variety growing in the sandy pine barrens of west Florida (Duncan and Pullen, 1962). Recent authors treat as *R. minus* var. *chapmanii* (Godfrey, 1988; Duncan & Pullen, 1962; Luteyn et al., 1996). Kartesz (1994) treats as full species. *R. minus* var. *minus* occurs in Georgia and southern Appalachians (Duncan & Pullen, 1962) (NatureServe, 2015).

Historical Range

Endemic to Florida, in Gulf, Liberty, Gadsden, and Clay counties. (USFWS, 2019a)

Current Range

Endemic to Florida and restricted to Gulf, Liberty/Gadsden and Clay counties. (USFWS, 2019a)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Blooms in mid-March to early April (USFWS, 2019a)

Reproduction Narrative

Adult: Although *R. chapmanii* flowers and fruits abundantly, no seedlings were observed in the 1996 monitoring event (author, pers. obs.), and only one was found in the 1985 monitoring event (Hardin, et al., 1985). Plants are grown from seed for the nursery trade (Hardin, et al., 1985), so presumably they are reasonably easy to germinate and grow in captivity.; Ann Redmond made notes and diagrams of five plants that she excavated to a depth of ca 20 cm near the permanent monitoring plots in Gulf and Liberty/Gadsden counties (Redmond, 1985).

She observed that clumps of stems, which would have been considered several "plants" for monitoring purposes from an above-ground point of view, often were found to arise from the same underground rootstock when excavated. Thus there were actually fewer genetic individuals present than there were stem clumps tagged. She also noted evidence of areas in the rootstock where former stems had died and rotted away and evidence of grafting between stems from different sources. From her rough diagrams it appears that the underground biomass of rootstock plus roots would exceed the biomass of the aboveground stems. All of the excavations showed rhizomes heading out from the central rootstock to beyond the area of the excavation which generally covered an area of less than 1 square meter. PHENOLOGY: *Rhododendron chapmanii* has a fairly narrow two to three week flowering period which may begin from mid- March to early April (Duncan and Pullen, 1962; Hardin et al., 1985; Schultz and Johnson, 1996). A hard freeze in January and March 1985 may have delayed and reduced flowering in that year by killing the buds (Hardin, et al., 1985) (NatureServe, 2015).

Habitat Type

Adult: Between upland mesic or scrubby flatwoods and floodplain swamps or baygalls; mesic pine flatwoods (USFWS, 2019a)

Habitat Vegetation or Surface Water Classification

Adult: Terrestrial

Dependencies on Specific Environmental Elements

Adult: Acidic sandy soil (USFWS, 2019a)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 2019a)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: *Rhododendron m. chapmanii* usually occurs in a transitional area between upland mesic or scrubby flatwoods and floodplain swamps or baygalls. This species is also found within mesic pine flatwoods or on the lower elevations of the sandhills. Consequently, it appears to require acidic sandy soil, good to moderately well-drained to somewhat poorly drained sandy soils of 0-5% slope, and no flooding. The Camp Blanding population grows on the edge of xeric hammock next to a stream bank. The plants tolerate full sun to moderate shade (Negrón-Ortiz, 2010, pers. observ.), and heavy shade once they are mature as at Camp Blanding (Hall 2005). (USFWS, 2019a)

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Declining (USFWS, 2019)

Number of Populations:

3 (USFWS, 2019a)

Population Size:

approximately 3,000 clumps (USFWS, 2019a)

Population Narrative:

Rhododendron m. chapmanii is restricted to the Florida panhandle with only three known populations occurring in coastal Gulf County, Liberty and Gadsden counties in the vicinity of Hosford, and Clay County on the Camp Blanding Military Reservation. The population near Hosford is the largest and is privately owned by AgReserve Inc., which may maintain timber production and agricultural uses of the lands. The smallest and most geographically isolated of these populations is within the Florida National Guard post at Camp Blanding, about 165 miles east of the Hosford population. Throughout Florida, surveys and censuses collectively recorded about 55 occurrences or sites. Although we have limited information regarding trends, current data assessment suggest the presence of only 35 sites (about 36 % decline). In May 2019 FNAI performed a comprehensive review of all *R.m. chapmanii* element occurrences (EO2). The 55 areas where the species was observed are currently mapped as 23 EOs. This is based on NatureServe 2004 guidance (EO separation distance of 1 km) with the addition of separation based on differences in management practices, threats, and habitat conditions. If considering only the parameter of 1 km separation distance, the 23 EOs technically represent 15 EOs (J. Annis, FNAI, 07/02/2019, pers. comm.). (USFWS, 2019a)

Threats and Stressors

Stressor: Urbanization (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: In addition to being one of the largest private landowners in northwest Florida, the St Joe Company is also one of the largest real estate operating companies in the Southeast. This Company develops both residential and commercial properties along roadways and near or within business districts in the region. Urbanized land in Florida, statewide, is projected to double by 2070 along with a growth of about 33.7 million residents—almost 15 million more people than in 2010 (University of Florida GeoPlan Center 2017). Since the species occurs on Company-owned property in Gulf, Liberty, and Gadsden counties, Florida, there is no guarantee that these properties will not be utilized for residential or commercial development in the near future. Therefore, residential or commercial development is a threat. (USFWS, 2019)

Stressor: Forestry practices (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: The timber industry in North Florida became well established in the 1850s. Privately owned companies grow trees for their byproducts by mechanically preparing the site for planting, planting seedlings, and mechanically harvesting the trees. Harvesting typically involves thinning, and later clear cutting the site; the process is then repeated. The St. Joe Company had close to a million acres in timber in the eastern region of the panhandle and they plan to continue to harvest and replant indefinitely. Tree farming, i.e., privately owned forest managed

(clearcutting, mechanical site preparation, and pine plantations) for timber production, is a primary threat since there are many thousands of acres of tree farms. In 2013, the St Joe Company sold more than 380,000 acres of its land to AgReserves, Inc., a for-profit company that has primarily focused on cattle grazing. The land sold included timberlands in Bay, Calhoun, Franklin, Gadsden, Gulf, Jefferson, Leon, Liberty and Wakulla counties. The safety of the Hosford population, sold to AgReserves, Inc., is undetermined because it is not protected. Also, the Gulf County population is primarily on tree farm land; therefore, tree farming is a threat to this species. (USFWS, 2019)

Stressor: Fire suppression (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: Suppression of fire continues to threaten pineland and savanna flora as fire is an important element in the maintenance of flatwoods (Abrahamson and Hartnett 1990). Fire influences community structure and composition (Abrahamson and Hartnett 1990), and with insufficient frequency in longleaf pine communities, a woody midstory quickly develops (Glitzenstein et al. 1995), negatively affecting the understory diversity. Several studies have shown that frequent prescribed fire regimes are important for maintenance of flatwoods diversity (Hiers et al. 2007). Prescribed burnings are needed to maintain optimal habitat for *R.m. chapmanii* populations; specifically to avoid the encroachment of *Cyrilla racemiflora* L. (swamp titi). (USFWS, 2019)

Stressor: Drainage (USFWS, 2019)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Drainage of adjacent bogs to increase areas of pine plantings affects seasonal hydrology. Drained sites become more desiccated, and this affects processes such as seed germination and seedling establishment. Therefore, drainage of adjacent bogs is still a threat due to tree farming activities. (USFWS, 2019)

Stressor: Overutilization (USFWS, 2019)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: The Recovery Plan identified this as a threat to *R.m. chapmanii*. Specifically, the Plan suggested that this species was taken from the wild for ornamental purposes (Tatum and Lake 1979). According to Simmons (1983), numerous plants were removed in the late 1940's from the Camp Blanding for the nursery trade. Similarly, 100-200 plants were removed from the Hosford population (USFWS 1983). Therefore, this species was a 'commercially exploited plant' and is still sold by several nurseries (e.g., <https://shop.shadygardensnursery.com/>). This activity does not currently seem to be a major problem because most cuttings and seeds come from plants collected in the past. However, we cannot discount the possibility of sporadic plant removal. (USFWS, 2019)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2019)

Exposure:

Response:**Consequence:**

Narrative: The Endangered Species Act (Act) of 1973, as amended prohibits the removal of federally listed threatened and endangered plants or the malicious damage of such plants on areas under federal jurisdiction, or the destruction of endangered plants on non-federal areas in knowing violation of state law or regulations or in the course of any violation of a state criminal trespass law. However, the Act does not provide protection for plants on private lands or unless it's in violation of state law. Several populations of *R.m. chapmanii* occur on private timberland. While the Act requires federal agencies to carry out programs for the conservation of endangered and threatened species, no such programs are stipulated for private landowners. Neither section of the Act provides protection for plants on private lands as long as the activity is permissible under state/local laws. Seeds of both threatened and endangered species found on federal lands are regulated under the Act. In addition, the seeds of an endangered species are regulated if they are going to be purchased/traded/bartered in interstate commerce. Since *R.m. chapmanii* is an endangered species, the seeds are regulated under the specified conditions. However, the seeds are not regulated if they are provided freely (no exchange of money, goods, or services; 7 CFR 319.37.2, USDA 2008). The State requires permission of private landowners for collecting of state-listed plants from their property. *Rhododendron m. chapmanii* is protected under Florida State Law, chapter 581.185: Preservation of native flora of Florida, which includes preventions of take, transport, and the sale of the plants listed under the State Law. The rule Chap. 5B-40, Florida Administrative Code, contains the "Regulated Plant Index" (5B-40.0055) and lists endangered, threatened, and commercially exploited plant species for Florida; defines the categories; lists instances where permits may be issued; and describes penalties for violations (Coile and Garland 2003). This law does not protect habitat. Based on the information summarized above, the existing regulatory mechanisms are deemed inadequate for plants. (USFWS, 2019)

Recovery**Reclassification Criteria:**

1. The dense 10-acre population near Hosford is maintaining a stable or increasing population of healthy plants. (USFWS, 1983).
2. The remaining part of the Hosford population continues to occupy at least 200 acres with at least 500 plants. (USFWS, 1983)
3. The Gulf County population continues to occupy at least 200 acres with at least 500 plants. (USFWS, 1983)
4. The Camp Blanding population continues to have at least 20 plants. (USFWS, 1983)
5. There is a permanent increase of about 1,000 plants at any combination of sites 2, 3, and 4 to increase to a total of at least 2,000 plants at these sites. (USFWS, 1983)

Delisting Criteria:

1. The three (3) existing populations (Hosford, Gulf, and Clay) and their occupied habitat are conserved, restored, and properly managed, and monitoring demonstrates that the populations

are stable or increasing over multiple prescribed burn cycles, evidenced by a type of natural recruitment and/or multiple size-classes (addresses Factors A and D). (USFWS, 2019b)

2. At least five (5) new populations are discovered or established within the historic range of the species on lands protected by a conservation mechanism, and exhibit stable or increasing trends over multiple prescribed burn cycles, evidenced by a type of recruitment and/or multiple size-classes (addresses Factors A and E). (USFWS, 2019b)

3. Threats (e.g. urban development, timbering, agriculture, inadequate fire management, invasive species) have been reduced and/or managed to a degree that *R. m. chapmanii* will remain viable into the foreseeable future (addresses Factors A and D). (USFWS, 2019b)

Recovery Actions:

- 1. Highest priority for the recovery of Chapman's rhododendron should be to reverse the habitat and population declines that are occurring in the wild population. This can be accomplished through a combination of protection, management and monitoring. Most important in accomplishing this goal is to establish and maintain a strong, friendly and longlasting working relationship with the St. Joe Paper Company, which owns over 99 percent of the wild population and its habitat. The Company has expressed a willingness to help (pers. comm.), and, indeed, has already taken some steps to protect the species and its habitat. Camp Blanding guards the small population there rather closely, and has expressed willingness to help manage the site. (USFWS, 1983)
- 2. Strengthening existing populations by planting nursery-grown plants is clearly less important than habitat protection and management. It may nevertheless prove to be essential for long-term survival of the species. It provides a tested (plantings have been done by Simons in the wild in Suwannee, Levy and Putnam Counties with 100 percent success rates) and easy method to quickly strengthen a population. (USFWS, 1983)
- 3. Establish new populations. Determine historical range. Locate suitable habitat. Obtain permission and cooperation for establishing planting. Collect seed. Grow plants and plant out in December - January at a 20 by 20 foot spacing (about 100 per acre). (USFWS, 1983)
- 4. Research is the lowest priority, because it seems least important from the standpoint of the immediate and near-term needs of the species. However, the farther one looks into the future, the more important research is. The amount of research recommended here is the minimum necessary to provide for implementation of this recovery plan. (USFWS, 1983)
- The level of occupancy of the three existing populations persists as at least: 5,000 acres for Hosford, 6,000 acres for Gulf County with a minimum of 2,000 clumps, and 30 clumps for Clay County (addresses Factors A and D) and management with prescribed fire is implemented on a 3 to 5 year return interval. (USFWS, 2019b)
- Foster a partnership with the current landowner of the AgReserves, Inc. to promote the protection of the Hosford population (found in Liberty and Gadsden counties) and help implement best management practices (e.g., prescribed fire, mowing/fuel reduction, invasive species removal) (addresses Factors A and D). (USFWS, 2019b)
- A long-term ex-situ conservation program is ongoing to help avert the risk of extinction from stochastic events, environmental catastrophes, or development. The living collection should emphasize the privately owned Hosford population and coastal areas (see Justification of criteria 1 and 3). The collection should be maintained at botanical gardens and other Service approved facilities for research, recovery, and public outreach (addresses Factors A and E,

- and representation). The full genetic diversity represented in the Hosford population needs to be protected through ex-situ management efforts. (USFWS, 2019b)
- The contribution of sexual reproduction to population maintenance is assessed via research related to in-situ soil seed bank, seed viability, and seedling recruitment (in-situ seed germination, seedling survival and growth) (addresses Factors A, D, E, and resiliency). (USFWS, 2019b)
 - The genetic composition within and among populations is assessed to clarify species boundaries, define evolutionarily significant units, detect inbreeding, identify clonal reproduction, and determine effective management (addresses Factors A, D, E; informs the ecological principle of representation). (USFWS, 2019)
 - Assess the *R. m. chapmanii* demographic responses (e.g., recruitment, reproduction, and mortality) to hurricane and fire disturbances (addresses Factor E and resiliency). (USFWS, 2019b)
 - A comprehensive census is conducted throughout the present distribution and on new locations where appropriate habitat exists (addresses Factor A and redundancy). (USFWS, 2019b)

Conservation Measures and Best Management Practices:

- Acquisition of the following private lands will benefit the status of this species: - Several land parcels adjacent to the SJSBP, Gulf County that has Chapman's Rhododendron and a suite of other rare species. - The Hosford population located in Liberty and Gadsden counties. (USFWS, 2019a)
- Complete a comprehensive census (e.g., the total number of individuals, number of flowering vs. non-flowering plants, and whether seedling recruitment is occurring) throughout the present distribution. Follow a standardized method for accurate population counts to ensure consistency in collected data. (USFWS, 2019a)
- Conduct surveys for new populations where similar habitat exists. This action can include the use of aerial photographs and species distribution modeling methods to initially determine potential sites, with subsequent validation or inspection of the sites for plants. Follow a standardized method for accurate population counts to ensure consistency in collected data. (USFWS, 2019a)
- Garden propagation and reintroduction. An ex-situ seed collection should be actively pursued and implemented to help avert the risk of extinction from stochastic events, environmental catastrophes, or development. The living collection should emphasize the privately owned Hosford population and coastal areas, and maintained at botanical gardens and other Service approved facilities for research, recovery, and public outreach. (USFWS, 2019a)
- Complete a population genetic study to determine the levels and distribution of genetic diversity within and among populations of *R. m. chapmanii*. The study should test whether the Camp Blanding population is an artificial (planted) population. The Recovery Plan deemed it "unlikely" that this population was planted, but this would provide a further test. (USFWS, 2019a)
- The contribution of sexual reproduction to population maintenance is assessed via research related to in-situ soil seed bank, seed viability, and seedling recruitment (in-situ seed germination, seedling survival and growth). (USFWS, 2019a)
- Assess the *R. m. chapmanii* demographic responses (e.g., recruitment, reproduction, and mortality) to hurricane disturbance. (USFWS, 2019a)

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SPECIES ACCOUNT: *Rhus michauxii* (Michaux's sumac)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 9/28/1989

Physical Description

A low-growing, densely hairy, dioecious shrub, mostly 0.3 to 0.6 m tall. Leaves are pinnately compound with 7-13 leaflets that are coarsely toothed. Female plants produce erect clusters of greenish-yellow to white 4-5 parted flowers and conspicuous red drupes. Flowers from April to June. Fruits persist from August through September or October (NatureServe, 2015).

Taxonomy

Andre Michaux discovered this species on July 20, 1794 in Mecklenburg County, NC (the area is now part of Union County). He named the species *Rhus pumila* in 1803; however, since the specific epithet *pumila* had already been used for another species, Sargent assigned the name *R. michauxii* in 1895 (Barden and Matthews 2004). There have been no changes to the taxonomic classification or nomenclature since *Rhus michauxii* was listed as endangered in 1989 (USFWS, 2014).

Historical Range

Historically endemic to the Inner Coastal Plain and lower Piedmont of North Carolina, South Carolina, and Georgia (USFWS 1989). HISTORIC RANGE: From the time of its discovery in 1895 until 1989, half of the known occurrences of *Rhus michauxii* have been extirpated (USFWS 1989). Thirty-two occurrences were historically reported from 23 counties in NC, SC, and GA (USFWS 1989). Four occurrences historically known from Cobb, Columbia, Newton, and Rabun counties, GA, are believed extirpated (Murdock and Moore 1991, Patrick 1993). Historical collections are known from Florence, Kershaw, and Oconee counties, SC. Following extensive, unsuccessful searches of their last known locations, as well as other areas of suitable habitat, Michaux's sumac is believed extirpated from the state (USFWS 1989, Murdock and Moore 1991). Historical and/or extirpated NC records exist (year last seen in parentheses) for Durham (1949), Franklin (1914), Hoke (1981), Johnston (1833), Lincoln (prior to 1917), Mecklenburg (pre-1800s), Moore (1901), Orange (1964), Robeson (1982), Wake (1942), and Wilson (1958) counties (Murdock and Moore 1991, NCNHP 1993). Considered extirpated from Florida, where the original collection was made in 1961 in Alachua County (Murdock and Moore 1991). Apparently by 1989 the collection site had been developed and was occupied by at least one residential home. Kathy Burkes of FNAI notes: "Whether the plants seen in 1961 were waifs carried far afield from the Piedmont by humans or other animals in "recent" times, or were true relicts of a former wide distribution reaching south into Florida is another question. We may never know for sure about that." (NatureServe, 2015).

Current Range

Extant occurrences are currently known to exist in North Carolina, Virginia, and Georgia. In NC, 44 occurrences (number of occurrences for each county follows in parentheses) are currently known from Cumberland (1), Davie (1), Franklin (1), Hoke (5), Moore (4), Richmond (18), Robeson (1), Scotland (8), and Wake (3) counties (NCNHP 2005). The range of this species in North Carolina, when calculated by minimum convex polygon, is approximately 290 km². In 1993, the Virginia Department of Conservation and Recreation's Division of Natural Heritage

discovered a large population of Michaux's sumac on Fort Pickett Military Reservation in Dinwiddie and Nottoway counties, Virginia (Fleming 1993). By the end of inventory work in 1993, 32 subpopulations containing an estimated total of 20,000+ plants had been documented within approximately 10,000 acres (Fleming 1993). The largest of these more-or-less continuous subpopulations contained an estimated 10,000+ plants, and several others contained an estimated 1,000+ plants (Fleming 1993). It should be noted that at the time of the 1993 survey, plants were seen that were presumed to be a hybrid but by 1995, due to genetic research on Fort Pickett colonies (Burke and Hamrick 1995), it was decided that these plants with little to no stem pubescence but pubescent leaflets should be included under *R. michauxii*. Therefore, the 1993 stem count total underestimates the true total. By 1995, an additional 65 subpopulations with at least 7500 stems were found within the occurrence area (Van Alstine and Smith 1995). Other populations recognized as separate occurrences were found on Fort Pickett by either DCR-DNH staff or Fort Pickett personnel adding 5 other occurrences totaling at least 250-300 stems and expanding the known occurrences south into Brunswick County. In 2003, consultants surveying an abandoned railroad track right-of-way for a proposed high speed rail line found the first occurrence in Virginia located outside of Fort Pickett. This population of 230 stems in Brunswick County occurs in a fairly ruderal habitat next to a railroad grade with trash and weeds. Three years of surveys (2003-2005) in areas surrounding Fort Pickett including public roadside utility line rights-of-way and roadsides and clearcuts on private lands have been unsuccessful in finding any more occurrences (Van Alstine and Belden 2005, N. Van Alstine 2006). The current range extent in Virginia occupies ca. 87 km², determined using a minimum convex polygon. In Georgia both extant and historical populations of *R. michauxii* occur on mafic/sub-mafic substrates and derivatives. This type of habitat in GA is extremely limited (NatureServe, 2015).

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Asexual: vegetative (USFWS, 2014)

Reproduction Narrative

Adult: Most of the surviving populations appear to contain plants of only one sex and therefore reproduce only vegetatively, if at all. Due to the rhizomatous nature of the species, this may mean that the single-sex populations are clones of one or a few individuals; two populations sampled for genetic diversity by Sherman-Broyles et al. (1992) appeared to each consist of a single clone (USFWS, 1993). Single sex populations that are clonal in nature prohibit sexual reproduction and seed production in this species. In populations where seeds are produced, it appears that seed germination is very low (USFWS, 2014). Although specific pollinators are unknown, Michaux's sumac, like other species in the genus, is probably pollinated by insects. Sherman-Broyles et al. (1992) observed that bees visited the flowers of other sumac species and that birds dispersed the fruits (USFWS, 1993).

Habitat Type

Adult: Open Woodland (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Michaux's sumac occurs in sandy or rocky open woods, sometimes in association with circumneutral soils (USFWS 1990). In the fall line sandhills region it occurs in submesic loamy swales. In the eastern Piedmont, it occurs on sand soils derived from granite. In the central Piedmont, it occurs on clayey soils derived from mafic rocks (Weakley 2004). In all of its habitats, *Rhus michauxii* is dependent upon some form of disturbance to maintain the open quality of its habitat (USFWS 1989). Periodic, naturally occurring fires provided such disturbance historically. Today, however, many of the Michaux's sumac occurrences are in areas that are artificially disturbed, such as highway and railroad rights-of-way, pine plantations, edges of cultivated fields, and other cleared lands (USFWS 1989, TNC 1991-93, NCNHP 1993, Center for Plant Conservation 2002). Although roadside occurrences appear to be thriving in the presence of some level of disturbance (i.e., mowing), they are always under the constant threat of catastrophic disturbance. Roadbed widening or heavy equipment activity on cleared lands, for example, may dramatically reduce the number of individuals. These reductions, if they come at a crucial stage in the species' reproductive cycle (i.e., during flower or fruit production), could have severe long-term effects on the population. Although it appears that Michaux's sumac can rebound from large disturbances, it is not clear how much genetic diversity is lost with each disturbance. In the North Carolina Sandhills region, naturally occurring *Rhus michauxii* appears to be restricted to slightly loamy, but still well-drained, sites which are scattered through longleaf pine/scrub oak/wiregrass woodlands. Loamy soil sites are usually found in slight depressions, swales, or along lower slopes and are quickly recognized by their high diversity of herbs, especially with regard to their high number of legume, composite and grass species (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance range are inferred based on specific habitat needs and low number of populations.

Dispersal/Migration

Motility/Mobility

Adult: Birds? (USFWS, 1993)

Dispersal/Migration Narrative

Adult: Sherman-Broyles et al. (1992) observed that bees visited the flowers of other sumac species and that birds dispersed the fruits (USFWS, 1993).

Population Information and Trends**Population Trends:**

Short-term Trend: Decline of <30% to relatively stable. Long-term Trend: Decline of 30-50% (NatureServe, 2015)

Resiliency:

Moderate (inferred from NatureServe, 2015)

Representation:

Moderate (inferred from NatureServe, 2015)

Redundancy:

Moderate (inferred from NatureServe, 2015)

Number of Populations:

21 - 80 (NatureServe, 2015)

Population Size:

2500 - 100,000 total individuals (NatureServe, 2015)

Population Narrative:

Has disappeared (or is disappearing) from the southern half of its range. However, the long term trend in Virginia is unknown; it may well be that in Virginia *Rhus michauxii* has increased there over the past 200 years. Decline of 30-50% The number of stems range-wide is estimated at 89,000 - 96,000 but given the clonal nature of the species, the actual number of genetically distinct individuals is likely far lower than the number of stems present. About 50 extant occurrences. Most are located in North Carolina; the largest single occurrence is in Virginia (NatureServe, 2015). NatureServe ((2015) notes that the long term trend is a decline of 30-50% and the sort term trend is a decline of 30% to relatively stable. Moderate redundancy, resiliency and representation are inferred based on the number of known populations and individual plants.

Threats and Stressors

Stressor: Fire suppression (USFWS, 2014)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: This species is threatened by fire suppression and the ecological succession (competition and/or shading by woody species) that occurs in areas that are not burned on a regular basis (USFWS, 2014).

Stressor: Low reproductive capacity (NatureServe, 2015)

Exposure:

Response:

Consequence: Population degradation

Narrative: Low reproductive capacity resulting from the geographic isolation of small single-sex populations is a threat to this species (USFWS 1990) (NatureServe, 2015).

Stressor: Logging (USFWS, 2014)

Exposure:

Response:

Consequence: Loss of habitat/Loss of plants

Narrative: Forested populations are threatened by timber operations. Logging activities can crush plants and or compact the soil where they grow (USFWS, 2014).

Stressor: Herbicides (USFWS, 2014)

Exposure:

Response:

Consequence: Loss of plants

Narrative: Sites located within utility rights-of way are threatened by herbicide use, mowing during critical growth periods, and ground disturbing activities (USFWS, 2014).

Stressor: Development (USFWS, 2014)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Habitat destruction, the result of development or land conversion, also threatens this species (Boyer 1996) (USFWS, 2014).

Stressor: Climate change (USFWS, 2014)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The effects of climate change on this species are unknown at this time. However, since this species occurs on dry soils in fire maintained habitat, it seems reasonable to believe that it will not be negatively affected by the predicted increase in droughts and wildfires (USFWS, 2014).

Recovery

Delisting Criteria:

1. It has been documented that at least 19 self-sustaining populations exist and that necessary management actions have been undertaken by the landowners or cooperating agencies to ensure their continued survival (USFWS, 1993).
2. All of the above populations and their habitat are protected from present and foreseeable human-related and natural threats that may interfere with the survival of any of the populations (USFWS, 1993).

Conservation Measures and Best Management Practices:

- Revisit known populations that have not been visited in the past three years; monitor the habitat condition of each site including threats and fire regime; monitor population size and evidence of reproduction (sexual, asexual and seed viability); discuss conservation options with landowners where appropriate; update Natural Heritage Program files with this information (USFWS, 2014).

- Search for additional populations throughout the range of the species (USFWS, 2014).
- Prioritize known sites for protection (USFWS, 2014).
- Protect additional populations through fee simple acquisition, conservation easements, etc. (USFWS, 2014).
- Develop management plans including the use of prescribed fire for all protected populations (USFWS, 2014).
- Develop standardized monitoring protocols, initiate long-term population monitoring and determine the criteria for sustaining populations (USFWS, 2014).
- Reinstate monitoring that was initiated in the early 1990s by Boyer (1996) (USFWS, 2014).
- Conduct research on general biology of the species including life history and reproductive biology (breeding systems, seed production and seedling survivorship) (USFWS, 2014).
- Compare, genetically, the populations of questionable taxonomy in VA with those known from NC and GA (especially populations suspected of hybridizing with other species of *Rhus*) (USFWS, 2014).
- Work with NC Botanical Garden to conserve seeds and germplasm, and develop propagation protocols (USFWS, 2014).
- Consider augmenting populations to increase genetic variation (USFWS, 2014).

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SPECIES ACCOUNT: *Ribes echinellum* (Miccosukee gooseberry)

Species Taxonomic and Listing Information

Listing Status: Threatened; 8/19/1985; Southeast Region (R4)

Physical Description

A bushy shrub that reaches 1 m in height and often forms patches that are several meters in diameter. Leaves are small (1-2 cm long), closely spaced, and more-or-less 3-lobed. Stems are armed with spines. Flowers (late February into early April) are inconspicuous, greenish-white. Fruits are spiny green berries (NatureServe, 2015).

Taxonomy

Recent work using molecular phylogenetic approaches has confirmed the distinctness of this very rare shrub (Morgan & Soltis 1993, Sinters & Soltis 2003, Shultheis & Donoghue. 2004) (NatureServe, 2015).

Historical Range

See Current

Current Range

Occurs in three locations: along the shores of Lake Miccosukee in Jefferson County, Florida, and along Stevens Creek and a site on the Sumter National Forest, Edgefield Ranger District in McCormick County, South Carolina. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Vegetative/Sexual (USFWS, 2015)

Reproduction Narrative

Adult: Vegetative reproduction is common by cuttings and by rooting at the stem whenever the decumbent branches come in contact with the ground (Jones 1986; Engstrom 2011). Fire appears to promote clonal reproduction by increasing the number of plant clumps (Slapcinsky and Gordon 2005). No evidence of strong clonality was found by the genetic study of Oleas et al. (2014); however, in SC putative clonality was higher and especially high at the Sumter NF. The Sumter NF subpopulation is represented by one large cluster and eight small subgroups (each 1–2 m²), which might explain the clonality results. Sexual reproduction might occur (Jones 1986), but recruitment appears to be limited or absent (Negrón-Ortiz 2014). Seed germination potential assessed with 1% tetrazolium solution indicated that out of 173 Florida seed tested, 60 % were viable (Negrón-Ortiz, 2014, pers. observ.) In addition, an ongoing in-situ study indicated 25 % seed germination. However, none of the Florida seedlings survive a full year (Negrón-Ortiz 2014, pers. observ.) (USFWS, 2015). Floral biology and flower visitors were observed and

described for the Florida and South Carolina populations (Caitling 1998). The author concluded that pollinators and/or visitors were not the limiting factor determining the species' abundance. Below is a detailed account of the findings. a. Floral biology and behavior at anthesis. The stamens are the first reproductive structure elongating within one or two days of floral anthesis. It is followed by reflexing of the calyx lobes and dehiscence of the anthers. The style elongates within one to three days of stamen elongation, separates into two parts, reaching an equal or longer length than the stamen. This floral maturation suggests protandry (male function precedes female function), a breeding system that promotes outcrossing. Interestingly, the style failed to elongate in 20% of the flowers, but unfortunately, the author did not provide a description of these flowers to assess whether these flowers are female sterile. If they are female-sterile, the breeding system is not simple protandry, but also andromonoecious (species that have bisexual and male flowers on the same plant). b. Insect visitation and pollination. The author recorded five different visitors to the flowers, with *Bombus impatiens* Cresson (bumble bee) and *Habropoda laboriosa* Fab. (southeastern blueberry bee) as the two most abundant visitors for both Florida and South Carolina populations. Visitation movements occurred between and within plants (USFWS, 2015).

Habitat Type

Adult: Hardwood forest (USFWS, 2015)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 2015)

Environmental Specificity

Adult: Narrow/specialist (USFWS, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 2015)

Site Fidelity

Adult: High (inferred from USFWS, 2015)

Habitat Narrative

Adult: Jefferson County, Florida: Miccosukee gooseberry is found over an area of 105-110 acres between 24.4 to 36.6 m of elevation, at sites of high floristic diversity (Table 3), on mesic and well drained soils with underlying limestone (Schultz and Hardin 1985, USFWS 2000). These sites are dominated by deciduous species (Table 3, Harper 1925), with the west-facing slope dominated by a mixed hardwood forest containing trees such as hickories, elms, white ash, hackberries, and oaks (Table 3) (Caitling 1998, USFWS 2000) and a shrub layer dominated by buckeye and poison ivy. The site, located in the bottomland hammock is dominated by American beech and southern magnolia. McCormick County, South Carolina Steven's Creek Heritage Preserve: The plants are found over an area of 35 acres along Steven's Creek on a steep north facing slope containing stands of deciduous hardwood trees. The forest community was described by Radford (1959) as mixed mesophytic. It is also floristically very rich with species of *Carya* and *Quercus* accounting for over 50% of the composition of the tree size-class (Table 3). The soil texture is considered a sandy loam with high pH (6.7 to 7.4) and calcium levels (Jones 1986). Sumter National Forest, Long Cane Ranger District The site is characterized by a lower slope with an easterly aspect. The plants are found over an area of 30 acres. The forest, a

mature (<100 years) hardwood forest with a sparse understory, is dominated by cherrybark oak, swamp chestnut oak, painted buckeye, and southern sugar maple. In addition, scarlet oaks, beech, witch hazel and ironwood are common members of the community. The soil is Tatum, a derivative from fine-grained phyllite, with pH ranging from 6.2 to 6.4 (USFWS, 2015). Narrow environmental specificity and clumped spatial arrangement of the population are based on the species specific habitat needs and known populations. High ecological integrity of the community and site fidelity as well as low tolerance range are inferred based on the specific habitat needs of the species and the small number of populations known to exist.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Coville (1924) postulated that birds with long bills (mockingbirds, catbirds, or thrushes) would be adapted to opening the berries to eat the seed. The daily range of these species would be limited, therefore the potential dispersal distance would be limited. Dissemination by these agents would be by internal means (NatureServe, 2015).

Population Information and Trends

Resiliency:

Low (inferred from NatureServe, 2015)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

Florida ~ 5,000 plants, South Carolina ~ 9,870 plants (USFWS, 2015)

Population Narrative:

Grows extremely densely with as many as 500 stems in a .04 ha circular plot (USFWS 2008). The population at the type locality in Florida was estimated to be approximately 5000 plants (Schultz and Hardin 1985 cited by USFWS 2008). As many as 9,870 clumps are present at the Steven's Creek, South Carolina site (Gaddy 2008). The Sumter National Forest, South Carolina site has approximately 270 ramets (USFWS 2008). Two occurrences in close proximity are believed extant in Jefferson County, Florida. In the disjunct area of McCormick County, South Carolina, it is known from two sites, Steven's Creek Heritage Preserve and Sumter National Forest, Edgefield Ranger District. (NatureServe, 2015) Short-term Trend Comments: The Steven's Creek site may be declining (USFWS 2008). The Sumter National Forest and Florida sites appear to be stable (USFWS 2008). Low representation, resiliency and redundancy are inferred based on low number of populations and specific habitat needs of the species.

Threats and Stressors

Stressor: Development (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The threat of habitat destruction or alteration is greatest at the Florida site where *R. echinellum* occurs exclusively on private property. There is no guarantee that the properties will not be developed for home-sites, agriculture, logging of associated hardwoods, recreational facilities, or other purposes in the future, although the owners have not given any indication that they intend to do so (USFWS, 2015).

Stressor: Predation (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Deer browsing, feral hogs rooting and fruit predation by the cotton mouse are listed as threats to this species (USFWS, 2015).

Stressor: Non-native species (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The proliferation of non-native (invasive) species represents a threat to *R. echinellum* in the Steven's Creek population and to some extent at Sumter NF and in Florida. In Florida, the invasive species Japanese climbing fern (*Lygodium japonicum*) and Chinese privet (*Ligustrum* spp.) were observed on the Mays Pond conservation easement property (Negrón-Ortiz, 2007, pers. observ.). Chinese privet, coral ardisia (*Ardisia crenata*), and nandina (*Nandina domestica*) are abundant in places on Norias Plantation (Engstrom, 2010, pers. comm.). Thus this threat is not a significant concern at the current time. The manager for Steven's Creek (M. Bunch) noted significant invasion of the gooseberry site by Chinese privet and Japanese honeysuckle (*Lonicera japonica*), predominantly in the riparian area and on the north facing outcrops. The SC Department of Natural Resources hosted several volunteer workdays, and staff has worked on the problem at Steven's Creek reducing the Chinese privet, mostly by manual removal. They have conducted a limited amount of cutting and painting Chinese privet stumps using glyphosate and started controlling the Japanese honeysuckle by hand pulling. The riparian area, which was most heavily covered with Chinese privet, is now greatly improved with about 70% of this invasive removed. The same invasives have been reported for the Sumter NF subpopulations, but this threat is not currently significant (USFWS, 2015).

Stressor: Drought (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Prior to 2007, the South Carolina and Florida populations were facing a severe drought. Currently, drought is not a threat for the FL population (USFWS, 2015).

Recovery

Reclassification Criteria:

Not relevant.

Delisting Criteria:

Not developed - a recovery plan has not been issued. (USFWS, 2015)

Recovery Actions:

- There is no Recovery Plan for this species. (USFWS, 2015)

Conservation Measures and Best Management Practices:

- Management: Foster a working partnership between Tall Timbers, the Service, and the Mays Pond conservation easement for the Florida population. (USFWS, 2015)
- Management: Foster a working partnership with the Norias Plantation and Reed property landowners. (USFWS, 2015)
- Management: Fence a larger area at Steven's Creek to protect the plants from deer herbivory and to better assess the impact of browsing on *R. echinellum*.
- Management: Monitoring and managing for invasive species i. Frequent inventories or surveys of the Florida population for invasive plant species should be established, which will help with the early detection and eradication of small patches of exotic invasive plants within the sites. This is an ongoing action for the South Carolina populations conducted by SC DNR staff and volunteers and by Sumter NF staff. ii. Eradicate the feral hog population at the Steve's Creek and Long Cane sites. Starting in May 2015, USDA APHIS has been trapping hogs for the Forest Service in compartment 314 as an effort to protect *R. echinellum* from hog damage. This should reduce hog damage in both the SNF and Steven's Creek. iii. Fence a larger area at Steven's Creek to protect the plants from feral hog damage. Fencing should consist of woven wire at least 28 inches in height to exclude feral hogs. The fence should be staked tightly against the ground to prevent uprooting and access to protected areas. (USFWS, 2015)
- Management: Fire management: Slapcinsky et al. (2010) reported that *R. echinellum* is not fire-dependent, although plant density increased gradually for three years post-fire, and reproduction increased the second year post-fire. This species has responded in different ways to fire. Management protocols cannot be implemented until a comprehensive study is conducted. i. Monitor the effect of fire (if the areas are burned) on density, fecundity, and size structure. ii. Address the following questions: What is the effect of local fire temperature, or the range of fire temperatures tolerable for the persistence of the species? How often should a prescribed fire be performed? Determine whether the lower size classes, (<30 cm tall), that were increased after fire represent 1) seedlings recruited from a seed bank present in the soil, 2) rooting branches no longer connected to the plants and growing as new clumps, and/or resprouts of fire killed stems. (USFWS, 2015)
- Management: Silvicultural practices: South Carolina population: Silvicultural practices in pine plantations upslope from *R. echinellum* are recommended to promote open woodlands dominated by native pines (shortleaf or longleaf) (SCDNR 2013). Upslope from the Sumter NF population is an area soon to be proposed for longleaf pine woodland restoration, creating more open conditions for pollinators. (USFWS, 2015)
- Research: Reproductive biology studies: The lack of sexual reproduction over long-term may threaten this species, and requires further evaluation (Gordon, 2008, pers. comm.; Negrón-Ortiz, 2012-2014, pers. observ.). a. Since recruitment from seed appeared rare (Negrón-Ortiz, 2013-2014, pers. observ.), seed germination and seedling survival studies should be expanded and continue at

the FL population, and initiated at the South Carolina population. It would be desirable to compare open pollinated to hand-crossed (within source population, and between FL-SC) in seed set and seed germination. b. Establish an experimental garden Since the two populations of *R. echinellum* show low genetic diversity, signatures of bottlenecks, and excess of heterozygous which might be caused by overdominance (heterozygote has higher fitness than either homozygote; Oleas et al. 2014), an experimental garden comprising plants from both populations (FL-SC) could be established allowing natural pollination or using manual pollen transfer. The site could be where a population could be controlled (e.g. botanical garden). Fruits from crosses may then be planted, and seed germination and seedling establishment monitored. (USFWS, 2015)

- Research: Expand the seed predation study carried out by Engstrom and Radzio (2014): To answer whether the small cotton mouse is driving changes in seedling recruitment, a series of exclosures and control plots could be established at the FL population. The exclosure plots will prevent small-mammals access the plots. To determine predation of fruits, fruits should be counted before they ripen; then seed germination, seedling recruitment and plant establishment should be monitored in the experimental plots for up to three years. (USFWS, 2015)
- Research: Determine the effect of spring moisture on seed germination and recruitment.
- Research: Ex-situ initiatives: Germplasm should be separately collected from the two different populations, as the Bayesian genetic structure indicates that the FL and the SC represent different genetic clusters. Within populations, cuttings should be obtained from individuals located at greater spatial distances. Seeds from two Florida subpopulations (FL3 and FL4, see Oleas et al. 2014) should be chosen for ex situ collection because both are the localities with the highest genetic diversity. (USFWS, 2015)
- Research: The genetic study by Oreas et al. (2014) can inform reintroduction (establishment of *R. echinellum* in an area which was once part of its historical range) and augmentation (addition of *R. echinellum* plants to an existing population with the goal of strengthen numbers or provide a more varied genetic structure). According to the study, Florida subpopulation FL 4 shows higher level of genetic diversity and the individuals of this group might be considered good candidates for augmentation or reintroduction programs within the FL population. (USFWS, 2015)
- Research: Establish or implement monitoring for both Florida and South Carolina populations, as needed. Note: The Sumter NF already has a monitoring program, and Steven's Creek began a long-term study in February 2008. Given the limited distribution of the species, a monitoring program should be implemented. Jones (1986) suggested a monitoring program at 10 year intervals, which was implemented to some extent by TNC but at one year interval from 1992 to 2001 in Florida. a. In Florida, TNC transects are well-established with the re-bar and metal labels in Mays Pond North and Mays Pond South. Data should be collected on these transects every five years to monitor these subpopulations. In the future, all trees >10 cm DBH and all *R. echinellum* patches should be mapped within each transect. This will provide guidance for positioning the survey tape and monitoring clumps (a rooted stem or tight cluster of stems that is separated by at least 10 cm from the next closest rooted stem; Engstrom 2011) within patches (group of clumps that are at least 1 m from any other clump or patch; Engstrom 2011) will provide another dimension to *R. echinellum* dynamics. b. The entire Florida population, which has been geo-referenced, should be re-surveyed every five years. The approximate number of clumps, patches, flowers and fruits should be noted at each GPS point. c. For both the Florida and the South Carolina populations, permanent plots could be established, and for each plot: Establish size classes (clump length and width), and estimate population size (density and abundance of individuals and/or clumps) and reproductive clumps (no. of flowering plants, and no. of flowers, fruits and seeds/fruits per plant). The length of longest stem should be used as one of the monitoring clump. This is an ongoing effort for the FL population. (USFWS, 2015)

- Research: Conduct surveys/inventories on potentially new sites, between Northern Florida and South Carolina. This action can include the use of GIS to initially determine potential sites, and later inspection for plants. South Carolina DNR recommend additional surveys of both the steeper bluffs with basic mesic forests and the drier sites along the Steven's/Turkey Creek drainage throughout the adjoining Sumter NF. (USFWS, 2015)
- Research: Population genetic studies: Molecular studies will help clarify the extent and pattern of genetic variability throughout these populations and potential sources of rarity (e.g., unique alleles). A genetic study of the South Carolina sites is encouraged. (USFWS, 2015)
- Research: The development of a Biological Species Status Assessment is recommended for this species. The assessment will provide an in-depth account of the species' overall viability and extinction risk. (USFWS, 2015)

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SPECIES ACCOUNT: *Rorippa gambellii* (Gambel's watercress)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial rhizomatous (with creeping underground stems) branched herb that can grow up to 2 meters (6 feet) tall (this height is confirmed by John Chesnut [in litt. 1998] at Oso Flaco Lake). It roots at lower stem nodes, while the upper stem generally remains erect (Figure 2, Photo 2). It blooms from April to July, producing dense inflorescences (flower clusters) with white flowers; the lateral inflorescences may bloom through August. The inflorescences produce 15 to 30 fruits with about 10 to 30 seeds each (Price 1989). The plant has pinnate (feather-shaped) leaves with 7 to 13 uniform leaflets, which are angular and dentate (toothed) in the upper leaves. Small lobes are present at the base of the leaf stalk. Lower flower stalks often have bracts (specialized leaves), and pedicel (flower stalk) junctions with the main stem are flat. These characters separate this taxon from a look-alike, watercress (*Rorippa nasturtium-aquaticum*), whose three to seven lateral leaflets are entire or wavy-margined and smaller than the terminal leaflet; the leaflets are more lobed than angular in the upper leaves. The smaller flowers of *Rorippa nasturtium aquaticum* are supported by pedicels without bracts or flat stem junctions. Moreover, the linear and narrower fruits of *Rorippa gambellii* have more finely reticulate (net-patterned) seeds, which are arranged in one row per chamber, versus two rows per chamber in *Rorippa nasturtium-aquaticum*. (USFWS, 1998)

Taxonomy

Nasturtium gambellii was originally described as *Cardamine gambellii* in 1876 based on a specimen collected by William Gambel in 1844 in the vicinity of Santa Barbara (Watson 1876). *Nasturtium gambellii*, the currently recognized name, was originally listed by the Service as endangered under the name *Rorippa gambellii* (Service 1993). While the circumscription of the species (the limits of the species characters and range) has remained constant since its original description, it has been recognized under several different names (some of the names have similar spelling, but because they were recorded with slightly different names they are listed separately), including *Cardamine gambellii* (Watson 1876, Abrams 1944), *Cardamine gambellii* (Jepson 1923; Munz 1959, 1968, 1970, 1974; Hoover 1970; Roberts 1989), *Rorippa gambellii* (Smith 1976, 1998; Roberts 1998; Service 1998, CNPS 2001), *Rorippa gambellii* (Al-Shehbaz and Rollins 1988, Rollins 1993, Service 1993, Skinner and Pavlik 1994), *Nasturtium gambellii* (Al-Shehbaz and Price 1998), and *Nasturtium gambellii* (Index of California Plant Names 2009). (USFWS, 2011)

Historical Range

Historically, *Nasturtium gambellii* occurred in cismontane regions (on the coastward side of the mountains) of central and southern California, in Orange, San Bernardino, Los Angeles, Santa Barbara, and San Luis Obispo Counties, California. (USFWS, 2011)

Current Range

Pure *Nasturtium gambellii* plants are currently known from one remaining wild population on Vandenberg Air Force Base in Santa Barbara County, California (Keil 1997, CNDDB 2010), and

one additional site where plants were introduced in October 2008 on the Refuge in San Luis Obispo County, California. (USFWS, 2011)

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Self-pollinating (NatureServe, 2015)

Reproduction Narrative

Adult: Pollinator exclusion experiments have been conducted on this species in the field (Mazer et al. 1994) and demonstrated seed set in bagged specimens. No pollinators were ever seen in 2 seasons of fieldwork. Soil cores taken from the sites where *Rorippa* are still extant show a viable seed bank in the soil throughout the spring and summer growing season. These seeds germinated under greenhouse conditions. Detailed mortality and longevity data are not yet available for these dormant seeds. The average lifetime fruit and seed production for the Black Lake Canyon population of *Rorippa* has been estimated at 85.8 fruits and 882 seeds.; *Rorippa gambelii* requires permanent fresh or brackish wetland areas. It is intolerant of competition and seems to require clearings to survive. Encroaching eucalyptus trees are competing for water and light, and alleopathic effects from the trees may also be harming the *Rorippa* population. No known diseases or pests attack *Rorippa*. The very limited distribution of this species and changes in local hydrology are threatening it with extinction.; Predominantly selfing (NatureServe, 2015).

Habitat Type

Adult: Wetlands (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits permanent wetlands, fresh or brackish, in marshes or along the borders of lakes and slow-flowing streams or ditches. Soils are acidic sandy peats. Sea level to 450 m elevation. (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the limited number of populations and the specific habitat requirements of this species.

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Seed dispersal needs further research (USFWS, 1998)

Population Information and Trends**Population Trends:**

Decreasing (NatureServe, 2015)

Resiliency:

Low (NatureServe, 2015)

Representation:

Low (NatureServe, 2015)

Redundancy:

Low (NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

250 - 2500 individuals (NatureServe, 2015)

Population Narrative:

Does not tolerate competition or changes in hydrology. Reduction of habitat has rendered this species fragile because it has no new habitat as the conditions of marshes change. The long term trend is assumed to be one of moderate decline. Decline of 30-50% The number of individuals over all extant EO's is no more than 1700 plants but these counts are primarily from the mid-1990's and may be out of date. The historical distribution included several southern Calif. counties and a disjunct occurrence in the Valley of Mexico, near Mexico City. Today, the plant is only known from a few occurrences in San Luis Obispo County and adjacent Santa Barbara County, California. The populations further south appear to have been extirpated (NatureServe, 2015).

Threats and Stressors

Stressor: Development/Urbanization (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Since the time of listing, there has been a loss and degradation of habitat due to development and urbanization and a conversion of marsh habitat due to the collateral, but indirect, effects from development and urbanization. Some of this habitat loss has occurred in watersheds that are classified as impaired by the Regional Water Quality Control Board due to excessive amounts of nitrogen and other nutrients (California State Water Resources Control

Board 2006a). The vegetation in these watersheds exhibits excessive growth that is consistent with biostimulation and eutrophication (California State Water Resources Control Board 2006a, California State Water Resources Control Board 2006b, Central Coast Ambient Monitoring Program 2002, Dodds et. al. 1998). The excessive growth of some vegetation (e.g., willows, bulrush, Typha (cattails)) causes type conversion of habitat (such as at Black Lake Canyon and Oso Flaco Lake) and a decline in the quantity and quality of habitat suitable for *Nasturtium gambelii*. Most of the historical populations and their surrounding areas are urbanized and/or indirectly impacted by urbanization, which has further limited this species' ability to colonize adjacent suitable habitat. These conditions also limit sites and opportunities for successful introductions and reintroductions. (USFWS, 2011).

Stressor: Predation (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Herbivory has been noted on plants at the introduced site on the Refuge (M.A. Elvin, pers. obs. 2009) and on plants under propagation at University of California, Irvine (UCI) Arboretum (Barry Nerhus, U.C. Irvine, pers. comm. 2006). While this plant may be able to withstand some herbivory, the herbivory may cause a reduction in its reproductive success due to the loss of flowers and the corresponding reduction in the production of seeds. The extent of this threat is not known, but the loss of even a few flowers due to herbivory, if it led to an even slight decrease in reproductive success, may have a significant effect on the long-term survival of *N. gambelii* because there are so few individuals remaining in the wild. Therefore, the relative threat from predation is greater now than was thought to be the case at the time of listing, because there are fewer populations and fewer individuals per population than at the time of listing (USFWS, 2011).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: From the time of listing until recently, existing regulatory mechanisms appear to have done little to ameliorate threats to *Nasturtium gambelii*, and substantial threats remain; however, recent efforts to improve protections may provide additional benefit to the species in the future. Other Federal and State regulatory mechanisms (e.g., CEQA, California Coastal Act) provide discretionary protections for the species based on current project review and permitting practices (USFWS, 2011).

Stressor: Small population size (USFWS, 2011)

Exposure:

Response:

Consequence: Extinction/lack of genetic diversity

Narrative: The conservation biology literature commonly notes the vulnerability of taxa known from very few locations or from small and highly variable populations (e.g., Shaffer 1981, 1987; Primack 2006; Groom et al. 2006). The small size of the gene pool of the species (Mazer et al. 2000) may depress reproductive vigor, or increase the likelihood that a single human-caused or natural environmental disturbance (e.g., flood, drought, disease) could cause the extinction of *Nasturtium gambelii*. Small populations are threatened by inbreeding depression (Ellstrand and

Elam 1993). Small plant populations can have significantly lower germination rates than larger populations of the same species due to high levels of homozygosity (having identical pairs of alleles for any given gene), which could result in the expression of disadvantageous traits (Menges 1991). Genetic stochasticity results from changes in gene frequencies due to founder effect, random fixation, or inbreeding (Shaffer 1981). The low levels of genetic variation among and within populations could impair the species' ability to adapt to changes in the environment or contribute to inbreeding depression (i.e., loss of reproductive fitness or vigor). The existence of less than five populations and the small number of individuals in these populations places *Nasturtium gambelii* at extreme risk of extinction due to low levels of genetic diversity (USFWS, 2011).

Stressor: Other natural or manmade factors (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat/extinction

Narrative: Natural catastrophes such as fire, landslide, or prolonged drought could result in the loss of populations (Shaffer 1981), particularly for species with fewer than five populations. An increase in urban development has reduced the range of *Nasturtium gambelii* considerably. Indirect effects from urbanization in the watershed include changes in hydrology, changes in vegetation, and an increase in nonnative species. Increasing development in the area will likely increase threats from stochastic events. We believe that the existence of one known wild population and the small number of individuals in the population exacerbate the risk of extinction to *Nasturtium gambelii* from stochastic events.

Stressor: Competition with nonnative species (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The effects of competition with nonnative species are most problematic immediately adjacent to urban areas and in habitat that has been isolated or fragmented by development (Alberts et al. 1993). These factors may not be enough to threaten the survival of *Nasturtium gambelii* independently, but taking into account its limited range, the cumulative and synergistic effects of all of these factors combined could be a threat to the survival and recovery of *N. gambelii* (USFWS, 2011).

Stressor: Nutrient loading in watersheds (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Threats identified since the time of listing include excessive amounts of nitrogen and other nutrients in watersheds that either currently support or historically supported *Nasturtium gambelii*. These nutrient levels can cause excessive growth of vegetation (biostimulation) in some species that may out-compete *N. gambelii* plants. The excessive growth of other vegetation (both native and nonnative) can have direct effects on *N. gambelii* individuals. The other plants can outcompete *N. gambelii* individuals for essential physical and biological elements (i.e., space for growth, food, water, light, minerals). This stress likely effects the survival of some individual plants or occurrences and increases the impact of threats to the species from stochastic events (USFWS, 2011).

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Park et al. (1989) projected that of the saltmarshes along the coast of the contiguous United States, 30 percent would be lost with a 1.6-foot (0.5-m) SLR, 46 percent with a 3.3-foot (1-m) SLR, 52 percent with a 6.6-foot (2-m) SLR, and 65 percent with a 9.8-foot (3-m) SLR. While we cannot project directly to California from the estimates of Park et al. (1989) who focused on the east coast and Gulf coast of the United States, we can anticipate that with a projected SLR of up to almost 6.6 feet (2 m) that much of the coastal saltmarshes in California would be lost by 2100. Beaches, dunes, and coastal areas would be subject to greater and more frequent wave attack, with a general rule of thumb that 50 to 100 feet (15 to 30 m) of beach width will be lost from use for every foot of sea level rise by the year 2100 (CCC 2001, Heberger et al. 2009). This is estimated to result in erosion and shoreline retreat between 459 and 1,083 feet (140 and 330 m), corresponding to an estimated loss of approximately 1.4 square miles (896 acres) of dunes in San Luis Obispo County by the year 2100 (CCC 2001, Heberger et al. 2009). Because *Nasturtium gambelii* historically occurred in coastal dune habitats throughout its range, erosion of these areas caused by an estimated rise in sea level could cause a loss of individual plants and seed banks for this species (USFWS, 2011).

Stressor: Genetic swamping (USFWS, 2011)

Exposure:

Response:

Consequence: Lack of genetic variability

Narrative: The *N. gambelii* plants at Oso Flaco Lake appear to be genetically compromised and introgressed with the locally abundant nonnative species *N. officinale* based on morphological and molecular evidence of hybridization (Mazer et al. 2000; Prince 2008a, 2008b; CNDDDB 2009, 2010; CNPS 2009). The *N. gambelii* population (at VAFB) has at least two individuals that may be of hybrid origin with *N. officinale* (Prince 2008a, 2008b). The introgression of *N. gambelii* plants at Oso Flaco Lake and the potential introgression of two *N. gambelii* plants at VAFB (Mazer et al. 2000; Prince 2008a, 2008b; CNDDDB 2009, 2010; CNPS 2009) suggest the species is in danger of extinction.

Recovery

Reclassification Criteria:

1. When new plants are established so that there are at least 5 populations of at least 500 individuals each (USFWS, 1998)
2. When some of the populations occur in permanently protected habitats within the Black Lake Canyon and the dune lakes area (USFWS, 1998)
3. When some of the populations are in other areas of suitable habitat with the species' historical range in the United States (USFWS, 1998)

4. When the populations remain viable for at least 5 years. Viable populations are defined as those that are showing natural reproduction and either stable or increasing in size over time, without artificial augmentation (USFWS, 1998)

Delisting Criteria:

1. If threats are reduced or eliminated so that protected populations are capable of persisting without significant human intervention or perpetual endowments are secured for management necessary to maintain the continued existence of the species. The most outstanding management needs currently are: a) controlling competition with nonnative species and hybridization with common watercress, and b) managing water conditions, particularly flow and nutrient loads, that the species depends on. (USFWS, 2019)

2. If populations are established across the species ecological settings (in addition to Black Lake Canyon and the Dune Lakes area in San Luis Obispo County), including suitable site(s) in the Santa Barbara County and Ventura County region (e.g.; the San Antonio Creek drainage on Vandenberg Air Force Base or comparable sites); and coastal wetlands in Los Angeles, Orange, or San Bernardino Counties (USFWS, 2019)

3. If the populations remain viable for at least 10 years. Because this species has narrow microhabitat conditions that it will tolerate, particularly with respect to water flow and nutrient loads, and in light of fluctuations that can occur with climatic conditions and local water availability and nutrient loading, the persistence of populations with these varying conditions over time needs to be confirmed. (USFWS, 2019)

Recovery Actions:

- 1. Protect, maintain, and enhance species habitats. The most important immediate objective in the recovery plan for *Rorippa gambelii* is the protection of its habitat. - Coordinate among agencies involved in recovery activities. - Define and maintain the sensitive Resource Area boundary and restrictions at Black Lake Canyon. - Establish protection agreements. - Acquire key land parcels and conservation easements. Enhance existing habitat at Black Lake Canyon. - Continue to protect, maintain, and enhance habitat in the Dune Lakes area. - Communicate species and habitat protection information to all concerned parties. (USFWS, 1998)
- 2. Document and monitor population and habitat characteristics. - Conduct plant surveys. - Protect newly discovered populations. - Monitor all populations and habitats. (USFWS, 1998)
- 3. Conduct research on the ecology and biology of the species. - Identify potential impacts of conducting research. - Determine population characteristics and life history of the species. - evaluate species' tolerances. - Investigate the effects of genetic diversity. (USFWS, 1998)
- 4. Augment existing populations. In addition to protecting existing and newly discovered habitats of *Rorippa gambelii*, monitoring these populations and their habitats, and conducting research on the biology and ecology of the species, attempts should be made to augment existing populations. (USFWS, 1998)
- 5. Establish new populations. Because *Rorippa gambelii* currently has very restricted distribution in California, establishment of new populations within the historic range of the species at potentially suitable sites other than at historic sites should be attempted. If new populations are successfully established, it will reduce the likelihood that a catastrophic

event could result in the extinction of the species with its current restricted distribution. (USFWS, 1998)

- 6. Evaluate Progress and Update Management and Recovery Guidelines. Results of all recovery activities should be evaluated and incorporated into updated management and recovery guidelines for the species. All relevant information should be distributed. (USFWS, 1998)

Conservation Measures and Best Management Practices:

- Work with the U.S. Air Force at Vandenberg Air Force Base to implement site-specific management activities in the immediate future to avoid and alleviate threats (such as from stochastic events) to prevent the loss of the last, known remaining wild population (USFWS, 2011).
- Work with others to establish new populations in the near future to reduce the risk of extinction to *Nasturtium gambelii* in each of the two ecological regions of its historical range in California (coastal central California and coastal southern California) (USFWS, 2011).
- Work with others to establish and maintain ex situ stock populations with at least one institution in each of the three ecological regions of its historical ranges (USFWS, 2011).
- Work with the Central Coast Regional Water Quality Control Board to determine nutrient levels in the watersheds which historically supported *Nasturtium gambelii* in the recent past (particularly Black Lake Canyon and Oso Flaco Lake) to determine what may have led to the loss of *N. gambelii* from these sites, and work with local landowners and stakeholders to alleviate (and remove) any threats to *N. gambelii* that are associated with water quality (USFWS, 2011).
- Continue genetic analyses to determine the extent of variation within and between *Nasturtium gambelii* populations and the magnitude of the threat of gene swamping from *N. officinale* to help determine an appropriate recovery and reintroduction strategy (USFWS, 2011).

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SPECIES ACCOUNT: *Sanicula mariversa* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

Sanicula mariversa is a perennial herbaceous plant in the Apiaceae (parsley family). Basal leaves arise from a thick underground storage root, and are up to 23-cm (9 in) wide with three to five lobes. The yellow flowers are borne in masses on stems up to 0.7 m (2.3 ft) tall. Some of the flowers are perfect (with both male and female reproductive parts) and others have only staminoid (male) parts. The egg-shaped fruits are 4 to 6 mm (about 0.2 in) long and covered with hooked bristles (Wagner et al 1999; Makua Implementation Team 2003) (USFWS, 2016).

Historical Range

Historic data indicate *Sanicula mariversa* occurred in the central Waianae Mountains of Oahu (68 FR 35950). This species was first discovered in the 1970s, on Ohikilolo Ridge, and nothing is known of its past distribution and abundance (Makua Implementation Team 2003). When the species was listed, only two occurrences totaling less than 200 individuals were known (USFWS, 2016).

Current Range

Currently, *S. mariversa* occurs in four population units totaling approximately 224 individuals, none of which is stable (Table SB 32). These population units are found on Federal, State, and city/county lands (68 FR 35950) (USFWS, 2016).

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Sanicula mariversa* under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Sanicula mariversa* (77 FR 57648-57862). The critical habitat designation includes 11 critical habitat units, which encompass approximately 7,332 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Sanicula mariversa* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Sanicula mariversa* includes 11 critical habitat units, covering two ecosystem types, which encompass approximately 7,332 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3; Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac (105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Sanicula mariversa* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Sanicula mariversa* occurs within the lowland mesic and dry cliff ecosystems in the Waianae Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy:

Antidesma, Chamaesyce, Diospyros, Dodonaea. (F) Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Sanicula mariversa* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Likely insect pollinated (USFWS, 2016)

Lifespan

Adult: <10 years (USFWS, 2016)

Breeding Season

Adult: Flowering occurs from February through May, with fruits maturing a few months later (USFWS, 2016).

Reproduction Narrative

Adult: Leaves and stems die back to the storage root usually in May, and the plants are dormant during the dry summer months until new growth emerges usually in October or November. Flowering occurs from February through May, with fruits maturing a few months later. The massed inflorescences suggest pollination by insects, and bristles on the fruit suggest dispersal by birds. Because *S. mariversa* is an herbaceous species, its longevity probably is similar to that of other small plants that live less than 10 years (i.e., short-lived perennials) (Makua Implementation Team 2003). Other demographic information for *S. mariversa* in the wild is unknown, including longevity, dormancy cycles, number of seeds produced, age at sexual maturity, survivorship to sexual maturity, pollination and seed dispersal, vegetative reproduction and specific environmental requirements (USFWS, 2016).

Habitat Type

Adult: ridgelines/ridgecrests (USFWS, 2016)

Habitat Narrative

Adult: *Sanicula mariversa* occurs on dry, well-drained slopes at elevations of about 750 m (2,461 ft), usually on north-facing slopes just below the ridgeline or on exposed ridge crests. Most of the known plants grow in deep soil, although two plants were found at Puu Kawiwi in the cracks of a nearly vertical rock face (Makua Implementation Team 2003) (USFWS, 2016).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: The massed inflorescences suggest pollination by insects, and bristles on the fruit suggest dispersal by birds (USFWS, 2016).

Population Information and Trends**Population Trends:**

Unknown

Number of Populations:

4 (USFWS, 2016)

Population Size:

~224 (USFWS, 2016)

Population Narrative:

When the species was listed, only two occurrences totaling less than 200 individuals were known. Currently, *S. mariversa* occurs in four population units totaling approximately 224 individuals, none of which is stable (Table SB 32). These population units are found on Federal, State, and city/county lands (68 FR 35950). Currently demographic data is insufficient to detect trends in *Sanicula mariversa*. Since listing, consistent surveys have been conducted for only two locations. These surveys have shown that annual counts do not necessarily reflect numerical individual trends or the number of mature and immature individuals persisting. *Sanicula mariversa* is a perennial herb that is dormant during the summer. In addition, individual plants do not emerge each year and take many years to mature making detection in the field challenging. Mature plants flower inconsistently and appear to die after flowering once. Environmental conditions, such as large seed production years or favorable germination conditions may influence age at maturity and the length of dormancy periods. All these characteristics result in unpredictable population fluctuations from year to year (U.S. Army Garrison 2005b). Plants in the Keaau and Ohikilolo population units are located in low and very low risk zones for training-related wildfire. Thus, due to low numbers, lack of population units meeting stabilization numeric criteria, and insufficient knowledge of ecological influences on population dynamics, demographic data for *S. mariversa* are insufficient to determine whether the species is sustaining its numbers or declining (USFWS, 2016).

Threats and Stressors

Stressor: Landslides (USFWS, 2016)

Exposure:

Response:

Consequence: Extinction

Narrative: Population units of *S. mariversa* are especially vulnerable to extirpation from naturally occurring events such as landslides (USFWS, 2016).

Stressor: Reduced vegetative vigor (USFWS, 2016)

Exposure:

Response:**Consequence:** Loss of habitat**Narrative:** Population units of *S. mariversa* are especially vulnerable to extirpation from naturally occurring events such as landslides and/or reduced reproductive vigor due to small population size and limited distribution (56 FR 55770; 68 FR 35950; Service 1995a; Service 1998a) (USFWS, 2016).**Stressor:** Trampling (USFWS, 2016)**Exposure:****Response:****Consequence:** Loss of individuals**Narrative:** *Sanicula mariversa* also is threatened by trampling by hunters and hikers on Keaau Ridge, and potentially by fence maintenance activities on Ohikilolo Ridge (Makua Implementation Team 2003) (USFWS, 2016).**Recovery****Delisting Criteria:**

Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1995a, 1998a). The numerical criterion for stabilization of short-lived perennials is generally defined as three population units each consisting of 50 mature, reproducing individuals. Owing to infrequent, inconsistent flowering and significant population fluctuations from year to year, this standard was increased for *S. mariversa* to 100 mature, reproducing individuals per population unit. Other particular needs for the conservation of *S. mariversa* include research on seasonal life cycle, dormancy, and seed bank influences, and development of an effective monitoring program to determine whether stabilization criteria should be revised. For example, a five-year average of plants at various stages of maturation may be a more suitable goal for this species than annual counts of observed individuals. In addition, refinement of genetic storage goals require better data on seed dormancy, and propagation techniques must be developed (U.S. Army Garrison 2005b) (USFWS, 2016).

Conservation Measures and Best Management Practices:

- The Makua Implementation Team (2003) has developed stabilization protocols for *Sanicula mariversa*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). In addition, individuals of this species occur in three management units where they will benefit from population unit and/or ecosystem-level protection. The management units include Kamaileunu, and Keaau and Makaha, which are not fenced; and Ohikilolo, which is fenced. Germination trials with fresh *Sanicula mariversa* seed have been unsuccessful, and research is needed to determine dormancy constraints and appropriate propagation and outplanting techniques. In the wild, plants reintroduced in the Ohikilolo population unit have not been seen since 2003, and seed-sowing trials in 1999 resulted in only one germinated plant (U.S. Army Garrison 2005b). In 2005, ex situ collections for this species included 11 ungerminated seeds in a nursery (Harold L. Lyon Arboretum) and 11,000 seeds in seed storage (Lyon Arboretum Seed Storage Facility) (Service 2005b) (USFWS, 2016).

References

USFWS. 2016. Status of the Species and Critical Habitat: *Sanicula mariversa* (No Common Name). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

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Endangered Status for 23 Species on Oahu and Designation of Critical Habitat for 124 Species. Final Rule. 77 FR 57648-57862 (September 18, 2012)

USFWS 2016. Status of the Species and Critical Habitat: *Sanicula mariversa* (No Common Name). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016

SPECIES ACCOUNT: *Sanicula purpurea* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

Sanicula purpurea is a stout and erect perennial member of the Apiaceae (parsley family). It ranges in height from 8 to 36 cm (3.1 to 14.2 in) with stems originating from numerous kidney-to heart-shaped basal leaves that are 3 to 7-lobed and 2 to 8 cm (0.8 to 3.1 in) wide. The small purple or cream-colored flowers form branched terminal umbels of 6 to 10 flowers. Fruits are spherical, prickly, and 2.0 to 3.5 mm (0.08 to 0.14 in) long and 2 to 3 mm (0.08 to 0.12 in) wide (Wagner et al. 1999).

Historical Range

See current range/distribution

Current Range

Sanicula purpurea is known from Oahu and Maui. On Oahu, it occurred along the Koolau Mountain summit crest from 700 to 1,698 m (2,300 to 5,570 ft) elevation on wet, windswept slopes. Currently, on Oahu, 45 individuals are found as part of six occurrences at Helemano-Punaluu divide (10 individuals), north Kaukonahua-Punaluu Summit (8), Kaukonahua-Kahana summit (22), Waimalu-Kahaluu summit divide (1), Puu Keahiakahoe (1), and Wailupe-Waimanalo summit divide (3) (HINHP Database 2001; K. Kawelo, U.S. Army, pers. comm. 2003; J. Lau, HINHP, pers. comm. 2003). On West Maui, 200 individuals are distributed throughout seven scattered occurrences along 2.5 km (1.6 mi) of the Puu Kukui trail and on the West Maui Natural Area Reserve in the Puu Kukui watershed. In total, there are 245 individuals of *S. purpurea* known to remain in the wild (Service 1999b; K. Kawelo, U.S. Army, pers. comm. 2003; J. Lau, HINHP, pers. comm. 2003).

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Sanicula purpurea* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in Hawaii (81 FR 17790-18110). On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Sanicula purpurea* under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Sanicula purpurea* (77 FR 57648-57862). The critical habitat designation includes 14 critical habitat units, which encompass approximately 30,056 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Sanicula purpurea* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Sanicula purpurea* includes seven CHUs in Maui County, Hawaii. Approximately 1,399 ac (567 ha) of federal, private and state land on the Island of Maui (west Maui) are being designated as critical habitat for *Sanicula purpurea*. (81 FR 17790-18110).

Maui—Montane Wet—Unit 6 (and) *Palmeria dolei*—Unit 15—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 15—Montane Wet This area consists of 1,113 ac (451 ha) of State land, and 286 ac (116 ha) of privately owned land, at the summit and surrounding areas on west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta*, *Calamagrostis hillebrandii*, *Cyanea kunthiana*, *Geranium hillebrandii*, *Myrsine vaccinioides*, and *Sanicula purpurea*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 6 is not known to be occupied by the plants *Acaena exigua*, *Cyrtandra oxybapha*, *Huperzia mannii*, *Phyllostegia bracteata*, or *Platanthera holochila*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat designation for *Sanicula purpurea* includes 14 critical habitat units, covering two ecosystem types, which encompass approximately 30,056 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; Oahu—Wet Cliff—Units 6, 7, 8.

Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Waialele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Haula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikeekee, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet—Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of

Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet—Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu—Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamo Ridge.

Oahu—Wet Cliff—Unit 6 [151 ac (61 ha)]. This area consists of 151 ac (61 ha) in the wet cliff ecosystem on State land on the windward side of the Koolau Mountains in Kaipapau Gulch, entirely within the Kaipapau Forest Reserve. Oahu—Wet Cliff—Unit 7 [144 ac (58 ha)]. This area consists of 144 ac (58 ha) in the wet cliff ecosystem in State land on the windward side of the Koolau Mountains in Hauula Gulch, entirely within the Hauula Forest Reserve. Oahu—Wet Cliff—Unit 8 [4,649 ac (1,881 ha)]. This area consists of 1,479 ac (598 ha) of State land, 1,281 ac (519 ha) of City and County of Honolulu land, 5 ac (2 ha) of Federal land, and 1,884 ac (762 ha) of privately owned land, in the wet cliff ecosystem along the summit of the Koolau Mountains, overlapping portions of Sacred Falls State Park, the Waiahole FR (Waiahole and Iolekaa sections), the Kaneohe and Honolulu Watershed FRs, and the Nuana Pali State Wayside.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Sanicula purpurea* critical habitat consists of one component (81 FR 17790-18110):

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*. Species- specific physical or biological features: Bogs.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Sanicula purpurea* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Sanicula purpurea* occurs within the Lowland wet and Wet cliff ecosystems in the Koolau Mountain caldera complex:

Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (F) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Oahu—Wet Cliff—Units 6, 7, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: >65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: *Broussaia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. (F) Understory: Bryophytes, Ferns, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the

critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Sanicula purpurea* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors for *S. purpurea* are unknown. *S. purpurea* is considered to be a short-lived perennial (Service 1999b).

Habitat Type

Adult: Montane bogs

Habitat Narrative

Adult: *Sanicula purpurea* occurs in open mixed montane bogs or *Metrosideros* polymorph-dominated mixed montane bogs and windswept shrublands within the cloud zone between 415 and 959 m (1,361 and 3,146 ft) elevation. Associated native plant species include *Bidens* spp., *Cheirodendron* spp., *Dicanthelium koolauense*, *Gahnia beechyi*, *Leptecophylla tameiameia*, *Lycopodium* spp., *Machaerina angustifolia*, *Plantago pachyphylla*, *Sadleria pallida*, and *Vaccinium* spp. (HINHP Database 2001).

Dispersal/Migration***Population Information and Trends*****Population Narrative:**

New Status Information: • In 2012, Army Natural Resources reported 76 immature individuals, three mature, and two seedlings at East Range (O'ahu) (Army Natural Resources 2018). Currently, two populations on west Maui total fewer than 10 individuals, and two populations in the Ko'olau Mountains of O'ahu total approximately 16 individuals (PEPP 2015, 2016, 2017a, 2017b, 2018; Oppenheimer 2018, in litt.). There is no new information regarding the status of populations on west Maui at Paunau and the 'Eke Crater area (last observed in the early 2000s). The O'ahu population at the Ko'olau summit at Wailupe has not been monitored since 2013 (Ching 2018, in litt.). The IUCN recently estimated as many as 60 individuals in eight subpopulations for both islands (Keir et al. 2016). • In 2012, critical habitat was designated in 14 units on O'ahu in two ecosystems (lowland wet and wet cliff) (30,058 ac; 12,162 ha) (77 FR 57648, September 18, 2012). In 2016, two critical habitat units in one ecosystem (montane wet) were designated on west Maui for *Sanicula purpurea* (1,479 ac; 599 ha) (81 FR 17790, March 30, 2016) (USFWS, 2018).

Threats and Stressors**Stressor:****Exposure:****Response:****Consequence:**

Narrative: Threats to *Sanicula purpurea* on Oahu include potential effects of on-going and future Army training activities, habitat degradation by feral pigs, competition from non-native plant

species, reduced reproductive vigor, and a risk of extinction due to the small number of existing occurrences and stochastic events. The non-native plant species *Axonopus fissifolius* and *Clidemia hirta* threaten *S. purpurea* by altering its habitat and competing with it for nutrients, light, and space (HINHP Database 2001; Service 1999b).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: We previously reported that climate change may pose a threat to this species, anticipating an analysis by 2013. The assessment conducted by Fortini et al. (2013) concluded that *Sanicula purpurea* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.705 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions may be needed to conserve this taxon into the future (USFWS, 2018).

Recovery

Conservation Measures and Best Management Practices:

- A State-wide management plan should be developed and implemented for the long-term conservation of all known occurrences of *Sanicula purpurea*. This plan should also include broader landscape actions that are needed for the recovery of this plant throughout its range. The recovery plan for this species identifies the following important conservation actions: construction of exclosures protect the known occurrences from feral pigs and goats, subsequent control and/or removal of ungulates, and removal of competitive non-native plant species. Priority for all of these actions should be given to those occurrences with only a few individuals (e.g., Waimalu-Kahaluu Summit Divide, Puu Keahiakahoe). Additional surveys are also needed throughout suitable habitat to locate new occurrences and update the status of those occurrences that have not been seen in recent years (Service 1999b). Ongoing Conservation Actions: *Sanicula purpurea* is found in bog habitat in the Puu Kukui watershed owned by Maui Land and Pineapple on Maui. Since 1988, Maui Land and Pineapple has managed Puu Kukui Watershed and is receiving funding from the Service to survey for rare plants on their lands and build feral ungulate exclosures to protect listed species, including *S. purpurea*, that occur in the watershed. Maui Land and Pineapple have also constructed a boardwalk in Puu Kukui that spans the known range of this occurrence of *S. purpurea*. Entry into this area is strictly regulated to prevent the inadvertent introduction of competitive non-native plant species (Service 1999b; 68 FR 25934).
- New Management Actions: • Surveys and inventories—In 2016, the Plant Extinction Prevention Program (PEPP) noted that *Sanicula purpurea* on O‘ahu should be elevated to “POP” status (potential PEPP, with fewer than 50 individuals in the wild) and that additional surveys of known populations on west Maui were needed to determine if elevation to a “POP” status was necessary (PEPP 2016). • Captive propagation for genetic storage and reintroduction— o In 2017, collections were made from five of 10 founders from Helemano (Oahu) and two of 27 founders from East Range (Oahu) (PEPP 2017b). o The Oahu Army Natural Resource Program’s seed bank stores seeds from one founder from Opaepala and five founders from Helemano (Army Natural Resources 2018). o In 2017, the Lyon Seed Conservation Laboratory reported 53 seeds in storage from Honokōhau (west Maui) and 81 seeds in storage from Honokōwai (west Maui) (Lyon Arboretum 2017) (USFWS, 2018).
- Recommendations for Future Actions: We are not aware of any new threats or significant new information regarding the species’ biological status since the last 5-year review in 2011. Thus, the

following recommendations for future actions are reiterated for 5-year review for 2018. • Surveys and inventories—Continue to survey for additional populations of *Sanicula purpurea* in areas of potentially suitable habitat on west Maui. Reassess the status of populations at Paunau and 'Eke on west Maui, and the status of the population at the Ko'olau summit at Waimānalo on Oahu. • Ungulate monitoring and control—Maintain existing fences to protect populations from the negative impacts of feral pigs. • Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations of *S. purpurea*. • Rodent predation and herbivory—Control rats in the vicinity of known populations. • Slug herbivory—Develop and implement methods to control slugs. • Captive propagation for genetic storage and reintroduction—Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. • Reintroduction and translocation—Augment known populations and reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Human disturbance—Continue to maintain fencing to protect populations from hiking and trail maintenance impacts. • Stochastic events—Reduced viability—Research life-cycle aspects of the species that affect seed production, viability, and regeneration. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for its recovery. • Alliance and partnership development—Work with the west Maui and Oahu land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2018).

References

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SPECIES ACCOUNT: *Sanicula sandwicensis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2016a)

Physical Description

Sanicula sandwicensis (NCN) is a stout, erect, perennial herb in the parsley family (Apiaceae). This species is 8 to 28 in (20 and 70 cm) tall, with multiple, profusely-branched stems arising from the rootstalk. The basal leaves are numerous, chartaceous, orbicular, 1 to 5 in (3 to 12 cm) wide, and palmately 3-parted or 5-parted nearly to the petiole. The yellow flowers are umbellately arranged in terminal clusters of 2 to 5 stalks, with up to 20 flowers. Fruit is ovoid, 0.2 in (4 mm) long, and covered with stout, hooked, bulbous prickles (Constance and Affolter 1999, p. 210) (USFWS, 2015).

Taxonomy

Sanicula sandwicensis is recognized as a distinct taxon by Constance and Affolter in Wagner et al. (1999, p. 210), the most recently accepted taxonomic treatment of this species (USFWS, 2015).

Historical Range

Sanicula sandwicensis is historically known from the islands of Maui (Haleakala) and Hawaii (Mauna Kea, Mauna Loa, and Hualalai) (Constance and Affolter 1999, p. 210) (USFWS, 2015).

Current Range

Currently, there are fewer than 20 individuals of *S. sandwicensis* on east and west Maui (MNTF 2010, in litt.; PEPP 2011, pp. 162–164). This species has not been observed on Hawaii Island since the 1990s (HBMP 2010; MNTF 2010, in litt.) (USFWS, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Habitat Type

Adult: Shrubland/woodland (USFWS, 2015)

Spatial Arrangements of the Population

Adult: Clumped (inferred from USFWS, 2015)

Environmental Specificity

Adult: Narrow/specialist (inferred from USFWS, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 2015)

Site Fidelity

Adult: High (inferred from USFWS, 2015)

Habitat Narrative

Adult: *Sanicula sandwicensis* occurs at 6,500 to 8,500 ft (2,000 to 2,600 m) in shrubland and woodland on the islands of Maui and Hawaii Island, in the montane mesic (Hawaii Island and Maui), montane dry (Hawaii Island), and subalpine (Hawaii Island and Maui) ecosystems (Constance and Affolter 1999, p. 210; TNCH 2007; HBMP 2010). Currently, there are fewer than 20 individuals of *S. sandwicensis* on east and west Maui (MNTF 2010, in litt.; PEPP 2011, pp. 162–164). This species has not been observed on Hawaii Island since the 1990s (HBMP 2010; MNTF 2010, in litt.). The remaining occurrences of *Sanicula sandwicensis* and habitat for its reintroduction are at risk; the known individuals are restricted to a small area on Maui (USFWS, 2015). Clumped spatial arrangement of the population, narrow environmental specificity, low tolerance ranges and high site fidelity and ecological integrity of the community are inferred based on the species unique habitat requirements, small geographic area and the low number of known populations

Dispersal/Migration***Population Information and Trends*****Population Trends:**

No information found.

Resiliency:

Low (inferred from USFWS, 2016b)

Redundancy:

Low (inferred from USFWS, 2016b)

Population Size:

Maui: > 50; Hawaii: 46 mature (USFWS, 2016b)

Population Narrative:

Currently, there are more than 50 individuals of *S. sandwicensis* on east and west Maui (MNTF 2010, in litt.; PEPP 2011, pp. 162–164; Oppenheimer 2015, in litt.). In 2008, an occurrence of fewer than 20 individuals was found in Hawaii Volcanoes National Park (Benitez et al. 2008, p. 59). Following ungulate removal, this occurrence increased to as many as 45 individuals, with many juvenile plant (Orlando 2015, in litt.). A single individual was found farther east at about 7,400 ft (Orlando 2015, in litt.) (USFWS, 2016b).

Threats and Stressors

Stressor: Feral goats (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Feral goats modify and destroy the habitat of *Sanicula sandwicensis* on Maui, with evidence of the activities of these animals reported in the areas where this species occurs (PEPP 2011, pp. 162–164) (USFWS, 2015).

Stressor: Nonnative plants (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Nonnative plants modify and destroy the habitat of *S. sandwicensis*, and displace this species and other native Hawaiian plants by competing for water, nutrients, light, and space, or they may produce chemicals that inhibit the growth of other plants (Smith 1985, pp. 180–250; Vitousek et al. 1987 in Cuddihy and Stone 1990, p. 74; PEPP 2011, pp. 162–164) (USFWS, 2015).

Stressor: Rats (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of viability

Narrative: Seed predation by rats is likely to adversely affect this species (HBMP 2010) (USFWS, 2015).

Stressor: Stochastic events (USFWS, 2015)

Exposure:

Response:

Consequence: Extinction

Narrative: Stochastic events such as drought, flooding, and fires are all reported to pose a threat to this species (PEPP 2011, pp. 162–164). Erosion is a threat to occurrences on Maui (PEPP 2011, pp. 162–163) (USFWS, 2015).

Stressor: Reduced vegetative vigor (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: This species may experience reduced reproductive vigor due to low levels of genetic variability, leading to diminished capacity to adapt to environmental changes, thereby lessening the probability of its long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361) (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Climate change may result in alteration of the environmental conditions and ecosystems that support this species. *Sanicula sandwicensis* may be unable to tolerate or respond to changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini et al. 2013, p. 88) (USFWS, 2015).

Recovery

Recovery Actions:

- A recovery plan has not been issued for this species.

References

U.S. Fish and Wildlife Service. 2015. Endangered and Threatened Wildlife and Plants

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Proposed Rule. FR Vol. 80, No. 189. Pages 58820-58909

USFWS. 2016a. Environmental Conservation Online System (ECOS) – Species Profile.
<http://ecos.fws.gov/ecp0/>. Accessed August 2016

USFWS. 2016b. Endangered and Threatened Wildlife and Plants

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SPECIES ACCOUNT: *Santalum haleakalae* var. *lanaiense* (= *S. freycinetianum* var. *l.*) (ʻiliahi, Lanai sandalwood)

Species Taxonomic and Listing Information

Listing Status: Endangered; 01/24/1986; Pacific Region (R1) (USFWS, 2016)

Physical Description

A shrub or tree 1 - 13 m tall. Flowers are dark red to greenish yellow externally, and dark red within (NatureServe, 2015).

Taxonomy

A member of the sandalwood family (Santalaceae) (USFWS, 2016). *Santalum freycinetianum* has been divided taxonomically into three varieties: var. *freycinetianum*, var. *lanaiense*, and var. *pyrularium*. In her revision of the Hawaiian species of *Santalum*, Harbaugh et al. (2010) moved the plants previously recognized as *S. freycinetianum* var. *lanaiense* to *S. haleakalae* var. *lanaiense* (USFWS, 2011).

Historical Range

This plant is known from Kanepuʻu and the summit ridge system of the island of Lanaʻi and, as the taxon is defined in Wagner et al. (1990), populations that occur at scattered locations on Maui. Prior to its discovery by the scientific community, the range of *Santalum freycinetianum* var. *lanaiense* may have been considerably reduced by Hawaiʻi's highly profitable sandalwood trade (USFWS, 1995).

Current Range

Currently, *S. haleakalae* var. *lanaiense* is known from Molokai, Lanai, and Maui (USFWS, 2016).

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Santalum haleakalae* var. *lanaiense* (Lanai sandalwood (=ʻiliahi)) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 26 detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Santalum haleakalae* var. *lanaiense* includes 26 CHUs in Maui County, Hawaii with detailed unit information. There are also an unknown number of units on Lanai that contain this species (number of units is unknown because detailed unit descriptions for Lanai are not available) (81 FR 17790-18110).

Molokai—Lowland Mesic—Unit 1 (and) *Palmeria dolei*—Unit 37—Lowland Mesic (and) *Pseudonestor xanthophrys*—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Ctenitis*

squamigera, *Cyanea dunbariae*, *C. mannii*, *C. profuga*, *Cyperus fauriei*, *Cyrtandra filipes*, *Gouania hillebrandii*, *Labordia triflora*, *Neraudia sericea*, *Santalum haleakalae* var. *lanaiense*, *Schiedea lydgatei*, *S. sarmentosa*, *Silene alexandri*, *S. lanceolata*, *Spermolepis hawaiiensis*, and *Zanthoxylum hawaiiense*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Lowland Mesic—Unit 1 is not known to be occupied by *Asplenium dielerectum*, *Bonamia menziesii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea procera*, *C. solanacea*, *Diplazium molokaiense*, *Festuca molokaiensis*, *Flueggea neowawraea*, *Isodendron pyriformis*, *Kadua laxiflora*, *Melicope mucronulata*, *M. munroi*, *M. reflexa*, *Phyllostegia haliakalae*, *P. mannii*, *P. pilosa*, *Sesbania tomentosa*, *Stenogyne bifida*, or *Vigna o-wahuensis*, or the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 1 consists of 11,465 ac (4,640 ha) of State land, 2,069 ac (837 ha) of federally owned land, and 3 ac (1 ha) of privately owned land, from Kanaio to Kahualau Gulch on the southern slopes of east Maui. This unit is occupied by the plants *Bonamia menziesii*, *Cenchrus agrimonoides*, *Flueggea neowawraea*, *Melicope adscendens*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 1 is not known to be occupied by *Alectryon macrococcus*, *Bidens micrantha* ssp. *kalealaha*, *Canavalia pubescens*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Sesbania tomentosa*, *Solanum incompletum*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 2 consists of 1,851 ac (749 ha) of State land at Keokea on the southern slopes of east Maui. This unit is occupied by the plants *Bonamia menziesii*, *Canavalia pubescens*, and *Hibiscus brackenridgei*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 2 is not known to be occupied by *Alectryon macrococcus*, *Bidens micrantha* ssp. *kalealaha*, *Cenchrus agrimonoides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or

Zanthoxylum hawaiiense, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 3 consists of 188 ac (76 ha) of privately owned land, at Keauhou on the southern slopes of east Maui. This unit is occupied by the plant *Canavalia pubescens*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 3 is not known to be occupied by *Bidens micrantha* ssp. *kalealaha*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 4 consists of 1,266 ac (512 ha) of State land (including the Department of Land and Natural Resources) at Ahihi-Kinau Natural Area Reserve on the southern slopes of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Maui—Lowland Dry—Unit 4 is not currently occupied by *Bidens micrantha* ssp. *kalealaha*, *Bonamia menziesii*, *Canavalia pubescens*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 5 consists of 3,615 ac (1,463 ha) of State land, and 43 ac (17 ha) of privately owned land, from Panaewa to Manawainui on the western and southern slopes of west Maui. This unit is occupied by the plants *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, *Cenchrus agrimonioides*, *Gouania hillebrandii*, *Kadua coriacea*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and *Tetramolopium capillare*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing

wild populations. Although Maui—Lowland Dry—Unit 5 is not known to be occupied by *Ctenitis squamigera*, *Cyanea obtusa*, *Hesperomannia arbuscula*, *Hibiscus brackenridgei*, *Lysimachia lydgatei*, *Neraudia sericea*, *Schiedea salicaria*, *Sesbania tomentosa*, or *T. remyi*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 6 consists of 3 ac (1 ha) of State land, and 237 ac (96 ha) of privately owned land, from Paleaahu Gulch to Puu Hona on the southern slopes of west Maui. This unit is occupied by the plants *Hibiscus brackenridgei* and *Schiedea salicaria*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 6 is not known to be occupied by *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, *Cenchrus agrimonoides*, *Ctenitis squamigera*, *Cyanea obtusa*, *Gouania hillebrandii*, *Hesperomannia arbuscula*, *Kadua coriacea*, *Lysimachia lydgatei*, *Neraudia sericea*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Spermolepis hawaiiensis*, *Tetramolopium capillare*, or *T. remyi*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Mesic—Unit 1 (and) *Palmeria dolei*—Unit 42—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 42— Montane Mesic This area consists of 257 ac (104 ha) of State land, and 559 ac (226 ha) of privately owned land from Kamiloloa to Makolelau in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Bidens wiebkei*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Montane Mesic—Unit 1 is not known to be occupied by *Asplenium dielerectum*, *Cyanea dunbariae*, *C. mannii*, *C. procera*, *C. solanacea*, *Cyperus fauriei*, *Kadua laxiflora*, *Melicope mucronulata*, *Neraudia sericea*, *Plantago princeps*, or *Stenogyne bifida*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Mesic—Unit 2 consists of 1,034 ac (419 ha) of State land, and 113 ac (46 ha) of privately owned land, from Honokohau to Launiupoko on the western slopes of west Maui. This unit is occupied by the plants *Ctenitis squamigera*, *Remya mauiensis*, *Santalum haleakalae* var.

lanaiense, and *Zanthoxylum hawaiiense*, and includes the mixed hermland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Mesic—Unit 2 is not known to be occupied by *Asplenium dielirectum*, *Bidens campylotheca* ssp. *pentamera*, or *Colubrina oppositifolia*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within its historical range. Due to its small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could approach recovery.

Maui—Lowland Mesic—Unit 3 (and) *Palmeria dolei*—Unit 1—Lowland Mesic (and) *Pseudonestor xanthophrys*—Unit 1— Lowland Mesic This area consists of 477 ac (193 ha) of State land at Ukumehame on the southern slopes of west Maui. These units include the mixed hermland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). Although Maui—Lowland Mesic—Unit 3 is not currently occupied by the plants *Asplenium dielirectum*, *Bidens campylotheca* ssp. *pentamera*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Zanthoxylum hawaiiense*, or by the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 2 (and) *Palmeria dolei*—Unit 3—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 3— Lowland Wet (and) *Newcombia cumingi*—Unit 1—Lowland Wet This area consists of 65 ac (26 ha) of State land at Moomoku, on the northwestern slopes of west Maui. These units include the mixed hermland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. Although Maui—Lowland Wet—Unit 2 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendrion pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), or by the Newcomb's tree snail (*Newcombia cumingi*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 3 (and) *Palmeria dolei*—Unit 4—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 4— Lowland Wet This area consists of 1,247 ac (505 ha) of State land at Honanana Gulch on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta*, *Cyanea asplenifolia*, and *Pteris lidgatei*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 3 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwiku* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 4 (and) *Palmeria dolei*—Unit 5—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 5— Lowland Wet This area consists of 864 ac (350 ha) of State land at Kahakuloa Valley on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta* and *Cyanea asplenifolia*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 4 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwiku* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 5 (and) *Palmeria dolei*—Unit 6—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 6— Lowland Wet This area consists of 30 ac (12 ha) of State land at Iao Valley on the eastern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 5 is not known to be occupied by the plants *Alectryon macrococcus*,

Asplenium dielerectum, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 6 (and) *Palmeria dolei*—Unit 7—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 7— Lowland Wet This area consists of 136 ac (55 ha) of State land at Honokowai and Wahikuli valleys on the western slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 6 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 7 (and) *Palmeria dolei*—Unit 8—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 8— Lowland Wet This area consists of 898 ac (364 ha) of State land at Olowalu Valley, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Alectryon macrococcus*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 7 is not currently occupied by the plants *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have

determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 8 (and) *Palmeria dolei*—Unit 9—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 9— Lowland Wet This area consists of 230 ac (93 ha) of State land at upper Ukumehame Gulch, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 8 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 1 (and) *Palmeria dolei*—Unit 18—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 18— Montane Mesic This area consists of 6,593 ac (2,668 ha) of State land, 707 ac (286 ha) of privately owned land, and 3,672 ac (1,486 ha) of federally owned land (Haleakala National Park), from Kealahou to Puualae, nearly circumscribing the summit of Haleakala on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Asplenium dielerectum*, *A. peruvianum* var. *insulare*, *Clermontia lindseyana*, *Cyanea horrida*, *C. obtusa*, *Cyrtandra ferrispilosa*, *C. oxybapha*, *Diplazium molokaiense*, *Geranium arboreum*, *G. multiflorum*, *Huperzia mannii*, *Melicope adscendens*, and *Neraudia sericea*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 1 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Cyanea glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. mceldowneyi*, *Phyllostegia bracteata*, *P. mannii*, *Santalum haleakalae* var. *lanaiense*, *Wikstroemia villosa*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 2 (and) *Palmeria dolei*—Unit 19—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 19— Montane Mesic This area consists of 124 ac (50 ha) of State land at Helu and the upper reaches of Puehuhunui on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Lysimachia lydgatei*, *Remya mauiensis*, and *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 2 is not known to be occupied by the plants *Geranium hillebrandii*, *Huperzia mannii*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 3 (and) *Palmeria dolei*—Unit 20—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 20— Montane Mesic This area consists of 174 ac (70 ha) of State land at Lihau on the southwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plant *Geranium hillebrandii*, and contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 3 is not known to be occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Huperzia mannii*, *Lysimachia lydgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 4 (and) *Palmeria dolei*—Unit 21—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 21— Montane Mesic This area consists of 72 ac (29 ha) of State land at Halepohaku on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). Although Maui—Montane Mesic—Unit 4 is not known to be occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Geranium hillebrandii*, *Huperzia mannii*, *Lysimachia lydgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their

small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 5 (and) *Palmeria dolei*—Unit 22—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 22— Montane Mesic This area consists of 170 ac (69 ha) of State land at the upper reaches of Manawainui Gulch on the southeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants *Remya mauiensis* and *Santalum haleakalae* var. *lanaiense*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 5 is not known to be occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Geranium hillebrandii*, *Huperzia mannii*, *Lysimachia lydgatei*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Dry—Unit 1 consists of 2,962 ac (1,199 ha) of State land, and 563 ac (228 ha) of federally owned land (Haleakala National Park), from Kanaio to Naholoku and Kaupo Gap along the southern slopes of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane dry ecosystem (see Table 5). Although Maui—Montane Dry—Unit 1 is not known to be occupied by the plants *Alectryon macrococcus*, *Geranium arboreum*, *Melicope knudsenii*, *M. mucronulata*, *Santalum haleakalae* var. *lanaiense*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these montane dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 6 (and) *Palmeria dolei*—Unit 35—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 35— Wet Cliff This area consists of 1,858 ac (752 ha) of State land, and 253 ac (102 ha) of privately owned land, at the summit ridges of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plants *Alectryon macrococcus*, *B. conjuncta*, *Ctenitis squamigera*, *Cyrtandra munroi*, *Remya mauiensis*, and *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 6 is not known to be occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Bonamia menziesii*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendrion pyriformis*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, or *Tetramolopium capillare*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu

(*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 7 (and) *Palmeria dolei*—Unit 36—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 36—Wet Cliff This area consists of 556 ac (225 ha) of State land along Honokowai ridge on the northwestern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units are occupied by the plants *Cyrtandra filipes* and *C. munroi*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 7 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 8 consists of 337 ac (137 ha) of State land along Kahakuloa ridge on the north side of west Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff—Unit 8 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Santalum haleakalae* var. *lanaiense* critical habitat consists of seven components. Lowland dry (east Maui and west Maui), Lowland mesic (west Maui, Lanai and Molokai), Lowland wet (west Maui and Lanai), Montane wet (Lanai), Montane mesic (east Maui, west Maui and Molokai), Montane dry (east Maui) and Wet cliff (west Maui and Lanai) (81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: Diospyros, Myoporum, Pleomele, Santalum. Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Sicyos.

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: Acacia, Charpentiera, Cheirodendron, Metrosideros. Subcanopy: Broussaisia, Cibotium, Eurya, Ilex, Myrsine. Understory: Ferns, Carex, Coprosma, Leptecophylla, Oreobolus, Rhynchospora, Vaccinium.

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: Acacia, Ilex, Metrosideros, Myrsine, Nestegis, Nothocestrum, Pisonia, Pittosporum, Psychotria, Sophora, Zanthoxylum. Subcanopy: Alyxia, Charpentiera, Coprosma, Dodonaea, Kadua, Labordia, Leptecophylla, Phyllostegia, Vaccinium. Understory: Ferns, Carex, Peperomia.

Ecosystem: Montane Dry. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Dry cinder or ash soils, loamy volcanic sands, blocky lava, rock outcroppings. Canopy: Acacia, Metrosideros, Myoporum, Santalum, Sophora. Subcanopy: Chamaesyce, Coprosma, Dodonaea, Dubautia, Leptecophylla, Osteomeles, Wikstroemia. Understory: Bidens, Eragrostis, Melanthera, Vaccinium.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: Broussaisia, Cheirodendron, Leptecophylla, Metrosideros. Understory: Bryophytes, Ferns, Coprosma, Dubautia, Kadua, Peperomia.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is

needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass),

and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylothea* ssp. *pentamera*, *B. campylothea* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Food Source

Adult: Plant roots (USFWS, 2011)

Food/Nutrient Narrative

Adult: *Santalum* trees are root-parasitic, which means they have special root extensions that capture water and nutrients from roots of other plants. The plants that donate nutrients to *Santalum* are called hosts, and *Santalum* does not grow well without them (Merlin et al. 2006). *Santalum haleakalae* obtains vital nutrients from other woody species such as koa (*Acacia koa*), an endemic forest tree which, when available, is reportedly the main host (USFWS, 2011).

Lifespan

Adult: > 10 years (inferred from USFWS, 2016)

Reproduction Narrative

Adult: It is a long-lived perennial (USFWS, 2016).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Lowland to highland dry, moist and wet forests and shrublands (NatureServe, 2015; USFWS, 1995)

Environmental Specificity

Adult: Broad (inferred from USFWS, 1995)

Habitat Narrative

Adult: Inhabits dry, moist and wet forests and shrublands. On Lanai and West Maui: ridgetops, gulch slopes and plains. On East Maui: old lava flows (NatureServe, 2015). The habitat of *Santalum freycinetianum* var. *lanaiense* is quite diverse, including lowland dry forest on well-drained barren soils to mesic forest on shallow soils at higher elevations. *Santalum freycinetianum* var. *lanaiense* has been observed in mostly mesic, sometimes wet, areas of level to gentle slope with deep soil; on mesic, moderate to steep, lower to upper gulch slopes and ridgecrests in mixed native shrubland grading to forest; in xeric to wet forest and shrublands; and in *Nestegis*/*Diospyros* lowland dry forest with dense growth of *Melinis* and *Lantana* (USFWS, 1995).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Low (inferred from USFWS, 2016; see current range/distribution)

Redundancy:

Moderate (inferred from USFWS, 2016)

Number of Populations:

~13 (USFWS, 2018)

Population Size:

~ 100 (USFWS, 2018)

Population Narrative:

New Status Information: • The 2011, the 5-year review for *Santalum haleakalae* var. *lanaiense* (as *Santalum freycinetianum* var. *lanaiense*) reported at least 110 individuals in 40 locations on Lānaʻi, Molokaʻi, and Maui; however, a species expert estimated there may be more than 2,000 individuals total (Harbaugh et al. 2010). Currently, there are additional individuals reported on west Maui at Kahana, Honokōwai, Launiupoko-Kauaʻula, and Manawainui (ca 60 individuals) (NTBG 2011, 2013c, Oppenheimer 2018, in litt.). On east Maui, there are fewer than 10 new individuals at Keʻānae, south of Kahua, and in the upper Kepuni drainage (NTBG 2013a, b, 2014, 2016). On Lānaʻi, plants are in the same areas, and total about approximately 30 individuals (Oppenheimer 2018, in litt.). On Molokaʻi, there is one population at Puaʻahala, totaling between 25 and 50 individuals (Bakutis 2018, in litt.). • In 2012, the Service revised critical habitat for *Santalum haleakalae* var. *lanaiense*, and the proposed rule identified six critical

habitat units in four ecosystems (lowland mesic, lowland wet, montane wet, and wet cliff) on Lānaʻi (112,988 ac, 5,257 ha) (77 FR 34464, July 11, 2012). In the final rule, the Service excluded critical habitat for this variety on the island of Lānaʻi because as demonstrated by the ongoing conservation activities by the private landowner, their commitment to develop the Lānaʻi Natural Resources Plan, and a memorandum of understanding with the Service, exclusion from critical habitat would provide greater long-term benefits to the species than designation of critical habitat (USFWS 2015; 81 FR 17790, March 30, 2016). • In 2016, 24 critical habitat units were designated for *S. haleakalae* var. *lanaiense* in six ecosystems (lowland dry, lowland mesic, lowland wet, montane mesic, montane dry, and wet cliff) on both east and west Maui (43,875 ac, 17,756 ha), and two critical habitat units were designated in two ecosystems (lowland mesic and montane mesic) on Molokaʻi (9,586 ac, 3,879 ha) (81 FR 17790, March 30, 2016) (USFWS, 2018).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs, goats, axis deer, and mouflon), nonnative plants, fire, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Fire can destroy dormant seeds and plants, even in steep and inaccessible areas. Successive fires can remove habitat for native species by altering microclimate conditions favorable to alien plants. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, goats, axis deer, mouflon, rats, and slugs) is considered an ongoing threat to *Santalum haleakalae lanaiense* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: —Climate change may pose a threat to this variety. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai'i using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The analysis by Fortini et al. (2013) was conducted at the species level, and concluded that *Santalum haleakalae* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.66 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions may be needed to conserve this taxon into the future (USFWS, 2018).

Stressor: Lack of adequate hunting regulations

Exposure:

Response:

Consequence:

Narrative: Two populations on west Maui, two populations on Lāna'i, and one population on Moloka'i of *Santalum haleakalae* var. *lanaiense* occur in State hunting areas. Two of these, in Kānepu'u Preserve units on Lāna'i, are fenced; however, any breach in the fence may lead to the loss of these populations. Habitat destruction, and predation, by feral pigs, goats, mouflon, and axis deer are threats to this variety. Public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations are at risk (DLNR 2010) (USFWS, 2018).

Recovery

Reclassification Criteria:

1. A total of five to seven populations are documented on Lanai and at least one other island where they now occur or occurred historically (USFWS, 1995).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population (for long-lived perennials) (USFWS, 1995).
3. Each of these populations must persist at this level for at least 5 consecutive years before downlisting is considered (USFWS, 1995).

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Lanai and at least one other island where they now occur or occurred historically (USFWS, 1995).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population (for long-lived perennials) (USFWS, 1995).
3. Each population should persist at this level for at least 5 consecutive years before delisting is considered (USFWS, 1995).

Recovery Actions:

- Protect habitat of current populations and manage threats (USFWS, 1995).

- Conduct research essential to conservation of the species (USFWS, 1995).
- Expand current populations (USFWS, 1995).
- Establish new populations as needed to reach recovery objectives (USFWS, 1995).
- Validate and revise recovery objectives (USFWS, 1995).

Conservation Measures and Best Management Practices:

- Fence existing populations to provide protection from the negative impacts of feral ungulates (USFWS, 2011).
- Control invasive introduced species around known populations (USFWS, 2011).
- Develop and implement methods to control the two-spotted leaf hopper and black twig borer (USFWS, 2011).
- Control rats in the vicinity of these populations (USFWS, 2011).
- Develop and implement methods to control mice (USFWS, 2011).
- Propagate to augment the existing populations (USFWS, 2011).
- Establish additional populations within protected suitable habitat (USFWS, 2011).
- Develop and implement a wildfire management plan (USFWS, 2011).
- Survey areas where *Santalum haleakalae* var. *lanaiense* has been reported to determine if the variety warrants delisting under the new taxonomic treatment (USFWS, 2011).
- Work with Hawaii Division of Forestry and Wildlife, The Nature Conservancy of Hawaii, and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2011).
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2011).
- New Management Actions:
 - Ungulate monitoring and control—
 - o The West Maui Mountains Watershed Partnership continues to construct fencing to protect the west Maui watershed from feral pigs, goats, and axis deer (WMMWP 2013). The partnership consists of 10 landowners, two associate partners, the Service, and Tri-Isle RC & D. Pigs and goats have been eliminated from most of the watershed; however, goats persist in some areas and surrounding axis deer populations are increasing. Some current fencing is being retrofitted with 8-ft high fencing to keep axis deer out of protected areas.
 - o Leeward Haleakalā Watershed Restoration Partnership (LHWRP), consisting of 11 landowners on leeward east Maui, is working to protect rare and endangered species by constructing fencing, conducting ungulate control, and outplanting the native tree *Acacia koa* in the upper elevations of leeward east Maui (LHWRP 2006), all of which may benefit *S. haleakalae* var. *lanaiense* and its habitat.
 - o In 1993, East Maui Irrigation (EMI) and the Department of Land and Natural Resources (DLNR) entered into a right-of-entry agreement to permit the use of EMI roads by public hunters in the area of Ha'ikū Uka, with the intention of increasing hunting activities to control feral pigs, goats, and axis deer in the Ko'olau FR. In 1996, constituents of the East Maui Watershed Partnership (EMWP) prepared an ungulate exclusion fencing strategy to preserve and protect 12,000 ac (4,856 ha) of land (called the core area) on the east Maui slope between Hanawī NAR and Ko'olau Gap, including the Ha'ikū Uka area, and The Nature Conservancy's (TNC's) Waikamoi Preserve (EMWP 2009, p. 3). Approximately 7,000 ac (2,833 ha) of the core area consists of State forest reserve and EMI lands, and approximately 5,000 ac (2,024 ha) are within TNC's Waikamoi Preserve. In 2005 and 2006, the Service and others provided funding for the construction of an ungulate exclusion fence at 3,600 ft (1,100 m) elevation and for improving hunter access to EMWP lands. The Waikamoi Preserve and Haleakalā National Park fences provide the upper boundary of the fenced area (TNC 2006). The fence was completed in 2006, and the enclosed area is divided into five management units (Honomanū, Ko'olau Gap, Walua Nui, Wailua Iki, and Kopiliula), which are

managed through the cooperation of landowners, including EMI, and other partners (EMWP 2009, pp. 3–17). The completion of this fencing for ungulate management represents a significant contribution to the conservation of the Maui Nui species, including individuals of *Santalum haleakalae* var. *lanaiense* that occur in the area. o In 2016, the Hawaii DLNR, Division of Forestry and Wildlife and TNC (for the East Moloka'i Watershed Partnership) submitted a draft Environmental Assessment for the proposed Pāku'i Watershed Project. The proposed project's goal is the construction of a 5.5-mile fence, which, in conjunction with the existing Kapualei Extension fence, will enclose the Pāku'i Unit and protect 2,080 ac (842 ha) of vital watershed on southeast Moloka'i (TNC 2016). If completed, the fence would provide protection from ungulates to the occurrences of *S. haleakalae* var. *lanaiense* and other rare plant species at Pua'ahala and Kua Gulch. o Pūlama Lāna'i, under their Lāna'i Natural Resources Plan (in prep), will assist TNC with control of ungulates within subunits of the Kanepu'u Preserve (Donoho 2016, in litt.). They are also conducting other fence inspections to prioritize and schedule previously deferred fence maintenance. These actions will benefit *S. haleakalae* var. *lanaiense* and its habitat. • Invasive plant monitoring and control—The ungulate control projects described above also include nonnative plant control efforts. • Captive propagation for genetic storage and reintroduction— o In 2011, 2013, 2014, and 2016, herbarium collections were made of scattered individuals of *S. haleakalae* var. *lanaiense* found on east and west Maui (NTBG 2011, 2013a, b, c, 2014, 2016). o Lyon Arboretum has approximately 300 seeds in storage from plants at Kanepu'u, Lāna'i (Lyon Arboretum 2017). o The Olinda Rare Plant Facility (ORPF) reported four potted plants in storage from cuttings of *S. haleakalae* var. *lanaiense* on east and west Maui and Lāna'i (ORPF 2013, 2014, 2017). o Fleming Arboretum on east Maui reports a collection of a group of young *S. haleakalae* var. *lanaiense* plants that flower annually (Fleming Arboretum 2017) (USFWS, 2018).

- Recommendations for Future Actions: The inadequacy of hunting regulations has been noted as a threat since the last 5-year review in 2011; however, this information does not change the species' biological status. Therefore, the following recommendations for future actions are added or reiterated for the 5-year review for 2018. • Ungulate monitoring and control— o Continue to construct and maintain fenced exclosures to protect individuals from the negative impacts of feral ungulates. o Protect all occurrences against browsing and habitat disturbances from feral ungulates to prevent imminent extinction. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative species that compete with the species around all populations. • Captive propagation for genetic storage and reintroduction—Continue seed collection and propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Continue reintroduction of individuals into suitable habitat within historic range that is being managed for known threats to this subspecies. Propagate to augment existing populations. • Climate change adaptation strategy—Assess the modeled effects of climate change on this variety, and determine future landscape needed for its recovery. • Fire monitoring and control—Develop and implement fire prevention management plans. • Rodent predation or herbivory—Control rats in the vicinity of all populations. Develop and implement effective controls for mice. • Invertebrate predation or herbivory—Develop and implement effective controls for the black twig borer and the two-spotted leaf hopper. • Habitat and natural process management and restoration—Strategic planning—Continue to work with the Hawai'i Division of Forestry and Wildlife, watershed partnerships, TNC, and other land managers to continue implementation of ecosystem-level restoration and management to benefit this variety (USFWS, 2018).

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SPECIES ACCOUNT: *Santalum involutum* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2016)

Physical Description

Santalum involutum (iliahi) is a shrub or small tree in the sandalwood family (Santalaceae). This species is 7 to 23 ft (2 to 7 m) tall, with yellowish-green to grayish-green leaves that are thinly chartaceous and often appearing droopy. The flowers are cream to purple, or greenish with a purple interior (Harbaugh et al. 2010, pp. 827– 838) (USFWS, 2015).

Taxonomy

Kartesz (1994, 1999) included *Santalum involutum* in *S. freycinetianum* var. *pyrularium*. (NatureServe, 2015)

Historical Range

Known only from isolated forest pockets in Pohakuao and Kalalau valleys, Kaua'i. (NatureServe, 2015) Historically, this species was known from northern Kauai at Kee, Hanakapiai, and Wainiha, and from southern Kauai at Wahiawa, but has not been observed in these areas for 30 years (Harbaugh et al. 2010, p. 835) (USFWS, 2016b).

Current Range

Currently, approximately 50 to 100 individuals occur in isolated forest pockets in Pohakuao and Kalalau valleys (Harbaugh et al. 2010, p. 835) (USFWS, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: There is no specific information regarding reproduction for this species. However, other sandalwood species (*Santalum freycinetianum* var. *lanaiense*) notes the following 'The flowering period for *Santalum freycinetianum* var. *lanaiense* may be variable, usually in late summer or fall, with flowering frequent and fruiting occasional. Vegetative reproduction by root suckers has been noted infrequently in Maui populations (Medeiros et al. 1986). Observations of other species of *Santalum* indicate that flowering does not usually begin until plants are 3 years old and viable fruit is produced at about 5 years (Hamilton and Conrad 1990). *Santalum freycinetianum* var. *lanaiense* appears to flower and fruit readily, but rats eat the fruits before seeding occurs (USFWS 1986a). Birds are important seed dispersal agents for other sandalwoods (Hamilton and Conrad 1990); that may also be true for *Santalum freycinetianum* var. *lanaiense*. If seed is set and dispersed, the availability of suitable habitat for the seedlings may be a limiting factor (e.g. Medeiros et al. 1986). Historically the taxon may have preferred drier areas than those in which it is currently found, but these areas were the first to be destroyed. In addition, for successful growth of *Santalum freycinetianum* var. *lanaiense*, other plants or trees probably

must grow nearby. Related species of *Santalum* are known to be hemiparasites and require the availability of the roots of other plants to maintain vigor during at least some growth stages, particularly young stages (Hamilton and Conrad 1990; R. Hobdy, personal communication 1992). The specific requirements and preferences regarding these aspects of the life cycle of *Santalum freycinetianum* var. *lanaiense* are not known (Hamilton and Conrad 1990). ' USFWS, 1995.

Habitat Type

Adult: Mesic to wet forest (USFWS, 2015)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 2015)

Habitat Narrative

Adult: Habitat for *Santalum involutum* is mesic and wet forest on Kauai, at 400 to 2,500 ft (120 to 750 m), in the lowland mesic and lowland wet ecosystems (TNCH 2007; Harbaugh et al. 2010, pp. 827–838) (USFWS, 2015). Clumped spatial arrangement of the population is based on the species being found in 'isolated forest pockets' (USFWS, 2015).

Dispersal/Migration***Population Information and Trends*****Population Trends:**

No information found.

Resiliency:

Low (inferred from USFWS, 2016b)

Population Size:

50 - 100 (USFWS, 2016b)

Population Narrative:

Currently, approximately 50 to 100 individuals occur in isolated forest pockets on Kauai (Harbaugh et al. 2010, p. 835; Wood 2015, in litt.) (USFWS, 2016b).

Threats and Stressors

Stressor: Feral pigs, goats and deer (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Feral pigs, goats, and black-tailed deer modify and destroy the habitat of *Santalum involutum* on Kauai, with evidence of the activities of these animals reported in the areas where this species occurs (Harbaugh et al. 2010, pp. 835–836). Herbivory is also an issue (USFWS, 2015).

Stressor: Nonnative plants (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Nonnative plants modify and destroy the native habitat of *S. involutum*, and displace this species and other native Hawaiian plants by competing for water, nutrients, light, and space, or they may produce chemicals that inhibit the growth of other plants (Smith 1985, pp. 180–250; Vitousek et al. 1987 in Cuddihy and Stone 1990, p. 74; HBMP 2010). Nonnative plants reported to modify and destroy habitat of *S. involutum* are: *Psidium guajava*, *P. cattleianum*, *Lantana camara*, *Rubus argutus*, *Hedychium gardnerianum*, *Clidemia hirta*, *Melinis minutiflora* (molasses grass) (Harbaugh et al. 2010, p. 836) (USFWS, 2015).

Stressor: Rats (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Herbivory and seed predation by rats is reported to pose a threat to *S. involutum* (Harbaugh et al. 2010, p. 836) (USFWS, 2015).

Stressor: Fire (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Wildfire is a potential threat to this species in mesic areas (Harbaugh et al. 2010, p. 836) (USFWS, 2015).

Stressor: Reduced vegetative vigor (USFWS, 2015)

Exposure:

Response:

Consequence: Extinction

Narrative: This species may experience reduced reproductive vigor due to low levels of genetic variability, leading to diminished capacity to adapt to environmental changes, thereby lessening the probability of its long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361) (USFWS, 2015).

Recovery**Recovery Actions:**

- There is no recovery plan for this species.

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Proposed Rule. FR Vol. 80, No. 189. Pages 58820-58909.

SPECIES ACCOUNT: *Sarracenia oreophila* (Green pitcher-plant)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 10/21/1979

Physical Description

A perennial, carnivorous herb arising from rhizomes. The leaves consist of two types: tubular or pitcher-shaped leaves, appearing in the spring, that grow 2-7.5 dm tall, which, in late summer begin to wither and are replaced by flat, prostrate leaves that persist until the following spring. Flowers 5-parted, with yellow petals 4-5.5 cm long; pendent, borne singly on an erect, leafless scape to 7 dm tall. Flowering Season: early May to early June (NatureServe, 2015).

Taxonomy

Distinct species, one of only three species of *Sarracenia* with a geographical distribution outside the coastal plain (NatureServe, 2015).

Historical Range

Historically, the distribution of *Sarracenia oreophila* spanned five different geographical provinces: The Cumberland Plateau, Blue Ridge, Piedmont, Ridge and Valley, and East Gulf Coastal Plain (U.S. Fish and Wildlife Service 1985) (NatureServe, 2015).

Current Range

Restricted to areas of the Cumberland Plateau and the Ridge and Valley province in these four regions: Coosa Valley, Lake Chatuge, Lookout Mountain, and Sand Mountain (USFWS 2013). Extent of occurrence was calculated during the 2015 conservation status review to be approximately 9,000 sq. km. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Food/Nutrient Narrative

Adult: Carnivory is the most striking interaction between members of the genus *Sarracenia* and other species, though the precise benefit to pitcher plants from this highly specialized adaption is not understood. Christensen (1976) found that when insects were fed to *Sarracenia flava*, there was no consequent increase in Ca, Mg, or K in the plants' leaf tissue. However, nitrogen and phosphorus did increase, indicating that carnivory may be useful in soils low in these elements. Folkerts (1982) suggests that carnivory may be used to obtain micronutrients, such as molybdenum, which are present at very low levels in a low pH environment. Folkerts (1982) also proposes that carnivory may be important at times of nutrient stress since nutrient levels in bogs decrease over the course of the growing season. Another possibility is that the breakdown of prey detritus from decaying pitchers may help fertilize the soil around the plants (Christensen 1976) (USFWS, 2013).

Breeding Season

Adult: The flowers of the green pitcher plant mature in late April at lower elevations, and mature in May at higher elevations (Troup 1982) (NatureServe, 2015).

Reproduction Narrative

Adult: *Sarracenia oreophila* reproduces both sexually and asexually, though in some situations, reproduction may be limited to asexual means, resulting in large spreading clones (Troup and McDaniel 1980). Humphrey (1987) estimates that green pitcher plants do not become sexually mature until they are 6-7 years old. The flowers of the green pitcher plant mature in late April at lower elevations, and mature in May at higher elevations (Troup 1982). Cross pollination is needed for seed to set (Troup and McDaniel 1980). Insects associated with *S. oreophila* flowers which may act as pollinators include flies (*Sarcophaga* spp.), honeybees (*Apis* spp.) and bumblebees (*Bombus* spp.) (Troup and McDaniel 1980). Fruits mature in early autumn, but seed may not be released right away (Troup and McDaniel 1980). Seeds are apparently water dispersed (Troup and McDaniel 1980) (NatureServe, 2015).

Habitat Type

Adult: Streambanks/Bogs/Flatwoods (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Sandy and highly acidic soils (NatureServe, 2015)

Environmental Specificity

Adult: Narrow. Specialist or community with key requirements common. (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Historically, the distribution of *Sarracenia oreophila* spanned five different geographical provinces: The Cumberland Plateau, Blue Ridge, Piedmont, Ridge and Valley, and East Gulf Coastal Plain (U.S. Fish and Wildlife Service 1985). The present distribution of *S. oreophila* is restricted to the Cumberland Plateau, Blue Ridge, and Ridge and Valley provinces (U.S. Fish and Wildlife Service 1985), with known, extant populations in northeastern Alabama (Jackson, Marshall, DeKalb, Cherokee and Etowah Counties), northeastern Georgia (Towns county) and adjacent North Carolina (Clay County) (Humphrey 1987). Three distinct habitat types have been described for *S. oreophila*. They are sandstone streambanks, with 13 extant colonies in the Cumberland Plateau; mixed oak or pine flatwoods, with 5 extant colonies in the Cumberland Plateau; and seepage bogs, with 5 extant colonies in the Cumberland, 2 colonies in the Blue Ridge, and 2 colonies in the Ridge and Valley provinces (U.S. Fish and Wildlife Service 1985). The soils in all of these habitats are sandy and highly acidic. Woodland and bog soils are sandy clays and loams with an upper layer of organic material, while the streambank soils are composed almost purely of sand (U.S. Fish and Wildlife Service 1985) (NatureServe, 2015). High ecological integrity of the community and site fidelity along with low tolerance ranges are inferred based on the specific habitat needs of this species.

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Seed dispersal is poorly understood for this species. However, a study of a related, wide-spread pitcher plant species, *Sarracenia purpurea*, indicates that seed dispersal distance from parent plants is typically only a few inches (Ellison and Parker 2002). These authors further suggest that water may facilitate dispersal over longer distances for *Sarracenia* species. Indeed, flooding events are thought to be responsible for the establishment of some green pitcher plant colonies (G. Folkerts 1992). For example, flooding may have transported seeds from upland bog colonies to suitable streambanks within the Little River watershed (Emanuel 1998) (USFWS, 2013).

Population Information and Trends**Population Trends:**

Decreasing (NatureServe, 2015)

Resiliency:

Given proper habitat conditions, this species has demonstrated high fecundity - able to grow quickly and reproduce. (NatureServe, 2015)

Population Growth Rate:

Likely stable as fires were allowed to burn freely and naturally across the landscape, covering thousands of acres. Only recently, within the past 60 years, has public sentiment changed in opposition to free-ranging fires, due to impacts such fires have on timber production, agriculture, and development. Consequently, a broad range of fire maintained species, including *S. oreophila*, have become critically imperiled (NatureServe, 2015).

Number of Populations:

21 - 80 (NatureServe, 2015)

Population Size:

1000 - 2500 individuals (NatureServe, 2015)

Adaptability:

Given proper habitat conditions, this species has demonstrated high fecundity - able to grow quickly and reproduce. (NatureServe, 2015)

Threats and Stressors

Stressor: Development (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat/Loss of populations

Narrative: Development of land for agriculture and housing is a threat to this species (USFWS, 2013).

Stressor: Fire suppression (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Fire is an integral part of maintaining green pitcher plant bog habitats (Service 1994; Boyer and Carter 2011; NatureServe 2013). In the absence of regular fires, competing plant species encroach on green pitcher plant habitats and out-compete the pitcher plants for resources (e.g., nutrients and light) (Troup and McDaniel 1980; Jennings and Rohr 2011). Encroachment of competing vegetation can lead to the eventual elimination of green pitcher plants (44 FR 54922). Furthermore, excessive fuel accumulation may occur at sites where fire has been excluded or occurs rarely, thus increasing the risk of re-introduced fires having potentially detrimental effects to green pitcher plants (Hermann 2014, in litt.). Alternatively, burning too frequently (e.g., multiple annual fires) or regularly burning during unfavorable seasons (e.g., winter) may reduce habitat suitability for green pitcher plants (Service 1994). Similarly, frequent application of early growing season burns may eliminate seedling recruitment (Determann 2013c, in litt.) (USFWS, 2013).

Stressor: Over-collection (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of individual plants/loss of populations

Narrative: Over-collection was cited as a reason for listing the green pitcher plant in 1979 (44 FR 54922) and was considered a serious threat when the current recovery plan was revised 15 years later (Service 1994). Recent reviews of threats to carnivorous species note that over-collection of wild plants and plant parts remain a persistent threat to *Sarracenia* species (McPherson 2007; Jennings and Rohr 2011). More recently, over-collection pressure from plant poachers may have declined as evidence (e.g., holes in the ground) of removal of whole green pitcher plants is limited, but not absent (Emanuel 2002; ALNHP 2012; Byrd 2013a; Determann 2013b, in litt.; Hermann 2013, in litt.; Hodges 2013c, in litt.; Shew 2013c, in litt.). Collection pressure may have been somewhat ameliorated by limited, legal interstate sale of commercially grown green pitcher plants from 16 U.S. Fish and Wildlife Service issued Section 10 permitted growers and sellers. However, Hermann (2013, in litt.) proposed that poaching of individual green pitcher plants may not be readily apparent as evidence of poaching could be easily obscured. Alternatively, Hodges (2013b, in litt.) suggested that poaching of plants may have shifted to unauthorized seed collection. Byrd (2013a) stated that several green pitcher plant populations are easily accessible and, thus, are vulnerable to illegal collection by poachers. Indeed, Byrd (2013a) noted that plants from at least one of these populations were recently poached (USFWS, 2013).

Stressor: Inadequacy of regulatory mechanisms (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of individual plants/loss of populations

Narrative: Green pitcher plant receives some legal protection in Georgia and North Carolina; however, these laws do not protect against habitat destruction. Collection of green pitcher plants on public lands without a permit is prohibited in Georgia under the Georgia Wildflower Preservation Act of 1973. No such provisions are afforded to plants found on privately-owned lands in the State. North Carolina General Statute 106-202.12- 202.19, also known as the Plant Protection and Conservation Act, authorizes the State to establish a list of protected plants and

regulate the collection, sale, and transport of plants on this list. Green pitcher plant is included on the North Carolina's list of protected plants. The species does not receive any specific legal protections from State laws or regulations in Alabama USFWS, 2013).

Stressor: Genetics (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of genetic variability

Narrative: As summarized by Godt and Hamrick (1996), small population sizes have been associated with low genetic diversity and reduced fitness in a variety of plant species. Within populations of *S. oreophila*, genetic diversity is relatively low and related to population size and geographic isolation. Specifically, small and isolated populations exhibit less genetic diversity than larger, less isolated populations (Godt and Hamrick 1996). Effects of small population size and low genetic diversity on *S. oreophila*'s fitness have yet to be assessed. However, together, low genetic diversity, small population sizes, and isolation of some populations may limit *S. oreophila*'s ability to respond and adapt to stochastic environmental events and future climate change (USFWS, 2013).

Stressor: Climate change (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The precise magnitude and impacts of climate change on the southeastern United States are uncertain, but models have projected that climate change in the region may include increased temperatures of 2 to 4°C (3.6 to 7.2°F) accompanied by reduced average annual precipitation by the end of the century (Joyce et al. 2011). Climate change has the potential to affect distribution and abundance of plants by influencing seasonal weather patterns, frequency and timing of severe weather events, and myriad plant physiological responses (Hawkins et al. 2008). The specific impacts of climate change on green pitcher plant populations are poorly understood; however, a variety of impacts are possible. For example, climate change may threaten green pitcher plant populations if the habitats that the species relies on become drier as a result of higher temperatures and reduced rain (Devall and Parresol 1998; Wilcox 2012). Indeed, Wilcox (2012) notes that pitcher plant declines at a TNC preserve in North Carolina were associated with two droughts and lower water tables during the early 2000s. However, Davenport (2007) suggests that climate change's effects might be somewhat ameliorated for this species if drier climates increase the frequency of fires that maintain green pitcher plant habitats. In addition, climate change may disrupt plant-pollinator interactions via phenological shifts in flowering and/or pollinator activity (Mehmott et al. 2007; Hawkins et al. 2008), which may thereby reduce sexual reproduction of green pitcher plants. Any disruption in pollinator efficacy may further threaten isolated green pitcher plant populations that are already pollinator limited (*sensu* D. Folkerts 1999). While disease is not currently known to threaten green pitcher plants, climate change has the potential to promote the spread of infectious diseases among plants, particularly if arthropod vectors become more widespread and abundant (Anderson et al. 2004; Garrett et al. 2006; Hawkins et al. 2008). Given the variety and complexity of the potential effects of climate change on plant species and communities (*cf.* Hawkins et al. 2008; Walther 2010), more research is needed to assess its potential long-term impacts on green pitcher plant populations and habitats (USFWS, 2013).

Stressor: Livestock disturbance (USFWS, 2013)

Exposure:

Response:

Consequence: Degradation of habitat

Narrative: Trampling and soil disturbance from cattle have destroyed or degraded several green pitcher plant habitats and populations (Service 1994; Gunn 1994, in litt., 1996, in litt.; Emanuel 2002; NCNHP 2012) (USFWS, 2013).

Stressor: Logging (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Logging/forestry activity is listed as a threat to this species (USFWS, 2013).

Recovery

Conservation Measures and Best Management Practices:

- Work with federal and state entities, non-governmental organizations, and private individuals to permanently protect and manage existing habitats and populations, including the development and implementation of management plans, as needed (USFWS, 2013).
- • Continue use of prescribed fires at protected sites and encourage owners of unprotected sites to conduct prescribed fires as frequently as possible (USFWS, 2013).
- Study and evaluate efficacy of a variety of prescribed fire regimes (USFWS, 2013).
- Study and evaluate efficacy of alternative management strategies to prescribed fire, such as hand clearing, mowing, and limited herbicide application (USFWS, 2013).
- Update population inventories, create detailed maps of all populations and their habitats to assist with population management, and attempt to relocate populations (USFWS, 2013).
- Characterize genetic diversity and representation of current ex situ safeguarded collections. Expand ex situ preservation of genetic stock, including long-term cryopreservation of seeds as well as live collections, to represent all populations with increased emphasis placed on preserving and safeguarding individual genets within and across populations (USFWS, 2013).
- Continue and expand conservation genetics work to include all populations and determine effective population sizes (USFWS, 2013).

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SPECIES ACCOUNT: *Sarracenia rubra ssp. alabamensis* (Alabama canebrake pitcher-plant)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 3/10/1989

Physical Description

An insectivorous perennial herb with light green, red-veined leaves that form erect, vase-like structures, 1-5 dm tall (in late summer, these are enlarged and turn yellow-green). Flowers are 5-merous, with maroon petals that are constricted medially, to 2.5 cm in width and 3.6 cm in length; pendent, borne singly on an erect, leafless scape to 60 cm in height. Flowering season: late April to early June (NatureServe, 2015).

Taxonomy

There is taxonomic uncertainty within the genus *Sarracenia* as a whole but the Services and others recognize the taxon as a subspecies within the "rubra complex" (i.e., *Sarracenia rubra ssp. alabamensis*) (USFWS, 2018).

Historical Range

The Alabama canebrake pitcher plant is a carnivorous plant that is endemic to central Alabama, with all known populations, extant and extirpated, found in the Fall Line Hills ecoregion (USFWS, 2019). Species historically occurred in Autauga, Chilton, and Elmore Counties, Alabama. In Autauga County one population has since been extirpated (Byrd 2016) and the remaining five now represent three populations, with two populations continuing as distinct populations and three of the former populations now representing three sub-populations comprising one population. No extant populations are known to occur in Elmore County (USFWS, 2018).

Current Range

There are currently seven natural, extant populations of Alabama canebrake pitcher plant known (Autauga County – 3; Chilton County – 4) (USFWS, 2018). All are found in the Fall Line Hills ecoregion (see Griffith et al. 2001 for ecoregion description). Furthermore, within this ecoregion, most of the species' populations are known from the Upper Alabama subbasin (8-digit hydrologic unit code: 03150201) while the remaining populations are known from the Lower Coosa subbasin (03150107) (USFWS, 2019).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Food/Nutrient Narrative

Adult: This is a carnivorous plant, although it is unclear what benefit it receives from its carnivory (USFWS, 1992). Studies found that Alabama canebrake pitcher plants captured

comparatively more flying insects than crawling insects, likely due to the species' relatively tall stature (USFWS, 2018).

Reproductive Strategy

Adult: Vegetatively

Lifespan

Adult: Perennial herb, 60+ years (USFWS, 2012)

Dependency on Other Individuals or Species

Adult: Likely pollinators for this species are small bumblees (USFWS, 2018).

Reproduction Narrative

Adult: Seedling recruitment was reported to be absent from the majority of populations (Brewer and Chesser 2009), further inhibiting recovery efforts, as well as long-term viability and evolutionary potential. Because the species can reproduce vegetatively, seedling recruitment may not be paramount at sites experiencing light to moderate levels of fire exclusion; however, vegetative reproduction may not compensate for mortality or the lack of sexual reproduction at some sites (Brewer and Chesser 2009) (USFWS, 2012). Likely pollinators are small bumblebees (*Bombus* spp.) which have a flight distance of 1 mile; at distances greater than 1 mile, pollen flow (and consequent gene flow) is restricted by the inability of pollinators to traverse this distance (USFWS, 2018).

Habitat Type

Adult: Hillside seepage bogs and in bottomland or streamside vegetation(USFWS, 2012)

Environmental Specificity

Adult: Narrow. Specialist or community with key requirements common. (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: *Sarracenia rubra* ssp. *alabamensis* inhabits two distinct habitat types that share similar floristic composition. The majority of sites are characterized as hillside seepage bogs, permanently saturated areas that attain their greatest development where an impervious layer of clay lies in close proximity to the ground surface. Precipitation, once reaching this clay zone, becomes restricted and is gradually propelled along a sloping gradient until surfacing further downslope. The other habitat type occurs in association with bottomland or streamside vegetation. Unlike the foregoing habitat, moisture conditions are generally maintained with greater connection to topography and precipitation amounts (USFWS, 2012). All extant populations of *S. rubra* ssp. *alabamensis* occur in close association with the following combination of arborescent and herbaceous species (which therefore serve as the best indicators of suitable habitat): *Osmunda cinnamomea* (cinnamon fern), *Rhynchospora chalarocephala* (loosehead beak sedge), *Dichanthelium scoparium* (velvet panicgrass), *Xyris*

torta (twisted yellow-eyed grass), *Eriocaulon decangulare* (tenangle pipewort), *Arundinaria gigantea* (giant cane), *Cleistes bifaria* (small spreading pogonia), *Calopogon tuberosus* (tuberous grass pink), *Platanthera ciliaris* (yellow-fringed orchid), *Viola primulifolia* (white violet), *Rhexia nashii* (maid Marian), *Eryngium integrifolium* (blue coyotethistle), *Asclepias rubra* (red milkweed), *Magnolia virginiana* (sweetbay magnolia), *Solidago rugosa* (wrinkle-leaf goldenrod), *Eupatorium fistulosum* (joe pye weed), *Fuirena squarrosa* (hairy umbrella-sedge), and *Sphagnum* spp. Bottomland and streamside populations generally contain a greater proportion of woody species and *A. gigantea* (U.S. Fish and Wildlife Service 1992, Garrett 2004, Schotz 2006) (USFWS, 2012). It is most vigorous in open bogs and declines when the habitat becomes overgrown with woody vegetation (NatureServe, 2015).

Dispersal/Migration

Dispersal

Adult: Seed dispersal is poorly understood but studies with similar pitcher plants indicate seed dispersal distances from parent plants at typically a few inches and water or birds may facilitate dispersal over longer distances, but this remains unstudied for Alabama canebrake pitcher plant (USFWS, 2018).

Dispersal/Migration Narrative

Adult: Brewer and Chesser (2009) at the University of Mississippi recently completed a study correlating seedling recruitment and population dynamics in relation to site differences. They found that seedling recruitment was greater on sites with higher soil moisture content as opposed to drier sites. This correlation held true even when comparing unmanaged wet sites to managed dry sites (USFWS, 2012).

Population Information and Trends

Population Trends:

Stable (USFWS, 2018)

Species Trends:

Stable (USFWS, 2018)

Resiliency:

Low (inferred from NatureServe, 2015)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

7 (USFWS, 2018)

Population Size:

3-200 individuals (USFWS, 2018)

Population Narrative:

Given proper habitat conditions, this species has demonstrated high fecundity - able to grow quickly and reproduce. According to anecdotal information furnished by wildflower enthusiasts, some sites historically contained thousands of plants. Was likely stable when fires were allowed to burn freely and naturally across the landscape, covering thousands of acres. Only recently, within the past 60 years, has public sentiment changed in opposition to free-ranging fires, due to the impact such fires have on timber production, agriculture, and development. Consequently, a broad range of fire maintained species, including *Sarracenia rubra* ssp. *alabamensis*, have become critically imperiled (NatureServe, 2015). Short-term trends indicate that species has remained stable, despite the recent loss of one small population and apparent local population declines at some sites which are likely offset by population increases at the largest sites. Currently, there are seven natural, extant populations of this species (3 in Autauga County and 4 in Chilton County) where a population is considered distinct if separated by at least 1 mile from nearest known neighbors; no new populations have been discovered since 2012. Currently, individual subpopulations range in size from 3 or 4 plants to well over 200 and all populations are privately owned. Only 3 populations are comprised of 100 or more individuals, while 2 populations have fewer than 10 individuals (Byrd 2016, 2017, Yawn 2018). Several attempts to augment and establish populations are known but information on sites is limited and their contribution to recovery is uncertain. Conservation efforts in cooperation with various entities has occurred and 3 populations are permanently protected and managed by TNC but three populations have been extirpated since the species was listed (USFWS, 2018).

Threats and Stressors

Stressor: Woody succession (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The inability to regularly burn some sites has reduced habitat suitability by allowing continued encroachment of woody species that increase shade for this shade-intolerant species (USFWS, 2012).

Stressor: Fire suppression (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: All populations occur in fire-maintained habitat, requiring an active prescribed burning regimen to sustain species viability and site integrity. As with all pitcher-plants, *S. rubra* ssp. *alabamensis* is intolerant of shade, quickly becoming depauperate and unable to reproduce with the encroachment of woody vegetation. Therefore, site integrity and viability of all populations are inherently linked to regular prescribed burning. Efforts by U.S. Fish and Wildlife Service, ALNHP, TNC, and Atlanta Botanical Gardens to adequately maintain specific populations have been hampered by difficulties in obtaining permission to apply prescribed fires at some of the known populations and unfavorable burning condition (USFWS, 2012).

Stressor: Gravel mining (USFWS, 2012)

Exposure:

Response:**Consequence:** loss of habitat

Narrative: Gravel mining in close proximity to another population has adversely altered the hydrology of the site, further hampering recovery efforts (Byrd 2011, Tassin in litt. 2011b) (USFWS, 2012). However, the cooperation and interest in conserving this site by the landowner has allowed land management activities to reduce the impacts of gravel mining induced hydrologic alterations (Byrd 2016, 2017, ANHP 2018, Yawn 2018) (USFWS, 2018).

Stressor: Drainage of wetlands/bogs (USFWS, 2012)**Exposure:****Response:****Consequence:** loss of habitat

Narrative: Alabama canebrake pitcher plant populations continue to be threatened by development and incompatible land use, such as drainage for agriculture and livestock grazing (USFWS, 2012).

Stressor: Habitat modification (USFWS, 2018).**Exposure:****Response:****Consequence:**

Narrative: The species continues to be threatened by development, agricultural activities, gravel mining, and livestock management (Schotz 2006, Byrd 2016, 2017, ANHP 2018, Yawn 2018), which can exacerbate threats posed by inadequate habitat management (e.g., fire exclusion) and encroachment of competing vegetation (including non-native invasive species)(USFWS, 2018).

Stressor: Hydrologic alterations (USFWS, 2018)**Exposure:****Response:****Consequence:**

Narrative: Two populations have historically been subjected to hydrological alterations as a result of beaver (*Castor canadensis*) activities, one of which was nearly extirpated by flooding. Beaver trapping has occurred at one of these populations to reduce their impact (USFWS, 2018).

Stressor: Inadequate habitat management (USFWS, 2018)**Exposure:****Response:****Consequence:**

Narrative: Inadequate habitat management threatens the long-term viability of some populations. All populations occur in habitat requiring periodic fire to maintain site ecological integrity and population viability. The lack of prescribed fire or periodic mowing and hand clearing of competing vegetation at some sites allows for unchecked growth of woody species and other fast-growing herbaceous species that can increase shade and competition for resources. Alabama canebrake pitcher plant is intolerant of shade, with individual plants and, ultimately, populations, quickly becoming depauperate and unable to reproduce following woody species encroachment and consequent increased shade. Prescribed fires and other vegetation clearing activities help to maintain Alabama canebrake pitcher plant's necessary open, sunny habitat. In addition, over the years, ANHP, TNC, and ABG have occasionally had difficulties obtaining landowner permission to apply prescribed fires at some sites, thus hampering

necessary efforts to adequately maintain these sites (Byrd 2016, ANHP 2018). One small population was recently lost, possibly due to incompatible road right-of-way maintenance, such as herbicide application (Byrd 2016). Habitat management is needed to promote seedling recruitment. Alabama canebrake pitcher plant continues to be extremely vulnerable due to the small number of populations and small population size at many of these sites (USFWS, 2018).

Recovery

Reclassification Criteria:

1. At least 10 geographically distinct populations of sufficient size within the Fall Line Hills ecoregion in Alabama exhibit stable or increasing population trends, as evidenced by natural recruitment and multiple generations over an appropriate time span. Populations are considered to be geographically distinct when they are separated by at least 1 mile (1.6 kilometer) from their nearest neighbors. (Addresses Factors A, B, E) (USFWS, 2019).
2. These 10 populations are protected by a conservation mechanism that addresses the conservation needs of the Alabama canebrake pitcher plant. (Addresses Factors A, D) (USFWS, 2019).
3. Protected populations are managed to promote open canopies, integrity of native plant communities, and Alabama canebrake pitcher plant growth. (Addresses Factors A, E) (USFWS, 2019).

Delisting Criteria:

In addition to meeting downlisting criteria, the Alabama canebrake pitcher plant will be considered for delisting when the following criteria are met:

4. At least 10 additional geographically distinct populations of sufficient size (as described in Criterion 1) within the Fall Line Hills ecoregion in Alabama exhibit stable or increasing population trends, as evidenced by natural recruitment and multiple generations over an appropriate time span. (Addresses Factors A, B, D, E) (USFWS, 2019).
5. The Upper Alabama and Lower Coosa sub-basins within Fall Line Hills ecoregion each support at least three (3) viable populations protected by a conservation mechanism. (Addresses Factors A, E) (USFWS, 2019).

Recovery Actions:

- A. Continue use of prescribed fires at protected sites and encourage owners of unprotected sites to conduct prescribed fires as frequently as possible (USFWS, 2012).
- B. Continue to track population trends and evaluate management needs as a means to gather baseline data and implement long-term monitoring efforts (USFWS, 2012).
- C. Continue surveys in vicinity of known populations and revisit all known historical sites regularly (USFWS, 2012).
- D. Work to secure protection, either through conservation easements or acquisition, of privately-owned populations (USFWS, 2012).
- E. Renew contact with state and county highway departments to ensure proper protective measures are implemented for those areas where plants occur on roadside rights-of-way (USFWS, 2012).

- F. Continue to preserve genetic material from all populations to the extent possible through long-term seed storage and propagation efforts at the Atlanta Botanical Gardens, Georgia (USFWS, 2012). Efforts have expanded to include Auburn University's Donald E. David Arboretum (USFWS, 2018).
- G. Implement all other tasks identified in the recovery plan, as appropriate (USFWS, 2012).
- H. Update the recovery plan, as appropriate (USFWS, 2012).

Conservation Measures and Best Management Practices:

- Continue use of prescribed fires at protected sites and encourage owners of unprotected sites to conduct prescribed fires as frequently as possible (USFWS, 2012).
- Continue to track population trends and evaluate management needs as a means to gather baseline data and implement long-term monitoring efforts (USFWS, 2012).
- Continue surveys in vicinity of known populations and revisit all known historical sites regularly (USFWS, 2012).
- Work to secure protection, either through conservation easements or acquisition, of privately-owned populations (USFWS, 2012).
- Renew contact with state and county highway departments to ensure proper protective measures are implemented for those areas where plants occur on roadside rights-of-way. 10 (USFWS, 2012).
- Continue to preserve genetic material from all populations to the extent possible through long-term seed storage and propagation efforts at the Atlanta Botanical Gardens, Georgia (USFWS, 2012).
- Implement all other tasks identified in the recovery plan, as appropriate (USFWS, 2012).
- Update the recovery plan, as appropriate (USFWS, 2012).

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SPECIES ACCOUNT: *Sarracenia rubra ssp. jonesii* (Mountain sweet pitcher-plant)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 9/30/1988

Physical Description

An insectivorous perennial herb with waxy-green, maroon-veined leaves that form erect, vase-like "pitchers" with ascending "lids." The pitchers are usually about 4.5 dm tall and are often partially filled with a broth of decaying insects. The sweet-smelling flowers are borne singly, each nodding on erect flowering stems that are usually taller than the pitcher. Flower petals are pendulous, maroon on the outside and yellowish, tinged with red on the inner surface. Blooms in spring. (NatureServe, 2015)

Taxonomy

Treated as a subspecies of *Sarracenia rubra* by Kartesz (1994 checklist), but considered a distinct species (*S. jonesii*) by North Carolina Heritage Program (1993), CITES (2001), and FNA (vol. 8, 2009). (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Endemic to a few mountain bogs and waterslides in southwest North Carolina and northwest South Carolina on both sides of the Blue Ridge divide (U.S. Fish and Wildlife Service 1990). Four populations are in the French Broad River drainage in Henderson and Transylvania Counties, North Carolina, five are in the Saluda River drainage in Greenville County, South Carolina, and one population is in the Enoree River drainage also in Greenville County, South Carolina (U.S. Fish and Wildlife Service 1990). (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Food/Nutrient Narrative

Adult: Carnivory is the most striking interaction between members of the genus *Sarracenia* and other species, though the precise benefit to pitcher plants from this highly specialized adaption is not understood. Christensen (1976) found that when insects were fed to *Sarracenia flava*, there was no consequent increase in calcium, magnesium, or potassium in the plants' leaf tissue. However, nitrogen and phosphorus did increase, indicating that carnivory may be useful in soils low in these elements. Folkerts (1982) suggests that carnivory may be used to obtain micronutrients, such as molybdenum, which are present at very low levels in a low pH environment. Folkerts (1982) also proposes that carnivory may be important at times of nutrient

stress since nutrient levels in bogs decrease over the course of the growing season. Another possibility is that the breakdown of prey detritus from decaying pitchers may help fertilize the soil around the plants (Christensen 1976). In addition to carnivory, pitcher plants have intricate relationships with several different animal taxa. Members of the genus *Sarracenia* are the exclusive food of at least five species of moth (Damman and French 1987), and other insects are known to live inside pitchers (U.S. Fish and Wildlife Service 1990). Some insects may be restricted to *S. jonesii* (T. Gibson, pers. comm., in U. S. Fish and Wildlife Service 1990).

Reproductive Strategy

Adult: Asexual and sexual (NatureServe, 2015)

Lifespan

Adult: Perennial herb (USFWS, 1990)

Breeding Season

Adult: Flowering occurs from April to June, with fruits ripening in August (U.S. Fish and Wildlife Service 1990) (NatureServe, 2015).

Reproduction Narrative

Adult: REPRODUCTION: Reproduction in *S. jonesii* occurs by seed and by fragmentation of the rhizomes, but the relative importance of sexual versus vegetative reproduction is not known (U.S. Fish and Wildlife Service 1990). Flowering occurs from April to June, with fruits ripening in August (U.S. Fish and Wildlife Service 1990). Pollinators of *S. jonesii* are not known, but bumblebees are important pollinators of other species of *Sarracenia* (U.S. Fish and Wildlife Service 1990). Water is the only known means of seed dispersal (U.S. Fish and Wildlife Service 1990). GENETICS: Many populations of *S. jonesii* are small and have likely been isolated for a long time. Consequently, inbreeding depression may be occurring (U.S. Fish and Wildlife Service 1990).; ASEXUAL; Perfect; Predominantly outcrossing; SEXUAL; Vegetative spread; ABIOTIC; Water; BIOTIC; Insects, other (NatureServe, 2015).

Habitat Type

Adult: Bogs (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (inferred from NatureServe, 2015)

Environmental Specificity

Adult: Narrow/Specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: The mountain sweet pitcher plant occurs in two types of habitat, depression bogs and cataract bogs. Most commonly, this species is found in depression bogs with flat to gently

sloping topography in valley bottoms not subjected to flooding (Schafale and Weakley 1990; U.S. Fish and Wildlife Service 1990). The soils of these bogs are deep, poorly drained loam/sand/silt, with high organic matter and acidic pH. The soil series is usually Toxaway silt loam or Hatboro loam (U.S. Fish and Wildlife Service 1990). These bogs are palustrine and usually fed by seepages. The moisture level within the bogs ranges from permanently saturated to intermittently dry (Schafale and Weakley 1990). In the cataract bog habitat, the pitcher plants grow in thin strips along the edges of the waterfall, or on soil islands actually on the granite rock face where moisture conditions are appropriate (U.S. Fish and Wildlife Service 1990; S. Benjamin, pers. observ.). Shrub species associated with *Sarracenia jonesii* populations include *Rhus vernix* (poison sumac), *Aronia arbutifolia* (chokeberry), *Alnus serrulata* (alder), *Rhododendron maximum* (rhododendron), *Rhododendron viscosum* (azalea), *Viburnum cassinoides* (viburnum), *Kalmia angustifolia* (sheep laurel) and *Kalmia latifolia* (mountain laurel) (U.S. Fish and Wildlife Service 1990). Associated herb species include several sedges (*Carex leptalea*, *C. muricata*, *C. folliculata*, and *C. collinsii*), twigrush (*Cladium mariscoides*), beak rush (*Rhynchospora alba*), bulrush (*Scirpus expansus*), and several *Sphagnum* species (U.S. Fish and Wildlife Service 1990) (NatureServe, 2015). Clumped spatial arrangement of the population, high ecological integrity of the community and site fidelity and low tolerance ranges are inferred based on the specific habitat requirements of this species and the relatively low number of known populations.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: At least some seed dispersal is by water; however, little else is known, including how far seeds can be dispersed by this vector and others and what conditions are optimal for dispersal (USFWS, 1990).

Population Information and Trends

Population Trends:

Short term trend: Decline of 10-30% (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015 and USFWS, 2013)

Representation:

Low (inferred from NatureServe, 2015 and USFWS, 2013)

Redundancy:

Low (inferred from NatureServe, 2015 and USFWS, 2013)

Number of Populations:

Twelve (USFWS, 2013)

Population Narrative:

The species persists in 12 extant populations across North and South Carolina, in remnant bog habitats that are subject to repeated threats from the continued alteration of the surrounding landscape, particularly the ecological processes (namely hydrologic regimes) which render these

wetlands suitable for species such as *S. jonesii* (USFWS, 2013). NatureServe (2015) notes that there is a short-term population decline of 10-30%. Low resiliency, representation and redundancy are inferred based on the low number of populations and the specific habitat requirements of this species.

Threats and Stressors

Stressor: Stream channelization (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: This, in conjunction with stream channelization efforts throughout the surrounding watershed, continues to work against the processes which create new wetland acreage, which in turn forces those species that are dependent upon these habitats to be confined to whatever remnant acreage that remains (USFWS, 2013).

Stressor: Lack of beaver dams (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Beavers were largely eliminated from much of the southern Appalachian landscape by the turn of the last century. Although still active, their effectiveness at creating new wetland habitat is severely hindered by humans who regard beavers as a nuisance species, and repeatedly breach beaver impoundments (USFWS, 2013).

Stressor: Wetland draining (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Because many bogs are located in low-lying flat areas favored for agriculture, they often have been the focus of wetland ditching and draining efforts which have left the hydrology of these sites inherently altered. Further compounded by a nearly complete absence of natural disturbance regimes (such as grazing and/or fire) that may have played a role in keeping woody vegetation at low densities, the structure and composition of southern Appalachian wetlands faces a nearly constant and synergistic set of threats (USFWS, 2013).

Stressor: Lack of fire (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Periodic fire may have also played an historical role in keeping some mountain bog habitats structurally open, with the higher light levels favored by species such as *S. jonesii*. Most *Sarracenia* species occur in fire-prone habitats, and many *Sarracenia* species decline during periods of prolonged fire suppression. The historical role of fire in mountain bogs is less clear than in coastal plain habitats, but the presence of fire-adapted species such as pitch pine (*Pinus rigida*) certainly suggests a role for fire in the formation and maintenance of these habitats. However, the extent to which fire suppression may be causing or exacerbating woody vegetation encroachment in bog habitats is presently speculative, at best (USFWS, 2013).

Recovery**Delisting Criteria:**

Criterion 1: It has been documented that at least four populations within each drainage (Enoree, French Broad, and Saluda Rivers) are self-sustaining and that necessary management actions have been undertaken by the landowners or cooperating agencies to ensure their continued survival (USFWS, 2013).

Criterion 2: ...All 12 of the above populations and their habitat are protected from present and foreseeable human-related and natural threats that may interfere with the survival of any of the populations (USFWS, 2013).

Recovery Actions:

- Protect existing populations and essential habitat. Develop interim research and management plans in conjunction with landowners. Search for additional populations. Determine habitat protection priorities. Evaluate habitat protection alternatives (USFWS, 1990).
- Determine and implement management necessary for long-term reproduction. establishment. maintenance, and vigor. Determine population size and stage-class distribution for all populations. Study abiotic and biotic features of the species' habitat. Conduct long-term demographic studies. Determine the effects of past and ongoing habitat disturbance. Define criteria for self-sustaining populations and develop appropriate habitat management guidelines based upon the data obtained from Tasks 2.2 through 2.4. Implement appropriate management techniques as they are developed from previous tasks. Develop techniques and reestablish populations in a suitable habitat within the species' historic range (USFWS, 1990).
- Develop a cultivated source of plants and provide for long-term seed storage (USFWS, 1990).
- Enforce laws protecting the species and/or its habitat (USFWS, 1990).
- Develop materials to inform the public about the status of the species and the recovery plan objectives. Prepare and distribute news releases and informational brochures. Prepare articles for popular and scientific publications (USFWS, 1990).
- Annually assess success of recovery efforts for the species (USFWS, 1990).

Conservation Measures and Best Management Practices:

- Recovery Task 2.1: Determine population size and stage class distribution for all populations • Map the spatial extent of each population, assess flower abundance and (of lower priority, only if time permits) the abundance of pitchers/clumps. Perform these assessments in a manner that ensures comparability to the baseline maps and other data obtained for these sites in 1991 and 1992 (Rudd and Sutter 1998 and references therein). Assess whether the spatial extent and/or abundance of populations has remained stable, increased or decreased since that time, accounting for any increases due to population augmentation efforts. Record information on environmental parameters that can impact the plant (e.g., light availability and depth to water table) to examine possible correlations with these parameters and the population size and stage class distribution for all populations (USFWS, 2013).

- Recovery Task 2.7: Develop techniques and re-establish populations in suitable habitat within the species' historic range. • Work with the Atlanta Botanical Garden (ABG) to summarize prior reintroduction, augmentation and introduction activities across all populations. Using this information, conduct site visits as needed to obtain current estimates of transplant survivorship for prior augmentation efforts. • Use this information, supplemented by updated data on overall spatial extent (obtained from mapping) and estimates of flower/pitcher abundance, to assess each population for its current potential to be self-sustaining without augmentation. For populations where augmentation is deemed necessary (this may currently be most populations), establish preliminary population objectives clarifying the minimum desired number of plants at each location, and a strategy and timeline for meeting this objective through augmentation. Work with ABG and landowners to implement actions required to meet this objective at as many sites as possible, and then discontinue additional augmentation while monitoring is undertaken to determine transplant survivorship and population trends at the new (augmented) baseline (USFWS, 2013).
- Recovery Task 3: Develop a cultivated source of plants and provide for long-term seed storage • Review the provenance of material currently held as seeds or otherwise represented in exsitu holdings at botanical gardens (esp. ABG but also the North Carolina Botanical Garden) to ensure that all known extant populations are represented. • Work with ABG to assess the viability of seed collections, and the longevity of seeds held in long-term storage (USFWS, 2013).
- Recovery Task 6: Annually assess success of recovery efforts • The two existing recovery criteria (for de-listing) are largely redundant; revise criteria that are more specific, objective, and measurable. • Establish down-listing criteria (for reclassification from endangered to threatened). • Finalize technical revision to the federal list of threatened and endangered plant species, changing taxonomy from *Sarracenia rubra* ssp. *jonesii* to *Sarracenia jonesii*.

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SPECIES ACCOUNT: *Scaevola coriacea* (Dwarf naupaka)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

A prostrate perennial herb, barely woody in older portions. Flowers are yellowish green externally, cream-colored within. (NatureServe, 2015)

Taxonomy

Genus found in Australia, coasts of tropical Asia, Africa, and Polynesia. Although this species has been collected on all of the major Hawaiian Islands, the evidence suggests that it was never well established on any but Maui island. (NatureServe, 2015)

Historical Range

historical occurrences from Mokuhooniki Islet (off Coast of East Molokai), Niihau, Kauai, Oahu, Lanai, and Hawaii. (NatureServe, 2015)

Current Range

Currently known from Maui. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Flowers year-round (USFWS, 1997).

Reproduction Narrative

Adult: This species is salt-tolerant, relatively long-lived, and flowers year round (USFWS, 1997).

Habitat Type

Adult: Coastal sand dunes (USFWS, 1997; NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 1997)

Environmental Specificity

Adult: Narrow/specialist (USFWS, 1997)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1997)

Site Fidelity

Adult: High (inferred from USFWS, 1997)

Habitat Narrative

Adult: Species inhabits dry coastal shrublands on consolidated calcareous sand dunes and thin basaltic soils. (NatureServe, 2015). *Scaevola coriacea* usually occurs in relatively hot, dry coastal sites on low, consolidated sand dunes near sea level. The sites receive high insolation, and most of the vegetation is at or near ground level (USFWS, 1997). Clumped spatial arrangement of the population and narrow environmental specificity are based on the geography of the known locations and the unique habitat requirements of this species. High ecological integrity of the population and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species and the relatively small geographic range in which it is known to occur.

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Decreasing (USFWS, 2014)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Fragility unknown. Only current occurrence consists of about 100 plants. 1 current (between 1982 and 1997) occurrence and 15 historical occurrences, one of which is destroyed. (NatureServe, 2015). New status information: In addition to those populations cited in the previous 5-year review, new observations include the following: ? The Plant Extinction Prevention Program [PEPP] (2010) reported three individuals of *S. coriacea* on Mokapu Islet off of Molokai. ? On Maui, there were 98 wild mature individuals and 2 immature individuals of *S. coriacea* (PEPP 2011). ? On Moku Hooniki Islet, off of Molokai, two of the four wild individuals remained (PEPP 2013). Overall, the numbers of individuals have decreased from approximately a 108 wild individual reported in the previous 5-year review to approximately 103 wild mature individuals (PEPP 2010, 2011, 2013) (USFWS, 2014).

Threats and Stressors

Stressor: Ungulates (USFWS, 2014)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Habitat degradation and herbivory by ungulates is listed as a threat to this species (USFWS, 2014).

Stressor: Invasive introduced plants (USFWS, 2014)

Exposure:**Response:****Consequence:** Loss of habitat**Narrative:** Invasive introduced plants are listed as a threat to this species (USFWS, 2014).**Stressor:** Development (USFWS, 2014)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** Development is listed as a threat to the at least one population of this species (USFWS, 2014).**Stressor:** Off-road vehicles (USFWS, 2014)**Exposure:****Response:****Consequence:** Loss of habitat/loss of individuals**Narrative:** Off-road vehicles are listed as a threat to the at least one population of this species (USFWS, 2014).**Stressor:** Landslides and flooding (USFWS, 2014)**Exposure:****Response:****Consequence:** Loss of habitat/loss of individuals**Narrative:** Landslides and flooding are listed as a threat to the at least one population of this species (USFWS, 2014).**Stressor:** Over-collection (USFWS, 2014)**Exposure:****Response:****Consequence:** Loss of individuals**Narrative:** Collecting impacts are listed as a threat to this species (USFWS, 2014).**Stressor:** Rodents (USFWS, 2014)**Exposure:****Response:****Consequence:** Loss of individuals**Narrative:** Rodent predation/herbivory is listed as a threat to the at least one population of this species (USFWS, 2014).**Stressor:** Snails (USFWS, 2014)**Exposure:****Response:****Consequence:** Loss of individuals**Narrative:** Invertebrate herbivory is listed as a threat to the at least one population of this species (USFWS, 2014).**Stressor:** Slugs (USFWS, 2014)**Exposure:**

Response:**Consequence:** Loss of individuals**Narrative:** Slug herbivory is listed as a threat to the at least one population of this species (USFWS, 2014).**Stressor:** Fire (USFWS, 2014)**Exposure:****Response:****Consequence:** Loss of habitat/loss of individuals**Narrative:** Fire is listed as a threat to the at least one population of this species (USFWS, 2014).**Stressor:** Low numbers (USFWS, 2014)**Exposure:****Response:****Consequence:** Extinction**Narrative:** Low numbers are listed as a threat to the at least one population of this species (USFWS, 2014).**Stressor:** Climate change**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** Climate change is listed as a threat to this species (USFWS, 2014).***Recovery*****Reclassification Criteria:**

This species is a short-lived perennial. For downlisting, a total of five to seven populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. In certain cases, however, a particular taxon maybe eligible for downlisting even if all five to seven of the populations are on only one island, provided all of the other recovery criteria have been met and the populations in question are widely distributed and secure enough that one might reasonably conclude that the taxon is not in danger of extinction throughout all or a significant part of its range. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 1997).

Delisting Criteria:

This species is a short-lived perennial. For delisting, a total of 8 to 10 populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. As with downlisting, there maybe cases in which a particular taxon maybe eligible for delisting even if all 8 to 10 of the populations are on only one island, provided all of the other recovery criteria have been met and the populations in question are widely distributed and secure enough that one might reasonably conclude that the taxon is not likely to become an endangered species within the foreseeable future throughout all or a significant portion of its

range. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of five consecutive years (USFWS, 1997).

Conservation Measures and Best Management Practices:

- Surveys/inventories – Survey geographical and historical range for a current assessment of the species' status (USFWS, 2014).
- Captive propagation genetic storage and reintroduction o Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range.
 - o Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' high vulnerability to climate change (USFWS, 2014).
- Ungulate monitoring and control – Fence remaining populations to protect them from the impacts of feral ungulates (USFWS, 2014).
- Invasive plant monitoring and control – Control invasive introduced plant species within the vicinity of all known *S. coriacea* populations (USFWS, 2014).
- Predator / herbivore monitoring and control – Control slugs, giant African snails (*Achatina fulica*), and rodents within the vicinity of all known *S. coriacea* populations (USFWS, 2014).
- Population viability monitoring and analysis – Continue monitoring wild and outplanted individuals (USFWS, 2014).
- Climate change adaptation strategy – Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. As a species likely to wink out by 2100, ensure that adequate genetic storage is maintained as viable material (USFWS, 2014).
- Alliance and partnership development – Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2014).

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SPECIES ACCOUNT: *Schenkia (=Centaurium) sebaeoides* (Awiwi)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/29/1991; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

It is an annual herb about 6 to 20 cm (2.4 to 8 in) tall. The leaves are rather fleshy, inversely ovate or elliptic, and 0.7 to 3.2 cm (0.3 to 1.3 in) long by less than 2 cm (1 in) wide. Flowers are stalkless and are arranged along the stems near their ends. The fused sepals are 8 mm (0.3 in) long and are divided into uneven lobes. The white or pale pink petals are fused into a tube up to 10 mm (0.4 in) long, with lobes up to 4.5 mm (0.2 in) long. The cylindrical capsules are up to 9.5 mm (0.4 in) long and contain numerous tiny brown seeds. (USFWS, 1999)

Taxonomy

A new taxonomic treatment of the polyphyletic genus *Centaurium* was published in 2004. This new classification defines monophyletic groups reflecting the phylogenetic relationships within the subtribe Chironiinae of the Gentianaceae family. For this purpose, the establishment of a new genus, *Zeltnera*, along with the reinstatement of the genera *Gyrandra* and *Schenkia*, resulted in numerous new species combinations. Fifteen genera were recognized, to include 108 species. Of them the genus *Schenkia* comprises only five species: *S. spicata* is broadly distributed in Eurasia and north Africa; *S. australis*, *S. clementii*, and *S. japonica* are confined to Australia and the Pacific region; while *S. sebaeoides* is the only species endemic to Hawaii (Mansion 2004). (USFWS, 2010)

Historical Range

Historically, *Centaurium sebaeoides* was known from scattered localities on State and private land on the islands of Kauai, Oahu, Molokai, Lanai, and Maui (Wagner et al. 1990). (USFWS, 1999)

Current Range

This species is currently known from Kauai, Oahu, Molokai, Lanai, and Maui. (NatureServe, 2015)

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On March 18, 2003 (Revised March 30, 2016), the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Centaurium sebaeoides* (Awiwi) (aka *Cyrtandra oxybapha*) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 10 detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Schenkia (=Centaurium) sebaeoides* (Awiwi) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Schenkia (=Centaurium) sebaeoides* (77 FR 57648-57862). The critical habitat designation includes 15 critical habitat units, which encompass approximately 1,332 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Schenkia* (=Centaureum) *sebaeoides* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

On February 27, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Alectryon macrococcus* (Mahoe) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Hawaii (68 FR 9116-9479).

Critical Habitat Designation

The critical habitat designation for *Centaureum sebaeoides* includes 10 CHUs in Maui County, Hawaii with detailed unit information. There are also an unknown number of units on Lanai that contain this species (number of units is unknown because detailed unit descriptions for Lanai are not available) (81 FR 17790-18110).

Molokai—Coastal—Unit 1 consists of 70 ac (28 ha) of privately owned land, and 54 ac (22 ha) of federally owned land (U.S. Coast Guard) at Laau Point, from Kahaiaawa to Keawakalani, along the western coast of Molokai. This unit is occupied by the plant *Marsilea villosa*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 1 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 2 consists of 263 ac (106 ha) of State land, and 710 ac (287 ha) of privately owned land, from Ilio Point to Kaa Gulch, along the northwestern coast of Molokai. This unit is occupied by the plant *Marsilea villosa* and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 2 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 3 consists of 794 ac (321 ha) of State land, and 3 ac (1 ha) of federally owned land (Kalaupapa National Historical Park), from Kahu Point to Wainene, along the north-central coast of Molokai. This unit is occupied by the plants *Pittosporum halophilum*, *Schenkia sebaeoides*, and *Tetramolopium rockii*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 3 is not known to be occupied by *Bidens wiebkii*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrne*, *Marsilea villosa*, *Peucedanum sandwicense*, or *Sesbania tomentosa*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 4 consists of 10 ac (4 ha) on Mokapu Island on the northern coast of Molokai. This area is State-owned, and is classified as a State Seabird Sanctuary. This unit is occupied by the plants *Peucedanum sandwicense* and *Pittosporum halophilum*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 4 is not known to be occupied by *Bidens wiebkii*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrne*, *Marsilea villosa*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 5 consists of 1 ac (0.5 ha) on Huelo islet on the northern coast of Molokai. This area is State-owned, and is classified as a State Seabird Sanctuary. This unit is occupied by the plants *Brighamia rockii*, *Peucedanum sandwicense*, and *Pittosporum halophilum*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 5 is not known to be occupied by *Bidens wiebkii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrne*, *Marsilea villosa*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 6 consists of 190 ac (77 ha) of State land, and 1,685 ac (682 ha) of privately owned land, from Kaholaiki Bay to Halawa Bay, on the northeastern coast of Molokai. This unit is occupied by the plants *Bidens wiebkei*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, and *Ischaemum byrone*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 6 is not known to be occupied by *Brighamia rockii*, *Hibiscus brackenridgei*, *Marsilea villosa*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 7 consists of 49 ac (20 ha) of privately owned land from Alanuihipaka Ridge to Kalanikaula, on the northeastern coast of Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). Although Molokai—Coastal—Unit 7 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Marsilea villosa*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 9 consists of 170 ac (69 ha) of State land and 0.3 ac (0.1 ha) of privately owned land, from Poelua Bay to Mokolea Point on the northwestern coast of west Maui. This unit is occupied by the plants *Schenkia sebaeoides* and *Sesbania tomentosa*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Coastal—Unit 9 is not known to be occupied by *Brighamia rockii*, we have determined this area to be essential for the conservation and recovery of this coastal species because it provides the PCEs necessary for the reestablishment of wild populations within its historical range. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could approach recovery.

Maui—Coastal—Unit 10 consists of 147 ac (60 ha) of State land and 26 ac (10 ha) of privately owned land, from Kahakuloa Head to Waihee Point on the northeastern coast of west Maui. This unit is occupied by the plant *Schenkia sebaeoides*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also

contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Coastal—Unit 10 is not known to be occupied by *Brighamia rockii* or *Sesbania tomentosa*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within its historical range. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could approach recovery.

Maui—Coastal—Unit 11 consists of 6 ac (3 ha) of State land on Mokeehia Island on the northeastern coast of west Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). Although Maui—Coastal—Unit 11 is not currently occupied by *Brighamia rockii*, *Schenkia sebaeoides*, or *Sesbania tomentosa*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat designation for *Schenkia* (=Centaurium) *sebaeoides* includes 15 critical habitat units, covering one ecosystem type, which encompasses approximately 1,332 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Coastal—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15.

Oahu—Coastal—Unit 1 [958 ac (388 ha)]. This area consists of 946 ac (383 ha) of State land, 11 ac (4 ha) of Federal land, and 2 ac (1 ha) of privately owned land in the coastal ecosystem along the northwestern coast of Oahu from Kaena Point east to Kauhao Pali and southeast to Keawaula. This unit is partially within Kaena Point State Park. Oahu—Coastal—Unit 2 [12 ac (5 ha)]. This area consists of 12 ac (5 ha) in the coastal ecosystem on Mokuauia, an islet east of Kalanai Point on the northeastern coast of Oahu. This unit is State-owned and is classified as a State Seabird Sanctuary. Oahu—Coastal—Unit 3 [15 ac (6 ha)]. consists of 15 ac (6 ha) in the coastal ecosystem, on the larger of two islets (Moku Manu) off the windward coast of Oahu near Mokapu Peninsula. This unit is Stateowned, classified as a State Seabird Sanctuary. Oahu—Coastal—Unit 4 [3 ac (1 ha)]. This area consists of 3 ac (1 ha) in the coastal ecosystem, the smaller of two islets (Moku Manu) off the windward coast of Oahu near Mokapu Peninsula. This unit is Stateowned, classified as a State Seabird Sanctuary. Oahu—Coastal—Unit 5 [12 ac (5 ha)]. This area consists of 12 ac (5 ha) in the coastal ecosystem, the larger of two islands (Mokulua Islands) off the windward coast of Oahu near Wailea Point. This unit is State-owned, classified as a State Seabird Sanctuary. Oahu—Coastal—Unit 6 [9 ac (4 ha)]. This area consists of 9 ac (4 ha) in the coastal ecosystem, on the smaller of two islands (Mokulua Islands) off the windward coast of Oahu near Wailea Point. This unit is Stateowned, classified as a State Seabird Sanctuary. Oahu—Coastal—Unit 7 [67 ac (27 ha)]. This area consists of 67 ac (27 ha) in the coastal ecosystem, on the larger of two islands (Manana Island) off the windward coast of Oahu near Makapuu Point. This unit is Stateowned, classified as a State Seabird Sanctuary. Oahu—Coastal—Unit 8 [10 ac (4 ha)]. This area consists of 10 ac (4 ha) in the coastal ecosystem, on the smaller of two islands (Kaohikaipu Island) off the windward coast of Oahu near Makapuu Point. This unit is Stateowned, classified as a State Seabird Sanctuary. Oahu—Coastal—Unit 9 [80 ac (33 ha)]. This area consists of 80 ac (33

ha) of State land in the coastal ecosystem on the leeward side of Makapuu Point (Puuokipahulu). Oahu—Coastal—Unit 10 [74 ac (30 ha)]. This area consists of 74 ac (30 ha) in the coastal ecosystem, owned by the City and County of Honolulu at Halona Point on the leeward side of Koko Crater, extending from Sandy Beach to Kahauloa. Oahu—Coastal—Unit 11 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) of privately owned land in the coastal ecosystem, at Ihiihilauakea on Koko Head (Kaihuokapuaa). Oahu—Coastal—Unit 12 [11 ac (5 ha)]. This area consists of 11 ac (5 ha) of City and County land in the coastal ecosystem, at Nonoula on Koko Head (Kaihuokapuaa). Oahu—Coastal—Unit 13 [23 ac (10 ha)]. This area consists of 19 ac (8 ha) of City and County land, 1 ac (0.5 ha) of State land, and 3 ac (1 ha) of privately owned land in the coastal ecosystem at Kalaeloa. Oahu—Coastal—Unit 14 [4 ac (2 ha)]. This area consists of 2 ac (1 ha) of City and County of Honolulu land, and 2 ac (1 ha) of Federal land (U.S. Coast Guard) in the coastal ecosystem at Kalaeloa. Oahu—Coastal—Unit 15 [33 ac (13 ha)]. This area consists of 9 ac (4 ha) of State land, 2 ac (1 ha) of privately owned land, and 21 ac (9 ha) of Federal (Pearl Harbor NWR) land at Kalaeloa.

The critical habitat designation for *Alectryon macrococcus* includes one CHU in Kauai County, Hawaii (68 FR 9116-9479).

Kauai 11—*Centaurium sebaeoides*—a: This unit is critical habitat for *Centaurium sebaeoides* and is 155 ha (385 ac) on State land (Hono o Na Pali NAR, Puu Ka Pele Forest Reserve, and Milolii, Nualolo, and Na Pali Coast State Parks). This unit contains Awaawapuhi, Honopu, Kalalau, Milolii, and Nualolo Valleys; Hanakoa, Hoolulu, Kalalau, and Waiahuakua Streams; Mukuaiki and Puanaiea Points; and Kalalau Beach. This unit provides habitat for four populations of 500 mature, reproducing individuals of the annual *Centaurium sebaeoides* and is currently occupied with between 22 and 52 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. It provides habitat for the westernmost range of the species. The habitat features contained in this unit that are essential for this species include, but are not limited to, volcanic or clay soils or cliffs in arid coastal areas. This unit provides for four populations within this multi-island species' historical range on Kauai that are some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Centaurium sebaeoides* critical habitat consists of two components. Coastal (west Maui and Molokai) and Lowland dry (Lanai) (81 FR 17790-18110):

Ecosystem: Coastal. Elevation: <980 ft (<300 m). Annual precipitation: <20 in (<50 cm). Substrate: Well-drained, calcareous, talus slopes; dunes; weathered clay soils; ephemeral pools; mudflats. Canopy: Hibiscus, Myoporum, Santalum, Scaevola. Subcanopy: Gossypium, Sida, Vitex. Understory: Eragrostis, Jacquemontia, Lyceum, Nama, Sesuvium, Sporobolus, Vigna.

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: Diospyros, Myoporum, Pleomele, Santalum. Subcanopy: Chamaesyce, Dodonaea, Leptecophylla,

Osteomeles, Psydrax, Scaevola, Wikstroemia. Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Sicyos.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Schenkia* (=Centaurium) *sebaeoides* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Schenkia* (=Centaurium) *sebaeoides* occurs within the indicated ecosystem in the Waianae Mountain caldera complex and the Koolau Mountain caldera complex:

(i) Oahu—Coastal—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15. Coastal. (A) Elevation: <980 ft (<300 m). (B) Annual Precipitation: <20 in (<50 cm). (C) Substrate: Well-drained, calcareous, talus slopes; dunes; weathered clay soils; ephemeral pools; mudflats. (D) Canopy: Hibiscus, Myoporum, Santalum, Scaevola. (E) Subcanopy: Gossypium, Sida, Vitex. (F) Understory: Eragrostis, Jacquemontia, Lyceum, Nama, Sesuvium, Sporobolus, Vigna.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Alectryon macrococcus* critical habitat consists of two components (68 FR 9116-9479):

(i) Volcanic or clay soils or on cliffs in arid coastal areas and containing one or more of the following native plant species: *Artemisia* spp., *Bidens* spp., *Chamaesyce celastroides*, *Cyperus phleoides*, *Dodonaea viscosa*, *Fimbristylis cymosa*, *Heteropogon contortus*, *Jacquemontia ovalifolia*, *Lipochaeta* spp., *Lycium sandwicense*, *Lysimachia mauritiana*, *Melanthera integrifolia*, *Panicum fauriei*, *Panicum torridum*, *Scaevola sericea*, *Sida fallax*, or *Wikstroemia uva-ursi*; and

(ii) Elevations between 0 and 147 m (0 and 483 ft).

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua*

coriacea, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkii*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C.*

maritae, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Schenkia* (=Centaurium) *sebaeoides* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species and therefore are not included in the critical habitat designations.

Life History

Food/Nutrient Resources

Lifespan

Adult: 1 year (USFWS, 1999)

Breeding Season

Adult: April (USFWS, 1999)

Key Resources Needed for Breeding

Adult: Rainfall (USFWS, 1999)

Reproduction Narrative

Adult: *Centaurium sebaeoides* has been observed flowering in April. Flowering may be induced by heavy rainfall. Populations are found in dry areas, and plants are more likely to be found following heavy rains (USFWS 1995). (USFWS, 1999)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Shrubland/chaparral (NatureServe, 2015)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1999)

Habitat Narrative

Adult: This species is found on dry shrublands primarily at coastal sites with coralline or basaltic substrates. On Molokai, *Schenkia sebaeoides* grows in volcanic or clay soils or on cliffs in arid dune ecosystems at elevations between sea level and 409 meters (0 and 1,341 feet). On Kauai, *Schenkia sebaeoides* typically grows in volcanic or clay soils or on cliffs in arid coastal areas at elevations between sea level and 147 meters (483 feet). On Oahu, *Schenkia sebaeoides* typically grows in volcanic or clay soils or on cliffs in arid coastal areas or on coral plains below 368 meters (1,207 ft) elevation. (USFWS, 1999; USFWS, 2010; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Medium (inferred from USFWS, 2010)

Redundancy:

Medium (inferred from USFWS, 2010)

Number of Populations:

17-18 (USFWS, 2010)

Population Size:

~6,000 plants (USFWS, 2010)

Population Narrative:

Currently, on Kauai there are a total of three populations with approximately 22 to 52 individuals on State-owned land. On Molokai, there are at least four populations containing thousands of individuals. On Oahu, two populations have between 100 to 130 individuals total. On West Maui, the most recent estimates are 7 to 8 populations, with several 1,000 plants. Lanai had one population in Maunalei Valley with approximately 23 individuals (Hawaii Biodiversity and Mapping Program 2009; USFWS 1999). The number of individuals fluctuates

dramatically with the seasons. The total number of populations statewide is estimated to be 17 or 18, with as many as 6,000 individuals when rainfall is abundant. (USFWS, 2010)

Threats and Stressors

Stressor: Rats (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Rats are a newly described threat to this species at the Halona Gulch area (S. Ching, pers. comm. 2011). (USFWS, 2013)

Stressor: Drought (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Drought is another threat not previously mentioned for this species, as reported at Halona Gulch and Kaena Point (S. Ching, pers. comm. 2011). (USFWS, 2013)

Stressor: Fire (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: In July 2009, a fire in the Manini/Alau vicinity of Kaena Point burned designated critical habitat for *Schenkia sebaeoides* (U.S. Army Garrison 2009). Fire was not previously reported as a threat at this location. (USFWS, 2013)

Stressor: Invasive plant species (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: On Molokai, other major threats to this species include competition with invasive introduced woody plant species such as *Casuarina equisetifolia* (ironwood), *Casuarina glauca* (saltmarsh), *Leucaena leucocephala* (koa haole), *Prosopis pallida* (kiawe), *Schinus terebinthifolius* (Christmasberry), *Syzygium cumini* (Java plum), and *Tournefortia argentea* (tree heliotrope). On Maui, competing invasive introduced plant species include *Cynodon dactylon* (Bermuda grass), *Digitaria ciliaris* (crabgrass), and *Pluchea indica* (Indian fleabane) (Hawaii Biodiversity and Mapping Program 2009; National Tropical Botanical Garden 2009; Wood 2009). The major threats to this species on Kauai include competition from invasive introduced plant species (Factor E) including *Casuarina equisetifolia*, *Bryophyllum pinnatum* (airplant), *Furcraea foetida* (Mauritius hemp), *Pluchea carolinensis* (sourbush), *Portulaca pilosa* (pigweed), *Plantago lanceolata* (narrow-leaved plantain), *Lantana camara* (lantana), *Leucaena leucocephala* (haole koa), *Prosopis pallida*, *Schinus terebinthifolius*, *Syzygium cumini* (Java plum), and *Tournefortia argentea* (tree heliotrope). The major threats on Oahu include competition from invasive introduced plant species *Leucaena leucocephala*, *Casuarina equisetifolia*, *C. glauca*, *Leucaena leucocephala*, *Prosopis pallida*, *Schinus terebinthifolius*, *Syzygium cumini*, and *Tournefortia argentea*. Site invasion by *Casuarina* spp. appears to be particularly damaging because of the smothering leaf litter layers that exclude most other plant species. (USFWS, 2010)

Stressor: Overgrazing (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Indirect effects of overgrazing, such as trampling and erosion, are also likely contributors to the decline or disappearance of the species depending on the severity, timing, longevity, and nature of the disturbance. (USFWS, 2010)

Stressor: Off-road vehicles (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Destruction of plants growing in coastal sites by off-road vehicles may also be an important source of mortality (Medeiros et al. 2000). (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to *Schenkia sebaeoides*. However, current climate change models do not allow us to predict specifically what those effects, and their extent, would be for this species. (USFWS, 2010)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on islands where they now occur or occurred historically. (USFWS, 1999)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure with the following minimum numbers of mature individuals per population: 100 for long-lived perennials, 300 for short-lived perennials, and 500 for the annual taxa. (USFWS, 1999)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1999)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on islands where they now occur or occurred historically. (USFWS, 1999)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with the following minimum numbers of mature individuals per population: 100 for long-lived perennials, 300 for short-lived perennials, and 500 for the annual taxa. (USFWS, 1999)
3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1999)

Recovery Actions:

- Exclosures should be constructed around the known populations of *Centaurium sebaeoides* on State and private land to reduce impacts from feral ungulates. Subsequent control or removal of ungulates from these areas will alleviate their impact on native ecosystems. Additionally, those populations that have only a few remaining individuals, such as at Mokio Point and Manaopapa on Molokai should be fenced and protected immediately. (USFWS, 1999)
- A long-range management plan to control alien plants such as koa haole needs to be developed. Additionally, populations that have only a few remaining individuals such as those at Mokio Point and Manaopapa on Molokai should be weeded and protected immediately. (USFWS, 1999)
- Implement a coordinated effort of fire protection actions for endangered plant species on State and private land where just a few individuals occur. (USFWS, 1999)

Conservation Measures and Best Management Practices:

- Construct exclosures and remove ungulates in wild populations. (USFWS, 2013)
- Control invasive introduced plant species in wild populations. (USFWS, 2013)
- Develop and implement fire management plans for populations at risk of fire. (USFWS, 2013)
- Monitor populations which are fluctuating or ephemeral based on rainfall, since the former presence of the species at a given location would indicate that a seed bank might be present. (USFWS, 2013)
- Collect material for genetic storage and propagation for reintroduction. (USFWS, 2013)
- Initiate planning and contribute to implementation of ecosystem level restoration and management to benefit this taxon. (USFWS, 2013)

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SPECIES ACCOUNT: *Schiedea* (= *Alsinidendron*) *lychnoides* (Kuawawaenuhu)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Alsinidendron lychnoides, a member of the pink family (Caryophyllaceae), is a weakly climbing or sprawling subshrub. The main stems are 0.4 to 3 m (1.3 to 9.8 ft) long with short side branches. The plant is woody, at least at the base, and densely covered with fine glandular hairs throughout. The thin leaves are egg-shaped to elliptic and are 3.5 to 6.5 cm (1.4 to 2.6 in) long and 1.5 to 3.8 cm (0.6 to 1.5 in) wide. Eighteen to 21 flowers are arranged in clusters with stalks ranging from 2 to 2.4 cm (0.8 to 0.9 in) long. The four sepals are white and thin, and remain so at maturity. The outer two sepals greatly overlap the inner ones. The sepals are oblong-ovate, 10 to 12 mm (0.4 to 0.5 in) long, but enlarge to 12 to 16 mm (0.5 to 0.6 in) long in fruit, completely enclosing the fruit at maturity. The stamens are scarcely fused at the base with basal outgrowths 2.5 to 3.5 mm (0.1 in) long, nearly as wide, and two-to three-toothed. The fruit are egg-shaped capsules, 9 to 12 mm (0.4 to 0.5 in) long, with 8 to 11 valves. The black seeds are approximately 1 mm (0.04 in) long with low transverse ridges on the surface. (USFWS, 1998)

Taxonomy

This species is distinguished from others in this endemic Hawaiian genus by the weakly climbing or sprawling habit, color of the sepals, number of flowers per cluster, and size of the leaves. *Alsinidendron lychnoides* is closely related to *Alsinidendron viscosum*, which differs primarily in having narrower leaves, fewer capsule valves, and fewer flowers per cluster (USFWS 1996). (USFWS, 1998)

Historical Range

Historically, *Alsinidendron lychnoides* has been found on the east rim of Kalalan Valley near Keanapuka, the western and southeastern margins of the Alakai Swamp, and southwest of the Swamp near Kaholuamano on the island of Kauai. (USFWS, 1998)

Current Range

Found in Kauai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Schiedea* (= *Alsinidendron*) *lychnoides* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Schiedea* (=Alsinidendron) *lychnoides* includes three units totaling 2,921 acres in Kauai County, Hawaii. The units are Kauai 11—Alsinidendron *lychnoides*—a, b, c.

Kauai 11—Alsinidendron *lychnoides*—a: This unit is critical habitat for Alsinidendron *lychnoides* and is 994 ha (2,457 ac) on State (Alakai Wilderness Preserve, Halelea Forest Reserve, Hono o Na Pali NAR, and Na Pali Coast State Park) and private land. This unit contains portions of the Alakai Trail and Alealau, Hono o Na Pali, Keanapuka, Moaalele, Pihea, Pohakea, and Waiahuakua Summits. This unit provides habitat for six populations of 100 mature, reproducing individuals of the long-lived perennial Alsinidendron *lychnoides* and is currently occupied with three plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep riparian clay or silty soil banks in montane wet forests, and is the area most likely to contain a viable seed bank on this side of the island. This unit is geographically separated from the other two units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—Alsinidendron *lychnoides*—b: This unit is critical habitat for Alsinidendron *lychnoides* and is 138 ha (340 ac) on State land (Alakai Wilderness Preserve) and contains a portion of the Mohihi-Waialae Trail and the Alakai Swamp. This unit provides habitat for two populations of 100 mature, reproducing individuals of the long-lived perennial Alsinidendron *lychnoides* and is currently occupied with one plant. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep riparian clay or silty soil banks in montane wet forests. This unit is geographically separated from the other two units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—Alsinidendron *lychnoides*—c: This unit is critical habitat for Alsinidendron *lychnoides* and is 55 ha (136 ac) on State land (Alakai Wilderness Preserve) and contains a portion of the Mohihi Waialai Trail, Mohihi Stream and the Alakai Swamp. This unit provides habitat for two populations of 100 mature, reproducing individuals of the long-lived perennial Alsinidendron *lychnoides* and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is essential to the establishment of additional populations on Kauai in order to reach recovery goals. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep riparian clay or silty soil banks in montane wet forests. This unit is geographically separated from the other two units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

- (i) Steep riparian clay or silty soil banks in montane wet forests dominated by *Metrosideros polymorpha* and *Cheirodendron* spp., or by *Metrosideros polymorpha* and *Dicranopteris linearis* and containing one or more of the following native plant species: *Asplenium* spp., *Astelia* spp.,

Broussaisia arguta, Carex spp., Cyrtandra spp., Diplazium sandwichianum, Elaphoglossum spp., Hedyotis terminalis, Machaerina spp., Peperomia spp., or Vaccinium spp.; and

(ii) Elevations between 828 and 1,344 m (2,715 and 4,408 ft).

Special Management Considerations or Protections

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Dependency on Other Individuals or Species

Adult: Schiedea lychnoides is most likely pollinated by nectar-eating birds as it produces abundant nectar, and has open, showy flowers typical of bird-pollinated flowers. Schiedea lychnoides produces seeds that remain in the capsule after maturation and are released as the capsules gradually disintegrate (Wagner et al. 2005). (USFWS, 2010)

Reproduction Narrative

Adult: Schiedea lychnoides is most likely pollinated by nectar-eating birds as it produces abundant nectar, and has open, showy flowers typical of bird-pollinated flowers. Schiedea lychnoides produces seeds that remain in the capsule after maturation and are released as the capsules gradually disintegrate (Wagner et al. 2005). (USFWS, 2010)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 828 and 1,355 meters (USFWS, 2010)

Environmental Specificity

Adult: Low, with few key requirements (USFWS, 2010)

Habitat Narrative

Adult: Schiedea lychnoides grows on steep riparian clay or silty soil banks, often along streams, in montane wet forests dominated by Metrosideros polymorpha (ohia), Cheirodendron spp. (olapa) or in M. polymorpha – Dicranopteris linearis (uluhe) habitat. This species is often found

on ridges and plateau lands. It has a trailing growth habit, spreading on the ground or sprawling over other forest plants at elevations between 828 and 1,344 meters (2,715 and 4,408 feet) (USFWS 2003; Wagner et al. 2005). (USFWS, 2010)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Resiliency:

Very low (inferred from USFWS, 2010)

Redundancy:

Very low (inferred from USFWS, 2010)

Number of Populations:

11 to 15 (USFWS, 2017)

Population Size:

60 to 85 individuals (USFWS, 2017)

Population Narrative:

New Status Information: In addition to those populations cited in the previous 5-year review, new observations include the following: • At the time *Alsinidendron lychnoides* was listed, *Alsinidendron* was considered to be a genus of four species distinct from *Schiedea* (Wagner et al. 1999). Analysis of nuclear DNA and morphology by Wagner et al. (2005) showed that the *Alsinidendron* clade is nested within *Schiedea*. This change has been accepted by the most recent update to the Manual of Flowering Plants of Hawaii (Wagner et al. 2012). In 2015, the Service published a technical correction for this and other plant and wildlife species, recognizing the taxonomic change from *Alsinidendron lychnoides* to *Schiedea lychnoides* (80 FR 35860, June 23, 2015). This taxonomic change does not affect the range or endangered status of this species. • At the time of the last 5-year review in 2010 there were 7 populations totaling 35 individuals at Kalalau, Pihea, Kawaiikoi, Waiakoali, Mohihi-Waialae trail (east and west), and Laau Ridge on Kauai. Recent surveys have confirmed individuals at MohihiWaialae Trail (15) (NTBG 2016b; PEPP 2010). New occurrences are reported at Kawaiiki (2-4), Kauaikinana (3), Manono ridge to Hanakoa stream (1), Koaie stream headwaters (1-2), and Waialae trail (3) (NTBG 2009, 2011, 2012, 2013, 2014a-c, 2015; PEPP 2010). The status of populations at Pihea (2), Kawaiikoi (3), Kalalau rim (3-5), and Waiakoali (13) has not been reported since 2010. These 11 small populations total 60 or fewer individuals. In 2016, the IUCN Red List of Threatened Species reported 10 subpopulations at 4 locations, totaling 85 individuals, with the largest population consisting of 30 individuals (Clark 2016) (USFWS, 2017).

Threats and Stressors

Stressor: Natural disasters (USFWS, 1998)

Exposure:

Response:

Consequence:

Narrative: This species is also threatened by a risk of extinction from naturally occurring events (such as landslides or hurricanes) and by reduced reproductive vigor due to the small number of extant individuals (USFWS 1996). One plant in Kalalau Valley has died since Hurricane Iniki struck Kauai in September 1992, probably as a result of a landslide caused by hurricane-denuded slopes (Ken Wood and S. Perlman, NTBG, personal communication 1997). (USFWS, 1998)

Stressor: Invasive plant species (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The major threats to this species are competition from invasive introduced plant species such as *Ageratum conyzoides* (billygoat weed), *Andropogon virginicus* (broomsedge), *Conyza bonariensis* (hairy horseweed), *Cyperus meyenianus* (NCN), *Emilia fosbergii* (Flora's paintbrush), *Erechtites valerianifolia* (fireweed daisy), *Erigeron karvinskianus* (daisy fleabane), *Hedychium gardnerianum* (Kahili ginger), *Juncus planifolius* (bog rush), *Passiflora tarminiana* (banana poka), *Sacciolepis indica* (Glenwood grass), *Schizachyrium condensatum* (beardgrass), *Rubus argutus* (prickly Florida blackberry), *R. rosifolius* (thimbleberry), and *Youngia japonica* (oriental hawkbeard). (USFWS, 2010)

Stressor: Habitat degradation (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Other threats include habitat degradation by feral pigs (*Sus scrofa*) and goats (*Capra hircus*). Rats (*Rattus* spp.) have been mentioned as a threat to this species. (USFWS, 2010)

Stressor: Human disturbances (USFWS, 2010; NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: Trampling by humans from recreation (hiking). (USFWS, 2010; NatureServe, 2015)

Stressor: Small population size (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: In addition to all of the other threats, species like *Schiedea lychnoides* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding, and disease outbreaks. (USFWS, 2010)

Stressor: Climate change loss or degradation of habitat

Exposure:**Response:****Consequence:**

Narrative: —Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Schiedea lychnoides* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.724 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, Fortini et al. show that Caryophyllaceae is one of the top four most vulnerable native plant families, and, at the genus level, *Schiedea* had one of the highest vulnerability scores. Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery**Reclassification Criteria:**

1. A total of five to seven populations of each taxon should be documented on Kauai where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Kauai where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1998)

Recovery Actions:

- In order to prevent this taxon from going extinct, propagation efforts and the maintenance of adequate genetic stock ex situ should be continued. Additional wild seeds should be collected periodically until the cryopreservation method of long-term storage is perfected. This will insure that viable seed stock is available for out planting. (USFWS, 1998)
- Without this protection, this species will continue to decline due to degradation of habitat by feral pigs. Once enclosed, those areas should undergo management to remove alien

plant species, like the prickly Florida blackberry, which have been predominantly spread by feral pigs. (USFWS, 1998)

- Completion of the Alakai Wilderness Preserve board walk will help reduce potential trampling by humans as well as reduce the spread of alien plants by limiting the amount of area impacted by humans. (USFWS, 1998)

Conservation Measures and Best Management Practices:

- Fence wild populations to prevent trampling and uprooting disturbances from feral ungulates. (USFWS, 2010)
- Collect seed and/or cuttings from all known populations. (USFWS, 2010)
- Determine how to stabilize cliff areas where goats have degraded habitat. (USFWS, 2010)
- Augment existing populations once habitat is protected. (USFWS, 2010)
- Remove invasive introduced plants in the immediate vicinity of *Schiedea lychnoides* populations. (USFWS, 2010)
- Work with Hawaii Division of Forestry and Wildlife and Hawaii State Parks to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2010)
- Update the listed entity on 50 CFR 17 to match the currently recognized taxonomy. (USFWS, 2010)
- New Management Actions: • NTBG has plants in their nursery from a collection along Mohihi-Waialae Trail. The NTBG seed bank has five collections totaling almost 25,000 seeds representing the Waiakoali, Kauaikinana, Mohihi-Waialae, and Koaie populations. It is uncertain how many individuals are represented (NTBG 2017). UCI has 200 seeds and 50 plants from one founder at the Pihea Trail population (UCI 2017). • PEPP has been collecting seeds for collections at NTBG (PEPP 2010). • Lyon Arboretum has three founders from Mohihi represented at their seed bank (Lyon Arboretum 2017). • PEPP is monitoring populations at Mohihi and Kawaiiki (PEPP 2010, 2011) (USFWS, 2017).
- Recommendations for Future Actions: No new threats and no other significant new information regarding the species' biological status have been reported since the last 5-year review in 2010. Therefore, the following recommendations for future actions are reiterated for the 5-year review for 2017. • Ungulate monitoring and control—Fence wild and reintroduced populations to prevent trampling and uprooting disturbances from feral ungulates. Construct smallscale fences around all currently unprotected populations until ecosystem-level fences are constructed and areas are ungulate-free. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative species that compete with the species around all populations. • Captive propagation for genetic storage and reintroduction—Continue to collect seeds and cuttings from all known populations. • Reintroduction and translocation—Augment existing populations once habitat is protected. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered throughout historic range to reduce impacts from hurricanes (USFWS, 2017).

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SPECIES ACCOUNT: *Schiedea adamantis* (Diamond Head schiedea)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

An erect shrub 3-8 dm tall. The small flowers are borne in terminal clusters. (NatureServe, 2015)

Taxonomy

Genus endemic to Hawaiian Islands, species endemic to diamond head crater, Oahu. First collected in 1955 & described by St. John in 1970. Wagner et al. Are maintaining this taxon. (NatureServe, 2015)

Current Range

Restricted to Diamond Head Crater, Oahu. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Pollinators unknown. Female, male and hermaphrodites exist. Females have fewer, but more viable seeds than hermaphrodites (USFWS, 1994).

Lifespan

Adult: Perennial plant (USFWS, 1994)

Breeding Season

Adult: According to field and green house observations by Sakai and Weller (unpublished data), flowering of *Schiedea adamantis* occurs during the winter and appears to be induced by local rainfall. A plant may flower over several days and sometimes weeks, although a given flower is receptive for only 2-3 days. If rainfall is abundant, the flowering season for the population as a whole may extend over several months (USFWS, 1994).

Reproduction Narrative

Adult: According to field and green house observations by Sakai and Weller (unpublished data), flowering of *Schiedea adamantis* occurs during the winter and appears to be induced by local rainfall. A plant may flower over several days and sometimes weeks, although a given flower is receptive for only 2-3 days. If rainfall is abundant, the flowering season for the population as a whole may extend over several months. No native pollinators have been observed visiting the small yellow-green flowers (Weller et al. 1990). The most common visitor to *Schiedea adamantis* was *Simosyrphus grandicornis* (Macquart), an introduced syrphid fly. Occasional visits by *Allograpta exotica* (Wiedemann), another introduced syrphid species, were also noted. Flies were equally likely to land on females and hermaphrodites and the length of the foraging bouts

were similar for the two sexes. Flies may have been feeding on the pollen, but they did not appear to be foraging for nectar. It is unclear whether the flies served as effective pollinators. Although *Lipochaeta lobata* (Gaud.) DC. var. *lobata* (Asteraceae) was also flowering and intermingled with the *Schiedea*; flies were more likely to land on and remain on *Lipochaeta* than *S. adamantis*. Based on greenhouse studies using controlled crosses hermaphroditic plants are capable of selfing. Preliminary studies indicate inbreeding depression in *Schiedea adamantis*, as shown by a reduced number of seeds per capsule for selfed hermaphrodites compared to outcrossed hermaphrodites (Weller and Sakai 1990). Other *Schiedea* species show strong inbreeding depression at many stages of their life history, including reduced numbers of seeds per capsule, biomass, flowering and survival rates, and poorer performance of progeny resulting from selfing (Sakai et al. 1989). Natural rates of selfing in the field are unknown. Many of the electrophoretic markers often used to detect outcrossing rates are monomorphic in *S. adamantis*, and cannot be used. According to Sakai and Weller (unpublished data), observations of females and hermaphrodites revealed similar numbers of flowers per inflorescence (a mean of 40-70 depending on year) and numbers of inflorescences (a mean of 11-19 depending on year). However, females had more capsules per inflorescence than hermaphrodites, and fewer but larger viable seeds with higher germination rates (Sakai and Weller, unpublished data). As a result, females produced far more seeds per plant on an annual basis than hermaphrodites. Fruits mature approximately 3 weeks after pollination. The dry capsules open on the plants and seeds are dispersed by wind and gravity. Seeds apparently do not germinate immediately but require a 6-9 month dormancy. Seeds are shed in the early spring, lie dormant during the dry summer, and germinate with the onset of the following rainy season. Surveys of seedling density in December 1988, showed a mean of 7-8 seedlings within a 20 x 20 centimeter area at the base of each large plant surveyed (plants with >10 inflorescences, N=36). These surveys were conducted near the top of the crater rim, where the population density of *Schiedea* was greatest. Seedling survival was not followed, but mortality was undoubtedly high, especially with drier conditions (Sakai and Weller, unpublished data). Plants are perennial and can live for several years. Over a two year period (1988-1990), 17 of 211 (8%) marked flowering plants died; most of these were small plants (Sakai and Weller, unpublished data) (USFWS, 1994).

Habitat Type

Adult: Volcanic cone (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (inferred from USFWS, 1994)

Environmental Specificity

Adult: Narrow/specialist (inferred from USFWS, 1994)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1994)

Site Fidelity

Adult: High (inferred from USFWS, 1994)

Habitat Narrative

Adult: Site now dominated by alien shrubs. On an old volcanic cone of consolidated ash. (NatureServe, 2015). Habitat requirements for *Schiedea adamantis* can only be inferred by

observing the one site on which it currently exists. This site is located on the Diamond Head crater, a palagonite tuff cone which has a substrate consisting of consolidated volcanic ash with pockets of loose, shallow soil interspersed along a steep, well-drained slope. An average annual rainfall of 60 centimeters (23 inches) falls in intense storms, mostly between November and March. (USFWS, 1994). Clumped spatial arrangement of the population, narrow environmental specificity, low tolerance ranges and high site fidelity and ecological integrity of the community are inferred based on the species unique habitat requirements and the low number of known populations (one).

Dispersal/Migration

Dispersal

Adult: Low. Seed is wind and gravity dispersed. Do not appear to be carried far by wind (USFWS, 1994).

Dispersal/Migration Narrative

Adult: The dry capsules open on the plants and seeds are dispersed by wind and gravity. Seeds apparently do not germinate immediately but require a 6-9 month dormancy. Seeds are shed in the early spring, lie dormant during the dry summer, and germinate with the onset of the following rainy season. Surveys of seedling density in December 1988, showed a mean of 7-8 seedlings within a 20 x 20 centimeter area at the base of each large plant surveyed (plants with >10 inflorescences, N=36) (USFWS, 1994).

Population Information and Trends

Population Trends:

Decreasing (USFWS, 2013)

Resiliency:

Low (inferred from USFWS, 2013)

Representation:

Low (inferred from USFWS, 2013)

Redundancy:

Low (inferred from USFWS, 2013)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Fragility unknown. Currently known from one population with less than 300 individuals. 1 current (between 1982 and 1997) occurrence and no historical occurrences. (NatureServe, 2015). Only one wild population exists, on the rim of Diamond Head (Leahi) Crater. In the summer of 2012, it contained four mature and nine immature individuals. Oahu Plant Extinction

Prevention Program (PEPP) staff considers this to be positive, since there have been drought conditions at this site for several years, and PEPP staff had not observed immature individuals or seedlings in the several years previously. In 2011, good summer rains resulted in seedlings germinating in December 2011. They are all still alive at this time, and all look stressed (S. Ching, PEPP, pers. comm. 2012a). ? Severe decline in the number of wild individuals and lack of substantial survivorship of reintroduced individuals is potentially mitigated by the extensive banking of seeds in at least two places, which together offers a broad representation of existing genetic variation in the species. Propagation and reintroduction from these seeds will be necessary to the survival of the species (S. Weller, University of California, Irvine, pers. comm. 2012) (USFWS, 2013). Low resiliency, redundancy and representation are inferred based on there being only one known population of this species with a limited number of individuals (4 mature and 9 immature (USFWS, 2013)) as well as a limited geographic area in which the species is known to occur.

Threats and Stressors

Stressor: Drought (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat/extinction

Narrative: Drought is listed as a threat to this species (USFWS, 2013).

Stressor: Fire (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat/extinction

Narrative: Fire is listed as a threat to this species (USFWS, 2013).

Stressor: Invasive plants (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Invasive introduced plants are listed as a threat to this species (USFWS, 2013).

Stressor: Low population size (USFWS, 2013)

Exposure:

Response:

Consequence: Extinction

Narrative: Low population size is listed as a threat to this species (USFWS, 2013).

Stressor: Foot traffic from hikers (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Foot traffic from hikers (trampling) is listed as a threat to this species (USFWS, 2013).

Stressor: Climate change (USFWS, 2013)

Exposure:

Response:**Consequence:** Loss of habitat**Narrative:** Climate change is listed as a threat to this species (USFWS, 2013).***Recovery*****Reclassification Criteria:**

Schiedea adamantis is a short-lived perennial, and to be considered for downlisting, the wild population should be increased to at least 500 reproductive plants and two more populations of at least 500 reproductive plants should be established. All populations should be naturally reproducing as indicated by the presence of varied age classes ranging from seedlings to mature, reproducing adults, and should remain at these numbers for a minimum of ten years (USFWS, 2013).

Delisting Criteria:

The downlisting goals for this species have not been met, as no population has 500 or more mature individuals (Table 1), and all threats are not being sufficiently managed throughout the populations (Table 2). Therefore, Schiedea adamantis meets the definition of endangered as it remains in danger of extinction throughout its range (USFWS, 2013).

Conservation Measures and Best Management Practices:

- Captive propagation for genetic storage and reintroduction - Continue collecting material for genetic storage and propagation for reintroduction (USFWS, 2013).
- Reintroduction / translocation: o Install and maintain adequate irrigation at all S. adamantis sites. o Continue to reintroduce the species back into its known historical range, in and around Diamond Head in at least two new sites as well as augmenting the existing population and reintroduction sites. o Consider additional reintroduction sites at higher elevation and somewhat wetter habitat (USFWS, 2013).
- Ecosystem-altering invasive plant species control - Remove invasive introduced plant species within wild and reintroduced populations and maintain those areas free of invasive introduced plants (USFWS, 2013).
- Threats research - Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2013).
- Fire protection – Continue to implement a fire management plan in cooperation with the landowner (USFWS, 2013).
- Population biology research - Implement genetic studies to assess the viability of remaining individuals (USFWS, 2013).
- Population biology research - Investigate causes of reproductive failure and techniques to improve natural recruitment (USFWS, 2013).
- Population viability monitoring – Continue studies of Schiedea adamantis with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2013).
- Alliance and partnership development - Initiate planning and contribute to implementation of ecosystem level restoration and management to benefit this taxon (USFWS, 2013).

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U.S. Fish and Wildlife Service. 2013. 5-YEAR REVIEW Short Form Summary Species Reviewed: *Schiedea adamantis* (Diamond Head schiedea) Current Classification: Endangered.

SPECIES ACCOUNT: *Schiedea apokremnos* (Ma`oli`oli)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/30/1991; Pacific Region (R1) (USFWS, 2016)

Physical Description

A branching shrub 2 - 5 dm tall. The small flowers are borne in terminal clusters (NatureServe, 2015). The leaves are oppositely arranged, oblong, somewhat fleshy and glabrous, about 3 to 5 centimeters (1 to 2 inches) long and 0.6 to 1.2 centimeters (0.2 to 0.5 inches) wide. The flowers lack petals and are in clusters with green and often purple-tinged bracts and sepals; the sepals are about 2 to 3 millimeters (0.1 inches) long (USFWS, 1995).

Taxonomy

A member of the pink family (Caryophyllaceae) (USFWS, 2003). The genus is endemic to the Hawaiian Islands, this species is endemic to Kauai. First described by St. John in 1970 & maintained by Wagner et al. (NatureServe, 2015).

Historical Range

Endemic to Northwest Kauai. (NatureServe, 2015). *Schiedea apokremnos* has been collected from Nualolo Kai on the Na Pali coast, Kaaweiki Ridge and three areas along a 10.5 kilometers (6.5 miles) long section of the Na Pali coast: Milolii Valley, Kalalau Beach, between Kaaalahina and Manono ridges and as far north as Pohakuao Valley (USFWS, 1995).

Current Range

It is currently known to occur at Nakeikianaiwi, Pohakuao, Nualolo Valley, Haeleele Valley, and Kawaiiki Valley within the Na Pali Coast State Park and Puu Ka Pele Forest Reserve; Alealau and Polihale Ridge (Kauai) (USFWS, 2010).

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Schiedea apokremnos* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Schiedea apokremnos* includes three units totaling 1,613 acres in Kauai County, Hawaii. The units are Kauai 11—*Schiedea apokremnos*—a, b, c.

Kauai 11—*Schiedea apokremnos*—a: This unit is critical habitat for *Schiedea apokremnos* and is 170 ha (421 ac) on State land (Na Pali Coast State Park), containing Nakeikionaiwi Pillar. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial *Schiedea apokremnos* and is currently occupied with one plant. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this

species include, but are not limited to, crevices of near-vertical basalt coastal cliff faces in sparse dry coastal cliff shrub vegetation. This unit is geographically separated from the other two units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Schiedea apokremnos*—b: This unit is critical habitat for *Schiedea apokremnos* and is 187 ha (463 ac) on State land (Na Pali Coast State Park), containing Kanakou Summit. This unit provides habitat for two populations of 300 mature, reproducing individuals of the shortlived perennial *Schiedea apokremnos* and is currently occupied with 100 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, crevices of near-vertical basalt coastal cliff faces in sparse dry coastal cliff shrub vegetation. This unit is geographically separated from the other two units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Schiedea apokremnos*—c: This unit is critical habitat for *Schiedea apokremnos* and is 295 ha (730 ac) on State land (Na Pali Coast State Park and Puu Ka Pele Forest Reserve). This unit contains portions of Kawaiula, Milolii, Paaiki, and Poopooiki Valleys. This unit provides habitat for five populations of 300 mature, reproducing individuals of the shortlived perennial *Schiedea apokremnos* and is currently occupied with 100 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, crevices of near-vertical basalt coastal cliff faces in sparse dry coastal cliff shrub vegetation. This unit is geographically separated from the other two units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

- (i) Crevices of near-vertical basalt coastal cliff faces in sparse dry coastal cliff shrub vegetation and containing one or more of the following associated native plant species: *Artemisia australis*, *Bidens* spp., *Carex meyenii*, *Chamaesyce celastroides*, *Eragrostis variabilis*, *Lepidium serra*, *Lipochaeta connata*, *Lobelia niihauensis*, *Myoporum sandwicense*, *Peperomia* spp., *Pleomele aurea*, *Psydrax odorata*, or *Wilkesia* spp.; and
- (ii) Elevations between 11 and 538 m (35 and 1,765 ft).

Special Management Considerations or Protections

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and

regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species in paragraph (b) of this section and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (USFWS, 2003)

Lifespan

Adult: < 10 years (USFWS, 2010)

Breeding Season

Adult: Unknown (USFWS, 2003)

Key Resources Needed for Breeding

Adult: Unknown (USFWS, 2003)

Reproduction Narrative

Adult: It is a short-lived perennial (fewer than 10 years). *Schiedea apokremnos* is a gynodioecious species, having hermaphrodite or female flowers (Sakai 1997) (USFWS, 2010). Some individuals of *Schiedea apokremnos* are functionally female and must be cross-pollinated to set seed. Flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown (Service 1995) (USFWS, 2003).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Dry shrublands (NatureServe, 2015); coastal cliffs (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: 200 - 1,100 ft. elevation (USFWS, 2010)

Habitat Narrative

Adult: Inhabits dry shrublands on steep slopes and cliff faces (NatureServe, 2015). *Schiedea apokremnos* grows in the crevices on nearly vertical coastal cliffs, from 60 to 330 meters (200 to 1,100 feet) elevation. These cliffs have sparse, dry coastal shrub vegetation (USFWS, 2010).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Extirpated at 3 locations, increase in known number of individuals (USFWS, 2010)

Resiliency:

Low (inferred from USFWS, 2010; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2010)

Number of Populations:

15 subpopulations (USFWS, 2017)

Population Size:

<2500 (USFWS, 2017)

Population Narrative:

At the time of the last 5-year review in 2010 there were nine populations totaling between 750 and 850 individuals on Kauai. Recent surveys confirm individuals at Haeleele, Nualolo Kai, and Awaawapuhi, totaling at least 200 individuals (NTBG 2010a-f, 2011ad, 2012, 2014). There have not been recent surveys at Kaaweiki, Makaha, Polihale, Milolii, Honopu, Kalalau, Nakeikionaiwi, Pohakuao, Alealau, or Hanakoa, but it is likely many individuals still survive on steep, isolated cliffs in these areas. In 2016, Clark (2016) reported that *Schiedea apokremnos* is limited to a small area along coastal cliff faces in the same areas, and numbers totaled fewer than 2,500 individuals in 15 'subpopulations' (considered 'populations' by USFWS) with the largest population consisting of 300 individuals. While this represents a net increase in the number of known individuals, it should be noted that *S. apokremnos* appears to be extirpated from several of the previously known locations, and this total reflects estimates for all known sites, regardless of how recently they have been surveyed (USFWS, 2017).

Threats and Stressors

Stressor: Invasive plants (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: Invasive introduced plant species, specifically *Leucaena leucocephala* (haole koa), *Hyptis pectinata* (comb hyptis), *Opuntia* sp. (NCN), and *Pluchea carolinensis* (sourbush), are threats to *Schiedea apokremnos*. Other invasive introduced plant species include *Ageratum conyzoides* (billy goat weed), *Bryophyllum pinnatum*, *Clidemia hirta* (Koster's curse), *Conyza bonariensis* (hairy horseweed), *Elephantopus mollis* (elephant's foot), *Erigeron karvinskianus*, *Furcraea foetida* (Mauritius hemp), *Lantana camara*, *Pluchea carolinensis*, *Psidium guajava* (common guava), *Salvia occidentalis*, *Setaria parviflora*, *Syzygium cumini* (Java plum), and *Xanthium strumarium* var. *canadense* (cocklebur). Introduced invasive grasses include *Andropogon virginicus* (broomsedge), *Bromus rigidus* (riggut grass), *Ehrharta stipoides* (meadow ricegrass), *Oplismenus hirtellus* (basketgrass), and *Vulpia bromoides* (brome fescue). Introduced ferns include *Adiantum hispidulum*, *Adiantum raddianum*, *Blechnum appendiculatum*, *Christella dentata*, and *Nephrolepis multiflora* (USFWS 1995; Wood 2009) (USFWS, 2010).

Stressor: Fire (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: Because Hawaiian plants were subjected to fire during their evolution only in areas of volcanic activity and from occasional lightning strikes, they are not adapted to recurring fire regimes and are unable to recover well following a fire. The most prominent threat is fires caused by people pursuing recreational activities, and prevailing winds spreading fires to inland areas. Fire could destroy seeds as well as plants, even on steep cliffs (Clarke and Cuddihy 1980, Corn et al. 1979, Cuddihy and Stone 1990) (USFWS, 1995).

Stressor: Drought (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: Not available

Stressor: Goats (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: Goats not only disturb the cliff habitats and open areas for the incursions of introduced invasive plants, but they eat the native vegetation including *Schiedea* species (USFWS, 2010).

Stressor: Invasive insects (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: In the Hawaiian Islands, the black twig borer has many hosts, disperses easily, and is probably present at most elevations up to 670 meters (2,500 feet). *Sophonia rufofascia* (two-spotted leafhopper) is a potential threat to the Kauai cluster taxa and the surrounding

ecosystems. Recent observations indicate that this insect is killing plants on the Na Pali Coast and in the Haupū Range (Ken Wood, NTBG, personal communication 1994) (USFWS, 1995).

Stressor: Small population size (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The small size of most populations and a restricted distribution pose potential threats to this species. A limited gene pool may depress reproductive vigor, or a single environmental disturbance could destroy a significant percentage of the extant individuals. Landslides also pose additional potential threats. Some *S. apokremnos* individuals are functionally female and must be cross-pollinated to set seed. This reproductive strategy may threaten populations with few individuals dispersed over wide areas (USFWS 1995) (USFWS, 2010).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Schiedea apokremnos* is extremely vulnerable to the impacts of climate change, with a vulnerability score of 0.948 (on a scale of 0 being not vulnerable to 1 being most vulnerable to climate change). In addition, Fortini et al. show that Caryophyllaceae is one of the top four most vulnerable native plant families, and, at the genus level, *Schiedea* had one of the highest vulnerability scores. Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Stressor: Hurricanes—Loss and degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Hurricanes were not specified in the last five year review. In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event, and 70 percent of all listed plant species on Kauai are only found on Kauai. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013) (USFWS, 2017).

Recovery**Reclassification Criteria:**

1. A total of five to seven populations should be documented on Kauai and at least one other island where they now occur or occurred historically (USFWS, 1995).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population for short-lived perennials (USFWS, 1995).
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 1995).

Delisting Criteria:

1. A total of eight to ten populations should be documented on Kauai and at least one other island where they now occur or occurred historically (USFWS, 1995).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population for short-lived perennials (USFWS, 1995).
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 1995).

Recovery Actions:

- Protect current populations, control threats and monitor (USFWS, 1995).
- Expand current populations (USFWS, 1995).
- Conduct research essential to conservation of the species (USFWS, 1995).
- Establish new populations as needed to reach recovery objectives (USFWS, 1995).
- Validate and revise recovery objectives (USFWS, 1995).
- Devise and implement a public education program (USFWS, 1995).

Conservation Measures and Best Management Practices:

- Determine methods to protect populations from goats in the steep areas where the species occurs (USFWS, 2010).
- Collect seeds for adequate genetic storage (USFWS, 2010).
- Propagate for reintroduction within protected suitable habitat (USFWS, 2010).
- Establish additional populations within protected suitable habitat (USFWS, 2010).
- Survey suitable habitat in historical range to determine current status of species (USFWS, 2010).
- Work with Hawaii Division of Forestry and Wildlife and Hawaii State Parks to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2010).
- New Management Actions: • Between 2008 and 2012, the NTBG seed bank received twelve collections from Haena (one collection of 25 seeds) and Nualolo Kai (thousands of seeds from eleven different founders) (NTBG 2017). • The University of California at Irvine has 16 plants representing four founders from the population between Kalalau and Hanakoa Valley, and 64 plants representing

three founders from the Nualolo Kai population maintained in the greenhouse (UCI 2016) (USFWS, 2017).

- Recommendations for Future Actions: No new threats and no other significant new information regarding the species' biological status have been reported since the last 5-year review in 2010. Therefore, the following recommendations for future actions are reiterated for the 5-year review for 2017. • Surveys and inventories—Survey suitable habitat in historic range to determine current status of the species. • Ungulate monitoring and control—Construct fenced exclosures to exclude feral ungulates from wild populations. Protect all occurrences against browsing and disturbances from feral ungulates. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative species that compete with the species around all populations. • Fire monitoring and control—Develop and implement fire management plans for all wild and reintroduced populations. • Predator and herbivore control research—Study *Schiedea apokremnos* populations to determine level of threat from invertebrate herbivory and any additional needed recovery actions. • Captive propagation for genetic storage and reintroduction—Continue collecting seeds from all populations for adequate genetic storage. • Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Population biology research—Study *Schiedea apokremnos* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides, drought, and tsunamis (USFWS, 2017).

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SPECIES ACCOUNT: *Schiedea attenuata* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (R1) (USFWS, 2016)

Physical Description

An erect, sparingly branched shrub up to 75 cm tall. Leaves are opposite, and somewhat succulent. Cymes are terminal and open (NatureServe, 2015).

Taxonomy

A member of the pink family (Caryophyllaceae) (USFWS, 2010b). This species is most closely related to *S. globosa* (NatureServe, 2015).

Historical Range

Schiedea attenuata was discovered in 1991 by K. Wood during a rappel on the cliffs in an area of precipitous slopes above the Kalalau Valley on Kauai (USFWS, 2010b).

Current Range

Known from a single site in Kalalau Valley, island of Kauai, state of Hawaii (NatureServe, 2015). Individuals were last observed at the site of discovery in 1994 (M. Bruegmann 1994b; Wagner et al. 1994, p. 187; Wagner et al. 2005, pp. 45–47) (USFWS, 2010b).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Schiedea attenuata* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Schiedea attenuata* includes two CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Dry Cliff—Section 1: Dry Cliff—Section 1 consists of 404 ac (163 ha) in the dry cliff ecosystem, along cliffs from Kalanu to Pihea peak, within the Na Pali Coast State Park (Figure 5). The entire section is within previously designated critical habitat and is State-owned; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 67a. This section is occupied by the plants *Chamaesyce eleanoriae*, *Lysimachia scopulensis*, *Schiedea attenuata*, and *Stenogyne kealiae*. This section includes the dry cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the dry cliff ecosystem (Table 3).

Kauai—Dry Cliff—Section 2: Dry Cliff—Section 2 consists of 309 ac (125 ha) in the dry cliff ecosystem, including cliffs and ridges extending from Kanakou to Keanapuka and along Manono Ridge, surrounding the hanging valley Pohakuao, in the Na Pali Coast State Park (Figure 5, above). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 67a. This section is occupied by the plant

Chamaesyce eleanoriae and includes the dry cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the dry cliff ecosystem (Table 3). Although Dry Cliff - Section 3 is not known to be occupied by the plants *Lysimachia scopulensis*, *Schiedea attenuata*, and *Stenogyne kealiae*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range of the species. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Schiedea attenuata* critical habitat consists of one component (Dry cliff) (75 FR 18960-19165):

Ecosystem: Dry Cliff. Elevation: unrestricted. Annual precipitation: < 75 in (<190 cm). Substrate: >65 degree slope, rocky talus. Canopy: None. Subcanopy: *Antidesma*, *Chamaesyce*, *Diospyros*, *Dodonaea*. Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Schiedea*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., "sustained yield") in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access

to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Mesic forest (NatureServe, 2015); dry cliff (USFWS, 2010b)

Geographic or Habitat Restraints or Barriers

Adult: 2,297 - 2,625 ft. elevation (USFWS, 2010b)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits diverse mesic forest pockets and vertical cliffs. The environmental specificity is unknown (NatureServe, 2015). It occurs on cliffs at elevations between 2,297 and 2,625 ft. (700 and 900 m) in the dry cliff ecosystem (Wagner et al. 1994, pp. 187– 190; TNCH 2007) (USFWS, 2010b).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Species Trends:

Declining (NatureServe, 2015)

Resiliency:

Very low (inferred from NatureServe, 2015; see current range/distribution)

Redundancy:

Very low (inferred from USFWS, 2010a)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1 - 50 individuals (NatureServe, 2015)

Population Narrative:

The long term population trend is unknown. It is reasonable to assume the populations have continued to decline, since all of the threats are not managed (Russell 2004) (NatureServe, 2015). There is one population totaling ten individuals (USFWS, 2010a). The last observation of this species was in 1994, when there were 20 individuals of *Schiedea attenuata* in one population in the Kalalau region of Kauai. There has only been one visit to this population and a collection was made at that time (USFWS, 2017).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from non-native plants, goats, fire, hurricanes, landslides, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Landslides destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. Fire can destroy dormant seeds and plants, even in steep in inaccessible areas. Successive fires can remove habitat for native species by altering microclimate conditions favorable to alien plants.

Stressor: Predation and herbivory (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species present an immediate and significant threat to *Schiedea attenuata* throughout its range due to documented browsing and trampling by pigs, goats, and deer (USFWS, 2010).

Stressor: Small populations (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: *Schiedea attenuata* is known only from a single population with fewer than 50 individuals. Research on *Pittosporum* species suggests that small populations are susceptible to loss of genetic variation through inbreeding and drift (USFWS, 2010).

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Recovery

Reclassification Criteria:

In addition to achieving 5 to 10 populations with 500 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually)

includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats (USFWS, 2017).

Delisting Criteria:

In addition to achieving 5 to 10 populations with 500 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis (USFWS, 2017).

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys (USFWS, 2010a).
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units (USFWS, 2010a).
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys (USFWS, 2010a).
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range (USFWS, 2010a).
- Conduct research on control methods for introduced slugs and avian malaria (USFWS, 2010a).
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction (USFWS, 2010a).
- Identify threats and prioritize which ones to address first for the two birds (USFWS, 2010a).
- Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program (USFWS, 2010a).
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security (USFWS, 2010a).
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems (USFWS, 2010a).

- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations (USFWS, 2010a).

Conservation Measures and Best Management Practices:

- This species is currently in controlled propagation for genetic storage and/or reintroduction efforts (USFWS, 2010a).
- RECOMMENDATIONS FOR FUTURE ACTIONS • Surveys and inventories—Continue to survey for populations of *Schiedea attenuata* in areas of potentially suitable habitat. • Ungulate monitoring and control—Protect all occurrences against browsing and disturbances from feral ungulates. Construct and maintain fenced exclosures around existing populations to prevent imminent extinction. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative plant species around all populations that compete with the species. • Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms. • Population biology research—Study *Schiedea attenuata* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. • Based on the recovery criteria above, consider development of a recovery plan (USFWS, 2017).

References

USFWS. 2016. Environmental Conservation Online System (ECOS) – Species Profile. <http://ecos.fws.gov/ecp0/>. Accessed August 2016

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

USFWS 2010b. Endangered and Threatened Wildlife and Plants

Determination of Endangered Status for 48 Species on Kauai and Designation of Critical Habitat. 75 Federal Register 70. April 13, 2010. Pages 18960 - 19165.

U.S. Fish and Wildlife Service. 2010. Endangered and Threatened Wildlife and Plants

Determination of Endangered Status for 48 Species on Kauai and Designation of Critical Habitat

Final Rule . 75 FR 18960-19165 (April 13, 2010).

U.S. Fish & Wildlife Service. 2010a. Recovery Outline for the Kauai Ecosystem. U.S. Fish and Wildlife Service, Region 1 Pacific Islands Fish and Wildlife Office. U.S. Fish and Wildlife Service. 2017. *Schiedea attenuata* (No common name) 5-Year Review Summary and Evaluation. 18 pp.

USFWS. 2010. Determination of Endangered Status for 48 Species on Kauai and Designation of Critical Habitat

Final Rule. 75 Federal Register 70, April 13, 2010. Pages 18960 - 19165.

U.S. Fish & Wildlife Service. 2010a. Recovery Outline for the Kauai Ecosystem. U.S. Fish and Wildlife Service, Region 1 Pacific Islands Fish and Wildlife Office.

U.S. Fish and Wildlife Service. 2017. *Schiedea attenuata* (No common name) 5-Year Review Summary and Evaluation. 18 pp.

SPECIES ACCOUNT: *Schiedea diffusa* ssp. *diffusa* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2016)

Physical Description

Schiedea diffusa ssp. *diffusa* (NCN) is a reclining or weakly climbing vine in the pink family (Caryophyllaceae). This species is woody at the base, and glabrous or nearly so below, with purple-tinged hairs. Lanceolate to ovate leaves are 2 to 5 in (4 to 12 cm) long. Inflorescences have 20 to 90 flowers with purple or purple-tinged stalks. Capsules are very broadly ovoid, 0.2 to 0.3 in (5 to 7 mm) long (USFWS, 2015).

Taxonomy

Schiedea diffusa ssp. *diffusa* was described by Wawra (1825, in Wagner et al. 2005, pp. 103–104) as *S. diffusa* ssp. *angustifolia*, now a synonym. This subspecies is currently recognized as a distinct taxon in Wagner et al. (1999, pp. 511–512) and in the *Schiedea* monograph by Wagner et al. (2005, pp. 103–106), the most recently accepted taxonomic treatments of this subspecies. *Schiedea diffusa* ssp. (USFWS, 2011).

Historical Range

Schiedea diffusa ssp. *diffusa* was historically found on the islands of Molokai and Maui. On Molokai, this subspecies was known from Kawela to Waikolu valleys; on Maui, it was wideranging on both the east and west mountains (Wagner et al. 2005, p. 106) (USFWS, 2015).

Current Range

Currently, *S. diffusa* ssp. *diffusa* is known from east Maui in six occurrences (fewer than 50 individuals total), in a much smaller range, from Puu o Kalae to Keanae (spanning about 5 mi (8 km)). On Molokai, there were two occurrences totaling fewer than 10 individuals, one at west Kawela Gulch, and one on the rim of Pelekunu Valley, last observed in the 1990s (HBMP 2010) (USFWS, 2015).

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Habitat Type**

Adult: Wet forest (USFWS, 2015)

Spatial Arrangements of the Population

Adult: Clumped (inferred from USFW, 2015)

Environmental Specificity

Adult: Narrow/specialist (inferred from USFW, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFW, 2015)

Site Fidelity

Adult: High (inferred from USFW, 2015)

Habitat Narrative

Adult: *Schiedea diffusa* ssp. *diffusa* occurs in wet forest at 3,000 to 5,300 ft (915 to 1,600 m) on Molokai, and to 6,700 ft (2,050 m) on Maui, in the lowland wet (Maui) and montane wet (Maui and Molokai) ecosystems (Wagner et al. 1999, p. 512; HBMP 2010; TNCH 2007) (USFWS, 2015). Clumped spatial arrangement of the population, narrow environmental specificity, low tolerance ranges and high site fidelity and ecological integrity of the community are inferred based on the species unique habitat requirements and the low number of known populations.

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Not defined

Resiliency:

Low (inferred from USFWS, 2015)

Representation:

Low (inferred from USFWS, 2015)

Redundancy:

Low (inferred from USFWS, 2015)

Population Narrative:

Currently, *S. diffusa* ssp. *diffusa* is known from east Maui in six occurrences (fewer than 50 individuals total), in a much smaller range, from Puu o Kalae to Keanae (spanning about 5 mi (8 km)). On Molokai, there were two occurrences totaling fewer than 10 individuals, one at west Kawela Gulch, and one on the rim of Pelekunu Valley, last observed in the 1990s (HBMP 2010) (USFWS, 2015). Low resiliency, representation and redundancy are inferred based on the species limited range, number of known populations and individuals as well as habitat requirements.

Threats and Stressors

Stressor: Feral pigs (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Feral pigs modify and destroy the habitat of *Schiedea diffusa* ssp. *diffusa* on Maui and Molokai, with evidence of the activities of these animals reported in the areas where this subspecies occurs (PEPP 2014, p. 159; HBMP 2010) (USFWS, 2015).

Stressor: Nonnative plants (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Nonnative plants modify and destroy the native habitat of *S. diffusa* ssp. *diffusa*, and displace this subspecies and other native Hawaiian plants by competing for water, nutrients, light, and space, or they may produce chemicals that inhibit the growth of other plants (Smith 1985, pp. 180–250; Vitousek et al. 1987 in Cuddihy and Stone 1990, p. 74; HBMP 2010; PEPP 2014, p. 159) (USFWS, 2015).

Stressor: Predation (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Herbivory by slugs and seed predation by rats are both reported to pose a threat to this subspecies (HBMP 2010; PEPP 2014, p. 159) (USFWS, 2015).

Stressor: Low genetic variability (USFWS, 2015)

Exposure:

Response:

Consequence: Extinction

Narrative: This subspecies may experience reduced reproductive vigor due to low levels of genetic variability, leading to diminished capacity to adapt to environmental changes, thereby lessening the probability of its long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361) (USFWS, 2015).

Recovery

References

U.S. Fish and Wildlife Service. 2015. Endangered and Threatened Wildlife and Plants

Endangered Status for 49 Species From the Hawaiian Islands

Proposed Rule. FR Vol. 80, No. 189. Pages 58820-58909. USFWS. 2016. Environmental Conservation Online System (ECOS) – Species Profile. <http://ecos.fws.gov/ecp0/>. Accessed August 2016.

Proposed Rule. FR Vol. 80, No. 189. Pages 58820-58909.

SPECIES ACCOUNT: *Schiedea diffusa* ssp. *macraei* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Historical Range

Historically, known from the Kohala Mountains, the windward slopes of Mauna Loa, and the Olaa Tract of Hawaii Volcanoes National Park (Perlman et al. 2001, in litt.; Wagner et al. 2005; HBMP 2010 cited by USFWS 2012). (NatureServe, 2015)

Current Range

As of 2012, known only from the Kohala Mountains on the island of Hawai'i (USFWS 2012). (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Obligate and facultative autogamous also hermaphroditic (USFWS, 2013)

Reproduction Narrative

Adult: One peer reviewer stated that *Schiedea diffusa* ssp. *macraei* and *S. hawaiiensis* are obligate autogamous species (i.e., reproduces by self-pollination) and facultative autogamous (i.e., reproduces by self and cross-pollination), respectively. Because both of these species are hermaphroditic and autogamous, they are capable of regenerating from single individuals, and may not be severely hampered by inbreeding depression. Unfortunately, autogamous species of *Schiedea* also appear to be short-lived, emphasizing the importance of appropriate conditions for regeneration. Our Response: We agree that the obligate and facultative autogamous nature of *Schiedea diffusa* ssp. *macraei* and *S. hawaiiensis*, respectively, in addition to being hermaphroditic, afford these species the ability to regenerate from single individuals and may not be severely hampered by inbreeding depression (USFWS, 2013).

Habitat Type

Adult: Montane wet ecosystem (USFWS, 2013)

Habitat Narrative

Adult: Currently, there is one individual of *S. diffusa* ssp. *macraei* on the slopes of Eke in the Kohala Mountains, in the montane wet ecosystem (Wagner et al. 2005d, p. 106; Bio 2011, pers. comm.) (USFWS, 2013).

Dispersal/Migration

Population Information and Trends

Population Trends:

Unknown

Population Narrative:

Currently, there is one individual of *S. diffusa* ssp. *macraei* on the slopes of Eke in the Kohala Mountains, in the montane wet ecosystem (Wagner et al. 2005d, p. 106; Bio 2011, pers. comm.) (USFWS, 2013).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence: loss of habitat/extinction

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs and cattle), nonnative plants, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, cattle, and rats) is considered an ongoing threat to *Schiedea diffusa* ssp. *macraei* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor: Small populations (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: *Schiedea diffusa* ssp. *macraei* faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). This species is known from a single individual in the Kohala Mountain (USFWS, 2013).

Stressor:

Exposure:

Response:

Consequence:**Narrative:*****Recovery*****Recovery Actions:**

- There is no recovery plan for this species.

References

USFWS. 2016. Environmental Conservation Online System (ECOS) – Species Profile.
<http://ecos.fws.gov/ecp0/>. Accessed August 2016.

U.S. Fish and Wildlife Service. 2013. Endangered and Threatened Wildlife and Plants
Determination of Endangered Species Status for 15 Species on Hawaii Island

Final Rule. FR Vol. 78, No. 209. Pages 64638-64690.

USFWS. 2013. Determination of Endangered Species Status for 15 Species on Hawaii Island
Final Rule. 78 Federal Register 209, October 29, 2013. Pages 64638 - 64690.

SPECIES ACCOUNT: *Schiedea haleakalensis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

A shrub about 3-6 dm tall, with numerous ascending to erect stems. Leaves narrow. Flowers are borne in terminal clusters. (NatureServe, 2015)

Taxonomy

Genus endemic to Hawaiian Islands, species endemic to east Maui. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Endemic to crater of Haleakala, East Maui. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Schiedea haleakalensis* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Schiedea haleakalensis* includes six CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Subalpine—Unit 1 (and) *Palmeria dolei*—Unit 24—Subalpine (and) *Pseudonestor xanthophrys*—Unit 24— Subalpine This area consists of 10,785 ac (4,365 ha) of State land, 1,622 ac (656 ha) of privately owned land, and 3,568 ac (1,444 ha) of federally owned land (Haleakala National Park), from Kanaio north to Puu Nianiau on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the subalpine ecosystem (see Table 5). They are occupied by the plants *Bidens micrantha* ssp. *kalealaha* and *Geranium arboreum*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Subalpine—Unit 1 is not known to be occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Asplenium peruvianum* var. *insulare*, *Geranium multiflorum*, *Phyllostegia bracteata*, *Schiedea haleakalensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these subalpine species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and

space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Subalpine—Unit 2 (and) *Palmeria dolei*—Unit 25—Subalpine (and) *Pseudonestor xanthophrys*—Unit 25— Subalpine This area consists of 50 ac (20 ha) of privately owned land, and 9,836 ac (3,981 ha) of federally owned land (Haleakala National Park), from the summit north to Koolau Gap and east to Kalapawili Ridge on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the subalpine ecosystem (see Table 5). They are occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Geranium multiflorum*, and *Schiedea haleakalensis*, and by the forest bird, the *akohekohe* (*Palmeria dolei*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui— Subalpine—Unit 2 is not known to be occupied by the plants *Asplenium peruvianum* var. *insulare*, *Bidens micrantha* ssp. *kalealaha*, *Geranium arboreum*, *Phyllostegia bracteata*, or *Zanthoxylum hawaiiense*, or by the forest bird, the *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these subalpine species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 1 (and) *Palmeria dolei*—Unit 26—Dry Cliff (and) *Pseudonestor xanthophrys*—Unit 26— Dry Cliff This area consists of 755 ac (305 ha) of federally owned land (Haleakala National Park), from Pakaoao to Koolau Gap on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). Although Maui—Dry Cliff— Unit 1 is not known to be occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Diplazium molokaiense*, *Geranium multiflorum*, *Plantago princeps*, or *Schiedea haleakalensis*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 2 consists of 688 ac (279 ha) of federally owned land (Haleakala National Park) from Haupaakea Peak to Kaupo Gap on east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). It is occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Geranium multiflorum*, *Plantago princeps*, and *Schiedea haleakalensis*, and contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Dry Cliff—Unit 2 is not known to be occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, or *Diplazium molokaiense*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations

within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 3 (and) *Palmeria dolei*—Unit 27—Dry Cliff (and) *Pseudonestor xanthophrys*—Unit 27—Dry Cliff This area consists of 200 ac (81 ha) of federally owned land (Haleakala National Park) near Papaanui on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). It is occupied by the plant *Plantago princeps*, and contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Dry Cliff—Unit 3 is not currently occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Diplazium molokaiense*, *Geranium multiflorum*, or *Schiedea haleakalensis*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 4 (and) *Palmeria dolei*—Unit 28—Dry Cliff (and) *Pseudonestor xanthophrys*—Unit 28—Dry Cliff This area consists of 315 ac (127 ha) federally owned land (Haleakala National Park), along Kalapawili Ridge on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). Although Maui—Dry Cliff—Unit 4 is not currently occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Diplazium molokaiense*, *Geranium multiflorum*, *Plantago princeps*, or *Schiedea haleakalensis*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Schiedea haleakalensis* critical habitat consists of two components. Sub-alpine (east Maui) and Dry cliff (east Maui) (81 FR 17790-18110):

Ecosystem: Subalpine. Elevation: 6,500–9,800 ft (2,000–3,000 m). Annual precipitation: 15–40 in (38–100 cm). Substrate: Dry ash, sandy loam, rocky, undeveloped soils, weathered lava. Canopy: *Chamaesyce*, *Chenopodium*, *Metrosideros*, *Myoporum*, *Santalum*, *Sophora*. Subcanopy: *Coprosma*, *Dodonaea*, *Dubautia*, *Geranium*, *Leptecophylla*, *Vaccinium*, *Wikstroemia*. Understory: Ferns, *Bidens*, *Carex*, *Deschampsia*, *Eragrostis*, *Gahnia*, *Luzula*, *Panicum*, *Pseudognaphalium*, *Sicyos*, *Tetramolopium*.

Ecosystem: Dry Cliff. Elevation: unrestricted. Annual precipitation: <75 in (<190 cm). Substrate: >65 degree slope, rocky talus. Canopy: None. Subcanopy: *Antidesma*, *Chamaesyce*, *Diospyros*, *Dodonaea*. Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Schiedea*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special

management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylothea* ssp. *pentamera*, *B. campylothea* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Probably requires cross-pollination by small insects for seed set. Small flies and moths have been noted visiting the flowers at both known populations (Loope and Medeiros 1994c) (USFWS, 1997).

Breeding Season

Adult: Fruits and seeds have been observed in August/ September (USFWS, 1997).

Reproduction Narrative

Adult: Little is known about the life history of *Schiedea haleakalensis*. This species is known to be gynodioecious (bearing female and both-sexed flowers on separate plants) (Stephen Weller,

University of California at Irvine and A.C. Medeiros, personal communication 1994) and, hence, probably requires cross-pollination by small insects for seed set. Small flies and moths have been noted visiting the flowers at both known populations (Loope and Medeiros 1994c). These insects are generally relatively short- flighted. Fruits and seeds have been observed in August/ September. There are no obvious dispersal devices for seeds other than gravity and water-borne movement (USFWS, 1997).

Habitat Type

Adult: Dry subalpine cliffs (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (inferred from USFWS, 1997)

Environmental Specificity

Adult: Narrow/specialist (inferred from USFWS, 1997)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1997)

Site Fidelity

Adult: High (inferred from USFWS, 1997)

Habitat Narrative

Adult: Dry subalpine cliffs with native shrubs. (NatureServe, 2015). The current habitat of *Schiedea haleakalensis* is in rock cracks on sheer cliffs at 1,800 and 2,440 meters (5,910 and 8,010 feet) elevation adjacent to barren lava and predominantly native subalpine shrublands and grasslands. The substrate is cinder, weathered volcanic ash, or bare lava with little or no soil development. Periodic freezing temperatures occur in this habitat. Associated native species include *Artemisia mauiensis*, *Bidens micrantha*, *Dubautia mensiezii*, *Styphelia tameiameia*, *Vaccinium reticulatum*, and *Viola chamissoniana* (Medeiros, Loope, and Holt 1986) (USFWS, 1997). Clumped spatial arrangement of the population, narrow environmental specificity, low tolerance ranges and high site fidelity and ecological integrity of the community are inferred based on the species unique habitat requirements and the low number of known populations. Species only survives on precipitous cliff faces not accessible to goats (USFWS, 1997)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: There are no obvious dispersal devices for seeds other than gravity and water-borne movement (USFWS, 1997).

Population Information and Trends**Population Trends:**

Unknown

Resiliency:

Low (inferred from USFWS, 2011)

Representation:

Low (inferred from USFWS, 2011)

Redundancy:

Low (inferred from USFWS, 2011)

Number of Populations:

2 (USFWS, 2018)

Population Size:

18 individuals (USFWS, 2018))

Population Narrative:

New Status Information: • In 2011, there were 18 observed individuals at Kaupō Gap. Currently, *Schiedea haleakalaensis* is found in two occurrences, one at Leleiwi Pali (seven individuals) and one at Kaupō Gap (one individual) (Robertson 2016, in litt.) • In 2016, six critical habitat units in two ecosystems (subalpine and dry cliff) were designated on east Maui for *Schiedea haleakalaensis* (27,819 ac; 11,258 ha) (81 FR 17790, March 30, 2016) (USFWS, 2018).

Threats and Stressors

Stressor: Feral goats (USFWS, 1997)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: The primary threat historically responsible for the endangerment of this species is habitat degradation and herbivory by feral goats (USFWS, 1997).

Stressor: Small population size (USFWS, 1997)

Exposure:

Response:

Consequence: Extinction

Narrative: The very small remaining number of individuals of *Schiedea haleakalaensis* and the limited and scattered distribution of the species are threats since a single natural or human-caused environmental disturbance could be catastrophic to all or a significant part of the populations. In addition, the limited gene pool may depress reproductive vigor. Just as importantly, a very small, scattered population may not receive adequate cross-pollination (USFWS, 1997).

Stressor: Slugs (USFWS, 1997)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Feeding by slugs (*Milax gagates*): Based on recent unpublished evidence, recruitment of *Schiedea* germinants [seedlings] can be catastrophically suppressed by herbivory of alien slugs in the Waianae Mountains of Oahu (Steve Weller and Ann Sakai, University of California at Irvine, personal communication 1994). Nocturnal herbivory by the invasive garden slug *Milax gagates*

has been observed to partially defoliate larger, established plants of *Schiedea haleakalensis* in the western Kaupo population (A.C. Medeiros, personal observation 1994). This slug is now widespread on upper Haleakala Volcano in a variety of high-elevation sites, arid to wet, and has been observed feeding on such rare native plants as the green sword (Gagne 1983) (USFWS, 1997).

Stressor: Ants (USFWS, 1997)

Exposure:

Response:

Consequence: Loss of habitat/Loss of pollinators

Narrative: Invasion of habitat and elimination of pollinators by the Argentine ant (*Iridomyrmex humilis*): This ant species is capable of reducing or eliminating native pollinators wherever it invades on Haleakala Volcano (Cole et al. 1992). As of 1994, the invasion had descended from Kalahaka on the rim of Haleakala Crater to the crater floor very near the Holua population of *Schiedea haleakalensis* (USFWS, 1997).

Stressor: Feral ungulates (USFWS, 1997)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Feral ungulates: Although feral goats have been removed from Haleakala National Park by a program of active management and are no longer an immediate threat to native plant species within the park, the potential for the ingress and reestablishment of goats exists. Maintenance of a goat-free situation requires continuation of an active management program, which requires substantial sustained commitment by Haleakala National Park and funding for fence maintenance and goat removal (USFWS, 1997).

Stressor: Fire (USFWS, 1997)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The possibility of fire is a threat to the existence of *Schiedea haleakalensis*; a single fire could affect a significant portion of the population of *Schiedea haleakalensis* (A.C. Medeiros, personal communication 1990) (USFWS, 1997).

Stressor: Nonnative invasive plants

Exposure:

Response:

Consequence:

Narrative: Two additional nonnative invasive plants, *Pinus radiata* (Monterey pine) and *Cortaderia jubata* (pampas grass) are observed to be a threat to *Schiedea haleakalaensis*, by modifying and degrading habitat, and by direct competition (Robertson 2016, in litt.) (USFWS, 2018).

Stressor: Drought degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Drought is observed to be a threat to populations of *S. haleakalensis* at Leleiwi Pali and Kaupō Gap (Robertson 2016, in litt.). Over the last 100 years, the Hawaiian Islands have experienced an annual decline in precipitation of over nine percent, increasing to as much as 15 percent within the last 20 years (US-NSTC 2008; Chu and Chen 2005; Diaz 2005). Drought affects plants directly by desiccation. The increase in drought frequency and intensity leads to a self-perpetuating cycle of increase in cover of nonnative plants, increase in the number of fires, and an increase of erosion (US-GCRP 2009; Warren 2011) (USFWS, 2018).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: We previously reported that climate change may pose a threat to this species, anticipating an analysis by 2013. The assessment conducted by Fortini et al. (2013) concluded that *S. haleakalensis* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.605 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions may be needed to conserve this taxon into the future (USFWS, 2018).

Recovery

Reclassification Criteria:

For downlisting, a total of five to seven populations of *Schiedea haleakalensis* should be documented on islands where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 2011).

Delisting Criteria:

For delisting, a total of eight to ten populations of *Schiedea haleakalensis* should be documented on islands where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with 300 mature individuals per population for long-lived perennials. Each population should persist at this level for a minimum of five consecutive years before delisting is considered (USFWS, 2011).

Conservation Measures and Best Management Practices:

- Continue to collect seeds and other propagules for genetic storage and reintroduction (USFWS, 2011).
- Maintain the fences around existing populations to provide protection from the negative impacts of feral ungulates (USFWS, 2011).
- Control invasive introduced species around known populations (USFWS, 2011).
- Survey areas where *Schiedea haleakalensis* has been reported to determine current status of the species (USFWS, 2011).
- Develop and implement methods to control slugs and ants (USFWS, 2011).
- Control rats in the vicinity of these populations (USFWS, 2011).

- Propagate to augment the existing populations (USFWS, 2011).
- Research limiting factors to reintroduction success and possible solutions (USFWS, 2011).
- Establish additional populations within protected suitable habitat (USFWS, 2011).
- Work with the National Park Service, Plant Extinction Prevention Program, and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2011).
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2011).
- New Management Actions:
 - Captive propagation for genetic storage and reintroduction—
 - o Haleakalā National Park (HNP) maintains a living collection of *S. haleakalensis*, and hand-pollination has produced more than 5,000 seeds for storage and propagation (Robertson 2016, in litt.). The HNP reported 900 seeds representing five individuals in storage in 2013; 58 plants representing four individuals in storage in 2015; and 119 plants representing four individuals in storage in 2016.
 - o Lyon Arboretum Micropropagation Laboratory reported 32 containers of propagules of *S. haleakalensis* in storage, representing one founder (Lyon Arboretum 2017).
 - o The University of California—Irvine reported one plant representing one individual in storage in 2014 (USFWS, 2018).
- Recommendations for Future Actions: Drought and two nonnative invasive plants are additional threats; however, we are not aware of any significant new information regarding the species' biological status since the last 5-year review in 2011. Thus, the following recommendations for future actions are added or reiterated for the 5-year review for 2018.
 - Surveys and inventories—Survey areas where *Schiedea haleakalensis* has been reported to determine current status of the species on east Maui.
 - Ungulate monitoring and control—Maintain fencing to provide protection from negative impacts of feral ungulates.
 - Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species around all populations of *S. haleakalensis*.
 - Captive propagation for genetic storage and reintroduction—Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range.
 - Reintroduction and translocation—
 - o Augment known populations and reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.
 - o Research limiting factors contributing to failure of reintroduced individuals and populations.
 - Rodent predation and herbivory—Control rats in the vicinity of all populations.
 - Invertebrate predation and herbivory—Develop and implement methods to control slugs and ants.
 - Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for the recovery of the species.
 - Alliance and partnership development—Work with the National Park Service, the Plant Extinction Prevention Program, and other land managers to initiate planning and contribute to ecosystem-level restoration and management to benefit this species (USFWS, 2018).

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

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U.S. Fish and Wildlife Service. 2018. 5-YEAR REVIEW. Short Form Summary. Species Reviewed: *Schiedea haleakalensis* (no common name). 9 pp.

U.S. Fish and Wildlife Service. 2011. *Schiedea haleakalensis* (no common name) 5-Year Review Summary and Evaluation U.S. Fish and Wildlife Service Pacific Islands Fish and Wildlife Office Honolulu, Hawaii.

SPECIES ACCOUNT: *Schiedea hawaiiensis* (Ma`oli`oli)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

Perennial herbs or subshrubs, pale yellowish green throughout or stems purple-tinged in lower portion of the plant. Stems 3-7 dm long or perhaps longer, ascending to sprawling when longer. Leaves opposite. Leaf blades 4-5.8 cm long, 1.7-2.8 cm wide, ovate to elliptic-ovate. Inflorescences panicle-like, 30-40 cm long. Capsules broadly ovoid, 3.5-4 mm long. (NatureServe, 2015)

Taxonomy

Kartesz (1999) includes *Schiedea hawaiiensis* in *S. diffusa*, however, Wagner et al. (1999) resurrect it from synonymy (the 1990 edition included it). Only known from one individual discovered in 1996 (per Wagner 1999). Also accepted as distinct by Wagner et al. (2012). (NatureServe, 2015)

Historical Range

Schiedea hawaiiensis is endemic to the island of Hawaii in the Hawaiian Islands. It has been recorded from only two locations, both in the northern part of the island. It is on the Pohakuloa Training Area in the saddle between Mauna Kea and Mauna Loa (volcanoes). (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: No information found.

Habitat Type

Adult: Montane dry ecosystem (USFWS, 2013)

Habitat Narrative

Adult: Currently, *S. hawaiiensis* is known from 25 to 40 individuals on the U.S. Army's Pohakuloa Training Area (PTA) in the montane dry ecosystem, in the saddle area between Moana Loa and Mauna Kea (Gon III and Tierney 1996 in Wagner et al. 2005d, p. 92; Wagner et al. 2005d, p. 92; Evans 2011, in litt.). In addition, there are over 150 individuals outplanted at PTA (Kipuka Alala and Kalawamauna), Puu Huluhulu, Puu Waawaa, and Kipuka Oweowe (Evans 2011, in litt.) (USFWS, 2013).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: No information available.

Population Information and Trends**Population Trends:**

Unknown

Population Size:

25-40 individuals (USFWS, 2013)

Population Narrative:

Currently, *S. hawaiiensis* is known from 25 to 40 individuals on the U.S. Army's Pohakuloa Training Area (PTA) in the montane dry ecosystem, in the saddle area between Moana Loa and Mauna Kea (Gon III and Tierney 1996 in Wagner et al. 2005d, p. 92; Wagner et al. 2005d, p. 92; Evans 2011, in litt.). In addition, there are over 150 individuals outplanted at PTA (Kipuka Alala and Kalawamauna), Puu Huluhulu, Puu Waawaa, and Kipuka Oweowe (Evans 2011, in litt.) (USFWS, 2013).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs, goats, sheep, and mouflon), nonnative plants, fire, hurricanes, and drought. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Fire can destroy dormant seeds and plants, even in steep and inaccessible areas. Successive fires can remove habitat for native species by altering microclimate conditions favorable to alien plants. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Severe episodes of drought cannot only directly kill individuals of a species or entire populations, but drought frequently leads to an increase in the number and intensity of forest and brush fires. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, goats, sheep, mouflon, and rats) is considered an ongoing threat to *Schiedea hawaiiensis* throughout the species range. Non-

native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor: Small populations (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: *Schiedea hawaiiensis* faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). Habitat destruction or direct predation by ungulates, nonnative plants, drought, and fire are threats to the 25 to 40 individuals of *Schiedea hawaiiensis* (USFWS, 2013).

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Recovery

References

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U.S. Fish and Wildlife Service. 2013. Endangered and Threatened Wildlife and Plants

Determination of Endangered Species Status for 15 Species on Hawaii Island

Final Rule. FR Vol. 78, No. 209. Pages 64638-64690.

USFWS. 2013. Determination of Endangered Species Status for 15 Species on Hawaii Island

Final Rule. 78 Federal Register 209, October 29, 2013. Pages 64638 - 64690.

SPECIES ACCOUNT: *Schiedea helleri* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

Schiedea helleri, a member of the pink family, is a vine. The stems, smooth below and minutely hairy above, are probably prostrate and at least 0.15 m (0.5 ft) long with internodes at least 4 to 15 cm (1.6 to 6 in) long. The opposite leaves are somewhat thick and range from 10 to 14 cm (4 to 5.5 in) long and 4.5 to 6 cm (1.8 to 2.4 in) wide. The leaves are triangular, egg-shaped to heart-shaped, conspicuously three-veined, and nearly hairless to sparsely covered with short, fine hairs, especially along the margins. The perfect flowers occur in loose, open branched clusters, each branch being 20 to 26 cm (8 to 10.2 in) long. The flower contains 3 styles and probably 10 stamens. The fruits are capsules, about 3 to 3.4 mm (0.12 to 0.13 in) long. (USFWS, 1998)

Taxonomy

Genus nearly endemic to Hawaiian Islands, with one species in Tahiti, species endemic to Kauai. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Endemic to the island of Kauai, state of Hawaii. (NatureServe, 2015)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Schiedea helleri* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Schiedea helleri* includes three units totaling 2,001 acres in Kauai County, Hawaii. The units are Kauai 11—*Schiedea helleri*—a, b, c.

Kauai 11—*Schiedea helleri*—a: This unit is critical habitat for *Schiedea helleri* and is 483 ha (1,194 ac) on State land (Alakai Wilderness Preserve), containing portions of Halehaha and Halepaakai Streams. This unit provides habitat for three populations of 300 mature, reproducing individuals of the short-lived perennial *Schiedea helleri* and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is important to the establishment of additional populations on Kauai in order to reach recovery goals. The habitat features contained in this unit that are essential for this species include, but are not limited to, ridges and steep cliffs in closed *Metrosideros polymorpha*-*Dicranopteris linearis* montane wet forest, *M. polymorpha*-*Cheirodendron* spp. montane wet forest, or *Acacia koa*-*M. polymorpha* montane

mesic forest. This unit is geographically separated from the other two units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Although the Service does not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is at an appropriate distance from the other units to avoid their destruction by one naturally occurring catastrophic event. Kauai 11—*Schiedea helleri*—b: This unit is critical habitat for *Schiedea helleri* and is 154 ha (381 ac) on State land (Alakai Wilderness Preserve) on portions of Kohua Ridge and the Mohihi-Waialae Trail. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial *Schiedea helleri* and is currently occupied with 50 to 60 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, ridges and steep cliffs in closed *Metrosideros polymorpha*-*Dicranopteris linearis* montane wet forest, *M. polymorpha*-*Cheirodendron* spp. montane wet forest, or *Acacia koa*-*M. polymorpha* montane mesic forest. This unit is geographically separated from the other two units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Although the Service does not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is at an appropriate distance from the other units to avoid their destruction by one naturally occurring catastrophic event. Kauai 11—*Schiedea helleri*—c: This unit is critical habitat for *Schiedea helleri* and is 172 ha (426 ac) on State land (Alakai Wilderness Preserve), containing portions of Kipalau Valley. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial *Schiedea helleri* and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is important to the establishment of additional populations on Kauai in order to reach recovery goals. The habitat features contained in this unit that are essential for this species include, but are not limited to, ridges and steep cliffs in closed *Metrosideros polymorpha*-*Dicranopteris linearis* montane wet forest, *M. polymorpha*-*Cheirodendron* spp. montane wet forest, or *Acacia koa*-*M. polymorpha* montane mesic forest. This unit is geographically separated from the other two units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Although the Service does not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is at an appropriate distance from the other units to avoid their destruction by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

- (i) Ridges and steep cliffs in closed *Metrosideros polymorpha*-*Dicranopteris linearis* montane wet forest, *M. polymorpha*-*Cheirodendron* spp. montane wet forest, or *Acacia koa*-*M. polymorpha* montane mesic forest and containing one or more of the following associated native plant species: *Broussaisia arguta*, *Cheirodendron* spp., *Cibotium* spp., *Cyanea* spp., *Dianella sandwicensis*, *Dubautia* spp., *Elaeocarpus bifidus*, *Hedyotis terminalis*, *Melicope* spp., *Myrsine* spp., *Poa sandwicensis*, *Scaevola procera*, *Syzygium sandwicensis*, or *Viola wailenalenae*; and

(ii) Elevations between 664 and 1,361 m (2,178 and 4,464 ft).

Special Management Considerations or Protections

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species in paragraph (b) of this section and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (inferred from USFWS, 1998)

Breeding Season

Adult: February (USFWS, 1998)

Reproduction Narrative

Adult: Three plants were observed flowering by botanists from the National Tropical Botanical Garden in February 1995 (Steve Perlman, NTBG Provenance Report 1995). (USFWS, 1998)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland, cliffs (USFWS, 1998; NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations of approximately 1,070 meters (3,500 feet) (USFWS, 1998)

Environmental Specificity

Adult: Low to medium, with some key requirements (USFWS, 1998)

Habitat Narrative

Adult: *Schiedea helleri* is found on steep cliffs in closed ohia-uluhe montane wet forest on State-owned land, within or close to the Alakai Wilderness Preserve, at approximately 1,070 meters (3,500 feet) elevation. Other native plants growing in association with this population include hapuu, kanawao, olapa, *Cyanea hirtella* (haha), *Dianella sandwicensis* (ukiuki), and *Viola wailenalenae*. The federally endangered *Poa sandwicensis* is also found here (USFWS 1996). (USFWS, 1998)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2010)

Redundancy:

Very low (inferred from USFWS, 2010)

Number of Populations:

3-4 (USFWS, 2017)

Population Size:

<50 (USFWS, 2010)

Population Narrative:

New Status Information: In addition to those populations cited in the previous 5-year review, new observations include the following: • At the time of the last 5-year review in 2010 there were two populations totaling between 85 and 101 individuals on Kauai. Recent surveys confirm individuals at Mohihi in three small subpopulations (this includes one previously unknown occurrence) and one individual at Nawaimaka (NTBG 2012, 2014, 2015; PEPP 2010, 2011, 2013, 2014, 2015). These populations total fewer than 50 individuals. Clark (2016) reports that there are 40 mature plants total in four subpopulations, with the largest subpopulation consisting of 20 individuals (USFWS, 2017).

Threats and Stressors

Stressor: Alien species and fire (NatureServe, 2015)

Exposure:**Response:****Consequence:**

Narrative: Major threats include alien species and fire. (NatureServe, 2015)

Stressor: Habitat modification by pigs (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: Although the recovery plan did not consider pigs (*Sus scrofa*) to be a major problem to this species, botanists since that time have repeatedly observed them as a threat to the habitat. (USFWS, 2010)

Stressor: Human trampling (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: Since weeding was done in the area at Mohihi-Waialae by Kokee Resource Conservation Program, a hunter's trail has been cut right through the population. Human trampling and damage is a concern for this population. (USFWS, 2010)

Stressor: Habitat modification by mule deer and goats (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: Mule deer (*Odocoileus hemionus*) and goats (*Capra hircus*) are also considered threats because they modify the sloping terrain, causing erosion when heavy rains and flooding occur (Perlman 2008). (USFWS, 2010)

Stressor: Invasive introduced species (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: Invasive introduced plant species which modify the habitat and compete with *Schiedea helleri* include *Hedychium gardnerianum* (kahili ginger), *Passiflora mollissima* (banana poka), and *Rubus argutus* (blackberry) (National Tropical Botanical Garden 2008). (USFWS, 2010)

Stressor: Small population size (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: In addition to all of the other threats, species like *Schiedea helleri* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding and disease outbreaks. (USFWS, 2010)

Stressor: Low number of populations (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: The effects of these processes on this single-island endemic are exacerbated by anthropogenic threats, such as habitat loss for human development or predation by introduced species (USFWS 1998). (USFWS, 2010)

Stressor: Climate change loss or degradation of habitat

Exposure:**Response:****Consequence:**

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Schiedea helleri* is extremely vulnerable to the impacts of climate change, with a vulnerability score of 0.948 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this assessment classified *S. helleri* as a “wink-out” species. “Wink-out” species are those species with no future climate envelope. No projected suitable climate areas exist for the species to persist in the future. Also, Fortini et al. show that Caryophyllaceae is one of the top four most vulnerable native plant families, and, at the genus level, *Schiedea* had one of the highest vulnerability scores. Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery**Reclassification Criteria:**

1. A total of five to seven populations of each taxon should be documented on Kauai where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Kauai where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)

3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1998)

Recovery Actions:

- In order to prevent this taxon from going extinct, propagation efforts and the maintenance of adequate genetic stock ex situ should be continued. Additional wild seeds should be collected periodically until the cryopreservation method of long-term storage is perfected. This will insure that viable seed stock is available for outplanting. (USFWS, 1998)
- Monitoring of the existing population and attempts to find further populations should be undertaken. This work presents practical difficulties due to the location of one of the largest populations on a steep cliff off Mohihi Stream. Because of the habitat that the *Schiedea helleri* prefers, monitoring populations using rock-climbing techniques could cause damage to the fragile vegetation. Therefore, care must be taken not to damage cliff vegetation. (USFWS, 1998)
- Outplanting using collected seeds should be attempted immediately after further surveys are conducted to identify appropriate areas. These surveys should focus on the following areas where the *Schiedea helleri* are currently and historically found: steep cliff off Mohihi Stream and along the Mohihi Waialeale Trail and Nawaimaka Valley. (USFWS, 1998)
- Given the degraded nature of the Kauai plant cluster's habitat, their precariously low numbers, and the severity of the threats, the highest priority actions must be aimed at protecting all extant wild individuals and populations, managing habitat to enhance survival and ensuring maintenance of adequate genetic stock ex situ. (USFWS, 1995)
- It is hoped that by eliminating current threats through management, populations of the Kauai cluster taxa will expand naturally. However, in certain special instances, wild populations of the Kauai cluster taxa may need to be augmented. (USFWS, 1995)
- Research into various aspects of the life history, habitat, pollinators, reproductive biology, symbionts, optimum requirements for growth, requirements for population viability, and control of threats to each of the Kauai cluster taxa must be carried out to better understand the requirements necessary for perpetuation of these plants. (USFWS, 1995)
- If necessary to meet recovery objectives, populations should be reestablished in areas where they are known to have occurred historically, particularly if genetically uncontaminated, cultivated materials exist which are known to have originated from the historical site. (USFWS, 1995)
- The scientific validity of the recovery objectives should be reviewed as more information becomes available. (USFWS, 1995)
- A public education program is needed to increase awareness of and support for plant recovery efforts in Hawaii. (USFWS, 1995)

Conservation Measures and Best Management Practices:

- Continue to collect seeds for genetic storage and reintroduction. (USFWS, 2010)
- Control introduced invasive plant species around wild plants. (USFWS, 2010)
- Construct large-scale fences around all naturally occurring and reintroduced individuals to control feral ungulates. (USFWS, 2010)
- Assess genetic variability among and within extant populations. (USFWS, 2010)
- Reintroduce individuals into protected suitable habitat within historical range. (USFWS, 2010)

- Work with Hawaii Division of Forestry, The Nature Conservancy of Hawaii, and Wildlife and Hawaii State Parks to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2010)
- Study *Schiedea helleri* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. (USFWS, 2010)
- Investigate techniques to improve natural recruitment. (USFWS, 2010)
- New Management Actions:
 - NTBG seed bank has two large bulk collections from 2005 from Mohihi Stream. In June, 2008, 19 separate collections were made over two days from all three sites, possibly representing 19 different wild plants. There are at least four different wild plants (founders) that have been established in the NTBG nursery clonally (via cuttings) (NTBG 2017).
 - Lyon Arboretum has a collection from the one founder at Nawaimaka, 10 founders from one of the Nohihi Stream sites, and one founder from another Mohihi site (Lyon Arboretum 2017).
 - The Kokee Rare Plant Facility has 40 plants in their nursery from six founders at one Mohihi site, twelve founders from a second Mohihi site, and one founder from the third. It also has the one founder represented from Nawaimaka (Waialae). All founders are represented clonally (via cuttings; DOAFW 2016).
 - Eighteen plants have been outplanted in Mohihi (DOFAW 2016) (USFWS, 2017).
- Recommendations for Future Actions: No new threats and no other significant new information regarding the species' biological status have been reported since the last 5-year review in 2010. Therefore, the following recommendations for future actions are reiterated for the 5-year review for 2017.
 - Surveys and inventories—Survey for populations of *Schiedea helleri* in areas of potentially suitable habitat.
 - Ungulate monitoring and control—Protect all occurrences against disturbances from feral ungulates. Construct and maintain small-scale fenced exclosures around all populations to prevent imminent extinction.
 - Invasive plant monitoring and control—
 - o Control established ecosystem-altering nonnative invasive plant species around all populations.
 - o Control invasive nonnative species that compete with the species around all populations.
 - Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock.
 - Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.
 - Human interaction monitoring and management—Develop and implement effective measures to reduce impacts of hikers and trail maintenance.
 - Population biology research—Study *Schiedea helleri* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2017).

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SPECIES ACCOUNT: *Schiedea hookeri* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

Schiedea hookeri is a relatively long-lived perennial of the Caryophyllaceae (pink) family. It is a sprawling or clumped sub-shrub (stems woody at the base) with stems 0.3 to 0.5 m (1 to 1.6 ft) long that curve slightly upward or lie close to the ground in matted clumps. The narrow, oppositely arranged leaves are 3 to 8 cm (1.2 to 3.2 in) long and 0.4 to 1.5-cm (0.2 to 0.6 in) wide. The small, perfect flowers (with both male and female reproductive parts) have no petals and are borne in open, branched clusters that are hairy and somewhat sticky. The fruit is a capsule about 3 mm (0.1 in) long (Wagner et al 1999) (USFWS, 2016).

Historical Range

Schiedea is a genus endemic to the Hawaiian Islands. Trends in distribution indicate range restriction in *Schiedea hookeri*, which historically occurred in the Waianae Mountains of Oahu and perhaps occurred on Maui (although the single fragmentary collection from East Maui may represent another species) (61 FR 53108) (USFWS, 2016).

Current Range

Currently, this species occurs only in the Waianae Mountains (USFWS, 2016).

Critical Habitat Designated

Yes; 6/13/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Schiedea hookeri* under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Schiedea hookeri* (77 FR 57648-57862). The critical habitat designation includes 27 critical habitat units, which encompass approximately 8,806 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Schiedea hookeri* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Schiedea hookeri* includes 27 critical habitat units, covering five ecosystem types, which encompass approximately 8,806 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Dry—Units 1, 2, 8, 9, 10, 11; , Oahu— Lowland Mesic—Units 1, 2, 3; , Oahu—Lowland Wet—Units 1, 2, 3, 4, 5; Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8; Oahu—Wet Cliff—Units 1, 2, 3, 4, 5.

Oahu—Lowland Dry—Unit 1 [102 ac (41 ha)]; This area consists of 49 ac (20 ha) of State land and 53 ac (22 ha) of privately owned land in the Waianae Mountains, extending from Haili Gulch to

Kawaipahai. Oahu—Lowland Dry— Unit 2 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland dry ecosystem in the Waianae Mountains, on Federal land within Kaena Point State Park. Oahu—Lowland Dry—Unit 8 [99 ac (40 ha)]. Oahu—This area consists of 96 ac (40 ha) of privately owned land and 3 ac (1 ha) of State land as part of the old railroad right-of-way in the lowland dry ecosystem, at the Kalaeloa Barber's Point Harbor area. Oahu—Lowland Dry—Unit 9 [37 ac (15 ha)]. This area consists of 17 ac (7 ha) of City and County land, 3 ac (1 ha) of privately owned land, 1 ac (0.5 ha) of State land, and 16 ac (6 ha) of Federal (Pearl Harbor NWR) land in the lowland dry ecosystem at Kalaeloa. Oahu—Lowland Dry— Unit 10 [43 ac (17 ha)]. This area consists of 43 ac (17 ha) of State land (DHHL) in the lowland dry ecosystem at Kalaeloa. Oahu—Lowland Dry—Unit 11 [166 ac (67 ha)]. This area consists of 166 ac (67 ha) of federal land (U.S. Navy) in the lowland dry ecosystem at Kalaeloa.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Oahu—Lowland Wet—Unit 1 [541 ac (219 ha)]. This area consists of 428 ac (173 ha) of State land and 112 ac (46 ha) of City and County of Honolulu land in the lowland wet ecosystem on the windward side of the Waianae Mountains, and partially within the Mokuleia and Waianae Kai Forest Reserves. Oahu—Lowland Wet—Unit 2 [20 ac (8 ha)]. This area consists of 19 ac (8 ha) of State land in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puuhapapa. Oahu—Lowland Wet—Unit 3 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puukanehoa. Oahu—Lowland Wet—Unit 4 [27 ac (11 ha)]. This area consists of 27 ac (11 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains on State land at Puukaua.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38

ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac(105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

Oahu—Wet Cliff—Unit 1 [235 ac (95 ha)]. This area consists of 167 ac (68 ha) of State land, 68 ac (28 ha) of City and County of Honolulu land, and less than 1 ac (less than 1 ha) of privately owned land in the wet cliff ecosystem in the Waianae Mountains, near the summit of Kaala, and partially within the Mokuleia and Waianae Kai FRs and the Kaala Natural Area Reserve. Oahu—Wet Cliff—Unit 2 [3 ac (1 ha)]. This area consists of 3 ac (1 ha) of State land in the wet cliff ecosystem in the Waianae Mountains at Puuhapapa, within a small area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Oahu—Wet Cliff—Unit 3 [16 ac (6 ha)]. This area consists of 16 ac (6 ha) in the wet cliff ecosystem on State land in the Waianae Mountains at Puukanehoa, partially within an area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Oahu—Wet Cliff—Unit 4 [23 ac (9 ha)]. This area consists of 23 ac (9 ha) in the wet cliff ecosystem on State land in the Waianae Mountains at Puukaua, partially overlapping an area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and recently acquired by the State. Oahu—Wet Cliff—Unit 5 [31 ac (13 ha)]. This area consists of 31 ac (13 ha) of State land in the wet cliff ecosystem in the Waianae Mountains, at Palikea and north of Palikea.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Schiedea hookeri* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Schiedea hookeri* occurs within the Lowland dry, Lowland mesic, Lowland wet, Dry cliff and Wet cliff ecosystems in the Waianae Mountain caldera complex:

Oahu—Lowland Dry—Units 1, 2, 8, 9, 10, 11. (A) Elevation: <3,300 ft (<1,000 m). (B) Annual Precipitation: <50 in (<130 cm). (C) Substrate: Weathered silty loams to stony clay, rocky ledges, little weathered lava. (D) Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*, *Sapindes*. (E) Subcanopy: *Chamaesyce*, *Dodonaea*, *Leptecophylla*, *Osteomeles*, *Psydrax*, *Scaevola*, *Wikstroemia*. (F) Understory: *Alyxia*, *Artemisia*, *Bidens*, *Chenopodium*, *Nephrolepis*, *Peperomia*, *Plumbago*, *Sicyos*, *Sida*, *Waltheria*.

Oahu— Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Oahu—Lowland Wet—Units 1, 2, 3, 4, 5. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (F) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepidia*.

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. (F) Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Oahu—Wet Cliff—Units 1, 2, 3, 4, 5. (A) Elevation: unrestricted. (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: >65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: Broussaisia, Cheirodendron, Leptecophylla, Metrosideros. (F) Understory: Bryophytes, Ferns, Coprosma, Dubautia, Kadua, Peperomia.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Schiedea hookeri* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Likely insect pollinated (USFWS, 2016)

Lifespan

Adult: <10 years (USFWS, 2016)

Reproduction Narrative

Adult: *Schiedea hookeri* is an outcrossing species probably pollinated by insects. Mature fruits have been observed in June and August, but seed dispersal mechanisms are unknown. This species varies considerably throughout its range in potential for vegetative (clonal) growth and spread. Upright plants at one site, for example, show little clonal potential, whereas decumbent plants at another site exhibit clonal growth by nodal rooting (68 FR 35950; Service 1999a). Plant longevity is probably similar to that of other small, semi-woody shrubs that live less than 10 years (i.e., short-lived perennials). Other demographic information for *S. hookeri* in the wild is unknown, including phenology, number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, timing of reproductive output, pollination and seed dispersal, vegetative reproduction and specific environmental requirements (USFWS, 2016).

Habitat Type

Adult: Mesic or dry lowland forest (USFWS, 2016)

Habitat Narrative

Adult: *Schiedea hookeri* occurs in the understory of diverse mesic or dry lowland forests typically dominated by *Metrosideros polymorpha* or *Diospyros* species, at elevations ranging between 350 and 900 m (1,148 and 2,953 ft) (61 FR 53108; 68 FR 35950; Wagner et al 1999). It usually grows on slopes, cliffs and cliff bases, rock walls, and ledges (USFWS, 2016).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seed dispersal mechanisms are unknown (USFWS, 2016).

Population Information and Trends

Population Trends:

Unknown

Number of Populations:

~8 (USFWS, 2018)

Population Size:

~500 individuals (USFWS, 2018)

Population Narrative:

New Status Information: • The IUCN recently estimated as many as 500 individuals in eight subpopulations on O'ahu (Brueggemann et al. 2016). These numbers, however, are mostly from old observations from the early 2000s (US Army 2017), and considering the degradation of habitat, are likely lower. • In 2012, critical habitat was designated in 28 units on O'ahu in five ecosystems (lowland dry, lowland mesic, lowland wet, dry cliff, and wet cliff) (10,447 ac; 4,229 ha) (77 FR 57648, September 18, 2012) (USFWS, 2018).

Threats and Stressors

Stressor: Invertebrates (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: *Schiedea hookeri* is particularly vulnerable to predation by non-native slugs and snails (61 FR 53108). Seedlings from other *Schiedea* species that occur in mesic or wet sites are apparently consumed by these alien invertebrates (USFWS, 2016).

Stressor: Lack of pollinators (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: *Schiedea* species that occur in dry areas, however, produce abundant seedlings following winter rains, perhaps because drier sites have fewer non-native invertebrate herbivores (Service 1999a). *Schiedea hookeri* also may suffer from a lack of pollinators (Service 1999a) (USFWS, 2016).

Stressor: Fire (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Wildfire ignited by military training activities is a threat to this species in the Makua and Schofield Barracks action areas (USFWS, 2016).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: We previously reported that climate change may pose a threat to this species, anticipating an analysis by 2013. The assessment conducted by Fortini et al. (2013) concluded that *Schiedea hookeri* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.662 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions may be needed to conserve this taxon into the future (USFWS, 2018).

Recovery

Delisting Criteria:

Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1999a). Conservation actions required for stabilization are described in the “Stabilization” section of the project description for this opinion. However, *S. hookeri* is not included as a target taxon for stabilization under the Makua Implementation Plan Addendum. The Army does not actively manage this species in the Makua or Schofield Barracks action areas (Service 2003a). Research on slug control in forest settings is needed to find ways to reduce invertebrate threats to *S. hookeri* and associated native plants (USFWS, 2016).

Conservation Measures and Best Management Practices:

- No information is available on conservation management for *Schiedea hookeri* since it was listed as endangered. However, about 128 individuals (30 percent of all remaining individuals) of this species occur action area in management units where they will benefit from population unit and/or ecosystem-level protection. The management units include Keaau and Kahanahaiki, which are not fenced; and Kaluakauila and Ohikilolo, which are fenced. The Nature Conservancy of Hawaii’s long-range management plan for Honouliuli Preserve includes management actions to control non-native plants, feral ungulates, and fire, and to recover rare species and restore native habitats; this plan will benefit any *S. hookeri* within the preserve. This species is represented in ex situ collections that include nine cuttings in a nursery (Harold L. Lyon Arboretum) and 30 plants in a botanical garden (Waimea Valley Audubon Center) (Service 2005b) (USFWS, 2016)
- New Management Actions: • Surveys and inventories—Although *Schiedea hookeri* is not covered under the Army INRMP, the Army Natural Resources team monitors known individuals within and around their management units in the Wai’anae Mountains of O’ahu. They reported populations of this species in the following management units: Kaluakauila, Kamā’ili, South Hale’au’au, and Mohiākea (total number of individuals not reported) (US Army 2010, 2016, 2017). They have monitored 11 plants, 10 in one location in Palikea gulch, and 1 in another location in Manuwai,

- within the last five years (US Army 2017). • Captive propagation for genetic storage and reintroduction—
- o The University of California-Irvine reported at least 13 individuals in their nursery representing three wild individuals from Wai‘anae Kai and one founder from Kaluaa (UC-Irvine 2014, 2017).
 - o Waimea Arboretum reported 16 plants in storage representing two wild individuals in 2013; 90 plants representing two individuals (2014); 36 plants representing two individuals (2015), and 40 plants representing two individuals (2017) (USFWS, 2018).
- Recommendations for Future Actions: We are not aware of any new threats or significant new information regarding the species’ biological status since the last 5-year review in 2011. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2018. • Ungulate monitoring and control—Maintain existing fences and construct additional fences to protect populations from the negative impacts of feral ungulates. • Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations of *S. hookeri*. • Rodent predation and herbivory—Control rats in the vicinity of known populations. • Slug herbivory—Develop and implement methods to control slugs. • Captive propagation for genetic storage and reintroduction—Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. • Reintroduction and translocation—Augment known populations and reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Human disturbance—Fire mortality and reduced viability—Develop and implement a fire management plan for populations not within an Army management unit. • Stochastic events—Reduced viability—Research genetic variation between populations. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for its recovery. • Alliance and partnership development—Work with the Division of Forestry and Management, the Army Natural Resources team, and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2018).

References

USFWS. 2016. Status of the Species and Critical Habitat: *Schiedea hookeri* (No Common Name). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016

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SPECIES ACCOUNT: *Schiedea jacobii* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

Perennial herbs or subshrubs, pale yellowish green throughout. Stems 4.0-7.6 dm long, ascending to sprawling when longer. Leaves opposite. Leaf blades 4.5-10.5 cm long, 1.4-2.6 cm wide, lanceolate to oblong-elliptic. Inflorescence panicle-like, 40-50 cm long. Capsules ovoid, 3.7-4.2 mm long. (NatureServe, 2015)

Taxonomy

New species; published in Novon 9: 284-287. 1999. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Endemic to the island of Maui in the Hawaiian Islands. It was discovered at a location on the north flank of Haleakala in the Hanawi Natural Area Reserve (NatureServe, 2015).

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Schiedea jacobii* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes five detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Schiedea jacobii* includes five CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Montane Wet—Unit 1 (and) *Palmeria dolei*—Unit 10—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 10— Montane Wet This area consists of 1,313 ac (531 ha) of State land and 798 ac (323 ha) of privately owned land, at Haiku Uka on the northern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Cyanea duvalliorum*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *Phyllostegia pilosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 1 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp.

haleakalaensis, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 11—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 11— Montane Wet This area consists of 4,075 ac (1,649 ha) of State land, 9,633 ac (3,898 ha) of privately owned land, and 875 ac (354 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Puukaukanu and upper Waihoi Valley, on the northern and northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Geranium hanaense*, *G. multiflorum*, and *Wikstroemia villosa*, and by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 2 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea glabra*, *C. maritae*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, and *Schiedea jacobii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 3 (and) *Palmeria dolei*—Unit 12—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 12— Montane Wet This area consists of 2,228 ac (902 ha) of federally owned land (Haleakala National Park) in Kipahulu Valley, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. maritae*, and *Melicope ovalis*, and by the forest bird, *kiwikiu* (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 3 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea duvalliorum*, *C. glabra*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P.*

mannii, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest bird, the akohekohe (*Palmeria dolei*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 4 (and) *Palmeria dolei*—Unit 13—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 13— Montane Wet This area consists of 180 ac (73 ha) of State land and 1,653 ac (669 ha) of federally owned land (Haleakala National Park), in Kaapahu Valley on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *Cyrtandra ferripilosa*, and *Huperzia mannii*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 4 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea duvalliorum*, *C. glabra*, *C. mceldowneyi*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 5 (and) *Palmeria dolei*—Unit 14—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 14— Montane Wet This area consists of 222 ac (90 ha) of State land, and 165 ac (67 ha) of federally owned land (Haleakala National Park), near Kaumakani on the eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plant *Bidens campylotheca* ssp. *pentamera*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 5 is not currently occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the

reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Schiedea jacobii* critical habitat consists of one component. Montane wet (east Maui) (81 FR 17790-18110):

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: *Ferns*, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire,

drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: No information found.

Habitat Type

Adult: Wet cliffs (USFWS, 2016)

Spatial Arrangements of the Population

Adult: Clumped (inferred from USFWS, 2016)

Environmental Specificity

Adult: Narrow/specialist (inferred from USFWS, 2016)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 2016)

Site Fidelity

Adult: High (inferred from USFWS, 2016)

Habitat Narrative

Adult: Discovered in 1992, the single occurrence consisted of nine individuals along wet cliffs between Hanawi Stream and Kuhiwa drainage (in Hanawi Natural Area Reserve), in the montane wet ecosystem on east Maui (Wagner et al. 1999j, p. 286) (USFWS, 2016). Clumped spatial arrangement of the population, narrow environmental specificity, low tolerance ranges and high site fidelity and ecological integrity of the community are inferred based on the species unique habitat requirements and the low number of known populations (one).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: No information found.

Population Information and Trends**Population Trends:**

Possible extirpated in the wild unless the 2011 outplanting was successful.

Population Narrative:

Schiedea jacobii (NCN), a short-lived perennial herb or subshrub in the pink family (Caryophyllaceae), occurs only on Maui (Wagner et al. 1999j, p. 284). Discovered in 1992, the single occurrence consisted of nine individuals along wet cliffs between Hanawi Stream and Kuhiwa drainage (in Hanawi NAR), in the montane wet ecosystem on east Maui (Wagner et al. 1999j, p. 286). By 1995, only four plants could be relocated in this location. It appeared that the other five known individuals had been destroyed by a landslide (Wagner et al. 1999j, p. 286). In 2004, one seedling was observed in the same location, and in 2010, no individuals were relocated (Perlman 2010, in litt.). The State of Hawaii plans to outplant propagated individuals in a fenced area in Hanawi Natural Area Reserve in 2011 (Oppenheimer 2010a, in litt.; Perlman 2010, in litt.) (USFWS, 2016).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (goats, axis deer, and cattle), drought, landslides, treefalls, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Drought, landslides, and treefalls destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (goats, axis deer, cattle, and slugs) is considered an ongoing threat to *Schiedea jacobii* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor: Small populations (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: *Schiedea jacobii* faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). The only known wild individuals of *Schiedea jacobii* were likely destroyed by landslides because of their location along wet cliffs between Hanawi Stream and Kuhiwa drainage in the montane wet ecosystem on east Maui. The State plans to outplant propagated individuals in Hanawi Natural Area Reserve in 2011 (USFWS, 2013).

Recovery

References

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

Final Rule . 81 FR 17790-18110 (March 30, 2016).

U.S. Fish and Wildlife Service. 2016. Endangered and Threatened Wildlife and Plants

Final Rule. FR Vol. 81, No. 61. Pages 17790-18110.

USFWS. 2013. Determination of Endangered Status for 38 Species on Molokai, Lanai, and Maui

Final Rule. 78 Federal Register 102, May 28, 2013. Pages 32014 - 32065.

SPECIES ACCOUNT: *Schiedea kaalae* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/29/1991; Pacific Region (R1) (USFWS, 2016)

Physical Description

Schiedea kaalae is a short-lived perennial of the Caryophyllaceae (pink) family. It has a short woody caudex (perennial stem at the ground surface) less than 20 cm (8 in) tall, with short branches that trail along the ground and end in rosettes of thick, oppositely arranged leaves. The small, perfect flowers (with both male and female reproductive parts) are borne in open, branched clusters up to 40 cm (15.6 in) long. The fruit is a small capsule filled with tiny, dark seeds (Wagner et al 1999; Makua Implementation Team 2003).

Current Range

Schiedea is a genus endemic to the Hawaiian Islands. Historic data indicate *Schiedea kaalae* was known from the north-central and south-central Waianae Mountains and the northern Koolau Mountains of Oahu. When listed in 1991, there were five occurrences in the Waianae Mountains and two occurrences in the Koolau Mountains that together totaled less than 100 individuals (56 FR 55770). In 2003, eight population units totaling 24 to 25 individuals indicated a steady decline for this species (Makua Implementation Team 2003). The latest information available indicates an increasing in detection due to more diligent survey effort and augmentation, with 10 population units totaling 235 individuals located on Federal, State, and private lands (68 FR 35950) (Table SB 34). Of these, 62 individuals are naturally occurring and 173 are augmentations from greenhouse-propagated stock. A new population unit was recently discovered at Kahana, and additional individuals were discovered at the Makua population unit (U.S. Army Garrison 2005b). None of the population units have reached the numeric targets for stabilization (defined as 50 mature individuals for short-lived perennials).

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Schiedea kaalae* under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Schiedea kaalae* (77 FR 57648-57862). The critical habitat designation includes 20 critical habitat units, which encompass approximately 13,765 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Schiedea kaalae* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Schiedea kaalae* includes 20 critical habitat units, covering three ecosystem types, which encompass approximately 13,765 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—

Units 1, 2, 3, 4, 5, 6, 7; Oahu—Lowland Wet—Units 1, 2, 3, 4, 5; Oahu— Wet Cliff—Units 1, 2, 3, 4, 5, 6, 7, 8.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

Oahu—Lowland Wet—Unit 1 [541 ac (219 ha)]. This area consists of 428 ac (173 ha) of State land and 112 ac (46 ha) of City and County of Honolulu land in the lowland wet ecosystem on the windward side of the Waianae Mountains, and partially within the Mokuleia and Waianae Kai Forest Reserves. Oahu—Lowland Wet—Unit 2 [20 ac (8 ha)]. This area consists of 19 ac (8 ha) of State land in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puuhapapa. Oahu—Lowland Wet—Unit 3 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puukanehoa. Oahu—Lowland Wet—Unit 4 [27 ac (11 ha)]. This area consists of 27 ac (11 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains on State land at Puukaua. Oahu—Lowland Wet—Unit 5 [74 ac (30 ha)]. This area consists of 74 ac (30 ha) of State land in the lowland wet ecosystem, on the windward side of the Waianae Mountains at Palikea.

Oahu—Wet Cliff—Unit 1 [235 ac (95 ha)]. This area consists of 167 ac (68 ha) of State land, 68 ac (28 ha) of City and County of Honolulu land, and less than 1 ac (less than 1 ha) of privately owned land in the wet cliff ecosystem in the Waianae Mountains, near the summit of Kaala, and partially within the Mokuleia and Waianae Kai FRs and the Kaala Natural Area Reserve. Oahu—Wet Cliff—Unit 2 [3 ac (1 ha)]. This area consists of 3 ac (1 ha) of State land in the wet cliff ecosystem in the Waianae Mountains at Puuhapapa, within a small area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Oahu—Wet Cliff—Unit 3 [16 ac (6 ha)]. This area consists of 16 ac (6 ha) in the wet cliff ecosystem on State land in the Waianae Mountains at Puukanehoa, partially within an area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Oahu—Wet Cliff—Unit 4 [23 ac (9 ha)]. This area consists of 23 ac (9 ha) in the wet

cliff ecosystem on State land in the Waianae Mountains at Puukaua, partially overlapping an area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and recently acquired by the State. Oahu—Wet Cliff—Unit 5 [31 ac (13 ha)]. This area consists of 31 ac (13 ha) of State land in the wet cliff ecosystem in the Waianae Mountains, at Palikea and north of Palikea. Oahu—Wet Cliff—Unit 6 [151 ac (61 ha)]. This area consists of 151 ac (61 ha) in the wet cliff ecosystem on State land on the windward side of the Koolau Mountains in Kaipapau Gulch, entirely within the Kaipapau Forest Reserve. Oahu—Wet Cliff—Unit 7 [144 ac (58 ha)]. This area consists of 144 ac (58 ha) in the wet cliff ecosystem in State land on the windward side of the Koolau Mountains in Hauula Gulch, entirely within the Hauula Forest Reserve. Oahu—Wet Cliff—Unit 8 [4,649 ac (1,881 ha)]. This area consists of 1,479 ac (598 ha) of State land, 1,281 ac (519 ha) of City and County of Honolulu land, 5 ac (2 ha) of Federal land, and 1,884 ac (762 ha) of privately owned land, in the wet cliff ecosystem along the summit of the Koolau Mountains, overlapping portions of Sacred Falls State Park, the Waiahole FR (Waiahole and Iolekaa sections), the Kaneohe and Honolulu Watershed FRs, and the Nuana Pali State Wayside.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Schiedea kaalae* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Schiedea kaalae* occurs within the Lowland mesic, Lowland wet and Wet cliff ecosystems in the Waianae Mountain caldera complex and the Lowland mesic and Wet cliff ecosystems in the Koolau Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Oahu—Lowland Wet—Units 1, 2, 3, 4, 5. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (F) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Oahu—Wet Cliff—Units 1, 2, 3, 4, 5, 6, 7, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: >65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. (F) Understory: *Bryophytes*, *Ferns*, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Schiedea kaalae* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats

will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Lifespan

Adult: probably <10 years

Breeding Season

Adult: flowers from March through June

Reproduction Narrative

Adult: Schiedea kaalae flowers from March through June. Cultivated plants are capable of self-pollination, but *S. kaalae* is an outcrossing species that requires pollinators, probably insects, for fruit production (Wagner et al 2005). In the field, biologists have observed a non-native syrphid fly visiting the plants (Makua Implementation Team 2003). Plant longevity probably is similar to that of other small, semi-woody shrubs that live less than 10 years (i.e., short-lived perennials) (Makua Implementation Team 2003). Other demographic information on *S. kaalae* in the wild is unknown, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, timing of reproductive output, pollination and seed dispersal, vegetative reproduction and specific environmental requirements.

Habitat Type

Adult: Mesic to wet forest

Habitat Narrative

Adult: Schiedea kaalae in the Waianae Mountains is consistently found on steep slopes and shaded sites in the understory of diverse mesic forest and wet forest, usually in gulch bottoms or low to mid gulch slopes, at elevations between 210 to 790 m (689-2,592 ft). It often grows on slopes with sparse groundcover and occasionally in cracks in rock embankments. In the Koolau Mountains, *S. kaalae* occurs in gulch bottoms and on lower gulch slopes within mesic to wet habitats, some of which are constantly wet from seeping water. Plants can grow on gentle to moderate slopes, steep rock embankments, and nearly vertical cliffs (56 FR 55770; Makua Implementation Team 2003). Where *S. kaalae* occurs in the same drainages as its relatives *S. hookeri*, *S. nuttallii*, *S. obovata*, and *S. pentandra*, it is usually found in the drier areas.

Dispersal/Migration

Population Information and Trends

Number of Populations:

10

Population Size:

235

Population Narrative:

In 2003, eight population units totaling 24 to 25 individuals indicated a steady decline for this species (Makua Implementation Team 2003). The latest information available indicates an increasing in detection due to more diligent survey effort and augmentation, with 10 population units totaling 235 individuals located on Federal, State, and private lands (68 FR 35950) (Table SB 34). Of these, 62 individuals are naturally occurring and 173 are augmentations from greenhouse-propagated stock. A new population unit was recently discovered at Kahana, and additional individuals were discovered at the Makua population unit (U.S. Army Garrison 2005b). None of the population units have reached the numeric targets for stabilization (defined as 50 mature individuals for short-lived perennials). Demographic information in the wild is unknown, as *Schiedea kaalae* seedlings and immature plants are seldom seen, especially in Waianae population units. The apparent lack of recruitment is probably due to seedling predation by non-native slugs and snails (Makua Implementation Team 2003; U.S. Army Garrison 2004a, 2005b). The Nature Conservancy of Hawaii has propagated and outplanted *S. kaalae* from seed and cuttings, but no seedlings have been observed at those outplanting sites (U.S. Army Garrison 2004a). No information is available on the survival rate of immature outplantings. Individuals of this species are at risk from training-related wildfire in the Makua and Schofield Barracks Military Reservation action areas. Thus, *S. kaalae* is characterized by extremely low numbers that are increasing only by augmentation and occasional discovery of new occurrences.

Threats and Stressors**Stressor:****Exposure:****Response:****Consequence:**

Narrative: *Schiedea kaalae* was listed as endangered because of major ecosystem-level threats to its survival and recovery. *Schiedea kaalae* is particularly vulnerable to predation by non-native slugs and snails. One study noted, for example, that seedling mortality for the related species *S. obovata* doubled when exposed to slug herbivory (U.S. Army Garrison 2005b). In addition to the very low risk of training-related wildfire from military activities at Makua, one individual of *S. kaalae* is exposed to the risk of training-related wildfire at Mohiakea Gulch in the Schofield Barracks Military Reservation action area (Service 2003a). Most importantly, occurrences of *Schiedea kaalae* are vulnerable to extirpation from naturally occurring events and/or reduced reproductive vigor due to small population size and limited distribution (56 FR 55770; 68 FR 35950; Service 1995a, 1998a). In addition, *S. kaalae* and the related species *S. nuttallii* and *S. pentandra* are characterized by low isozyme variability and inbreeding due to small population size (Wagner et al 2005). Reductions in population size could result in expression of inbreeding depression among progeny, for example in reduced reproductive vigor, with potentially deleterious consequences for the long-term persistence of this species. However, low levels of genetic diversity in *S. kaalae* populations may not be detrimental to the species as plants from populations that appear to have undergone repeated self-fertilization are vigorous in cultivation (Makua Implementation Team 2003). Nonetheless, the science of conservation biology has documented a general pattern of population collapse for a wide range of plant and animal species (Dennis et al 1991; Schemske et al 1994; Morris et al 1999; Menges 2000). According to this pattern, *S. kaalae* already is in a phase of “quasi-extinction,” with numbers that have

declined to the point where demographic stochasticity alone can result in extirpation. Thus, *S. kaalae* has a very high background risk of species extinction, and any additional threats could eliminate expectation of its long-term persistence.

Recovery

Conservation Measures and Best Management Practices:

- Conservation actions that should be implemented for the recovery of *Schiedea kaalae* are described in the introduction to the “Status and Environmental Baseline of the Species and Critical Habitat” section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1995a, 1998a). The three population units identified for stabilization of *S. kaalae* are all located on State or private lands. The Army proposes to manage an additional two population units for stabilization at Maakua and Kahana, in the Koolau Mountains (U.S. Army Garrison 2005b). Research on slug control in forest settings is needed to find ways to reduce invertebrate threats to *S. kaalae* and associated native plants.
- Ongoing Conservation Actions: The Makua Implementation Team (2003) has developed stabilization protocols for *Schiedea kaalae*, which are incorporated in the Army’s Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). Population units of *S. kaalae* are fenced in the Pahole, South Ekahanui, Kaluua and Waieli, Makuaa, Mohiakea, and North Palawai population units; weeds are partially controlled only in the Mohiakea, North Palawai, and Kahana population units (U.S. Army Garrison 2005b). In addition, this species occurs in three management units where it will benefit from population unit and/or ecosystem-level protection. The management units include Lower Kahana, which is not fenced; and Ekahanui and Pahole, which are fenced. The South Ekahanui population unit is augmented by The Nature Conservancy of Hawaii. The Nature Conservancy of Hawaii’s long-range management plan for Honouliuli Preserve includes management actions to control non-native plants, feral ungulates, and fire, and to recover rare species and restore native habitats, including the South Ekahanui population unit of *S. kaalae*. Seeds and cuttings have been taken from the recently discovered plants in the Kahana population unit for propagation and augmentation (U.S. Army Garrison 2005b). Obtaining sufficient seed for genetic storage of *Schiedea kaalae* is difficult because plants do not produce much seed at one time. This species can be propagated from both seed and cuttings. Germination rates of fresh seeds vary from less than 15 percent to 75 percent (U.S. Army Garrison 2005b). The Nature Conservancy of Hawaii has propagated this species successfully from seed in the greenhouse, and has reintroduced plants to three sites in Honouliuli Preserve. Survivorship of these outplants appears good, but they have not yet produced any seedlings (U.S. Army Garrison 2005b). This species is represented in several ex situ collections, including one apical vegetative bud in micropropagation (Harold L. Lyon Arboretum), 23 cuttings in a nursery (Harold L. Lyon Arboretum), 17 plants in a nursery (Harold L. Lyon Arboretum), nine plants in a botanical garden (Waimea Valley Audubon Center), 598 ungerminated seeds in a nursery (Harold L. Lyon Arboretum), 6000 seeds in seed storage (Lyon Arboretum Seed Storage Facility), and 193 seedlings in a nursery (Harold L. Lyon Arboretum) (Service 2005b).

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SPECIES ACCOUNT: *Schiedea kauaiensis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

A generally hairless, erect subshrub, with stems normally 0.3 to 1.5 m long. Its apetalous flowers have small, green or sometimes purple-tinged sepals, and are borne in open branched inflorescences (as cited in U.S. Fish and Wildlife Service 1996). (NatureServe, 2015)

Taxonomy

Wagner et al. (2005) recognize *Schiedea kauaiensis* with *S. wichmanii* as a synonym. Note that, although Wagner and Herbst (1999) commented that *S. nuttallii* var. *pauciflora* would be included in *S. kauaiensis*, *S. nuttallii* var. *pauciflora* was actually included in the newly published species, *S. perlmanii*, in Wagner et al. (2005). (NatureServe, 2015)

Historical Range

Historically no additional range. (NatureServe, 2015)

Current Range

Currently known from northwestern Kauai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Schiedea kauaiensis* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Schiedea kauaiensis* includes four units totaling 2,291 acres in Kauai County, Hawaii. The units are Kauai 11—*Schiedea kauaiensis*—a, b, c, d.

Kauai 11—*Schiedea kauaiensis*—a: This unit is critical habitat for *Schiedea kauaiensis* and is 12 ha (29 ac) on private land, containing Pohakukane Cliffs. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Schiedea kauaiensis* and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is important to the establishment of additional populations on Kauai in order to reach recovery goals. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep slopes in diverse mesic to wet *Acacia koa*-*Metrosideros polymorpha* forest. This unit is geographically separated from the other three units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Schiedea kauaiensis*—b: This unit is critical habitat for *Schiedea kauaiensis* and is 395 ha (975 ac) on State land (Kokee and Na Pali Coast State Parks). This unit contains Kahuamaa Flat, and Kalahu, Pihea, and Puu o Kila Summits, and Kalalau Lookout. This unit provides habitat for two

populations of 300 mature, reproducing individuals of the shortlived perennial *Schiedea kauaiensis* and is currently occupied with five plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep slopes in diverse mesic to wet *Acacia koa*-*Metrosideros polymorpha* forest. This unit is geographically separated from the other three units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Schiedea kauaiensis*—c: This unit is critical habitat for *Schiedea kauaiensis* and is 510 ha (1,260 ac) on State land (Kuia NAR). This unit contains portions of Kuia and Mahanaloa Valleys and Milolii Ridge. This unit provides habitat for three populations of 300 mature, reproducing individuals of the short-lived perennial *Schiedea kauaiensis* and is currently occupied with 17 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep slopes in diverse mesic to wet *Acacia koa*-*Metrosideros polymorpha* forest. This unit is geographically separated from the other three units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Schiedea kauaiensis*—d: This unit is critical habitat for *Schiedea kauaiensis* and is 11 ha (28 ac) on State land (Hono o Na Pali NAR), containing portions of Kalalau Trail. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Schiedea kauaiensis* and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is important to the establishment of additional populations on Kauai in order to reach recovery goals. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep slopes in diverse mesic to wet *Acacia koa*-*Metrosideros polymorpha* forest. This unit is geographically separated from the other three units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Steep slopes in diverse mesic to wet *Acacia koa*-*Metrosideros polymorpha* forest and containing one or more of the following associated plant species: *Alphitonia ponderosa*, *Cryptocarya mannii*, *Diospyros* spp., *Dodonaea viscosa*, *Euphorbia haeleeleana*, *Exocarpos luteolus*, *Leptocophylla tameiameia*, *Microlepia strigosa*, *Nestegis sandwicensis*, *Peucedanum sandwicense*, *Pisonia* spp., *Psychotria* spp., or *Psydrax odorata*; and

(ii) Elevations between 117 and 1,290 m (385 and 4,232 ft).

Special Management Considerations or Protections

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their

immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species in paragraph (b) of this section and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Breeding Season

Adult: Fruit and flowers have been observed in July and August, and flowering material has been collected in September (S. Weller in litt. 1994) (USFWS, 1998).

Reproduction Narrative

Adult: Little is known about the life history of this taxon. Fruit and flowers have been observed in July and August, and flowering material has been collected in September (S. Weller in litt. 1994). There is no evidence of regeneration from seed under field conditions. Seedlings of species of *Schiedea* occurring in mesic or wet sites are apparently consumed by introduced slugs and snails. These have been observed feeding on *Schiedea membranacea*, another mesic forest species that occurs on Kauai. In contrast to mesic-forest species, *Schiedea* occurring in dry areas produce abundant seedlings following winter rains, presumably because there are fewer alien consumers in the drier sites (S. Weller, personal communication 1997). Reproductive cycles, longevity, specific environmental requirements and limiting factors are unknown (USFWS, 1998).

Habitat Type

Adult: Mesic to wet forest (USFWS, 1998)

Spatial Arrangements of the Population

Adult: Clumped (inferred from USFWS, 2008)

Environmental Specificity

Adult: Narrow/specialist (inferred from USFWS, 2008)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 2008)

Site Fidelity

Adult: High (inferred from USFWS, 2008)

Habitat Narrative

Adult: Schiedea kauaiensis typically grows in diverse mesic forest on steep slopes (as cited in U.S. Fish and Wildlife Service 1996). (NatureServe, 2015). Schiedea kauaiensis typically grows in diverse mesic to wet forest on steep slopes. Associated plant taxa include Psychotria hexandra (kopiko), Exocarpus luteolus (heau), lama, the federally threatened Peucedanum sandwicense (makou), and the federally endangered Euphorbia haeleeleana (akoko) (USFWS 1996a; S. Weller, in litt. 1994) (USFWS, 1998). Two known population (USFWS, 2008). Clumped spatial arrangement of the population, narrow environmental specificity, low tolerance ranges and high site fidelity and ecological integrity of the community are inferred based on the species unique habitat requirements and the low number of known populations.

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Reproductive cycles, longevity, specific environmental requirements and limiting factors are unknown (USFWS, 1998).

Population Information and Trends**Resiliency:**

Low (inferred from NatureServe, 2015))

Representation:

Low (inferred from NatureServe, 2015))

Redundancy:

Low (inferred from NatureServe, 2015))

Number of Populations:

5-6 (USFWS, 2017)

Population Size:

~12 individuals (USFWS, 2017)

Population Narrative:

New Status Information: In addition to those populations cited in the previous 5-year review, new observations include the following: • At the time of the last 5-year review in 2008 there were 2 populations totaling 12 individuals at Mahanaloa and Limahuli on Kauai. An individual at Limahuli was last observed in 2011 (PEPP 2011). Recent surveys have confirmed individuals at Makaha (1 to 5) and Mahanaloa (1) (NTBG 2013b, 2016a-b; PEPP 2015), and discovered new populations at Nualolo (3), Awaawapuhi (1) and Manoa (2) (NTBG 2011, 2012, 2013a, c, 2014a;

PEPP 2014, 2015). These five to six small populations had totaled 12 or fewer individuals at the time. The IUCN Red List of Threatened Species reports only nine individuals at five locations, with the largest population consisting of three plants (Clark 2016). The Plant Extinction Prevention Program's 2016 estimates document further decline, observing the one individual at Mahanaloa, only one individual at Nualolo, and two individuals each at Mahanaloa and Manoa (PEPP 2017) (USFWS, 2017).

Threats and Stressors

Stressor: Feral animals (USFWS, 2008)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Threats to *Schiedea kauaiensis* include habitat destruction by feral goats (*Capra hircus*), pigs (*Sus serofa*), and cattle (*Ros taurus*) (Factors A and D); landslides and erosion resulting from the ungulate destruction of habitat (Factor E) (USFWS, 2008).

Stressor: Invasive plants (USFWS, 2008)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Competition from invasive introduced plant species is listed as a threat to this species (USFWS, 2008).

Stressor: Fire (USFWS, 2008)

Exposure:

Response:

Consequence: Extinction/Loss of habitat

Narrative: *Schiedea kauaiensis* is also potentially threatened by fire, particularly in years of low rainfall (USFWS 2003) (USFWS, 2008)..

Stressor: Small population size/geography (USFWS, 2008)

Exposure:

Response:

Consequence: Extinction

Narrative: In addition to all of the other threats, species like *Schiedea kauaiensis* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes and disease outbreaks (Factor E). When considered on their own, the natural processes associated with being a single island endemic do not affect *S. kauaiensis* to such a degree that it is threatened or endangered with extinction in the foreseeable future, but these natural processes can exacerbate the threat from anthropogenic factors, such as habitat loss for human development or predation by alien species (Factor E) (USFWS 1998) (USFWS, 2008).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Schiedea kauaiensis* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.742 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, Fortini et al. show that Caryophyllaceae is one of the top four most vulnerable native plant families, and, at the genus level, *Schiedea* had one of the highest vulnerability scores. Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery**Reclassification Criteria:**

For downlisting, a total of five to seven populations of each taxon should be documented on Kauai and at least one other island where they now occur or occurred historically. In certain cases, however, a particular taxon may be eligible for downlisting even if all five to seven of the populations are on only one island, provided all of the other recovery criteria have been met and the populations in question are widely distributed and secure enough that one might reasonably conclude that the taxon is not in danger of extinction throughout all or a significant part of its range. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1995).

Delisting Criteria:

For delisting, a total of 8 to 10 populations of each taxon should be documented on Kauai and at least one other island where they now occur or occurred historically. As with downlisting, there may be cases in which a particular taxon may be eligible for delisting even if all 8 to 10 of the populations are on only one island, provided all of the other recovery criteria have been met and the populations in question are widely distributed and secure enough that one might reasonably conclude that the taxon is not likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1995).

Conservation Measures and Best Management Practices:

- Collect material from every remaining individual for genetic storage and reintroduction (USFWS, 2008).
- Control ungulates and weeds in the vicinity of the remaining wild individuals (USFWS, 2008).
- Continue reintroducing individuals into protected suitable habitat within historical range (USFWS, 2008).
- Study *Schiedea kauaiensis* populations with regard to population size and structure, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements,

and limiting factors. There is a need to monitor current occurrences and search for more individuals, as well as to continue genetic storage, propagation and outplanting (USFWS, 2008).

- New Management Actions: • PEPP has been collecting seeds and cuttings for collections at DOFAW, NTBG, and UCI (PEPP 2010, 2012, 2014, 2015). The Kokee Rare Plant Facility has one founder represented by six plants in their nursery from the Nualolo wild plant (DOFAW 2016). • NTBG has plants in their nurseries from seed and cutting collections at Makaha, Mahanaloa, Limahuli. In their seed bank they have collections from Awaawapuhi, Mahanaloa, Makaha (plant #1), and serves as a backup for the University of California, Irvine (UCI) collection (NTBG 2017). • UCI has seeds and plants from one to two founders in Mahanaloa, as well as plants from two founders in Makaha and one founder from Nualolo (UCI 2017). • PEPP is monitoring populations at Mahanaloa, Nualolo, Manoa, Awaawapuhi, and Makaha (PEPP 2010, 2011, 2012, 2014, 2015) (USFWS, 2017).
- Recommendations for Future Actions: No new threats and no other significant new information regarding the species' biological status have been reported since the last 5-year review in 2008. Therefore, the following recommendations for future actions are reiterated for the 5-year review for 2017. • Surveys and inventories—Survey for populations of *Schiedea kauaiensis* in areas of potentially suitable habitat and monitor known occurrences. • Ungulate monitoring and control—Protect all occurrences against browsing and disturbances from feral ungulates. Construct and maintain small-scale fenced exclosures around all populations to prevent imminent extinction. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative species that compete with the species around all populations. • Fire monitoring and control—Develop and implement fire prevention management plans. • Predator and herbivore monitoring and control—Determine and implement effective control methods for slugs. • Captive propagation for genetic storage and reintroduction—Continue to collect seeds for adequate genetic storage. • Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Population biology research—Study *Schiedea kauaiensis* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered throughout historic range to reduce impacts from landslides (USFWS, 2017).

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SPECIES ACCOUNT: *Schiedea kealiae* (Ma`oli`oli)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

A subshrub with weakly ascending to sprawling stems 2 - 5 dm long that form loose clumps. Small flowers are borne in terminal clusters (NatureServe, 2015).

Taxonomy

A member of the pink family (Caryophyllaceae) (USFWS, 2003).

Historical Range

The species is endemic to Oahu, Hawaii (NatureServe, 2015). Historically, *Schiedea kealiae* was known from the northern Waianae Mountains and one collection from the Palikea area, near the southern end of the same mountain range (USFWS 1996b; 1998).

Current Range

Currently, populations are located on the cliffs above Dillingham Airfield and Camp Erdman and at Kaena Point at the northern end of the Waianae Mountains (USFWS, 2003).

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Schiedea kealiae* (Ma`oli`oli) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Schiedea kealiae* (77 FR 57648-57862). The critical habitat designation includes 10 critical habitat units, which encompass approximately 1,493 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Ctenitis squamigera* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Schiedea kealiae* includes 10 critical habitat units, covering two ecosystem types, which encompass approximately 1,493 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Coastal—Units 1, 13, 14, 15, Oahu—Lowland Dry—Units 1, 2, 8, 9, 10, 11.

Oahu—Coastal—Unit 1 [958 ac (388 ha)]. This area consists of 946 ac (383 ha) of State land, 11 ac (4 ha) of Federal land, and 2 ac (1 ha) of privately owned land in the coastal ecosystem along the northwestern coast of Oahu from Kaena Point east to Kauhao Pali and southeast to Keawaula. This unit is partially within Kaena Point State Park. Oahu—Coastal—Unit 13 [23 ac (10 ha)]. This area consists of 19 ac (8 ha) of City and County land, 1 ac (0.5 ha) of State land, and 3 ac (1 ha) of

privately owned land in the coastal ecosystem at Kalaeloa. Oahu—Coastal—Unit 14 [4 ac (2 ha)]. This area consists of 2 ac (1 ha) of City and County of Honolulu land, and 2 ac (1 ha) of Federal land (U.S. Coast Guard) in the coastal ecosystem at Kalaeloa. Oahu—Coastal—Unit 15 [33 ac (13 ha)]. This area consists of 9 ac (4 ha) of State land, 2 ac (1 ha) of privately owned land, and 21 ac (9 ha) of Federal (Pearl Harbor NWR) land at Kalaeloa.

Oahu—Lowland Dry—Unit 1 [102 ac (41 ha)]; This area consists of 49 ac (20 ha) of State land and 53 ac (22 ha) of privately owned land in the Waianae Mountains, extending from Haili Gulch to Kawaipahai. Oahu—Lowland Dry— Unit 2 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland dry ecosystem in the Waianae Mountains, on Federal land within Kaena Point State Park. Oahu—Lowland Dry—Unit 8 [99 ac (40 ha)]. Oahu—This area consists of 96 ac (40 ha) of privately owned land and 3 ac (1 ha) of State land as part of the old railroad right-of-way in the lowland dry ecosystem, at the Kalaeloa Barber's Point Harbor area. Oahu—Lowland Dry—Unit 9 [37 ac (15 ha)]. This area consists of 17 ac (7 ha) of City and County land, 3 ac (1 ha) of privately owned land, 1 ac (0.5 ha) of State land, and 16 ac (6 ha) of Federal (Pearl Harbor NWR) land in the lowland dry ecosystem at Kalaeloa. Oahu—Lowland Dry— Unit 10 [43 ac (17 ha)]. This area consists of 43 ac (17 ha) of State land (DHHL) in the lowland dry ecosystem at Kalaeloa. Oahu—Lowland Dry—Unit 11 [166 ac (67 ha)]. This area consists of 166 ac (67 ha) of federal land (U.S. Navy) in the lowland dry ecosystem at Kalaeloa.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Schiedea kealiae* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Schiedea kealiae* occurs within the Coastal and Lowland dry ecosystems in the Waianae Mountain caldera complex:

Oahu—Coastal—Units 1, 13, 14, 15. (A) Elevation: <980 ft (<300 m). (B) Annual Precipitation: <20 in (<50 cm). (C) Substrate: Well-drained, calcareous, talus slopes; dunes; weathered clay soils; ephemeral pools; mudflats. (D) Canopy: Hibiscus, Myoporum, Santalum, Scaevola. (E) Subcanopy: Gossypium, Sida, Vitex. (F) Understory: Eragrostis, Jacquemontia, Lyceum, Nama, Sesuvium, Sporobolus, Vigna.

Oahu— Lowland Dry—Units 1, 2, 8, 9, 10, 11. (A) Elevation: <3,300 ft (<1,000 m). (B) Annual Precipitation: <50 in (<130 cm). (C) Substrate: Weathered silty loams to stony clay, rocky ledges, little weathered lava. (D) Canopy: Diospyros, Myoporum, Pleomele, Santalum, Sapindes. (E) Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. (F) Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Plumbago, Sicyos, Sida, Waltheria.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Schiedea kealiae* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats

will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual: cross-pollination, self-pollination (USFWS, 1998)

Lifespan

Adult: < 10 years (USFWS, 2013)

Breeding Season

Adult: December (USFWS, 1998)

Key Resources Needed for Breeding

Adult: Wind (USFWS, 2013)

Reproduction Narrative

Adult: The species is considered to be wind pollinated (S. Weller, University of California, Irvine, pers. comm. 2012). This species is a short-lived perennial (fewer than 10 years) (USFWS, 2013). It has been observed in flower in December. A series of self pollinations, within-population crosses, and crosses among occurrences has demonstrated that many related *Schiedea* species experience moderately strong inbreeding depression (USFWS, 1998).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Dry shrublands and forests (NatureServe, 2015); *Erythrina sandwicensis* or *Pisonia sandwicensis* forest (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: 200 - 1,000 ft. elevation (USFWS, 2010)

Habitat Narrative

Adult: Inhabits dry shrublands and forests on headlands, cliffs and cliff ledges not far from the coast (NatureServe, 2015). *Schiedea kealiae* is usually found on steep slopes and cliff faces at elevations from 60 to 305 meters (200 to 1,000 feet), in dry remnant *Erythrina sandwicensis* (wiliwili) or *Pisonia sandwicensis* (aalu, papala kepau, alaa) forest (USFWS, 2010).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Resiliency:

Very low (inferred from USFWS, 2003; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2003)

Number of Populations:

4 (USFWS, 2003)

Population Size:

265 - 315 (USFWS, 2003)

Population Narrative:

Currently, there are 4 occurrences totaling between 265 and 315 plants (USFWS, 2003).

Threats and Stressors

Stressor: Nonnative plants (USFWS, 2003)

Exposure:

Response:

Consequence:

Narrative: It is threatened by competition with the nonnative plant species *Leucaena leucocephala*, *Panicum maximum*, and *Schinus terebinthifolius* (USFWS, 2003).

Stressor: Climate change (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species (USFWS, 2013).

Stressor: Predation (USFWS, 2003)

Exposure:

Response:

Consequence:

Narrative: Seedlings of *Schiedea* species occurring in mesic or wet sites are apparently consumed by introduced unidentified slugs and snails, which have been observed feeding on *Schiedea membranacea*, a mesic forest species from Kauai (USFWS, 2010).

Stressor: Lack of pollinators (USFWS, 2003)

Exposure:

Response:

Consequence:

Narrative: Not available

Stressor: Small population size (USFWS, 2003)

Exposure:

Response:

Consequence:

Narrative: This species is at risk of extinction from naturally occurring events and/or reduced reproductive vigor due to the small number of existing occurrences. The Kaena Point occurrence is additionally threatened by naturally occurring rock slides and fire (HINHP Database 2001; Service 1998b; 61 FR 53089) (USFWS, 2003).

Stressor: Habitat destruction and modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Feral ungulates, especially goats (*Capra hircus*) and pigs (*Sus scrofa*), as well as fires and landslides (Perlman 2008) (USFWS, 2010).

Recovery

Reclassification Criteria:

1. A total of five to seven populations of the species should be documented on Oahu and at least one other island where it now occurs or occurred historically (USFWS, 1998).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1998).
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1998).

Delisting Criteria:

1. A total of 8 to 10 populations of the species should be documented on Oahu and at least one other island where it now occurs or occurred historically (USFWS, 1998).
2. Oahu and at least one other island where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1998).
3. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1998).

Recovery Actions:

- Protect habitat and control threats (USFWS, 1998).
- Expand existing wild populations (USFWS, 1998).
- Conduct essential research (USFWS, 1998).
- Develop and maintain monitoring plans (USFWS, 1998).

- Reestablish wild populations within historic range (USFWS, 1998).
- Validate and revise recovery criteria (USFWS, 1998).
- Control competing alien plant species (USFWS, 1998).
- Control of introduced snails and slugs (USFWS, 1998).
- Research on pollinators (USFWS, 1998).
- Reduce substrate loss (USFWS, 1998).
- Provide protection from fire (USFWS, 1998).

Conservation Measures and Best Management Practices:

- Captive propagation for genetic storage and reintroduction - Continue collecting material for genetic storage and propagation for reintroduction. Investigate new propagation methods (USFWS, 2013).
- Invertebrate control research - Investigate slug herbivory and appropriate insect control methods (USFWS, 2013).
- Ungulate exclosures - Fence remaining populations to protect them from the impacts of feral ungulates (USFWS, 2013).
- Ecosystem-altering invasive plant species control - Remove competing invasive introduced plant species within fenced areas and maintain those areas free of invasive introduced plants (USFWS, 2013).
- Fire protection – Develop and implement fire prevention plans to protect the most vulnerable populations (USFWS, 2013).
- Population biology research - Implement genetic studies to assess the viability of remaining populations. Investigate the causes of reproductive failure and techniques to improve natural recruitment (USFWS, 2013).
- Surveys / inventories – Survey geographical and historical range for a thorough current assessment of the species status (USFWS, 2013).
- Alliance and partnership development - Initiate planning and contribute to implementation of ecosystem level restoration and management to benefit this taxon (USFWS, 2013).
- Threats research – Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2013).

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USFWS 2013. Schiedea kealiae (ma oli oli) 5-Year Review Short Form Summary. Region 1/Pacific Islands Fish and Wildlife Office (PIFWO), Honolulu, Hawaii.

SPECIES ACCOUNT: *Schiedea laui* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (R1) (USFWS, 2017)

Physical Description

A short-lived perennial herb or subshrub (USFWS, 2016).

Taxonomy

A member of the pink family (Caryophyllaceae) (USFWS, 2016).

Historical Range

Discovered in Kamakou Preserve in 1998 (USFWS, 2016).

Current Range

Known only from Molokai (USFWS 2012). (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Schiedea laui* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Schiedea laui* includes three CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Molokai—Montane Wet—Unit 1 (and) *Palmeria dolei*—Unit 40—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 40— Montane Wet This area consists of 1,545 ac (625 ha) of State land, and 1,851 ac (749 ha) of privately owned land, from the headwaters of Waialeale Stream and above Pelekunu Valley, eastward along the summit area to Mapulehu, in northcentral Molokai. These units are occupied by the plants *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. profuga*, *Phyllostegia hispida*, and *Pteris lidgatei*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Montane Wet—Unit 1 is not known to be occupied by *Adenophorus periens*, *Cyanea procera*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Melicope reflexa*, *Phyllostegia mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their

small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 41—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 41—Montane Wet This area consists of 871 ac (353 ha) of State land, and 39 ac (16 ha) of privately owned land, from Honukaupu to Olokui (between Pelekunu and Wailau valleys), in north-central Molokai. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). Although Molokai—Montane Wet—Unit 2 is not known to be occupied by *Adenophorus periens*, *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. procera*, *C. profuga*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Melicope reflexa*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Pteris lidgatei*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 3 consists of 77 ac (31 ha) of State land, and 726 ac (294 ha) of privately owned land, above the east rim of Wailau Valley on eastern Molokai. This unit is occupied by the plant *Melicope reflexa*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Montane Wet—Unit 3 is not known to be occupied by *Adenophorus periens*, *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. procera*, *C. profuga*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Pteris lidgatei*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Schiedea laui* critical habitat consists of one component. Montane wet (Molokai) (81 FR 17790-18110):

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cooki*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant

species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: No information found.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cave/montane wet ecosystem (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (inferred from NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits a cave along a narrow stream corridor at the base of a waterfall in the montane wet ecosystem on Molokai (USFWS 2012). Clumped spatial arrangement of the population, narrow environmental specificity, low tolerance ranges and high site fidelity and ecological integrity of the community are inferred based on the species unique habitat requirements and the fact that there is only one known population (NatureServe, 2015).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: No information found.

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Very low (inferred from NatureServe, 2015)

Redundancy:

Very low (inferred from NatureServe, 2015)

Number of Populations:

1 (NatureServe, 2015)

Population Size:

24 - 34 (NatureServe, 2015)

Population Narrative:

There are 24 to 34 individuals known as of 2010 (Bakutis 2010 cited by USFWS 2012.). One location, a cave in Kamakou Preserve (Bakutis 2010 cited by USFWS 2012). (NatureServe, 2015) In 1998, when this species was first observed, there were 19 individuals located in a cave along a narrow stream corridor at the base of a waterfall in the Kamakou Preserve, in the montane wet ecosystem (Wagner et al. 2005b, pp. 90– 92). By 2000, only 9 individuals with a few immature plants and seedlings were relocated, and in 2006, 13 plants were seen (Wagner et al. 2005b, pp. 90–92; PEPP 2007, p. 57) (USFWS, 2016).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative plants, flooding, landslides, and hurricanes. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Flooding and landslides destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (rats, and slugs) is considered an ongoing threat to *Schiedea laui* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor: Small populations (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: *Schiedea laui* faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). The 24 to 34 individuals of *Schiedea laui* are facing imminent threats from flooding and landslides because of their location in a grotto (USFWS, 2013).

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Recovery**Recovery Actions:**

- There is no recovery plan for this species.

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species. Final rule. 81 FR 17789 - 18110 (March 30, 2016).

U.S. Fish and Wildlife Service. 2016. Endangered and Threatened Wildlife and Plants

Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

Final Rule . 81 FR 17790-18110 (March 30, 2016).

USFWS. 2013. Determination of Endangered Status for 38 Species on Molokai, Lanai, and Maui

Final Rule. 78 Federal Register 102, May 28, 2013. Pages 32014 - 32065.

SPECIES ACCOUNT: *Schiedea lydgatei* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/08/1992; Pacific Region (R1) (USFWS, 2017)

Physical Description

A subshrub with stems 1-4 dm long. Flowers are borne in terminal clusters. (NatureServe, 2015)

Taxonomy

Genus endemic to Hawaiian Islands, species endemic to eastern Molokai. (NatureServe, 2015) A member of the pink family (Caryophyllaceae) (USFWS, 2016).

Historical Range

Historically no additional range. (NatureServe, 2015)

Current Range

Current range includes Eastern Molokai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Schiedea lydgatei* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one detailed critical habitat unit (CHU), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Schiedea lydgatei* includes one CHU in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Molokai—Lowland Mesic—Unit 1 (and) Palmeria dolei—Unit 37—Lowland Mesic (and) Pseudonestor xanthophrys—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Ctenitis squamigera*, *Cyanea dunbariae*, *C. mannii*, *C. profuga*, *Cyperus fauriei*, *Cyrtandra filipes*, *Gouania hillebrandii*, *Labordia triflora*, *Neraudia sericea*, *Santalum haleakalae* var. *lanaiense*, *Schiedea lydgatei*, *S. sarmentosa*, *Silene alexandri*, *S. lanceolata*, *Spermolepis hawaiiensis*, and *Zanthoxylum hawaiiense*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Mesic—Unit 1 is not known to be occupied by *Asplenium dielirectum*, *Bonamia menziesii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea procera*, *C. solanacea*, *Diplazium molokaiense*, *Festuca molokaiensis*, *Flueggea neowawraea*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Melicope mucronulata*, *M. munroi*, *M. reflexa*, *Phyllostegia haliakalae*, *P. mannii*, *P. pilosa*, *Sesbania*

tomentosa, *Stenogyne bifida*, or *Vigna o-wahuensis*, or the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Schiedea lydgatei* critical habitat consists of one component. Lowland mesic (Molokai) (81 FR 17790-18110):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further

degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkii*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources**Reproductive Strategy**

Adult: Wind and moth pollinated; sexual: cross-pollination, self-pollination (USFWS, 2011)

Breeding Season

Adult: This species was observed with flowers and fruit in June 1990 (HHP 1990g) (USFWS, 1995).

Reproduction Narrative

Adult: *Schiedea lydgatei* has a hermaphroditic breeding system, which is rare among dry habitat adapted *Schiedea* species (Weller and Sakai 2010). A study of outcrossing and pollination biology on the maintenance of hermaphroditism in *S. lydgatei* found that both wind and native moths in the family Pyralidae are responsible for its pollination. Outcrossing rates were generally high, especially in years when many plants flowered during the same time period. High outcrossing rates and substantial inbreeding depression indicated that at present females would not be favored in the population. Pollination by both wind and insects is consistent with the hypothesis that hermaphroditism is the result of a relatively recent reversal, as the ancestor of *S. lydgatei* was probably wind pollinated and gynodioecious, with few females. A shift from wind to predominately insect pollination on Molokai may have resulted in increased outcrossing rates and prevented the expression of high inbreeding depression among progeny of hermaphrodites, a condition that would select against females and favor a reversal to hermaphroditism. Because few females were likely to have been present in ancestral populations that colonized Molokai, the founder effect is another potential explanation for loss of females. In either case, current high levels of outcrossing prevent re-establishment of females in populations of *S. lydgatei* (Norman et al. 1997) (USFWS, 2011). This species was observed with flowers and fruit in June 1990 (HHP 1990g). Currently, no additional life history information is available (USFWS, 1996).

Habitat Type

Adult: Dry to mesic grasslands, shrublands, and forests (USFWS, 1996)

Spatial Arrangements of the Population

Adult: Clumped (inferred from USFWS, 1996)

Environmental Specificity

Adult: Narrow/specialist (inferred from USFWS, 1996)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1996)

Site Fidelity

Adult: High (inferred from USFWS, 1996)

Habitat Narrative

Adult: Species inhabits dry to moist shrublands and forests. Ridgetops and gulch slopes. (NatureServe, 2015). This species is found along ridges and on cattle trails in dry to mesic grasslands, shrublands, and forests with scattered native and alien trees. It ranges in elevation

from about 600 to 650 meters (2,000 to 2,100 feet). Associated plant species include aalii, ohia, pukiawe, and uluhe (USEWS 1992) (USFWS, 1996). As of 2010, there are at least 200 individuals in 5 populations located between Kawela and Malolelau Gulch on Molokai (Oppenheimer 2010a) (USFWS, 2011). Clumped spatial arrangement of the population, narrow environmental specificity, low tolerance ranges and high site fidelity and ecological integrity of the community are inferred based on the species unique habitat requirements and the low number of known populations.

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Decreasing (USFWS, 2011)

Resiliency:

Low (inferred from USFWS, 2011)

Representation:

Low (inferred from USFWS, 2011)

Redundancy:

Low (inferred from USFWS, 2016)

Number of Populations:

2 (USFWS, 2018)

Population Size:

> 1000 (USFWS, 2018)

Population Narrative:

New Status Information: • There are two populations (Kawela and Kūpā'ia) on Moloka'i estimated to total more than 1,000 individuals combined (Bakutis 2018, in litt.). • Visits to the Kawela population in 2018 documented suspected hybrids between *Schiedea lydgatei* and *S. sarmentosa* (Weisenberger 2018, in litt.). • In 2016, one critical habitat unit in the lowland mesic ecosystem was designated on Moloka'i for *Schiedea lydgatei* (8,770 ac; 3,549 ha) (81 FR 17790, March 30, 2016) (USFWS, 2018).

Threats and Stressors

Stressor: Fire (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Fire is listed as a threat to this species (USFWS, 2011)

Stressor: Feral goats, rats and slugs

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Feral goats are a threat based both in terms of habitat modification and herbivory. Slugs and rats are a threat due to herbivory (USFWS, 2011).

Stressor: Invasive plants (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Introduced invasive plant species are also a threat to *Schiedea lydgatei* because they compete with the species for water, light, and nutrients (USFWS, 2011).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: We previously reported that climate change may pose a threat to this species, anticipating an analysis by 2013. The assessment conducted by Fortini et al. (2013) concluded that *S. lydgatei* is extremely vulnerable to the impacts of climate change, with a vulnerability score of 0.983 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, *S. lydgatei* is one of the most vulnerable native Hawaiian plant species that has a projected future climate envelope. Therefore, additional management actions are needed to conserve this taxon into the future, such as locating key microsites that overlap with current and future climate envelopes for outplanting efforts (USFWS, 2018).

Recovery

Reclassification Criteria:

For downlisting, a total of five to seven populations of each taxon should be documented on Molokai and at least one other island where they now occur or occurred historically. In certain cases, however, a particular taxon may be eligible for downlisting even if all five to seven of the populations are on only one island, provided all of the other recovery criteria have been met and the populations in question are widely distributed and secure enough that one might reasonably conclude that the taxon is not in danger of extinction throughout all or a significant part of its range. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1996).

Delisting Criteria:

For taxa other than *Tetramolopium rockii*, the following delisting criteria are recommended. A total of 8 to 10 populations of each taxon should be documented on Molokai and at least 1 other island where they now occur or occurred historically. As with downlisting, there may be cases in which a particular taxon may be eligible for delisting even if all 8 to 10 of the populations are on

only 1 island, provided all of the other recovery criteria have been met and the populations in question are widely distributed and secure enough that one might reasonably conclude that the taxon is not likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1996).

Recovery Actions:

- U.S. Fish and Wildlife Service. 1996. Recovery Plan for the Molokai Plant Cluster. U.S. Fish and Wildlife Service, Portland, OR. 143 pp (USFWS, 1996).

Conservation Measures and Best Management Practices:

- Survey areas where *Schiedea lydgatei* have been reported to establish current status of the species (USFWS, 2011).
- Monitor known populations and continue collection of seeds or cuttings for genetic storage and reintroduction (USFWS, 2011).
- Research methods to increase and maintain numbers of female individuals within populations (USFWS, 2011).
- Completely fence existing populations to provide protection from the negative impacts of feral ungulates (USFWS, 2011).
- Control invasive introduced plant species around known populations (USFWS, 2011).
- Control rats in the vicinity of these populations (USFWS, 2011).
- Develop and implement methods to control introduced slugs (USFWS, 2011).
- Propagate to augment the existing populations (USFWS, 2011).
- Establish additional populations within protected suitable habitat (USFWS, 2011).
- Develop and implement a wildfire management plan (USFWS, 2011).
- Work with East Molokai Watershed Partnership Program, Hawaii Division of Forestry and Wildlife, and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2011).
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2011).
- New Management Actions:
 - Captive propagation for genetic storage and reintroduction—In 2014, the University of California—Irvine reported 10 plants from Mākolēlau in storage, representing 10 different individuals (USFWS, 2018).
- Recommendations for Future Actions: Hybridization may be a new threat to this species; however, we are not aware of any significant new information regarding the species' biological status since the last 5-year review in 2011. Thus, the following recommendations for future actions are added or reiterated for the 5-year review for 2018.
 - Surveys and inventories—Survey areas where *Schiedea lydgatei* has been reported to determine current status of the species on Molokaʻi.
 - Ungulate monitoring and control—Fence existing populations to provide protection from negative impacts of feral ungulates.
 - Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations of *S. lydgatei*.
 - Fire destruction or degradation of habitat—Develop and implement a wildfire management plan.
 - Captive propagation for genetic storage and reintroduction—Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range.

Reintroduction and translocation— o Augment known populations and reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. o Research methods to increase and maintain numbers of female individuals within populations. o Study the possible effects of hybridization on this species. • Rodent predation and herbivory— Control rats in the vicinity of all populations. • Invertebrate predation and herbivory—Develop and implement methods to control slugs. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for the recovery of the species. • Alliance and partnership development—Work with the East Molokaʻi Watershed Partnership program, the Hawaiʻi Division of Forestry and Wildlife, and other land managers to initiate planning and contribute to ecosystem-level restoration and management to benefit this species (USFWS, 2018).

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SPECIES ACCOUNT: *Schiedea membranacea* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

A perennial herb that dies back to a woody caudex in the dry season. Stems are 5-10 dm long, and apparently unbranched. The small flowers are borne in terminal clusters. (NatureServe, 2015)

Taxonomy

Endemic genus of 22 species, species endemic to NW Kauai. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Endemic to northwest Kauai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Schiedea membranacea* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Schiedea membranacea* includes four units totaling 3,311 acres in Kauai County, Hawaii. The units are Kauai 11—*Schiedea membranacea*—a, b, c, d.

Kauai 11—*Schiedea membranacea*—a: This unit is critical habitat for *Schiedea membranacea* and is 251 ha (620 ac) on State land (Alakai Wilderness Preserve) within the Koaie Canyon. This unit provides habitat for two populations of 300 mature, reproducing individuals of the shortlived perennial *Schiedea membranacea* and is currently occupied with 6 to 10 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, cliffs or cliff bases of mesic or wet habitats, in lowland or montane shrubland, or forest communities dominated by *Acacia koa*, *Pipturus* spp. and *Metrosideros polymorpha* or *Urticaceae* shrubland on talus slopes. This unit is geographically separated from the other three units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Schiedea membranacea*—b: This unit is critical habitat for *Schiedea membranacea* and is 234 ha (580 ac) on State land (Kokee and Na Pali Coast State Parks). This unit contains Kalahu and Puu o Kila Summits and Kalalu Lookout. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial

Schiedea membranacea and is currently occupied with 24 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, cliffs or cliff bases of mesic or wet habitats, in lowland or montane shrubland, or forest communities dominated by *Acacia koa*, *Pipturus* spp. and *Metrosideros polymorpha* or *Urticaceae* shrubland on talus slopes. This unit is geographically separated from the other three units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Schiedea membranacea*—c: This unit is critical habitat for *Schiedea membranacea* and is 528 ha (1,303 ac) on State land (Kuia NAR and Puu Ka Pele Forest Reserve). This unit contains portions of Kuia and Mahanaloa Valleys and Milolii Ridge. This unit provides habitat for three populations of 300 mature, reproducing individuals of the short-lived perennial *Schiedea membranacea* and is currently occupied with 266 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, cliffs or cliff bases of mesic or wet habitats, in lowland or montane shrubland, or forest communities dominated by *Acacia koa*, *Pipturus* spp. and *Metrosideros polymorpha* or *Urticaceae* shrubland on talus slopes. This unit is geographically separated from the other three units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Schiedea membranacea*—d: This unit is critical habitat for *Schiedea membranacea* and is 327 ha (810 ac) on State land (Kuia NAR and Kokee State Park). This unit contains portions of Awaawapuhi and Honopu Trails and Kainamau Summit. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Schiedea membranacea* and is currently occupied with eight plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, cliffs or cliff bases of mesic or wet habitats, in lowland or montane shrubland, or forest communities dominated by *Acacia koa*, *Pipturus* spp. and *Metrosideros polymorpha* or *Urticaceae* shrubland on talus slopes. This unit is geographically separated from the other three units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

- (i) Cliffs or cliff bases in mesic or wet habitats in lowland or montane shrubland or forest communities dominated by *Acacia koa*, *Pipturus* spp. and *Metrosideros polymorpha* or *Urticaceae* shrubland on talus slopes and containing one or more of the following associated native plant species: *Alphitonia ponderosa*, *Alyxia oliviformis*, *Asplenium* spp., *Athyrium sandwicensis*, *Bobea brevipes*, *Boehmeria grandis*, *Cyrtandra* spp., *Diplazium sandwichianum*, *Dodonaea viscosa*, *Eragrostis variabilis*, *Hedyotis terminalis*, *Hibiscus waimeae*, *Joinvillea ascendens* ssp. *ascendens*, *Labordia helleri*, *Lepidium serra*, *Lysimachia kalalauensis*, *Machaerina*

angustifolia, Mariscus pennatifolius, Melicope spp., Myrsine spp., Perrottetia sandwicensis, Pisonia spp., Pleomele aurea, Poa mannii, Poa sandwicensis, Pouteria sandwicensis, Psychotria spp., Psydrax odorata, Remya kauaiensis, Sadleria cyatheoides, Scaevola procera, Thelypteris cyatheoides, Thelypteris sandwicensis, or Touchardia latifolia; and

(ii) Elevations between 423 and 1,259 m (1,386 and 4,131 ft).

Special Management Considerations or Protections

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species in paragraph (b) of this section and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Outcrossing (USFWS, 2010)

Reproduction Narrative

Adult: Schiedea membranacea has been determined to be strongly outcrossing, with a high level of inbreeding depression (Culley et al. 1999). For this reason, the lack of observed pollinators is a serious concern (USFWS, 2010). Schiedea membranacea appears to be a long-lived perennial. Plants marked in Mahanaloa Gulch in 1987 were alive in 1997, despite Hurricane Iniki. There was no evidence of recruitment in the population, despite the production of abundant seed during all years of observation (1987, 1994-1997). Schiedea membranacea is extremely diverse at allozyme loci, based on observations of plants from Mahanaloa Gulch (mean number of alleles per locus+3.00; percentage of polymorphic loci=66.7; mean heterozygosity=0.366). As

expected for a genetically diverse species, inbreeding depression is very high. In an artificial crossing program, the relative inbreeding depression averaged over 11 maternal parents was 0.73, suggesting that very few selfed progeny would survive to adulthood if germination were successful. Under current conditions of pollination, *Schiedea membranacea* is largely outcrossed, based on outcrossing rates of 0.925 in 1993 and 0.749 in 1994. Pollinators for *Schiedea membranacea* are unknown. No visitors have been seen during the daytime, and none were observed during one set of night observations (Steve Weller, University of California at Irvine, personal communication 1997) (USFWS, 1998).

Habitat Type

Adult: Moist and wet forest (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (inferred from USFWS, 1998)

Environmental Specificity

Adult: Narrow/specialist (inferred from USFWS, 1998)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1998)

Site Fidelity

Adult: High (inferred from USFWS, 1998)

Habitat Narrative

Adult: Moist and wet forests in gulch bottoms. (NatureServe, 2015). This species is typically found on cliffs and cliff bases in a wide variety of mesic to wet habitats between 520 and 1,160 meters (1,700 and 3,800 feet) elevation. The vegetation ranges from open to closed lowland to montane shrubland to forest communities with either a variety of canopy and understory species or dominated by kukui, mamaki, or ohia (USFWS 1996) (USFWS, 1998). Clumped spatial arrangement of the population, narrow environmental specificity, low tolerance ranges and high site fidelity and ecological integrity of the community are inferred based on the species unique habitat requirements and the low number of known populations.

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Decreasing (USFWS, 2010)

Number of Populations:

5 (USFWS, 2017)

Population Size:

84 individuals (USFWS, 2017)

Population Narrative:

New Status Information: In addition to those populations cited in the previous 5-year review, new observations include the following: • At the time of the last 5-year review in 2010 there were 5 populations totaling fewer than 90 individuals at Awaawapuhi, Kalalau, Koaie canyon, Kuia, Mahanaloa, Nualolo, Paaiki, Waialae, and Wainiha on Kauai. The status of populations at Waialae, Paaiki, Nualolo, and Koaie canyon has not been reported since 2010. Recent surveys have confirmed individuals at Kalalau (1), Kuia (5), Wainiha (55), Awaawapuhi (3), and Mahanaloa (20) (NTBG 2009, 2014, 2015a-g, 2016; PEPP 2010, 2011, 2013, 2014, 2015). Individuals were rediscovered at Wainiha, where *Schiedea membranacea* was last observed 20 years ago (PEPP 2015). There are 2 occurrences, one of about 35 individuals and another of about 20 individuals at this location (PEPP 2015). • These populations total 5 small occurrences with 84 individuals. In 2016, the IUCN Red List of Threatened Species reported 4 subpopulations totaling 45 individuals, most of which are at Mahanaloa (Clark 2016). It is uncertain why there is a discrepancy in estimates, as it appears the Wainiha population, which had been considered the largest population in the past, may have not been included in the assessment, or may have recently suffered a drastic population decline (USFWS, 2017).

Threats and Stressors

Stressor: Feral goats and pigs (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Threats to this species throughout its range include habitat degradation and herbivory by feral goats (*Capra hircus*) and pigs (*Sus scrofa*) (USFWS, 2010).

Stressor: Invasive plants (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Competition with invasive introduced plants is listed as a threat to this species (USFWS, 2010).

Stressor: Snails (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Various species of introduced snails have been observed feeding on flowers and developing seed capsules, and introduced garlic snails (*Oxychilus alliarius*) are common near the individuals (USFWS, 2010).

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Climate change may also pose a threat to *Schiedea membranacea* (Factors A and E). However, current climate change models do not allow us to predict specifically what those effects, and their extent, would be for this species (USFWS, 2010).

Stressor: Ungulate degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Mule (black-tailed) deer (*Odocoileus hemionus*) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil (Loope 1998; van Riper and van Riper 1982). Mule deer and evidence of their activities have been observed at Kuia and Awaawapuhi where *Schiedea membranacea* occurs (NTBG 2014, 2015g) (USFWS, 2017).

Stressor: Landslides and flooding destruction or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: *Schiedea membranacea* occurs on steep cliffs that are subject to landslides that can destroy individual plants and populations (NTBG 2015b-d). Landslides destabilize substrates, damage and destroy individual plants, and alter hydrological patterns (Stearns 1985). Habitat disturbance by feral goats can lead to landslides (USFWS, 2017).

Stressor: Erosion degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Erosion due to natural weathering and also resulting from activities of feral goats and deer destabilizes the habitat of *Schiedea membranacea* and can destroy individual plants and populations (PEPP 2010, 2011, 2013, 2014). • Drought degradation of habitat—Drought affects plants directly by desiccation and leads to an increase in the number of forest and brush fires (Giambelluca et al. 1991), causing a reduction of native plant cover and habitat (D’Antonio and Vitousek 1992). Drought is reported to be a threat to populations of *Schiedea membranacea* at Mahanaloa and Kuia (PEPP 2013, 2014) (USFWS, 2017)

Stressor: Hurricanes—Loss and degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Hurricanes were omitted in the last five year review. In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event, and 70 percent of all listed plant species on Kauai are only found on Kauai. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et

al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013) (USFWS, 2017).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Schiedea membranacea* is vulnerable to the impacts of climate change, with a vulnerability score of 0.458 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, Fortini et al. show that Caryophyllaceae is one of the top four most vulnerable native plant families, and, at the genus level, *Schiedea* had one of the highest vulnerability scores. Therefore, additional management actions are needed to conserve this taxon into the future. • Ungulate predation or herbivory—Herbivory by deer is an additional threat to *Schiedea membranacea* (NTBG 2014, 2015g) (USFWS, 2017).

Stressor: Rodent predation or herbivory

Exposure:

Response:

Consequence:

Narrative: Herbivory by rats is noted to be a threat to *Schiedea membranacea* at the Wainiha, Awaawapuhi, and Kuia population (HBMP 2010; NTBG 2015). Rats eat virtually every part of plants and at every stage: fleshy fruits, seeds, flowers, stems, leaves, shoot, seedlings, and roots (Russell 1980; Cuddihy and Stone 1990). The effects on plants range from reduced vigor and decreased reproduction to mortality of individuals and complete lack of recruitment (NTBG 2009, 2014, 2015b-d, g, 2016; PEPP 2015) (USFWS, 2017).

Stressor: Herbivory by slugs

Exposure:

Response:

Consequence:

Narrative: Herbivory by slugs has been reported as a threat to this species (NTBG 2009, 2015a, e-f) (USFWS, 2017).

Stressor: Human disturbance

Exposure:

Response:

Consequence:

Narrative: Hiking and trail maintenance impacts—Trampling of plants has been reported as a threat to this species (2015e) (USFWS, 2017).

Stressor: Stochastic events

Exposure:

Response:**Consequence:**

Narrative: Reduced viability due to low numbers—*Schiedea membranacea* has been determined to be strongly outcrossing, with a high level of inbreeding depression (Culley et al. 1999).

Pollinators of *S. membranacea* may be native moths in the Pyralid family, similar to those observed on *S. lydgatei* (Norman et al. 1997), but this has not been confirmed by observations (USFWS, 2017).

Recovery**Reclassification Criteria:**

For downlisting, a total of five to seven populations of each taxon should be documented on Kauai and at least one other island where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 1995).

Delisting Criteria:

For delisting, a total of 8 to 10 populations of each taxon should be documented on Kauai and at least one other island where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of five consecutive years (USFWS, 1995).

Conservation Measures and Best Management Practices:

- Continue collecting seeds from all individuals for genetic storage and reintroduction (USFWS, 1995).
- Construct exclosures around existing populations to protect from negative impacts from feral ungulates (USFWS, 2010).
- Propagate material for augmentation of existing populations and reintroductions, as suitable protected sites become available (USFWS, 2010).
- Conduct surveys, particularly in areas where *Schiedea membranacea* has not been observed since the 1990s, which include Paaiki, Nualolo, Koaie, Makaha, Waialae Ridge, and Awaawapuhi (USFWS, 2010).
- Research the presence of a seed bank (USFWS, 2010).
- Research the cause of low recruitment in the natural populations (USFWS, 2010).
- Determine the species and abundance of pollinators (USFWS, 2010).
- Work with Hawaii Division of Forestry and Wildlife, especially in Kuia and Mahanaloa, and Hawaii State Parks to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2010).
- New Management Actions: • NTBG has collected hundreds of seeds of *Schiedea membranacea* from populations for storage and propagation. Five founders from Wainiha are represented in the seed bank. There are also three separate collections from the Mahanaloa population. There are plants from several different founders from Mahanaloa (NTBG 2017). • The University of California, Irvine has seven founders from Mahanaloa represented in their greenhouse, and 24 plants from five

founders at Wainiha (UCI 2017). • PEPP has been collecting seeds for collections at NTBG and DOFAW nurseries (PEPP 2011, 2014). • PEPP is monitoring populations at Mahanaloa, Kuia, and Wainiha (PEPP 2010, 2011, 2013, 2014, 2015) (USFWS, 2017).

- Recommendations for Future Actions: Mule (black-tailed) deer have been reported as a threat to the habitat and to individuals of *Schiedea membranacea*, as well as herbivory by rats and slugs. In addition, drought, landslides, erosion, and human trampling have been reported as threats to this species. With fewer than 90 individuals, and no single populations of more than 55 individuals of this facultative outcrosser, inbreeding depression is a potential threat. No other significant new information regarding the species' biological status has been reported since the last 5-year review in 2010. Therefore, the following recommendations for future actions are added or reiterated for the 5-year review for 2017. • Surveys and inventories—Conduct surveys, particularly in areas where *Schiedea membranacea* has not been observed since the 1990s, which include Paaiki, Nualolo, Koaie, Makaha, and Waialae Ridge. • Ungulate monitoring and control—Construct small-scale exclosures around existing populations to protect from negative impacts from feral ungulates to prevent imminent extinction. Protect all occurrences against disturbances from feral ungulates. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative species that compete with the species around all populations. • Predator and herbivore monitoring and control— o Determine and implement effective control methods for slugs. o Implement effective control methods for nonnative snails. o Implement effective control methods for rodents. • Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Human interaction monitoring and management—Develop and implement effective measures to reduce the impact of collecting, hiking, and trail maintenance. • Population biology research—Study *Schiedea membranacea* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered throughout historic range to reduce impacts from low numbers of individuals.

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SPECIES ACCOUNT: *Schiedea nuttallii* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

Schiedea nuttallii is a short-lived perennial of the Caryophyllaceae (pink family). It is an erect subshrub (stems woody at the base) up to 1.5 m (4.9 ft) tall with purple-tinged, oppositely-arranged leaves 5 to 13 cm (2.0 to 5.1 in) long. The small, perfect flowers (with both male and female reproductive parts) are borne in terminal clusters 20 to 25 cm (7.8 to 9.8 in) long. The tiny hard, black seeds are contained within small papery capsules 2.5 to 3.5 mm (0.1 to 0.14 in) long (Wagner et al 1999; Makua Implementation Team 2003) (USFWS, 2016).

Historical Range

Historic data indicate considerable range restriction in *Schiedea nuttallii*, which was one of the most widely distributed species in the genus with documented occurrences on Oahu, Molokai (recently extirpated), and West Maui (historical) (Wagner et al 2005). On Oahu, *S. nuttallii* was recorded from scattered occurrences throughout the Waianae Mountains and the southeastern Koolau Mountains (USFWS, 2016).

Current Range

The species is now restricted to the northern Waianae Mountains; plants in the southern Waianae Mountains have not been seen since the late 1970s (Makua Implementation Team 2003). Plants are located on Federal and State lands (68 FR 35950). The Ekahanui Gulch occurrence at the privately owned Honouliuli Preserve, which was noted when the species was listed, has not been seen since 1978 (Service 1999a) (USFWS, 2016).

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Schiedea nuttallii* under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Schiedea nuttallii* (77 FR 57648-57862). The critical habitat designation includes 7 critical habitat units, which encompass approximately 7,823 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Schiedea nuttallii* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Schiedea nuttallii* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Schiedea nuttallii* includes 7 critical habitat units, covering one ecosystem type, which encompasses approximately 7,823 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

The critical habitat designation for *Schiedea nuttallii* includes one unit totaling 697 acres in Kauai County, Hawaii. The unit is Kauai 7—*Schiedea nuttallii*—a.

Kauai 7—*Schiedea nuttallii*—a: This unit is critical habitat for *Schiedea nuttallii* and is 282 ha (698 ac) on private land. This unit contains Hauapu and Naluakeina Summits and Queen Victoria's Profile. This unit provides habitat for two populations of 100 mature, reproducing individuals of the long-lived perennial *Schiedea nuttallii* and is currently occupied with ten to 50 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. It provides habitat for the westernmost range of the species that is unique to Kauai. The habitat features contained in this unit that are essential for this species include, but are not limited to, cliffs in lowland diverse mesic forest dominated by *Metrosideros polymorpha*. This unit provides for two populations within this multi-island species' historical range on Kauai that are some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Schiedea nuttallii* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Schiedea nuttallii*

occurs within the indicated ecosystem in the Waianae Mountain caldera complex and was known historically (last observed > 20 yrs ago) from indicated ecosystem in the Koolau Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (F) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Within this unit, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

- (i) Cliffs in lowland diverse mesic forest dominated by *Metrosideros polymorpha* and containing one or more of the following associated native plant species: *Antidesma platyphyllum* var. *hillebrandii*, *Bidens valida*, *Chamaesyce celastroides*, *Eragrostis variabilis*, *Hedyotis acuminata*, *Hedyotis fluvialis*, *Heteropogon contortus*, *Lepidium* spp., *Lobelia niihauensis*, *Psychotria* spp., *Perrottetia sandwicensis*, or *Pisonia* spp.; and
- (ii) Elevations between 127 and 702 m (418 and 2,303 ft).

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Schiedea nuttallii* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (USFWS, 2016)

Lifespan

Adult: <10 years (USFWS, 2016)

Breeding Season

Adult: Flowers and fruits are abundant in the wet season and less so throughout the year (USFWS, 2016).

Reproduction Narrative

Adult: Flowers and fruits are abundant in the wet season and less so throughout the year. *Schiedea nuttallii* is an outcrossing species that requires pollinators, probably insects, for fruit production (Wagner et al 2005). Plant longevity probably is similar to that of other small, semi-woody shrubs that live less than 10 years (i.e., short-lived perennials) (Makua Implementation Team 2003). Other demographic information for *S. nuttallii* in the wild is unknown, including longevity, number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, timing of reproductive output, pollination and seed dispersal in the wild, vegetative reproduction in the wild, and specific environmental requirements (USFWS, 2016).

Habitat Type

Adult: Rock walls/forest slopes (USFWS, 2016)

Habitat Narrative

Adult: *Schiedea nuttallii* occurs in the understory of diverse mesic forest at elevations between 400 and 730 m (1,312 and 2,395 ft). It typically grows on steep rock walls and forested slopes of north-facing gulches in *Acacia koa*-*Metrosideros polymorpha* lowland mesic forest and *Metrosideros polymorpha*-*Dodonaea viscosa* forest (68 FR 35950) (USFWS, 2016).

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Increasing (USFWS, 2016)

Number of Populations:

2 (USFWS, 2016)

Population Size:

91 (USFWS, 2016)

Population Narrative:

Currently, this species consists of only two known population units totaling 94 individuals (Table SB 35). The Kahanahaiki portion of the Kahanahaiki to Pahole population unit is located on Makua. The Pahole portion of the Kahanahaiki to Pahole population unit and the Kapuna-Keawapilau Ridge population unit are located in Pahole Natural Area Reserve. The Kahanahaiki to Pahole population unit currently contains 80 mature individuals, and may meet the numerical criterion for stability (defined as 50 mature, reproducing individuals for short-lived perennials). This population unit increased from about 48 total individuals in 2003 to 91 total individuals in

2006, primarily owing to Army augmentation efforts (Makua Implementation Team 2003, U.S. Army Garrison 2006d). About 50 percent of all currently existing individuals are augmentations from greenhouse-propagated stock, including about 52 percent of all mature individuals and 36 percent of all immature individuals. The Kahanahaiki to Pahole population unit is located within low to very low zones at risk from training-related wildfire (USFWS, 2016).

Threats and Stressors

Stressor: Non-native slugs and snails (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: *Schiedea nuttallii* is particularly vulnerable to predation by non-native slugs and snails. Seedlings have been observed in wild populations, but recruitment is reduced because of these alien invertebrates. Augmented *S. nuttallii* individuals seem to survive the initial outplanting transition but are subsequently weakened by invertebrate injury (Makua Implementation Team 2003). One study noted, for example, that seedling mortality for the related species *S. obovata* doubled when exposed to slug herbivory (U.S. Army Garrison 2005b) (USFWS, 2016).

Stressor: Black twig borer (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: This species also may be threatened by the black twig borer *Xylosandrus compactus*, which causes slight to severe defoliation and reduced plant vigor that may kill branches or the entire plant (68 FR 35950; U.S. Army Garrison 2004a). Black twig borer predation would be of particular concern for *S. nuttallii* because no control methods are available that do not also harm native scolytid beetles (USFWS, 2016).

Stressor: Fire (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Regarding fire vulnerability, *S. nuttalli* is a small, understory herbaceous plant less than 1.5 m (4.9 ft) tall with stems that are woody only at the base. Whether *S. nuttallii* resprouts or regenerates from buried seeds after fire is unknown, but it is probably similar to most native Hawaiian plants in lack of resistance or tolerance to fire (USFWS, 2016).

Stressor: Stochastic events/reduced vegetative vigor (USFWS, 2016)

Exposure:

Response:

Consequence: Extinction

Narrative: Most importantly, occurrences of *Schiedea nuttallii* are vulnerable to extirpation from naturally occurring events such as landslides and/or reduced reproductive vigor due to small population size and limited distribution (61 FR 53108; 68 FR 35950; Service 1999a) (USFWS, 2016).

Stressor: Low isozyme variability (USFWS, 2016)

Exposure:**Response:****Consequence:** Extinction

Narrative: *S. nuttallii* and the related species *S. kaalae* and *S. pentandra* are characterized by low isozyme variability and inbreeding due to small population size (Wagner et al 2005). Reductions in population size could result in expression of inbreeding depression among progeny, for example in reduced reproductive vigor, with potentially deleterious consequences for the long-term persistence of this species. The science of conservation biology has documented a general pattern of population collapse for a wide range of plant and animal species (Dennis et al 1991; Schemske et al 1994; Morris et al 1999; Menges 2000). According to this pattern, *S. nuttallii* already is in a phase of “quasi-extinction” with numbers that have declined to the point where demographic stochasticity alone can result in extirpation. Thus, *S. nuttallii* has a very high background risk of species extinction and any additional threats could eliminate expectation of its long-term persistence (USFWS, 2016).

Recovery**Delisting Criteria:**

Conservation actions that should be implemented for the recovery of *Schiedea nuttallii* are described in the introduction to the “Status and Environmental Baseline of the Species and Critical Habitat” section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1999a). Research on slug control in forest settings is needed to find ways to reduce invertebrate threats to *S. nuttallii* and associated native plants.

Conservation Measures and Best Management Practices:

- The Makua Implementation Team (2003) has developed stabilization protocols for *Schiedea nuttallii*, which are incorporated in the Army’s Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). The Army has been augmenting occurrences in the Kahanahaiki and Pahole population unit since 2003. In addition, this species is located in occurrences over three management units where it will benefit from population unit and/or ecosystem-level protection. The management units include Upper Kapuna, which is not fenced; and Kahanahaiki and Pahole, which are fenced. *Schiedea nuttallii* has been successfully propagated by tissue culture from seed, and from cuttings. The germination rate of fresh seed is about 50 percent, and the success rate of cuttings is 10 to 50 percent. Seed can be stored with little or no decrease in viability, but germination trials have not yet been conducted because so few plants are available to provide material (U.S. Army Garrison 2005b). Both remaining population units, Kahanahaiki to Pahole and Kapuna-Keawapilau Ridge, are represented in ex situ collections (U.S. Army Garrison 2005b). In 2005, these ex situ collections included 108 cuttings in nurseries (Army Environmental Division, Oahu, and Harold L. Lyon Arboretum), 54 ungerminated seeds in a nursery (Harold L. Lyon Arboretum), 1,300 seeds in seed storage (Lyon Arboretum Seed Storage Facility), and 20 seedlings in a nursery (Harold L. Lyon Arboretum) (Service 2005b).

References

USFWS. 2016. Status of the Species and Critical Habitat: *Schiedea nuttallii* (No Common Name). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016

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SPECIES ACCOUNT: *Schiedea obovata* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

A subshrub 3-10 dm tall, with somewhat fleshy leaves, and congested clusters of 7-12 white and green flowers. (NatureServe, 2015)

Historical Range

Historically, this species was known from the northern and southern parts of the Waianae Mountains (USFWS, 2016)

Current Range

Endemic to Waianae Mountains of Oahu (NatureServe, 2015).

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Schiedea obovata* under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Schiedea obovata* (77 FR 57648-57862). The critical habitat designation includes 11 critical habitat units, which encompass approximately 7,332 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Schiedea obovata* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Schiedea obovata* includes 11 critical habitat units, covering two ecosystem types, which encompass approximately 7,332 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3; Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac(105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Schiedea obovata* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Schiedea obovata* occurs within the Lowland mesic and Dry cliff ecosystems in the Waianae Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (F) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. (F) Understory: Bidens, Eragrostis, Melanthera, *Schiedea*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Schiedea obovata* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats

will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Self-fertilizing (USFWS, 2016)

Lifespan

Adult: 3-6 years (USFWS, 2016)

Breeding Season

Adult: Flowers and fruit are produced year-round, especially in response to rainfall during winter and spring (USFWS, 2016).

Reproduction Narrative

Adult: Plants generally flower after two years of growth, and are normally self-fertilizing (Makua Implementation Team 2003). Flowers and fruit are produced year-round, especially in response to rainfall during winter and spring. Seed dispersal mechanism is unknown, although the plant's "false berry" possibly may attract fruit-eating birds that may disperse the seeds (Makua Implementation Team 2003). Plants survive 3 to 6 years, or less under drought conditions (Service 1995a, Service 1998a). Population units in the wild have been known to disappear for a number of years and then reappear after large rainfall events, apparently owing to persistence of seeds in the soil seed bank (U.S. Army Garrison 2004a). Other demographic information for *S. obovata* in the wild is unknown, including number of seeds produced, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, seed dispersal, vegetative reproduction and specific environmental requirements (USFWS, 2016).

Habitat Type

Adult: Forested ridges and slopes (USFWS, 2016)

Habitat Narrative

Adult: *Schiedea obovata* occurs on ridges and slopes in lowland diverse mesic forests dominated by *Acacia koa* and *Metrosideros polymorpha*, at elevations of 560 to 760 m (1,837 to 2,494 ft) (USFWS, 2016).

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Unknown

Number of Populations:

2 (USFWS, 2016)

Population Size:

389 individuals (USFWS, 2016))

Population Narrative:

Currently, two population units, Kahanahaiki to Pahole and Keawapilau to West Makaleha, total 389 individuals located on Federal and State lands (68 FR 35950) (Table SB 36). The Kahanahaiki to Pahole population unit has met numerical criteria for stabilization (defined for this species as 100 mature individuals per population unit) (Makua Implementation Team 2003). The existing population units also are located within low and very low fire risk zones for training-related wildfire. Demographic data indicate *Schiedea obovata* is increasing in numbers only due to augmentation efforts and the discovery of a new population unit in North West Makaleha. About 82 percent of all of individuals are augmentations from greenhouse-propagated stock. Recruitment of seedlings and immature plants into the mature population is limited by predation by non-native slugs and snails that feed on and damage leaves and stems (Makua Implementation Team 2003; U.S. Army Garrison 2004a; U.S. Army Garrison 2005b). One study noted, for example, that seedling mortality doubled when exposed to slug herbivory (U.S. Army Garrison 2005b). Furthermore, slugs have the potential to completely halt seedling regeneration in several sites (U.S. Army Garrison 2004a, 2005b). Thus, *S. obovata* is characterized by declining in the current range and two existing population units with low numbers, of which one is exceeding minimum numerical criteria for stabilization and increasing through augmentation and discovery of new individuals (USFWS, 2016).

Threats and Stressors

Stressor: Slugs and snails (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: *Schiedea obovata* is particularly vulnerable to predation by non-native slugs and snails (Makua Implementation Team 2003; U.S. Army Garrison 2005b) (USFWS, 2016).

Stressor: Residential development (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Residential development is listed as a threat to this species (USFWS, 2016).

Stressor: Reforestation (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Reforestation with non-native trees is listed as a threat to this species (USFWS, 2016).

Stressor: Military installations (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Establishment of military installations is listed as a threat to this species (USFWS, 2016).

Stressor: Trampling/collection

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Trampling and illegal collecting by people is listed as a threat to this species (USFWS, 2016).

Stressor: Stochastic events (USFWS, 2016)

Exposure:

Response:

Consequence: Extinction

Narrative: Population units of *S. obovata* are vulnerable to extirpation from naturally occurring events such as rockslides and/or reduced reproductive vigor due to small population size and limited distribution (56 FR 55770; 68 FR 35950; Service 1995a, 1998a) (USFWS, 2016).

Stressor: Drought (USFWS, 2016)

Exposure:

Response:

Consequence: Population fluctuation

Narrative: This species experiences large population fluctuations related to drought and its natural recruitment is severely reduced by slug predation (U.S. Army Garrison 2005c) (USFWS, 2016).

Recovery

Delisting Criteria:

Conservation actions that should be implemented for the recovery of *Schiedea obovata* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1995a, 1998a). At least 50 mature, reproducing individuals are needed per population unit to attain stabilization criteria for short-lived perennials. However, because of the common, large declines or fluctuations in numbers of *S. obovata*, the Makua Implementation Team (2003) identified a stabilization target of at least 100 mature individuals for each population unit of this species. An increased stabilization criterion is needed because any adverse disturbance during a major low point in a population unit's fluctuation could extirpate that unit. In addition to stabilizing the two existing population units, a third population unit must be established by reintroduction and managed for stabilization outside the action area. Research on slug control in forest settings is needed to find ways to reduce this threat to *S. obovata* and associated native plants (USFWS, 2016).

The Makua Implementation Team (2003) has developed stabilization protocols for *Schiedea obovata*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). This species occurs in the Kahanahaiki, Pahole, and West Makaleha

Management Units where it will benefit from population unit and/or ecosystem-level protection. The Army and the Hawaii Division of Forestry and Wildlife have been outplanting this species within fenced exclosures since 1999. The Kahanahaiki to Pahole population unit is located within the fenced Kahanahaiki and Pahole Management Units, and the North West Makaleha site within the Keawapilau to West Makaleha population unit is fenced. Fence construction is planned for the entire West Makaleha Management Unit in 2007. Invasive weeds are controlled at extant *S. obovata* sites, but not at historical sites. *Schiedea obovata* seed can be successfully stored and remain viable for several years, and outplantings have been successful (U.S. Army Garrison 2005b). In 2005, this species was represented in the following ex situ collections: one cutting in a nursery (Army Environmental Division, Oahu), 14 plants in a botanical garden (Waimea Valley Audubon Center), 161 seeds in micropropagation (Harold L. Lyon Arboretum), 236,814 seeds in seed storage (Lyon Arboretum Seed Storage Facility), and 13 seedlings in micropropagation (Harold L. Lyon Arboretum) (Service 2005b) (USFWS, 2016).

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SPECIES ACCOUNT: *Schiedea pubescens* (ma'oli'oli)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2016)

Physical Description

Schiedea pubescens is a reclining or weakly climbing vine with a woody base. The plant is glabrous except for the inflorescence, which has dense purple-tinged hairs. The stems are 3.3 to 20 feet (ft) (1 to 6 meters (m)) long with internodes that are usually 2.4 to 4.7 inches (in) (6 to 12 centimeters (cm)) long. Opposite, green leaves are sometimes purple tinged especially along the midrib. In addition they are thick, leathery and narrowly lanceolate. The tiny flowers are perfect and are arranged in open cymes. The inflorescence is 12 to 20 in (30 to 50 cm) long with green bracts, which are sometimes tinged with purple (Wagner et al. 1999a, p. 519).

Taxonomy

Kingdom: Plantae; Phylum: Anthophyta; Class: Dicotyledoneae; Order: Caryophyllales; Family: Caryophyllaceae (Pinks). *Schiedea pubescens* was described by Hillebrand (1888). This species is recognized as a distinct taxon in the Manual of Flowering Plants of Hawaii (Wagner et al. 1999a, p. 519), and Wagner et al. (2005).

Historical Range

Schiedea pubescens was historically found scattered on the islands of Molokai, Lanai, and Maui. On Molokai, it was found from Kalae to Pukoo ridge; on Maui, it was known from the western mountains at Olowalu, Kaanapali, and Waihee, and from the eastern mountains at Makawao; and on Lanai, it was known from the Lanaihale area (HBMP 2008). On Lanai, it was known from the Lanaihale summit area but has not been observed since 1922 (USFWS, 2016).

Current Range

This species, which is declining and extremely threatened, is known from 13 populations on Maui, Molokai, and Hawaii (Wood, in litt. 2001; Oppenheimer, in litt. 2006; HBMP 2008; Bakutis, in litt. 2010; Oppenheimer, in litt. 2010; Perlman, in litt. 2010).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (USFWS, 2016)

Reproduction Narrative

Adult: This species is outcrossing (USFWS, 2016).

Habitat Type

Adult: Diverse mesic to wet forest

Habitat Vegetation or Surface Water Classification

Adult: Forest - Hardwood

Habitat Narrative

Adult: This species occurs in diverse mesic to wet *Metrosideros* (ohia) forest at elevations between 2,000 and 3,000ft (600 and 900 m) (Hawaii Biodiversity and Mapping Program (HBMP) 2008; Wagner et al. 1999a, 519).

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Not available

Redundancy:

Schiedea pubescens (ma'oli'oli)

Number of Populations:

Molokai: 1; Maui: 7 (USFWS, 2016)

Population Size:

Molokai: < 30 (USFWS, 2016)

Population Narrative:

Currently, this species is known from one occurrence on Molokai totaling fewer than 30 individuals. The occurrence on east Maui has not been re-observed, but this species is found at seven locations on west Maui (Wood 2001, in litt.; Oppenheimer 2006, in litt.; Bakutis 2010, in litt.; HBMP 2010; MNTF 2010, in litt.; Oppenheimer 2010, in litt.; PEPP 2014, pp. 162–163; Oppenheimer 2015, in litt.) (USFWS, 2016).

Threats and Stressors

Stressor: Feral pigs, goats, and nonnative plants

Exposure:

Response: Habitat degradation and destruction

Consequence:

Narrative: *Schiedea pubescens* is highly and imminently threatened by feral pigs (*Sus scrofa*) and feral goats (*Capra hircus*) that degrade and destroy habitat (HBMP 2008). Evidence of the activities of feral pigs has been reported at the Hawaii, Maui, and Molokai populations, and of feral goats at the Hawaii population (HBMP 2008). Hawaiian ecosystems, having evolved without hoofed mammals, are susceptible to large-scale disturbance by pigs, goats, and other introduced ungulates (Loope et al. 1991). Because of demonstrated habitat modifications by feral pigs and goats, such as destruction of native plants, disruption of topsoil leading to erosion, and establishment and spread of nonnative plants, the U.S. Fish and Wildlife Service (FWS) believes they are a threat to *S. pubescens*.

Stressor: Predation (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Feral pigs have been observed browsing on young shoots, leaves and fronds of a wide variety plants, of which over 85 percent were endemic species (Diong 1982). A stomach content analyses also showed that the pigs food sources consisted of native plants, 60 percent of which were *Cibotium* spp.(tree ferns), alternating with *Psidium cattleianum* when it was available. Pigs have also been observed felling and removing the bark of *Clermontia*, *Cibotium*, *Coprosma*, *Psychotria*, and *Hedyotis* species (herbaceous and woody plants), and causing enough damage to kill larger trees over a few months of repeated feedings (Diong 1982). Goats browse on introduced grasses and native plants and are able to reach more remote and inaccessible areas than other ungulates. They thrive on a variety of food plants and are instrumental in the decline of native vegetation in many areas (Cuddihy and Stone 1990). Because Hawaii's native plants evolved without any browsing or grazing mammals present, many lost natural defenses to such impacts (Carlquist 1980). Browsing by ungulates has been observed on many other native species, including common and rare or endangered species (Cuddihy and Stone 1990; Loope et al. 1991). Therefore, though we have no direct evidence of browsing for this species, it is likely that pigs and goats impact *S. pubescens* directly as well as the surrounding habitat. Herbivory by slugs and seed predation by rats are both reported to be threats to *S. pubescens* on Maui (HBMP 2010; PEPP 2014, p. 162; Duvall 2015, in litt.) (USFWS, 2016).

Stressor: Fire

Exposure:

Response:

Consequence:

Narrative: Fire is a likely threat to the population in the Army's Pohakuloa Training Area on the island of Hawaii (HBMP 2008). This area is dry, windy, and at risk of fire due to military training activities. The fire-adapted nonnative grass, *Pennisetum setaceum*, is a serious pest in dry areas as it can alter the fire characteristics of its habitat (Smith 1989). Because Hawaiian plants were subjected to fire during their evolution only in areas of volcanic activity and from occasional lightning strikes, they are not adapted to recurring fire regimes and do not quickly recover following a fire. Alien plants are often better adapted to fire than native plant species, and some fire-adapted grasses have become widespread in Hawaii. Native shrubland and dry forest can thus be converted to land dominated by alien grasses. The presence of such species in Hawaiian ecosystems greatly increases the intensity, extent, and frequency of fire, especially during drier months or drought. Fire-adapted alien plant taxa can reestablish in a burned area, resulting in a reduction in the amount of native vegetation after each fire. Fire can destroy dormant seeds as well as plants, even in steep or inaccessible areas. Fires may result from natural causes, or may be accidentally or purposely started by humans (Cuddihy and Stone 1990).

Stressor: Low genetic variation (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: This species is outcrossing; however, very low population sizes may have reduced its genetic variation (Weller 2015, in litt.) (USFWS, 2016).

Stressor: Climate change (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013, p. 88) found that, as environmental conditions are altered by climate change, *S. pubescens* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions (USFWS, 2016).

Recovery

Recovery Actions:

- Survey for populations of *Schiedea pubescens* in areas of potentially suitable habitat.
- Remove feral pigs and goats from areas where *S. pubescens* populations exist and prevent reinvasion through the use of exclosures.
- Control alien plants using physical, mechanical, and biological control methods, as well as herbicides when necessary.
- Conduct research into potential biocontrol species.
- Begin propagation efforts for maintenance of genetic stock.
- Reintroduce individuals of *S. pubescens* into suitable habitat within historic range that is being managed for known threats to this species.

Conservation Measures and Best Management Practices:

- Remove feral pigs and goats from areas where *S. pubescens* populations exist and prevent reinvasion through the use of exclosures.
- Control alien plants using physical, mechanical, and biological control methods, as well as herbicides when necessary.
- Begin propagation efforts for maintenance of genetic stock.
- Reintroduce individuals of *S. pubescens* into suitable habitat within historic range that is being managed for known threats to this species.

References

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Pacific Region (Region 1)

14 p.

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Final rule. 81 Federal Register 190. September 30, 2016. Pages 67786 - 67860.

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for *Schiedea pubescens* (ma'oli'oli)

SPECIES ACCOUNT: *Schiedea salicaria* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

An erect subshrub or shrub, 3-18 dm tall. Inflorescences terminal, 8-11 cm long. (NatureServe, 2015)

Taxonomy

Hawaiian endemic genus of 22 species, species endemic to west Maui. No varieties recognized by Wagner et al. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Endemic to the southern and eastern side of West Maui, state of Hawaii. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Schiedea salicaria* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two detailed critical habitat units (CHUs), in Maui County in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Schiedea salicaria* includes two CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Lowland Dry—Unit 5 consists of 3,615 ac (1,463 ha) of State land, and 43 ac (17 ha) of privately owned land, from Panaewa to Manawainui on the western and southern slopes of west Maui. This unit is occupied by the plants *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, *Cenchrus agrimonioides*, *Gouania hillebrandii*, *Kadua coriacea*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and *Tetramolopium capillare*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 5 is not known to be occupied by *Ctenitis squamigera*, *Cyanea obtusa*, *Hesperomannia arbuscula*, *Hibiscus brackenridgei*, *Lysimachia lydgatei*, *Neraudia sericea*, *Schiedea salicaria*, *Sesbania tomentosa*, or *T. remyi*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes,

suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 6 consists of 3 ac (1 ha) of State land, and 237 ac (96 ha) of privately owned land, from Paleaahu Gulch to Puu Hona on the southern slopes of west Maui. This unit is occupied by the plants *Hibiscus brackenridgei* and *Schiedea salicaria*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 6 is not known to be occupied by *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, *Cenchrus agrimonoides*, *Ctenitis squamigera*, *Cyanea obtusa*, *Gouania hillebrandii*, *Hesperomannia arbuscula*, *Kadua coriacea*, *Lysimachia lydgatei*, *Neraudia sericea*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Spermolepis hawaiiensis*, *Tetramolopium capillare*, or *T. remyi*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Schiedea salicaria* critical habitat consists of one component. Lowland dry (west Maui) (81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*. Subcanopy: *Chamaesyce*, *Dodonaea*, *Leptecophylla*, *Osteomeles*, *Psydrax*, *Scaevola*, *Wikstroemia*. Understory: *Alyxia*, *Artemisia*, *Bidens*, *Chenopodium*, *Nephrolepis*, *Peperomia*, *Sicyos*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species

that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*,

Bidens campylotheca ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: No information found.

Habitat Type

Adult: Dry shrublands (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (inferred from USFWS, 2016)

Environmental Specificity

Adult: Narrow/specialist (inferred from USFWS, 2016)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 2016)

Site Fidelity

Adult: High (inferred from USFWS, 2016)

Habitat Narrative

Adult: Species inhabits dry shrublands on steep slopes and ridgetops. (NatureServe, 2015). Currently, this species is found in three occurrences: Kaunoahua gulch (500 to 1,000 individuals), Puu Hona (about 50 individuals), and Waikapu Stream (3 to 5 individuals), in the lowland dry ecosystem on west Maui (TNC 2007; Oppenheimer 2010k, in litt.; Oppenheimer 2010l, in litt.) (USFWS, 2016). Clumped spatial arrangement of the population, narrow environmental specificity, low tolerance ranges and high site fidelity and ecological integrity of the community are inferred based on the species unique habitat requirements and the low number of known populations.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: No information found.

Population Information and Trends**Population Trends:**

Decreasing (NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

250 - 2500 individuals (NatureServe, 2015)

Population Narrative:

While there are no historic records of numbers of populations or individuals, qualitative accounts indicate this species was not uncommon on West Maui (Russell 2004). Decline of 30-70% Original estimated total for this species ranges from about 1,000 to about 2,000. Although, U.S Fish and Wildlife Service currently have an 2005 estimate as 100 to 300 (USFWS 2006). Total number of occurrences are 5, of those 4 are known extant occurrences found on the island of Maui. (NatureServe, 2015)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (goats, axis deer, and cattle), nonnative plants, fire, drought, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Fire can destroy dormant seeds and plants, even in steep and inaccessible areas. Successive fires can remove habitat for native species by altering microclimate conditions favorable to alien plants. Drought destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities.. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (axis deer, cattle, and goats) is considered an ongoing threat to *Schiedea salicaria* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Recovery

Reclassification Criteria:

No information found.

Delisting Criteria:

No information found.

Conservation Measures and Best Management Practices:

- No information found.

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USFWS. 2016. Environmental Conservation Online System (ECOS) – Species Profile. <http://ecos.fws.gov/ecp0/>. Accessed August 2016.

U.S. Fish and Wildlife Service. 2016. Endangered and Threatened Wildlife and Plants

Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

Final Rule . 81 FR 17790-18110 (March 30, 2016).

U.S. Fish and Wildlife Service. 2016. Endangered and Threatened Wildlife and Plants

Final Rule. Federal Register Vol. 81, No. 61. Pages 17790-18110

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.”

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Final Rule. 78 Federal Register 102, May 28, 2013. Pages 32014 - 32065.

SPECIES ACCOUNT: *Schiedea sarmentosa* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2017)

Physical Description

A many-branched subshrub 30-45 cm tall. The flowers are borne in terminal clusters.
(NatureServe, 2015)

Taxonomy

Schiedea sarmentosa is being resurrected by W.L. Wagner (W.L. Wagner, pers. comm. to Christa Russell, 1994); Kartesz's 1994 Checklist included *S. sarmentosa* in synonymy of *S. menziesii*, but the 1999 Synthesis recognizes the taxon as a distinct species. *Schiedea menziesii* had Candidate, Category 2 status in the 1990 and 1993 USFWS notices of review, but in Oct., 1995, only *S. sarmentosa* was proposed for listing and the Oct. 10, 1996 determination to list *S. sarmentosa*, explains that the switch is due to the fact that, "*S. sarmentosa* was included in *S. menziesii* by Wagner et al. (1990). Warren Wagner and Stephen Weller, who are preparing a monograph of the genus, now consider *S. sarmentosa* to be a separate species." *S. menziesii* is not mentioned in the Oct. 31, 1996 reprint of the List of Endangered and Threatened Wildlife and Plants or in the Sept. 1997 notice of review. (NatureServe, 2015) A member of the pink family (Caryophyllaceae) (USFWS, 2016).

Historical Range

Historically no additional range. (NatureServe, 2015)

Current Range

Current range includes Molokai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Schiedea sarmentosa* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one detailed critical habitat unit (CHU), in Maui County in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Schiedea sarmentosa* includes one CHU in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Molokai—Lowland Mesic—Unit 1 (and) *Palmeria dolei*—Unit 37—Lowland Mesic (and) *Pseudonestor xanthophrys*—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Ctenitis squamigera*, *Cyanea dunbariae*, *C. mannii*, *C. profuga*, *Cyperus fauriei*, *Cyrtandra filipes*, *Gouania hillebrandii*, *Labordia triflora*, *Neraudia sericea*, *Santalum haleakalae* var. *lanaiense*, *Schiedea*

lydgatei, *S. sarmentosa*, *Silene alexandri*, *S. lanceolata*, *Spermolepis hawaiiensis*, and *Zanthoxylum hawaiiense*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Mesic—Unit 1 is not known to be occupied by *Asplenium dielirectum*, *Bonamia menziesii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea procera*, *C. solanacea*, *Diplazium molokaiense*, *Festuca molokaiensis*, *Flueggea neowawraea*, *Isodendron pyriformis*, *Kadua laxiflora*, *Melicope mucronulata*, *M. munroi*, *M. reflexa*, *Phyllostegia haliakalae*, *P. mannii*, *P. pilosa*, *Sesbania tomentosa*, *Stenogyne bifida*, or *Vigna o-wahuensis*, or the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Schiedea sarmentosa* critical habitat consists of one component. Lowland mesic (Molokai) (81 FR 17790-18110):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*,

Cyperus trachysanthos, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookii*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus perianthus*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkii*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C.*

duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. magnicalyx, C. mannii, C. maritae, C. mceldowneyi, C. profuga, C. solanacea, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Dubautia plantaginea ssp. humilis, Geranium hanaense, G. multiflorum, Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Possibly wind pollinated, sexual (USFWS, 1998)

Reproduction Narrative

Adult: The flowers are female on some plants and bisexual on others. The population in Makolelau Gulch has a frequency of females of 31 percent. Based on analyses of pollen-ovule ratios, pollen size, inflorescence structure, and comparison to other Schiedea species tested in a wind tunnel, Schiedea sarmentosa could be wind-pollinated (Steven Weller, University of California, Irvine, personal communication 1997). No other life history information for this species is available (USFWS, 1998).

Habitat Type

Adult: Steeply sloped shrubland (USFWS, 1998)

Habitat Vegetation or Surface Water Classification

Adult: Lwoland dry or mesic shrubland (USFWS, 1998)

Dependencies on Specific Environmental Elements

Adult: Lwoland mesic ecosystem (see population narrative)

Geographic or Habitat Restraints or Barriers

Adult: 2,000 - 2,600 ft. elevation (USFWS, 1998)

Spatial Arrangements of the Population

Adult: Clumped (Inferred from NatureServe, 2015 and USFWS, 1998)

Environmental Specificity

Adult: Narrow/specialist (Inferred from NatureServe, 2015 and USFWS, 1998)

Tolerance Ranges/Thresholds

Adult: Low (Inferred from NatureServe, 2015 and USFWS, 1998)

Site Fidelity

Adult: High (Inferred from NatureServe, 2015 and USFWS, 1998)

Habitat Narrative

Adult: Dry and moist forests and shrublands. Often on rocky gulch slopes and cliffs. (NatureServe, 2015). *Schiedea sarmentosa* is typically found on steep slopes in ohia-Dodonaea viscosa (aalii) lowland dry or mesic shrubland between 610 and 790 meters (2,000 and 2,600 feet) elevation (I-THP 1991b, 1993b; HPCC 1991b, 1992). Associated species include *Syphelia tameiameia* (pukiawe), *Chenopodium oahuensis* (aheahea), *Alyxia oliviformis* (maile), *Pleomele* sp. (hala pepe), and *Chamaesyce* sp. (akoko) (HHP 1993b; HPCC 1991b, 1992) (USFWS, 1998). lumped spatial arrangement of the population, narrow environmental specificity, low tolerance ranges and high site fidelity and ecological integrity of the community are inferred based on the species unique habitat requirements and the low number of known populations.

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Increasing (USFWS, 2011)

Resiliency:

Low (inferred from USFWS, 2011)

Representation:

Low (inferred from USFWS, 2011)

Redundancy:

Low (inferred from USFWS, 2016)

Number of Populations:

1 (USFWS, 2018)

Population Size:

> 1000 (USFWS, 2018)

Population Narrative:

New Status Information: • There is one population estimated to total more than 1,000 individuals on Moloka'i (Bakutis 2018, in litt.) • Visits to the Kawela population in 2018 documented suspected hybrids between *Schiedea lydgatei* and *S. sarmentosa* (Weisenberger 2018, in litt.). • In 2016, one critical habitat unit in the lowland mesic ecosystem was designated on Moloka'i for *Schiedea sarmentosa* (8,770 ac; 3,549 ha) (81 FR 17790, March 30, 2016) (USFWS, 2018).

Threats and Stressors

Stressor: Feral goats, rats and slugs (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Goats, rats (*Rattus* spp.), and slugs (unidentified species) may eat parts of this plant (Perlman 2010; Wood 2010). Spittle bugs (the juvenile stage of certain leafhoppers) were observed on this species in April 2009 (Oppenheimer 2010). In addition, goats degrade the habitat through trampling the species (USFWS, 2011).

Stressor: Invasive plants (USFWS, 2011)

Exposure:**Response:**

Consequence: Loss of habitat

Narrative: Invasive plants are listed as a threat to this species (USFWS, 2011).

Stressor: Climate change loss or degradation of habitat

Exposure:**Response:**

Consequence: Loss of habitat

Narrative: We previously reported that climate change may pose a threat to this species, anticipating an analysis by 2013. The assessment conducted by Fortini et al. (2013) concluded that *S. sarmentosa* is extremely vulnerable to the impacts of climate change, with a vulnerability score of 0.977 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future, such as locating key microsites that overlap with current and future climate envelopes for outplanting efforts (USFWS, 2018).

Recovery**Reclassification Criteria:**

A total of five to seven populations of each taxon should be documented on Molokai. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 2011).

Delisting Criteria:

A total of 8 to 10 populations of each taxon should be documented on Molokai. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 2011).

Conservation Measures and Best Management Practices:

- Conduct surveys where *Schiedea sarmentosa* has been reported to determine current status of the species (USFWS, 2011).
- Continue collection of seeds or cuttings for genetic storage and reintroduction (USFWS, 2011).
- Monitor known populations (USFWS, 2011).
- Fence all populations to provide protection from the negative impacts of feral ungulates (USFWS, 2011).
- Control invasive introduced plant species around all populations (USFWS, 2011).

- Control rats in the vicinity of these populations (USFWS, 2011).
- Develop and implement methods to control slugs and spittle bugs (USFWS, 2011).
- Establish additional populations within protected suitable habitat (USFWS, 2011).
- Develop and implement a wildfire management plan (USFWS, 2011).
- Work with the East Molokai Watershed Partnership and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2011).
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2011).
- New Management Actions: • Captive propagation for genetic storage and reintroduction—In 2014, the University of California—Irvine reported 12 plants from Mākolēlau in storage, representing 12 different individuals (USFWS, 2018).
- Recommendations for Future Actions: Hybridization may be a new threat to this species; however, we are not aware of any significant new information regarding the species' biological status since the last 5-year review in 2011. Thus, the following recommendations for future actions are added or reiterated for the 5-year review for 2018. • Surveys and inventories—Survey areas where *Schiedea sarmentosa* has been reported to determine current status of the species on Moloka'i. • Ungulate monitoring and control—Fence existing populations to provide protection from negative impacts of feral ungulates. • Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations of *S. sarmentosa*. • Fire destruction or degradation of habitat—Develop and implement a wildfire management plan. • Captive propagation for genetic storage and reintroduction—Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. • Reintroduction and translocation—
 - o Augment known populations and reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.
 - o Research methods to increase and maintain numbers of female individuals within populations.
 - o Study the possible effects of hybridization on this species.• Rodent predation and herbivory—Control rats in the vicinity of all populations. • Invertebrate predation and herbivory—Develop and implement methods to control slugs and spittle bugs. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for the recovery of the species. • Alliance and partnership development—Work with the East Molokai Watershed Partnership program, the Hawai'i Division of Forestry and Wildlife, and other land managers to initiate planning and contribute to ecosystem-level restoration and management to benefit this species.

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SPECIES ACCOUNT: *Schiedea spergulina* var. *leiopoda* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

An erect or weakly erect subshrub 3-6 dm tall. The small flowers are borne in terminal clusters. (NatureServe, 2015)

Taxonomy

Gray (1854) described *Schiedea spergulina* based upon a specimen collected in 1840 on Kauai during the United States Exploring Expedition. The specific epithet means “resembling *Spergula*,” another genus in the same plant family. Two varieties of *Schiedea spergulina* are recognized in the current treatment of the genus (Wagner et al. 1990): the typical variety, which includes var. *degeneriana*, named by Sherff (1956); and var. *leiopoda* (Sherff 1944), which includes var. *major*, also named by Sherff (1944) (USFWS, 1995).

Historical Range

Historically no additional range. (NatureServe, 2015)

Current Range

Current range includes southern Kauai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Schiedea spergulina* var. *leiopoda* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Schiedea spergulina* var. *leiopoda* includes one unit totaling 11 acres in Kauai County, Hawaii. The unit is Kauai 9—*Schiedea spergulina* var. *leiopoda*—a.

Kauai 9—*Schiedea spergulina* var. *leiopoda*—a: This unit is critical habitat for *Schiedea spergulina* var. *leiopoda* and is 5 ha (11 ac) on private land within Lawai Valley. This unit provides habitat for one population of 300 mature, reproducing individuals of the shortlived perennial *Schiedea spergulina* var. *leiopoda* and is currently occupied with 135 to 150 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, bare rock outcrops or sparsely vegetated portions of rocky cliff faces or cliff bases in diverse lowland dry to mesic forests. Although the Service does not feel that there is enough habitat designated to reach the recovery goal of 8 to 10 populations, this

species is a very narrow endemic and probably never naturally occurred in more than a single or a few populations.

Primary Constituent Elements/Physical or Biological Features

Within this unit, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Bare rock outcrops or sparsely vegetated portions of rocky cliff faces or cliff bases in diverse lowland dry to mesic forests and containing one or more of the following native plant species: *Acacia koa*, *Artemisia australis*, *Bidens sandwicensis*, *Carex meyenii*, *Chamaesyce celastroides*, *Dianella sandwicensis*, *Doryopteris* spp., *Eragrostis variabilis*, *Erythrina sandwicensis*, *Gahnia* spp., *Heliotropium* spp., *Lepidium serra*, *Lipochaeta connata*, *Microlepis strigosa*, *Nestegis sandwicensis*, *Nototrichium sandwicense*, *Panicum lineale*, *Peucedanum sandwicense*, or *Wilkesia gymnoxiphium*; and

(ii) Elevations between 21 and 90 m (69 and 294 ft).

Special Management Considerations or Protections

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species in paragraph (b) of this section and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Little is known about the life history of *Schiedea spergulina* var. *leipoda*. Flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown (USFWS, 1995).

Habitat Type

Adult: Rock outcrops (USFWS, 1995)

Spatial Arrangements of the Population

Adult: Clumped (inferred from USFWS, 1995 and USFWS, 2010)

Environmental Specificity

Adult: Narrow/specialist (inferred from USFWS, 1995 and USFWS, 2010)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1995 and USFWS, 2010)

Site Fidelity

Adult: High (inferred from USFWS, 1995 and USFWS, 2010)

Habitat Narrative

Adult: This taxon is usually found on bare rock outcrops or sparsely vegetated portions of rocky cliff faces or cliff bases in diverse lowland mesic forests at elevations between 180 and 800 meters (590 and 3,000 feet). Plant taxa associated with *Schiedea spergulina* var. *spergulina* include ahinahina, Chinaberry, lantana, Sacramento bur, and *Nototrichium sandwicense* (kului) (USFWS 1994a) (USFWS, 1995). Historically, *Schiedea spergulina* var. *leipoda* was found on a ridge on the east side of Hanapepe on Kauai and one population of approximately 50 to 100 individuals was known on the west side of Lawai Valley on Kauai, on a plateau and adjacent cliffs above the McBryde Garden of the National Tropical Botanical Garden (National Tropical Botanical Garden 2008; USFWS 1995). Currently the Hanapepe population has not been seen for many years, and the Lawai Valley population has between 120 to 325 individuals, including mature, immature, and seedlings. Seeds have been collected from 160 different individuals in the last four years (National Tropical Botanical Garden 2008; Perlman 2009; N, Tangalin, National Tropical Botanical Garden, pers. comm. 2009) (USFWS, 2010). Clumped spatial arrangement of the population, narrow environmental specificity, low tolerance ranges and high site fidelity and ecological integrity of the community are inferred based on the species unique habitat requirements and the low number of known populations.

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Little is known about the life history of *Schiedea spergulina* var. *leipoda*. Flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown (USFWS, 1995).

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Number of Populations:

1 (USFWS, 2017)

Population Size:

85 individuals (USFWS, 2017)

Population Narrative:

At the time of the last 5-year review in 2010 there was 1 population totaling between 120 to 325 individuals at Lawai Valley on Kauai. Currently, this population is declining, and there are at least 85 individuals in the same area (NTBG 2012, 2016a-b). In 2016, IUCN reported 5 subpopulations of *S. spergulina* (with no varieties) totaling approximately 600 individuals (Clark 2016) (USFWS, 2017).

Threats and Stressors

Stressor: Invasive plants

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Invasive plants are listed as a threat to this species (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Climate change may also pose a threat to *Schiedea spergulina* var. *leiopoda* (Factors A and E). However, current climate change models do not allow us to predict specifically what those effects, and their extent, would be for this species (USFWS, 2010).

Stressor: Feral goat (USFWS< 1995)

Exposure:

Response:

Consequence: Loss of individuals/Loss of habitat

Narrative: Habitat degradation and erosion caused by feral goats (*Capra hircus*) is listed as a threat to this species (USFWS, 1995).

Stressor: Stochastic events (USFWS, 1995)

Exposure:

Response:

Consequence: Extinction

Narrative: Stochastic natural events such as fire, landslides, etc. are a threat to this species due to its limited range and single extant population (USFWS, 1995).

Stressor: Pesticides (USFWS, 1995)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: The use of pesticides on nearby sugarcane fields is listed as a threat to this species (USFWS, 1995).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Schiedea spergulina* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.702 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, Fortini et al. show that Caryophyllaceae is one of the top four most vulnerable native plant families, and, at the genus level, *Schiedea* had one of the highest vulnerability scores. Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Stressor: Hurricanes—Loss and degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Hurricanes were omitted in the last five year review. In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event, and 70 percent of all listed plant species on Kauai are only found on Kauai. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013) (USFWS, 2017).

Recovery

Reclassification Criteria:

For downlisting, a total of five to seven populations of *Schiedea spergulina* var. *leiopoda* should be documented on islands where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 2010).

Delisting Criteria:

For delisting, a total of eight to ten populations of *Schiedea spergulina* var. *leiopoda* should be documented on islands where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of five consecutive years before delisting is considered (USFWS, 2010).

Conservation Measures and Best Management Practices:

- Continue control of invasive introduced plant species at the one known population (USFWS, 2010).
- Continue to collect for adequate genetic storage and reintroduction (USFWS, 2010).
- Establish additional populations (USFWS, 2010).
- Conduct surveys throughout historical range to determine the current status of the species as a whole, which is necessary before the species can be reclassified (USFWS, 2010).
- Work with Hawaii Division of Forestry and Wildlife to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit future reintroduced populations of this species (USFWS, 2010).
- Update the listed entity on 50 CFR 17 to match the currently recognized taxonomy after a thorough status survey has been completed (USFWS, 2010).
- New Management Actions: • NTBG has been collecting thousands of seeds of *Schiedea spergulina* from Lawai for storage and propagation. They have at least 30 founders represented in their seed bank (NTBG 2017). • The University of California, Irvine has nine founders from Lawai represented by 120 plants in their greenhouse (UCI 2017). • PEPP was monitoring the Lawai population; however, the *S. spergulina* var. *leiopoda* was recently downgraded from PEP (fewer than 50 in the wild) to POP (potential PEP) as a result of the reported combination of the two varieties (PEPP 2012, 2013) (USFWS, 2017).
- Recommendations for Future Actions: No new threats and no other significant new information regarding the species' biological status have been reported since the last 5-year review in 2010. Therefore, the following recommendations for future actions are reiterated for the 5-year review for 2017. • Surveys and inventories—Conduct surveys throughout historical range to determine the current status of the species as a whole, which is necessary before the species can be reclassified. • Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Update the listed entity on 50 CFR 17.12 to combine *S. spergulina* var. *leiopoda* with *S. spergulina* and remove *S. spergulina* var. *leiopoda* if further genetic studies verify this taxonomic change (USFWS, 2017).

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SPECIES ACCOUNT: *Schiedea spergulina* var. *spergulina* (No common name)

Species Taxonomic and Listing Information

Listing Status: Threatened; 02/25/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

An erect or weakly erect subshrub 3-6 dm tall. The flowers are borne in terminal clusters. (NatureServe, 2015)

Taxonomy

Gray (1854) described *Schiedea spergulina* based upon a specimen collected in 1840 on Kauai during the United States Exploring Expedition. The specific epithet means “resembling *Spergula*,” another genus in the same plant family. Two varieties of *Schiedea spergulina* are recognized in the current treatment of the genus (Wagner et al. 1990): the typical variety, which includes var. *degeneriana*, named by Sherff (1956); and var. *leiopoda* (Sherff 1944), which includes var. *major*, also named by Sherff (1944) (USFWS, 1995).

Historical Range

Historically no additional range. (NatureServe, 2015)

Current Range

Current range includes Waimea Canyon area of Kauai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Schiedea spergulina* var. *spergulina* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Schiedea spergulina* var. *spergulina* includes three units totaling 1,059 acres in Kauai County, Hawaii. The units are Kauai 11—*Schiedea spergulina* var. *spergulina*—a, b and Kauai 13—*Schiedea spergulina* var. *spergulina*—c.

Kauai 11—*Schiedea spergulina* var. *spergulina*—a: This unit is critical habitat for *Schiedea spergulina* var. *spergulina* and is 131 ha (324 ac) on State land (Na Pali Coast State Park) within Kalalau Valley. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial *Schiedea spergulina* var. *spergulina* and is currently occupied with one plant. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, bare rock outcrops or sparsely vegetated portions of rocky cliff faces or cliff bases in diverse lowland dry to

mesic forests. This unit is geographically separated from the other two units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Although the Service does not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is at an appropriate distance from the other units to avoid their destruction by one naturally occurring catastrophic event. Kauai 11—*Schiedea spergulina* var. *spergulina*—b: This unit is critical habitat for *Schiedea spergulina* var. *spergulina* and is 77 ha (191 ac) on State land within Kawaiiki Valley. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial *Schiedea spergulina* var. *spergulina* and is currently occupied with five plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, bare rock outcrops or sparsely vegetated portions of rocky cliff faces or cliff bases in diverse lowland dry to mesic forests. This unit is geographically separated from the other two units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Although the Service does not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is at an appropriate distance from the other units to avoid their destruction by one naturally occurring catastrophic event.

Kauai 13—*Schiedea spergulina* var. *spergulina*—c: This unit is critical habitat for *Schiedea spergulina* var. *spergulina* and is 221 ha (545 ac) on State land within Waimea Canyon. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial *Schiedea spergulina* var. *spergulina* and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is important to the establishment of additional populations on Kauai in order to reach recovery goals. The habitat features contained in this unit that are essential for this species include, but are not limited to, bare rock outcrops or sparsely vegetated portions of rocky cliff faces or cliff bases in diverse lowland dry to mesic forests. This unit is geographically separated from the other two units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Although the Service does not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is at an appropriate distance from the other unit to avoid their destruction by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Bare rock outcrops or sparsely vegetated portions of rocky cliff faces or cliff bases in diverse lowland dry to mesic forests and containing one or more of the following associated plant species: *Acacia koa*, *Artemisia australis*, *Bidens sandwicensis*, *Carex meyenii*, *Chamaesyce celastroides*, *Dianella sandwicensis*, *Doryopteris* spp., *Eragrostis variabilis*, *Erythrina sandwicensis*, *Gahnia* spp., *Heliotropium* spp., *Lepidium serra*, *Lipochaeta connata*, *Microlepia strigosa*, *Nestegis sandwicensis*, *Nototrichium sandwicense*, *Panicum lineale*, *Peucedanum sandwicense*, or *Wilkesia gymnoxiphium*; and

(ii) Elevations between 145 and 829 m (474 and 2,718 ft).

Special Management Considerations or Protections

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species in paragraph (b) of this section and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Little is known about the life history of *Schiedea spergulina* var. *spergulina*. Flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown (USFWS, 1995).

Habitat Type

Adult: Rock outcrops (USFWS, 1995)

Spatial Arrangements of the Population

Adult: Clumped (inferred from USFWS, 1995 and USFWS, 2010)

Environmental Specificity

Adult: Narrow/specialist (inferred from USFWS, 1995 and USFWS, 2010)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1995 and USFWS, 2010)

Site Fidelity

Adult: High (inferred from USFWS, 1995 and USFWS, 2010)

Habitat Narrative

Adult: This taxon is usually found on bare rock outcrops or sparsely vegetated portions of rocky cliff faces or cliff bases in diverse lowland mesic forests at elevations between 180 and 800 meters (590 and 3,000 feet). Plant taxa associated with *Schiedea spergulina* var. *spergulina* include ahinahina, Chinaberry, lantana, Sacramento bur, and *Nototrichium sandwicense* (kului) (USFWS 1994a) (USFWS, 1995). There are 6 known populations totaling 440 to 585 individuals (USFWS, 2010). Clumped spatial arrangement of the population, narrow environmental specificity, low tolerance ranges and high site fidelity and ecological integrity of the community are inferred based on the species unique habitat requirements and the low number of known populations.

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Little is known about the life history of *Schiedea spergulina* var. *spergulina*. Flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown (USFWS, 1995).

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Number of Populations:

4 (USFWS, 2017)

Population Size:

500-1000 individuals (USFWS, 2017)

Population Narrative:

At the time of the last 5-year review in 2010 there were six populations totaling between 440 to 585 individuals at Kaeha, Waimea, Koaie, Hipalau, Kalalau, and Kahuamaa Flat on Kauai. Currently, there are 1,000 or more individuals along Waimea Canyon road and at least four individuals at Makaha (NTBG 2011a-d, 2012a-i, 2014a-b). The status of populations at Kalalau rim, Koaie, and Kaeha has not been reported since 2008. In 2016, Clark reported five subpopulations of *S. spergulina* (with no varieties) totaling approximately 600 individuals (Clark 2016). Considering population estimates for *Schiedea spergulina* var. *leiopoda* are approximately 100 individuals, this puts the range of known plants for *Schiedea spergulina* var. *spergulina* at between 500 to 1,000 individuals total at four populations (USFWS, 2017).

Threats and Stressors

Stressor: Feral goats (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Habitat degradation and erosion caused by feral goats (*Capra hircus*) is listed as a threat to this species (USFWS, 2010).

Stressor: Invasive plants (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Competition with invasive introduced plant species is listed as a threat to this species (USFWS, 2010).

Stressor: Fire (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Fire is listed as a threat to this species (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Climate change may also pose a threat to *Schiedea spergulina* var. *spergulina* (Factors A and E). However, current climate change models do not allow us to predict specifically what those effects, and their extent, would be for this species (USFWS, 2010).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Schiedea spergulina* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.702 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, Fortini et al. show that Caryophyllaceae is one of the top four most vulnerable native plant families, and, at the genus level, *Schiedea* had one of the highest vulnerability scores. Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Stressor: Hurricanes—Loss and degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Hurricanes were omitted in the last five year review. In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with

maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event, and 70 percent of all listed plant species on Kauai are only found on Kauai. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013) (USFWS, 2017).

Recovery

Reclassification Criteria:

For downlisting, a total of five to seven populations of *Schiedea spergulina* var. *spergulina* should be documented on islands where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 2010).

Delisting Criteria:

For delisting, a total of eight to ten populations of *Schiedea spergulina* var. *spergulina* should be documented on islands where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of five consecutive years before delisting is considered (USFWS, 2010).

Conservation Measures and Best Management Practices:

- Control goats around existing populations (USFWS, 2010).
- Continue to collect for adequate genetic storage and propagation (USFWS, 2010).
- Establish reintroductions within protected suitable habitat (USFWS, 2010).
- Conduct surveys throughout historical range to determine the current status of the species, which is necessary before the species can be reclassified (USFWS, 2010).
- Work with Hawaii Division of Forestry and Wildlife and other landowners to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2010).
- Update the listed entity on 50 CFR 17 to match the currently recognized taxonomy after thorough surveys of the species have been conducted (USFWS, 2010).
- New Management Actions: • NTBG has one collection of this former variety of *Schiedea spergulina* from Makaha in their seed bank. They have plants from Waimea Canyon in the nursery (NTBG 2017).
 - The University of California, Irvine, has one founder represented by nine plants in their greenhouse from the Waimea Canyon population (USFWS, 2017).
- Recommendations for Future Actions: No new threats and no other significant new information regarding the species' biological status have been reported since the last 5-year review in 2010.

Therefore, the following recommendations for future actions are reiterated for the 5-year review for 2017. • Surveys and inventories—Conduct surveys throughout historic range to determine the current status of the species as a whole, which is necessary before the species can be reclassified. • Ungulate monitoring and control—Construct fenced exclosures to provide protection against feral ungulates. Protect all populations against browsing and disturbances from feral ungulates. • Invasive plant monitoring and control— o Control invasive nonnative plant species at all known populations. o Control invasive plant species that compete with the species around all known populations. • Fire monitoring and control—Develop and implement fire management plans for all wild and reintroduced populations. • Captive propagation for genetic storage and reintroduction—Continue to collect for adequate genetic storage and reintroduction. • Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides. • Population biology research—Study *Schiedea spergulina* var. *spergulina* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. • Update the listed entity on 50 CFR 17.12 to combine *S. spergulina* var. *leiopoda* with *S. spergulina* and remove *S. spergulina* var. *leiopoda* if further genetic studies verify this taxonomic change (USFWS, 2017).

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- U.S. Fish and Wildlife Service. 2010. *Schiedea spergulina* var. *spergulina* (no common name) 5-Year Review Summary and Evaluation. U.S. Fish and Wildlife Service Pacific Islands Fish and Wildlife Office Honolulu, Hawaii.

SPECIES ACCOUNT: *Schiedea stellarioides* (Laulihilihi)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

A weakly erect to sprawling subshrub 3-6 dm tall. Leaves are narrow. The small flowers are borne in open clusters. (NatureServe, 2015)

Taxonomy

Mann and Brigham first collected a specimen of *Schiedea stellarioides* in the mountains of Kauai between 1864 and 1865. Benedict Pierre George Hochreutiner and E.E. Sherff published several varieties of this species, characterized only by slight differences in leaf-shape and size, which are not recognized in the current treatment of the family (USFWS 1996) (USFWS, 1998).

Historical Range

See current range/distribution

Current Range

Current range Kauai, recently rediscovered (1991-1992); known historically from Kauai.

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Schiedea stellarioides* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Schiedea stellarioides* includes two units totaling 3,432 acres in Kauai county, Hawaii. The units are Kauai 11—*Schiedea stellarioides*—a, b.

Kauai 11—*Schiedea stellarioides*—a: This unit is critical habitat for *Schiedea stellarioides* and is 1,259 ha (3,113 ac) on State land (Alakai Wilderness Preserve and Puu Ka Pele Forest Reserve). This unit contains portions of Kaluahaulu and Kawaiiki Ridges, and Kawaiiki and Kipalau Valleys. This unit provides habitat for five populations of 300 mature, reproducing individuals of the shortlived perennial *Schiedea stellarioides* and is currently occupied with 200 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep slopes in closed *Acacia koa*-*Metrosideros polymorpha* lowland or montane mesic forest or shrubland. This unit is geographically separated from the other unit designated as critical habitat for this islandendemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Although the Service does not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is at an appropriate size and distance from

the other unit to avoid their destruction by one naturally occurring catastrophic event. Kauai 11—*Schiedea stellarioides*—b: This unit is critical habitat for *Schiedea stellarioides* and is 129 ha (320 ac) on State land (Alakai Wilderness Preserve) within upper Waialae Valley. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Schiedea stellarioides* and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is important to the establishment of additional populations on Kauai in order to reach recovery goals. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep slopes in closed *Acacia koa*/*Metrosideros polymorpha* lowland or montane mesic forest or shrubland. This unit is geographically separated from the other unit designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Although the Service does not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is at an appropriate distance from the other unit to avoid their destruction by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

- (i) Steep slopes in closed *Acacia koa*/*Metrosideros polymorpha* lowland or montane mesic forest or shrubland and containing one or more of the following native plant species: *Alsinidendron viscosum*, *Artemisia australis*, *Bidens cosmoides*, *Chenopodium* spp., *Dianella sandwicensis*, *Dodonaea viscosa*, *Mariscus* spp., *Melicope* spp., *Nototrichium sandwicense*, *Pipturus* spp., *Leptecophylla tameiameia*, *Syzygium sandwicensis*, or *Zanthoxylum dipetalum*; and
- (ii) Elevations between 376 and 1,251 m (1,135 and 4,102 ft).

Special Management Considerations or Protections

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species in paragraph (b) of this section and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations;

maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Breeding Season

Adult: Plants were observed flowering by botanists from the National Tropical Botanical Garden in February 1995 (USFWS, 1998).

Reproduction Narrative

Adult: Plants were observed flowering by botanists from the National Tropical Botanical Garden in February 1995 (Steve Perlman, NTBG Provenance Report 1995). No additional life history information for this species is currently available (USFWS, 1998).

Habitat Type

Adult: Mesic forest (USFWS, 1998)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 2010; USFWS, 1998)

Environmental Specificity

Adult: Narrow/specialist (USFWS, 2010; USFWS, 1998)

Tolerance Ranges/Thresholds

Adult: Low (USFWS, 2010; USFWS, 1998)

Site Fidelity

Adult: High (USFWS, 2010; USFWS, 1998)

Habitat Narrative

Adult: *Schiedea stellarioides* is found on steep slopes in a closed koa-ohia lowland to montane mesic forest between 610 and 1,120 meters (2,000 and 3,680 feet) elevation (USFWS 1996). Associated plant species include aalii, alani, ukiuki, *Bidens cosmoides* (poola nui), *Mariscus* sp., and *Styphelia tameiameia* (pukiawe) (USFWS 1996) (USFWS, 1998). USFWS (2010) notes that there are 3 known populations with likely less than 200 total plants. Clumped spatial arrangement of the population, narrow environmental specificity, low tolerance ranges and high site fidelity and ecological integrity of the community are inferred based on the species unique habitat requirements and the low number of known populations.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Plants were observed flowering by botanists from the National Tropical Botanical Garden in February 1995 (Steve Perlman, NTBG Provenance Report 1995). No additional life history information for this species is currently available (USFWS, 1998).

Population Information and Trends

Population Trends:

Decreasing (USFWS, 2010)

Number of Populations:

3 (USFWS, 2010))

Population Size:

~200 (USFWS, 2010))

Population Narrative:

Historically, *Schiedea stellarioides* was found at the sea cliffs of Hanakapiai Beach, Kaholuamanu-Opaewela region, the ridge between Waialae and Nawaimaka Valleys, and Haupu Range on the island of Kauai. At the time of listing this species was found only at the ridge between Waialae and Nawaimaka Valleys on State land, just 0.8 kilometer (0.5 mile) northwest of the Kaholuamanu-Opaewela region. This population of approximately 500 to 1,000 individuals was found on steep slopes in a closed *Acacia koa* (*koa*) – *Metrosideros polymorpha* (*ohia*) lowland to montane mesic forest between 610 and 1,120 meters (2,000 and 3,680 feet) elevation. The plants were scattered in approximately a 2-kilometer (1.25-mile) by 0.3-kilometer (0.2-mile) area (USFWS 1996). This situation remains substantially the same, although an additional population in Kawaiiki has been observed, and no plants have been noted from Nawaimaka Stream for some time. The total number of plants may now be less than 200 in the previously known populations (Perlman 2008; National Tropical Botanical Garden 2008). One hundred or more individuals were observed on the south rim of the Waialae Valley by botanists of the National Tropical Botanical Garden at 1,005 to 1,066 meters (3,300 to 3,500 feet) elevation in the years from 1991 through 2004 (Perlman 2008). At a visit in May 2008 Ken Wood of the National Tropical Botanical Garden estimated about 200 plants in the area (Wood 2008). A smaller population occurs in upper Kawaiiki Valley, along the slope below Kaluahaula Ridge. Fifty to sixty scattered individuals were noted through 2001 by Ken Wood of National Tropical Botanical Garden in the Kawaiiki area (Wood 2008) and by Perlman in 2005 (Perlman 2008). The top of a drainage below Kawaiiki Ridge was visited in June 2004 by botanist Natalia Tangalin from the National Tropical Botanical Garden (Tangalin 2005) who saw 20 plants and collected seed from three of them, and in July 2005 by Perlman and Tangalin, who observed about 50 individuals (Perlman 2008; Tangalin 2005; National Tropical Botanical Garden 2008). In May 2008, Wood observed about 20 individuals in this area of Kawaiiki, off Kaluahaula ridge, in the upper forest and drainage to the south of Koaie and north of Waialae (Wood 2008). The third location at the Nawaimaka stream near Waialae was last visited in February 1995 by Steve Perlman (Perlman 2008) and in July 1996 by Ken Wood (Wood 2008). Although the number of plants at that time was not noted, they were observed to be flowering in February (Perlman 2008) (USFWS, 2010). New Status Information: In addition to those populations cited in the previous 5-year review, new observations include the following: • At the time of the last 5-year review in 2010 there were four populations totaling fewer than 200 individuals at Kaholuamanu-Opaewela, Kawaiiki, Waialae, and Nawaimaka. The status of the population at

Kaholuamanu-Opaewela has not been reported since 2010, and *S. stellarioides* has not been reported at Hanakapiai and Haupu since the early 1900s. Currently, there are two populations, one at Kawaiiki to Kaluahaulu ridge and one along the ridge between Waialae and Nawaimaka valleys including above the water fall at Waialae. These occurrences total at least 100 individuals (NTBG 2009, 2010, 2013, 2014, 20151-d; PEPP 2011, 2012, 2013, 2014, 2015). In 2016, IUCN Red List of Threatened Species reported two 'subpopulations' (considered populations by USFWS) of 50 individuals each at the same locations (Clark 2016) (USFWS, 2017).

Threats and Stressors

Stressor: Feral/invasive animals (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Major threats to this species are feral goats, deer, pigs and rats both in terms of trampling and predation (USFWS< 2010).

Stressor: Fire (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Fire is listed as a major threat to this species (USFWS, 2010).

Stressor: Invasive plants (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Invasive plants are listed as a major threat to this species (USFWS, 2010).

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Climate change may also pose a threat to *Schiedea stellarioides* (Factors A and E). However, current climate change models do not allow us to predict specifically what those effects, and their extent, would be for this species (USFWS, 2010)..

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Schiedea stellarioides* is extremely vulnerable to the impacts of climate change, with a vulnerability score of 0.878 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition,

Fortini et al. show that Caryophyllaceae is one of the top four most vulnerable native plant families, and, at the genus level, *Schiedea* had one of the highest vulnerability scores. Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Stressor: Hurricanes—Loss and degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Hurricanes were omitted in the last five year review. In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event, and 70 percent of all listed plant species on Kauai are only found on Kauai. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013) (USFWS, 2017).

Recovery

Reclassification Criteria:

For downlisting, a total of five to seven populations of each taxon should be documented on Kauai where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1998).

Delisting Criteria:

For delisting, a total of 8 to 10 populations of each taxon should be documented on Kauai where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years (Species is a short-lived perennial) (USFWS, 1998).

Conservation Measures and Best Management Practices:

- Fence areas where this species grows to protect against pig damage (USFWS, 2010).
- Determine and implement methods to control rat and slug control around known plants (USFWS, 2010).
- Continue to collect seeds for genetic storage and reintroduction (USFWS, 2010).
- Propagate plants for outplanting (USFWS, 2010).

- Work with Hawaii Division of Forestry and Wildlife and Hawaii State Parks to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2010).
- New Management Actions: • NTBG has several collections from Kawaiiki represented by plants in their nursery. The NTBG seed bank has six founders represented from the Waialae population from a collection in 2008, and one collection from Kawaiiki in 2015 (NTBG 2017). • The University of California, Irvine has 11 founders represented by 12 plants total in their nursery from the Waialae Valley population. • The Lyon Arboretum seed bank has 17 founders represented from a 2010 collection at Nawaimaka, and four founders represented from a 2016 collection at Kawaiiki (Lyon Arboretum 2017). • PEPP is monitoring individuals at Kawaiiki, and outplanted at least 10 individuals, of which 6 survive, with some natural reproduction (PEPP 2011, 2012, 2013, 2014, 2015) (USFWS, 2017).
- Recommendations for Future Actions: No new threats and no other significant new information regarding the species' biological status have been reported since the last 5-year review in 2010. Therefore, the following recommendations for future actions are reiterated for the 5-year review for 2017. • Surveys and inventories—Survey for populations of *Schiedea stellarioides* in areas of potentially suitable habitat. • Ungulate monitoring and control—Protect all occurrences against disturbances from feral ungulates. Construct and maintain fenced exclosures around all populations. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative species that compete with the species around all populations. • Fire monitoring and control—Develop and implement fire management plans for all wild and reintroduced populations. • Predator and herbivore monitoring and control—Implement effective control methods for rodents. Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Population biology research—Study *Schiedea stellarioides* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2017).

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SPECIES ACCOUNT: *Schiedea trinervis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/29/1991; Pacific Region (R1) (USFWS, 2016)

Physical Description

An erect, branched subshrub 3-8 dm tall. The white and green flowers are borne in clusters of 7-20. (NatureServe, 2015)

Taxonomy

No new taxonomic information has been received since the last 5-year review (USFWS 2009). However, the 2012 supplement to the Manual of the Flowering Plants of Hawaii (Wagner et al. 2012) reiterates the change from the genus *Alsinidendron* to the currently accepted *Schiedea*. In 2012, USFWS revised the taxonomic status for this species when it revised critical habitat on Oahu, with no change in range or distribution (USFWS 2012). This species is now listed as *Schiedea trinervis* (USFWS, 2013).

Historical Range

See current range/distribution

Current Range

Current range: Waianae Mountains of Oahu. Historically no additional range.

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

September 18, 2012, the U.S. Fish and Wildlife Service (Service), revised critical habitat for *Schiedea trinervis* on Oahu.

Critical Habitat Designation

Oahu—Montane Wet—Unit 1, Oahu—Dry Cliff—Unit 1, Oahu—Dry Cliff—Unit 2, Oahu—Dry Cliff—Unit 3, Oahu—Dry Cliff—Unit 4, Oahu—Dry Cliff—Unit 6, Oahu—Dry Cliff—Unit 7a, Oahu—Dry Cliff—Unit 7b, Oahu—Dry Cliff—Unit 8, Oahu—Wet Cliff—Unit 1, Oahu—Wet Cliff—Unit 2, Oahu—Wet Cliff—Unit 3, Oahu—Wet Cliff—Unit 4, and Oahu—Wet Cliff—Unit 5 constitute critical habitat for *Schiedea trinervis* on Oahu.

Oahu—Montane Wet—Unit 1 consists of 18 ac (7 ha) of City and County of Honolulu land, 352 ac (142 ha) of State land, and less than 1 ac (less than one ha) of privately-owned land in the montane wet ecosystem at the summit of the Waianae Mountains at Kaala, and partially within the Mokuleia Forest Reserve and the Kaala Natural Area Reserve. This unit is occupied by the plants *Cyanea acuminata*, *C. calycina*, *Labordia cyrtandrae*, *Melicope christophersenii*, and *Schiedea trinervis*, and includes the wet forest and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 4). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations.

Oahu—Dry Cliff—Unit 1 consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. This unit is on State land within the Pahole Natural Area Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). This unit is occupied by the plants *Alectryon macrococcus*, *Cenchrus agrimonioides*, *Chamaesyce herbstii*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Kadua degeneri*, *Plantago princeps* var. *princeps*, and *Schiedea obovata*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 1 is not currently occupied by *Abutilon sandwicense*, *Achyranthes splendens* var. *rotundata*, *Bonamia menziesii*, *Chamaesyce kuwaleana*, *Diellia falcata*, *D. unisora*, *Dubautia herbtsobatae*, *Eragrostis fosbergii*, *Flueggea neowawraea*, *Gouania meyenii*, *G. vitifolia*, *Isodendron laurifolium*, *I. pyrifolium*, *Kadua parvula*, *Korthalsella degeneri*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *M. saint-johnii*, *Neraudia angulata*, *Nototrichium humile*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Platydesma cornuta* var. *decurrans*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Sanicula mariversa*, *Schiedea hookeri*, *S. trinervis*, *Silene lanceolata*, *S. perlmannii*, *Spermolepis hawaiiensis*, *Tetramolopium filiforme*, *T. lepidotum* ssp. *lepidotum*, or *Viola chamissoniana* ssp. *chamissoniana*, the Service has determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 2 consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. This unit is almost entirely within the Makua Keaau Forest Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). Dry Cliff—Unit 2 is occupied by the plants *Abutilon sandwicense*, *Alectryon macrococcus*, *Dubautia herbtsobatae*, *Gouania vitifolia*, *Kadua parvula*, *Lepidium arbuscula*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *Nototrichium humile*, *Peucedanum sandwicense*, *Platydesma cornuta* var. *decurrans*, *Pleomele forbesii*, *Sanicula mariversa*, *Schiedea hookeri*, *Tetramolopium filiforme*, and *Viola chamissoniana* ssp. *chamissoniana*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 2 is not currently occupied by *Achyranthes splendens* var. *rotundata*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Chamaesyce herbstii*, *C. kuwaleana*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia falcata*, *D. unisora*, *Eragrostis fosbergii*, *Flueggea neowawraea*, *Gouania meyenii*, *Isodendron laurifolium*, *I. pyrifolium*, *Kadua degeneri*, *Korthalsella degeneri*, *Lipochaeta lobata* var. *leptophylla*, *Melicope saint-johnii*, *Neraudia angulata*, *Phyllostegia kaalaensis*, *Plantago princeps*, *Pteralyxia macrocarpa*, *Schiedea obovata*, *S. trinervis*, *Silene lanceolata*, *S. perlmannii*, *Spermolepis hawaiiensis*, or *Tetramolopium lepidotum* ssp. *lepidotum*, the Service has determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of

individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 3 consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. This unit is partially within the Waianae Kai Forest Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). This unit is occupied by the plants *Abutilon sandwicense*, *Alectryon macrococcus*, *Bonamia menziesii*, *Diellia falcata*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Flueggea neowawraea*, *Gouania meyenii*, *Isodendron laurifolium*, *Korthalsella degeneri*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *Neraudia angulata*, *Nototrichium humile*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Schiedea hookeri*, *Silene lanceolata*, *Tetramolopium filiforme*, and *Viola chamissoniana* ssp. *chamissoniana*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 3 is not currently occupied by *Achyranthes splendens* var. *rotundata*, *Cenchrus agrimonioides*, *Chamaesyce herbstii*, *C. kuwaleana*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia unisora*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua degeneri*, *K. parvula*, *Melicope saint-johnii*, *Plantago princeps*, *Platydesma cornuta* var. *decurrens*, *Sanicula mariversa*, *Schiedea obovata*, *S. trinervis*, *Silene perlmanii*, *Spermolepis hawaiiensis*, or *Tetramolopium lepidotum* ssp. *lepidotum*, the Service has determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 4 consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. This unit is partially within the Waianae Kai Forest Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). This unit is occupied by the plants *Alectryon macrococcus*, *Chamaesyce kuwaleana*, and *Spermolepis hawaiiensis*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 4 is not currently occupied by *Abutilon sandwicense*, *Achyranthes splendens* var. *rotundata*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Chamaesyce herbstii*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia falcata*, *D. unisora*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Flueggea neowawraea*, *Gouania meyenii*, *G. vitifolia*, *Isodendron laurifolium*, *I. pyriformis*, *Kadua degeneri*, *K. parvula*, *Korthalsella degeneri*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *M. saintjohnii*, *Neraudia angulata*, *Nototrichium humile*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Plantago princeps*, *Platydesma cornuta* var. *decurrens*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Sanicula mariversa*, *Schiedea hookeri*, *S. obovata*, *S. trinervis*, *Silene lanceolata*, *S. perlmanii*, *Tetramolopium filiforme*, *T. lepidotum* ssp. *lepidotum*, or *Viola chamissoniana* ssp. *chamissoniana*, the Service has determined this area to be essential for the conservation and

recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 6 consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). The unit is occupied by the plants *Cenchrus agrimonioides*, *Diellia unisora*, *Flueggea neowawraea*, *Lepidium arbuscula*, *Lobelia niihauensis*, *Melicope saintjohnii*, *Neraudia angulata*, *Plantago princeps*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, and *Tetramolopium lepidotum* ssp. *lepidotum*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 6 is not currently occupied by *Abutilon sandwicense*, *Achyranthes splendens* var. *rotundata*, *Alectryon macrococcus*, *Bonamia menziesii*, *Chamaesyce herbstii*, *C. kuwaleana*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia falcata*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Gouania meyenii*, *G. vitifolia*, *Isodendron laurifolium*, *I. pyrifolium*, *Kadua degeneri*, *K. parvula*, *Korthalsella degeneri*, *Lipochaeta lobata* var. *leptophylla*, *Melanthera tenuifolia*, *Melicope makahae*, *Nototrichium humile*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Platydesma cornuta* var. *decurrens*, *Sanicula mariversa*, *Schiedea hookeri*, *S. obovata*, *S. trinervis*, *Silene lanceolata*, *S. perlmanii*, *Spermolepis hawaiiensis*, *Tetramolopium filiforme*, or *Viola chamissoniana* ssp. *chamissoniana*, the Service has determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 7a consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4), and is occupied by the plants *Flueggea neowawraea*, *Kadua parvula*, *Melicope saint-johnii*, *Plantago princeps*, *Platydesma cornuta* var. *decurrens*,

Pleomele forbesii, *Silene perlmanii*, and *Viola chamissoniana* ssp. *chamissoniana*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 7a is not currently occupied by *Abutilon sandwicense*, *Achyranthes splendens* var. *rotundata*, *Alectryon macrococcus*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Chamaesyce herbstii*, *C. kuwaleana*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia falcata*, *D. unisora*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Gouania meyenii*, *G. vitifolia*, *Isodendron laurifolium*, *I. pyrifolium*, *Kadua degeneri*, *Korthalsella degeneri*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *Neraudia angulata*, *Nototrichium humile*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Pteralyxia*

macrocarpa, *Sanicula mariversa*, *Schiedea hookeri*, *S. obovata*, *S. trinervis*, *Silene lanceolata*, *Spermolepis hawaiiensis*, *Tetramolopium filiforme*, or *T. lepidotum* ssp. *lepidotum*, the Service has determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 7b consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). Although Oahu—Dry Cliff—Unit 7b is not currently occupied by *Abutilon sandwicense*, *Achyranthes splendens* var. *rotundata*, *Alectryon macrococcus*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Chamaesyce herbstii*, *C. kuwaleana*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia falcata*, *D. unisora*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Flueggea neowawraea*, *Gouania meyenii*, *G. vitifolia*, *Isodendron laurifolium*, *I. pyriforme*, *Kadua degeneri*, *K. parvula*, *Korthalsella degeneri*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *M. saintjohnii*, *Neraudia angulata*, *Nototrichium humile*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Plantago princeps*, *Platydesma cornuta* var. *decurrens*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Sanicula mariversa*, *Schiedea hookeri*, *S. obovata*, *S. trinervis*, *Silene lanceolata*, *S. perlmannii*, *Spermolepis hawaiiensis*, *Tetramolopium filiforme*, *T. lepidotum* ssp. *lepidotum*, or *Viola chamissoniana* ssp. *chamissoniana*, the Service has determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Wet Cliff—Unit 1 consists of 167 ac (68 ha) of State land, 68 ac (28 ha) of City and County of Honolulu land, and less than 1 ac (less than 1 ha) of privately owned land in the wet cliff ecosystem in the Waianae Mountains, near the summit of Kaala, and partially within the Mokuleia and Waianae Kai FRs and the Kaala Natural Area Reserve. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 4). Wet Cliff—Unit 1 is occupied by the plants *Cyanea calycina*, *Melicope christophersenii*, and *Schiedea trinervis*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations.

Oahu—Wet Cliff—Unit 2 consists of 3 ac (1 ha) of State land in the wet cliff ecosystem in the Waianae Mountains at Puuhapapa, within a small area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 4). Wet Cliff—Unit 2 is occupied by the plants *Cyanea calycina* and *Melicope christophersenii*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing

the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Wet Cliff—Unit 2 is not currently occupied by *Cyanea acuminata*, *Labordia cyrtandrae*, *Lobelia oahuensis*, *Phyllostegia hirsuta*, *Pteralyxia macrocarpa*, *Schiedea hookeri*, *S. kaalae*, or *S. trinervis*, the Service has determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Wet Cliff—Unit 3 consists of 16 ac (6 ha) in the wet cliff ecosystem on State land in the Waianae Mountains at Puukanehoa, partially within an area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 4). Although Oahu—Wet Cliff—Unit 3 is not currently occupied by *Cyanea acuminata*, *C. calycina*, *Labordia cyrtandrae*, *Lobelia oahuensis*, *Melicope christophersenii*, *Phyllostegia hirsuta*, *Pteralyxia macrocarpa*, *Schiedea hookeri*, *S. kaalae*, or *S. trinervis*, the Service has determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Wet Cliff—Unit 4 consists of 23 ac (9 ha) in the wet cliff ecosystem on State land in the Waianae Mountains at Puukaua, partially overlapping an area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 4). This unit is occupied by the plants *Phyllostegia hirsuta* and *Schiedea hookeri*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Wet Cliff—Unit 4 is not currently occupied by *Cyanea acuminata*, *C. calycina*, *Labordia cyrtandrae*, *Lobelia oahuensis*, *Melicope christophersenii*, *Pteralyxia macrocarpa*, *Schiedea kaalae*, or *S. trinervis*, the Service has determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Wet Cliff—Unit 5 consists of 31 ac (13 ha) of State land in the wet cliff ecosystem in the Waianae Mountains, at Palikea and north of Palikea. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 4). Although Oahu—Wet Cliff—Unit 5 is not currently occupied by *Cyanea acuminata*, *C. calycina*, *Labordia cyrtandrae*, *Lobelia oahuensis*, *Melicope christophersenii*, *Phyllostegia hirsuta*, *Pteralyxia macrocarpa*, *Schiedea hookeri*, *S. kaalae*, or *S. trinervis*, the Service has determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small

numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Primary Constituent Elements/Physical or Biological Features

(i) In unit Oahu—Montane Wet—Unit 1, the physical and biological features of critical habitat are: (A) Elevation: 3,300 to 6,600 ft (1,000 to 2,000 m). (B) Annual precipitation: Greater than 75 in (190 cm). (C) Substrate: Well-developed soils, montane bogs. (D) Canopy: Acacia, Charpentiera, Cheirodendron, Metrosideros. (E) Subcanopy: Broussaisia, Cibotium, Eurya, Ilex, Myrsine. (F) Understory: Ferns, Carex, Coprosma, Leptecophylla, Oreobolus, Rhynchospora, Vaccinium.

(ii) In units Oahu—Dry Cliff—Unit 1, Oahu—Dry Cliff—Unit 2, Oahu—Dry Cliff—Unit 3, Oahu—Dry Cliff—Unit 4, Oahu—Dry Cliff—Unit 6, Oahu—Dry Cliff—Unit 7a, Oahu—Dry Cliff—Unit 7b, and Oahu—Dry Cliff—Unit 8, the physical and biological features of critical habitat are: (A) Elevation: Unrestricted. (B) Annual precipitation: Less than 75 in (190 cm). (C) Substrate: Greater than 65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. (F) Understory: Bidens, Eragrostis, Melanthera, Schiedea.

(iii) In units Oahu—Wet Cliff—Unit 1, Oahu—Wet Cliff—Unit 2, Oahu—Wet Cliff—Unit 3, Oahu—Wet Cliff—Unit 4, and Oahu—Wet Cliff—Unit 5, the physical and biological features of critical habitat are: (A) Elevation: Unrestricted. (B) Annual precipitation: Greater than 75 in (190 cm). (C) Substrate: Greater than 65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: Broussaisia, Cheirodendron, Leptecophylla, Metrosideros. (F) Understory: Bryophytes, Ferns, Coprosma, Dubautia, Kadua, Peperomia.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Little information found although NatureServe (2015) notes the species reproduces sexually.

Reproduction Narrative

Adult: SEXUAL; (NatureServe, 2015). Alsiniidendron trinerve flowers and fruits throughout the year with the possible exception of fall (USFWS 1995) (USFWS, 1998).

Habitat Type

Adult: Wet/mesic forest (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 2013)

Environmental Specificity

Adult: Narrow/specialist (USFWS, 1998; USFWS, 2013)

Tolerance Ranges/Thresholds

Adult: Low (USFWS, 1998; USFWS, 2013)

Site Fidelity

Adult: High (USFWS, 1998; USFWS, 2013)

Habitat Narrative

Adult: Species inhabits slopes or ridges in wet forest or wetter portions of diverse mesic forest. Also found in drier forests. (NatureServe, 2015). *Alsinidendron trinerve* typically grows on slopes in wet forest or the wetter portions of diverse mesic forest dominated by ohia and flex anomala (kawau) at an elevation of 900 to 1,200 meters (3,000 to 4,000 feet) (USFWS 1995). Associated plants include *Coprosma* sp. (pilo), *Gunnera* (apeape), *Melicope* sp. (alani), *Cibotium* sp. (hapuu), *Antidesma platyphylla* (hame), and mamaki (USFWS 1995) (USFWS, 1998). USFWS (2013) notes that there is only one known population. Clumped spatial arrangement of the population, narrow environmental specificity, low tolerance ranges and high site fidelity and ecological integrity of the community are inferred based on the species unique habitat requirements and the low number of known populations (One).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: No information found.

Population Information and Trends**Population Trends:**

Increasing (USFWS, 2013)

Resiliency:

Low (USFWS, 2013)

Representation:

Low (USFWS, 2013)

Redundancy:

Low (USFWS, 2013)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Fragility unknown. Less than forty plants. Two current (between 1982 and 1997) and four historical occurrences. (NatureServe, 2015). In 2010, a few individuals of *Schiedea trinervis* were rediscovered in East Makalela, an area to be fenced after the signing of an U. S. Army Garrison and State of Hawaii real estate agreement (U.S. Army Garrison 2010). In 2011, there were a total of 666 individuals in all populations of which 200 were mature and 185 were immature individuals, and 281 were seedlings (U.S. Army Garrison 2011) (USFWS, 2013). Low

resiliency, redundancy and representation are based on the species only having one known population with a limited number of individuals.

Threats and Stressors

Stressor: Ungulates (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Trampling from feral animals (especially pigs) is listed as a threat to this species (USFWS, 2013)

Stressor: Military training activities (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: This species sole population is found on an army installation. Military training activities are a threat to this species (USFWS, 2013).

Stressor: Alien plant species (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Alien plant species are known to alter the ecosystem and are listed as a threat to this species (USFWS, 2013).

Stressor: Human trampling (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Trampling by humans is listed as a threat to this species (USFWS, 2013).

Stressor: Over-collection (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Collection by humans is listed as a threat to this species (USFWS, 2013).

Stressor: Slugs (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Predation by slugs is listed as a threat to this species (USFWS, 2013).

Stressor: Climate change (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) funded climate modeling that will help resolve these spatial limitations. High spatial resolution climate outputs are expected in 2013 (USFWS, 2013).

Recovery

Reclassification Criteria:

For downlisting, a total of five to seven populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1998).

Delisting Criteria:

A total of 8 to 10 populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1998).

Conservation Measures and Best Management Practices:

- Surveys/inventories o Search for additional individuals of *Schiedea trinervis* in its historical range. o Continue mapping the entire range of populations (USFWS, 2013).
- Population biology research o Study *Schiedea trinervis* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. o Determine if additional populations should be reintroduced or if this species can be recovered with one large population (USFWS, 2013).
- Genetic research - Assess genetic variability within the one extant population (USFWS, 2013).
- Existing population management and restoration o Protect, manage within current wild populations o Manage all individuals of *Schiedea trinervis* (USFWS, 2013).
- Alliance and partnership development - Alliance and partnership development - Continue planning and contribute to implementation of ecosystem-level management and restoration to benefit this species with the U.S. Army Garrison, Hawaii Division of Forestry and Wildlife, and other landowners (USFWS, 2013).
- Captive propagation for genetic storage and reintroduction: Complete collection of fruit from wild individuals; augment these collections with seed from reintroduced individuals to add genetic diversity of ex situ seed storage (USFWS, 2013).
- Ecosystem-altering invasive plant species control: Control introduced invasive plant species around wild and reintroduced plants (USFWS, 2013).
- Ungulate exclosures - Construct large-scale fences to control feral ungulates around entire population and reintroduced individuals (USFWS, 2013).

- Reintroduction / translocation - Continue reintroducing individuals into protected suitable habitat within historical range (USFWS, 2013).
- Threats research - Investigate techniques to improve natural recruitment, including the development of an effective slug control method (USFWS, 2013).

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SPECIES ACCOUNT: *Schiedea verticillata* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 08/21/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

A fleshy, perennial herb with an enlarged root. Stems are ascending, sometimes pendent, 4-6 dm long. The plant dies back to its root during the dry season. (NatureServe, 2015)

Taxonomy

The first specimens of *Schiedea verticillata* were collected near Derby's Landing in 1923. Brown (in Christophersen and Caum 1931) chose the specific epithet to refer to the verticillate (whorled) arrangement of the leaves. Although Sherff (1944) transferred the species to the genus *Alsinidendron*, current workers (Wagner et al. 1990) consider it to be a species of *Schiedea* (USFWS, 1998).

Historical Range

See current range/distribution

Current Range

Known only on Nihoa Island in Hawaii (USFWS, 2003).

Critical Habitat Designated

Yes; 5/22/2003.

Legal Description

On May 22, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat for *Schiedea verticillata*.

Critical Habitat Designation

Nihoa 3 constitutes critical habitat for *Schiedea verticillata*. This unit is critical habitat for *Schiedea verticillata* and is 69 ha (171 ac) on federally owned land. It includes the entire island, which is part of the HINWR. The unit provides habitat that is essential to the conservation of 300 mature, reproducing individuals of this short-lived perennial and, based on surveys conducted in 1996, contained at least 11 colonies and a total of at least 372 individuals. The habitat features contained in this unit that are essential for this species include, but are not limited to, rocky scree, soil pockets, and cracks on coastal cliff faces and in *Pritchardia remota* coastal mesic forest that contain one or more of the following associated native species and lichens: *Eragrostis variabilis*, *Rumex albescens*, and *Tribulus cistoides*. This critical habitat unit is essential to the conservation of the species because it supports extant colonies of *S. verticillata* and includes habitat that is important to the expansion of the present population on Nihoa.

Primary Constituent Elements/Physical or Biological Features

On Nihoa, the currently known primary constituent elements of critical habitat for *Schiedea verticillata* include, but are not limited to, the habitat components provided by:

(1) Rocky scree, soil pockets, and cracks on coastal cliff faces and in *Pritchardia remota* coastal mesic forest and containing one or more of the following associated native plant species: *Eragrostis variabilis*, *Rumex albescens*, *Tribulus cistoides*, or lichens; and

(2) Elevations between 30 and 242 m (100 and 800 ft).

Special Management Considerations or Protections

In general, taking all of the recommended management actions into account, the following management actions are ranked in order of importance. It should be noted, however, that, on a case-by-case basis, some of these actions may rise to a higher level of importance for a particular species or area, depending on the biological and physical requirements of the species and the location(s) of the individual plants: (1) Nonnative plant control; (2) Rodent control; (3) Invertebrate pest control; (4) Fire control; (5) Maintenance of genetic material of the endangered plant species; (6) Propagation, reintroduction, and/or augmentation of existing populations into areas deemed essential for the recovery of the species; (7) Ongoing management of the wild, outplanted, and augmented populations; (8) Maintenance of natural pollinators and pollinating systems, when known; (9) Habitat management and restoration in areas deemed essential for the recovery of the species; (10) Monitoring of the wild, outplanted, and augmented populations; (11) Rare plant surveys; and (12) Control of human activities/ access

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Unknown (USFWS, 1998)

Dependency on Other Individuals or Species

Adult: Moth pollinated (USFWS, 2017).

Reproduction Narrative

Adult: *Schiedea verticillata* is a short-lived perennial. Conant's data (1985) indicated that the reproductive cycle may not be seasonal, since many life stages were found simultaneously throughout the year. Her observations also indicated that the plants flower, set, and disperse seed in a relatively short period of time (USFWS, 1998). A 2015 study provided evidence in support of moth pollination of *S. verticillata*. In addition, genetic analysis shows that *S. verticillata* maintains a high level of genetic diversity despite being a single-island endemic (*S. Weller pers. comm. in Plentovich et al. 2015*)(USFWS, 2017).

Habitat Type

Adult: Cliff faces (USFWS, 1998)

Spatial Arrangements of the Population

Adult: Clumped (inferred from USFWS, 1998)

Environmental Specificity

Adult: Narrow/specialist (inferred from USFWS, 1998)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1998)

Site Fidelity

Adult: High (inferred from USFWS, 1998)

Habitat Narrative

Adult: *Schiedea verticillata* typically grows in soil pockets and cracks on coastal cliff faces at elevations between 30 and 242 meters (100 and 800 feet). Associated taxa include *Tribulus cistoides*, *Eragrostis variabilis*, *Rumex albescens*, and lichens on surrounding rock (USFWS, 1998). Clumped spatial arrangement of the population, narrow environmental specificity, low tolerance ranges and high site fidelity and ecological integrity of the community are inferred based on the species unique habitat requirements and the low number of known populations.

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: *Schiedea verticillata* is a short-lived perennial. Conant's data (1985) indicated that the reproductive cycle may not be seasonal, since many life stages were found simultaneously throughout the year. Her observations also indicated that the plants flower, set, and disperse seed in a relatively short period of time. The means of pollination are unknown (USFWS, 1998).

Population Information and Trends**Population Trends:**

Stable to increasing (USFWS, 2009)

Number of Populations:

8 (USFWS, 2017)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Schiedea verticillata was discovered on Nihoa in 1923 and described in 1931 by Forrest Brown, and has never been found elsewhere. All but one of the historically known colonies were still known to be extant at the time of the critical habitat designation (USFWS 2003), and colony locations and plant numbers were observed to shift with each visit. However, total numbers island-wide remained relatively stable until the large increase during the last census in 2006. Populations are apparently able to recover from recent periodic vagrant grasshopper (*Schistocerca nitens*) infestations (USFWS, 2009). Currently there are eight estimated to be 1,000 individuals from Dog's Head to Derby's Beach, at Devil's Slide, Needle Rock, Miller's Peak, Albatross Plateau, Middle Valley, Tanager Peak, and Tunnel Cave on the island of Nihoa (USFWS, 2017).

Threats and Stressors

Stressor: Alien plants and insects (USFWS, 1998)

Exposure:**Response:**

Consequence: Loss of habitat

Narrative: Alien plant and insect species on the island may be posing threats to this species (USFWS, 1998).

Stressor: Rodent predation (USFWS, 1998)

Exposure:**Response:**

Consequence: Loss of individuals

Narrative: Rodent predation could prove disastrous for *Schiedea verticillata*, since rodents may be attracted to feed on its fleshy root. Rodents have yet to be found on Nihoa but the threat of their unintentional transport there is ongoing (USFWS, 1998).

Stressor: Stochastic extinction/Reduced vegetative vigor (USFWS, 1998)

Exposure:**Response:**

Consequence: Extinction

Narrative: It is threatened by stochastic extinction and/or reduced reproductive vigor due to its very restricted range, small numbers, and the vulnerability of plants to disturbance events in their steep, rocky habitat (Conant 1985) (USFWS, 1985).

Stressor: Fire/human disturbance (USFWS, 1998)

Exposure:**Response:**

Consequence: Loss of habitat/loss of individuals

Narrative: Fire and other human disturbances also pose potential threats to this species (USFWS, 1998).

Stressor: Climate change loss or degradation of habitat (USFWS, 2017)

Exposure:**Response:****Consequence:**

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment was not conducted specifically for *Schiedea verticillata*. However, it was concluded that the genus *Schiedea* (with a vulnerability score of 0.512; on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change) is the genus most vulnerable to climate change. Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery**Reclassification Criteria:**

For downlisting, interim objectives must be attained. In addition, a total of at least five colonies should exist on Nihoa and successful propagation and outplanting ex situ must be underway. Each of these must be stable, secure, and naturally reproducing. Colony sizes on Nihoa should

be increased with caution, and only if there is good evidence that Nihoa can support additional colony growth without negative ecological impacts. This is a concern because of Nihoa's small size and its relatively intact, native ecosystem. Colony sizes will ultimately be determined by the carrying capacity of the site where they are grown. However, a preliminary target level for *Schiedea verticillata* is a minimum of 300 mature individuals per colony. Each colony should be stable or increasing minimum of five consecutive years before downlisting is considered. The need for continued species-specific management actions should not preclude downlisting. As a component of threat control, a remote monitoring system should be installed on Nihoa to detect and record illegal landings and shipwrecks on the island and relay the information to National Wildlife Refuge (NWR) staff in Honolulu (USFWS, 2009).

Delisting Criteria:

To achieve delisting objectives, downlisting objectives must be attained. In addition, delisting may be considered with the establishment of one to three additional colonies on an island other than Nihoa. Necker Island, Kilauea Point, and Midway Atoll NWRs should be assessed for suitability since they are protected areas, have plant nursery facilities, and have full-time staffs. Midway has a similar climate to Nihoa and Kilauea Point, with has north-facing cliffs similar to those on Nihoa. Should establishment of one to three colonies of this taxon on an island other than Nihoa occur, delisting may be considered when they have reached the same targets as those described for downlisting, including a minimum of 300 mature individuals per colony. Each colony should be stable or increasing for a minimum of five consecutive years. If the establishment of this taxon on a second island proves unfeasible, delisting may be considered if the downlisting objectives have been met and the colonies persist at target levels for a minimum of ten years. In order to initiate delisting in any of the above situations, there should no longer be a need for continued species-specific management actions, but delisting may proceed if there is a continuing need for ecosystem-wide management actions (USFWS, 2009).

Recovery Actions:

- 1. Invasive plant monitoring and control— Continue to prevent invasion of any introduced species to Nihoa and control invasive introduced plant species in all existing populations and periodically monitor to ensure invasive species are not establishing nearby (USFWS, 2017).
- 2. Predator and herbivore monitoring and control—Determine if control of the vagrant grasshopper is needed, and if so, develop an efficient and effective control method (USFWS, 2017).
- 3. Captive propagation for genetic storage and reintroduction—Continue seed and cuttings collection for ex situ genetic storage (USFWS, 2017).
- 4. Reintroduction and translocation— Begin reintroduction efforts to increase underrepresented individuals into suitable habitat being managed for known threats to this species and Assess feasibility of outplanting *Schiedea verticillata* on Lehua Island State Bird Sanctuary, Necker Island National Wildlife Refuge (NWR), Kilauea Point NWR, and Midway Atoll NWR, which are the closest islands to Nihoa and are managed for conservation (USFWS, 2017).
- 5. Human disturbance—Continue to restrict access to Nihoa Island (USFWS, 2017).
- 6. Population biology research—Study *Schiedea verticillata* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Continue seed and cuttings collection for ex situ genetic storage and reintroduction from underrepresented individuals (USFWS, 2009).
- Continue to restrict human access (USFWS, 2009).
- Control invasive introduced plant species in all existing populations and periodically monitor to ensure invasive species are not establishing nearby (USFWS, 2009).
- Continue to prevent invasion of any introduced species on Nihoa (USFWS, 2009).
- Determine if control of the vagrant grasshopper is needed, and if so, develop an efficient and effective control method (USFWS, 2009).
- Assess feasibility of outplanting *Schiedea verticillata* on Lehua Island State Bird Sanctuary, Necker Island National Wildlife Refuge (NWR), Kilauea Point NWR, and Midway Atoll NWR, which are the closest islands to Nihoa and are managed for conservation (USFWS, 2009).
- Work with Hawaii Division of Forestry and Wildlife and NWRs to provide ecosystem level restoration and management of reintroduction sites to benefit this species (USFWS, 2009).
- Study *Schiedea verticillata* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2009).

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SPECIES ACCOUNT: *Schiedea viscosa* (= *Alsinidendron viscosum*) (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Alsinidendron viscosum, a member of the pink family, is a weakly climbing or sprawling subshrub. The stems are 0.6 to 3 m (2.0 to 9.8 ft) long, and densely covered with fine glandular hairs throughout. The thin and membranous leaves are narrowly elliptic and are 2.5 to 5 cm (1.0 to 2.0 in) long and 0.8 to 1.8 cm (0.3 to 0.7 in) wide. Usually three to nine flowers are arranged in loose clusters with stalks ranging from 2 to 3.5 cm (0.8 to 1.4 in) long. The four sepals are white, thin, and membranous, and remain so at maturity. The outer two sepals greatly overlap the inner ones. The sepals are oblong in shape and 8 to 9 millimeters (0.3 inch) long, but enlarge to approximately 12 mm (0.5 in) long in fruit, completely enclosing the fruit at maturity. The stamens are scarcely fused at the base and the basal outgrowths are about 3 mm (0.1 in) long, nearly as wide, and two-toothed. The fruits are egg-shaped capsules, 8 to 12 mm (0.3 to 0.5 in) long, and opening by five to seven valves. The seeds are dark reddish brown, and approximately 0.8 mm (0.03 in) long with a minutely hairy surface. (USFWS, 1998)

Taxonomy

Described by H. Mann in 1866 as *Schiedea viscosa* from collections he made between 1864 and 1865 with W. Brigham, E.E. Sherff later transferred the species to *Alsinidendron*, which was considered distinct from *Schiedea* based on a suite of characters (Wagner et al. 1999). More recently, based on molecular and morphological data, Wagner et al. (2005) concluded that *Alsinidendron* formed a monophyletic group within *Schiedea*, and should therefore be subsumed into the latter genus. As such, the synonym *Schiedea viscosa* H. Mann was reestablished as the recognized species name. Therefore, the Service will refer to the taxon as *S. viscosa* throughout the remainder of this review. *Alsinidendron viscosum* is closely related to *Alsinidendron lychnoides*, which differs primarily in having wider leaves and more capsule valves and flowers per cluster (USFWS 1996). (USFWS, 2009; USFWS, 1998)

Historical Range

Historically, *Alsinidendron viscosum* was found at the Kaholuamano, Kokee, Halemanu, Nawaimaka, and Waialae areas of northwestern Kauai (USFWS 1996). (USFWS, 1998)

Current Range

This species is currently found only in Kauai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Schiedea viscosa* (= *Alsinidendron viscosum*) on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Schiedea viscosa* (= *Alsinidendron viscosum*) includes four units totaling 2,066 acres in Kauai County, Hawaii. The units are Kauai 11—*Alsinidendron viscosum*—a, b, c, d.

Kauai 11—*Alsinidendron viscosum*—a: This unit is critical habitat for *Alsinidendron viscosum* and is 736 ha (1,820 ac) on State land (Alakai Wilderness Preserve). This unit contains portions of Kaluahaulu and Kawaiiki Ridge. This unit provides habitat for seven populations of 300 mature, reproducing individuals of the shortlived perennial *Alsinidendron viscosum* and is currently occupied with 26 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep slopes in *Acacia koa*-*Metrosideros polymorpha* lowland or montane mesic forest. This unit is geographically separated from other units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Alsinidendron viscosum*—b: This unit is critical habitat for *Alsinidendron viscosum* and is 17 ha (42 ac) on State land (Kokee State Park) and contains a portion of Kumuela Ridge. This unit, in combination with *Alsinidendron viscosum*—c, provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Alsinidendron viscosum* and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is essential to the establishment of additional populations on Kauai in order to reach recovery goals. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep slopes in *Acacia koa*-*Metrosideros polymorpha* lowland or montane mesic forest. This unit is geographically separated from other units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Alsinidendron viscosum*—c: This unit is critical habitat for *Alsinidendron viscosum* and is 22 ha (55 ac) on State land (Kokee State Park) and contains a portion of Kauaikinana Stream and Kumuela Trail and Ridge. This unit, in combination with *Alsinidendron viscosum*—b, provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Alsinidendron viscosum* and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is essential to the establishment of additional populations on Kauai in order to reach recovery goals. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep slopes in *Acacia koa*-*Metrosideros polymorpha* lowland or montane mesic forest. This unit is geographically separated from other units designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—*Alsinidendron viscosum*—d: This unit is critical habitat for *Alsinidendron viscosum* and is 61 ha (150 ac) on State land (Alakai Wilderness Preserve) and contains a portion of Mohihi Waiālae Trail and Kohua Ridge. This unit provides habitat for one population of 300 mature, reproducing individuals of the shortlived perennial *Alsinidendron viscosum* and is currently occupied with 26 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, steep slopes in *Acacia koa*-*Metrosideros polymorpha* lowland or montane mesic forest. This unit is geographically separated from the

other three units designated as critical habitat for this island-endemic species to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. The 267 other plants on Kauai are not included in critical habitat because the habitat they occupy is not considered essential to the conservation of this species. The more appropriate habitat on Kauai, within its historical range, are being designated as critical habitat.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Steep slopes in *Acacia koa*/*Metrosideros polymorpha* lowland and montane mesic forest and containing one or more of the following native plant species: *Alyxia oliviformis*, *Asplenium polyodon*, *Bidens cosmoides*, *Bobea* spp., *Carex meyenii*, *Carex wahuensis*, *Coprosma* spp., *Dianella sandwicensis*, *Dodonaea viscosa*, *Doodia kunthiana*, *Dryopteris glabra*, *Dryopteris unidentata*, *Dryopteris wallichiana*, *Dubautia laevigata*, *Gahnia* spp., *Ilex anomala*, *Melicope* spp., *Panicum nephelophilum*, *Pleomele aurea*, *Psychotria* spp., *Pteridium aquilinum* var. *decompositum*, *Schiedea stellarioides*, or *Vaccinium dentatum*; and

(ii) Elevations between 754 and 1,224 m (2,474 and 4,016 ft).

Special Management Considerations or Protections

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: *Alsinidendron viscosum* was observed in flower during January, February, and April 1995 (5. Perlman, NTBG, Provenance Report 1995). Herbarium vouchers at Bernice P. Bishop Museum (C. Imada, Bernice P. Bishop Museum, pers. comm. 2008) and National Tropical Botanical Garden (2008a) were flowering in January, February, March, April, May, June, and December; fruiting specimens were found from January, February, March, April, July or August, and December. Seeds are self-fertilized in cultivation (Wagner et al. 2005). (USFWS, 1998)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 820 and 1,070 meters on steep slopes (USFWS, 1998)

Environmental Specificity

Adult: Low, with few key requirements (USFWS, 1998)

Habitat Narrative

Adult: *Alsinidendron viscosum* is typically found at elevations between 820 and 1,070 meters (2,700 and 3,510 feet), on steep slopes in *Acacia koa* (*koa*)-*ohia* lowland mesic or wet forest. Associated plant species include *Alyxia oliviformis* (*maile*), *Bobea* sp. (*ahakea*), *Carex* sp., *Dodonaea viscosa* (*aalii*), *ilex anomala* (*aiea*), *Melicope* sp. (*alani*), *Pleomele* sp. (*halapepe*), and *Psychotrias* (*kopiko*) (USFWS 1996). (USFWS, 1998)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2009)

Redundancy:

Very low (inferred from USFWS, 2009)

Number of Populations:

4-7 (USFWS, 2009)

Population Size:

30 - 300 individuals (USFWS, 2009)

Population Narrative:

The critical habitat designation for Kauai and Niihau (USFWS 2003) reports seven populations with about 319 individuals, all on State-owned land at the Halemanu-Kokee Trail, Mohihi-Waialae Trail, Kawaiiki Valley, Waialae Falls, and Nawaimaka Valley in the Alakai Wilderness Preserve, Kokee State Park, and the Na Pali-Kona Forest Reserve. Perlman (2006) listed four populations with 30 individuals as of mid-2005, and Katie Cassell of the Kokee Resource Conservation Program reported a few more individuals in Kokee in 2007, although exact numbers are unknown (USFWS 2008). (USFWS, 2009). At the time of the last 5-year review in 2009 there were four populations totaling 30 or more individuals from Nawaimaka Valley and Mohihi-Waialae Trail on the island of Kauai. Since then, there are between nine and 16 occurrences totaling fewer than 300 individuals (NTBG 2008, 2010, 2011, 2012a-b, 2013a-e, 2014a-b, 2015, 2016; PEPP 2011, 2012, 2013, 2014, 2015). In 2016, Clark reported 100

individuals in nine 'subpopulations' (considered as populations by USFWS), with the largest population consisting of only 20 individuals (Clark 2016). These populations occur in Kokee, Kawaiiki, Koaie, Mohihi, and Poomau (USFWS, 2017).

Threats and Stressors

Stressor: Invasive plant species (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Introduced invasive plant species threatening *S. viscosa* include *Lantana camara* (lantana), *Psidium guajava* (guava), *P. cattleianum* (strawberry guava), *Gravillea robusta* (silk-oak), *Erigeron karvinskianus* (daisy fleabane), *Hedychium gardnerianum* (kahili ginger), *Rubus argutus* (prickly Florida blackberry), and *Melinis minutiflora* (molasses grass) (USFWS 1996, 1998, 2003; K. Wood, Research Biologist, National Tropical Botanical Garden, pers. comm. 2008). (USFWS, 2009)

Stressor: Habitat degradation and predation (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Habitat degradation and predation by feral pigs (*Sus scrofa*), goats (*Capra hircus*), and mule deer (*Odocoileus hemionus*) continue to be threats to the remaining individuals of *Schiedea viscosa*. (USFWS, 2009)

Stressor: Small population size (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: In addition to all of the other threats, species like *Schiedea viscosa* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding and disease outbreaks. When considered on their own, the natural processes associated with being a single island endemic do not affect *S. viscosa* to such a degree that it is threatened or endangered with extinction in the foreseeable future, but these natural processes can exacerbate the threat from anthropogenic factors, such as habitat loss from or predation by introduced species (USFWS 1998). (USFWS, 2009)

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Schiedea viscosa* is extremely

vulnerable to the impacts of climate change, with a vulnerability score of 0.839 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, Fortini et al. show that Caryophyllaceae is one of the top four most vulnerable native plant families, and, at the genus level, *Schiedea* had one of the highest vulnerability scores. Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Kauai where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Kauai where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1998)

Recovery Actions:

- Remove alien plants inside completed enclosures. The U.S. Fish and Wildlife Service intends to fence the Nawaikama population in 1998 to protect it from imminent destruction by goats. Once enclosed, this area should be surveyed and managed to reduce threats from the following plant species: prickly Florida blackberry, lantana, and molasses grass. (USFWS, 1998)
- Additional enclosures should be constructed around the Waialae Ridge population, the Ditch Trail population and the Mohihi-Waialae Trail population. Once enclosed, those areas should undergo management to remove alien plants. (USFWS, 1998)
- In order to prevent this taxon from going extinct, propagation efforts and the maintenance of adequate genetic stock ex situ should be continued. Additional wild seeds should be collected periodically until the cryopreservation method of long-term storage is perfected. This will insure that viable seed stock is available for outplanting. (USFWS, 1998)
- Ongoing monitoring in those areas that are fenced should be used to determine the most appropriate outplanting sites in the future. Outplanting in these areas can boost population numbers to reduce risk of extinction from naturally occurring events or from reduced

reproductive vigor, due to the small numbers of extant populations and individuals. (USFWS, 1998)

Conservation Measures and Best Management Practices:

- Continue seed collection for ex situ genetic storage and future reintroductions. (USFWS, 2009)
- Manage feral ungulates and invasive introduced plant species around remaining individuals. (USFWS, 2009)
- Augment populations as plants become available in nurseries and habitat is protected. (USFWS, 2009)
- Reintroduce individuals into suitable habitat within historical range that is being managed for known threats to this species. (USFWS, 2009)
- Assess of genetic variability within extant and ex situ populations. (USFWS, 2009)
- Continue surveys for additional populations and individuals in known historical sites and other areas of suitable habitat. (USFWS, 2009)
- Study *Schiedea viscosa* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. (USFWS, 2009)
- Update the name of the listed entity in 50 CFR 17 to match the currently recognized taxonomy. (USFWS, 2009)
- New Management Actions: • NTBG seed bank has 33 collections from seven populations totaling thousands of seeds. Dozens of plants are also in the NTBG nursery (NTBG 2017). The University of California at Irvine has 22 plants in their nursery from Mohihi-Waialae Trail (UCI 2014). PEPP botanists collected seeds for propagation at Lyon Arboretum and NTBG (PEPP 2011, 2013, 2015). Lyon Arboretum's Seed Conservation Laboratory has over 150,000 seeds in storage. There are nine founders represented from Halemanu, one from Waineke, 16 founders from one site and one founder from another site in Kawaiiki, two founders from Mohihi, six founders from Kehua Ridge, and 22 founders from Poomau. This totals 57 founders, over half of the known plants. Lyon Arboretum's Micropropagation lab maintains explants from three founders from Kokee (Lyon Arboretum 2017). The Kokee Rare Plant Facility has 50 plants from four founders (three from Poomau and one from Mohihi) at its nursery (DOFAW 2016). • PEPP outplanted *Schiedea viscosa* into monitored exclosures at Kawaiiki (12 individuals), Koaie (13 individuals), and Kumuwela (23 individuals) (PEPP 2012, 2013, 2014). • PEPP monitors wild populations of *Schiedea viscosa* at Kawaiiki, Mohihi, Koaie, Kokee Ditch Trail, Halemanu, and Kohua ridge (PEPP 2011, 2012, 2013, 2014, 2015) (USFWS, 2017).
- Recommendations for Future Actions: No new threats and no other significant new information regarding the species' biological status have been reported since the last 5-year review in 2009. Therefore, the following recommendations for future actions are reiterated for the 5-year review for 2017. • Surveys and inventories—Survey for additional populations and individuals in known historical sites and other areas of suitable habitat. • Ungulate monitoring and control—Protect all occurrences against browsing and disturbances from feral ungulates. Continue to construct and maintain fenced exclosures around all populations. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control nonnative plant species in the immediate vicinity of *Schiedea viscosa* populations that compete with this species. • Captive propagation for genetic storage and reintroduction—Continue collection of seeds and propagation for reintroduction, using hand pollination of flowers to increase seed set, where possible. • Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historical range that is being managed for known threats to this species.

- Population biology research—Study *Schiedea viscosa* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2017).

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SPECIES ACCOUNT: *Schoenocrambe argillacea* (Clay reed-mustard)

Species Taxonomic and Listing Information

Listing Status: Threatened; 01/14/1992; Mountain-Prairie Region (Region 6) (USFWS, 2016)

Physical Description

A perennial herbaceous plant in the mustard family, with sparsely leafed stems 15 to 30 cm (6 to 12 in) tall arising from a woody root crown. The leaves are very narrow with a smooth margin, 10 to 35 mm (0.4 to 1.4 in) long and, usually, less than 2 mm (0.1 inch) wide. The leaf blades are alternately arranged on the stem and, for the most part, are attached directly to the stem without a petiole. The narrow, fleshy leaves are covered with a white, waxy surface. The flowers of clay reed-mustard have petals that are pale lavender to whitish with prominent purple veins and measure 8 to 11 mm (0.3 to 0.4 inch) long and 3.5 to 4.5 mm (0.14 to 0.18 inch) wide. The entire flowers are about 1 cm (0.4 inch) across in full anthesis and are displayed in a raceme of 3 to 20 flowers at the end of the plant's leafy stems. Flowers are pale lavender to whitish with conspicuous purple veins. Blooms in late April and early May. (USFWS, 2016; NatureServe, 2015)

Taxonomy

The species was first discovered and recorded by Dr. Duane Atwood in 1976. It was described as *Thelypodium argillacea* in 1977, moved to the genus *Schoenocrambe* in 1982, and most recently renamed *Hesperidanthus argillaceus* (Al-Shehbaz 2010). The latter is the name now accepted for this species by the Flora of North America and the integrated taxonomic information system (Al-Shehbaz 2010; ITIS 2017). (USFWS, 2019)

Current Range

Endemic to the Uinta Basin (Book Cliffs area) in Uintah County, northeast Utah. Known range is only about 24 km x 12 km, from the west side of the Green River to the east side of Willow Creek (USFWS 1994). Franklin (2005) describes the three population areas as follows: "along the east slopes of Big Pack Mountain and in Broome Canyon to the east; along the west slopes of Wild Horse Bench, from the vicinity of Kings Canyon and south nearly to The Wrinkles; and along the slopes of the canyons above Ray's Bottom, on the west side of the Green River." (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 1994)

Breeding Season

Adult: April to May (USFWS, 1994)

Reproduction Narrative

Adult: Flowering occurs from April to May and fruiting occurs May to June in all three species. Reproduction in each of the three species is sexual. (USFWS, 1994)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Bare rock/talus/scree, barrens, desert (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at elevations between 1440 to 1765 meters (NatureServe, 2015)

Habitat Narrative

Adult: Occurs within shadscale, Indian ricegrass, pygmy sagebrush, and other mixed desert shrub communities on precipitous, typically north-facing slopes. On these slopes (elevations from 1440 to 1765 m), plants grow in both exposed and protected sites, with protected sites usually having the more robust plants. Substrates consist of at-the-surface bedrock, scree, and fine-textured soils, often clay soils rich in gypsum (shale barrens) overlain with sandstone talus. Occurs about the zone of contact between the Tertiary lower Uinta Formation and the Evacuon Creek Member of the upper Green River shale Formation. Commonly associated species include *Eriogonum corymbosum*, *Ephedra torreyana*, *Atriplex confertifolia*, *Atriplex gardneri* var. *cuneata*, *Elymus salinus*, *Tetradymia nuttallii*, and *Amelanchier utahensis*; other associates include *Agropyron smithii*, *Arabis pendulina*, *Arabis pulchra*, *Artemisia nova*, *Astragalus chamaeleuce*, *Astragalus convallarius*, *Brickellia oblongifolia*, *Castilleja chromosa*, *Chrysothamnus viscidiflorus*, *Cryptantha rollinsii*, *Cymopterus fendleri*, *Eriogonum ovalifolium*, *Euphorbia fendleri*, *Leptodactylon pungens*, *Penstemon carnosus*, *Petradora pumila*, *Cymopterus terebinthinus*, *Stipa hymenoides*, *Tetradymia spinosa*, and *Thelesperma subnudum*. (NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Number of Populations:

3 (USFWS, 2011)

Population Size:

~6,000 (USFWS, 2011)

Population Narrative:

Schoenocrambe argillacea occurs in six populations in Uintah County. In 1992, the Utah Natural Heritage Program completed an extensive survey of potential habitat for Schoenocrambe argillacea and estimated the total number of S. argillacea was 6,000 plants (Franklin 1992; Service 1994). (USFWS, 2011)

Threats and Stressors

Stressor: Oil and gas development (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Oil and gas development remains a significant threat to Schoenocrambe argillacea populations and habitat (Service 1990; 1994). All Federal lands on which known populations of S. argillacea occur are leased for oil and gas development (Utah Division of Oil, Gas, and Mining (UDOGM) 2011). To date, oil and gas development within known S. argillacea areas has been moderate. The Service does not know the actual ground disturbance at this point from oil and gas development, but the Service estimates approximately 5 acres (2 hectares) of total disturbance per well, including roads and infrastructure. After excluding directional wells (which are usually drilled from existing well pads), the Service calculated that at least 130 acres are disturbed within S. argillacea populations as mapped, and an additional 85 acres could be disturbed as currently approved oil and gas wells are drilled within the next 2 years (UDOGM 2011). Oil and gas development remains a significant threat to Schoenocrambe argillacea populations and habitat (Service 1990; 1994). All Federal lands on which known populations of S. argillacea occur are leased for oil and gas development (Utah Division of Oil, Gas, and Mining (UDOGM) 2011). To date, oil and gas development within known S. argillacea areas has been moderate. The Service does not know the actual ground disturbance at this point from oil and gas development, but the Service estimates approximately 5 acres (2 hectares) of total disturbance per well, including roads and infrastructure. After excluding directional wells (which are usually drilled from existing well pads), the Service calculated that at least 130 acres are disturbed within S. argillacea populations as mapped, and an additional 85 acres could be disturbed as currently approved oil and gas wells are drilled within the next 2 years (UDOGM 2011). (USFWS, 2011)

Stressor: Habitat fragmentation (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Schoenocrambe argillacea exists in small, low-density populations that are likely prone to negative effects from habitat fragmentation. For example, small plant populations fluctuate more widely over time and the smaller the remnant, the more susceptible the population is to extinction (Soulé et al. 1992; Forman and Alexander 1998; Menges 2002; Lienert 2004). Small plant populations can lose genetic variation and their population viability decreases (Ellstrand and Elam 1993; Lienert 2004; Kolb 2008). Fruit set, germination rate, offspring survival, and total numbers of flowers per plant are higher in large populations than in small populations (Paschke et al. 2002). Similarly, the number of capsules per plant and the number of seedlings per plant are positively correlated with population size (Schmidt and Jensen 2000). Roads associated with energy exploration and development cause a high level of habitat fragmentation. Increased oil and gas developments result in more roads developed near and potentially in Schoenocrambe

argillacea habitat. Ecological effects of roads to plants can extend more than 328 feet (100 meters) from the road (Angold 1997; Forman 2000; Forman and Deblinger 2000). Disturbance can occur directly from construction or indirectly from road dust, discussed further below (Eller 1977; Spatt and Miller 1981; Thompson et al. 1984; Farmer 1993; Angold 1997; Sharifi et al. 1997; Trombulak and Frissell 2000; Hobbs 2001; Myers-Smith et al. 2006). There is a strong correlation between vegetation composition and health with distance from a road, although it may take decades for the full effects of road development to be realized (Auerbach et al. 1997; Myers-Smith et al. 2006). (USFWS, 2011)

Stressor: Road dust (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Schoenocrambe argillacea may be impacted by the indirect effects of road dust associated with oil and gas development. Road traffic mobilizes and spreads dust (Farmer 1993; Trombulak and Frissell 2000), and for every vehicle traveling 1 mile (1.6 kilometers) of unpaved roadway once a day, every day for a year, approximately 2.5 tons of dust are deposited along a 1,000-foot (~300-meter) corridor centered on the road (Sanders pers. comm. 2008). Dust deposition tends to be highest near the road and decreases with increasing distance from the road (Everett 1980; Spatt and Miller 1981; Walker and Everett 1987; Santelmann and Gorham 1988; Myers-Smith et al. 2006). For example, in one study, 97 percent of dust was deposited within 410 feet (125 meters) of the road (Walker and Everett 1987). The distance from a road at which dust can affect vegetation varies (see McCrea 1984; Myers-Smith et al. 2006), but negative impacts can occur up to 984 feet (300 meters) away from the road (Everett 1980). Using information from these studies, the BLM now implements a buffer of 300 feet (91 meters) for surface disturbance activities near *S. argillacea* occupied habitat and a requirement for monitoring plants where surface disturbance occurs within the 300-foot (91-meter) buffer. Dust negatively affects photosynthesis, respiration, transpiration, water use efficiency, leaf conductance, growth rate, plant vigor, gas exchange, and allows the penetration of phytotoxic gaseous pollutants (Eller 1977; Spatt and Miller 1981; Thompson et al. 1984; Farmer 1993; Sharifi et al. 1997; Trombulak and Frissell 2000; Hobbs 2001). Dust comprised of finer particulates caused more improper functioning of the stomata than larger particles (Ricks and Williams 1974; Eller and Brunner 1975; Eveling and Bataille 1984; Rawson and Clarke 1988; Hirano et al. 1995). Improperly functioning stomata result in increased water loss in two ways: due to an increased transpiration rate because of increased leaf temperatures and due to clogged stomata that are unable to close at night (Hirano et al. 1995). Dust also can inhibit sunlight from reaching plant surfaces (Sharifi et al. 1997). Additionally, dusted leaves were 4 to 5°F (2 to 3°C) warmer (Sharifi et al. 1997) than undusted, control leaves (Hirano et al. 1995). Dust from roads also impacts soil quality and vegetation type. Soils near roads can have significantly lower nutrient levels, altered organic horizon depth, higher bulk density, and lower moisture (Auerbach et al. 1997). Furthermore, soil characteristics and plant community composition can remain significantly different up to 28 years after road development (Myers-Smith et al. 2006). (USFWS, 2011)

Stressor: Plant-pollinator interactions (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Many of the negative effects of habitat fragmentation to plants are due to effects on plant-pollinator interactions (Debinski and Holt 2000; Moody-Weis and Heywood 2001; Aizen et al. 2002; Gathmann and Tscharntke 2002; Lennartsson 2002; Kolb 2008). Fragmented plant populations appear to be less attractive to insect pollinators, which spend more time in larger, unfragmented plant habitats (Aizen et al. 2002; Goverde et al. 2002; Lennartsson 2002; Kolb 2008). Furthermore, insect pollinator diversity increases in larger populations (Mustajarvi et al. 2001) and decreases in isolated habitats with smaller plant population size (Steffan-Dewenter and Tscharntke 1999). Lower pollinator visitation rates were associated with lower seed sets and reproductive success in fragmented sites compared to intact sites (Jennersten 1988). Bumblebees visit more flowers on fewer flower stalks in sparser plant populations (Mustajarvi et al. 2001; Goverde et al. 2002). This leads to increased self-pollination or near-neighbor pollination and contributes to inbreeding (Goverde et al. 2002; Lennartsson 2002). Inbred plants produce fewer flowers and seeds, have smaller plant height and smaller leaf-size, and reduced reproductive success (Steffan-Dewenter and Tscharntke 1999; Lienert 2004; Kolb 2008). (USFWS, 2011)

Stressor: Erosion and sedimentation (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Although oil and gas development may not occur directly on the steep habitat *Schoenocrambe argillacea* occupies, erosion or sedimentation could still impact this species, particularly if the plants are downslope of development activities. In fact, development-related erosion and sedimentation may be a particular concern to this species because it grows on precipitous hillsides. Because of this unique vulnerability, the BLM Vernal Field Office requires energy companies to get site-specific approval from both the BLM and the Service when disturbance will occur upslope of habitat (BLM 2008a). This conservation measure is in effect because the species is listed as threatened by the ESA. (USFWS, 2011)

Stressor: Predation (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: When we listed *Schoenocrambe argillacea*, the Service believed sheep and cattle grazing may have had an historical impact on this species. However, by 1994 grazing was no longer expected to impact *S. argillacea* due to changes in grazing management, namely reduced numbers of sheep and cattle on the land (Service 1994). Grazing levels have not increased appreciably since then, and thus the Service still concludes that grazing is not impacting *S. argillacea*. Elk were reported in *S. argillacea* habitat, but the Service has not determined whether they browse on this species (Glisson 2005). Insect and small mammal herbivory occurs on *S. argillacea* fruits (Glisson 2005), but the Service does not have any information that this is occurring at a level that negatively impacts the species. (USFWS, 2011)

Stressor: Small populations (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: When *Schoenocrambe argillacea* was listed, it was known to occur in 2 general areas—around the Green River and Willow Creek—in 6 populations with fewer than 6,000 individuals, and most sites contained fewer than 200 individuals. Estimates for the Recovery Plan did not indicate significant changes, and the Service does not have more recent comprehensive data indicating changes in population size. Small populations and species with limited distributions are vulnerable to relatively minor environmental disturbances (Given 1994). Small populations also are at an increased risk of extinction due to the potential for inbreeding depression, loss of genetic diversity, and lower sexual reproduction rates (Ellstrand and Elam 1993; Wilcock and Neiland 2002). Lower genetic diversity may, in turn, lead to even smaller populations by decreasing the species' ability to adapt, thereby increasing the probability of population extinction (Barrett and Kohn 1991; Newman and Pilson 1997). On the other hand, many naturally rare species have persisted for long periods within small geographic areas, and many naturally rare species exhibit traits that allow them to persist, despite their small population sizes. Species with limited climatic ranges and restricted habitat requirements are typically the most vulnerable to extinction (Intergovernmental Panel on Climate Change (IPCC) 2002; Machinski et al. 2006). The risk of extinction is expected to increase for species with low population numbers (IPCC 2002; Jump and Penuelas 2005). (USFWS, 2011)

Stressor: Invasive species (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Invasive, exotic plant species can contribute to the extinction of native plants (Soulé et al. 1992). Exotic invasive species are common along highways because seeds are carried and deposited along roads by vehicles, and spread via vehicle-caused air turbulence (Forman and Alexander 1998). Roads often promote the spread of invasive species by altering soil characteristics, stressing native plant species, and providing easier movement by wild or human vectors (Trombulak and Frissell 2000). Spread of invasive species via roads coupled with increased road dust can exacerbate the impact on native species; an increase in fine dust particles can increase nonnative, exotic plant species (Reynolds et al. 2001). Cheatgrass (*Bromus tectorum*) occurs in *S. argillacea* habitat (Glisson 2005). Cheatgrass can out-compete native species for soil nutrients and water (Melgoza et al. 1990; Aguirre and Johnson 1991; Pyke and Novak 1994). If it establishes in sufficient density in native plant communities, cheatgrass increases flammability, leading to shortened fire return intervals that make it difficult for native plants to re-establish (D'antonio and Vitousek 1992). Halogeton (*Halogeton glomeratus*) is another invasive species that is found in the vicinity of *S. argillacea* habitat, but is not documented within occupied habitat (Brunson 2009; Buys & Associates 2009). Halogeton quickly infests areas that are either left barren from fire or are exposed to some type of soil disturbance (Pavek 1992). Halogeton tends to be a poor competitor, but it can accumulate sodium in the soil and alter soil microbiota to the disadvantage of native plants (Kitchen and Jorgensen 2001; Kitchen and Carlson 2008). Although invasive species are present in *Schoenocrambe argillacea* habitat, they have not been identified in high numbers or densities. Atmospheric levels of carbon dioxide are expected to double before the end of the 21st century (IPCC 2002), which is likely to increase biomass and seed production of invasive annuals (Mayeux et al. 1994; Smith et al. 2000; Ziska et al. 2005). This effect, if manifested, could facilitate the expansion of cheatgrass and other invasive plants that could compete with and further threaten *S. argillacea*. Regardless, the Service does not currently consider invasive species a threat to *S. argillacea*. (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Climate change is likely to affect long-term survival or distribution of native species. In the southwestern United States, including Utah and *Schoenocrambe argillacea* habitat, average temperatures have increased ~1.5°F (0.8°C) compared to a 1960-1979 baseline (Karl et al. 2009). By the end of this century, temperatures are expected to warm a total of 4 to 10°F (2 to 5°C) in the Southwest (Karl et al. 2009). Hot extremes, heat waves, and heavy precipitation will increase in frequency, with the Southwest experiencing the greatest temperature increase in the continental United States (IPCC 2007). The Service does not know how changes in precipitation will affect *Schoenocrambe argillacea*. However, we do know that increased drought can be detrimental to many drought-tolerant species. Drought conditions led to a noticeable decline in survival, vigor, and reproductive output of rare plants in the Southwest during the drought years of 2001-2004 (Anderton 2002; Van Buren and Harper 2002, 2003; Hughes 2005; Clark and Clark 2007; Roth 2008a, 2008b). Effects related to climate change, such as persistent or prolonged drought conditions, may affect the long-term persistence of *S. argillacea*, but without further research or information, it is difficult to predict how. (USFWS, 2011)

Recovery

Reclassification Criteria:

1. Discover or establish a minimum of five separate populations with 2,000 or more individuals per population for each species. These populations must be demonstrated to be at or above minimum viable population levels. (USFWS, 1994)
2. Document the presence of or, if necessary, establish formal land management designations which would provide for long—term protection on undisturbed habitat for the above five populations of each species. (USFWS, 1994)

Delisting Criteria:

1. Discovery or establishment of a minimum of 10 separate populations with 2,000 or more individuals per population for each species. These populations must be demonstrated to be at or above minimum viable population levels. (USFWS, 1994)
2. Document the presence of or, if necessary, establish formal land management designations which would provide for long—term protection on undisturbed habitat for the above 10 populations of each species. (USFWS, 1994)

Recovery Actions:

- Inventory suitable habitat for *S. argillacea*, *S. barnebyi*, and *S. suffrutescens* and determine with a reasonable degree of accuracy the population and distribution of each species. (USFWS, 1994)
- Establish and conduct at least three minimum viable population studies on each of at least three different populations of each species. (USFWS, 1994)
- Document the presence of or, if necessary, establish formal land management designations which would provide for long-term protection on undisturbed habitat for each species. (USFWS, 1994)

- Control activities which affect the habitat of *S. argillacea*, *S. barnebyi*, and *S. suffrutescens* through sections 7 and 9 of the Endangered Species Act and other relevant laws and regulations. (USFWS, 1994)

Conservation Measures and Best Management Practices:

- The Service recommends creating a better distribution map for *Schoenocrambe argillacea*. Because of the difficult terrain it inhabits and previous inaccuracies in habitat mapping, we also recommend developing alternative mapping techniques, such as using satellite imagery to map and ground-truth suitable habitat. (USFWS, 2011)
- The Service recommends developing a reliable comprehensive population estimate every 5 years. Populations that are accessible by foot should be resurveyed routinely. General estimates may be used for inaccessible areas. Should additional populations and higher numbers be identified, this may address the small population size and limited distributional concerns cited in section 2.3.2.5 and 2.4 above. Improved habitat mapping and better population counts should also be considered in land use decisions to minimize impacts to the species. Finally, improved habitat maps and population estimates should be used to help revise the Recovery Plan (as recommended below). (USFWS, 2011)
- The Service will work with the BLM to establish long-term demographic monitoring plots for *Schoenocrambe argillacea*. The Service will review available information (Glisson 2005) and coordinate with experts to identify appropriate monitoring plots. Data the Service collects on survival, reproduction, and habitat condition for the species will help us identify trends, threats, and whether conservation measures incorporated thus far are effective. (USFWS, 2011)
- We will work with the BIA and the Ute Tribe to map potential habitat and survey for new populations of *Schoenocrambe argillacea*, if discovered on Uintah and Ouray Indian Reservation lands. (USFWS, 2011)
- Approximately 11 percent of mapped *Schoenocrambe argillacea* populations occur on State and private lands. The Service should work with SITLA and private landowners to survey and conserve *S. argillacea* habitat and increase outreach efforts. (USFWS, 2011)
- Basic biological and ecological information should be obtained for this species, including determining pollination mechanisms and pollinators. The habitat also needs to be better defined by accurately characterizing parent material, soil, and landscape characteristics of occupied habitat. (USFWS, 2011)
- The Service should collect seeds to include this species in the Center for Plant Conservation collection. Seeds also should be tested for viability and longevity. (USFWS, 2011)
- Once habitat requirements are better understood and reliable suitable habitat maps are developed (see above actions), the Service recommends studying the feasibility of introducing *Schoenocrambe argillacea* into new areas of unoccupied suitable habitat near existing populations. (USFWS, 2011)
- On Federal lands, the Service should continue to avoid development in *Schoenocrambe argillacea* populations and suitable, unoccupied habitat to the extent possible, until we can complete research showing what level of development in *S. argillacea* habitat is tolerable. The Service should ensure that developers follow established conservation measures when disturbance occurs and that habitat fragmentation is reduced to the extent possible. (USFWS, 2011)
- Using better distribution maps and updated survey information, we should identify and establish core conservation areas in minimally-disturbed habitat (both occupied and unoccupied) for long-term protection of *Schoenocrambe argillacea*. The Service should work with the BLM to adopt these conservation areas under a long-term conservation agreement. (USFWS, 2011)

- Use conservation area information to identify and establish an Area of Critical Environmental Concern (ACEC) on BLM land to protect *Schoenocrambe argillacea* and its habitat. The ACEC should include no surface occupancy stipulations for those areas where mineral rights are not yet leased. The ACEC can be formally recommended to the BLM and incorporated during their resource management planning process. (USFWS, 2011)
- Develop a habitat management plan, which the BLM incorporates into the RMP and implements. Ensure that all *Schoenocrambe argillacea* occurrences on public lands are within management areas where maintenance of the species is a primary management goal. (USFWS, 2011)
- Develop conservation agreements with those federal mineral leaseholders whose leases are not subject to the terms of BLM management plans protecting the plants (leases that predate the RMP/habitat management plan). Through implementation of these conservation agreements, companies would implement conservation measures necessary to protect the species from mineral extraction activities. (USFWS, 2011)
- Once the Service has new survey data and research data available, we recommend revising the Recovery Plan to explicitly address the relevant listing factors. Time and cost required to meet the criteria and recover the species should be included in the Recovery Plan. (USFWS, 2011)
- The Service will publish in the Federal Register a formal name change from *Schoenocrambe argillacea* to *Hesperidanthus argillacea* to reflect the best available science. (USFWS, 2011)
- The Service will formally request the name be changed from *Schoenocrambe argillacea* to *Hesperidanthus argillacea* in the ITIS and USDA plants databases. (USFWS, 2011)

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USFWS. 2011. *Schoenocrambe argillacea* (clay reed-mustard) 5-Year Review: Summary and Evaluation. Utah Field Office, – Ecological Services West Valley City, Utah

SPECIES ACCOUNT: *Schoenocrambe barnebyi* (Barneby reed-mustard)

Species Taxonomic and Listing Information

Listing Status: Endangered; 01/14/1992; Mountain-Prairie Region (Region 6) (USFWS, 2016)

Physical Description

Schoenocrambe barnebyi is a perennial herbaceous plant with sparsely leafed stems 22 to 35 cm (9 to 15 inches) tall arising from a woody root crown. The leaves are entire with a smooth margin, 1.5 to 5 cm (0.6 to 3 inches) long and 0.5 to 2.5 cm (0.2 to 1 inch) wide. The leaf blades are alternately arranged on the stem and are attached to the stem by a petiole. The flowers of *S. barnebyi* have petals that are light purple with prominent darker purple veins and measure about 12 mm (0.4 inch) long and 2.5 mm (0.1 inch) wide. The entire flowers are about 1 cm (0.4 inch) across in full anthesis and are displayed in a raceme of, commonly, two to eight flowers at the end of the plant's leafy stems (Welsh and Atwood 1980, Rollins 1982, Welsh et al. 1987). Flowers (May-June) have pale purple petals, prominently veined with darker purple. (USFWS, 1994; NatureServe, 2015)

Taxonomy

Rollins (1982), in reevaluating the cruciferous genera of *Schoenocrambe* and *Thelypodopsis*, moved *T. argillacea* and *T. barnebyi* from *Thelypodopsis* to *Schoenocrambe* as *S. argillacea* and *S. barnebyi*. Welsh and Chatterley (1985) moved *Glaucocarpuni suffrutescens* to the genus *Schoenocrambe* to complete what morphologically appears to be a discrete phylogenetic unit among the Brassicaceae. The genus *Schoenocrambe* currently includes five known species, two (*S. linearifolia* and *S. linifolia*) are abundant wide—ranging species from the dry lower elevations of the interior western Cordilleras. *S. linearifolia* occurs from southern Colorado and northern Arizona southward to western Texas and Durango and Sonora, Mexico. *S. linifolia* occurs from southeastern British Columbia, Canada, and western Montana southward to eastern Nevada and northern New Mexico. The remaining three, *S. argillacea*, *S. barnebyi*, and *S. suffrutescens*, are rare endemic species from low elevations of the northern and western portions of the Colorado Plateau in the State of Utah (Rollins 1982, Welsh et al. 1987). (USFWS, 1994)

Current Range

Endemic to the Canyonlands of south-central Utah, where known from two distinct clusters of occurrences: one in the southern portion of the San Rafael Swell near Muddy Creek in southern Emery County and the other in Capitol Reef National Park in the Fremont River drainage west of Fruita in central Wayne County. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 1994)

Breeding Season

Adult: April to May (USFWS, 1994)

Reproduction Narrative

Adult: We have little information on the biology and life history of Barneby reed-mustard. Plants reproduce sexually and flower from late April to mid or late May (Welsh and Neese 1984). (USFWS, 1994)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Bare rock/talus/scree, desert (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at elevations between 1460 and 1985 meters on sparsely vegetated sites (NatureServe, 2015)

Habitat Narrative

Adult: Mixed desert shrub communities (shadscale, Eriogonum, Ephedra), in sparsely vegetated sites on steep, eroding north to northeast facing slopes (elevations between 1460 and 1985 meters). Grows in xeric, fine-textured red clay soils rich in selenium and gypsum of the Moenkopi Formation, and, rarely, on soils eroded from it that now overlie the Chinle Formation and on the Carmel Formation. Associated species include Abronia fragrans, Amelanchier utahensis, Artemisia dracunculus, Astragalus brandegeei, Atriplex confertifolia, Chrysothamnus nauseosus, Ephedra torreyana, Ephedra viridis, Eriogonum corymbosum, Erioneuron pulchellum, Erioneuron pilosum, Hilaria jamesii, Monolepis nuttalliana, Opuntia polyacantha, Phacelia rafaensis, Sporobolus sp., Stanleya pinnata, and Townsendia incana. (NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Gravity, wind and rain are thought to be the primary dispersal agent of seeds (Welsh and Neese 1984). (USFWS, 1994)

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Resiliency:

Low (inferred from USFWS, 2011)

Representation:

Low (inferred from USFWS, 2011)

Redundancy:

Low (inferred from USFWS, 2011)

Number of Populations:

2 (NatureServe, 2015)

Population Size:

2,251 (USFWS, 2011)

Population Narrative:

The Service estimates the total population to be approximately 2,251 individuals within 4 *Schoenocrambe barnebyi* populations containing a total of 15 sites (Clark 2005a). (USFWS, 2011)

Threats and Stressors

Stressor: Mining (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The primary threat to *Schoenocrambe barnebyi* identified at the time of listing and in the Recovery Plan was habitat loss and degradation associated with future uranium mining on BLM lands (57 FR 1398, January 14, 1992; USFWS 1994). Mining related activities may result in increased surface disturbances, increased foot and vehicle traffic, reduced air quality, vegetation disturbance, and removal of top soil and overburden. Surface disturbances may impact the species by crushing or trampling plants, causing soil erosion and compaction, degrading suitable habitat, losing pollinator populations and habitat, reducing plant vigor and reproductive potential, reducing seed bank quantity and quality, and increasing invasive plant occurrences thereby increasing fire risk (Brock and Green 2003; BLM 2008a). All of the known individuals on BLM land occur in areas that are open to mineral exploration or development (BLM 2008a). Six mining claims occur near the Sy's Butte/Hidden Splendor Mine and mining activities may have extirpated a portion of this population during the 1950s and 1960s (Anderson 1985; USFWS 1994). Mining shafts from this time period are currently being closed (Conrad pers. comm. 2009; Ivory pers. comm. 2009). With the exception of the Lucky Strike Mine, there has been no mining since the 1960s (Conrad pers. comm. 2009; Ivory pers. comm. 2009). Because BLM lands remain open to mineral exploration and development and there are existing mining claims near the Sy's Butte/Hidden Splendor Mine population that may recommence at any time (Conrad pers. comm. 2009), future uranium mining continues to be a threat on BLM lands. The Service considers this threat to be currently low because it has been over 40 years since active mining occurred, and we are not aware of any current mining proposals in this area. (USFWS, 2011)

Stressor: Grazing (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Livestock grazing may result in the direct loss or damage to plants and their habitat through trampling, soil compaction, increased soil erosion, invasion of noxious weeds, and disturbance to pollinators (Kauffman et al. 1983; Fleischner 1994; Kearns et al. 1998; DiTomaso 2000). Sheep and cattle grazing were identified as possible historic threats to populations of *Schoenocrambe barnebyi* (57 FR 1398, January 14, 1992; USFWS 1994). At the time of listing, the

intensity of grazing at known *S. barnebyi* populations was not expected to significantly impact the species. Grazing intensity has not increased since we finalized the Recovery Plan (BLM 2009). However, the Service does not have any monitoring data that evaluates the effects of grazing on *S. barnebyi* populations. (USFWS, 2011)

Stressor: Off-highway vehicle use (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The Services did not identify off-highway vehicle (OHV) activities as threats to *Schoenocrambe barnebyi* when we listed the species in 1992, nor in the Recovery Plan (57 FR 1398, January 14, 1992; USFWS 1994). The OHV use may result in the direct loss or damage to plants and their habitat through soil compaction, increased soil erosion, reduced air quality, invasion of noxious weeds, and disturbance to pollinators and their habitat (Eckert et al. 1979; Lovich and Bainbridge 1999; Ouren et al. 2007; Wilson et al. 2009). The use of OHVs in Utah has exploded in popularity over the past several decades (Burr et al. 2008). From 1998-2006, the number of registered OHVs in Utah has increased by 233% (Burr et al. 2008). The known *Schoenocrambe barnebyi* population on BLM lands (Sy's Butte/Hidden Splendor Mine) occurs in an area that is open to OHV traffic along designated routes only (BLM 2008a). Although illegal OHV use occurs within the vicinity (BLM 2011), to date, no direct or indirect impacts to the population or individual plants have been documented (Ivory 2009). Due to the remoteness of the population and the steepness of the terrain, the Service expects the overall scope of the threat to be low. (USFWS, 2011)

Stressor: Erosion (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Erosion was not considered a threat at the time of listing or in the recovery plan (57 FR 1398, January 14, 1992; USFWS 1994). However, natural erosion of *Schoenocrambe barnebyi* habitat was listed as a potential threat in a 1992 survey report for the BLM (Ecosphere 1992). *Schoenocrambe barnebyi* grows in very steep habitats with sparse vegetation. Plants may be uprooted, damaged or destroyed by gullying, slumping or rockslides. Under natural circumstances, the Service presumes the species has adapted to living on a highly erodible substrate. However, erosion may increase as climate changes. Climate change will likely increase heavy precipitation events which can increase soil erosion (Nearing et al. 2004; IPCC 2007; see section 2.3.2.5 below). In addition, erosion may be accelerated through surface disturbing activities. As previously described, OHV use and grazing occur in the habitat of *Schoenocrambe barnebyi* on BLM lands. Although the Service believes the overall threat level of these activities to be currently low, the Service does not have monitoring data to adequately evaluate the effects, including erosion, of these uses to the plants. (USFWS, 2011)

Stressor: Trampling (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: At the time of listing and in our Recovery Plan, we identified trampling by Capitol Reef visitors as the primary impact on the *Schoenocrambe barnebyi* population at Sulphur Creek (57

FR 1398, January 14, 1992; USFWS 1994). However, trampling from hiking activities was later evaluated and determined to be unlikely (Clark 1997). Visitors tend to remain along the trail in the creek bottom, away from the plants and the habitat due to the steepness of the terrain. An historic livestock trail through the population is no longer in use but is occasionally used by deer (Clark pers. comm. 2009a). All other sites within Capitol Reef were evaluated for potential impacts caused by hiking trails but none were documented (Clark 2005b). For these reasons, we no longer consider trampling a threat. (USFWS, 2011)

Stressor: Invasive species and fire (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Invasive species and fire were not considered threats at the time of listing or in the species' Recovery Plan (57 FR 1398, January 14, 1992; USFWS 1994). However, the spread of nonnative invasive species is considered the second largest threat to imperiled plants in the United States (Wilcove et al. 1998). Invasive plants—specifically exotic annuals—negatively affect native vegetation, including rare plants. One of the most substantial effects is the change in vegetation fuel properties that, in turn, alter fire frequency, intensity, extent, type, and seasonality (Menakis et al. 2003; Brooks et al. 2004; McKenzie et al. 2004). Shortened fire return intervals make it difficult for native plants to reestablish or compete with invasive plants (D'Antonio and Vitousek 1992). Mining, grazing, and unauthorized OHV use are activities that disturb soil surfaces within *Schoenocrambe barnebyi* habitat on BLM lands. In general, *B. tectorum* is known to invade areas in response to these types of surface disturbing activities (Hobbs 1989; Rejmanek 1989; Hobbs and Huenneke 1992; Evans et al. 2001). These types of surface disturbing activities do not occur on the populations in Capitol Reef. Currently wildland fires are considered unlikely to occur in *S. barnebyi*'s habitat due to the sparseness of vegetation associated with the species (Borthwick pers. comm. 2009c; Ivory pers. comm. 2009). (USFWS, 2011)

Stressor: Herbivory (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: *Schoenocrambe barnebyi* appears to be highly palatable to deer (Clark 2005b). The Service expects browsing to be localized and only affect a small portion of the populations. However, we do not have any information that browsing is occurring at a level that negatively impacts the species as a whole (Clark 2005b; Ivory 2009). For these reasons, this factor has the potential to affect the species. (USFWS, 2011)

Stressor: Small populations (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The original listing decision cited the limited distribution and low population numbers as a factor affecting the species (57 FR 1398, January 14, 1992). The species' rarity and limited distribution make it highly vulnerable to localized stochastic extinction events. While more sites have been found since the species was listed, it remains narrowly distributed in few populations and may be in decline (Clark 1997; Anderton 2002). Half of the sites have fewer than 100 plants

(Clark 2005b; see Table 2). Although small population size is an intrinsic vulnerability of the species, some sites may hold so few plants that they are not demographically stable in the medium to long term and some may be lost as a result of natural variation in population numbers in the short term. Population genetics studies have not been undertaken for *Schoenocrambe barnebyi*, but despite the overall lack of information on the population ecology of the species, the Service does know that small populations are at an increased risk of extinction due to the potential for inbreeding depression, loss of genetic diversity, and lower sexual reproduction rates (Ellstrand and Elam 1993; Wilcock and Neiland 2002). Only the larger sites of *S. barnebyi* may have sufficient genetic variability to provide for long-term adaptation to natural or manmade changes in their environment. Small population size in and of itself is not considered a threat; however, it may increase the species' vulnerability if other threats discussed in this analysis are impacting the species. Even a small localized disturbance such as mining, OHV-related activities, or fire could result in the extirpation of a site. The Service determined the threat of climate change (see discussion below) has an overall threat level of moderate. Therefore, the Service considers the overall threat level for small population size to be moderate. (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Species with limited ranges and restricted habitat requirements also are more vulnerable to the effects of global climate change (IPCC 2002; Jump and Penuelas 2005; Machinski et al. 2006; Krause 2010). Climate change was not discussed in the original rule to list the species or in the Recovery Plan. Over the past 50 years, the frequency of cold days, cold nights, and frosts have become less frequent over most land areas, and hot days and hot nights have become more frequent (IPCC 2007). Changes in the global climate system during the 21st century are hypothesized to be larger than those observed during the 20th century (IPCC 2007). For the next two decades, a warming of about 0.2°C (0.4°F) per decade is projected (IPCC 2007). Afterward, temperature projections increasingly depend on specific emission scenarios (IPCC 2007). Various emissions scenarios suggest that by the end of the 21st century, average global temperatures are expected to increase of 0.6 to 4.0°C (1.1 to 7.2°F) with the greatest warming expected over land (IPCC 2007). Localized projections suggest the southwest may experience the greatest temperature increase of any area in the lower 48 States (IPCC 2007). Effects related to climate change, such as persistent or prolonged drought conditions, increased invasions of exotic species and pests, and increased heavy rainfall events, may affect the long-term persistence of *S. barnebyi*. Climate change could potentially reduce the overall abundance of *Schoenocrambe barnebyi*. However, a large degree of uncertainty exists regarding the extent of such effects. For these reasons, this factor has the potential to affect the species. Further studies should be conducted to monitor and minimize the effects of this potential threat. (USFWS, 2011)

Stressor: Lack of scientific knowledge/monitoring (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The lack of scientific knowledge of *Schoenocrambe barnebyi* may cause the species to be managed below optimal levels. While not a threat in and of itself, this factor affects our ability to manage and recover the species. We lack scientific knowledge and monitoring data throughout the range of the species. We know little about *S. barnebyi*--its pollinators, range,

habitat, and population trends. For example, we do not know why the original population estimate for BLM population was 2,000 individuals but surveys since have counted less than 200 plants. We do not know whether this represents a reduction in plant numbers or is an artifact of survey effort, making it difficult to analyze overall threat levels for the species. Because of this lack of scientific knowledge, opportunities for better management of the species could potentially be missed. Based on our current limited understanding of the species, we consider the overall threat levels for threats discussed in sections 2.3.2.1, 2.3.2.4, and 2.3.2.5 are all low. We could potentially move the species toward downlisting, recovery, and eventual delisting if we could better quantify the degree of threat the species faces and work toward alleviating those threats. However, the only site that has longer, albeit irregular, monitoring data shows the plant may be in decline, potentially negatively impacted by drought (Clark 1997; Anderton 2002), and potentially able to recover (Clark pers. comm. 2009b). The lack of trend data following the drought makes it difficult to determine to what degree drought may be a threat to the species. (USFWS, 2011)

Recovery

Reclassification Criteria:

1. Discover or establish a minimum of five separate populations with 2,000 or more individuals per population for each species. These populations must be demonstrated to be at or above minimum viable population levels. (USFWS, 2011)
2. Document the presence of or, if necessary, establish formal land management designations which would provide for long—term protection on undisturbed habitat for the above five populations of each species. (USFWS, 2011)

Delisting Criteria:

1. Discovery or establishment of a minimum of 10 separate populations with 2,000 or more individuals per population for each species. These populations must be demonstrated to be at or above minimum viable population levels. (USFWS, 2011)
2. Document the presence of or, if necessary, establish formal land management designations which would provide for long—term protection on undisturbed habitat for the above 10 populations of each species. (USFWS, 2011)

Recovery Actions:

- Inventory suitable habitat for *S. argillacea*, *S. barnebyi*, and *S. suffrutescens* and determine with a reasonable degree of accuracy the population and distribution of each species. (USFWS, 2011)
- Establish and conduct at least three minimum viable population studies on each of at least three different populations of each species. (USFWS, 2011)
- Document the presence of or, if necessary, establish formal land management designations which would provide for long—term protection on undisturbed habitat for each species. (USFWS, 2011)
- Control activities which affect the habitat of *S. argillacea*, *S. barnebyi*, and *S. suffrutescens* through sections 7 and 9 of the Endangered Species Act and other relevant laws and regulations. (USFWS, 2011)

Conservation Measures and Best Management Practices:

- The BLM and Capitol Reef should establish long-term trend monitoring to provide base line demographic data for the species. In addition to collecting baseline demographic data, BLM and Capitol Reef should collect data on the species' response to habitat conditions including how the factors considered in this 5-year review are affecting the species. (USFWS, 2011)
- Determine pollinators or pollination mechanisms including the identification of pollinators, pollinator availability, and their habitat requirements. (USFWS, 2011)
- Assess seedbank viability, including seed viability and dispersal mechanisms and determining germination requirements. (USFWS, 2011)
- Analyze population genetics to assess potential impacts from inbreeding depression. (USFWS, 2011)
- Determine the species' vulnerability to prolonged drought and the potential impacts of climate change. (USFWS, 2011)
- Determine the species response to invading nonnative species and its response to increased fire frequencies. (USFWS, 2011)
- Determine habitat requirements, including soils, aspects, and climatic variables. (USFWS, 2011)
- Determine the effects livestock grazing has on the species and its habitat. (USFWS, 2011)
- Determine the effects OHV use has on the species and its habitat. (USFWS, 2011)
- Determine the effects mining has on the species and its habitat. (USFWS, 2011)

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SPECIES ACCOUNT: *Schoenocrambe suffrutescens* (Shrubby reed-mustard)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/06/1987; Mountain-Prairie Region (Region 6) (USFWS, 2016)

Physical Description

Shrubby reed-mustard is a perennial herb in the mustard family, with clumped stems 10 to 25 cm (4 to 12 inches) tall arising from a branching woody root crown. The leaves are entire with a smooth margin, 1.0 to 2.5 cm (0.4 to 1 inch) long and 0.3 to 1.0 cm (0.12 to 0.4 inch) wide. The leaf blades are alternately arranged on the stem and are sessile or attached to the stem by a short petiole. The flowers of Shrubby reed-mustard have petals that are light yellow or greenish yellow and spatulately shaped measuring about 10 mm (0.4 inch) long and 3 mm (0.12 inch) wide. The entire flowers are about 1 cm (0.4 inch) across in full anthesis and are displayed in a raceme of, commonly, 5 to 20 flowers at the end of the plant's leafy stems. This herb produces yellow flowers May through June. (USFWS, 1994; NatureServe, 2015)

Taxonomy

The species was first discovered in 1935 by Edward Graham, described by Reed Rollins as *Thelypodium suffrutescens* (Graham 1937), and, in 1938, renamed *Glaucocarpum suffrutescens* (Rollins 1938; 52 FR 37416; October 6, 1987). The species was listed under the latter name (52 FR 37416; October 6, 1987). Since then, its genus was changed to *Schoenocrambe* (57 FR 1398; January 14, 1992), *Glaucocarpum* (Al-Shehbaz 2005), and most recently *Hesperidanthus* (Al-Shehbaz 2010). This last taxonomic change is currently accepted in the Flora of North America and the integrated taxonomic information system (ITIS) (Al-Shehbaz 2010; ITIS 2017). However, The Service will still use *Schoenocrambe suffrutescens* until a formal change in the Federal Register is completed. (USFWS, 2019)

Current Range

The species is endemic to the Uinta Basin region in northeastern Utah, and found exclusively within the Lower Green-Desolation Canyon and Willow Creek watersheds. (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 1994)

Dependency on Other Individuals or Species

Adult: The following native bee species may be *Schoenocrambe suffrutescens* pollinators: *Dialictus perdificilis*, *D. sedi*, *Evylaeus pulveris*, *Andrena walleye*, *A. prunorum* and *Halictus rubicundus* (USFWS 1994; Tepedino 2000; Lewis 2010). (USFWS, 2010)

Breeding Season

Adult: April to May (USFWS, 2010)

Other Reproductive Information

Adult: Shrubby reed-mustard could be pollinator limited if adequate and appropriate insect pollinators are not available (Lewis and Schupp 2014). Seed set is significantly lower in individuals that self-pollinate compared to individuals that are fertilized by cross-pollination (pollen from another plant; Lewis and Schupp 2014). These results also indicate that cross-pollination is critical for maximizing reproduction of the species. A related study of road dust impacts to shrubby reed-mustard found that increases in dust deposition reduced reproduction in the species by significantly decreasing the numbers of mature seeds produced, and showed trends of decreased seed numbers and weight (Lewis 2017). Mean stomatal conductance also significantly decreased with increasing dust presence on leaves, which may impact the overall health and reproductive capacity of the species (Lewis 2017). (USFWS 2019)

Reproduction Narrative

Adult: Reproduction is sexual (USFWS 1994), and the species is capable of self-pollination (Tepedino 2000). Flowering for this species occurs in April to May and fruiting occurs May to June. The following native bee species may be *Schoenocrambe suffrutescens* pollinators: *Dialictus perdificilis*, *D. sedi*, *Evylaeus pulveris*, *Andrena walleye*, *A. prunorum* and *Halictus rubicundus* (USFWS 1994; Tepedino 2000; Lewis 2010). (USFWS, 2010)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Desert, forest/woodland, woodland - conifer (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at elevations between 1555 and 1981 meters. (NatureServe, 2015)

Dependency on Other Individuals or Species for Habitat

Adult: Commonly on level to moderately sloping ground surfaces. Soils are dry, shallow, and fine-textured, and are usually overlain by shale fragments. (NatureServe, 2015)

Habitat Narrative

Adult: Mixed desert shrub communities and, at some locations, in pinyon -juniper and desert shrub, on semi-barren, white-shale layers of the Evacuation Creek Member of the Green River Formation. Commonly on level to moderately sloping ground surfaces. Soils are dry, shallow, and fine-textured, and are usually overlain by shale fragments. 1555-1981 m elevation. (NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Decline (NatureServe, 2015)

Species Trends:

Decline (NatureServe, 2015)

Number of Populations:

7 (USFWS, 2019)

Population Size:

3,161 (USFWS, 2019)

Additional Population-level Information:

Range-wide population trend monitoring plots were established by the BLM in 2017. Preliminary findings suggest that open interspaces are important habitat components for the species (BLM 2017). Species monitoring provided a baseline density of 1.9 shrubby reedmustard plants per one-meter squared for monitoring plots; however, subsequent consecutive surveys are needed to refine our understanding of species density (BLM 2017). It is too early to determine demographic and population trends from this monitoring effort. (USFWS, 2019)

Population Narrative:

In 2019, the Service estimated shrubby reed-mustard was limited to 3,161 individuals within three geographic areas and seven populations. The range of the Bad Land Cliffs population has been extended from the 2010 estimate after the discovery of 232 new individuals in an area that was previously unsurveyed (BLM 2017). (USFWS, 2019)

Threats and Stressors

Stressor: Oil and gas development (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Oil and gas resource development operations pose a significant threat to *Schoenocrambe suffrutescens* populations and habitat (USFWS 1990; 1994). All known populations of *S. suffrutescens* that occur on Federal lands are leased for oil and gas development (USFWS 1994). In addition, an ongoing natural gas project (currently in the first phase of development) overlaps the entire range of three of the known seven *S. suffrutescens* populations. These populations account for over 40 percent of the species' known suitable habitat and over 80 percent of all known individuals (USFWS 2008a). Development continues in unoccupied suitable habitat, thereby limiting potential expansion and recovery of the species. Furthermore, development continues to occur in habitats immediately adjacent to occupied habitats. While steps have been taken to minimize these indirect effects, it is unknown if this adjacent development is adversely impacting the viability of *S. suffrutescens* populations. These indirect effects, and the protections currently provided, are discussed below. (USFWS, 2010)

Stressor: Habitat fragmentation (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: *Schoenocrambe suffrutescens* exists in small, low-density populations that might be prone to negative effects from habitat fragmentation. For example, small plant populations fluctuate more widely over time and the smaller the remnant, the more susceptible the population is to extinction (Soulé et al. 1992; Forman and Alexander 1998; Menges 2002; Lienert 2004). Small plant populations can lose genetic variation and their population viability decreases (Ellstrand and Elam 1993; Lienert 2004; Kolb 2008). Fruit set, germination rate, offspring survival, and total numbers of flowers per plant are higher in larger populations than in small populations (Paschke et al. 2002). Similarly, the number of capsules per plant and the number of seedlings per plant are positively correlated with population size (Schmidt and Jensen 2000). Roads associated with energy exploration and development cause a high level of habitat fragmentation. Increased oil and gas developments result in more roads developed in and near *S. suffrutescens* habitat. Ecological effects of roads to plants can extend more than 328 feet (100 meters) from the road (Angold 1997; Forman 2000; Forman and Deblinger 2000). Disturbance can occur directly from construction or indirectly from road dust, discussed further below (Farmer 1993; Angold 1997; Trombulak and Frissel 2000). There is a strong correlation between vegetation composition and health with distance from a road, although it may take decades for the full effects of road development to be realized (Auerbach et al. 1997; Myers-Smith et al. 2006). (USFWS, 2010)

Stressor: Road dust (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: *Schoenocrambe suffrutescens* may be impacted by the indirect effects of road dust associated with oil and gas development. Road traffic mobilizes and spreads dust (Farmer 1993; Trombulak and Frissell 2000), and for every vehicle traveling 1 mile (1.6 kilometers) of unpaved roadway once a day, every day for a year, approximately 2.5 tons of dust are deposited along a 1,000-foot (~300-meter) corridor centered on the road (Sanders pers. comm. 2008). Dust deposition tends to be highest near the road and decreases with increasing distance from the road (Spatt and Miller 1981; Everett 1980; Walker and Everett 1987; Santelmann and Gorham 1988; Myers-Smith et al. 2006). For example, in one study 97 percent of dust was deposited within 410 feet (125 meters) of the road (Walker and Everett 1987). The distance from a road at which dust can affect vegetation varies (see McCrea 1984; Myers-Smith et al. 2006), but negative impacts can occur up to 984 feet (300 meters) away from the road (Everett 1980). Dust negatively affects photosynthesis, respiration, transpiration, water use efficiency, leaf conductance, growth rate, plant vigor, gas exchange, and allows the penetration of phytotoxic gaseous pollutants (Eller 1977; Spatt and Miller 1981; Thompson et al. 1984; Farmer 1993; Sharifi 1997; Trombulak and Frissell 2000; Hobbs 2001). Dust comprised of finer particulates was shown to cause more improper functioning of the stomata than larger particles (Ricks and Williams 1974; Eller and Brunner 1975; Eveling and Bataille 1984; Rawson and Clarke 1988; Hirano et al. 1995). Clogged stomata result in increased water loss in two ways: due to an increased transpiration rate because of increased temperatures and due to clogged stomata that are unable to close at night (Hirano et al. 1995). Other dust effects include inhibiting sunlight from reaching the surfaces of dusted plants (Sharifi et al. 1997). Additionally, a decrease in infra-red light reflectance can result in dusted leaves with a 4 to 5°F (2 to 3°C) higher temperature (Sharifi

et al. 1997) compared to undusted leaves (Hirano et al. 1995). Soils near roads can have significantly lower nutrient levels, altered organic horizon depth, higher bulk density, and lower moisture (Auerbach et al. 1997). Furthermore, soil characteristics and plant community composition can remain significantly different up to 28 years after road development (Myers-Smith et al. 2006). We do not know if dust negatively affects plant pollinators. (USFWS, 2010)

Stressor: Plant-pollinator interactions (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Many of the negative effects of habitat fragmentation to plants are due to effects on plant-pollinator interactions (Debinski and Holt 2000; Moody-Weis and Heywood 2001; Aizen et al. 2002; Gathmann and Tscharntke 2002; Lennartsson 2002; Kolb 2008). Fragmented plant populations appear to be less attractive to insect pollinators, which spend more time in larger, unfragmented plant habitats (Aizen et al. 2002; Lennartsson 2002; Kolb 2008; Goverde et al. 2002). Furthermore, insect pollinator diversity increases in larger populations (Mustajarvi et al. 2001) and decreases in isolated habitats with smaller plant population sizes (Steffan-Dewenter and Tscharntke 1999). Lower pollinator visitation rates are associated with lower seed sets and reproductive success in fragmented sites compared to intact sites (Jennersten 1988). Bumblebees were observed visiting more flowers on fewer flower stalks in sparser plant populations (Mustajarvi et al. 2001; Goverde et al. 2002). This led to increased self-pollination or near-neighbor pollination contributing to inbreeding (Goverde et al. 2002; Lennartsson 2002). Inbred plants produce fewer flowers and seeds, have smaller plant height and smaller leaf-size, and reduced reproductive success (Steffan-Dewenter and Tscharntke 1999; Lienert 2004; Kolb 2008). Overall, we believe energy related development can cause serious impacts to *Schoenocrambe suffrutescens* through habitat fragmentation, increased road dust, and disruption of plant-pollinator interactions. Current 300 feet (91 meters) buffers are likely adequate to minimize impacts to the species. Nevertheless, in 2009, the Service initiated studies to quantify the effects of continued energy development related to these factors. (USFWS, 2010)

Stressor: Building stone mining (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: *Schoenocrambe suffrutescens* habitat is associated with commercially valuable building stone. Building stone mining can directly disturb individual plants and their habitat, with other effects similar to oil and gas development, including habitat fragmentation, increased dust, and pollinator disturbance. Building stone mining was a significant historical threat to the species. Previous commercial stone excavation caused the extirpation of a portion of the species' population in the vicinity of Big and Little Pack Mountains (USFWS 1994). Today, this factor is only a substantive issue on private land. Although approximately 57 percent of mapped *Schoenocrambe suffrutescens* populations on BLM lands are open to leasing (BLM GIS data, September 2009), building stone mining does not currently occur in occupied habitat on BLM land (Hansen pers. comm. 2009). On private lands, building stone is currently mined in *Schoenocrambe suffrutescens* occupied habitat. At one site, seven individual plants and occupied habitat were destroyed (Brunson 2010). We do not know how widespread this impact is across *S. suffrutescens* habitat on private lands. With so few individuals of this species, we believe that the loss of any individuals could significantly impact the species. Therefore, based

on recently documented disturbance on private lands, the Service believes that building stone mining remains a threat to this species. (USFWS, 2010)

Stressor: Small populations (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: When *Schoenocrambe suffrutescens* was listed, it was known to occur in only nine populations with fewer than 3,000 individuals total, including three populations of fewer than 30 plants each. Recent estimates do not indicate significant changes. Small populations and species with limited distributions are vulnerable to relatively minor environmental disturbances (Given 1994). Small populations are also at an increased risk of extinction due to the potential for inbreeding depression, loss of genetic diversity, and lower sexual reproduction rates (Ellstrand and Elam 1993; Wilcock and Neiland 2002). Lower genetic diversity may, in turn, lead to even smaller populations by decreasing the species' ability to adapt, thereby increasing the probability of population extinction (Barrett and Kohn 1991; Newman and Pilson 1997). Species with limited climatic ranges and restricted habitat requirements are typically the most vulnerable to extinction (Intergovernmental Panel on Climate Change [IPCC] 2002; Machinski et al. 2006). The risk of extinction is expected to increase for species with low population numbers (IPCC 2002; Jump and Penuelas 2005). The Service lacks information on the population genetics of *Schoenocrambe suffrutescens*. Recent observations indicate this species produces more seed when it is outcrossed (Lewis 2010). Therefore, the fewer plants are located at a site, the less chance for cross-fertilization. Because population numbers are very low for this species, we consider small population size a threat to *S. suffrutescens*, but without further research or information, the Service cannot predict the magnitude of this threat. (USFWS, 2010)

Stressor: Invasive species (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Exotic species are common along highways because seeds are carried and deposited along roads by vehicles, and spread via vehicle-caused air turbulence (Forman and Alexander 1998). Roads promote the spread of invasive species by altering soil characteristics, stressing native vegetation, and providing easier movement by wild or human vectors (Trombulak and Frissell 2000). Spread of invasive species via roads coupled with increased road dust can exacerbate the impact on native species: an increase in fine dust particles can increase nonnative, exotic plant species (Reynolds et al. 2001). Invasive, exotic plant species can contribute to the extinction of native plants (Soulé et al. 1992). Cheatgrass (*Bromus tectorum*) was documented in *Schoenocrambe argillacea* habitat (Glisson 2005), in the vicinity of the Big Pack Mountain *S. suffrutescens* population. Cheatgrass can out-compete native species for soil nutrients and water (Melgoza et al. 1990; Aguirre and Johnson 1991; Pyke and Novak 1994). If it establishes in sufficient density in native plant communities, cheatgrass increases flammability, leading to shortened fire return intervals that make it difficult for native plants to re-establish (D'antonio and Vitousek 1992). Halogeton (*Halogeton glomeratus*) has been documented growing in *S. suffrutescens* occupied habitat (Brunson 2009; Buys and Associates 2009, Lewis 2010). Halogeton quickly infests areas that are either left barren from fire or disturbed from mechanical or land management means (Pavek 1992). Halogeton tends to be a poor competitor, but it can accumulate sodium in the soil and alter soil microbiota to the disadvantage of native

plants (Kitchen and Jorgensen 2001; Kitchen and Carlson 2008). Although invasive species are present in *Schoenocrambe suffrutescens* habitat, they have not been noted at high levels. Their distribution is likely to increase over time as invasive annuals increase biomass and seed production at elevated levels of carbon dioxide (Mayeux et al. 1994; Smith et al. 2000; Ziska et al. 2005). Regardless, we do not consider invasive species a threat to *S. suffrutescens* now or for the foreseeable future. (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Climate change is likely to affect long-term survival or distribution of native species. In the southwestern United States, including Utah and *Schoenocrambe suffrutescens* habitat, average temperatures have increased ~1.5°F (0.8°C) compared to a 1960-1979 baseline (Karl et al. 2009). By the end of this century, temperatures are expected to warm a total of 4 to 10°F (2 to 5°C) in the Southwest (Karl et al. 2009). Hot extremes, heat waves, and heavy precipitation will increase in frequency, with the Southwest experiencing the greatest temperature increase in the continental United States (IPCC 2007). We do not know how changes in precipitation will affect *Schoenocrambe suffrutescens*. However, we do know that increased drought can be detrimental to many drought-tolerant species. Drought conditions led to a noticeable decline in survival, vigor and reproductive output of rare plants in the southwest during the drought years of 2001-2004 (Roth 2008a, 2008b; Clark and Clark 2007; Hughes 2005; Anderton 2002; Van Buren and Harper 2002, 2003). On the other hand, there is some indication that high-stress areas may contain plants that are adapted to that stressor, and drought-adapted species may experience lower mortality during severe droughts (Gitlin et al. 2006). Effects related to climate change, such as persistent or prolonged drought conditions, may affect the long-term persistence of *Schoenocrambe suffrutescens*, but without further research or information, it is difficult to predict how. (USFWS, 2010)

Recovery

Reclassification Criteria:

1. Discover or establish a minimum of five separate populations with 2,000 or more individuals per population for each species. These populations must be demonstrated to be at or above minimum viable population levels. (USFWS, 1994)
2. Document the presence of or, if necessary, establish formal land management designations which would provide for long—term protection on undisturbed habitat for the above five populations of each species. (USFWS, 1994)

Delisting Criteria:

1. Discovery or establishment of a minimum of 10 separate populations with 2,000 or more individuals per population for each species. These populations must be demonstrated to be at or above minimum viable population levels. (USFWS, 1994)
2. Document the presence of or, if necessary, establish formal land management designations which would provide for long—term protection on undisturbed habitat for the above 10 populations of each species. (USFWS, 1994)

Recovery Actions:

- Inventory suitable habitat for *S. argillacea*, *S. barnebyi*, and *S. suffrutescens* and determine with a reasonable degree of accuracy the population and distribution of each species. (USFWS, 2011)
- Establish and conduct at least three minimum viable population studies on each of at least three different populations of each species. (USFWS, 2011)
- Document the presence of or, if necessary, establish formal land management designations which would provide for long-term protection on undisturbed habitat for each species. (USFWS, 2011)
- Control activities which affect the habitat of *S. argillacea*, *S. barnebyi*, and *S. suffrutescens* through sections 7 and 9 of the Endangered Species Act and other relevant laws and regulations. (USFWS, 2011)

Conservation Measures and Best Management Practices:

- We recommend conducting range-wide, comprehensive surveys for *Schoenocrambe suffrutescens* within the next year, especially in the Gray Knolls area on tribal land. These data should be used to define and delineate populations, and to help revise the Recovery Plan. (USFWS, 2010)
- Monitoring plots were established for testing plant response to disturbance, and basic demographic data are being collected. We recommend continuing to collect data from at least a portion of these plots indefinitely, even past the need for the disturbance study, to be able to answer basic demographic questions and to monitor reproduction. (USFWS, 2010)
- The previous geological nomenclature that was commonly used to identify potential *Schoenocrambe suffrutescens* habitat was discarded (Weiss 1990), thus complicating an already difficult search for this species. The Service needs to accurately characterize parent material, soil, and landscape characteristics for *S. suffrutescens*. This research would allow us to more accurately identify unoccupied but potentially important habitat, areas for focused surveys and reintroduction, and areas where oil and gas development are unlikely to harm the species. (USFWS, 2010)
- *Schoenocrambe suffrutescens* should be reintroduced to new areas of suitable but unoccupied habitat near existing populations. (USFWS, 2010)
- Basic biological and ecological information should be obtained for this species, including pollination mechanisms and pollinators. This research began in 2010. (USFWS, 2010)
- Studies to quantify the effects of dust, invasive species, and disturbance from continued energy development were initiated in 2009. These studies should be continued until the Service has enough data to draw conclusions. (USFWS, 2010)
- The Service should consider collecting seeds to include this species in the Center for Plant Conservation collection. Seeds should also be tested for viability and longevity. (USFWS, 2010)
- Nearly 40 percent of the mapped *Schoenocrambe suffrutescens* populations occur on non-Federal lands. We should continue to work with the Uintah and Ouray Indian Reservation, SITLA, and private landowners to survey and conserve *S. suffrutescens* habitat and increase outreach efforts. (USFWS, 2010)
- On Federal lands, the Service should continue to avoid development in *Schoenocrambe suffrutescens* populations and suitable, unoccupied habitat as much as possible, unless research becomes available to indicate that *S. suffrutescens* is unaffected by development. The Service should ensure that developers follow established conservation measures when disturbance occurs and that habitat fragmentation is reduced as much as possible. (USFWS, 2010)

- Using research collected on soil characteristics and response to disturbance, the Service should identify and establish core conservation areas in minimally-disturbed habitat (both occupied and unoccupied) for long-term protection of *S. suffrutescens*. (USFWS, 2010)
- Once the Service has new survey data and research data available, the Service recommends revising the Recovery Plan to explicitly address the relevant listing factors. Time and cost required to meet the criteria and recover the species should be included in the Recovery Plan. (USFWS, 2010)
- The Service will continue to monitor the acceptance of *Hesperidanthus* as the correct genus for this species and will officially change this species' name through an FR notice as needed. (USFWS, 2010)

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SPECIES ACCOUNT: *Schoepfia arenaria* (No common name)

Species Taxonomic and Listing Information

Listing Status: Threatened; Southeast Region (Region 4) (USFWS, 2015) 4/19/1991

Physical Description

An evergreen shrub or small tree up to 20 feet or 6 meters (in) tall and with several trunks from the base reaching 4 inches or 10 centimeters (cm) in diameter. The leaves are simple, alternate, without stipules, with petioles one—eighth of an inch or 4 millimeters (mm) long; the upper surface is green and slightly shiny, and the lower surface is light green. *Schoepfia arenaria* has been observed with flowers mainly in spring and fall, and with fruits in summer and winter. Usually two or three light yellow tubular—shaped flowers are borne on the end of the stalk at the leaf bases. The fruit is elliptic, one-seeded, shiny red, and one—half inch or 12 millimeters (mm) in diameter. The wood is light brown and hard (USFWS, 1991).

Historical Range

At the time the recovery plan was signed (1992), less than 200 individuals of *S. arenaria* were known within five areas: (A) Municipality of Isabela - approximately 100 individuals of all size classes; (B) Río Abajo Commonwealth Forest (RACF) - one individual; (C) Tortuguero Lagoon Natural Reserve (TLNR) - no population estimate; (D) Municipality of Loíza in the area of Punta Maldonado, Piñones - 30 mature plants and numerous saplings and seedlings; and (E) Municipality of Fajardo at El Convento - approximately 50 individuals. (USFWS, 2016).

Current Range

known from four sites in Puerto Rico: Isabela, Pinones, Fajardo, and the Río Abajo Commonwealth Forest. (USFWS, 1991). 2016 location refinements: Less than 200 individuals of *S. arenaria* were known back then from four sites: Isabela, Loíza (Punta Maldonado, Piñones), Fajardo (El Convento), and the Río Abajo Commonwealth Forest. A fifth location is also mentioned in the recovery plan from the Tortuguero Lagoon Natural Reserve. (USFWS, 2016).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Breeding Season

Adult: This species has been observed with flowers mainly in spring and fall, and with fruits in summer and winter (USFWS, 1991).

Other Reproductive Information

Adult: Santiago-Valentín and Rojas-Vázquez (2001) recorded leaf, flower and fruit phenology for a period of one year. Their results demonstrate that although flowers and fruits can be found throughout the year, flowering and fruiting is seasonal, with production peaks during the first months of the year (February to May, dry season of Puerto Rico). Production of new leaves occurred continuously during the year. Santiago (2011) collected seeds of *S. arenaria* during the

dry season (March) and he designed an experiment to determine if mechanical scarification of the seed has a difference in the germination time. He reported that the average germination time of scarified seeds is shorter (about 20 days earlier) than non-scarified (control) seeds. Furthermore, he reported that the germination success was significantly higher in scarified seeds than control, 95% and 68%, respectively. Unfortunately, longterm seed storage does not seem to be a viable option for this species, as the seeds that were air-dried and stored over a year showed less than 10 percent germination success (Santiago 2011). Additionally, he found that growth rate of seedlings of this species is very low and suggested that *S. arenaria* is hemiparasitic (seedlings need to establish connections with a host plant to absorb the nutrients and water for survival). The author mentioned that seedlings started to become yellow and their development decreased after a year and a half, and eventually all died. (USFWS, 2016).

Reproduction Narrative

Adult: Little information is currently available concerning the life history and reproductive biology of *Schoepfia arenaria*. This species has been observed with flowers mainly in spring and fall, and with fruits in summer and winter. Usually two or three light yellow tubular-shaped flowers are borne on the end of the stalk in the leaf bases. Many seedlings have been observed under mature trees, and plants of all size classes have been observed. Pollinization mechanisms, seed production and dispersal, seed viability and germination requirements, and seedling establishment and growth should be studied. Other species in this genus are considered as hemiparasitic, due to their root interconnections with other woody species (hosts) nearby, from which they obtain soil minerals (Quevedo, pers. comm.). Future research should document interspecific relations with other native taxa in order to determine whether or not *Schoepfia arenaria* is also a hemiparasite (USFWS, 1991).

Habitat Type

Adult: Evergreen and semi-evergreen forest (USFWS, 1991)

Spatial Arrangements of the Population

Adult: Clumped (inferred from USFWS, 1991)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1991)

Site Fidelity

Adult: High (inferred from USFWS, 1991)

Habitat Narrative

Adult: *Schoepfia arenaria*, an evergreen shrub or small tree, occurs in low elevation evergreen and semi—evergreen forests of the limestone hills of northern Puerto Rico. Deforestation and limestone hill destruction for industrial, urban, and tourist expansion have restricted this species to its present locations. It is threatened by development projects in Isabela, and by illegal land acquisition in Pinones (USFWS, 1991). Low tolerance range, high site fidelity and ecological integrity of the community are inferred based on specific habitat needs and relatively low number of populations and individuals. Clumped spatial arrangement is also inferred based on habitat needs and distribution of known populations.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Dispersal and migration has not yet been assessed (USFWS, 1992).

Population Information and Trends**Resiliency:**

Low (inferred from USFWS, 1991)

Representation:

Low (inferred from USFWS, 1991)

Redundancy:

Low (inferred from USFWS, 1991)

Number of Populations:

Four (USFWS, 1991)

Population Size:

~190 total individuals (USFWS, 1991)

Population Narrative:

As of 1991 there were four known populations totaling approximately 190 individuals.

Threats and Stressors

Stressor: Deforestation (USFWS, 1991)

Exposure:

Response:

Consequence:

Narrative: The species has become threatened as a result of deforestation in the coastal forests and limestone hills for urban, industrial, and tourist expansion in northern Puerto Rico (USFWS, 1991).

Stressor: Agriculture (USFWS, 1991)

Exposure:

Response:

Consequence:

Narrative: Among the factors which have historically limited the distribution of *Schoepfia arenaria* include deforestation and limestone hills destruction for agriculture, grazing, and more recently for urban, industrial and tourist developments, and associated roads and service facilities (USFWS, 1991).

Stressor: Grazing (USFWS, 1991)

Exposure:

Response:

Consequence:

Narrative: Among the factors which have historically limited the distribution of *Schoepfia arenaria* include deforestation and limestone hills destruction for agriculture, grazing, and more recently for urban, industrial and tourist developments, and associated roads and service facilities (USFWS, 1991).

Stressor: Urban, industrial and tourist development (USFWS, 1991)

Exposure:

Response:

Consequence:

Narrative: Among the factors which have historically limited the distribution of *Schoepfia arenaria* include deforestation and limestone hills destruction for agriculture, grazing, and more recently for urban, industrial and tourist developments, and associated roads and service facilities (USFWS, 1991).

Recovery

Delisting Criteria:

Delisting of *Schoepfia arenaria* will be considered when the privately-owned population sites are given protected status, and at least two self-sustaining populations in Commonwealth Forest units or other protected lands have been established (USFWS, 1991).

Recovery Actions:

- Monitor and protect existing populations to prevent further habitat loss and population decline. The known populations and habitat should be monitored and protected by both public agencies and private conservation organizations in order that the decline of individuals does not continue and that the complete extinction of the species does not occur. It is essential as well to maintain a source of material for propagation (USFWS, 1991).
- Continue to gather information on the distribution and abundance of *Schoepfia arenaria*. Additional information concerning the distribution and abundance of the species will affect future management decisions and the establishment of recovery priorities (USFWS, 1991).
- Research. Basic biological information is currently needed on *Schoepfia arenaria*. Studies should focus on aspects of life history, methods of propagation, and evaluation of possible introduction sites. These studies may be critical in the recovery of the species (USFWS, 1991).
- Refine recovery goals. As additional information on the biology, ecology, propagation, and management of *Schoepfia arenaria* is gathered, it will be necessary to better define, and possibly modify, recovery goals (USFWS, 1991).
- 2016 recommended actions - 1: Conduct comprehensive surveys to determine status of the species. (USFWS, 2016).
- 2016 - 2: Develop appropriate propagation techniques to enhance existing populations and to establish new ones. (USFWS, 2016).
- 2016 - 3: Conduct studies on the pollination and seed dispersal strategies in order to assess if any of these are limiting population growth and expansion. (USFWS, 2016).
- 2016 - 4: Efforts should continue to protect populations in privately-owned lands by reducing habitat deterioration and promoting sustainable land use practices. (USFWS, 2016).

- 2016 - 5: Continue working and foster partnership with regulatory agencies to address and minimize potential adverse effects of development projects on the species and its habitat. (USFWS, 2016).
- 2016 - 6: Monitor known populations to determine its long-term status. (USFWS, 2016).
- 2016 - 7: Model potential suitable habitat using GIS tools to search for possible reintroduction sites and other potential populations that may exist. (USFWS, 2016).
- 2016 - 8: Conduct studies to determine intra and inter-population genetic diversity. (USFWS, 2016).

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SPECIES ACCOUNT: *Schwalbea americana* (American chaffseed)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/29/1992; Southeast Region (Region 4)

Physical Description

Schwalbea is an erect herb with unbranched stems or stems branched only at the base, growing to a height of 3.0 to 6.0 dm (12 to 24 in). The plant is densely albeit minutely hairy throughout, including the flowers. The leaves are alternate, lance-shaped to elliptic, stalkless, 2.5 to 5.0 cm (0.8 to 2 in) long, and entire; the upper leaves are reduced to narrow bracts. The large, purplish-yellow, tubular flowers, 3.0 to 3.5 cm long (1.2 to 1.4 in) are borne singly on short stalks in the axils of the uppermost, reduced leaves (bracts) and form a many flowered, spike-like raceme. The showy flowers have a high degree of bilateral symmetry elaborated for pollination by bees (Pennell 1935). The fruit is a narrow capsule approximately 10 to 12 mm (0.4 to 0.5 in) long, with a septical dehiscence. The numerous seeds are pale greenish brown or yellowish-tan, narrowly linear, somewhat flattened or compressed, slightly curved, and enclosed in a loose-fitting, sac-like structure that provides the basis for the common name, chaffseed (Musselman and Mann 1978). Flowering occurs from April to June in the southern part of the species' range, and from June to mid-July in the northern part of its range. Fruits mature from early summer in the South to October in the North (Johnson 1988). (USFWS, 1995)

Taxonomy

Pennell (1935) recognized a northern and southern species of Schwalbea, *Schwalbea americana* L. and *Schwalbea australis* Pennell, respectively. He distinguished *Schwalbea americana* by mostly recurved hairs and leaves up to 1.0 cm (0.4 in) wide or less, and *Schwalbea australis* by a pubescence of mostly upcurved hairs and leaves up to 1.5 cm (0.6 in) wide. *Schwalbea americana* was known from Massachusetts southward to Virginia, and *Schwalbea australis* was known from North Carolina to Kentucky and southward to Florida and Louisiana. Fernald (1937) found characters of the leaves and calyx lobes to vary over the total range so that recognition of two species was unwarranted. Following an examination of herbarium material, Musselman and Mann (1977) concurred that there was little taxonomic merit in recognizing more than a single species. Therefore, the U.S. Fish and Wildlife Service accepts the more recent treatments of Fernald (1937) and Musselman and Mann (1977), which recognize *Schwalbea americana* and *Schwalbea australis* as one species, *Schwalbea americana*. In this plan, *Schwalbea americana* will be henceforth referred to as the monotypic genus *Schwalbea*. (USFWS, 1995)

Historical Range

Historically known from Massachusetts and New York south along the East Coast to Florida and west along the Gulf Coast states to Texas. (NatureServe, 2015)

Current Range

Currently found in the following states: Massachusetts, New Jersey, North Carolina, South Carolina, Georgia, Alabama, Florida, and Louisiana. (USFWS, 2019a)

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Asexual and sexual (outcrossing) (NatureServe, 2015)

Dependency on Other Individuals or Species

Adult: Schwalbea produces showy, insect-pollinated flowers with a high degree of zygomorphy elaborated for pollination by bees (Pennell 1935). (USFWS, 1995)

Breeding Season

Adult: April to June (USFWS, 1995)

Other Reproductive Information

Adult: The germination rates of collected Schwulbea seeds are high. Kirkman (1993) reported that the germination rate of seeds placed in petri dishes, with and without cold stratification, was approximately 90 percent. (USFWS, 1995)

Reproduction Narrative

Adult: This species produces showy, insect-pollinated flowers; the high degree of zygomorphy elaborated for pollination by bees (Pennell 1935). Reproduction primarily occurs via outcrossing (sexual) but can also reproduce asexually. Flowers bloom between April and June. (USFWS, 1995; NatureServe, 2015)

Habitat Type

Adult: Palustrine and terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Bog/fen, forest/woodland, savanna, woodland - mixed (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Sunny open areas (NatureServe, 2015)

Environmental Specificity

Adult: Sunny areas (NatureServe, 2015)

Dependency on Other Individuals or Species for Habitat

Adult: The root parasitic behavior of Schwalbea has been known since 1856 (Musselman and Mann 1977). Schwalbea is considered the rarest root parasitic plant in the South, and, like most parasitic Scrophulariaceae, it is not host-specific. (USFWS, 1995)

Habitat Narrative

Adult: Characteristically, Schwalbea occurs in sandy (sandy peat, sandy loam), acidic, seasonally moist to dry soils. The species is generally found in habitats described as pine flatwoods, fire-maintained savannas, ecotonal areas between peaty wetlands and xeric sandy soils, and other open grass-sedge systems (Kral 1983). Schwalbea appears to be shade intolerant and, therefore, occurs in areas maintained in an open to partially open condition. In Georgia, Schwalbea occurs in

ecotonal areas between freshwater wetlands and upland pine forests. In North Carolina, the species occurs in moist to dryish pine flatwoods, longleaf pine/wiregrass savannas, and on longleaf pine/oak sandhills composed of Upper Cretaceous deep, white sands, at the western edge of the coastal plain. In South Carolina, the predominant habitat is described as fire-maintained (or mowed, as under power lines), dry, well-drained, longleaf pine flatwoods. The soil is generally a sandy loam. In New Jersey, *Schwalbea* occurs in open areas that have been maintained by mowing within a pitch pine community. The site is next to a roadcut through a cedar swamp. (USFWS, 1995)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: The structure of the *Schwalbea* seed, somewhat flattened or compressed, slightly curved, and enclosed in a loose-fitting sac-like structure, suggests wind dispersal; however, no information is available to support this hypothesis. Information is lacking on both the mechanism and distance of seed dispersal. (USFWS, 1995)

Population Information and Trends

Population Trends:

Long-term trends indicate population declines from 50 to 90%, whereas short-term trends suggest declines of 10 to 30% (NatureServe, 2015)

Species Trends:

Declining (NatureServe, 2015)

Number of Populations:

43 (USFWS, 2019a)

Population Size:

2500 - 10,000 individuals (NatureServe, 2015)

Adaptability:

Moderate (NatureServe, 2015)

Population Narrative:

When *Schwalbea* was listed as an endangered species in 1992, 19 extant occurrences were known from the following States: New Jersey (1), North Carolina (1), South Carolina (11), Georgia (4), Florida (1), and Mississippi (1). At the completion of the recovery plan in 1995, extensive searches for this species that occurred in the Southeast, namely North and South Carolina, increased the number of extant occurrences to 72: New Jersey Pleasantville, New Jersey (1), North Carolina (18), South Carolina (42), Georgia (10), and Florida (1). The last comprehensive review of this species status occurred in 2008. At that time, 53 occurrences were extant (30% of sites extant) in 2008: New Jersey (2), North Carolina (11), South Carolina (33), Georgia (4), Alabama (1), Florida (1), and Louisiana (1). It is important to note that in the 1995 recovery plan and 2008 5-year review, the terms population and occurrence were used interchangeably. Since some *Schwalbea* populations have multiple element occurrences or sites per population, the number of populations across the species range was over-reported in some

cases. In order to standardize population numbers across state boundaries, NatureServe's (2018) population delimitation guidelines were used for all extant populations across Schwalbeas' range in this five-year review. Historic and unknown occurrences were not delimited. Currently, there are 43 extant populations across the species range: Massachusetts (1), New Jersey (2), North Carolina (6), South Carolina (18), Georgia (9), Alabama (2), Florida (3), and Louisiana (2). (USFWS, 2019a)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2019a)

Exposure:

Response:

Consequence:

Narrative: Habitat destruction and adverse modification of suitable habitat for Schwalbea continue to be major threats for this species. Development along the coast continues to threaten Schwalbea by (1) direct loss of habitat and (2) indirect threats due to urbanization resulting in fire suppression from either local air pollution regulations or safety concerns. Fire suppression continues to threaten this species on both private and public lands. Conversion of longleaf flatwoods and savannas to commercial pine plantations and agriculture fields continue to threaten this species. Although new Schwalbea populations are being discovered, the number of extant populations declined by approximately 25% since the last 2008-five year review. (USFWS, 2019a)

Stressor: Herbivory (USFWS, 2019a)

Exposure:

Response:

Consequence:

Narrative: Herbivory continues to serve as a minor threat to the species, herbivores include the striped leaf beetle (*Kuschelina* sp.), Chrysomelid leaf beetle sp., and Buckeye caterpillar (*Junonia coenia*) larvae (M. Jenkins, Florida Department of Agriculture and Consumer Resources, pers. comm. 2017; Bob Dellinger, U.S. Forest Service, pers. comm. 2017). The Lethcoe, FMNF population suffered from herbivory when fresh new growth sprouted following a prescribed fire. (USFWS, 2019a)

Stressor: Small population size (USFWS, 2019a)

Exposure:

Response:

Consequence:

Narrative: Small population size was noted as a threat in the last 2008 five-year review and remains a threat today. Populations that appear stable throughout time contain at least 100 individuals. Currently, 20 populations contain 100 or more individuals. Small populations are highly vulnerable to extirpation, especially in the absence of prescribed fire. Small populations may be less resilient to environmental changes related to climate change. (USFWS, 2019a)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2019a)

Exposure:

Response:

Consequence:

Narrative: Because the Act only grants protection to plants when a Federal nexus is involved (e.g., federal permit required, federally funded projects), existing regulatory mechanisms are inadequate to protect Schwalbea. Schwalbea receives protection from state rare plant protection laws in Massachusetts, New Jersey, North Carolina, South Carolina, Georgia, and Florida. (USFWS, 2019a)

Stressor: Drought (USFWS, 2019a)

Exposure:

Response:

Consequence:

Narrative: Since Schwalbea is mostly (can occur outside of ecotone areas in longleaf flatwoods) an ecotone species occurring in transitional areas between uplands and freshwater wetlands, an increase in drought frequency and decrease in precipitation events could threaten smaller, less resilient populations. (USFWS, 2019a)

Recovery

Reclassification Criteria:

1. Long-term protection is achieved for 50 geographically distinct, self-sustaining populations. The population sites must be protected from development and other anthropogenic threats that may interfere with the species' survival. Protection of populations on private lands will be evidenced through landowner agreements or conservation easements. Protection of Schwalbea on public lands will be secured through agreements that ensure the long-range protection, management, and monitoring of Schwalbea. Protected sites will be distributed to include, at a minimum, all of the States currently supporting Schwalbea, with at least four populations in the northern portion of the species' range. Site protection agreements will cover the immediate occurrence site and, where possible, enough contiguous unoccupied habitat to allow for dispersal and natural colonization and expansion of the species. (USFWS, 1995)
2. Management agreements or plans are developed for the 50 protected occurrence sites with the primary objective of ensuring that an ecosystem capable of supporting viable populations of Schwalbea will be permanently maintained. In the case of private ownership, these management agreements could be part of the conservation easement or landowner agreement. (USFWS, 1995)
3. Viable populations of Schwalbea are established at four sites in the northern portion of the species' range (Massachusetts to Virginia), preferably with genetic material from the only remaining northern population in New Jersey. (USFWS, 1995)
4. Biennial monitoring shows that the 50 protected populations are viable as well as stable or increasing over a 10-year period. Demographic population data will be required to meet this condition. (USFWS, 1995)
5. Life history and ecological requirements are understood sufficiently to reliably predict the effectiveness of protection, management, and monitoring. (USFWS, 1995)

Delisting Criteria:

1. Protection via a conservation mechanism is achieved for 50 geographically distinct, self-sustaining populations (Addresses listing factors A, D, and E). (USFWS, 2019b)
2. Protected populations will be distributed to include all of the states currently supporting Schwalbea, and at least four populations in the northern portion of the species range (Massachusetts to Virginia) (Addresses listing factors A, D, and E). (USFWS, 2019b)
3. The land management plans or agreements for the 50 protected Schwalbea populations must include management objectives that abate threats to Schwalbea such as fire suppression, hog damage, and/or silviculture practices (Addresses listing factors A, D, and E). (USFWS, 2019b)

Recovery Actions:

- Protect extant populations and manage habitat. Identify ownership of all known populations. Establish contact with landowners and negotiate landowner agreements or conservation easements. Ensure that activities and management on public lands are consistent with the protection and management of Schwalbea. Use existing regulatory mechanisms to protect Schwalbea. Conduct additional surveys. (USFWS, 1995)
- Expand the extent of Schwalbea in the northern portion of the current range. The New Jersey occurrence of Schwalbea, which is critical to maintaining the northern range of the species, will receive continued protection. In addition, populations should be established in New Jersey, Delaware, Maryland, New York, Connecticut, and Massachusetts to guard against the extirpation of the species from the northern portion of its range. Data are not currently available that indicate the genetic significance of the remaining northern population; however, Pennell (1935) considered the northern and southern populations of Schwalbea to be distinct species, with the southern species occurring as far north as Virginia (Reveal and Broome 1981). Genetic analyses (Recovery Task 6 below) may further support the significance of maintaining viable populations from the northern gene pool. (USFWS, 1995)
- Investigate best management techniques. Continue experiments to determine the effects of fire. Conduct experiments to determine the effects of other disturbances. (USFWS, 1995)
- Investigate the species' biology. Conduct research to obtain more comprehensive information on life history and population demography. Determine minimum viable population size. (USFWS, 1995)
- Investigate genetic variability. Genetic analyses should be conducted to determine inter and intra-genetic variability of populations. Differences in the genetic composition of populations may influence site protection and reintroduction priorities. Ongoing genetic analyses may be sufficient to determine if significant variability exists. (USFWS, 1995)
- Monitor populations. Meeting the recovery objectives is contingent upon the stabilization of viable populations over time. Consistent monitoring will provide population data necessary to determine if the recovery objectives are being met. (USFWS, 1995)
- Review recovery progress and revise recovery plan as necessary. The overall success of the recovery program should be periodically assessed, and recommendations regarding appropriate changes in recovery objectives or tasks as suggested by research, studies, or monitoring should be implemented. (USFWS, 1995)

Conservation Measures and Best Management Practices:

- Research and determine if in situ recruitment and reintroduction can occur under different levels of soil disturbance and watering regimes. (USFWS, 2019a)
- Continually search for new populations in areas managed for quail and/or red-cockaded woodpeckers or any areas with a 1-2 year fire return interval within the species' historic range. (USFWS, 2019a)
- Survey unknown and historic populations and if present negotiate landowner agreements or conservation easements. (USFWS, 2019a)
- Develop an easy and repeatable Schwalbea survey form and methodology for range-wide use in order to track/monitor recovery populations annually. (USFWS, 2019a)
- Research the germination ecology of Schwalbea in regards to moisture and light requirements and seedling recruitment / host attachment to understand Schwalbea's regeneration strategy. (USFWS, 2019a)
- Research fire seasonality effects, especially early April and late July/August fires, in conjunction with rainfall patterns/climatic fluctuations. (USFWS, 2019a)
- Continue population reintroductions within the historic range and introductions into protected areas with 1-3 year fire return intervals. (USFWS, 2019a)
- Expand the extent of Schwalbea in the northern portion of the current range. (USFWS, 2019a)

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SPECIES ACCOUNT: *Sclerocactus brevihamatus* ssp. *tobuschii* (Tobusch fishhook cactus)

Species Taxonomic and Listing Information

Commonly-used Acronym: SCLTOB

Listing Status: Endangered; 12/08/1979; Southwest Region (Region 2)

Physical Description

A cactus armed with fishhook-shaped spines. The hemispheric or short-columnar stems of mature plants are 3 to 10 centimeters (cm) (1.2 to 3.9 inches (in)) tall and 1 to 10 cm (0.4 to 3.9 in) in diameter; however, although the largest recorded individuals are as much as 10 cm (3.9 in) in diameter, few wild plants are greater than 5 cm (2.0 in) in diameter (Poole and Janssen 2002, p. 7). The stems are supported on short, conical taproots from which emerge numerous fibrous roots that typically grow horizontally along the surfaces and fissures of rock strata. The stems bear tubercles (podaria) up to 12 millimeters (mm) (0.5 in) long that have a groove (sulca) along their upper surfaces. The tubercles are arranged in 5 to 8 ribs (Marshall 1952, p. 79), or from 8 to 12 ribs (Poole et al. 2007, p.442). However, we note that the tubercles within each rib are nearly distinct from each other; the ribs, which may spiral, are difficult to discern, especially in smaller individuals, and the tubercles appear to alternate. Spines arise from areoles at the apex of each tubercle. The spines are of two types: Radial spines are fine, straight, from 1 to 2 cm (0.4 to 0.8 in) long, spreading at right angles to the tubercle from the edges of the areoles. From 3 to 5 thicker, flattened central spines, 2 to 4 cm (0.8 to 1.6 in) in length, arise from nearer the center of the areoles and project more or less outward from the stem; one of the central spines is abruptly recurved, and may reach 180° of curvature in older individuals. Spines are yellowish at first, and may have reddish tips, turning gray with age. Flowers emerge from the bases of young tubercles near the stem apex, and have numerous yellow tepals. Fruits are spineless, elongate, from 2.5 to 3 cm (1 to 1.2 in) long, turning reddish-green and usually splitting open along 1 or more lines when mature. (USFWS, 2017)

Taxonomy

The genus *Ancistrocactus*, which means "fishhook", contains four species, three occurring in the region of the Rio Grande River in southern Texas and adjacent Mexico, and one occurring farther south (Benson, 1982). According to Benson (1982) this genus is mostly closely related to *Coryphantha* and *Neolloydia*, all three genera being in the vast complex group of plants intermediate between *Mammillaria* and *Echinocactus*. Systematics of the Cactaceae has always been controversial. No single treatment is universally accepted, and the steady accumulation of phylogenetic analyses has forced continual revisions. In particular, there is no consensus among cactus authorities regarding the taxa pertaining to the related genera of *Ancistrocactus*, *Sclerocactus*, and *Ferocactus*. The following sources provide a brief review of the prevailing classifications. A number of synonyms have been applied to this taxon, including *Ancistrocactus tobuschii* (W.T. Marshall) W.T. Marshall ex Backeb, *Echinocactus tobuschii* (W.T. Marshall) Weniger and *Ferocactus tobuschii* (W.T. Marshall) N.P. Taylor. (USFWS, 1987; USFWS, 2010). An extensive discussion of the taxonomy is provided in the Species Status Assessment of 2017 (USFWS, 2017).

Historical Range

Endemic to the Edwards Plateau of Texas. (USFWS, 2017)

Current Range

In the following central counties in Texas: Bandera, Edwards, Kerr, Kimble, Kinney, Real, Uvalde, and Val Verde. (USFWS, 2017)

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (USFWS, 2017)

Lifespan

Adult: >10 years (USFWS, 2017)

Dependency on Other Individuals or Species

Adult: Pollinators; most common were several species of halictid bees (USFWS, 2017)

Breeding Season

Adult: Late January to mid-March (USFWS, 2017)

Other Reproductive Information

Adult: Tobusch fishhook cactus plants begin reproducing when they have grown to a diameter of about 2 cm (occasionally less); this is estimated to require 9 years of growth in the wild. Flowering occurs between late January and mid-March, depending on locality, and lasts a few weeks in each population. Honey bees and halictid bees are effective pollinators, although the latter group may be more active later in the flowering season. The breeding system is primarily by outcrossing, although self-fertilization occurs rarely. Fruits ripen around mid-May. (USFWS, 2017)

Reproduction Narrative

Adult: Tobusch fishhook cactus grows slowly, reaching a reproductive size of about 2 centimeters (0.8 inches) in diameter after 9 years. It flowers between late January and mid-March, and its major pollinators are honey bees and halictid bees. The breeding system is primarily out-crossing, but the species is capable of self-fertilization. Reproductive individuals produce an average of 112 seeds per year. Ants may be seed predators, dispersers, or both. Mammals or birds may also accomplish longer-distance seed dispersal. We have little evidence of a persistent soil seed bank. (USFWS, 2017)

Habitat Type

Adult: Terrestrial (USFWS, 2017)

Habitat Vegetation or Surface Water Classification

Adult: Shortgrass grasslands, oak-juniper woodlands, semi-desert shrublands (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Full sunlight (USFWS, 2017)

Spatial Arrangements of the Population

Adult: Discontinuous patches (USFWS, 2018)

Environmental Specificity

Adult: Moderate, with some key requirements (USFWS, 2017)

Habitat Narrative

Adult: The riparian habitats described in the original status report are atypical. The great majority of documented populations occur in upland sites dominated by Ashe juniper-live oak woodlands and savannas on outcrops of early Cretaceous limestone. Soils are classified in the Tarrant, Ector, Eckrant, and similar series. Within a matrix of woodland and savanna, the species occurs in discontinuous patches of very shallow, gravelly soils where bare limestone rock and rock fragments comprise a large proportion of the surface cover. Associated vegetation includes small bunch grasses and forbs. The species' distribution within habitat patches is clumped and tends to be further from woody plant cover. The presence of spikemosses (*Selaginella* spp.), and perhaps other cryptogams, may be useful indicators of fine-scale habitat suitability. Wildfire (including prescribed burning) causes negligible damage to Tobusch fishhook cactus populations. The species probably does not require fire for germination, establishment, or reproduction, but periodic burning may be necessary to prevent the encroachment of woody plants into its habitats. (USFWS, 2017)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Ants remove a large proportion of seeds, pulp, and funiculi, but whether the ants consume the seeds, or effectively disperse them, is not known. Mammals or birds also consume fruits and may accomplish longer-distance seed dispersal. Moderate numbers of viable seeds have been found in the soil near live plants, but the extent and longevity of soil seed banks is unknown. (USFWS, 2017)

Population Information and Trends**Population Trends:**

Increasing (USFWS, 2017)

Resiliency:

It is likely that Tobusch fishhook cactus has multiple, resilient populations (USFWS, 2017)

Representation:

Tobusch fishhook cactus currently possesses sufficient genetic diversity to conserve long-term adaptive capability. However, habitat fragmentation and disruption of gene flow among populations may have occurred too recently to be detected through genetic analyses.

Considering the naturally low densities of Tobusch fishhook cactus populations, gene flow among them may be easily disrupted. (USFWS, 2017)

Redundancy:

It is likely that Tobusch fishhook cactus has multiple, resilient populations (USFWS, 2017)

Number of Populations:

511 sites (USFWS, 2017)

Population Size:

Globally about 480,000 individuals (USFWS, 2017)

Population Narrative:

The TXNDD (2016) lists 97 EOs, totaling 3,336 individuals in 8 counties of the Edwards Plateau of Texas. • From 2009 to 2016 we received additional sources of population data, primarily from surveys conducted for development projects. • A total of 118 permanent plots at 12 protected natural areas have been monitored from 1991 through 2013. Plot data reveals that mortality is often very high, and consistently exceeds recruitment; however, the known population sizes have steadily increased, due to the discovery of previously undetected individuals and colonies. • The probability of detecting live Tobusch fishhook cactus individuals during a single survey is highly variable; Reemts (2014) calculated an overall detection rate of 50 percent. The inability to detect all living members of a population confounds determinations of population size and demographic trends. • Demographic population viability analyses of monitored populations, using integral projection models, predicted stable or increasing trends for 2 or 3 populations, moderate declines for 2 populations, and large to precipitous declines in 5 populations over the next 50 years. When expected climate changes were included in the analyses, 4 populations responded negatively to climate changes and 6 populations responded positively (compared to PVA without climate changes). We estimate that the global population size for Tobusch fishhook cactus is about 473,000 individuals distributed over an area of over 2 million ha (5 million ac). (USFWS, 2017)

Threats and Stressors

Stressor: Land Use Changes (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Relatively little urban and industrial development is occurring within the semi-arid, sparsely populated eight-county known range of Tobusch fishhook cactus. However, a significant ongoing trend throughout the species' range is the subdivision of large ranches into many small "ranchettes," leading to a proliferation of roads, fences, power lines, and residential development, all of which contribute incrementally to habitat loss and fragmentation. Land subdivision also engenders changes in land use and management which may be both beneficial and detrimental to Tobusch fishhook cactus. For example, the predominant, historic land use throughout the Edwards Plateau has been grazing of livestock, including goats, cattle, sheep, and horses. In many cases, poor rangeland management during the last century has caused the depletion of herbaceous vegetation, cessation of the natural wildfire cycle, proliferation of dense juniper stands, soil erosion, and reduced infiltration and storage of rainwater in the soil profile;

all of these changes are likely to have harmed Tobusch fishhook cactus populations. The change to a primarily recreational land use often entails continued grazing, in order to obtain agricultural tax exemptions, but at a sustainable stocking density (landowners may subsequently convert an agricultural exemption to a wildlife exemption). Currently, both large and small landowners are more aware of and concerned with conservation issues than during the last century. Prescribed burning may be one of the most important vegetation management tools for sustaining Tobusch fishhook cactus populations; the proliferation of residential development within the species' habitat makes this tool more challenging for natural resource managers to use. The subdivision of privately-owned land and associated threats are likely to continue. (USFWS, 2017)

Stressor: Changes in vegetation and wildfire frequency. (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Bray (1904, pp. 14–15, 23–24) documented the rapid transition of grasslands to woodlands in the Edwards Plateau occurring more than a century ago; he attributed this change to over-grazing, the depletion of grasses, and the cessation of wildfires. Fonteyn et al. (1988, p. 79) state that savannas covered portions of the pre-settlement Edwards Plateau, and since 1850 were transformed to shrubland or woodland “primarily by suppression of recurring natural and anthropogenic fires and the introduction of livestock.” They list the fire-sensitive Ashe Juniper as the most successful of many woody plants that have invaded grasslands. Reemts (2014 p. 1). lists the encroachment of woody plants into the rocky, open habitat as one of several habitat-related threats to Tobusch fishhook cactus. However, the historic extent of grasslands in the Edwards Plateau is an area of active scientific debate. It is likely that woodlands were most abundant on slopes in the Balcones Escarpment (which includes the southern and eastern portion of the Tobusch fishhook cactus range) and that grasslands were more abundant on flatter, deeper soils in the western Edwards Plateau (Diamond et al. 1995, pp. 191-193; Diamond and True 2008, pp. 53-54; Murray et al. 2013, pp. 298, 302). (USFWS, 2017)

Stressor: Livestock grazing. (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: The recovery plan stated “Ancistrocactus tobuschii plants have been observed that were either uprooted or had apical meristem injuries from livestock trampling.” Nevertheless, livestock trampling and herbivory have not subsequently been identified as significant causes of mortality or damage to Tobusch fishhook cactus plants. The recurved spines and small size probably discourage herbivory of Tobusch fishhook cactus plants. Livestock are not attracted to the sparsely vegetated outcrops where Tobusch fishhook cactus plants typically occur, and the plants are protected to some degree by surrounding rocks. While livestock trampling probably occurs in grazed habitats, particular where animals are concentrated, we have no evidence that it represents a significant threat to the species. A number of healthy Tobusch fishhook cactus populations occur on well-managed rangeland. We conclude that livestock grazing, especially where juniper thinning and prescribed burning are used to manage rangeland, is generally compatible with conservation of this cactus. (USFWS, 2017)

Stressor: Illicit collection. (USFWS, 2017)

Exposure:

Response:**Consequence:**

Narrative: Many rare cactus populations have been depleted by overzealous collectors. The recovery plan lists collection by unscrupulous cactus and succulent fanciers as a threat to the species. Westlund (1991, pp. 2, 35, 39) found six specimens of Tobusch fishhook cactus, grown legally from seed, for sale in commercial nurseries. Poole and Janssen (2002, p.9) noted that one population of Tobusch fishhook cactus was heavily depleted by collection, but concluded that “collection is not currently perceived to be a grave threat.” Although illicit collection has not significantly impacted the species, the wild populations openly accessed by the public remain vulnerable. The potential threat of illicit collection might be diminished if seeds and plants of legally-propagated Tobusch fishhook cactus are easier and less expensive to obtain than wild dug specimens. (USFWS, 2017)

Stressor: Parasites. (USFWS, 2017)

Exposure:**Response:****Consequence:**

Narrative: The Tobusch fishhook cactus weevil (*Gerstaeckeria* sp. nov.) and cactus longhorn beetle (*Moneilema* spp.) parasitize and kill Tobusch fishhook cactus plants and have contributed significantly to drastic declines in many of the known populations (Calvert 2003, all). Considering that the weevil (*Gerstaeckeria* sp. nov.) is a new species, and that it may be an obligate parasite of Tobusch fishhook cactus (Calvert 2003, p. 12), the weevil itself may be no less endangered than its host. Periodic outbreaks of insect parasitism appear to be an unavoidable natural cycle. For this reason, the recovery criterion of 3,000 individuals per population may be unattainable or unsustainable, as such large cactus populations would eventually host very large parasite populations, leading to their collapse. The most appropriate conservation strategy may be to protect larger numbers of small, widely-spaced populations, rather than fewer large populations that are more vulnerable to parasites; however, we do not currently know what the optimal parameters of size and spacing should be. (USFWS, 2017)

Stressor: Other herbivory. (USFWS, 2017)

Exposure:**Response:****Consequence:**

Narrative: Poole and Birnbaum (2003, pp. 11-12) report that jackrabbits browse the cactus, but in most sites cause less than 2 percent mortality. If the root systems are not too badly damaged, they may regenerate one or more new stems. Feral hogs have uprooted plants in many sites (also observed by Reemts (2015, p. 1)). An unidentified ant species has also caused 1 percent mortality at some sites by creating mounds on top of the stems. Federally-listed plants occurring on private lands have limited protection under the ESA, unless also protected by State laws; the State of Texas also provides very little protection to listed plant species on private lands. Approximately 95 percent of Texas land area is privately-owned. It is reasonable to assume that the vast majority of existing Tobusch fishhook cactus habitat, including sites that have not been documented, occurs on private land. Therefore, most of the species' populations and habitats are not subject to Federal or State protection unless there is a Federal nexus, such as provisions of the Clean Water Act or a federally-funded project. The ESA does provide some protection for listed plants on land under Federal jurisdiction. However, Tobusch fishhook cactus populations have not been documented on Federal land. International trade of Tobusch fishhook cactus (as

Sclerocactus brevihamatus ssp. *tobuschii*) is regulated under CITES Appendix I (Convention on International Trade in Endangered Species of Wild Fauna and Flora 2009). (USFWS, 2017)

Stressor: Demographic consequences of small population size and density. (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Poole and Birnbaum (2003, p. 1) estimated an MVP of 1,200 individuals (Section II.7.5). Small populations are less able to recover from losses caused by random environmental changes (Shaffer and Stein 2000, pp. 308-310), such as fluctuations in recruitment (demographic stochasticity), variations in rainfall (environmental stochasticity), or changes in the frequency of wildfires. Tobusch fishhook cactus has a predominantly out-crossing breeding system. The probability of successful fertilization between unrelated individuals is reduced in small, isolated populations. The remaining plants would produce fewer viable seeds, further reducing population recruitment and engendering a downward spiral toward extirpation. The demographic consequences of small population size are compounded by genetic consequences (discussed below), since reduced out-crossing corresponds to increased inbreeding. In addition to population size, it is likely that population density also influences population viability; density must be high enough for gene flow within metapopulations, but low enough to minimize parasite infestations. (USFWS, 2017)

Stressor: Genetic consequences of small population sizes. (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Small, reproductively isolated populations are susceptible to the loss of genetic diversity, to genetic drift, and to inbreeding. The loss of genetic diversity may reduce the ability of a species or population to resist pathogens and parasites, to adapt to changing environmental conditions, or to colonize new habitats. Conversely, populations that pass through a “genetic bottleneck” may subsequently benefit through the elimination of harmful alleles. Nevertheless, the net result of loss of the genetic diversity is likely to be a loss of fitness and lower chance of survival of populations and of the subspecies. Genetic drift is a change in the frequencies of alleles in a population over time. Genetic drift can arise from random differences in founder populations and the random loss of rare alleles in small isolated populations. Genetic drift may have a neutral effect on fitness, but is also a cause of the loss of genetic diversity in small populations. Genetic drift may also result in the adaptation of an isolated population to the climates and soils of specific sites, leading to the development of distinct ecotypes and to speciation. For example, the genetic divergence of *Sclerocactus brevihamatus* subspecies *brevihamatus* and *tobuschii* (Section II.2; Rayamajhi 2015, pp. 67, 98) may have resulted when populations of the species *brevihamatus* migrated into separate geographic regions, and once separated, each population adapted to different soils, climate, and pollinator species. Inbreeding depression is the loss of fitness among offspring of closely related individuals. While most animal species are susceptible to inbreeding depression, plant species vary greatly in response to inbreeding. Rayamajhi (2015, pp. 63-64) found relatively high inbreeding coefficients in 3 of 8 populations, which he attributed to mating of close relatives within small, isolated populations. Nevertheless, we do not know to what extent inbreeding has reduced fitness of these populations. (USFWS, 2017)

Stressor: Private land ownership. (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: A large portion of the known individuals and populations of Tobusch fishhook cactus occurs on privately owned land. This does not constitute a threat to the subspecies, and in fact many landowners have demonstrated interest and enthusiasm for its conservation. However, private ownership makes conservation more challenging for several reasons. Access to populations and habitats is subject to the interests of hundreds of individual landowners. Consequently, our knowledge of the subspecies' actual status is far from complete. Establishing and maintaining cooperative relationships with large numbers of private landowners is time-consuming, and these important relationships may lapse when personnel of conservation organizations retire or pursue other career choices. The ownership of private lands changes hands over time, and future owners may choose not to continue conservation efforts that were supported by previous owners. Hence, it is difficult to assure permanent conservation on private lands. These challenges underscore the importance of effective landowner outreach in the conservation of Tobusch fishhook cactus. (USFWS, 2017)

Stressor: Climate change. (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) (IPCC 2013, p. 23) projects the following changes by the end of the 21st century, relative to the 1986 to 2005 averages: It is virtually certain that most land areas will experience warmer and/or fewer cold days and nights; it is virtually certain that most land areas will experience warmer and/or more frequent hot days and nights; it is very likely that the frequency and/or duration of warm spells and heat waves will increase in most land areas; it is very likely that the frequency, intensity, and/or amount of heavy precipitation will increase in mid-latitude land masses; it is likely that the intensity and/or duration of droughts will increase on a regional to global scale. We do not know how Tobusch fishhook cactus responded to prior climate changes, nor can we determine how these projected climate changes, forecast by the range of models and emissions scenarios, will affect the synecology of Tobusch fishhook cactus and its habitat. Warmer winters could extend the growing season and improve reproduction and survival of Tobusch fishhook cactus, but might also increase survival of parasite larvae. Heavier, less frequent rainfall could reduce establishment of Tobusch fishhook cactus seedlings, but perhaps less so than the bunch grasses that it competes with. Zaya et al. (2014, pp. 37-38) projected that expected climate changes will be detrimental to 4 populations and beneficial to 6 others. Thus, although it is likely that the projected climate changes will affect the survival of Tobusch fishhook cactus in infinitely complex ways, we do not currently know what the net result of beneficial and detrimental effects will be. (USFWS, 2017)

Recovery

Reclassification Criteria:

No longer applicable due to revision to Threatened status. (USFWS, 2018)

Delisting Criteria:

1. Populations or portions of metapopulations occur within 10 or more protected natural areas. Protected natural areas include lands owned by federal, state, or local government agencies, or by private landowners, that are legally protected for the purpose of conserving native plants and animals and their habitats. Examples include, but are not limited to, state parks, state natural areas, and state wildlife management areas, conservation easements on private lands, lands owned and managed for conservation by non-profit organizations, and legally-binding long-term management agreements with other public agencies or private landowners. To be considered under this criterion, the potential habitats of Tobusch fishhook cactus must be managed in a manner that promotes the continued survival of the subspecies. (USFWS, 2019)
2. The 10 or more protected natural areas described in the previous criterion must conserve the full geographic and ecological range of the subspecies. To meet this criterion, one or more protected natural areas must occur within each of four equal-area quadrants (northeast, northwest, southeast, and southwest) of the subspecies' natural range. (USFWS, 2019)
3. Populations or portions of metapopulations within each protected natural area have 1,200 or more mature individuals. This criterion may be met by combining multiple protected areas that occur within the same metapopulation, as defined above. (USFWS, 2019)
4. Periodic monitoring indicates that the minimum viable population level of 1,200 mature individuals within each protected natural area has remained stable or has increased over a period of 45 years. Monitoring (censuses) of each protected natural area must be conducted at least once every 5 years. The size of large populations may be estimated through statistically valid sampling methods. (USFWS, 2019)

Recovery Actions:

- 1. Remove immediate human threats to *Ancistrocactus tobuschii* by protecting known populations from collecting and habitat destruction. (USFWS, 1987)
- 2. Establish a permanent living collection at a botanical garden or university. Even though plants in a living collection can not substitute for healthy populations in natural habitats, a living collection would still contribute significantly to the overall recovery effort. Much information on ecological requirements and reproductive potential could be obtained most easily from a living collection. In addition, a permanent well documented and accessible living collection, together with appropriate seed banking, could provide an important source of material for non-destructive research, maintenance of wild populations, and public awareness. An adequate living collection would remove the necessity of repeatedly returning to wild populations to collect plants for various recovery projects. (USFWS, 1987)
- 3. Minimize long-range threats to *Ancistrocactus tobuschii* by development of biological information relevant to recovery. A better understanding of the demography of populations and the life history and ecological requirements of the species would provide information useful to management. (USFWS, 1987)
- 4. Establish a long-term (five year) survey program to more precisely determine the true distribution of the species. Surveys for this cactus will be difficult because it is easily overlooked, particularly in the summer and fall when it is hidden by perennial grasses. (USFWS, 1987)
- 5. Develop a comprehensive trade management plan for all cacti. Studies are needed to determine what species are in trade, the overall trend of trade in listed cacti, and the feasibility of reducing collecting pressure on wild populations by promoting a commercial

artificial propagation program. These studies should be national in scope and address all cacti. The results will be used to develop policy and a comprehensive trade management plan for all cacti. Strategies for effective implementation of law enforcement responsibilities under ESA, CITES, Lacey Act, and State laws need to be developed. (USFWS, 1987)

- 6. Develop a program to provide propagated plants and seeds to the commercial market. If information from task 5 indicates that artificial propagation will reduce collecting from the wild, an effort should be made to see that adequate sources of propagated plants are commercially available. This may be particularly helpful for *Ancistrocactus tobuschii* because several of the historic sites are easily accessible and already well known from the literature. (USFWS, 1987)
- 7. Develop public awareness, appreciation, and support for preservation of the species. Public education is extremely important to this species' successful recovery. Landowners usually do not realize that this species exists and most will support protection and conservation efforts if they learn that a unique plant grows on their land. (USFWS, 1987)
- Recommended Future Actions from 2010 5-Year Review: 1. Continue monitoring and surveying the established protected reserves. 2. Conduct surveys of high-potential habitat within the known range of the species, focusing on sites that have not previously been surveyed. 3. Establish new reserves, using the LBJWC conservation fund and other resources. 4. Conduct public outreach efforts to encourage conservation of the species and its habitat on private lands; establish a private landowner support group, similar to the group now actively working to conserve Texas snowbells (*Styrax platanifolius* ssp. *texasus*). 5. Continue to investigate ecology and management, with special emphasis on woody plant control and prescribed burning; compare effects of prescribed burning conducted at different times of the year. 6. Investigate the factors influencing reproduction and dispersal in the wild, with emphasis on the fate of seeds collected by ants. 7. Apply sound management, as needed, to protected sites. 8. Investigate the phylogenetic and taxonomic relationship between *Sclerocactus brevihamatus* ssp. *brevihamatus*, *S. brevihamatus* ssp. *tobuschii*, *S. scheeri*, and other closely related taxa of *Sclerocactus* and/or *Ancistrocactus*. 9. Collect seeds of representative populations for propagation and seed banking, establish germ-plasm (live plant) refugia, and develop techniques for successful propagation and reintroduction. 10. Revise the 1987 recovery plan. (USFWS, 2010)

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SPECIES ACCOUNT: *Sclerocactus brevispinus* (Pariette cactus)

Species Taxonomic and Listing Information

Listing Status: Threatened; 09/15/2009; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

Small cactus with very short (2 mm) central hooked or straight spines. (NatureServe, 2015)

Taxonomy

The original listing rule for *S. glaucus* (44 FR 58868, October 11, 1979) included all hookless (straight central spines) *Sclerocactus* populations in western Colorado and northeastern Utah, and referred to them as *S. glaucus* per Benson (1966, pp. 50-57; 1982, pp. 728-729). This taxonomic classification is not supported by the results of more recent research. Genetic studies (Porter et al. 2000), common garden experiments (Hochstätter 1993; Welsh et al. 2003), and a reevaluation of the morphological characteristics of *S. glaucus*, led to separating this species into three distinct species: *S. brevispinus*, *S. glaucus*, and *S. wetlandicus* (Hochstätter 1993; Heil and Porter 2004). We recognized these three distinct species as threatened on September 15, 2009 (74 FR 47112). The Flora of North America recognizes 15 species in the genus *Sclerocactus*, including these 3 species (Heil and Porter 2004). Comparative DNA sequences (Porter et al. 2000) infer common ancestry between *S. brevispinus* and *S. wetlandicus*, but infer *S. glaucus* is more closely related to *S. parviflorus* (Devil's claw cactus) and *S. whipplei* (Whipple's fishhook cactus). The common name for *S. glaucus* was changed to Colorado hookless cactus as the species is endemic to western Colorado. *S. wetlandicus* is now known as the Uinta Basin hookless cactus as this species occurs across Utah's Uinta Basin. *S. brevispinus* is now known as the Pariette cactus as it is limited to the Pariette Draw of the central Uinta Basin. The Uinta Basin hookless cactus complex will be used to refer to the combination of all three species previously listed as a single entity (USFWS, 2010)

Current Range

Known only from a single area a few miles across in the Pariette Draw region of Duchesne County, Utah, U.S.A.

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Predominately insect pollinated (surrogate *S. glaucus* information) (USFWS, 2007)

Breeding Season

Adult: Flowering occurs in April-May, and fruits mature in May-June (surrogate *S. glaucus* information) (NatureServe, 2015).

Reproduction Narrative

Adult: Reproduction is predominantly sexual, although individuals may sprout multiple stems. Flowering occurs in April-May, and fruits mature in May-June. The species appears to be predominantly outcrossing but is marginally self-compatible. Ants and gravity appear to be the primary dispersal mechanisms (Peggy Lyon pers comm. 1998). Seed dispersal may be a limiting factor in the distribution of *Sclerocactus glaucus* (NatureServe, 2015). Information from *S. glaucus* is being used as a surrogate information for *S. wetlandicus* due to the species similarities and based on the following quote 'Because we lack life history data specific to *S. wetlandicus*, we have included life history data for *S. glaucus*, which should correlate to characteristics for *S. wetlandicus*' USFWS, 2010. Believed to be dispersed by heavy down-pours (Tepedino et al. 2010).; ABIOTIC; Water; (NatureServe, 2015). The species' life history is poorly known, but it is thought to be a longlived perennial usually flowering after 3 or 4 years. A broad assemblage of native bees, and possibly other insects including ants and beetles, pollinates *S. brevispinus* (USFWS 1990, p. 7) (USFWS, 2007).

Habitat Type

Adult: Clay badlands (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species is endemic to highly saline and alkaline soils, restricted to clay badlands within a single geologic formation in Utah. Occurs on exposed clay hills and in saltbush and sagebrush flats, 1400-1500 m. (NatureServe, 2015). High ecological integrity of the population and site fidelity as well as low tolerance ranges are inferred based on the species habitat requirements of the species and the relatively small geographic area this species inhabits.

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Unknown

Number of Populations:

1 - 5 (NatureServe, 2015)

Threats and Stressors

Stressor: Oil and Gas Development and Associated Impacts (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The BLM is monitoring *S. brevispinus* populations and neighboring *Sclerocactus* species, including impacts associated with oil and gas development. Initial results show potential effects of oil and gas development (i.e., roads and well pads) on the survival and reproductive success of *S. brevispinus* (72 FR 53215, September 18, 2007) (USFWS, 2010).

Stressor: Collection (USFWS, 2010)**Exposure:****Response:****Consequence:** Loss of individuals

Narrative: Illegal collection is a significant threat to *S. brevispinus*. The original listing of *S. glaucus* concluded that the cactus is prized among collectors and threatened by unregulated commercial trade (44 FR 58869, October 11, 1979). Collectors prefer larger, reproductive age individuals, leaving behind a younger, less reproductive population. As of 2006, approximately 96 percent of the known range of *S. brevispinus* (at the time, 5,733 ha or 14,166 ac) was within 400 m (1,312 ft) of a well (Service 2006). Such development facilitates human access and discovery by illegal collectors (72 FR 53216, September 18, 2007) (USFWS, 2010).

Stressor: Livestock Grazing and Trampling (USFWS, 2010)**Exposure:****Response:****Consequence:** Loss of individuals

Narrative: Nearly all *S. brevispinus* potential habitat on BLM land is leased for grazing. The species range overlaps four BLM grazing allotments. Most of the area is grazed by sheep, either continuously or on a deferred rotation, with some cattle grazing on the western and eastern edges of *S. brevispinus* potential habitat. Livestock grazing results in *S. brevispinus* mortality when livestock trample individual cacti (Service 1990; Utah Natural Heritage Program 2006; BLM 2008; 72 FR 53215, September 18, 2007). Overgrazing—the continued heavy grazing beyond the recovery capacity of forage plants (Vallentine 1990)—by domestic livestock degrades western ecosystem functions and structures (Fleischner 1994). Overgrazing can facilitate the establishment of invasive species like cheatgrass (Masters and Sheley 2001), which are difficult to eradicate and tend to outcompete native vegetation, including cacti. Invasive weeds (including *Bromus tectorum* and *Halogeton glomeratus*) are prevalent on BLM lands in the range of *S. brevispinus* cactus and less so on tribal lands where grazing has been concentrated in areas outside of suitable cactus habitat (72 FR 53214, September 18, 2007) (USFWS, 2010).

Stressor: Predation (USFWS, 2010)**Exposure:****Response:****Consequence:** Loss of individuals

Narrative: Parasitism by the cactus-borer beetle (*Moneilema semipunctatum*) is a significant but localized source of mortality to all *Sclerocactus* species on the Colorado Plateau, especially in larger, mature, reproducing individuals (Service 1990; 72 FR 53216, September 18, 2007). Parasitism is identified as a threat to *Sclerocactus* plants, however additional studies are needed to determine the long-term, population-level effects of the cactus-borer beetle to *S. brevispinus*. Another source of mortality is lagomorph and rodent browsing. While there have been numerous observations of *Sclerocactus* being removed by desert cottontail rabbits (*Sylvilagus audubonii*) and unknown rodents (CNHP 2010b; BioLogic 2008; Clayton 2006), in subsequent years some of

these plants have re-sprouted (Clayton 2010). Browsing likely goes unnoticed unless a marked individual is revisited within a 1- to 2-year period. We know very little about the magnitude of this threat (USFWS, 2010)

Stressor: Climate Change, Drought, and Impacts to the Vegetative Community (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Climate change is likely to affect long-term survival of native species, including *S. brevispinus*, especially if longer or more frequent droughts occur. For the southwestern region of the United States, warming is occurring more rapidly than elsewhere in the country with an increase of 1.5°F (0.8°C) since 1979 (Karl et al. 2009). Under lower emission scenarios temperature is expected to increase 5°F (2.8°C) and under higher emission scenarios temperature is expected to increase 10°F (5.6°C) by the end of the century, from the 1979 baseline (Karl et al. 2009). Other future projections for the southwest include more intense and longer-lasting heat waves, an increased probability of droughts that are worsened by higher temperatures, heavier downpours, increased flooding, and increased erosion (Karl et al. 2009, pp. 129-134). The levels of aridity of recent drought conditions and perhaps those of the 1950s drought years may become the new climatology for the southwestern United States (Seager et al. 2007). Effects related to climate change (e.g., such as persistent or prolonged drought conditions, changes in community assemblages and the ability of nonnative species to succeed) may affect long-term persistence of *S. brevispinus*. While the potential impacts of climate change could be serious, improved projections are needed to better understand this potential threat. *S. brevispinus* mortality due to drought is well documented (Service 1990; 72 FR 53217, September 18, 2007). Many dead *S. brevispinus* individuals were observed in the Uinta Basin after the severe drought of 1976 to 1977 (Service 1990). In addition, noxious weeds are often able to out-compete native species under drought conditions (Everard et al. 2010). Drought conditions could further hinder BLM's efforts to control noxious weeds and restore native vegetation, which is already difficult due to the extreme environment of the Uinta Basin (Service 1990; BLM 2005, 2008) (USFWS, 2010).

Stressor: Pesticides (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: *S. brevispinus* lives in or near areas that receive herbicide and pesticide treatments to remove undesirable species, such as noxious weeds and insect pests (Service 1990). Individual cacti are likely to be directly affected by these chemicals, and indirectly by effects on pollinators or by movement of contaminated soils (Service 1990). However, specifics of the species' pollination biology are currently unquantified (USFWS, 2010)

Stressor: Vulnerability Related to Population Size and Distribution (USFWS, 2010)

Exposure:

Response:

Consequence: Extinction

Narrative: *S. brevispinus*' small population size and restricted distribution means the species is vulnerable to extinction by natural processes or human disturbance (Ellestrand and Elam 1993; Levin et al. 1996). For example, random events causing population fluctuations or population

extirpations become a serious concern when the number of individuals or the geographic distribution of the species is very limited. Similarly, a single human-caused or natural environmental disturbance could destroy the entire population. The species' slow reproductive rate also increases the risk of effects of stochastic events as it is unlikely that the species will be able to rebound quickly (e.g., exhibit a high rate of population growth), even if environmental conditions improved after such an event. Other issues related to this factor include loss of genetic variability, which may reduce a species ability to respond to changing environmental conditions, (Godt et al. 1996) and inbreeding depression, which can decrease fertility and survival rates (Levin et al. 1996). No information exists to indicate that the species' range and population numbers have been significantly larger than they are currently, except for recent documented losses due to oil and gas development and illegal collection (USFWS, 2010).

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: We are not aware of any city, county or state laws, ordinances or zoning that provide for protection or conservation of the *S. brevispinus* or its habitat. Removal, damage, or destruction of plants on private lands is can be allowed through consultation with the Service. Conservation needs of *S. brevispinus* are addressed through interagency consultation (section 7 requirements) typically between the Service, BLM, and Bureau of Indian Affairs (BIA). Through this process, conservation measures are implemented on a project-by-project basis to minimize the loss of individual cacti from oil and gas activities. These measures include preconstruction cactus surveys and a required buffer around individual cacti. For example, the Castle Peak/Eightmile Flat Oil and Gas Expansion Project Final Environmental Impact Statement included conservation measures to specifically protect *S. brevispinus* and its habitat (BLM 2005). The BLM also has attempted to establish protected areas for *S. brevispinus*. The Pariette Wetlands Area of Critical Environmental Concern (ACEC) was established in 1994. The ACEC, intended to provide protection for this species, contains approximately 1,250 ha (3,086 ac) or 8 percent of the potential habitat of *S. brevispinus*. Management prescriptions for the ACEC state that the BLM will authorize no action in suitable habitat for threatened and endangered species if it would jeopardize the continued existence of the species or result in severe modification of the habitat (BLM 2008). Although the BLM Vernal Field Office Resource Management Plan designated the Pariette Wetlands ACEC as "no surface occupancy" for oil and gas development (BLM 2008), pre-existing lease rights still allow surface disturbance from oil and gas development within the ACEC (BLM 2005). As of November 2009, the ACEC contains one well for approximately every 30 ha (74 ac), with more development planned. The BLM is currently deferring approval of new wells and ancillary facilities located within the Pariette Wetlands ACEC until a master development plan is completed. In addition to the ACEC and project-specific protections such as cactus surveys, we need to establish consistent guidance and Resource Management Plan designations that provide adequate regulatory mechanisms over the longer term to protect large portions of the range of the *S. brevispinus* (USFWS, 2010).

Recovery

Recovery Actions:

- A Recovery Plan has not been published for this species.

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SPECIES ACCOUNT: *Sclerocactus glaucus* (Colorado hookless Cactus)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/11/1979; Mountain-Prairie Region (Region 6) (USFWS, 2016)

Physical Description

A squat, globular, spiny succulent. Each mature stem is 3-12 cm tall, 4-9 cm wide, although during the driest part of the year the stem may shrink to below ground-level. Central spines are straight (hookless). The plants are inconspicuous except when in flower (April-May), when showy, fragrant, pink to magenta flowers appear at the top of the stem. (NatureServe, 2015)

Taxonomy

The original listing rule for *S. glaucus* (44 FR 58868, October 11, 1979) included all hookless (straight central spines) *Sclerocactus* populations in western Colorado and northeastern Utah, and referred to them as *S. glaucus* per Benson (1966, pp. 50-57; 1982, pp. 728-729). Genetic studies (Porter et al. 2000), common garden experiments (Hochstätter 1993; Welsh et al. 2003), and a reevaluation of the morphological characteristics of *S. glaucus* have led to separating this species into three distinct species: *S. brevispinus*, *S. glaucus*, and *S. wetlandicus* (Hochstätter 1993; Heil and Porter 2004). The Flora of North America recognizes 15 species in the genus *Sclerocactus*, including these 3 species (Heil and Porter 2004). Comparative DNA sequences (Porter et al. 2000) infer common ancestry between *S. brevispinus* and *S. wetlandicus*, but infer *S. glaucus* is more closely related to *S. parviflorus* (Devil's claw cactus) and *S. whipplei* (Whipple's fishhook cactus). The common name for *S. glaucus* was changed to Colorado hookless cactus as the species is endemic to western Colorado. *S. wetlandicus* is now known as the Uinta Basin hookless cactus as this species occurs across Utah's Uinta Basin. *S. brevispinus* is now known as the Pariette cactus as it is limited to the Pariette Draw of the Central Uinta Basin. (USFWS, 2010)

Current Range

Colorado hookless cactus is an endemic plant found in Delta, Montrose, Mesa, and Garfield Counties, Colorado. There are two population centers of Colorado hookless cactus: (1) on alluvial river terraces of the Gunnison River from near Delta, Colorado, to southern Mesa County, Colorado; and (2) on alluvial river terraces of the Colorado River and in the Plateau and Roan Creek drainages in the vicinity of DeBeque, Colorado (Service 1990). (USFWS, 2010)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Predominately sexual (outcrossing) but can reproduce asexually (NatureServe, 2015)

Lifespan

Adult: 10-20 years (NatureServe, 2010)

Breeding Season

Adult: April to May (NatureServe, 2015)

Reproduction Narrative

Adult: Reproduction is predominately sexual, although individuals may sprout multiple stems. Flowering occurs in April-May, and fruits mature in May-June. The species appears to be predominantly outcrossing but is marginally self-compatible. Although no long-term demographic data is available, field observations suggest that plants may live for 10-20 years in good conditions (Ellen Mayo, Peggy Lyon pers. comm.) Population size may vary widely between years (Jim Ferguson, pers. comm.). Plants are typically sparsely distributed even in larger populations. Stems may fluctuate in size according to seasonal moisture availability, shrinking below the soil surface in dry times. Predation by a cactus borer beetle has been observed in Colorado populations, and may be very heavy in a localized area. Some herbivory by rodents has also been observed. (NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Desert, forest/woodland, shrubland/chaparral, woodland - conifer (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at elevations between 1200 and 2000 m (NatureServe, 2015)

Environmental Specificity

Adult: Moderate (inferred from NatureServe, 2015)

Habitat Narrative

Adult: The Colorado hookless cactus is found on exposed, gravel-covered, clay hills, saltbush or sagebrush flats, or pinyon-juniper woodlands at elevations from 1400 to 2000 m (Flora of North America Editorial Committee 2003). Populations occur primarily on alluvial benches along the Colorado and Gunnison Rivers and their tributaries. *Sclerocactus glaucus* generally occurs on gravelly, or rocky surfaces on river terrace deposits and lower mesa slopes. Exposures vary, but *S. glaucus* is more abundant on south-facing slopes. Soils are usually coarse, gravelly river alluvium above the river flood plains usually consisting of Mancos shale with volcanic cobbles and pebbles on the surface. Elevations range from 1200-2000 m. Associated vegetation is typically desert scrub dominated by shadscale (*Atriplex confertifolia*), galleta (*Hilaria jamesii*), black-sage (*Artemisia nova*), and Indian rice grass (*Stipa hymenoides*). Other important species include two similar spherical or cylindrical cactus species, strawberry hedgehog cactus (*Echinocereus triglochidiatus* var. *melanacanthus*) and Simpson's pincushion cactus (*Pediocactus simpsonii*). Other important species in the plant community include the prickly pear cactus (*Opuntia polyacantha*), winterfat (*Krascheninnikovia lanata*), yucca (*Yucca harrimaniae*), snakeweed (*Gutierrezia sarothrae*), low rabbitbrush (*Chrysothamnus viscidiflorus*), sand dropseed (*Sporobolus cryptandrus*), and Salina wildrye (*Elymus salinus*) (USFWS 1990, Scheck 1994). Fire is not typically characteristic of *S. glaucus* habitat, but areas with large infestations of cheatgrass (*Bromus tectorum*) may build up sufficient fuel to carry fire into *S. glaucus* populations. (NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Ants and gravity appear to be the primary dispersal mechanisms (Peggy Lyon pers comm. 1998). Seed dispersal may be a limiting factor in the distribution of *Sclerocactus glaucus*. (NatureServe, 2015)

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Resiliency:

Medium (inferred from USFWS, 2010)

Population Growth Rate:

Unknown (NatureServe, 2015)

Number of Populations:

98 (USFWS, 2010)

Population Size:

~19,000 (USFWS, 2010)

Population Narrative:

The species has been documented at 98 element occurrences (EOs) totaling approximately 13,300 individuals (CNHP 2010b). Forty-two of the EOs have not been observed in over 20 years. Over 6,000 additional individuals were located recently in field surveys for a proposed electric transmission line and a proposed oil and gas wastewater evaporation facility north of Delta, Colorado (Bio-Logic 2008; 2009). These newly discovered individuals have not yet been incorporated into the CNHP database. Therefore, by combining the new survey data and the CNHP data, we estimate the total known population of Colorado hookless cactus at over 19,000 plants. (USFWS, 2010)

Threats and Stressors

Stressor: Mineral and energy development (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The 1990 Recovery Plan identified threats associated with mineral and energy development including: oil and gas, oil shale and tar sands, sand and gravel quarrying, gold dredging, and building stone collecting and quarrying. A gravel mining project proposed near Whitewater, Colorado, poses a threat to several Colorado hookless cactus individuals (BLM 2010). The BLM recently closed an area where recreational gold panners were causing disturbance in close proximity to a Colorado hookless cactus occurrence (BLM 2009b). Oil and gas development remains a meaningful factor in the long-term conservation of the Colorado

hookless cactus. Thirty-six percent of the federally-owned potential habitat approximately 164,000 ac (66,000 ha) is leased for oil and gas development (Service 2010b). Increased surface disturbance from wells, roads and pipelines for oil and gas projects can result in the following impacts to S. and habitat. Oil and gas development fragments and destroys S. habitat (BLM 2005, 2008a). Each well disturbs approximately 1.5 ac (0.6 ha) of surface area (74 FR 47112, September 15, 2009). Increased erosion, soil compaction, and sedimentation can kill cacti (BLM 2005). Cactus seeds can be buried and lost due to erosion runoff from well-field facilities (BLM 2005). Increased surface disturbance increases airborne dust. Dust accumulation on cacti increases tissue temperature and reduces photosynthesis, thus decreasing plant growth, vigor, and water use efficiency (Farmer 1993; Sharifi et al. 1997). Dust effects can extend up to 300 m from roads (Everett 1980). Energy development requires the addition of access roads in previously undeveloped areas. In most cases, these access roads are open to the public. The ORV trail use increases erosion, fugitive dust, soil compaction, sedimentation, and can crush cactus (Service 1990; BLM 2008a). Human access can result in illegal collection and the direct loss of individual plants (Service 1990; BLM 2005). Oil and gas development increases weed invasions because of the associated surface disturbance. Increased invasive weeds alter the ecological characteristics of cactus habitat, making it less suitable for the species (Service 1990; BLM 2008a).

Stressor: Utility corridors (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: A BLM and Department of Energy designated Westwide Energy Corridor covers 70,142 ac (28,385 ha) of BLM land that is potential habitat for Colorado hookless cactus (Service 2010b; BLM 2008b). The BLM identified preferred corridors to limit the proliferation of additional rights-of-way across the landscape, but utilities are not limited to these corridors (BLM 2008b).

Twenty-nine of the species' 98 occurrences are at least partially located within this energy corridor (Service 2010b; BLM 2008b). Specific pipeline and transmission line routes within the energy corridor are not yet identified. The TransColorado (TransCO) gas pipeline resides in this corridor. Many of the 29 aforementioned occurrences were discovered during surveys for this project. The TransCO project resulted in transplantation of approximately 1,200 Colorado hookless cactus individuals. Monitoring documented a 19-percent mortality rate for the 129 monitored individuals between 1999 and 2003 (Bio-Logic 2008). Surveys for a new powerline north of Delta, Colorado (not in the designated energy corridor), located approximately 5,200 Colorado hookless cactus individuals (Bio-Logic 2008). Up to 100 individuals may be transplanted or destroyed during construction of this powerline in 2010 (Bio-Logic 2008). (USFWS, 2010)

Stressor: Invasive species (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Invasive weeds, including *Bromus tectorum* (cheatgrass) and *Halogeton glomeratus* (halogeton), are prevalent on BLM and private lands within the range of Colorado hookless cactus (CNHP 2010b). Invasive weeds alter the ecological characteristics of cactus habitat, making it less suitable for the species (Service 1990; BLM 2008a). In addition, invasive weeds are often able to out-compete native species under drought conditions (Everard et al. 2010). Several

EO records include cheatgrass invasion as a threat, and BLM attributes downward trend at several locations to cheatgrass invasion (CNHP 2010b; BLM 2009a). (USFWS, 2010)

Stressor: Off road vehicle use (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Despite ORV use being common within Colorado hookless cactus habitat, there have been few documented impacts to the plants. Observers documented ORV use as a threat to 3 of the 98 EOs (CNHP 2010b). Additionally, illegal off road driving damaged Colorado hookless cactus individuals during construction of the Collbran pipeline (WestWater Engineering 2009). The ORV use is expected to increase along with expected human population increases in the region in which Colorado hookless cactus is native and with increasing popularity and availability of improved ORVs. This is expected to result in an increase in damage to Colorado hookless cactus individuals and habitat (Service 1990). (USFWS, 2010)

Stressor: Water development (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The 1990 Recovery Plan identified water development as a threat to the species. It is likely that reservoir and irrigation canal development have impacted Colorado hookless cactus occurrences in the past; however, we have no documentation of those impacts. Two water reservoir projects known as Roan Creek and Sulphur Gulch have been proposed within potential and occupied habitat of Colorado hookless cactus. These potential reservoirs could permanently destroy plants and their habitat through project construction and inundation. After evaluation of numerous alternatives, the Roan Creek and Sulphur Gulch projects are no longer being considered (Bray and Drager pers. comm. 2008; Grand River Consulting Corporation 2009). Since the proposals have been withdrawn, these threats are not imminent. (USFWS, 2010)

Stressor: Collection (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The original listing of the Uinta Basin hookless cactus complex concluded that the cactus is prized among collectors and threatened by unregulated commercial trade (44 FR 58869, October 11, 1979). Collectors prefer larger, reproductive age individuals, leaving behind a younger, less reproductively fit population. We are not aware of illegal removal of *Sclerocactus* in Colorado prior to 2009. Three Colorado hookless cactus individuals were removed illegally in 2009 from sites proposed for a natural gas pipeline and a sewer pipeline in Mesa County, Colorado (Service 2010a; Glenne 2009). It did not appear that these plants were removed by collectors, but rather these were acts of vandalism. Additional damage to cacti occurred during project construction on the same natural gas pipeline (WestWater Engineering 2009). These incidents show that additional development increases risk to cacti of vandalism and removal by increasing human presence in areas previously rarely visited by humans. (USFWS, 2010)

Stressor: Livestock grazing and trampling (USFWS, 2010)

Exposure:

Response:**Consequence:**

Narrative: Of the 450,000 ac (182,000 ha) of Colorado hookless cactus potential habitat on Federal lands, approximately 94 percent, 424,000 ac (172,000 ha) falls within grazing allotments. Moderate to heavy domestic livestock grazing has been observed to cause physical damage to Sclerocactus plants through trampling, but we have no evidence to suggest that cattle browse on individual Sclerocactus plants (Service 1990). A study on another federally listed cactus, *S. wrightiae*, found that cacti density increased more rapidly in a fenced plot excluded from cattle grazing than in an unfenced plot with a reduced cattle stocking rate (Clark and Clark 2007). Overgrazing (the continued heavy grazing beyond the recovery capacity of forage plants) by domestic livestock can have a negative impact on North American xeric ecosystems (Jones 2000; Vallentine 1990). For example, overgrazing can facilitate the establishment of invasive species like *Bromus tectorum* (Masters and Sheley 2001), which are difficult to eradicate and tend to outcompete native vegetation, including cacti. (USFWS, 2010)

Stressor: Predation (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: Another source of mortality is lagomorph and rodent browsing on Colorado hookless cactus. While there have been numerous observations of *S. glaucus* individuals being removed by desert cottontail rabbits (*Sylvilagus audubonii*) and unknown rodents (CNHP 2010b; BioLogic 2008; Clayton 2006), some of these plants have re-sprouted in subsequent years (Clayton 2010). Browsing likely goes unnoticed unless a marked individual is revisited within a 1- to 2-year period. We know very little about the magnitude of this threat. Parasitism by the cactus-borer beetle (*Moneilema semipunctatum*) is a significant but localized source of mortality to all Sclerocactus species on the Colorado Plateau, especially in larger, mature, reproducing individuals (Service 1990; 74 FR 47112, September 15, 2009). Additional studies are needed to determine the long-term, population-level effects of the cactus-borer beetle to Colorado hookless cactus. (USFWS, 2010)

Stressor: Herbicides and pesticides (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: Colorado hookless cactus lives in or near areas that receive herbicide and pesticide treatments to remove undesirable species, such as cheatgrass and crop harming insects (Service 1990). Individual cacti are likely to be directly affected by herbicide use, and indirectly by effects of pesticides on pollinators (Service 1990). However, we cannot fully assess the magnitude of this threat, since the specific species that pollinate Colorado hookless cactus are currently unknown. (USFWS, 2010)

Stressor: Hybridizations (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: Extinction due to hybridization, both natural and human influenced, can be a major concern for rare and endangered species (Denver Botanic Gardens 2009b). Colorado hookless

cactus may hybridize with *S. parviflorus* (Heil & Porter 1987; Woodruff 2009; CNHP 2010b). The extent to which hybridization is occurring is unknown. Genetic research investigating this issue is essential for planning management and recovery efforts. The Denver Botanic Gardens has begun collecting floral tissue to examine the population genetic structure within and among the two population centers of Colorado hookless cactus and investigate the potential threat of introgression with *S. parviflorus* (Denver Botanic Gardens 2009b). (USFWS, 2010)

Stressor: Climate change, drought, and impacts to the vegetative community (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Climate change is likely to affect long-term survival of native species, including *Sclerocactus*, especially if longer or more frequent droughts occur. For the southwestern region of the United States, warming is occurring more rapidly than elsewhere in the country with an increase of 1.5°F (0.8°C) since 1979 (Karl et al. 2009). Under lower emission scenarios temperature is expected to increase 5°F (2.8°C) and under higher emission scenarios temperature is expected to increase 10°F (5.6°C) by the end of the century, from the 1979 baseline (Karl et al. 2009). Other future projections for the southwest include more intense and longer-lasting heat waves, an increased probability of droughts that are worsened by higher temperatures, heavier downpours, increased flooding, and increased erosion (Karl et al. 2009, pp. 129-134). The levels of aridity of recent drought conditions and perhaps those of the 1950s drought years may become the new climatology for the southwestern United States (Seager et al. 2007). Effects related to climate change (e.g., persistent or prolonged drought conditions, changes in community assemblages and the ability of nonnative species to succeed) may affect long-term persistence of Colorado hookless cactus. While the potential impacts of climate change could be significant, improved localized projections are needed to better understand this potential threat. In addition, invasive weeds are often able to out-compete native species under drought conditions (Everard et al. 2010). Drought conditions could further hinder BLM's efforts to control invasive weeds and restore native vegetation, which is already difficult due to the extreme environment of the Colorado and Gunnison River basins (Service 1990; BLM 2005, 2008a). (USFWS, 2010)

Recovery

Reclassification Criteria:

Reclassification criteria are not available.

Delisting Criteria:

Delisting criteria are not available.

Recovery Actions:

- Completion of a comprehensive survey throughout the species' range. (USFWS, 2010)
- Surveys also should more accurately delineate the Colorado hookless cactus range relative to other *Sclerocactus* species. (USFWS, 2010)
- Locate possible population connectivity corridors. (USFWS, 2010)
- Continue ongoing monitoring efforts and expand monitoring to include a larger and more representative sample of occupied sites. (USFWS, 2010)

- Identify sites in urgent need of habitat protection, set protection priorities, and implement protective measures. In the long run, land management agencies should establish formal land management designations to provide for long-term protection of important populations and habitat. (USFWS, 2010)
- Oil and gas leasing and other mineral extraction activities should avoid occupied sites and other important habitat. (USFWS, 2010)
- Develop and implement standard conservation measures to minimize future project and use impacts. (USFWS, 2010)
- Coordinate with land management agencies, project proponents, and other partners early in the planning process to limit direct and indirect impacts of planned activities. (USFWS, 2010)
- Prevent the collection of Colorado hookless cactus plants from natural populations. (USFWS, 2010)
- Resolve the taxonomic status of Colorado hookless cactus regarding the species relationship with *S. parviflorus*. Secondly, this study would assess genetic differences between Colorado hookless cactus populations. (USFWS, 2010)
- Continue research into Colorado hookless cactus life history and ecology, including pollinators. (USFWS, 2010)
- Study population dynamics and conduct a population viability analysis. (USFWS, 2010)
- Encourage investigations that project *Sclerocactus* species' vulnerability and response to climate change. (USFWS, 2010)
- Improve our understanding of livestock and native (e.g., rodent) grazing impacts. (USFWS, 2010)
- Monitor cactus-borer beetle (*Moneilema semipunctatum*) infestations, and study the relationship of episodic infestations with drought and other environmental factors. (USFWS, 2010)
- Monitor changes in invasive species prevalence and impacts on Colorado hookless cactus. Additionally, continue to explore approaches to minimize the risk posed by invasives and associated remediation actions. (USFWS, 2010)

Conservation Measures and Best Management Practices:

- Make a final determination on the proposed the taxonomic revision splitting *Sclerocactus glaucus* into *S. brevispinus*, *S. glaucus*, and *S. wetlandicus*. We expect to make a final determination on this proposal in 2008. (USFWS, 2008)
- Issue a proposed and final rulemaking to reclassify *S. brevispinus* from threatened to endangered as described in our recent 12-month finding (72 FR 53211, September 18, 2007). (USFWS, 2008)
- Develop a recovery plan for each of the three species. As required by Section 4(f)(1)(B), each recovery plan should incorporate: (i) a description of such site-specific management actions as may be necessary to achieve the plan's goal for the conservation and survival of the species; (ii) objective, measurable criteria which, when met, would result in a determination, in accordance with the provisions of this section, that the species be removed from the list; and (iii) estimates of the time required and the cost to carry out those measures needed to achieve the plan's goal and to achieve intermediate steps toward that goal. (USFWS, 2008)
- Conduct range-wide inventories for each species. Once completed, continue and improve population monitoring for each species. (USFWS, 2008)

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SPECIES ACCOUNT: *Sclerocactus mesae-verdae* (Mesa Verde cactus)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/29/1979; Southwest Region (Region 2) (USFWS, 2016)

Physical Description

The Mesa Verde cactus stems are usually singular, globose, 3.2-6.5 cm tall (1.5 - 3 in) and of equal diameter; central spine 0 (possibly 1-4); radial spines 8-11, 6-13 mm long (1/4-1/2 in), white, tan, straw or gray; flowers 2 cm in diameter (3/4 in), cream to yellow; fruit green, becoming brown with age and splitting open horizontally; seeds black. In late April a yellow or cream-colored flower blooms on top of the stem. (USFWS, 1984)

Taxonomy

Sclerocactus mesae-verdae and *S. wrightiae* have several morphological features in common: stem size, shape and color; flower shape and color; fruit dehiscence (not bearing scale leaves); and the ability to retract into the soil during periods of drought. *S. mesae-verdae* has 0-1 central spines, 8-11 radial spines, cream to yellow flowers with no fragrance, brownish-black seeds, while *S. wrightiae* has 4-6 central spines, 5-10 radial spines, cream to pink flowers with fragrance, and black seeds. (USFWS, 1984)

Current Range

Occurs only in parts of Montezuma County, Colorado and San Juan County, New Mexico. Mostly on Navajo Indian Reservation lands (Roth, pers. comm., 1998). (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual and asexual (USFWS, 2010)

Lifespan

Adult: ~20 years (USFWS, 2010)

Dependency on Other Individuals or Species

Adult: Pollen grain collected from the field averaged 91 percent viability (Cully et al. 1993) and the most frequent visitors and potential pollinators were small, solitary bees of the family Halictidae (Cully et al. 1993; Heil and Porter 1994; Colorado Natural Areas Program 2005; Navajo Nation Heritage Program 2004). Other common visitors included pleasing fungus beetles (*Tritoma* sp.) and blister beetles (*Epicauta* sp.), but it is still not known which insects are the effective pollinators for this cactus (Cully et al. 1993). (USFWS, 2010)

Breeding Season

Adult: Late April to early May (USFWS, 2010)

Key Resources Needed for Breeding

Adult: Repeated freezing and thawing (vernalization), seed coat scarification, and the proper temperature and moisture are required for successful germination (Service 1984). (USFWS, 2010)

Reproduction Narrative

Adult: *Sclerocactus mesae-verdae* is a perennial desert plant that grows slowly and has a lifespan of approximately 20 years (Colorado Natural Areas Program 2005). Stems begin producing flowers when they are about 2 cm (0.8 in) in diameter or about 8 years old and begin to flower each year after reaching 4 cm (1.6 in) in diameter (New Mexico State Forestry Division 2007). Flowers are diurnal, bloom from late April into early May, and open daily for up to five days (Heil and Porter 1994). Flowers possess both male and female organs (hermaphroditic) indicating self-compatibility, yet Heil and Porter (1994) suggest that self-fertilization rarely is found in the genus *Sclerocactus*. Tepedino (1998) found that a single plant can self-fertilize (selfing) using pollen from another flower on the same plant (geitonogamy) and produce viable seed, but not pollen from the same flower (autogamy). However, 50 percent less seed is produced from self-compatible fertilization when compared to the pollen donor coming from a flower on a nearby plant (xenogamy or outcrossing) (Tepedino 1998). Pollen grain collected from the field averaged 91 percent viability (Cully et al. 1993) and the most frequent visitors and potential pollinators were small, solitary bees of the family Halictidae (Cully et al. 1993; Heil and Porter 1994; Colorado Natural Areas Program 2005; Navajo Nation Heritage Program 2004). Other common visitors included pleasing fungus beetles (*Tritoma* sp.) and blister beetles (*Epicauta* sp.), but it is still not known which insects are the effective pollinators for this cactus (Cully et al. 1993). Repeated freezing and thawing (vernalization), seed coat scarification, and the proper temperature and moisture are required for successful germination (Service 1984). Seed dispersal distance and seed bank sampling found a total seed load around mature plants averaging 200 seeds within a 1 meter (m) (3.3 feet [ft]) radius with 80 percent of the seeds 0 - 3 cm (0 - 1 in) deep in the soil (Cully et al. 1993).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Desert (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Open sunny areas (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Restricted to dry exposed hills and mesas at elevations about 1,400 to 2,000 m; sparsely vegetated areas (USFWS, 2010; NatureServe, 2015)

Environmental Specificity

Adult: Medium (USFWS, 2010)

Tolerance Ranges/Thresholds

Adult: Moderate (USFWS, 2010)

Habitat Narrative

Adult: *Sclerocactus mesae-verdae* are restricted to sparsely vegetated badlands of clay loam soils derived from upper Cretaceous Mancos shale in Colorado, and Mancos and Fruitland shale in New Mexico (Service 1984). Populations are located in a narrow strip of land between Cortez, Colorado, and Sheep Springs, New Mexico, at elevations ranging from 1,400 to 2,000 m (4,600 - 6,560 ft) (Heil and Porter 1994; Coles and Naumann 2003). These formations erode easily, forming low, rolling hills where plants are found on hilltops and benches, but less so in basins or swales (Cully et al. 1993; Coles and Naumann 2003). The soils are sodic (high alkalinity; pH 7.5 to 8), gypsiferous (poor permeability), and have shrink-swell tendencies which make harsh sites for plant growth (Potter et al. 1985). However, during severe hot or cold dry periods, individual plants shrink and retract back into soils which can minimize desiccation or dehydration (Heil and Porter 1994). Colorado State University soil lab results on Colorado Natural Areas Program plots (2001) revealed clay and silty clay loams in texture, with low water permeability. Sodium, calcium, selenium and iron levels are elevated, while organic matter, phosphate and nitrate levels are low. Cracks in the clay soil, where the seeds fall and may germinate, are apparently an important part of the plant's microhabitat. Soils are typically high in selenite. Vegetative associates, though low in total percent ground cover (5 to 18 percent), include *Atriplex cuneata* (valley saltbush) and *A. corrugata* (mat saltbush) in New Mexico, and *A. corrugata*, *A. confertifolia* (shadscale saltbush), *A. gardneri* (Gardner's saltbush), and *Artemisia spinescens* (bud sagebrush) in Colorado (Cully et al. 1993; Coles and Naumann 2003). In both states, *A. corrugata* was consistently found to be the dominant shrub. (USFWS, 2010; NatureServe, 2015)

Dispersal/Migration**Dispersal**

Adult: Moderate (USFWS, 2010)

Dispersal/Migration Narrative

Adult: Harvester ants (*Pogonomyrmex* sp.) and erosional processes (rain) are the most effective short-range seed dispersers; whereas, wind may be more important to long-range dispersal (Cully et al. 1993; Rojas-Arechiga and Vasquez-Yanes 2000). Seed predation is well known in desert areas with frugivores (fruit eaters) being another type of important dispersal agent. Mainly rodents, but also birds, lizards, and some mammals prey on fruits and seeds (Rojas-Arechiga and Vasquez-Yanes 2000). No long-range dispersal was observed by rodents or birds for this species (Cully et al. 1993; Colorado Natural Areas Program 2005; Navajo Natural Heritage Program 2005). (USFWS, 2010)

Population Information and Trends**Population Trends:**

Long-term trends are unknown but short-term trends indicate a decline of 10-30% (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015)

Representation:

Low (inferred from USFWS, 2010)

Population Growth Rate:

Slow growth and reproduce success rate (NatureServe, 2015)

Number of Populations:

78 (NatureServe, 2015)

Population Size:

10,000 individuals (NatureServe, 2015)

Population Narrative:

Slow growth and low reproductive success rate; the taking of a few plants can deplete/extirpate a population. There is insufficient data to characterize long-term population trends but short-term trends indicate a decline of 10-30%. Approximately 2000 individuals have been documented in element occurrence records (CNHP 2012, NHPM 2003), although the species is estimated to be represented by as many as 10,000 individuals (Coles 2003). A total of 78 occurrences have been documented, 22 in Colorado and 56 in New Mexico (CNHP 2012, NHPM 2003). Twenty of the occurrences report less than 10 individuals each. (NatureServe, 2015)

Threats and Stressors

Stressor: Highway construction and right-of-ways for transmission lines (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The Navajo Nation and BLM have consulted with the Service for various projects that have taken place or are planned to occur in areas with occupied or suitable habitat for *S. mesae-verdae*. We provide a list of consultations in order to convey the number and diversity of projects and to acknowledge the continuing compliance of the Navajo Nation and BLM with accounting for rare species. In each case, however, after the Service provided non-jeopardy opinions, we did not receive any further information regarding implementation of conservation measures, including post-construction surveys or progress reports. To ensure that the conservation measures are implemented and effective, and to apply adaptive management, if needed, to modify measures to assist the cactus, providing documentation of the outcome of these projects and other monitoring data would be very beneficial to the Service. By sharing information about the effects of projects, all parties managing *S. mesae-verdae* can be informed of what conditions are most favorable for this cactus and what conservation measures are the most worthwhile for promoting this species' recovery and moving toward delisting. There is a need for a *S. mesae-verdae* multi-agency working group to share and disseminate information regarding this listed species to promote education, protection, and recovery. (USFWS, 2010)

Stressor: Off-highway vehicles (OHVs) (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The 1984 recovery plan correctly anticipated that OHV use would be one of the greatest human-caused threats to *S. mesae-verdae*. The use of OHVs appears to have increased

within the Navajo Nation (Roth 2009, pers. comm.) and on BLM lands ((Jamison 2009, pers. comm.). This increase is most likely due to the recent energy boom and the resultant population boom within San Juan County; a 55 percent increase in population from 1980 to 2006 (<http://wrdc.usu.edu/htm/publications/>). National all-terrain and off-highway vehicles retail sales from 1993-2003 show a dramatic increase from 2,920 total vehicles sold in 1993 to a total of 8,010 vehicles sold by 2003 (Cordell et al. 2005). However, the perception of increased OHV traffic may be more of an issue of unmanaged/unregulated use where one vehicle could cause extensive and severe habitat damage with one trip through closed areas. When a vehicle runs over a cactus, the growing tip is often damaged resulting in a failure to flower and set seed as well as an increased vulnerability to desiccation, herbivory, and pathogens. Cacti can also be directly uprooted or irreversibly damaged from OHVs or any other form of forceful contact. In addition to these direct impacts to the cactus, indirect effects from OHV riding also occur such as damage or destruction of annual and perennial plants, destruction of fragile soil crusts, soil erosion and compaction, alteration of drainage patterns, formation of dust, and proliferation of weeds (Brooks 2009; Lei 2009). Erosion and denuding of plants on dry soils from unauthorized OHV use changes soil properties and alters the hydrological dynamics of an area, with impacts spanning from the microhabitat to the landscape scale. These factors increase run-off and decrease the infiltration of precipitation into soils, further diminishing water storage and accessibility to plant roots. Off-highway vehicle activity can also disturb fragile cyanobacterial-lichen soil crusts, a dominant source of nitrogen in desert ecosystems (Belnap 1996). Belnap (1996) showed that anthropogenic surface disturbances may have serious implications for nitrogen budgets in cold-desert ecosystems similar to those occupied by *S. mesae-verdae*. Soil crusts also appear to be an important source of water for plants, as crusts were shown to have 53 percent greater volumetric water content than bare soils during the late fall when winter annuals are becoming established (DeFalco et al. 2001). Once the soil crusts are disturbed, non-native plants may colonize, become established, and outcompete native perennial and annual plant species (DeFalco et al. 2001). Surface disturbance from OHV activity can cause erosion and large amounts of dust to be discharged into the air. Recent studies addressing surface dust impacts on gas exchanges of desert shrubs showed that plants encrusted by dust have reduced photosynthesis and decreased water-use efficiency, which may decrease primary production during seasons when photosynthesis occurs (Wijayratne et al. 2005; Sharifi et al. 1997). Sharifi et al. (1997) also showed reduction in maximum leaf conductance, transpiration, and water-use efficiency due to dust. These effects may impact desert plants including *S. mesae-verdae*. Impacts from constant OHV use, causing soil, vegetation, and hydrological disturbances, have the capacity to compound over time, particularly if the source of OHV impacts is located high in a drainage (Brooks and Lair 2005). Repeated OHV trail use leads to new routes that are not included in road databases (Brooks and Lair 2009). As a result, continual unauthorized OHV use, especially off-trail riding, can create conditions less and less supportive for a habitat specialist such as this cactus species. Furthermore, reduced moisture availability and ground cover from OHV use can interact with other variables such as climate change or grazing, exacerbating drying conditions an already arid system. (USFWS, 2010)

Stressor: Coal mining (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: About 90 percent of known *S. mesae-verdae* habitat occurs in areas that lack coal reserves (Parker et al. 1977). The 1984 recovery plan reported that no coal mining was being

actively pursued within occupied habitat, although several strip mining operations were within a few miles of the Waterflow cactus population (Service 1984). This cactus population was the only one known growing on the coal-bearing Fruitland formation (Service 1984). We are not aware of any effects resulting from coal mining on this species (Sivinski 2000). Thus, we believe that coal mining is not currently a threat and is not likely to threaten the species in the foreseeable future. (USFWS, 2010)

Stressor: Oil and gas exploration and production (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: About 70 percent of the known occupied *S. mesae-verdae* habitat is located on Navajo Nation lands. Navajo Nation lands contain significant deposits of coal, oil, and natural gas. Development of energy resources in the Four Corners Basin continues to increase (Energy, Minerals, and Natural Resources Department 2008). The Fruitland Coal formation of the San Juan Basin is the largest coal bed methane producer in the United States (Energy, Minerals, and Natural Resources Department 2008). These resources occur subsurface in ancient marine shale layers, primarily Fruitland and Mancos layers, which coincide with *S. mesae-verdae* habitat. Nearly all known cactus habitat has the potential to be affected by natural gas or oil exploration and development. Another mineral, a decomposed type of coal (humate), is also found under much of *S. mesae-verdae* habitat (Colorado Natural Areas Program 2004). Humate is used as a soil conditioner and additive to drilling mud which increases the potential for development. About 12.1 billion tons of humate occur within the San Juan Basin (McLemore et al. 2002). Ground disturbing impacts from these activities include the construction and maintenance of pipelines, power lines, and associated roads; the total clearing of all vegetation on an average of three acres for every oil or gas well pad and associated facilities; and associated commercial and residential development. These activities lead to long-term degradation, fragmentation, or loss of habitat, with impacts to *S. mesae-verdae* similar to those described above in the OHV section. Most *S. mesae-verdae* habitat occurs on the Mancos Formation, with the Rattlesnake, Shiprock-Gallup, Horseshoe-Gallup, and Hogback oil fields located within high quality habitat. Destruction of cactus habitat from these oil fields appears to be extensive (Roth 2008, pers. comm.); however, data quantifying the size of each oil field, number of cactus mortalities, and leasing of other areas for associated activities are not available. (USFWS, 2010)

Stressor: Commercial and residential development (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Commercial and residential development threatens *S. mesae-verdae* on private and Tribal lands (Service 2009). Since the species was listed, cactus habitat has been increasingly impacted from urban development on Navajo Nation lands (Navajo Natural Heritage Program 2004). Urban development is not allowed within a BLM ACEC or on New Mexico State trust lands. The status of urban development on Ute Mountain Ute lands regarding this cactus is unknown at this time. Impacts from urban development include habitat loss, fragmentation, and degradation, along with other factors relating to soil, vegetation, and hydrologic disturbances described in more detail in the off-highway vehicles section above. These impacts not only directly damage cacti, but also can make occupied and potentially usable habitat inhospitable to *S. mesae-verdae* and result in the decline of individuals and populations. Urban development,

including homes, roads, power lines, pipelines, and waterlines; increased recreational activities, including use of OHVs; and commercial facilities have expanded in the proximity of Shiprock. In an effort to off-set the Navajo fairground project interfacing with the cactus, the Northern Navajo Fairground Conservation Area was established in 2001 to use for transplanting cacti that otherwise would be destroyed by the construction of the fairground. However, it is unknown at this time if signs and fences are in place to protect this area. (USFWS, 2010)

Stressor: Livestock grazing and trampling (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The 1984 Recovery Plan (Service) stated that livestock grazing was not believed to be a significant threat. Since that time, nearly all monitoring has documented disturbance of *S. mesae-verdae* by livestock. Livestock grazing occurs throughout the range of the cactus, and impacts from trampling, such as uprooted cacti, partially or entirely crushed cacti, and soil disturbance immediately adjacent to cactus individuals are regularly observed (Ecosphere Environmental Services 1985). Cattle have also been observed eating *S. mesae-verdae* (Service 1984; Ecosphere Environmental Services 1985). Livestock grazing continues to be permitted by the BLM within the Hogback ACEC (Bureau of Land Management 2003b). Navajo Nation staff noted heavy sheep and cattle grazing at the Sheep Springs population that historically supported *S. mesae-verdae* prior to 2004 (Navajo Natural Heritage Program 2004), but now appears to be extirpated (Roth 2008, pers. comm.). Three additional occupied areas on Tribal land were observed to have extensive livestock damage (Navajo Natural Heritage Program 2004). In Colorado, livestock trampling was also documented and believed to be the primary source of cactus mortality in 2005 (Colorado Natural Areas Program 2005). The 1984 Recovery Plan reported that when livestock are fenced in cactus habitat, trampling of the species could occur. High intensity grazing associated with fenced private or Tribal residences is likely to result in the permanent loss of cacti through trampling and soil compaction (Service 2009). On larger fenced acres, ranchers drive their trucks and OHVs off-road, tracking or herding their livestock (Jamison 2009, pers. comm.). Likewise, during capture of feral horse herds on the Navajo Nation, soils have become compacted within *S. mesae-verdae* habitat (Service 2009). Based on the increase in habitat degradation due to livestock trampling, whether it be compacted soils or vegetation displacement resulting in increased soil erosion and dust formation, we believe that livestock grazing and trampling has become a moderate threat to this species for the foreseeable future. (USFWS, 2010)

Stressor: Collectors (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Cacti are desirable plants whose wild populations in the U.S. and Mexico have been subject to illegal collection and trade (Robbins 2003). Some cactus hobbyists, known as cactophiles, are well known for their passion and interest in rare cacti. Many of these collectors have illegally obtained certain species for their private collections (Robbins 2003). In summary, illegal collection leads to the direct loss of plants and has threatened some *S. mesae-verdae* populations. Cactus collecting will probably continue at some level into the foreseeable future, but such activities are difficult to document and we have not discovered any new information to suggest that cactus theft is increasing (CITES 2000; Robbins 2003; Martin 2009). Although illegal

collection of *S. mesae-verdae* was considered a significant threat at the time of listing and during the development of the Recovery Plan, as evidenced by the second recovery criterion which directly addresses this threat, collecting appears to have decreased since the publishing of the Recovery Plan and is now considered a minor threat to the species for the foreseeable future. (USFWS, 2010)

Stressor: Predation (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: All *Sclerocactus* are susceptible to disease and predation, but only predation has been observed in this species. The longhorn cactus beetle (*Moneilema semipunctatum*) normally feeds upon *Opuntia* spp. However, during the 2002-2003 period of severe drought, the longhorn cactus beetle fed upon *S. mesaeverdae* and substantially reduced all of the monitored populations. Although the longhorn cactus beetle is a native species and *S. mesae-verdae* has likely evolved with it, this beetle has the potential to cause serious mortality in the foreseeable future with periodic atypical population eruptions. Native to the Great Plains and Intermountain West, a migratory, noctuid moth, the army cutworm (*Euxoa* spp), destroyed many *S. mesae-verdae* in the BLM Hogback ACEC study area during the drought of 2002-2003 (Bureau of Land Management 2003b). Numerous cacti also were reported killed by the army cutworm on Navajo Nation land (Roth 2008, pers. comm.). Since this insect is generally associated with agricultural crops which are found nearby BLM and Navajo Nation lands, but will also consume native plants, particularly grasses, the threat is still substantial. In 2003, a third type of cactus predator was observed in the Colorado (Navajo Natural Heritage Program 2004). Unfortunately, the identity of the predator was not determined, but the effects to the plant appear to be similar to those from the longhorn cactus beetle (Navajo Natural Heritage Program 2004). The Service believes that insect predators can be an ongoing, yet minor threat to *S. mesae-verdae*. However, during atypical drought episodes, the threat from these predators can be severe into the foreseeable future. (USFWS, 2010)

Stressor: Pesticide use (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Pesticides are considered a potential threat because they could directly harm a plant, but also could indirectly kill pollinators of *S. mesae-verdae* or their host plants (Service 1984). Herbicides are commonly used for noxious weed control, but no documentation has been provided on herbicide application occurring, and whether any *S. mesae-verdae* populations have been directly or indirectly affected. On the other hand, agricultural use of pesticides has been reported on nearby BLM lands. Pesticides, particularly insecticides, are linked to bee declines (Kearns et al 1998; Kremen et al. 2002; National Academy of Sciences 2007), with the abundance and diversity of wild bee communities negatively correlated with increasingly intensive chemical applications of pesticides (Tuell and Isaacs 2010). Although the toxicity of pesticides to pollinators is challenging to quantify in a field setting and varies depending on the chemistry, quantity applied, degree of contact, area treated, and seasonal timing (Mineau et al. 2008; Tuell and Isaacs 2010), some pesticides cause immediate mortality to bees if applied upon crops while bees are actively foraging (Johansen 1977). Both wild and honey bee (*Apis mellifera*) declines have been found in areas adjacent to sprayed fields, suggesting a wider spatial impact to the

pollinator community than just a targeted area (Kevan 1975; Kevan et al. 1990). Furthermore, depending on the seasonal timing of pesticide application, effects to pollinator communities may be chronic and cumulative, yet difficult to assess due to the different phenologies and nesting situations of pollinator species (Desneaux et al. 2007; Tuell and Isaacs 2010). Pesticide application, particularly aerial spraying, occurs in the local agricultural areas to control crop pests, including army cutworms (*Euxoa* spp). Most of the *S. mesae-verdae* populations are miles away and would not be impacted by drift (Sivinski 2000). However, a few cactus populations are situated near agricultural areas, such as the Waterflow population, which is close to an apple orchard and alfalfa field, yet it has been successfully setting fruit until the severe drought of 2002-2003. Due to the lack of information, we are uncertain whether pesticides directly or indirectly affect the survival of *S. mesae-verdae*. Thus, we do not consider pesticides to be a threat to this species in the foreseeable future. (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Based on the unequivocal evidence of warming of the earth's climate from observations of increases in average global air and ocean temperatures, widespread melting of glaciers and polar ice caps, and rising sea levels recorded in the Intergovernmental Panel on Climate Change Report (IPCC 2007), climate change is now a consideration for Federal agency analysis (GAO 2007). The earth's surface has warmed by an average of 0.74 °C (1.3 °F) during the 20th century (IPCC 2007). The IPCC (2007) projects that there will very likely be an increase in the frequency of hot extremes, heat waves, and heavy precipitation events as a result of climate change. Increases in predatory insects are also predicted with climate change (Enquist and Gori 2008). This was documented for *S. mesae-verdae* during the drought of 2002-2003 with the unusual and extensive invasion of the longhorn cactus beetle and the army cutworm. The drought combined with concurrent insect infestations significantly reduced *S. mesae-verdae* populations and recovery has been extremely slow. *Sclerocactus mesae-verdae* is likely to have experienced and rebounded from periods of drought and cycles of insect predation in the past. However, should substantial climate change materialize with increased severity and frequency of drought, it would likely reduce the long-term survivorship of this species. Since the documented decline of *S. mesae-verdae* was concurrent with the drought of the early 2000s, the Service believes that climate change is a severe threat to this species in the foreseeable future. (USFWS, 2010)

Recovery

Reclassification Criteria:

Reclassification criteria are not available.

Delisting Criteria:

1. Establish at least two restricted use areas for selected portions of *S. mesaeverdae* habitat on the Navajo Indian Reservation and on Bureau of Land Management (BLM) administered lands. (USFWS, 2010)

2. Provide *S. mesae-verdae* stock to trade outlets to help relieve the black market demand through the addition of 10,000 plants per year to commercial nurseries for 5 years. (USFWS, 2010)

Recovery Actions:

- Major actions listed in the recovery plan include species monitoring, management, and protection of the five known populations; establishment of at least two (additional) areas of restricted use; surveys of all potential species' habitat; development of a commercial artificial propagation program; and research into the distribution, population biology, and ecology of this species. (USFWS, 2010)

Conservation Measures and Best Management Practices:

- Revise the recovery plan for this species to incorporate new information on biology, ecology, threats, and management recommendations. Objective and measurable recovery criteria for down and delisting of the species should be developed which addresses all listing factors relevant to this species. (USFWS, 2010)
- Recommend more stringent off-highway vehicle use restrictions and stronger enforcement of OHV laws in known and potential cacti habitat. (USFWS, 2010)
- Develop a *S. mesae-verdae* multi-agency working group to share and disseminate information regarding this listed species to promote education, protection, and recovery. (USFWS, 2010)
- Develop standardized survey and monitoring protocols for this species to be conducted annually by well trained personnel. Continue monitoring of known sites as well as adding new sites to provide a robust dataset for long-term trend analysis. (USFWS, 2010)
- Develop a mitigation banking requirement (a system whereby project proponents pay for plants to be preserved in an area suitable for their preservation as mitigation for losses incurred during projects). (USFWS, 2010)
- Implement and monitor new transplant projects with experimental manipulations (watering, shading, planting depth, etc.) and controls to determine required establishment needs. (USFWS, 2010)
- Provide legally grown seeds and plants of *S. mesae-verdae* to the commercial succulent trade, but law enforcement must remain vigilant against the theft of cacti throughout its range. (USFWS, 2010)
- Provide viable *S. mesae-verdae* seeds to a seed bank operating under the Center for Plant Conservation guidelines. (USFWS, 2010)
- Collect data on seed dispersal and growth past the germination stage, timing of seed set, and seedling establishment to more clearly define the vulnerable life history stages of this species. (USFWS, 2010)
- Determine microhabitat needs of this species ("nurse" plants, pollinators, precipitation needs - amount and timing, slope and aspect requirements, disturbance patterns, etc.) to further quantify potential habitat for a transplant and mitigation site. (USFWS, 2010)
- Collect data on the biology, demographics, ecology, and movements of the longhorn cactus beetle and the army cutworm to determine their long-term significance as predators of this species. (USFWS, 2010)

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SPECIES ACCOUNT: *Sclerocactus wetlandicus* (Uinta Basin hookless cactus)

Species Taxonomic and Listing Information

Listing Status: Threatened; 09/15/2009; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

S. wetlandicus is a barrel-shaped cactus that ranges from 4 to 18 centimeters (cm) (1.5 to 7 inches (in.)) tall, with exceptional plants up to 30 cm (12 in.) tall. The stems have typically 12 to 15 ribs that extend from the ground to the tip of the plant. Along the ribs are areoles (small, cushion-like areas) with hooked spines radiating out (Heil and Porter 2004). There are two types of spines, radial and central, defined by the size and position on the plant (see Figure 1) (74 FR 47112, September 15, 2009). The 6 to 14 radial spines are located around the margin of the areole, extending in a plane parallel to the body of the plant. The radial spines are white or gray to light brown, and are 6 to 20 mm (0.24 to 0.8 in.) long. The one to five central spines (usually three) are 15 to 30 mm (0.5 to 2.0 in.) long, are generally longer than radial spines, and extend from the center of the areole. The central spines include abaxial and lateral forms. Abaxial spines are typically single and are noticeably bent at an angle usually less than 90 degrees. Lateral spines are usually present in pairs on either side of the abaxial spine, but are more or less straight and diverge from the abaxial spine at an acute angle (usually 20 to 50 degrees). The funnel-shaped flowers usually have pink to violet tepals (petal-like flower parts not differentiated into petals and sepals) with yellow stamens (the male reproductive organ of the flower), and are 2 to 5 cm (0.8 to 2 in.) long and 2 to 5 cm (0.8 to 2 in.) in diameter (74 FR 47112, September 15, 2009). The fruit is short, barrel-shaped, reddish or reddish grey when ripe, 7 to 12 mm (0.3 to 0.5 in.) wide, and 9 to 25 mm (0.35 to 1.0 in.) long (USFWS, 2010).

Taxonomy

The original listing rule for *S. glaucus* (44 FR 58868, October 11, 1979) included all hookless (straight central spines) *Sclerocactus* populations in western Colorado and northeastern Utah, and referred to them as *S. glaucus* per Benson (1966, pp. 50-57; 1982, pp. 728-729). This taxonomic classification is not supported by the results of more recent genetic and morphological research. Genetic studies (Porter et al. 2000), common garden experiments (Hochstätter 1993b; Welsh et al. 2003), and a reevaluation of the morphological characteristics of *S. glaucus* have led to separating this species into three distinct species: *S. brevispinus*, *S. glaucus*, and *S. wetlandicus* (Hochstätter 1993b; Heil and Porter 2004). The Flora of North America recognizes 15 species in the genus *Sclerocactus*, including these 3 species (Heil and Porter 2004). Comparative DNA sequences (Porter et al. 2000) infer common ancestry between *S. brevispinus* and *S. wetlandicus*, but infer *S. glaucus* is more closely related to *S. parviflorus* (Devil's claw cactus) and *S. whipplei* (Whipple's fishhook cactus). The common name for *S. glaucus* was changed to Colorado hookless cactus as the species is endemic to western Colorado. *S. wetlandicus* is now known as the Uinta Basin hookless cactus as this species occurs across Utah's Uinta Basin. *S. brevispinus* is now known as the Pariette cactus as it is limited to the Pariette Draw of the central Uinta Basin. The Uinta Basin hookless cactus complex will be used to refer to the combination of all three species previously listed as a single entity (USFWS, 2010).

Current Range

Known only from Duchesne and Uintah counties, Utah (Flora of North America Editorial Committee (2003).

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Predominately insect pollinated (surrogate *S. glaucus* information) (USFWS, 2007)

Breeding Season

Adult: Flowering occurs in April-May, and fruits mature in May-June (surrogate *S. glaucus* information) (NatureServe, 2015).

Reproduction Narrative

Adult: Reproduction is predominantly sexual, although individuals may sprout multiple stems. Flowering occurs in April-May, and fruits mature in May-June. The species appears to be predominantly outcrossing but is marginally self-compatible. Ants and gravity appear to be the primary dispersal mechanisms (Peggy Lyon pers comm. 1998). Seed dispersal may be a limiting factor in the distribution of *Sclerocactus glaucus* (NatureServe, 2015). Information from *S. glaucus* is being used as surrogate information for *S. wetlandicus* due to the species similarities and based on the following quote 'Because we lack life history data specific to *S. wetlandicus*, we have included life history data for *S. glaucus*, which should correlate to characteristics for *S. wetlandicus*' USFWS, 2010. Believed to be dispersed by heavy down-pours (Tepedino et al. 2010).; ABIOTIC; Water; (NatureServe, 2015). The species' life history is poorly known, but it is thought to be a longlived perennial usually flowering after 3 or 4 years. A broad assemblage of native bees, and possibly other insects including ants and beetles, pollinates *S. brevispinus* (USFWS 1990, p. 7) (USFWS, 2007).

Habitat Type

Adult: Salt desert shrub (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits salt desert shrub communities and pinon-juniper woodlands on river benches, valley slopes, and rolling hills (Franklin 2005). Gravel-covered clay hills, desert

grasslands, saltbush, and rabbitbrush flats (Flora of North America Editorial Committee 2003). (NatureServe, 2015). High ecological integrity of the population and site fidelity as well as low tolerance ranges are inferred based on the species habitat requirements of the species and the relatively small geographic area this species inhabits.

Dispersal/Migration

Dispersal

Adult: Believed to be dispersed by heavy down-pours (NatureServe, 2015)

Dispersal/Migration Narrative

Adult: Believed to be dispersed by heavy down-pours (Tepedino et al. 2010).; ABIOTIC; Water; (NatureServe, 2015)

Population Information and Trends

Population Trends:

Unknown

Resiliency:

Low (inferred from NatureServe, 2015)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

6 - 80 (NatureServe, 2015)

Population Narrative:

Approximately 8 occurrences observed since 1989 and 17 others last observed earlier (UTNHP 2009). (NatureServe, 2015). We do not have long-term status or trend population (USFWS, 2010). Low resiliency, redundancy and representation are inferred based on the relatively low number of known populations and the small geographic area this species is known to inhabit. data for *S. wetlandicus* (USFWS, 2010).

Threats and Stressors

Stressor: Oil and Gas Development and Associated Impacts (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The BLM is monitoring *S. wetlandicus* and neighboring *Sclerocactus* species, including impacts associated with oil and gas development. Initial results show that there may be impacts from oil and gas development (i.e., roads and well pads) on the survival and reproductive success

of *S. brevispinus* (72 FR 53215, September 18, 2007), and similar effects could be expected for *S. wetlandicus* (USFWS, 2010).

Stressor: Collection (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Illegal collection is a significant threat to *S. wetlandicus*. The original listing of *S. glaucus* concluded that the cactus is prized among collectors and threatened by unregulated commercial trade (44 FR 58869, October 11, 1979). Collectors prefer larger, reproductive age individuals, leaving behind a younger, less reproductive population. Approximately 40 percent of the potential habitat of *S. wetlandicus* is within 400 meters (1,312 feet) of a well (Service 2009). Such development facilitates human access and discovery by illegal collectors (72 FR 53216, September 18, 2007) (USFWS, 2010).

Stressor: Livestock Grazing and Trampling (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: A majority of *S. wetlandicus* potential habitat on BLM land is leased for grazing. At least 28 grazing allotments overlap with *S. wetlandicus* potential habitat, with both cattle and sheep grazing continuously and on deferred rotation. Livestock grazing results in *S. wetlandicus* mortality when livestock trample individual cacti (Service 1990; Utah Natural Heritage Program 2006; BLM 2008; 72 FR 53215, September 18, 2007). Overgrazing—the continued heavy grazing beyond the recovery capacity of forage plants (Vallentine 1990) - by domestic livestock degrades western ecosystem functions and structures (Fleischner 1994). Overgrazing can facilitate the establishment of invasive species like cheatgrass (Masters and Sheley 2001), which are difficult to eradicate and tend to outcompete native vegetation, including cacti. Invasive weeds (including *Bromus tectorum* and *Halogeton glomeratus*) are prevalent on BLM lands in the range of *S. wetlandicus* cactus and less so on tribal lands where grazing has been concentrated in areas outside of suitable cactus habitat (72 FR 53214, September 18, 2007) (USFWS, 2010).

Stressor: Predation (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Parasitism by the cactus-borer beetle (*Moneilema semipunctatum*) is a significant but localized source of mortality to all *Sclerocactus* species on the Colorado Plateau, especially in larger, mature, reproducing individuals (Service 1990; 72 FR 53216, September 18, 2007). Parasitism is identified as a threat to *Sclerocactus* plants; however, additional studies are needed to determine the long-term, population-level effects of the cactus-borer beetle to *S. wetlandicus*. Another source of mortality is lagomorph and rodent browsing. While there have been numerous observations *Sclerocactus* being removed by desert cottontail rabbits (*Sylvilagus audubonii*) and unknown rodents (Colorado Natural Heritage Program 2010b; BioLogic 2008; Clayton 2006), in subsequent years some of these plants have re-sprouted (Clayton 2010). Browsing likely goes unnoticed unless a marked individual is revisited within a 1- to 2-year period. We know very little about the magnitude of this threat (USFWS, 2010).

Stressor: Climate Change, Drought, and Impacts to the Vegetative Community (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Climate change is likely to affect long-term survival of native species, including *S. wetlandicus*, especially if longer or more frequent droughts occur. For the southwestern region of the United States, warming is occurring more rapidly than elsewhere in the country with an increase of 1.5°F (0.8°C) since 1979 (Karl et al. 2009). Under lower emission scenarios temperature is expected to increase 5°F (2.8°C) and under higher emission scenarios temperature is expected to increase 10°F (5.6°C) by the end of the century, from the 1979 baseline (Karl et al. 2009). Other future projections for the southwest include more intense and longer-lasting heat waves, an increased probability of droughts that are worsened by higher temperatures, heavier downpours, increased flooding, and increased erosion (Karl et al. 2009, pp. 129-134). The levels of aridity of recent drought conditions and perhaps those of the 1950s drought years may become the new climatology for the southwestern United States (Seager et al. 2007). Effects related to climate change (e.g., persistent or prolonged drought conditions, changes in community assemblages and the ability of nonnative species to succeed) may affect long-term persistence of *S. wetlandicus*. While the potential impacts of climate change could be serious, improved projections are needed to better understand this potential threat. *S. wetlandicus* mortality due to drought is well documented (Service 1990; 72 FR 53217, September 18, 2007). Many dead *S. wetlandicus* individuals were observed in the Uinta Basin after the severe drought of 1976 to 1977 (Service 1990). In addition, noxious weeds are often able to out-compete native species under drought conditions (Everard et al. 2010). Drought conditions could further hinder BLM's efforts to control noxious weeds and restore native vegetation, which is already difficult due to the extreme environment of the Uinta Basin (Service 1990; BLM 2005, 2008) (USFWS, 2010).

Stressor: Herbicides and Pesticides (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: *S. wetlandicus* lives in or near areas that receive herbicide and pesticide treatments to remove undesirable species, such as noxious weeds and insect pests (Service 1990). Individual cacti are likely to be directly affected by these chemicals, and indirectly by effects on pollinators or by movement of contaminated soils (Service 1990). However, specifics of the species' pollination biology are currently unquantified (USFWS, 2010).

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: We are not aware of any city, county, or State laws, ordinances, or zone that provide for protection or conservation of the *S. wetlandicus* or its habitat. Removal, damage, or destruction of plants on private lands is not prohibited under the Act. Removal from Federal lands is prohibited without a permit, but can be allowed through consultation with the Service. The BLM sometimes authorizes adverse effects to the *S. wetlandicus* if it will not jeopardize the continued existence of the species. Conservation needs of *S. wetlandicus* are addressed through interagency consultation (section 7 requirements) typically between the Service, BLM, and

Bureau of Indian Affairs. Through this process, conservation measures are implemented on a project-by-project basis to minimize the loss of individual cacti from oil and gas activities. These measures include preconstruction cactus surveys and a required buffer around individual cacti. For example, the Castle Peak/Eightmile Flat Oil and Gas Expansion Project Final Environmental Impact Statement included conservation measures to specifically protect *S. wetlandicus* and its habitat (BLM 2005). In addition to these project-specific protections, we need to establish consistent guidance and Resource Management Plan designations that provide adequate regulatory mechanisms over the longer term to protect large portions of the range of the *S. wetlandicus* (USFWS, 2010).

Recovery

Recovery Actions:

- Reclassification and delisting criteria are not available for this species.
- A Recovery Plan has not been published for this species.

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SPECIES ACCOUNT: *Sclerocactus wrightiae* (Wright fishhook cactus)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/11/1979; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

Wright fishhook cactus (*Sclerocactus wrightiae*) is named for Dorde Wright Woodruff who discovered Wright fishhook cactus (L. Benson) in Emery County in 1961 (Benson 1982). The species is endemic to south-central Utah occurring in scattered clusters in Wayne, Emery, and Sevier counties. Wright fishhook cactus is a small, perennial globose shaped cactus mainly 6 – 12 cm long and 4 - 8 cm in diameter growing as a single plant with a branched taproot (Welsh et al. 2008). If damaged, the cactus may form multiple stems. Spines, both lateral and central, emerge from warty protuberances called tubercles. The large, lower central spine is hooked, a noticeable character that gives the cactus its common name of “fishhook.” The flower is 3 to 4 cm in diameter, 3 to 4 cm long, white to cream or pink and fragrant. Sepaloids are green or green tinged with red or brown. Flowering occurs from late April through May and fruits are set in June. Fruits are barrel shaped and borne on the top of the cactus. Seeds are black, 2 mm long and 3.5 mm broad (Heil and Porter 1994). A distinguishing characteristic of the Wright fishhook cactus is the presence of magenta filaments with yellow anthers. Short spine length, round spines, early flowering time, small flower size, and magenta filaments help distinguish this species from other similar cacti (Heil and Porter 1994, Benson 1982).

Current Range

The known range of Wright fishhook cactus extends across approximately 696,099 acres (ac) (281,701 hectares (ha)) of Utah’s western Emery County, southeastern Sevier County, and central Wayne County.

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Almost completely self-incompatible and pollination is accomplished mostly by native sweat bees

Reproduction Narrative

Adult: Wright fishhook cactus is almost completely self-incompatible and pollination is accomplished mostly by native sweat bees (Halictidae) (Tepedino 2000). Eight species of bees from one family (halictid bees) and two genera (*Dialictus* and *Agapostemon*) are known to visit Wright fishhook cactus (Tepedino 2000). Pollination is limited by the foraging distance of the ground nesting bees, which is strongly correlated to body size (Greenleaf 2005). The distance that ground nesting bees travel from their nests is difficult to determine but it is believed that they do not travel far; the maximum travel distance reported for the two genera that pollinate Wright fishhook cactus is approximately a quarter mile (400 m) (Tepedino 2000). Cross

pollination is essential for Wright fishhook cactus to produce viable seeds; self-pollination would result in production of non-viable seeds. Little is known about the species' seed banks, seed viability, germination, dispersal, dormancy and establishment in the wild. Seeds fall directly from the base of the dry fruit onto the ground and most are believed to remain near the parent plant (USFWS 1985). Possible dispersal vectors include gravity, wind and water erosion, as well as insects and rodents (USFWS 1985, Kass 1990).

Habitat Type

Adult: Flat areas, low ridges and slopes

Habitat Narrative

Adult: Wright fishhook cactus occurs on semi-barren sites on flat areas, low ridges and slopes in sparsely vegetated arid desert environments. They occur in a variety of vegetation types including desert scrub, desert grasslands, and open pinyon-juniper woodland communities. Wright fishhook cacti are generally found between 1,290 and 2,300 m (4,230 and 7,545 ft) and occur on a variety of geologic formations including Curtis, Mancos Shale, Morrison, Summerville, Dakota, Carmel, Entrada, and Moenkopi. Soils where the species is found include a broad range of textures, including clays, sandy silts, fine sands, loam and loamy sand. Soils generally have an overlying layer of fine and medium sized gravels or a cryptobiotic soil surface crust (USFWS 1985, Kass 1990). The overall range of the species has not changed significantly since the publication of the 1985 Recovery Plan. However, survey and inventory efforts have greatly expanded our knowledge of the distribution of the species across its range. We now know of more occupied sites and in some cases, more continuous populations than at the time of listing. The known range of Wright fishhook cactus extends across approximately 696,099 acres (ac) (281,701 hectares (ha)) of Utah's western Emery County, southeastern Sevier County, and central Wayne County. Wright fishhook cactus occurs primarily on lands managed by the BLM's Price and Richfield Field Offices and by the NPS at CRNP. More than 300 localities of Wright fishhook cactus have been documented from BLM and CRNP lands. A cactus locality consists of one or more individual cacti. There are 22 localities on lands managed by the BLM's Price Field Office, 256 localities on lands managed by the Richfield field office, and 55 localities on CRNP lands. Ninety-five percent of the Wright fishhook cactus range occurs within 22 active grazing allotments, including BLM, CRNP, SITLA, and private lands. Grazing is not permitted on the BLM North Caineville Mesa (2,200 ac (890 ha)) and a small section of the Factory Butte SRMA (approximately 1,300 acres (526 ha)). Although grazing is not permitted at Goblin Valley State Park, portions of the park are not fenced and are therefore accessible to livestock from adjacent lands. The CRNP section of the Cathedral grazing allotment was retired in 1999; however, livestock trail through the area each fall when moving between their summer and winter ranges. Our most recent range-wide population estimate is 4,500 - 21,000 individuals (USFWS 2008). Inventory efforts within CRNP during 2011 – 2013 documented 2,551 live individuals in 55 localities (CRNP 2014b). This should be considered a conservative number as counting and mapping efforts at each locality were limited to four person-hours, and therefore not all cacti at a locality were counted. Potential habitat is widely available in the vicinity of known localities of the species throughout its range, and because the species is a relative generalist, abundance of habitat is not considered a limiting factor in the conservation or survival of the species. Much of this additional potential habitat has yet to be surveyed. During the 2014 field season CRNP staff conducted 106 belt transects to gather presence/absence data on Wright fishhook cacti and Winkler cacti within suitable habitat that has not been previously inventoried (Clark 2014). These efforts located 546 previously unmapped Wright fishhook cacti. Although additional

Wright fishhook cactus localities have been found since the species was listed, we cannot determine a trend. Previous surveys are not comparable because we do not have a measure of acreage surveyed or effort spent searching. The earliest estimates of 50,000 to 100,000 (Neese 1987, Kass 1990, Kass 2001a) are most likely not accurate because subsequent surveys do not support this estimate. In recent inventories conducted from 2011 and 2012, BLM and CRNP (BLM 2012a, CRNP 2012, CRNP 2013) found 10,724 individual cacti in 157 localities with the majority on BLM land. This number is likely to increase as inventories of the remaining known localities are made.

Dispersal/Migration

Population Information and Trends

Number of Populations:

130

Population Size:

2,348

Population Narrative:

Wright fishhook cactus is a long-lived species that is slow to reach reproductive maturity. Individual cacti begin flowering when around 4 to 5 years old, producing flowers generally less than 50 percent of the time (Kass 2001a, Clark and Clark 2007). The highest reproductive rates are associated with large adult plants (>3.5 in [9.0 cm] in diameter), which flower between 75 and 100 percent of the time producing a disproportionately large amount of seeds (Kass 2001a, Clark and Clark 2007). Depending on environmental conditions, Wright fishhook cactus is estimated to grow an average of 0.2 ± 0.1 in (0.5 ± 0.25 cm) in diameter within one year (Clark and Clark 2007) with seedlings growing at a faster rate than adults (Kass 2001a). Because of slow growth rates, the highest reproductive individuals may be at least 18 years old. Size class distribution of a population indicates its structure and stability, and can help to show vulnerabilities in each life stage. Between 1999 and 2008, Clark (2008a) collected size class data on Wright fishhook cactus collected at 130 of 151 sites surveyed. During these surveys, 2,348 cacti in the four size classes (excluding multiple stemmed plants) were recorded as follows: 10 percent seedlings, 37 percent juveniles, 52 percent young adults, and 2 percent old adults. Although it is likely that some seedlings were missed during this inventory effort, the percentage of old adults is likely accurate (Clark 2008a). Similar population structure results were reported from three demographic monitoring sites on BLM lands over a seven year period with most of the population in the young adult size class (Kass 2001a). Monitoring initiated at Factory Butte in 2009 also showed low numbers of seedlings (5 percent), higher numbers of juveniles (21 percent) and young adults (68 percent), and low numbers of older adults >8 cm in diameter (6 percent) (Clark 2009a). Overall, the majority of Wright fishhook cactus plants occur in the juvenile to young adult size classes throughout the range of the species (Kass 2001a, Clark and Clark 2007, Clark 2008a, Clark 2009a) with the largest and smallest size classes poorly represented. Low frequency in the occurrence in the smallest size classes indicates low levels of recruitment into the population. Demographic monitoring over a seven year period at three BLM Wright fishhook cactus monitoring plots reported a mortality to recruitment ratio of 2.5:1 in all plots (Kass 2001a). Low levels of recruitment are also reported in the Factory Butte area, where overall mortality was 8.9 percent between 2009 and 2010, and 6 percent between 2010

and 2011 (BLM 2012a). The mortality to recruitment ratio for both years was reported at 6:1 and 5:1, respectively (BLM 2012a). Low recruitment patterns and the small number of large older reproductive individuals may constitute a species wide pattern (Kass 2001a). For populations to persist in their environment, recruitment into the population must exceed mortality. Populations with a low percentage of seedlings or a low percentage of the highly reproductive individuals are potentially declining populations (Elzinga et al. 1998).

Threats and Stressors

Stressor:

Exposure:

Response:

Consequence:

Narrative: Threats to the species include damage to the habitat during mineral and gas exploration and the mining of coal, gypsum, bentonite and bentonite clay, uranium, vanadium, building stone and gravel. Livestock activity, such as trampling and uprooting of plants, is a threat. Off-road vehicle use causes damage. Illegal collecting is still a problem. The cactus apparently suffers from predation by the beetle *Moneilema semipunctatum* and perhaps other beetles. Small mammals such as Ord's kangaroo rat (*Dipodomys ordii*) and white-tailed antelope squirrel (*Ammospermophilus leucurus*) may eat the cactus. (NatureServe, 2015)

Recovery

References

USFWS 2016. Status of the Species and Critical Habitat: *Sclerocactus wrightiae* (Wright fishhook cactus). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016.

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

SPECIES ACCOUNT: *Scutellaria floridana* (Florida skullcap)

Species Taxonomic and Listing Information

Listing Status: Threatened; Southeast Region (R4) (USFWS, 2015) 5/8/1992

Physical Description

A perennial herb, up to 4 dm tall. Stems are solitary or few, mostly erect or ascending. Leaves are opposite, narrowly linear, 2-4 mm long, the margins strongly rolled. Flowers are solitary in the axils of leaves and are bright lavender-blue with a whitish throat. (Based on Kral 1983.) (NatureServe, 2015)

Taxonomy

The rarest of several southeastern species in this genus. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Known from the Apalachicola region of the Florida panhandle from Liberty, Franklin and Gulf counties. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: Perennial (USFWS, 2009)

Breeding Season

Adult: Flowering is in May and June (Kral 1983) (USFWS, 2009).

Reproduction Narrative

Adult: The Florida skullcap is a perennial herb with quadrangular stems and opposite leaves. The flowers are solitary, with a bell shaped calyx and bright lavender-blue corolla. The corolla has two lips, the lower one being white in the middle. The stigma sticks out from under the flower hood with the anthers residing inside. Bumblebees, megachilids and halictids are probably important pollinators. Plants flower from mid-April through early July and are most prolific after a fire (USFWS, 2009).

Habitat Type

Adult: Pine-palmetto flatwoods, wet prairies (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (Inferred from NatureServe, 2015)

Site Fidelity

Adult: High (Inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits dark, humus rich sands of pine-palmetto flatwoods, wet prairies, and savannahs. (Based on Kral 1983) Seepage slopes. (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species.

Dispersal/Migration**Motility/Mobility**

Adult: Low (inferred from NatureServe, 2015)

Dispersal

Adult: Low (inferred from NatureServe, 2015)

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Moderate (inferred from NatureServe, 2015)

Representation:

Moderate (inferred from NatureServe, 2015)

Redundancy:

Moderate (inferred from NatureServe, 2015)

Number of Populations:

21 - 80 (NatureServe, 2015)

Population Size:

1000 - 2500 individuals (NatureServe, 2015)

Population Narrative:

Reported to respond positively to fire by sprouting and blooming. They stop flowering if not burned at least once every three years. Pollinator visits were infrequent in one study that examined who and when pollinators visited *Scutellaria floridana*. In addition, native bees were the primary pollinator, and factors that effect bee density could affect *S. floridana* density. Based on recent surveys within range and habitat of the species (NatureServe, 2015). Moderate resiliency, representation and redundancy are inferred based on number of populations and individuals as well as relatively large area in which this species is known to occur.

Threats and Stressors

Stressor: Logging (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Pulpwood production in the outer Coastal Plain in the Apalachicola Basin The timber industry in North Florida became well established in the 1850s (FNAI 2005). It started in Franklin County in the 1870s and continued to be a prominent industry until the mid-1990s (Howell and Hartsell 1995). The St. Joe Timberland Company had close to a million acres in timber in the eastern region of the panhandle and they plan to continue to harvest and replant indefinitely. The Company also owned a paper mill in Port St. Joe until it was sold and shut down in 1999. According to J. Huffman (2009, pers. comm. to Negrón-Ortiz) tree farming, i.e., privately owned forest managed (clearcutting, mechanical site preparation, and pine plantations) for timber production, is a primary threat since there still is a mill in Panama City (Bay County) and there are many thousands of acres of tree farms that are smothering out *S. floridana* (as in around the SJBSBP). Therefore, tree farming is a threat to this species (USFWS, 2009).

Stressor: Real estate development (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Urban development continues to threaten Florida skullcap. The St. Joe Timberland Company still owns the former extensive timber land in Northwest Florida, and now focuses on commercial and residential development along roadways and near or within business districts in the region. Urbanized land in Florida, statewide, is projected to double by 2060 along with doubling of the population to 36 million (<http://www.1000friendsofflorida.org/PUBS/2060/01-Northwest-Florida>). Several *S. floridana*'s locations are found along U.S. and state roads. Construction activity may directly kill individual plants or convert habitat to unsuitable space; widening may convert native habitat to managed roadside; and culvert modification may change drainage patterns, which may change seasonal hydrology. Therefore, development, road widening and new roads continue to pose a threat to the species from direct habitat loss to severe habitat modification. As explained under C.1.e, this plant has unique habitat characteristics. Working together with partners on road maintenance activities, we can find possible alternatives that will support or maintain *S. floridana* (USFWS, 2009).

Stressor: Fire suppression (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Suppression of fire continues to threaten the pineland and savanna's flora since fire is essential for the maintenance of flatwoods (Abrahamson and Hartnett 1990). Fire influences community structure and composition (Abrahamson and Hartnett 1990), and with insufficient frequency in longleaf pine communities, a woody midstory quickly develops (Glitzenstein et al. 1995), negatively affecting the understory diversity. Thus, fire suppression continues to be a threat to *S. floridana*. Lack of fire, and subsequent growth of shrubs (particularly encroachment of *Cyrilla racemiflora* L., commonly known as swamp titi) and saplings in the understory, in addition to shading by planted pines, inhibits this species emergence (Negrón-Ortiz, 2008, pers. observ.; FNAI 2008). Declining fire frequency reduces *S. floridana* abundance in areas where it

was previously observed in great quantities (FNAI 2008). In recently burned areas, however, plant emergence is prolific within one year of the fire event (L. Keppner, 2008, pers. comm.). Several studies have shown that frequent prescribed fire regimes are important for maintenance of flatwoods diversity (Hiers et al. 2007). Therefore, frequent prescribed burnings, i.e., 1-3 yr interval, are needed to maintain optimal *S. floridana* populations. At present, the ANF utilizes a 3-5 yr interval burn rotation, Lathrop Bayou uses a 2-7 yr interval, and SJBSBP uses a 2-5 yr interval (USFWS, 2009).

Recovery

Reclassification Criteria:

Not available

Delisting Criteria:

For delisting the species, the goal is to adequately protect and manage 15 populations distributed throughout the species' historical range for 10 years. The plan states that these goals are by necessity only preliminary, and they will be refined (USFWS, 2009).

Recovery Actions:

- Protect and manage these plants outside Apalachicola National Forest (USFWS, 1994).
- Protect populations in Apalachicola National Forest and on other public lands (USFWS, 1994).
- Perform systematic and other studies (USFWS, 1994).
- Garden propagation and reintroduction (USFWS, 1994).
- Manage rights-of-way (USFWS, 1994).

Conservation Measures and Best Management Practices:

- Complete a comprehensive census (e.g., the total number of individuals, number of flowering vs. non-flowering plants, and whether seedling recruitment is occurring) throughout the present distribution including all the historical locations to determine the population numbers and range (USFWS, 2009).
- Determine the levels and distribution of genetic diversity. Knowledge of the levels and distribution of genetic variation in species of conservation concern can be important for the development of efficient and effective conservation practices. For example, the identification of populations with rare alleles or with elevated levels of genetic diversity may lead to greater efforts for their preservation relative to less genetically unique populations (USFWS, 2009).
- Conduct surveys/inventories on potentially new sites. This action can include the use of species distribution modeling methods to initially determine potential sites, with subsequent validation or inspection of the sites for plants (USFWS, 2009).
- Conduct population studies. a. Studies on the viability of dry-stored seeds, the timing of germination, and whether a persistent seed bank is present should be addressed. b. Establish and implement monitoring to address demography. Plants should be monitored several times during the first 12-month period to assess the best monitoring schedule (e.g. annually, biannually). Data from monitoring should be evaluated through 5-year reviews. • Establish permanent plots on protected locations throughout the species' historical range. Priority for populations should include those sites that can be managed with fire. For each plot: o Estimate the density, and abundance of individuals. If possible, investigate basic ecological questions (e.g., pollinators; flowering period; annual

variability in flowering; seed production). o Monitor the effect of fire (if the areas are burned) on density, fecundity, and size structure (USFWS, 2009).

- Manage ROWs Continue fostering conservation practices for utility and highway ROWs with the Forest Service, Talquin Electric, FDOT, and USFWS; a management plan should be developed and implemented (USFWS, 2009).
- The recovery plan should be updated to define objective measurable criteria and better address the five factors (USFWS, 2009).

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SPECIES ACCOUNT: *Scutellaria montana* (Large-flowered skullcap)

Species Taxonomic and Listing Information

Listing Status: Threatened (effective 2/13/2002; originally listed as Endangered (effective 7/21/1986); Southeast Region (R4)

Physical Description

A perennial herb with solitary, erect, square stems, usually from 30 to 50 centimeters (cm) tall (Figure 1). The leaves are lanceolate to ovate, on 1 to 2 cm petioles, with blades 5 to 8 cm long and 3 to 5 cm wide, crenate to serrate margins, and hairy on both surfaces. The inflorescence is a terminal, leafy-bracted raceme, with or without paired lateral racemes at the base. The calyx is two-lobed (characteristic of the genus *Scutellaria*). The corolla is relatively large, 2.6 to 3.5 cm long, blue and white, and lacking a fleshy ridge (annulus) within the corolla tube near the top of the calyx. Flowering occurs from mid-May to early June and fruits mature in June and early July. Bridges (1984b) stated, "The genus *Scutellaria* can be easily recognized by its distinctive calyx, with a protrusion, or 'cap' on the upper lobe." Within the genus there are other species with which *Scutellaria montana* could be confused. Bridges (1984b) listed some important characters that a specimen must have to be characterized as *Scutellaria montana*: (1) a terminal inflorescence; (2) a large corolla (at least 2.5 cm long); (3) tapering or truncate leaf bases, never cordate; (4) a midstem with at least some stipitate glandular hairs; (5) no sessile glands on the upper leaf surface, (6) a fairly densely pubescent lower leaf surface, often with glandular hairs; and, (7) a corolla tube lacking an annulus within. (USFWS, 1996)

Historical Range

See Current Range.

Current Range

Ridge and Valley and Cumberland Plateau physiographic provinces in Georgia and Tennessee. This includes the following counties: Georgia Counties: Bartow, Catoosa, Chattooga, Dade, Floyd, Gordon, Murray, Walker, Whitfield; Tennessee Counties: Bledsoe, Hamilton, Marion, Sequatchie. (USFWS, 1996)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (NatureServe, 2015)

Lifespan

Adult: 8+ years (USFWS, 1996)

Dependency on Other Individuals or Species

Adult: Pollination is principally or exclusively by Hymenoptera of the superfamily Apoidea (bees) (NatureServe, 2015).

Breeding Season

Adult: Collins (unpublished manuscript) summarizes the general life cycle as follows. "Nutlets are released from late June through early July (mid-June to mid-July?), overwinter, and apparently germinate in late March. Mature individuals that have perennated as rootstocks begin shoot growth in late March. By early April, plants are 5-10 cm tall and are pushing through the leaf litter. Anthesis typically begins during mid-May and continues through early June (NatureServe, 2015).

Reproduction Narrative

Adult: The nutlets have a smooth exterior and do not appear to be adapted for any means of long-distance dispersal; they most likely fall a short distance (≤ 5 m) from the parent plant due to explosion of mint capsule. They could be washed downslope by water, or carried by small animals, but have only remote chances of extra-population dispersal (Collins, unpublished manuscript).; The life history of *Scutellaria montana* has not been specifically studied, and relatively little of it is known. Mature nutlets were not even seen until about 1983 by workers at Shorter College, thus indicating the early stage of work on the biology of the species. Collins (unpublished manuscript) summarizes the general life cycle as follows. "Nutlets are released from late June through early July (mid-June to mid-July?), overwinter, and apparently germinate in late March. Mature individuals that have perennated as rootstocks begin shoot growth in late March. By early April, plants are 5-10 cm tall and are pushing through the leaf litter. Anthesis typically begins during mid-May and continues through early June. Pollination is principally or exclusively by Hymenoptera of the superfamily Apoidea (bees). The corolla shrivels somewhat and falls from the calyx one or two days after pollination, presumably within 24 hours of fertilization. The calyx closes around the developing fruit immediately after corolla abscission. During the next two to four weeks, the calyx and the enclosed nutlets enlarge and mature. The calyx then dehisces by the loss of the upper lip, and the nutlets are released...A different course is followed if fertilization does not occur. The corolla shrivels markedly and may or may not remain united to the calyx. The entire calyx, still open at the mouth, falls leaving the pedicel bare." Workers at Shorter College are apparently conducting demographic and autecological studies on *S. montana*. Preliminary results indicate that less than 40 % of the flowers produce mature nutlets. Collins (1976) found that in other species of this group of *Scutellaria* studied, 76 to 93% of the flowers form nutlets. This lowered rate of fruit production, and the often few-flowered inflorescences, combine to give *S. montana* a reproductive capacity less than many of its relatives. The nutlets have a smooth exterior and do not appear to be adapted for any means of long-distance dispersal; they most likely fall a short distance (≤ 5 m) from the parent plant due to explosion of mint capsule. They could be washed downslope by water, or carried by small animals, but have only remote chances of extra-population dispersal. However, as Collins (unpublished manuscript) notes, this cannot alone explain its rarity, in that all of its more widespread relatives have virtually identical seed dispersal. Conditions necessary for germination and establishment are still unknown, although the Marshall Forest population has variously been described as from 500 to 1300 plants. This may represent actual population fluctuations. *Scutellaria* species in the group to which *S. montana* belongs generally occur at fairly low density, scattered seemingly at random over fairly large areas of forest. Large colonies are seldom found, and individual plants are usually widely spaced and easily distinguishable. *S. montana* may sometimes occur in tighter colonies than many of its relatives, as indicated by its

clumped distribution at Marshall Forest. In the largest Tennessee population (ca. 5000 individuals), the plants are spaced at approximately 6" intervals (Hawks 1985b), giving a density of 4/sq ft, or ca. 40/sq meter. In the smaller Tennessee populations, however, density is 1 plant per sq meter or less, and individuals can be separated by 50m or more from the nearest *S. montana* (Bridges 1983, 1984; Bridges and Hawks 1984) Collins (unpublished manuscript) indicates that *S. montana* was only known to occur in minimally disturbed sites with a stable habitat. This would indicate it to be a plant of late-successional or climax forests. In Tennessee, some of the sites have clearly younger trees and more recent disturbances than the above would suggest. One site has trees generally 30-40 years old; most sites average trees less than 60 years old. The largest site is in a relatively old (50-60 yrs ?) forest, but is unique in that there had been a gentle ground fire about three years before the discovery of *S. montana* at the site. While *S. montana* will not, or has not been observed, to grow in early successional pine stands, it will occupy relatively mature stands with varying degrees of disturbances. Thus it can be considered a mid-to-late successional species which probably persists in, but is not restricted to, mature or climax forests. This is the typical situation for most forest herbs of the region.; BIOTIC; Hymenoptera (NatureServe, 2015). USFWS (1996) notes that this species can live for more than eight years.

Habitat Type

Adult: Oak-pine forests (NatureServe, 2015)

Environmental Specificity

Adult: Narrow. Specialist or community with key requirements common (NatureServe, 2015).

Tolerance Ranges/Thresholds

Adult: Low (NatureServe, 2015)

Site Fidelity

Adult: Moderate (NatureServe, 2015)

Habitat Narrative

Adult: SUMMARY: *Scutellaria montana* is typically found in rocky, shallow soils, and on submesic to xeric, well-drained, slightly acidic oak-pine forests in the Ridge and Valley and Cumberland Plateau provinces of Northwestern Georgia and adjacent southeastern Tennessee. In Georgia, it has been reported from elevations of 189 to 265 m on steep, lower slopes of all aspects. In Tennessee, the elevation range of the species is much greater, with one concentration of sites at 200 to 320 m on slightly sloping to steep lower to mid-slopes on the Upper Mississippian Pennington Formation. The other concentration is at 400 to 540 m on gentle to somewhat steep slopes of small ravines near the escarpment on the Cumberland Plateau, on Lower Pennsylvanian sandstone and shale (Bridges 1984). The soil is always rocky and somewhat shallow, with plants rooted in deeper soil between boulders, or on as little as 3 cm of soil over rocks (Collins, unpublished manuscript). The species appears to have little specific habitat preference, occurring in localized areas within its known range. It is unclear what limits the northern edge of its distribution (NatureServe, 2015).

Dispersal/Migration**Motility/Mobility**

Adult: Low (NatureServe, 2015)

Dispersal

Adult: Low (NatureServe, 2015)

Dispersal/Migration Narrative

Adult: The nutlets have a smooth exterior and do not appear to be adapted for any means of long-distance dispersal; they most likely fall a short distance (= 5 m) from the parent plant due to explosion of mint capsule. They could be washed downslope by water, or carried by small animals, but have only remote chances of extra population dispersal (Collins, unpublished manuscript) (NatureServe, 2015).

Population Information and Trends**Population Trends:**

Short-term trend: Declining (NatureServe, 2015).

Number of Populations:

TN: 28 populations (164 occurrences). GA: 52 occurrences (population distribution is under evaluation) (USFWS, 2015)

Population Size:

10,000 - 100,000 total individuals (NatureServe, 2015)

Population Narrative:

Appears to be self-maintaining in mature forests. However, at some sites, it is unclear whether the species is reproducing, as seedlings are infrequently detected. More than 50,000 individuals known (Fish and Wildlife Service 2002). Plants are fairly widely scattered, even within occurrences; often, additional search effort at the same site results in the discovery of additional plants. Some occurrences contain over 500 plants, but others have only 5 or 6. Many of the Georgia occurrences are small. Suitable habitat is abundant on the escarpment of the Cumberland Plateau in forests that are no longer logged or converted to pine monoculture. Suitable habitat also exists in Northern Alabama. 205 occurrences are currently mapped and considered extant, but delineating separate occurrences for this species is challenging because it occurs as small clumps that are relatively close together. Efforts are now underway to re-delineate occurrences, resulting in many closely-spaced small occurrences being lumped into fewer large occurrences with better viability ranks. Nevertheless, additional search effort for this species continues to result in the discovery of additional occurrences. Short-term Trend Comments: Areas containing two subpopulations that were declining were closed to the public (USFWS 2009). Transplantation was done at one of these subpopulations but has not yet been evaluated (USFWS 2009). Long-term Trend Comments: Three historical populations were extirpated by extensive recreational and residential development. Moderate resiliency, redundancy and representation are based on numbers of populations and individuals as well as its relatively wide-spread geography (NatureServe, 2015).

Threats and Stressors

Stressor: Logging (USFWS, 2015)

Exposure:**Response:****Consequence:** Loss of habitat**Narrative:** A recent status survey for *S. montana* in Tennessee identified the following potential threats to the species and its habitat: 1. Removal of mature forest by logging or development on private lands (USFWS, 2015).**Stressor:** ORV traffic (USFWS, 2015)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** 2. ORV traffic on undesignated trails (USFWS, 2015)**Stressor:** Invasive exotic plants (USFWS, 2015)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** 3. Invasive exotic plants (USFWS, 2015).**Stressor:** Trail construction (USFWS, 2015)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** 4. Trail construction and maintenance on public and conservation lands (USFWS, 2015).**Stressor:** Power line maintenance (USFWS, 2015)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** 5. Power line maintenance including the use of herbicide, manual, and mechanical treatments for vegetation management (USFWS, 2015).**Stressor:** Wildfire suppression (USFWS, 2015)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** 6. Wildfire suppression involving construction of large fire lines (USFWS, 2015).**Stressor:** Recreational impacts (USFWS, 2015)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** 7. Recreational impacts including unauthorized hiking, camping and picnicking on public and conservation lands (USFWS, 2015).**Stressor:** Mineral mining (USFWS, 2015)**Exposure:**

Response:**Consequence:** Loss of habitat**Narrative:** 8. Mineral mining and quarrying**Recovery****Reclassification Criteria:**

Not applicable.

Delisting Criteria:

Scutellaria montana (large-flowered skullcap) will be considered for delisting when there are 15 adequately protected and managed self-sustaining populations. Populations must be distributed throughout the range and must be maintained for 10 years. A population will be considered adequately protected when it is legally protected and all needed active management is provided. A population will be considered “self-sustaining” if monitoring data support the conclusion that it is reproducing successfully and is stable or increasing in size. The minimum number of individuals necessary for a self-sustaining population should be considered to be at least 100 until otherwise determined by demographic studies (USFWS, 1996).

Recovery Actions:

- Search for additional populations of Scutellaria montana and prioritize sites for protection. Since the species was listed, several additional populations have been discovered through thorough inventories of specific areas. Without a focused effort, the potential for increasing the known number of populations is slim. The ability to prioritize and protect the highest-quality sites will depend on having complete information on extant populations of the species. (USFWS, 1996)
- Protect known populations. Of the 17 populations currently known, eight are protected through public ownership or by the Tennessee River Gorge Trust and The Nature Conservancy. Eight populations, including the second and third largest, are privately owned. One population in Hamilton County, Tennessee, occurs on public and private land. The protected sites need management plans in order to effectively protect Scutellaria montana. (USFWS, 1996)
- Conduct long-term monitoring of known populations. All populations should be monitored annually for the first 5 years to check the number of individuals and to determine threats to the populations. For the larger protected populations, this should include permanent plots. (USFWS, 1996)
- Determine the effects of potential management techniques. Observations by individuals in the field can help direct studies to document the effects of potential management techniques on populations of S. montana. This work should incorporate knowledge about site management, disturbance history, and forest composition. (USFWS, 1996)
- Examine genetic diversity within and between populations. A study of the species’ genetic diversity should be conducted, and populations that are genetically diverse should be identified. This information should then be used to help set priorities for the preservation of genetic diversity. Information on genetic variability will help determine the number of populations and population size necessary to successfully maintain the species. (USFWS, 1996)

- Maintain plants and seeds ex situ. To protect against the loss of a population, attempts at propagation, using cuttings, should be attempted. In addition, seeds should be maintained at a long-term seed storage facility. (USFWS, 1996)
- Recommendation for Future Action from 2015 5-Year Review: Continue long-term monitoring using standardized protocols across the geographic range of *S. montana* to provide a basis for establishing whether populations exhibit cyclical patterns of demographic variability and for assessing population responses to local and regional environmental conditions. (USFWS, 2015)
- Recommendation for Future Action from 2015 5-Year Review: Work with TDEC, TVA, UT-Chattanooga, TNARNG, TN River Gorge Trust, TDF, NPS, and others to develop plan for collecting current census data, where needed in Tennessee, to evaluate long-term persistence and stability of populations for which recent data are lacking. Appendix B includes a draft list of EOs where census data should be collected. Georgia DNR will be collecting census data from populations in Georgia during 2014. (USFWS, 2015)
- Recommendation for Future Action from 2015 5-Year Review: Establish cooperative management agreements with landowners for protected occurrences and populations to ensure that conservation efforts for the species would continue following delisting of the species. (USFWS, 2015)
- Recommendation for Future Action from 2015 5-Year Review: Develop a post-delisting monitoring plan. (USFWS, 2015)

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SPECIES ACCOUNT: *Senecio layneae* (Layne's butterweed (=Packera))

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/18/1996; Pacific Southwest (R8)

Physical Description

A perennial herb of the aster family (Asteraceae) that sprouts from a rootstock. Its mostly basal lance-shaped leaves are 8 to 24 centimeters (3 to 10 inches) long. The several flower heads are 4 to 6 centimeters (2 to 3 inches) wide. Each flower head has 5 to 8 orange-yellow ray flowers (the flowers usually located on the edge of the inflorescence of members of the aster family) and numerous yellow disk flowers (flowers in the center portion of an inflorescence of a member of the aster family). *Senecio aronicoides* (rayless groundsel), *S. flaccidus* var. *douglasii* (Douglas' groundsel), and *S. vulgaris* (common groundsel) also occur on gabbro-derived soils in the Pine Hill area (Wilson 1986). These *Senecio* species can variously be differentiated from *S. layneae* by a combination of life form, type of flower, number of flower heads, flower color, and pubescence. (USFWS, 2002)

Taxonomy

Kate Layne-Curran collected the type specimen for *Senecio layneae* in May 1883 from El Dorado County, California, on Sweetwater Creek, not far from Folsom. Edward L. Greene first described *S. layneae* in 1883 (Greene 1883). Although Asa Gray (1884) reduced *S. layneae* to a variety of *S. fastigiatus*, it currently is known as *S. layneae* (Barkley 1993). *Senecio layneae* is a member of the aureoid group of *Senecio* that is united by most of the following characters: perennial herbs arising from creeping rootstocks or a stout caudex; well developed basal leaves with cauline (arising from the upper part of the stem) leaves progressively reduced upward; leaf margins without callose denticles (hard teeth); thin branching fibrous roots; and haploid chromosome numbers 22 or 23, or derived from these numbers (Barkley 1988). The aureoid group of *Senecio* is now known by some as the genus *Packera*. The type population of *S. layneae* is now thought to be extirpated due to inundation by Folsom Lake. (USFWS, 2002) In the second edition of the Jepson Manual, the genus to which Layne's butterweed belongs was changed from *Senecio* to *Packera* (Baldwin et al. 2012). (USFWS, 2019)

Historical Range

In western El Dorado County that includes the Pine Hill formation and adjacent serpentine; a few other colonies occur in the Eldorado National Forest in El Dorado County, California. (USFWS, 2002)

Current Range

On the Pine Hill formation in western El Dorado County, California; a few known isolated occurrences in El Dorado, Nevada and/or Tuolumne Counties. (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (USFWS, 2002)

Breeding Season

Adult: Senecio layneae is a perennial herb that flowers from April to July (USFWS, 2019).

Other Reproductive Information

Adult: It is unclear whether the species has the ability to resprout from its caudex after disturbance (Marsh and Ayres 2002). Although the seed of this species seems to germinate in a wide range of soil conditions and adult plants grow in a wide range of slope, aspect, light and elevation levels (Williams 2014), it appears to have little or no persistent seedbank, a short seed dispersal distance (Williams 2014), and is also shade intolerant (Baad and Hanna 1987). It is likely the species functions as a fugitive species, depending on a short fire return interval to create a regeneration niche and a supply of the short-lived seed from a nearby reproducing population to colonize the patch (Marsh and Ayres 2002). Little else is known about reproductive biology, ecology, and demography of the species. (USFWS, 2019)

Reproduction Narrative

Adult: Senecio layneae is a perennial herb that flowers from April to July (California Native Plant Society 1994). Twenty-two plants from Cameron Park were used to determine whether the predominant breeding system was self-fertilizing or outcrossing (mating not involving inbreeding). Pollinators were excluded from the flower heads with fine mesh fabric. Open pollinated flower heads had an 8-fold increase in potentially viable seeds over flower heads where the pollinators had been excluded, indicating that the predominant breeding system for Senecio layneae is outcrossing (Marsh 2000) (USFWS, 2002).

Habitat Type

Adult: Chapparral (NatureServe, 2015)

Habitat Narrative

Adult: In addition to occurring on gabbro soils, Layne's butterweed is also known to occur on serpentine soils. All serpentine sites, with the possible exception of the one in Shingle Springs, continue to support Layne's butterweed. Persistence in at least two separate habitat/soil types benefits these species by increasing their degree of representation. (USFWS, 2019)

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Stable to increasing (USFWS, 2019)

Number of Populations:

45 populations; 6 extant; 36 presumed extant; 3 possibly extirpated (USFWS, 2019)

Population Size:

Greater than 9,100 individuals (USFWS, 2019)

Population Narrative:

In general, a direct comparison of species abundance now versus at the time of listing is not possible due mainly to lack of abundance data at the time of listing. Contributing to that challenge is that there is not consistent current abundance data for many of the populations, especially those on private lands. However, given the increase in the number of populations of Layne's butterweed since listing, it is likely that overall abundance has increased for those species (CNDDDB 2018). (USFWS, 2019)

Threats and Stressors

Stressor: Habitat loss and fragmentation (USFWS, 2002)

Exposure:

Response:

Consequence:

Narrative: Historically, gold rush activities and clearing for agriculture reduced and fragmented habitat in western El Dorado County. More recently, vegetation on the Pine Hill formation has changed significantly due to commercial and residential development, road construction, and fragmentation. Commercial or residential developments have partially or completely destroyed occurrences of the species (California Natural Diversity Data Base 1998; California Department of Fish and Game 1990a, 1990b; G. Clark in litt. 1993). Proposed residential or commercial development within the Pine Hill formation threatens most of the remaining sites within the Pine Hill formation and adjacent serpentine in western El Dorado County, and either directly or indirectly will adversely affect most of the range of this species. Additionally, habitat fragments may be too small to support viable populations of animals serving as pollinators or seed dispersal agents for the species. Edge effects, which occur at the interfaces of any two or more habitat types, typically increase with habitat fragmentation and are more pronounced for natural communities bordered by human disturbances (USFWS, 2002).

Stressor: Altered fire regime (USFWS, 2002)

Exposure:

Response:

Consequence:

Narrative: The primary overall threat is encroachment of native vegetation due to succession, even on lands in conservation ownership, in the absence of the natural fire regime. The long fire return interval due to fire suppression is preventing the formation of necessary clearings for Layne's butterweed establishment and possibly the scarification of seeds needed for germination. (USFWS, 2019a)

Stressor: Land use activities (USFWS, 2002)

Exposure:

Response:

Consequence:

Narrative: The increasing number of people and changes in land uses will continue to place an increasing strain on undeveloped areas through activities such as off-road vehicle traffic, unauthorized garbage dumping, and changes in the pattern of wildfires. Horse paddocking in rural residential areas within the central and northern portions of the Pine Hill formation threatens this species. The horses, when confined, severely graze or trample most available

vegetation. The herbaceous gabbro plants are especially likely to be grazed (J. Van Ess pers. comm. 1993). (USFWS, 2002)

Stressor: Invasive nonnative plants (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: Invasive plants continue to present a minor threat to gabbro plant species. Populations within the Pine Hill Preserve are not significantly threatened by invasive plants and any small infestations identified are largely reduced or eliminated by mechanical means (BLM 2008). However, a population of Layne's butterweed at BLM's Red Hills Kanaka Point property in Tuolumne County is threatened by yellow starthistle (*Centaurea solstitialis*) and distaff thistle (*Carthamus lanatus*) (B. Brenneman, in litt. 2018b). (USFWS, 2019)

Recovery

Reclassification Criteria:

Not applicable.

Delisting Criteria:

1. Secure and protect specified recovery areas from incompatible uses: Populations representing the range of the species including: (a) Cameron Park preserve south of Highway 50, (b) Cameron Park preserve north of Highway 50, (c) Pine Hill preserve, (d) Penny Lane preserve, (e) Salmon Falls/Martel Creek preserve, (f) occupied habitat on BLM lands in Yuba and Tuolumne Counties, and (g) occupied habitat on the Eldorado National Forest; along with adjacent unoccupied habitat and a 150-meter (500-foot) buffer. (USFWS, 2002)
2. Management plan approved and implemented for recovery areas, including survival and recovery of the species as the objective: For all populations and any occupied or unoccupied habitat identified as necessary for survival and recovery (see previous column) (USFWS, 2002).
3. Monitoring in all recommended preserves shows: (a) Stable or increasing with evidence of natural recruitment for a period of 60 years that includes normal disturbance. (b) Habitat monitoring of recommended preserves shows a mosaic of multiage class stands and habitat fragmentation has not appreciably increased (less than 5 percent) within any preserves over current (2000) conditions. (c) Spatially and temporally, the establishment of occurrences must be at least 10 percent greater than the extirpation of occurrences. (USFWS, 2002)
4. Other actions: (a) Ameliorate or eliminate threats (see Appendix H); (aa) Study importance of fire for management; (b) seeds of disjunct populations stored in at least two Center for Plant Conservation certified facilities. (c) Maintain metapopulation dynamics of at least 1 very large, 1 large, 7 medium, and 24 small occurrences throughout the Pine Hill formation; of at least 1 large, 2 medium and 5 small in western El Dorado County; of at least 2 medium and 4 small in Tuolumne County; and of at least 2 small in Yuba County. (USFWS, 2002)

Recovery Actions:

- 1. Develop and implement a cooperative program and participation plan. A cooperative program is needed to coordinate local public and private land use planning with State and

- Federal land use and recovery planning for gabbro species. A cooperative program needs to be developed focusing on western El Dorado County. A participation plan produced from this program will increase the chances of recovery for listed species. (USFWS, 2002)
- 2. Protect and secure existing populations. Natural lands that contain this species need to be protected in perpetuity. Protection of these lands includes identification and minimization of threats in perpetuity and application of appropriate and adaptive management (see Task 3) to ensure species survival and recovery. Natural lands that need protection can be categorized into two types: (1) blocks of land that contain occupied or potential habitat for two or more this species and (2) blocks of land that contain occupied or potential habitat for one this species. All potential preserve areas should be evaluated based on current mapping information and ground-truthed prior to purchase to confirm their value for recovery. (USFWS, 2002)
 - 3. Manage Habitat Managing habitat is essential to the recovery of the listed species. Habitat management includes preparation and implementation of management plans for all areas inhabited by special status species being proposed for preservation, and periodic monitoring of populations in each of these areas. Within western El Dorado County, a multi-constituent committee should be formed to oversee the management of preserves located on the Pine Hill formation. The preserve management committee should include, at a minimum, representatives from the California Department of Fish and Game, U.S. Fish and Wildlife Service, Bureau of Land Management, El Dorado County, California Department of Forestry and Fire Protection, California Native Plant Society, American River Conservancy, and a private landowner representative. (USFWS, 2002)
 - 4. Survey historical locations and other potential habitat where this species may occur. Recovery of listed species may often require relocating historic populations or locating new populations of these species. Historical locations should be surveyed to determine whether suitable habitat remains, the species persists at the sites, and/or the sites may be suitable for repatriation. Suitability of historical locations for repatriation would depend upon: (1) whether potential habitat exists, (2) the presence and magnitude of threats, and (3) whether the sites can be secured and managed for the long-term protection of the species. Surveys should also include other potential gabbro or serpentine habitat to determine whether undiscovered populations may exist. If new populations are discovered, they need to be protected and managed as discussed above. During the surveys, potential introduction sites should also be identified. (USFWS, 2002)
 - 5. Conduct necessary biological research and use results to guide recovery/conservation efforts. - Develop propagation techniques for listed plant species for which enhancement, repatriation, or introductions would be appropriate. Geographic area research is outlined in the Recovery Plan. Species-specific research is described as follows: Habitat Survey Research: Serpentine soil areas off the Pine Hill formation in El Dorado County; Serpentine and Gabbro areas in Nevada County; Serpentine near Red Hills in Tuolumne . Reproduction and Demography Research: Including determining limiting life stages, seed production and survival in soil to determine appropriate fire return period, reproductive studies identifying pollinators, seed germination studies. . Genetics research. . Other Research Needs: Influence of disturbance and fire on seedling establishment; effects of grazing; metapopulation analysis; effects of fire; fire management techniques; determine efficacy of other types of disturbance regimes for species and habitat management; feasibility of habitat restoration/ enhancement. . Management Actions Needed: Disturbance/ burning; general surveys; baseline monitoring; monitoring for trends of populations, success of management actions and threats at all populations identified for protection; monitoring for

- habitat fragmentation, major shifts in vegetation type, and tracking of occurrence establishment, and extirpation; seed banking for disjunct populations. (USFWS, 2002)
- 6. Undertake artificial enhancement, repatriation, or introduction efforts where necessary. Where it is deemed necessary, artificial enhancement, repatriation, or introduction efforts for sensitive plants should be undertaken. Prior to repatriation or introduction of sensitive plants, genetics studies are needed (see Task 5) to ensure that new populations will not disrupt unique local gene complexes. Plant repatriation or introduction efforts should be undertaken using collected seeds or plant propagules. (USFWS, 2002)
 - 7. Determine possible prescribed burning management strategies and incorporate the strategies into the management plans (Priority 1). Possible prescribed burning management strategies need to be evaluated, peer reviewed, and incorporated into management plans. (USFWS, 2002)
 - 8. Perform metapopulation-type analyses for this species (Priority 2). The results of a metapopulation-type analysis may be useful in clarifying uncertainties, data needs, and research, management priorities, and delisting criteria. Metapopulation-type analyses should be based on the results of monitoring and research. (USFWS, 2002)

Conservation Measures and Best Management Practices:

- Dedicate more resources toward the investigation of best management approaches for the Pine Hill listed plant species, even at the cost of a temporary hiatus in land acquisition efforts. Investigation should be made into fire-related and non-fire related methods of disturbance to maintain listed plant species habitat. (USFWS, 2019)
- Once the best management strategy (in terms of technique, frequency, timing, and intensity) is determined at each site, implement these management practices to achieve and maintain a habitat mosaic that enables the attainment of recovery criteria for the species.

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SPECIES ACCOUNT: *Serianthes nelsonii* (Hayun lagu (=Guam), Tronkon guafi (Rota)))

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/18/1987; Pacific Region (R1) (USFWS, 2016)

Physical Description

Serianthes nelsonii is a large tree in the pea family (Fabaceae, subfamily Mimosoideae). Adult trees can reach heights over 30 m (98 ft) and diameters over 1.5 m (4 ft) (USFWS 1994, p. 11). Its bark is smooth and light brown in color. Fine rusty hairs cover the flowers, seed pods, and newer vegetation growth. Leaves are doubly pinnate with many pairs of leaflets. Flowers are brush-like with pink and white coloration, and fruits are hard, dry, brown pods (Stone 1970, p. 304). Seedlings closely resemble those of a small introduced tree, *Leucaena leucocephala* (tangantangan), but can be discerned by the fine pubescence on new leaf buds (USFWS 1994, p. 6).

Current Range

Serianthes nelsonii is endemic to the islands of Guam and Rota (USFWS 1987, p. 4907). Recorded specimens on Guam were mostly from northern limestone forests, but a few trees were recorded in southern clay soils (USFWS 1994, p. 8).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: What little is known about pollination, seed dispersal, phenology, flowering, and fruiting for this species comes mainly from incidental reports (USFWS 1994, p. 11). Fruiting occurs throughout the year, as seed pods have been observed during all months of the year (USFWS 1994, pp. 11-13). Similarly, flowering has been recorded during all months of the year, with one report (Schreiner and Nafus 1991, as cited in USFWS 1994, p. 11) reporting the highest proportion of branches with flowers in May and June. This report also indicated leaf production throughout the year with declines during the dry season from January to June. Age of reproduction in the wild is also unknown, but flowers and pods have been observed on cultivated trees as young as 10 years old (USFWS 1994, p. 13). *Serianthes nelsonii*, being a large, canopy tree species, provides habitat for a number of smaller species. This species supports a diverse community of arthropods including predator species such as spiders and mantids that may control other potentially problematic insect populations (Wiles et al. 1996, p. 233). *S. nelsonii* also hosts a variety of epiphytes including ferns, orchids, and other plants such as *Ficus* sp., and *Freycinetia reineckeii* (Wiles et al. 1996, p. 233-234).

Habitat Type

Adult: Limestone forests

Habitat Narrative

Adult: *Serianthes nelsonii* is endemic to the islands of Guam and Rota (USFWS 1987, p. 4907). Recorded specimens on Guam were mostly from northern limestone forests, but a few trees were recorded in southern clay soils (USFWS 1994, p. 8). Currently, the last remaining wild adult tree on Guam is located at NWF, AAFB in northern Guam. A new fence was constructed to exclude ungulates in 2012 by AAFB, the *Serianthes* tree and seedlings are monitored monthly by DoD. DoD has conducted research on limiting factors for seedlings, fallen seeds collected and stored for future use. In 2014, 31 *S. nelsonii* seedlings supplied to the Service by JRM were planted at the GNWR in northern Guam (Demeulenaere et al. 2015, p. 4). The 31 seedlings are maintained with 2 previously outplanted saplings on the GNWR. On AAFB, one outplanted sapling is located in the Tarague Basin. The history of *S. nelsonii*'s abundance and distribution on Rota is poorly known (USFWS 1994, p. 7), but surveys in 1994 estimated 121 adult trees with very little regeneration (Wiles et al. 1996, p. 232). Current estimates for Rota are 40 to 50 wild adult trees with little to no regeneration (J. Manglona, CNMI DLNR, pers. comm. 2015). *Serianthes nelsonii* is recorded mainly from limestone soils, with a few historical occurrences in clay soils in Guam (USFWS 1994, p. 8). Most of the adult trees in Rota occur on or near steep limestone cliffsides, and the last wild adult tree in Guam is located in rugged limestone karst habitat at NWF.

Dispersal/Migration***Population Information and Trends*****Population Size:**

50

Population Narrative:

The total wild population of *Serianthes nelsonii* is estimated to be 50 adult trees, with almost all of the population occurring in Rota, and a single wild adult tree in Guam. In addition, there are outplanted occurrences on each island, all younger than 20 years of age. Seedling propagation and outplanting on Rota have been ongoing with limited success over the past 20 years, mainly in the Isang area in southern Rota, and between the main villages of Songsong and Sinapalo. Approximately 10 outplanted individuals in Rota have survived to a reproductive age (J. Manglona, CNMI DLNR, pers. comm. 2015). Twenty seedlings were outplanted in 1999 in the Tarague Basin, on AAFB in Guam (M. Marutani, University of Guam, pers. comm. 2015). To date, only one of these saplings has survived (AAFB 2015), but has not produced any seed pods (A. Gawel, USFWS, pers. obs. 2014). In 2009, approximately 30 seedlings were planted at the GNWR; all but 5 have survived (J. Cruce, USFWS, pers. comm. 2015). In 2014, 31 seedlings were donated to GNWR by JRM and outplanted and are being maintained by the Guam Plant Extinction Prevention Program (Demeulenaere 2015, p. 4) and GNWR staff. Recent *Serianthes nelsonii* recovery efforts on Guam and Rota have been dependent on funding, the amount of available propagated seedlings in nurseries, and the seedling to adult survival rates in the wild. In early 2015, the total number of nursery seedlings and saplings in Guam and Rota was estimated at 300 individuals, with approximately 200 in Guam nurseries. However, this estimation may change rapidly if outplanting seedling survival is low. Recent studies from AAFB indicated that although many seeds fall from the Guam adult tree and many of the seeds germinate, there is very limited survival under the mother tree (AAFB 2015). Both islands'

populations have constant regeneration of wild seedlings that are several days to several months old. However, these seedlings experience incredibly high turn-over, and in recent decades, none have been known to survive to adulthood in the wild (J. Manglona, CNMI DLNR, pers. comm. 2015; AAFB 2015, pp. 4-5). Although wild seedling survival is bleak, progress has been made on increasing the likelihood of survival of outplanted individuals with new methods of insect control and exclusion, given insect herbivory and damage are the major cause of outplanted seedling early mortality (E. Demeulenare, GPEPP, pers. comm. 2015). Continued demographic decline of wild population on Rota. The decline anticipated by Wiles (1998) continues. Recent field reviews on Rota (AnnMarie Gawel, USFWS, pers. comm. 2016a & 2016b) confirmed an apparent large dieoff among the historic adult trees, relative to the approximately 120 adult trees inventoried in 1992 (Wiles et al 1996). Also, there was no regeneration (no seedlings recorded). The following is a more specific breakdown, organized by Wiles' original subpopulation numbers, all from Ann Marie Gawel, USFWS (pers. comm. 2016a & 2016b), except for subpopulations 1, 6, and 14.

- o Subpopulation 1: Of the 15 adult trees recorded in 1992, 11 remain alive (McBride field notes and GPS points, October 2016).
- o Subpopulations 2-5 and 7-10: Of the 63 adult trees in this area in 1992, only 19 were found alive in June 2016, while another 20+ large stumps and down logs (none recent) may represent some of the prior *Serianthes* lost there.
- o Subpopulation 6: Of the 4 adult trees recorded in 1992, none were found alive in this area; a large diameter snag and larger down log may represent two of the prior trees recorded here (McBride field notes and GPS points, January 2017).
- o Subpopulations 11-13: One live tree, with a full crown, was observed from the road in January 2017; Rota Forestry indicated that the rest of the 28 live trees in this area in 1992 had previously died (McBride field notes and GPS points, January 2017).
- o Subpopulation 14: Of the 8 adult trees recorded in 1992, one remains alive as of October 2016. However, this last survivor is in very poor condition, with less than 5% live crown (McBride field notes, October 2016).
- o Subpopulations 15-16: Rota Forestry observed that the 3 live *Serianthes* recorded here in 1992 have all subsequently died.

3 Rangewide demographic decline. In aggregate, including the one surviving adult *Serianthes* on Guam, the current numbers represent a 73% decline among these wild *Serianthes* trees from the 1992 baseline— from the 122 documented then to 33 currently known (USFWS, 2017). Reduction in geographic range of wild population on Rota. Along with the demographic decline, there has also been significant reduction in the known range of the wild population. At the time of the 1992 inventory, the species range on Rota could be described as largely surrounding the Mount Sabana massif, which dominates the west half of the island— a distance of nearly 8 km. Following the loss of Wiles' 1992 subpopulations in the Palii area (#'s 15 & 16), that distance has already been reduced by half to just under 4 km. Other outlying subpopulations (#14, in Lupok area, and #'s 11-13, in the Isang area) have greatly declined, down to a single surviving individual in each location at last report — representing a 93% reduction of the 36 total individuals recorded among these subpopulations in 1992. If these outlying populations are lost, the Rota population will be restricted to a 1.6 km area on the southwestern flank of Mount Sabana. Whether or not such continuing collapse transpires, 94% of today's remaining known wild *Serianthes* population on Rota survive within an area of less than 100 hectares. With this reduced range, the remaining population is highly vulnerable to large- to mid-scale disturbance events, whether of anthropogenic, climatic, or other origin (USFWS, 2017). On Guam, the lone adult tree at Ritidian continues to survive in a deteriorated condition, with no persisting natural regeneration to sustain a wild population. The one remaining mature *Serianthes* tree survives, despite evidence of its compromised condition (reduced crown volume; conks and visibly decayed wood showing development of *Ganoderma* fungus). This tree, including its flowers, fruits, seeds, and surrounding seedlings, were monitored

on a monthly basis through 2016. The prevalence of the fungus *Phellinus noxious* in other trees in close proximity this tree is a concern. While it is not established if the *Phellinus noxious* directly affects *Serianthes*, the fungus can be a lethal pathogen for several native forest tree species (AAFB 2016). Several researchers have monitored and studied the fate of seedlings under the crown. Marler and Cascasan (2015) studied the survival of seedlings germinating beneath this tree, documenting both their high recruitment potential (an average of >1 seedling emerging per day throughout 2013) and inability to survive to the juvenile stage. Over half the seedlings died within the first month after sprouting, while essentially all had died by 200 days post-emergence. During 2014-15, Marler and Musser (2015) monitored the survival and fate of 488 seedlings under the *Ritidian* tree, evaluating four different treatments as mitigations for potential seedling stressors. While insecticide, fertilizer, and supplemental lighting treatments did not meaningfully extend the longevity of test seedlings, those treated with a fungicide (Ridomil Gold) survived more than twice as long as the untreated control seedlings. This suggests that root pathogens may be significant agents of mortality, in addition to the previously-recognized problems of insect and ungulate herbivory. The capacity for *Serianthes* to regulate the soil's 4 biogeochemistry beneath its canopy was also studied; in contrast to more distant samples, those taken from within the litterfall area beneath the tree had significantly more nitrogen, carbon, calcium, magnesium, copper, and zinc; and less iron (Naval Facilities Marianas 2015). At the Guam National Wildlife Refuge, Deregnier (USFWS, pers. comm. 2016a) observed a range of insect herbivory agents, among which mealybugs have been the most problematic; their attacks on both foliage and (particularly) roots of *Serianthes* have caused 10 of 12 seedling deaths to date. Also on the Refuge, Deregnier found that outplanted trees seemed to do best in forest-gap settings: that is, with relatively high light and humidity, but low wind exposure (Ryan Deregnier, USFWS, pers. comm. 2016a). On both Guam and Rota, the high rate of loss of the remaining wild trees — together with the failure of seedlings to persist — emphasizes the importance both of studies of the mechanisms of decline in the wild populations, as well as into propagation methods to sustain the species through the near to mid-term (USFWS, 2017). In addition to these in situ studies, off-site research on Guam has contributed knowledge toward successful propagation practices and establishment of horticultural protocols. Marler et al. (2015) evaluated seedling emergence in varying shade conditions, finding that both percentage and velocity of seedling emergence for *Serianthes* were maximized in deep shade. They also found that seeds of *Serianthes* are not very short-lived, with germination observed after nine months of storage at ambient temperature and relative humidity. The University of Guam's Guam Plant Extinction Prevention Program (GPEPP) worked on in vitro seedling propagation, including tissue culture from seedling meristematic tissues to mitigate limited seed availability (GPEPP 2015) (USFWS, 2017). Other field observations: On Rota, during the June 2016 field reviews it was observed that the root masses of mature *Serianthes* trees extend laterally from the trunks 6 m or more above ground (and perhaps further sub-surface), which may provide the trees greater stability and water-uptake (AnnMarie Gawel, USFWS, pers. comm. 2016a). Older outplanted *Serianthes* became reproductive after 18-23 years (McBride, field observations August 2016), and may be capable of doing so as young as ages 12-15 (Manglona, pers. comm. 2016a & 2016b). On Guam, two trees less than 4 years old (outplanted in Nov. 2014) have produced flowers, but fruit has not yet been confirmed; these trees were known to be substantially stressed by mealybug infestations at the time (Ryan Deregnier, USFWS, pers. comm. 2016b) (USFWS, 2017). Distribution of recovered populations (future). Considering the delisting objective for Rota of having four populations separated by at least 1 km, some of these older outplanted trees may become the locations for those eventual recovery populations. Since the distribution of the currently known wild subpopulations would

only provide for two or three of the required recovery populations, it is evident that additional reintroduced (outplanted) populations may be essential to attain the delisting objective (USFWS, 2017). Anticipated: An upcoming study by E. Demeulenaere at the University of Guam on phylogenetics of *Serianthes*, which should clarify the degree of genetic similarity between the Guam and Rota populations. One objective of this study is to develop genetically-informed strategies for conservation of the species (USFWS, 2017). Anticipated: A study by GPEPP funded by McIntire Stennis to determine the genetic make-up of the *Serianthes* taxa, which will analyze the phylogenetic relationship of *Serianthes nelsonii* to other members of the *Serianthes* genus in the region. This project aims to confirm that *Serianthes nelsonii* is a valid species differing from congeners in the region (USFWS, 2017).

Threats and Stressors

Stressor: • Loss and degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Development from construction and military training has decreased the total recovery habitat for this species. *Serianthes nelsonii* habitat continues to be degraded by ungulates (Wiles et al. 1996, p. 234; DON 2013c), i.e. feral pigs and Philippine deer (*Rusa mariannae*), and by encroachment of invasive plants. In addition, declines in pollinators, seed dispersers, and insectivores have contributed to habitat loss (Wiles et al. 1996 p. 230).

Stressor: • Introduced predators and herbivores

Exposure:

Response:

Consequence:

Narrative: Introduced deer and pigs feed on *Serianthes nelsonii* (Wiles et al. 1996, p.234; Morton et al. 2000, p. 230). A number of invertebrate predators and herbivores also have been reported on this species: mealybugs (*Dysmoccocus brevipes*, *D. neobrevipes*, *Ferrisia virgate*, and *Planococcus* sp.), caterpillars of *Eurema blanda*, termites (USFWS 2012b), and katydids (A. Moore, University of Guam, pers. comm. 2014). In addition, insect predation occurs on seed pods in Rota, but the insect is unknown (USFWS 2012b).

Stressor: • Stochastic events

Exposure:

Response:

Consequence:

Narrative: Typhoons have resulted in damage and mortality to this species as well as damage to habitat (USFWS 2012b).

Recovery

Delisting Criteria:

For *Serianthes nelsonii* to be considered for delisting, the Service proposes that at least four populations be established on each island – Guam and Rota – each with a 10-year average of 500 or more reproductive plants (USFWS 1994, p. 26). The populations should have age structures comprised of a large proportion of adult trees as well as seedlings and immature

trees (USFWS 1994, p. 26). In addition, the Service recommends that the populations on Rota be separated by at least 1 km (0.621 mi), and that at least one of the populations in Guam should be in the southern part of the island (USFWS 1994, p. 26).

Recovery Actions:

- To achieve recovery needs, the Service outlines the following recovery actions (adapted from USFWS 1994, pp. 27-37):
- • Additional surveys are needed on both islands since the last surveys for this tree were in 1994. To prevent ungulate degradation and herbivory, subpopulations should be fenced wherever possible. Methodology to control insect pests should be developed and implemented. Existing individuals need to be monitored for survivorship, new threats, and any possible evidence of regeneration. Public education and community involvement should also be encouraged and developed.
- • Conduct research important to the management of *Serianthes nelsonii*. The ecology, life history, and habitat requirements of *S. nelsonii* are poorly understood and should be studied. Although a number of insect pests have been identified, many remain unidentified, and their ecology, specific effects, abundance, and especially control methods need to be investigated. The Service also recommends genetic studies, especially on the variation between Guam and Rota populations, as well as any effects from small population size and inbreeding.
- • Augment current populations and reintroduce to historical range. Plans for augmentation and reintroduction should be developed for both Guam and Rota. Areas for outplanting should be identified and secured, and plants should be propagated and transplanted to the identified areas.
- • Prevent clearing of forest next to *S. nelsonii*. Maintenance of an intact forest canopy next to *S. nelsonii* will reduce the potential of edge effects and for high winds during typhoons to break tree limbs and trunks.
- • Implement standardized control procedures for insect pests after research on insect control determines appropriate methodology.
- Propagation and outplanting programs on Guam: the Guam Plant Extinction Prevention Program propagated seedlings (seeds from the Ritidian tree) in their Rare Plant Nursery during FY2014-15; these were outplanted at the Guam National Wildlife Refuge, in partnership with Anderson AFB, USFWS, and LMS Landscape Services (Marler 2014, GPEPP 2015). From Nov. 2014 to Dec. 2016 at the Guam NWR, 68 young *Serianthes nelsonii* were outplanted, with 48 of those two- to four-year-old trees surviving as of December 13, 2016. Also, there are five surviving older (five to nine years old) outplanted *Serianthes*, planted during 2009-2012. All 73 seedlings were propagated by the University of Guam's Guam Plant Extinction Program, from seed from the last surviving adult *Serianthes* tree on Guam. These outplantings are distributed in four clusters throughout the Refuge. GPEPP recently planted 10 *Serianthes* seedlings at the University of Guam (UOG), 10 at the UOG Yigo Agricultural Research Station, and 15 at the Cotal Conservation area (USFWS, 2017).
- Outplanting sites are fenced to exclude ungulates, with individual trees enclosed in netting to prevent defoliation or other damage by insects, including mealybugs, ants, scale insects, whiteflies, psyllids, butterfly and looper caterpillars, and katydids and cerambycid beetles. Insecticidal treatment against mealybugs was conducted both directly (insecticidal soap on mealybugs themselves), and indirectly through bait poisons for their tending ants. Concern about potential negative effects of soil-borne pathogens on seeds led to the proposed usage

- of hanging seed collectors to capture some of the seedfall above the ground (AAFB 2016; Ryan Deregnier, USFWS, pers. comm. 2016a & 2016b). Finally, recent reports including monthly monitoring detail the condition, through September 2016, of the one older juvenile *Serianthes* persisting in the Tarague Basin. This is the lone survivor of 67 outplanted in 1999-2000; three had been alive as recently as 2013 (Naval Facilities Marianas 2015; AAFB 2016) (USFWS, 2017).
- Propagation and outplanting programs on Rota: from 2015-2016, 62 young *Serianthes* have been outplanted; these plants are protected by fenced enclosures and are currently two to three years old (Manglona 2016). Also, there are 10 older outplanted *Serianthes* (18-23 years old; identified as “mature” in Table 1) planted in four different locations (James Manglona, pers. comm. 2016b), among which at least 6 of 9 observed trees are currently producing flowers and seedpods (McBride, personal observation). Susceptibility of these outplants to scale insects and other pathogens necessitates their active management until reaching at least three meters in height to ensure their survival—and even larger trees are still visibly affected, if not lethally (James Manglona, pers. comm. 2016c). Some of the older outplantings are farther northeast and in lower elevations (100-125m) than the historical range of the species on Rota (above 150m, Mount Sabana massif only). This expansion of the species range on Rota through propagation could prove beneficial in the event of large-scale disturbances (USFWS, 2017).
 - Also on Rota, in 2016 Lainie Berry of CNMI Department of Lands and Natural Resources began work on surveys and propagation of *Serianthes*, under a USFWS Section 6 grant (F16AP00687). In addition to surveys for new individuals as well as all previously-known trees, efforts to propagate the species will also be undertaken. Anticipated propagation activities include seed and cutting collection, propagation via established techniques, outplanting in conservation areas, and initial monitoring. Existing fencing will be restored as needed, new fencing and signage established, and invasive plants hand-cleared where necessary to protect individual trees. This work is scheduled to conclude in 2018. Ongoing fence maintenance will be carried out by Rota Forestry, as well as longer-term monitoring if additional federal funding is secured (USFWS 2016) (USFWS, 2017).
 - In addition to the previously-described monitoring and propagation activities being conducted by Anderson AFB, in accord with the terms of their recovery permit, they have convened a *Serianthes* Strategy Team. The purpose of this team is to develop, in cooperation with AAFB, GPEPP, USFWS, and other recovery collaborators, a long-term conservation strategy for propagation and outplanting of *Serianthes nelsonii*, to replace the initial one-year strategy outlined in the permit by July 2017 (AAFB 2016) (USFWS, 2017).
 - Anticipated: The Department of Navy’s proposed relocation of the U.S. Marine Corps from Okinawa to Guam, as well as the associated activities on Guam, has been evaluated by the Service (USFWS 2015). In that Biological Opinion, the Service concluded that this project, including the construction and operation of a Live-Fire Training Range Complex (LFTRC) in close proximity to the lone surviving wild adult *Serianthes* on Guam, would likely have a number of effects on that mature tree, nearby seedlings, outplanted saplings, and the species’ recovery habitat on Guam. These anticipated effects include, but are not limited to, clearing of 948 acres of recovery habitat—including 65 acres of primary limestone karst forest, to within 100 feet of the surviving tree; increased exposure to wind loading and its potential for damage or injury to that adult tree; other abiotic and biotic edge effects, including microclimate alterations and increased invasibility by non-native species; potentially increased fire risk; potential disruption of ecological relationships such as pollination and seed dispersal; and reduced accessibility to the wild tree/seedling area and

the outplanted saplings for both research and management purposes. In that Opinion, the Service concluded 7 that the proposed action will adversely affect the last remaining adult *Serianthes nelsonii* tree in Guam, will negatively impact that wild tree and seedlings around it, and the outplanted saplings at the Refuge, and will result in the loss of 948 acres of recovery habitat. The Service further concluded that if the Department of Navy fully implements its proposed conservation measures and best management practices—including but not limited to the outplanting of 30 *Serianthes nelsonii* trees in a protected area, and their successful maintenance into adulthood—then it is unlikely that this project will preclude the recovery and survival of *S. nelsonii*. However, the Opinion also states that if new information suggests that the Guam population is distinct from *S. nelsonii* in Rota, or if the baseline for this species experiences an unforeseen major decline, this determination will need to be revisited. (For further details, see full Biological Opinion, USFWS 2015). Since *S. nelsonii* has undergone a major decline, the Navy has been notified of this status update and the Service is anticipating re-consultation (USFWS, 2017).

- Preserve the remaining genetic and geographic diversity of the species. Maintain presence of existing reproductive individuals on both islands. This will best assure continuity of seed sourcing for propagation efforts while safeguarding what remains of the species genetic diversity, and retaining some geographic distribution to mitigate the risk of catastrophic loss from disturbance events (USFWS, 2017).
- Similarly, research and other recommended actions below need be conducted in recognition that the populations between the two islands may be distinct in various ways: genetically, ecologically, or with regard to threats, and other survival or recovery issues. Original studies on each population may be necessary to inform effective management on the two islands (USFWS, 2017).
- Site / area / habitat protection – Develop and implement effective measures to reduce the impacts of military training activities, agricultural and urban development, and hurricanes (typhoons) (USFWS, 2017).
- Fire protection – Develop and implement a fire management plan for all populations (USFWS, 2017).
- Implement fencing plans for both outplanted trees and wild subpopulations as described in the recovery plan; this fencing should be designed to exclude ungulates and allow greater chance for successful establishment of seedling regeneration. As one example, the Aplalago “grove” (subpopulation #1) of 11 live adult trees could be enclosed with as little as 120-200 m of fencing, using the nearby cliff rim as a natural barrier along one side (USFWS, 2017).
- Ecosystem-altering invasive plant species control – Control invasive introduced plant species within fenced enclosures (USFWS, 2017).
- Surveys / inventories – Resurvey the historical range of the species to determine if previously unknown or newly reestablished populations exist (USFWS, 2017).
- Continue propagation and outplanting programs on both islands to establish *Serianthes* in a range of locations, particularly within the known historic distribution around the Mount Sabana massif on Rota (USFWS, 2017).
- Captive propagation for genetic storage and reintroduction:
 - o Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation.
 - o Augment the species with specimens from Rota to encourage genetic mixing of the Guam population (USFWS, 2017).
- Captive propagation protocol development – Protect seed pods with a fine mesh covering to prevent predation by arthropods before seeds mature (USFWS, 2017).

- On Rota, collect seed stock at the Aplalago subpopulation (#1), to broaden the genetic diversity of current propagation material, and thus potentially augment its characteristics for survival (USFWS, 2017).
- On Rota, conduct studies of the subpopulations (#1, #7) with better recent-term survival, to identify any characteristics potentially favoring enhanced survival (USFWS, 2017).
- Invertebrate herbivory research – continue studies to identify the effects of invertebrate predation on seeds and seedlings of *S. nelsonii*. If determined to be a limiting factor, develop and implement control measures to protect the species (USFWS, 2017).
- Root pathogen research – Develop studies to identify specific root pathogens that influence the survival of *S. nelsonii* seedlings, and the mechanisms by which this occurs. If determined to be a limiting factor, develop and implement control measures to protect the species (USFWS, 2017).
- Population biology research – Research the use of hand pollination to enhance outbreeding of the species (USFWS, 2017).
- Threats research:
 - o Research what factors are limiting the natural recruitment of individuals in each population--both on Guam, and on Rota.
 - o Assess the modeled effects of climate change on this species, and use results to determine future landscape needed for the recovery of the species (USFWS, 2017).
- Alliance and partnership development – Continue to work with Guam National Wildlife Refuge, Guam Plant Extinction and Prevention Program, the CNMI's Department of Lands and Natural Resources and both its Forestry Division and Fish and Wildlife Division, the Guam Department of Agriculture's Forestry and Soil Resources and Aquatics and Wildlife Divisions and other land managers to further their implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2017).
- Review the recovery plan (USFWS 1994) to determine if any new information suggests a need to update the plan to more effectively attain recovery goals (USFWS, 2017).

Conservation Measures and Best Management Practices:

- New management actions that have occurred in the last five years include: Since *Serianthes nelsonii* was listed in 1987, outplanting of individuals have been attempted with limited success. However, several recovery projects aimed at understanding and improving outplanting efforts and management of individuals have begun since 2012:
 - The last remaining adult tree in Guam is fenced to prevent access by ungulates. The Air Force has funded research to look at ecology, seedling survival, propagation methods, and health and life history of the adult tree (AAFB 2015).
 - The Service has funded a project with the CNMI Division of Forestry in Rota to outplant and maintain *Serianthes nelsonii* in fenced plots on private property.
 - The Service has funded a multi-year project for *Serianthes nelsonii* recovery on the GNWR to be managed by a full-time biologist. This person will work with the Guam Plant Extinction Prevention Program to maintain the *S. nelsonii* seedlings that were outplanted at the GNWR in 2014. The Service is collaborating with Guam Department of Agriculture, DoD, the University of Guam, and the Guam Plant Extinction Prevention Program.
- Recommendations for Future Actions (adapted from USFWS 2012b, pp. 17-18)
 - Captive propagation for genetic storage and reintroduction:
 - o Continue to collect seeds from all existing populations and propagate at multiple locations to increase success.
 - o Perform genetic studies to determine if Guam and Rota populations are distinct.
 - Captive propagation protocol development – Protect seed pods with a fine mesh covering to prevent predation by arthropods before seeds mature.
 - Reintroduction / translocation implementation:
 - o Propagate and maintain all outplanted individuals on the GNWR to a size where insect herbivory is less likely to cause mortality. This will

likely be when plants produce multiple branches and the main stem achieves a girth sufficient enough to withstand damage from *Eurema blanda* butterflies laying eggs in the plant's tissue. • Ungulate control – Continue to protect all populations against disturbances from feral ungulates. • Invertebrate control research – Research and identify the effects of invertebrate predation on seeds and seedlings of *S. nelsonii*. If determined to be a limiting factor, develop and implement control measures to protect the species. • Population biology research – Research the use of mechanical pollination to enhance outbreeding of the species. • Surveys / inventories – Resurvey the historical range of the species to determine if previously unknown or newly reestablished populations exist. • Threats research: o Research what factors are limiting the natural recruitment of individuals in Guam. o Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. • Ecosystem-altering invasive plant species control – Control invasive introduced plant species within fenced exclosures. • Site / area / habitat protection – Develop and implement effective measures to reduce the impacts of agricultural and urban development and hurricanes (typhoons). • Fire protection – Develop and implement a fire management plan for all populations. • Alliance and partnership development – Continue to work with GNWR, Guam Rare Plant Restoration Group, and other land managers to continue implementation of ecosystem-level restoration and management to benefit this species.

References

USFWS 2016. Status of the Species and Critical Habitat: *Serianthes nelsonii* (Hayun lagu (=Guam), Tronkon guafi (Rota))). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016.

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USFWS 2016. Status of the Species and Critical Habitat: *Serianthes nelsonii* (Hayun lagu (=Guam), Tronkon guafi (Rota))). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016. USFWS 2017. 5-YEAR REVIEW Short Form Summary. Species Reviewed: *Serianthes nelsonii* (Hayun lagu or Tronkon guafi).

USFWS 2017. 5-YEAR REVIEW Short Form Summary. Species Reviewed: *Serianthes nelsonii* (Hayun lagu or Tronkon guafi).

SPECIES ACCOUNT: *Sesbania tomentosa* (Ohai)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/10/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

Usually an erect to prostrate shrub; sometimes a small, erect tree. When prostrate, the branches are up to 14 m long. Trees are 2.5 - 6 m tall. Flowers are salmon tinged with yellow, orangish red, scarlet, or (rarely) pure yellow (NatureServe, 2015).

Taxonomy

A member of the pea family (Fabaceae). In the currently accepted classification by Geesink and others (1990), *S. arborea*, *S. hawaiiensis*, *S. hobdyi*, and *S. molokaiensis* are synonymized with *S. tomentosa* (USFWS, 1999).

Historical Range

It is known from Nihoa and Necker islands, part of the Papahānaumokuākea Marine National Monument, and all of the main Hawaiian Islands (Geesink et al. 1999) (USFWS, 2015).

Current Range

Currently, *Sesbania tomentosa* is known from Kauai, Molokai, Maui, Kahoolawe, Nihoa, Necker, Oahu, and Hawaii (USFWS 2012a; USFWS, 2015).

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Sesbania tomentosa* (Ohai) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 24 detailed critical habitat units (CHUs), in Maui County in Hawaii (81 FR 17790-18110).

On September 18, 2012, the U.S. Fish and Wildlife Service (Service), designated critical habitat under the Endangered Species Act of 1973, for *Sesbania tomentosa* on the island of Oahu, Hawaii.

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Sesbania tomentosa* on the island of Hawaii (68 FR 39623 - 39722).

On May 22, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Sesbania tomentosa*, known historically from the Northwestern Hawaiian Islands.

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Sesbania tomentosa*, known historically from the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Sesbania tomentosa* includes 24 CHUs in Maui County, Hawaii with detailed unit information. There are also an unknown number of units on Lanai that contain

this species (number of units is unknown because detailed unit descriptions for Lanai are not available) (81 FR 17790-18110).

Kahoolawe—Coastal—Unit 1 consists of 1,516 ac (613 ha) of State land from Kaneloa to Lae o Kaule, including Aleale, along the southern and eastern coast of Kahoolawe. It is occupied by the plant *Kanaloa kahoolawensis* and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Kahoolawe—Coastal—Unit 1 is not known to be occupied by the plants *Sesbania tomentosa* or *Vigna owahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the physical or biological features necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 1 consists of 70 ac (28 ha) of privately owned land, and 54 ac (22 ha) of federally owned land (U.S. Coast Guard) at Laau Point, from Kahaiaawa to Keawakalani, along the western coast of Molokai. This unit is occupied by the plant *Marsilea villosa*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 1 is not known to be occupied by *Bidens wiebkkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Kahoolawe—Coastal—Unit 2 consists of 12 ac (5 ha) of State land on Puukoa, an islet off the southern coast of Kahoolawe. It is occupied by the plant *Sesbania tomentosa* and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Kahoolawe—Coastal—Unit 2 is not known to be occupied by *Kanaloa kahoolawensis* or *Vigna o-wahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 2 consists of 263 ac (106 ha) of State land, and 710 ac (287 ha) of privately owned land, from Ilio Point to Kaa Gulch, along the northwestern coast of Molokai. This

unit is occupied by the plant *Marsilea villosa* and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 2 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Kahoolawe—Coastal—Unit 3 consists of 189 ac (76 ha) of State land from Laepaki to Honokanaia along the western coast of Kahoolawe. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). Although Kahoolawe—Coastal—Unit 3 is not known to be occupied by *Kanaloa kahoolawensis*, *Sesbania tomentosa*, or *Vigna o-wahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 3 consists of 794 ac (321 ha) of State land, and 3 ac (1 ha) of federally owned land (Kalaupapa National Historical Park), from Kahi Point to Wainene, along the north-central coast of Molokai. This unit is occupied by the plants *Pittosporum halophilum*, *Schenkia sebaeoides*, and *Tetramolopium rockii*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 3 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Marsilea villosa*, *Peucedanum sandwicense*, or *Sesbania tomentosa*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Kahoolawe—Lowland Dry—Unit 1 consists of 1,220 ac (494 ha) of State land, north of Waihonu Gulch on west Kahoolawe. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Kahoolawe—Lowland Dry—Unit 1 is not known to be occupied by *Gouania hillebrandii*, *Hibiscus brackenridgei*, *Kanaloa kahoolawensis*, *Neraudia sericea*, *Sesbania tomentosa*, or *Vigna owahuensis*, we have determined this area to be essential for the conservation and recovery of these lowland dry

species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 4 consists of 10 ac (4 ha) on Mokapu Island on the northern coast of Molokai. This area is State-owned, and is classified as a State Seabird Sanctuary. This unit is occupied by the plants *Peucedanum sandwicense* and *Pittosporum halophilum*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 4 is not known to be occupied by *Bidens wiebkii*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Marsilea villosa*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Kahoolawe—Lowland Dry—Unit 2 consists of 3,205 ac (1,297 ha) of State land from Lua o Kealialuna to Puu o Moaulaiki and Luamakika on the eastern side of Kahoolawe. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Kahoolawe—Lowland Dry—Unit 2 is not known to be occupied by *Gouania hillebrandii*, *Hibiscus brackenridgei*, *Kanaloa kahoolawensis*, *Neraudia sericea*, *Sesbania tomentosa*, or *Vigna o-wahuensis*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 5 consists of 1 ac (0.5 ha) on Huelo islet on the northern coast of Molokai. This area is State-owned, and is classified as a State Seabird Sanctuary. This unit is occupied by the plants *Brighamia rockii*, *Peucedanum sandwicense*, and *Pittosporum halophilum*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 5 is not known to be occupied by *Bidens wiebkii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Marsilea villosa*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 6 consists of 190 ac (77 ha) of State land, and 1,685 ac (682 ha) of privately owned land, from Kaholaiki Bay to Halawa Bay, on the northeastern coast of Molokai. This unit is occupied by the plants *Bidens wiebkei*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, and *Ischaemum byrone*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 6 is not known to be occupied by *Brighamia rockii*, *Hibiscus brackenridgei*, *Marsilea villosa*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 7 consists of 49 ac (20 ha) of privately owned land from Alanuihipaka Ridge to Kalanikaula, on the northeastern coast of Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). Although Molokai—Coastal—Unit 7 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Marsilea villosa*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Dry—Unit 1 consists of 24 ac (10 ha) of privately owned land, in a small gulch northwest of Mahana, in west-central Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Molokai—Lowland Dry—Unit 1 is not known to be occupied by *Bonamia menziesii*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Hibiscus brackenridgei*, *Kokia cookei*, or *Sesbania tomentosa*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 9 consists of 170 ac (69 ha) of State land and 0.3 ac (0.1 ha) of privately owned land, from Poelua Bay to Mokolea Point on the northwestern coast of west Maui. This unit is occupied by the plants *Schenkia sebaeoides* and *Sesbania tomentosa*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these

species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Coastal—Unit 9 is not known to be occupied by *Brighamia rockii*, we have determined this area to be essential for the conservation and recovery of this coastal species because it provides the PCEs necessary for the reestablishment of wild populations within its historical range. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could approach recovery.

Molokai—Lowland Dry—Unit 2 consists of 589 ac (238 ha) of State land at Kamiloloa on the southern slopes of Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Molokai—Lowland Dry—Unit 2 is not known to be occupied by *Bonamia menziesii*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Hibiscus brackenridgei*, *Kokia cookei*, or *Sesbania tomentosa*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 10 consists of 147 ac (60 ha) of State land and 26 ac (10 ha) of privately owned land, from Kahakuloa Head to Waihee Point on the northeastern coast of west Maui. This unit is occupied by the plant *Schenkia sebaeoides*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Coastal—Unit 10 is not known to be occupied by *Brighamia rockii* or *Sesbania tomentosa*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within its historical range. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could approach recovery.

Molokai—Lowland Mesic—Unit 1 (and) *Palmeria dolei*—Unit 37—Lowland Mesic (and) *Pseudonestor xanthophrys*—Unit 37—Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Ctenitis squamigera*, *Cyanea dunbariae*, *C. mannii*, *C. profuga*, *Cyperus fauriei*, *Cyrtandra filipes*, *Gouania hillebrandii*, *Labordia triflora*, *Neraudia sericea*, *Santalum haleakalae* var. *lanaiense*, *Schiedea lydgatei*, *S. sarmentosa*, *Silene alexandri*, *S. lanceolata*, *Spermolepis hawaiiensis*, and *Zanthoxylum hawaiiense*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Lowland Mesic—Unit 1 is not known to be occupied by *Asplenium dielirectum*, *Bonamia menziesii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea procera*, *C. solanacea*, *Diplazium molokaiense*,

Festuca molokaiensis, *Flueggea neowawraea*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Melicope mucronulata*, *M. munroi*, *M. reflexa*, *Phyllostegia haliakalae*, *P. mannii*, *P. pilosa*, *Sesbania tomentosa*, *Stenogyne bifida*, or *Vigna o-wahuensis*, or the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 11 consists of 6 ac (3 ha) of State land on Mokeehia Island on the northeastern coast of west Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). Although Maui—Coastal—Unit 11 is not currently occupied by *Brighamia rockii*, *Schenkia sebaeoides*, or *Sesbania tomentosa*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 1 consists of 11,465 ac (4,640 ha) of State land, 2,069 ac (837 ha) of federally owned land, and 3 ac (1 ha) of privately owned land, from Kanaio to Kahualau Gulch on the southern slopes of east Maui. This unit is occupied by the plants *Bonamia menziesii*, *Cenchrus agrimonoides*, *Flueggea neowawraea*, *Melicope adscendens*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 1 is not known to be occupied by *Alectryon macrococcus*, *Bidens micrantha* ssp. *kalealaha*, *Canavalia pubescens*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Sesbania tomentosa*, *Solanum incompletum*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 2 consists of 1,851 ac (749 ha) of State land at Keokea on the southern slopes of east Maui. This unit is occupied by the plants *Bonamia menziesii*, *Canavalia pubescens*, and *Hibiscus brackenridgei*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 2 is not known to be occupied by *Alectryon macrococcus*, *Bidens micrantha* ssp. *kalealaha*, *Cenchrus agrimonoides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae*

var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 3 consists of 188 ac (76 ha) of privately owned land, at Keauhou on the southern slopes of east Maui. This unit is occupied by the plant *Canavalia pubescens*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 3 is not known to be occupied by *Bidens micrantha* ssp. *kalealaha*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 4 consists of 1,266 ac (512 ha) of State land (including the Department of Land and Natural Resources) at Ahihi-Kinau Natural Area Reserve on the southern slopes of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Maui—Lowland Dry—Unit 4 is not currently occupied by *Bidens micrantha* ssp. *kalealaha*, *Bonamia menziesii*, *Canavalia pubescens*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 5 consists of 3,615 ac (1,463 ha) of State land, and 43 ac (17 ha) of privately owned land, from Panaewa to Manawainui on the western and southern slopes of west Maui. This unit is occupied by the plants *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, *Cenchrus agrimonioides*, *Gouania hillebrandii*, *Kadua coriacea*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and *Tetramolopium capillare*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the

conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 5 is not known to be occupied by *Ctenitis squamigera*, *Cyanea obtusa*, *Hesperomannia arbuscula*, *Hibiscus brackenridgei*, *Lysimachia lydgatei*, *Neraudia sericea*, *Schiedea salicaria*, *Sesbania tomentosa*, or *T. remyi*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 6 consists of 3 ac (1 ha) of State land, and 237 ac (96 ha) of privately owned land, from Paleaahu Gulch to Puu Hona on the southern slopes of west Maui. This unit is occupied by the plants *Hibiscus brackenridgei* and *Schiedea salicaria*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 6 is not known to be occupied by *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, *Cenchrus agrimonoides*, *Ctenitis squamigera*, *Cyanea obtusa*, *Gouania hillebrandii*, *Hesperomannia arbuscula*, *Kadua coriacea*, *Lysimachia lydgatei*, *Neraudia sericea*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Spermolepis hawaiiensis*, *Tetramolopium capillare*, or *T. remyi*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat designation for *Sesbania tomentosa* includes 15 units totaling 1,332 acres on Oahu. The units are Oahu—Coastal—Unit 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15.

Oahu—Coastal—Unit 1 consists of 946 ac (383 ha) of State land, 11 ac (4 ha) of Federal land, and 2 ac (1 ha) of privately owned land in the coastal ecosystem along the northwestern coast of Oahu from Kaena Point east to Kauhao Pali and southeast to Keawaula. This unit is partially within Kaena Point State Park. It is occupied by *Sesbania tomentosa* and includes the mixed herbland and shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the coastal ecosystem. This unit also contains unoccupied habitat that is essential to the conservation of the species by providing the PCEs necessary for the expansion of the existing wild populations. Oahu—Coastal—Unit 2 consists of 12 ac (5 ha) in the coastal ecosystem on Mokuauia, an islet east of Kalanai Point on the northeastern coast of Oahu. This unit is State-owned and is classified as a State Seabird Sanctuary. It includes the mixed herbland and shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the coastal ecosystem. Although this unit is not known to be occupied by *Sesbania tomentosa*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Coastal—Unit 3 consists of 15 ac (6 ha) in

the coastal ecosystem, on the larger of two islets (Moku Manu) off the windward coast of Oahu near Mokapu Peninsula. This unit is Stateowned, classified as a State Seabird Sanctuary, and includes the mixed herbland and shrubland, the moisture regime, and subcanopy and understory native plant species identified as PCEs in the coastal ecosystem. Although this unit is not known to be occupied by *Sesbania tomentosa*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Coastal—Unit 4 consists of 3 ac (1 ha) in the coastal ecosystem, the smaller of two islets (Moku Manu) off the windward coast of Oahu near Mokapu Peninsula. This unit is Stateowned, classified as a State Seabird Sanctuary, and includes the mixed herbland and shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the coastal ecosystem. Although this unit is not known to be occupied by *Sesbania tomentosa*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Coastal—Unit 5 consists of 12 ac (5 ha) in the coastal ecosystem, the larger of two islands (Mokulua Islands) off the windward coast of Oahu near Wailea Point. This unit is State-owned, classified as a State Seabird Sanctuary, and includes the mixed herbland and shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the coastal ecosystem. Although this unit is not known to be occupied by *Sesbania tomentosa*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Coastal—Unit 6 consists of 9 ac (4 ha) in the coastal ecosystem, on the smaller of two islands (Mokulua Islands) off the windward coast of Oahu near Wailea Point. This unit is Stateowned, classified as a State Seabird Sanctuary, and includes the mixed herbland and shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the coastal ecosystem. Although this unit is not known to be occupied by *Sesbania tomentosa*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Coastal—Unit 7 consists of 67 ac (27 ha) in the coastal ecosystem, on the larger of two islands (Manana Island) off the windward coast of Oahu near Makapuu Point. This unit is Stateowned, classified as a State Seabird Sanctuary, and includes the mixed herbland and shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the coastal ecosystem. Although this unit is not known to be occupied by *Sesbania tomentosa*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Coastal—Unit 8 consists of 10 ac (4 ha) in the coastal ecosystem, on the smaller of two islands (Kaohikaipu Island) off the windward coast of Oahu near Makapuu Point. This unit is Stateowned, classified as a State Seabird Sanctuary, and includes the mixed herbland and shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the coastal ecosystem. This unit is occupied by *Sesbania tomentosa* and contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Oahu—Coastal—Unit 9 consists of 80 ac (33 ha) of State land in the coastal ecosystem on the leeward side of Makapuu Point (Puuokipahulu). Although this unit is not known to be occupied by *Sesbania tomentosa*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Coastal—Unit 10 consists of 74 ac (30 ha) in the coastal ecosystem, owned by the City and County of Honolulu at Halona Point on the leeward side of Koko Crater, extending from Sandy Beach to Kahauloa. Although this unit is not known to be occupied by *Sesbania tomentosa*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Coastal—Unit 11 consists of 20 ac (8 ha) of privately owned land in the coastal ecosystem, at Ihiihilauakea on Koko Head (Kaihuokapuaa). Although this unit is not known to be occupied by *Sesbania tomentosa*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Coastal—Unit 13 consists of 19 ac (8 ha) of City and County land, 1 ac (0.5 ha) of State land, and 3 ac (1 ha) of privately owned land in the coastal ecosystem at Kalaeloa. Although this unit is not known to be occupied by *Sesbania tomentosa*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Coastal—Unit 14 consists of 2 ac (1 ha) of City and County of Honolulu land, and 2 ac (1 ha) of Federal land (U.S. Coast Guard) in the coastal ecosystem at Kalaeloa. Although this unit is not known to be occupied by *Sesbania tomentosa*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Coastal—Unit 15 consists of 9 ac (4 ha) of State land, 2 ac (1 ha) of privately owned land, and 21 ac (9 ha) of Federal (Pearl Harbor NWR) land at Kalaeloa. Although this unit is not known to be occupied by *Sesbania tomentosa*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires

suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

The critical habitat designation for *Sesbania tomentosa* includes two units totaling 3,185 acres in Hawaii County, Hawaii. The units are Hawaii 20—*Sesbania tomentosa*—a and Hawaii 23—*Sesbania tomentosa*—b. Both units are occupied by this species. Each unit is essential to the conservation of *S. tomentosa* because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. Each unit is geographically separated from other critical habitat for this multiisland species within its historical range in order to reduce the likelihood of all recovery populations being destroyed by one naturally occurring catastrophic event.

Hawaii 20—*Sesbania tomentosa*—a [486 ha (1,201 ac)]: This unit contains the area inland of Waiwelawela Point, all of Halemaoli Point and it lies entirely in the Pahala watershed. The unit also lies completely within HVNP; provides habitat for 1 population of 300 individuals; and is currently occupied by 10 to 15 individuals. This unit provides the southernmost critical habitat within the species' historical range.

Hawaii 23—*Sesbania tomentosa*—b [803 ha (1,984 ac)]: This unit contains Kipuka Nene, is entirely in the Kapapala watershed, and lies completely within HVNP. The unit provides habitat for 1 population of 300 individuals of *S. tomentosa*; and is currently occupied by 50 to 65 individuals. This unit provides the easternmost critical habitat within the species' historical range.

The critical habitat designation for *Sesbania tomentosa* includes two units totaling 217 acres on the islands of Nihoa and Necker. The units are Nihoa 4—*Sesbania tomentosa* and Necker 1—*Sesbania tomentosa*.

Nihoa 4—*Sesbania tomentosa*: This unit is critical habitat for *Sesbania tomentosa* and is 69 ha (171 ac) on federally owned land. It includes the entire island, which is part of the HINWR. The unit contains habitat essential to the conservation of 300 mature, reproducing individuals of this short-lived perennial and contains one island-wide population of at least 1,000 individuals. The habitat features contained in this unit that are essential for this species include, but are not limited to, shallow sandy soils on beaches and dunes in *Chenopodium oahuense* coastal dry shrubland that contain one or more of the following associated native plant species: *Pritchardia remota*, *Scaevola sericea*, *Sida fallax*, and *Solanum nelsonii*. This critical habitat unit is essential to the conservation of the species because it supports extant colonies of *Sesbania tomentosa* and is also geographically separated from designated critical habitat on other islands to avoid destruction by one naturally occurring catastrophic event.

Necker 1—*Sesbania tomentosa*: This unit is critical habitat for *Sesbania tomentosa* and is 19 ha (46 ac) on federally owned land. It includes the entire island, which is part of the HINWR. The unit contains Annexation and Summit Hills, is occupied by one population of undetermined size, and provides habitat that is essential for the conservation of up to one population of 300 mature, reproducing individuals of this short-lived perennial species. The habitat features contained in this unit that are essential for this species include, but are not limited to, shallow sandy soils on beaches and dunes in *Chenopodium oahuense* coastal dry shrubland that contain one or more of the following associated native plant species: *Sida fallax*, *Scaevola sericea*, *Solanum nelsonii*, and *Pritchardia remota*. This unit is essential to the conservation of *Sesbania tomentosa* because it

supports the only extant colony of the species on Necker. This unit also includes habitat that is important for the expansion of the present population, which is currently considered not viable. This unit is located at the westernmost range of this multi-island species and is geographically separated from designated critical habitat on other islands to avoid destruction by one naturally occurring catastrophic event.

The critical habitat designation for *Sesbania tomentosa* includes two units totaling 224 acres in Kauai County, Hawaii. The units are Kauai 8—*Sesbania tomentosa*—a and Kauai 14—*Sesbania tomentosa*—b.

Kauai 8—*Sesbania tomentosa*—a. This unit is critical habitat for *Sesbania tomentosa* and is 46 ha (115 ac) on private land, containing Pao Point and Naake Cape. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Sesbania tomentosa* and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is important to the establishment of additional populations on Kauai in order to reach recovery goals. It provides habitat for the westernmost range of the species. The habitat features contained in this unit that are essential for this species include, but are not limited to, sandy beaches, dunes, or pond margins in coastal dry shrublands or mixed coastal dry cliffs. This unit provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Kauai 14—*Sesbania tomentosa*—b This unit is critical habitat for *Sesbania tomentosa* and is 44 ha (109 ac) on State land (Polihale State Park). This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Sesbania tomentosa* and is currently occupied with 11 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. It provides habitat for the westernmost range of the species. The habitat features contained in this unit that are essential for this species include, but are not limited to, sandy beaches, dunes, or pond margins in coastal dry shrublands or mixed coastal dry cliffs. This unit provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Sesbania tomentosa* critical habitat consists of three components. Coastal (west Maui, Lanai, Molokai and Kahoolawe), Lowland dry (east Maui, west Maui, Lanai, Molokai and Lanai) and Lowland mesic (Molokai) (81 FR 17790-18110):

Ecosystem: Coastal. Elevation: <980 ft (<300 m). Annual precipitation: <20 in (<50 cm). Substrate: Well-drained, calcareous, talus slopes; dunes; weathered clay soils; ephemeral pools; mudflats. Canopy: Hibiscus, Myoporum, Santalum, Scaevola. Subcanopy: Gossypium, Sida, Vitex. Understory: Eragrostis, Jacquemontia, Lyceum, Nama, Sesuvium, Sporobolus, Vigna.

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: Diospyros, Myoporum, Pleomele, Santalum. Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Sicyos.

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Within these units, the physical and biological features of critical habitat are:

- (i) Elevation: Less than 980 ft (300 m).
- (ii) Annual precipitation: Less than 20 in (50 cm).
- (iii) Substrate: Well-drained, calcareous, talus slopes; weathered clay soils; ephemeral pools; mudflats.
- (iv) Canopy: Hibiscus, Myoporum, Santalum, Scaevola.
- (v) Subcanopy: Gossypium, Sida, Vitex.
- (vi) Understory: Eragrostis, Jacquemontia, Lyceum, Nama, Sesuvium, Sporobolus, Vigna.

Habitat features that are essential for this species include, but are not limited to, dry *Metrosideros polymorpha* forest with mixed native grasses, *Scaevola taccada* coastal dry shrubland on windswept slopes, and weathered basaltic slopes.

On Nihoa and Necker, the currently known primary constituent elements of critical habitat for *Sesbania tomentosa* include, but are not limited to, habitat components provided by:

- (1) Shallow soil on sandy beaches and dunes in *Chenopodium oahuense* coastal dry shrubland or mixed coastal dry cliffs and containing one or more of the following associated native plant species: *Pritchardia remota*, *Scaevola sericea*, *Sida fallax*, or *Solanum nelsonii*; and
- (2) Elevations between sea level and 84 m (0 and 276 ft).

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

- (i) Sandy beaches, dunes, or pond margins in coastal dry shrublands or mixed coastal dry cliffs, and containing one or more of the following associated native plant species: *Chamaesyce celastroides*, *Cuscuta sandwichiana*, *Dodonaea viscosa*, *Heteropogon contortus*, *Myoporum sandwicense*, *Nama sandwicensis*, *Scaevola sericea*, *Sida fallax*, *Sporobolus virginicus*, *Vitex rotundifolia*, or *Waltheria indica*; and

(ii) Elevations between 0 and 130 m (0 and 427 ft).

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into

native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkii*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

All critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required during nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat posed by fire to 25 of the designated ecosystem critical habitat units in particular: Oahu—Coastal—Unit 1, 9, 10, 11, 12, 13, 14, 15.

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for these species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Although this unit is not known to be occupied by *Sesbania tomentosa*, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

The following management actions are ranked in order of importance: (1) Nonnative plant control; (2) Rodent control; (3) Invertebrate pest control; (4) Fire control; (5) Maintenance of genetic material of the endangered plant species; (6) Propagation, reintroduction, and/or augmentation of existing populations into areas deemed essential for the recovery of the species; (7) Ongoing management of the wild, outplanted, and augmented populations; (8) Maintenance of natural pollinators and pollinating systems, when known; (9) Habitat management and restoration in areas deemed essential for the recovery of the species; (10) Monitoring of the wild, outplanted, and augmented populations; (11) Rare plant surveys; and (12) Control of human activities/ access.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 2015)

Lifespan

Adult: < 10 years (USFWS, 2015)

Breeding Season

Adult: Winter - spring (USFWS, 1999)

Key Resources Needed for Breeding

Adult: Insect pollinators, especially *Hylaeus* spp. (USFWS, 2015 and 2010); winter-spring rains (USFWS, 1999)

Reproduction Narrative

Adult: It is a short-lived perennial (fewer than 10 years). Pollination studies for *S. tomentosa* at Kipuka Nene determined that six insect species were floral visitors, and native *Hylaeus* (yellow-faced bees) and *Apis mellifera* honeybees were found to be transporting pollen of the rare plant (Pratt et al. 2011). The remaining four species participated in less than 10 percent of all floral visits and they include the nonnative *Linepithema humile* (Argentine ant), *Plagiolepis alluaudi* (little yellow ant), nonnative *Conocephalus saltator* (longhorned grasshopper), and *Lampides boeticus* (bean butterfly) (USFWS, 2015). Flowering at Kaena Point is highest during the winter-spring rains, and gradually declines throughout the rest of the year (D. Hopper, in lift. 1996) (USFWS, 1999). Studies of *Sesbania tomentosa* individuals at Kaena Point on Oahu revealed that *Hylaeus* species are the primary pollinators (USFWS, 2010).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Coastal dry shrublands and grasslands, ohia forest, mixed coastal dry cliff (USFWS, 1999); calcareous beach (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits dry shrublands or (rarely) dry forests. Often coastal, less often inland. Found on calcareous beaches and sand dunes, rocky ridges and slopes, deep red soil, and on soil pockets on lava; basaltic and calcareous substrates (NatureServe, 2015). *Sesbania tomentosa* is found on sandy beaches, dunes, soil pockets on lava, and along pond margins (Geesink et al. 1990). It commonly occurs in coastal dry shrublands and grasslands, but is also known from open ohia forests and Mixed Coastal Dry Cliffs (HINHP 1995) (USFWS, 1999). Research suggests that *S. tomentosa* forms beneficial associations with mycorrhizal fungus when the plant is growing in soils with low phosphorus levels (Gemma et al. 2002) (USFWS, 2010).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Stable (USFWS, 2015)

Resiliency:

Moderate (inferred from USFWS, 2015; see current range/distribution)

Redundancy:

Moderate (inferred from USFWS, 2010)

Number of Populations:

~20 (USFWS, 2010)

Population Size:

> 1,600 - 2,700 (USFWS, 2015)

Population Narrative:

There are > 1,600 to 2,700 wild individuals and approximately 475 outplanted individuals. The number of individuals has remained stable (USFWS, 2015). There are approximately 20 populations (USFWS, 2010).

Threats and Stressors

Stressor: Overutilization (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: *Sesbania tomentosa* that originated from natural populations, but is now grown from seed or vegetative propagules produced in nurseries, is available for sale by multiple nurseries and home improvement stores only within the State of Hawaii. Thus, a USFWS interstate permit under section 10(a)(1)(A) of the Endangered Species Act of 1973, as amended, is not required (USFWS, 2015).

Stressor: Predation (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Herbivory by slugs have been reported as a new threat to this species on Molokai (PEPP 2014). Rats and mice, twig borers, scales, aphids, gray bird grasshopper (*Schistocerca nitens*), black ants (USFWS, 2015).

Stressor: Habitat loss and degradation (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Ungulate herbivory, invasive plants, hiking and trail maintenance, off-road vehicles, agricultural and urban development (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high-resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *S. tomentosa* is moderately vulnerable to the impacts of climate change (USFWS, 2015).

Stressor: Loss of pollinators (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Lack of adequate pollination (USFWS, 2010).

Recovery

Reclassification Criteria:

1. A total of five to seven populations should be documented on islands where it now occurs or occurred historically (USFWS, 1999).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 1999).
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1999).

Delisting Criteria:

1. A total of 8 to 10 populations should be documented on islands where it now occurs or occurred historically (USFWS, 1999).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 1999).
3. Each population should persist at this level for a minimum of five consecutive years (USFWS, 1999).

Recovery Actions:

- Protect habitat and control threats (USFWS, 1999).
- Expand existing wild populations (USFWS, 1999).
- Conduct essential research (USFWS, 1999).
- Develop and maintain monitoring plans (USFWS, 1999).
- Reestablish wild populations within the historic range (USFWS, 1999).
- Validate and revise recovery criteria (USFWS, 1999).
- Find the reasons for poor reproductive success (USFWS, 1999).
- Construct exclosures to protect populations against feral and wild ungulates (cattle, goats, and axis deer) (USFWS, 1999).

- Control competing alien plant species (USFWS, 1999).
- Protect endangered plants from fire (USFWS, 1999).
- Construct devices to protect populations against off-road vehicular traffic (USFWS, 1999).
- Maintain adequate genetic stock (USFWS, 1999).
- Enhance wild populations and establish new populations (USFWS, 1999).

Conservation Measures and Best Management Practices:

- Surveys / inventories – Survey geographical and historical range for a current assessment of the species' status (USFWS, 2015).
- Captive propagation for genetic storage and reintroduction: Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change (USFWS, 2015).
- Ungulate monitoring and control – Maintain existing exclosures and monitor for potential incursions (USFWS, 2015).
- Invasive plant monitoring and control – Eradicate invasive introduced plants within ungulate exclosures and maintain exclosures free of invasive plants (USFWS, 2015).
- Population viability monitoring and analysis – Continue monitoring wild and reintroduced individuals (USFWS, 2015).
- Fire monitoring and control – Develop and implement a fire management plan at the existing exclosure (USFWS, 2015).
- Climate change adaptation strategy – Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change (USFWS, 2015).
- Alliance and partnership development – Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2015).

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SPECIES ACCOUNT: *Sibara filifolia* (Santa Cruz Island rockcress)

Species Taxonomic and Listing Information

Listing Status: Endangered; 9/8/1997; Pacific Southwest (R8)

Physical Description

An annual herb, usually with a single, slender, branching stem, 1.5-3 dm tall. Leaves are finely divided into many linear lobes. Flowers (March-May) have pink or purple, spoon-shaped petals. Fruit is a long slender pod. (NatureServe, 2015)

Taxonomy

Sibara filifolia (E. Greene) was first collected by Greene in 1886 and described as *Cardamine filifolia* (Greene 1887a, p. 30). Greene later transferred it to *Arabis filifolia* (1887b, p. 390). In 1896, Greene proposed the new genus *Sibara* to accommodate the species (Greene 1896, pp. 10–12). *Sibara filifolia* has been maintained by all subsequent floristic and systematic treatments (Munz 1974, pp. 300–301; Rollins 1993, pp. 435–436; Al-Shehbaz 2012, p. 562). There have been no changes in the nomenclature or taxonomic classification of *Sibara filifolia* since it was listed (USFWS, 2012).

Historical Range

See current range/distribution.

Current Range

California endemic, currently known only from San Clemente Island (possibly still be extant on Santa Catalina Island, although not seen there since 1973); formerly collected on distant Santa Cruz Island, so thought to have been more widespread in the past (USFWS 1997). (NatureServe, 2015)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Self-pollination (USFWS, 2012)

Breeding Season

Adult: Flowers in April (USFWS, 2012)

Reproduction Narrative

Adult: *Sibara filifolia* (Santa Cruz Island rock-cress) is a diminutive and slender annual herb in the Brassicaceae (mustard family) that flowers in April (Munz 1974, pp. 300–301). It is 13 to 38 centimeters (cm) (5 to 15 inches (in)) tall. The flowers are bisexual and are borne in small terminal unbranched flower stalks called racemes. Based on greenhouse observations, it appears that *Sibara filifolia* is self-compatible and capable of self-pollination or is possibly

apomictic (capable of producing seeds without pollination) (Wall, pers. comm., 2006; K. Helenurm, University of South Dakota, pers. comm., 2006). Under natural conditions, plants typically produce 2 to 10 fruits (Helenurm, pers. comm., 2006). Seed dispersal appears to be by gravity, with many seeds likely tumbling or washing downhill (Helenurm 2003, p. 184). Past germination trials at Rancho Santa Ana Botanic Garden have proven successful by simply placing *S. filifolia* seeds in the soil (Wall, pers. comm., 2006). As discussed in the 2006 5-year review, previous studies investigating the tolerance of *S. filifolia* seed to smoke and fire suggested that the plant is not well-adapted to fire (C. Ames, Rancho Santa Ana Botanic Garden, pers. comm., 2006; Wall, pers. comm., 2006). (USFWS, 2012).

Habitat Type

Adult: Volcanic scree (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (NatureServe, 2015)

Site Fidelity

Adult: High (NatureServe, 2015)

Habitat Narrative

Adult: Species is currently known only from south-facing, sunny, volcanic scree but historical populations were apparently found in shady places (NatureServe, 2015).

Dispersal/Migration**Dispersal**

Adult: Low (USFWS, 2012)

Dispersal/Migration Narrative

Adult: Seed dispersal appears to be by gravity, with many seeds likely tumbling or washing downhill (Helenurm 2003, p. 184). Past germination trials at Rancho Santa Ana Botanic Garden have proven successful by simply placing *S. filifolia* seeds in the soil (Wall, pers. comm., 2006). As discussed in the 2006 5-year review, previous studies investigating the tolerance of *S. filifolia* seed to smoke and fire suggested that the plant is not well-adapted to fire (C. Ames, Rancho Santa Ana Botanic Garden, pers. comm., 2006; Wall, pers. comm., 2006) (USFWS, 2012).

Population Information and Trends**Population Trends:**

Decreasing (NatureServe, 2015)

Resiliency:

Low (NatureServe, 2015)

Representation:

Low (NatureServe, 2015)

Redundancy:

Low (NatureServe, 2015)

Population Growth Rate:

The taxon was only known from the Channel Islands, but is believed to be extirpated from at least one. Proper management may increase suitable habitat for this taxon. Decline of >70% (NatureServe, 2015)

Population Narrative:

The taxon was only known from the Channel Islands, but is believed to be extirpated from at least one. Proper management may increase suitable habitat for this taxon. Decline of >70% (NatureServe, 2015)

Threats and Stressors

Stressor: Nonnative plants (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Invasive nonnative plants represent a significant, ongoing, rangewide threat to *Sibara filifolia*. Vectors for their dispersal into habitat occupied by *S. filifolia* can include vehicles, humans, and other animals. Increased fire frequency, associated with nonnative plants, can also produce type conversion from shrub-dominated landscapes to those occupied by mainly invasive, nonnative, annual grasses. Nonnative invasive plant removal activities are being implemented on both islands where *S. filifolia* is known to be extant. The implementation and effectiveness of such programs may be limited to currently monitored occurrences (Wild Boar Gully (EO 7) on Santa Catalina Island), where site-specific monitoring and treatment actions are identified and implemented. The implementation is absent and effectiveness unknown for nonnative plant control at point localities associated with the occurrence at Pyramid Point (EO 2) on San Clemente Island; this area is closed due to the presence of UXO. The long-term threat to habitat occupied by *S. filifolia* may be significantly reduced if sources of invasive plant propagules and vectors that facilitate their spread are reduced or eliminated. Impacts of invasive nonnative plants on *S. filifolia* habitat will continue at significant levels in areas where these elements are not controlled (USFWS, 2012).

Stressor: Fire (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: In summary, fire remains an ongoing threat to *Sibara filifolia* habitat on Santa Catalina and San Clemente Islands. The vulnerability results from small populations and potential type conversion of habitat resulting from fire, particularly the invasion of nonnative invasive annual grasses. Fires on San Clemente and Santa Catalina Islands occur frequently and fire prevention

measures and invasive plant control are necessary for the protection of *S. filifolia* habitat. Control of invasive nonnative grasses is necessary on Santa Catalina Island to prevent adverse fuel conditions that might impact *S. filifolia* habitat and seed bank. The FMP developed for San Clemente Island has identified measures to minimize the risk of fires spreading from the impact areas to adjoining habitat where *S. filifolia* may occur; however, lack of access will likely limit or preclude site specific management actions, fire response measures, and post-fire assessments (USFWS, 2012).

Stressor: Erosion (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Erosion from training exercises on the island has resulted in the past. The likely extent of erosion has recently been evaluated for off-road Assault Vehicle Maneuver Areas, Artillery Firing Points, Artillery Maneuvering Points, and Infantry Operations Area (Navy 2008a, pp. G-1, G-2). The Navy has proposed an erosion control plan that would consider a variety of erosion control methods to promote sustainable land use in support of military operations in these areas) (Navy 2008a, p. G-22); however, there is no approved off-highway vehicle use until this plan comes into effect (Munson, pers. comm., 2011a). The erosion control projects developed in this plan will be implemented in ways that best avoid threatened and endangered species (Munson, pers. comm., 2011a). Erosion impacts to *Sibara filifolia* habitat do not appear to be significant at this time (USFWS, 2012).

Stressor: Trampling (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Although trampling of native vegetation was not discussed directly as a threat in the listing rule, it was described relative to grazing of large mammalian herbivores, which together have facilitated the spread of nonnative plants on the Channel Islands (USFWS 1997a, p. 42693). The threat of trampling from large mammalian herbivores has been reduced since listing due to the removal of goats and pigs from Santa Catalina Island and San Clemente Island. The fencing surrounding Wild Boar Gully (EO 7) on Santa Catalina Island has also substantially reduced this threat. At present, the potential threat of trampling from large grazing animals (blackbuck antelope (*Antelope cervicapra*), mule deer (*Odocoileus hemionus*), and American bison (*Bison bison*)) only exists near Cape Canyon (EO 6) (Appendix 1). *Sibara filifolia* is at risk from human trampling due to the small size of the populations, although human access is regulated on each of the Channel Islands. Due to its cryptic appearance, this may result from biologists surveying or otherwise conducting management activities on the islands (Kellogg, pers. comm., 2006). On Santa Catalina Island, work crews removing invasive plant species likely represent the primary threat, as the area where the plant occurs is fenced with restricted public access. On San Clemente Island, the potential threat of trampling can result from biologists' activities as well as any military training activities that could involve troop movements through the area where the plant is distributed. The Navy proposed to brief military units on maneuver area boundaries prior to conducting operations to minimize the potential of incidental foot traffic in *S. filifolia* habitat; the use of markers to aid in identification of range boundaries or sensitive areas is considered incompatible with training (USFWS 2008, p. 140). The potential for human traffic is high, because the plant is distributed on ridgetops and flat areas rather than within inaccessible steep terrain,

(Kellogg, pers. comm., 2006). However, the incidence of impacts to *S. filifolia* is expected to be very low (USFWS, 2012).

Stressor: Small population size (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of genetic variability/extinction

Narrative: The listing rule discussed the vulnerabilities associated with few occurrences of small population sizes for *Sibara filifolia* (USFWS 1997a, p. 42699). *Sibara filifolia* is vulnerable to extirpation from a number of factors such as environmental stochasticity, genetic stochasticity, demographic stochasticity, and natural catastrophes, because it is an insular endemic species presumed to currently exist as three small, narrowly distributed occurrences (Shaffer 1981, p. 131). Small population size may be the result of several conditions, including local extirpations or ongoing natural or artificial factors limiting establishment and survival of the taxon. Stochastic events represent a significant threat to small occurrences. Given the extremely restricted distribution of this species, any natural catastrophe such as a fire, landslide, or prolonged drought on an island could lead to the extirpation of the species from one of the two islands currently known to support the species. On San Clemente Island, the known extant occurrence (EO 2) of *Sibara filifolia* could be affected by a single fire. The Santa Catalina Island occurrences (EOs 6, and 7) are also closely spaced and likely to be similarly affected by a single catastrophic event. However, the presence of *S. filifolia* on separate islands improves the prospects for continued survival of the species in the event of a natural catastrophe. The likelihood of maintaining genetic diversity decreases in smaller populations (Barrett and Kohn 1991, pp. 9, 10, and 13) and elevates concern for small, isolated populations of *Sibara filifolia*. The low genetic diversity and low differentiation observed from San Clemente Island may indicate a bottleneck or potentially nearly complete selfing lineages, or both for this population (McGlaughlin, pers. comm., 2011). Loss of genetic variation could limit the likelihood of this species maintaining tolerances suited to a changing environment (Helenurm 2003, p. 185). In contrast, the observed genetic diversity found within the Santa Catalina Island indicates the importance of those populations for seed banking and other conservation activities. The risk of extinction of *Sibara filifolia* from elements inherent in its small insular population size is lessened by the conservation seed bank established at RSABG since the listing (Wall, pers. comm., 2006). While seed banking, by itself, does not remove the systematic or stochastic threats facing natural populations of *S. filifolia*, these seeds can provide source material to reestablish populations in the wild should they become extirpated (USFWS, 2012).

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Impacts to *Sibara filifolia* under predicted future climate change remain unclear. While it appears reasonable to assume that this taxon may be affected, we lack sufficient certainty on knowing how and when climate change will affect the species, the extent of average temperature increases in California, or potential changes to the level of threat posed by fire on the Channel Islands. While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to *S. filifolia* at this time (USFWS, 2012).

Recovery**Recovery Actions:**

- No recovery plan or outline has been prepared for *Sibara filifolia* (USFWS, 2012).

Conservation Measures and Best Management Practices:

- Based on recommendations and genetic diversity of occurrences, establish an adequate seed bank for *Sibara filifolia* with sampling emphasis on genetically highly diverse sites on Santa Catalina and a lesser emphasis on the less diverse sites on San Clemente Island (USFWS, 2012).
- Maintain and improve invasive nonnative plant control programs with a focus on sites where *Sibara filifolia* occurs or where habitat conditions may support reemergence of the species from a dormant seed bank (USFWS, 2012).
- Continue to collaborate with the Navy on ongoing projects to assist with conservation of listed species on the island to help facilitate effective management and monitoring of *Sibara filifolia* (USFWS, 2012).
- Determine soil and habitat preferences for *Sibara filifolia* and conduct additional surveys on all three islands where *S. filifolia* has been collected historically using this data to look for previously undetected occurrences as well as identify and characterize potential reintroduction sites (USFWS, 2012).

References

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SPECIES ACCOUNT: *Sicyos albus* (= *S. alba*) ('anunu)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

An annual(?) vine up to 20 m long, with black-spotted stems. Flowers and fruit are white. (NatureServe, 2015)

Taxonomy

Sicyos alba, a member of the gourd family (Cucurbitaceae), was first described by Harold St. John in 1978 as the segregate genus *Sarx*. The holotype specimen was collected in Kulani on Hawaii Island by Wayne Gagné in 1974 and is housed at Bishop Museum (Telford 1989). However, the first collection was made by the U.S. Exploring Expedition in 1840 and 1841. Telford (1989) transferred the species to the genus *Sicyos*, and indicated that the floral and vegetative morphology of *S. alba* was so close to that of *S. cucumerinus* that further studies were warranted regarding whether the two species were distinct. Wagner and Shannon (1999) summarized the nomenclatural situation for Hawaiian members of the genus (USFWS, 2012).

Current Range

Current range is in the Volcano region of Hawaii; also reported from Mauna Kea but needs verification. (NatureServe, 2015)

Critical Habitat Designated

Yes; 7/2/2003.

Legal Description

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Sicyos albus* on the island of Hawaii (68 FR 39623 - 39722).

Critical Habitat Designation

The critical habitat designation for *Sicyos albus* includes one unit totaling 15,483 acres in Hawaii County, Hawaii. The unit is Hawaii 30—*Sicyos alba*—a.

Hawaii 30—*Sicyos alba*—a [6,266 ha (15,483 ac)]: This unit contains Puu Makaala and is entirely in the Kaahakini watershed. This unit lies within HVNP, Puu Makaala Natural Area Reserve, and Olaa-Kilauea Partnership lands. The unit provides habitat for 10 populations of 300 mature, reproducing individuals of the *S. alba* and is currently occupied by 4 individuals. This unit is essential to the conservation of *S. alba* because it supports an extant colony of this islandendemic species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. This unit is of an appropriate size so that each potential recovery population within the unit is separated enough to avoid their destruction by one naturally occurring catastrophic event. Beyond the 10 populations provided for in this unit, no other critical habitat is designated for this species.

Primary Constituent Elements/Physical or Biological Features

Habitat features that are essential for this species include, but are not limited to, *Metrosideros polymorpha*-*Cibotium glaucum* dominated montane wet forests.

Special Management Considerations or Protections

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for this species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Habitat Type**

Adult: Montane wet forest (USFWS, 1998)

Habitat Narrative

Adult: Species grows on wet forests on gentle, old volcanic slopes. (NatureServe, 2015). *Sicyos alba* typically grows in ohia- and hapuu-dominated Montane Wet Forests, at elevations between 975 and 1,130 meters (3,200 to 3,720 feet). Associated taxa include hapuu, kawau, kanawao, haiwale, *Stenogyne* sp., kopiko, *Perrottetia sandwicensis* (olomea), olapa, hoio, and *Cyanea tritomantha* (haha) (HHP 1991j1 ; HPCC 1991h, 1993c; Telford 1990; M. Brueggemann, in lift., 1994) (USFWS, 1998).

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Decreasing (USFWS, 2012)

Resiliency:

Low (inferred from NatureServe, 2015; USFWS, 2012)

Representation:

Low (inferred from NatureServe, 2015; USFWS, 2012)

Redundancy:

Low (inferred from NatureServe, 2015; USFWS, 2012)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Since this species is annual, location varies from year to year. There may not be more than a few dozen individuals at any given time. Two current (between 1982 and 1997) and three historical occurrences. (NatureServe, 2015). USFWS (2012) notes 'Species status review [FY 2011 Recovery Data Call (August 2011)]: Decreasing '. In 2007, a single individual was observed in fruit at Puu Makaala Natural Reserve Area (Plant Extinction Prevention Program 2008). From 2007 and 2008, a total of five individuals were observed at two sites in the Koa Unit of Hawaii Volcanoes National Park (Plant Extinction Prevention Program 2008). In 2010, the Plant Extinction Prevention Program (2009) reported a total of only five wild individuals of *Sicyos alba* on Hawaii Island (USFWS, 2012). Low resiliency, representation and redundancy are inferred based on this species limited geographic range, specific habitat requirements and low number of known populations.

Threats and Stressors

Stressor: Feral pigs (USFWS, 1998)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Habitat damage by feral pigs is listed as a threat to this species (USFWS, 1998).

Stressor: Trail clearing (USFWS, 1998)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Trail clearing is listed as a threat to this species (USFWS, 1998).

Stressor: Non-native plants (USFWS, 1998)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Non-native plants are listed as a threat to this species (USFWS, 1998).

Stressor: Volcanic activity (USFWS, 1998)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Habitat change due to volcanic activity is listed as a threat to this species (USFWS, 1998).

Stressor: Stochastic events (USFWS, 1998)

Exposure:

Response:

Consequence: Extinction

Narrative: Risk of extinction from man-made or natural events is listed as a threat to this species (USFWS, 1998).

Stressor: Reduced vegetative vigor (USFWS, 1998)

Exposure:

Response:

Consequence: Extinction

Narrative: Reduced vegetative vigor due to the small number of existing individuals is listed as a threat to this species (USFWS, 1998).

Recovery

Reclassification Criteria:

For downlisting, a total of five to seven populations of *Sicyos alba* should be documented on the island of Hawaii. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 500 mature individuals per population. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 2012).

Delisting Criteria:

For delisting, a total of eight to ten populations of *Sicyos alba* should be documented on the island of Hawaii. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with 500 mature individuals per population. Each population should persist at this level for a minimum of five consecutive years before delisting is considered (USFWS, 2012).

Recovery Actions:

- Neither the reclassification or delisting criteria have been met (USFWS, 2012).

Conservation Measures and Best Management Practices:

- Captive propagation for genetic storage and reintroduction: o Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation. o Propagate the species ex situ in at least two or three separate venues (USFWS, 2012).
- Reintroduction / translocation site identification – Determine areas within the native range of the species that are most suitable for reintroduction purposes (USFWS, 2012).
- Reintroduction / translocation implementation – Continue to reintroduce the species back into its known historical range (USFWS, 2012).
- Ungulate exclosure – Continue to construct fenced exclosures around all existing wild and reintroduced populations and monitor the fences for any signs of breaching (USFWS, 2012).
- Ungulate control – Protect all populations against disturbances from feral pigs (USFWS, 2012).
- Ecosystem-altering invasive plant species control – Control invasive introduced plant species within exclosures and from areas immediately adjacent to all known populations (USFWS, 2012).

- Surveys / inventories – Resurvey the historical geographical range of the species for previously unknown populations or individuals (USFWS, 2012).
- Population biology research – Carry out field studies to hand pollinate individuals in the wild to enhance reproductive success of the species (USFWS, 2012).
- Site / area / habitat protection – Develop and implement effective measures to reduce the impacts of hiking and trail maintenance and lava flow (USFWS, 2012).
- Threats monitoring and control: o Monitor populations at least twice a year for evidence of fence breaching by feral pigs or other introduced vertebrate species. o Monitor reintroductions and wild populations twice a year for evidence of pests or diseases. o Alliance and partnership development – Work with the National Park Service, Hawaii Division of Forestry and Wildlife, and other land managers to continue implementation of ecosystem-level restoration and management to benefit this species. o Threats research – Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species.

References

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SPECIES ACCOUNT: *Sicyos lanceoloideus* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2016a)

Physical Description

A perennial vine. Stems are 49 ft. (15 m) long with a woody base. Leaves are broadly ovate and palmately 3- to 5- lobed. Inflorescences are branched, 3 to 8 in (8 to 20 cm) long, with white flowers. Fruit are green, up to 1 in (25 mm) long and beaked (Telford 1999, p. 581) (USFWS, 2015).

Taxonomy

A member of the gourd family (Cucurbitaceae) (USFWS, 2015). *Sicyos lanceoloideus* was called "Sicyos sp. A" in Wagner et al. (1990, Manual); see Supplement (1999, P. 1873). The name was published in Novon 9(3): 444, 1999, as *Sicyos lanceoloideus* (St. John) W.L. Wagner & D.R. Herbst (NatureServe, 2015).

Historical Range

Sicyos lanceoloideus was historically found on the islands of Kauai (Kalalau Valley and Waimea Canyon) and Oahu (Waianae Mountains) (Telford 1999, p. 581) (USFWS, 2015).

Current Range

Currently, *S. lanceoloideus* occurs on Kauai in the Na Pali-Kona FR, and on Oahu in the Waianae Mountains (USFWS, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available

Habitat Type

Adult: Terrestrial (USFWS, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Mesic forest (USFWS, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 1,800 - 2,700 ft. elevation (USFWS, 2015)

Habitat Narrative

Adult: *Sicyos lanceoloideus* occurs on ridges or spurs in mesic forest at 1,800 to 2,700 ft. (550 to 800 m), in the dry cliff (Oahu), lowland mesic (Oahu and Kauai), and montane mesic (Kauai) ecosystems (Telford p. 581; HBMP 2010; TNCH 2007) (USFWS, 2015).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Resiliency:

Low (inferred from USFWS, 2016b)

Redundancy:

Low (inferred from USFWS, 2016b)

Number of Populations:

8 (USFWS, 2016b)

Population Size:

Kauai: 4; Oahu: < 35 (USFWS, 2016b)

Population Narrative:

Currently, on Kauai, there are four individuals in three locations (Kishida 2015, in litt.). On Oahu, this species occurs in 5 locations in the Waianae Mountains totaling fewer than 35 individuals (HBMP 2010; U.S. Army 2014 database). Because this species is a vine, determining exact numbers is difficult (PEPP 2013, p. 189). In addition, occurrences and numbers vary widely as individuals have been observed to persist for fewer than 7 years (Sailer 2015, in litt.) (USFWS, 2016b).

Threats and Stressors

Stressor: Feral ungulates (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Feral pigs and goats modify and destroy the habitat of *Sicyos lanceoloideus* on Kauai and Oahu, with evidence of the activities of these animals reported in the areas where this species occurs (PEPP 2013, p. 189; PEPP 2014, p. 166; HBMP 2010) (USFWS, 2015).

Stressor: Nonnative plants (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Nonnative plants modify and destroy the native habitat of *S. lanceoloideus*, and displace this species and other native Hawaiian plants by competing for water, nutrients, light, and space, or they may produce chemicals that inhibit the growth of other plants (Smith 1985, pp. 180–250; Vitousek et al. 1987 in Cuddihy and Stone 1990, p. 74; HBMP 2010) (USFWS, 2015).

Stressor: Small population size/stochastic events (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Drought and fire are also reported to pose a threat to *S. lanceoloideus* (PEPP 2014, pp. 166; HBMP 2010). Owing to the small remaining number of individuals, this species may experience reduced reproductive vigor due to low levels of genetic variability, leading to diminished capacity to adapt to environmental changes, thereby lessening the probability of its long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361) (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Climate change may result in alteration of the environmental conditions and ecosystems that support this species. *Sicyos lanceoloideus* may be unable to tolerate or respond to changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini et al. 2013, p. 89) (USFWS, 2015).

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- Survey for populations of *Sicyos lanceoloideus* in areas of potentially suitable habitat (USFWS, 2014).
- Continue propagation efforts for maintenance of genetic stock (USFWS, 2014).
- Reintroduce individuals into suitable habitat within historical range that is being managed for additional known threats (e.g., nonnative animals and plants) to this species (USFWS, 2014).

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Endangered Status for 49 Species From the Hawaiian Islands

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USFWS. 2016b. Endangered and Threatened Wildlife and Plants

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USFWS. 2015. Endangered and Threatened Wildlife and Plants

USFWS 2014. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form. *Sicyos lanceoloideus*. Region 1 (Pacific Region).

SPECIES ACCOUNT: *Sicyos macrophyllus* (ʻanunu, Largeleaf bur-cucumber)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2016a)

Physical Description

Sicyos macrophyllus is a perennial vine with stems up to 49 feet (ft) (15 meters (m)) long and 1.6 inches (in) (4 centimeters (cm)) in diameter. Annual stems are sparsely pubescent with black spots. Leaves are broadly ovate with a narrow basal sinus and are deeply lobed. The upper leaf surface is glabrous while the lower surface is densely pubescent. Tendrils are twice branched. Flowers are either male or female, occur in pubescent panicles, and have a greenish yellow corolla. The fruit is round and green (Telford 1999, p. 578).

Taxonomy

Kingdom: Plantae; Phylum: Anthophyta; Class: Dicotyledoneae; Order: Violales; Family: Cucurbitaceae (Cucumbers). *Sicyos macrophyllus* was described by Asa Gray. This species is recognized as a distinct taxon in the Manual of Flowering Plants of Hawaii (Telford 1999, p. 578).

Historical Range

Historically, *Sicyos macrophyllus* was known from Puuwaawaa, Laupahoehoe, Puna, and South Kona on the island of Hawaii; and from Kipahulu Valley on the island of Maui there is only a single historic record from the eastern side of Haleakala (volcano) from 1919 (HBMP 2008; NatureServe 2007).

Current Range

Currently, this species occurs on the island of Hawaii at Puu Mali, Puuwaawaa (Puu Iki), Honaunau, Hakalau National Wildlife Refuge-Kona Unit, Kaohe, Kukuipope, Kipuka Maunaiu, Kipuka Ki, and Puu Huluhulu (HBMP 2008; L. Pratt, U.S.G.S. Biological Resources Discipline, pers. comm. 2008; K. Bio, Plant Extinction Prevention (PEP) Program, pers. comm. 2008).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Habitat Type

Adult: Moist and wet forests on old volcanic substrates; large portions of the species' range is now pastureland with native remnants where individuals of the species can still be found (NatureServe 2007).

Habitat Vegetation or Surface Water Classification

Adult: Forest-Hardwood, Forest/Woodland

Environmental Specificity

Adult: Unknown

Habitat Narrative

Adult: Typical habitat is wet *Metrosideros polymorpha* (ohia) forest and subalpine *Sophora chrysophylla*-*Myoporum sandwicense* (mamane-naio) forest on old volcanic substrates at elevations between 4,000 and 6,600 ft (1,200 and 2,000 m) (Hawaii Biodiversity and Mapping Program (HBMP) 2008; Telford 1999, p. 578). Large portions of the species' range is now pastureland with native remnants where individuals of the species can still be found (NatureServe 2007).

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Declining

Species Trends:

Unknown

Number of Populations:

10 populations

Population Size:

24-26 individuals

Population Narrative:

Sicyos macrophyllus is endemic to the islands of Hawaii and Maui, but currently known from 10 populations on Hawaii only, totaling between 24 and 26 individuals (HBMP 2008; L. Pratt, U.S.G.S. Biological Resources Discipline, pers. comm. 2008; K. Bio, Plant Extinction Prevention Program, pers. comm. 2008). It appears that a naturally occurring population at Kipuka Ki in Hawaii Volcanoes National Park is reproducing on its own by seeds, but seeds have not been successfully germinated under nursery conditions (HBMP 2008; L. Pratt, pers. comm. 2005). This species has been outplanted at several sites in Hawaii Volcanoes National Park and is persisting (Orlando 2015, in litt.). The individual on Maui has not been observed since 1987 (HBMP 2010) (USFWS, 2016b).

Threats and Stressors

Stressor: Habitat degradation and destruction: Feral pigs, mouflon sheep, and cattle

Exposure:

Response:

Consequence:

Narrative: *Sicyos macrophyllus* is threatened by feral pigs (*Sus scrofa*), mouflon sheep (*Ovis aries*), and feral cattle (*Bos taurus*) that degrade and destroy habitat (HBMP 2008; PEP Program 2008, p. 109). While rooting in the ground in search of the invertebrates and plant material they eat, feral pigs disturb and destroy vegetative cover, trample plants and seedlings, and threaten

forest regeneration by damaging seeds and seedlings. They disturb soil and cause erosion, especially on slopes. Alien plant seeds are dispersed on their hooves and coats as well as through their digestive tracts, and the disturbed soil is fertilized by their feces, helping these plants to establish. Pigs are a major vector in the spread of many introduced plant species (Smith 1985; Stone 1985; Medeiros et al. 1986; Scott et al. 1986; Tomich 1986; Cuddihy and Stone 1990; Wagner et al. 1999a). Sheep roam the upper elevation dry forests of Mauna Kea, Mauna Loa, and Hualalai (above 3,300 ft (1,000 m)), causing damage similar to that of goats (Stone 1985). Sheep have decimated vast areas of native forest and shrubland on Mauna Kea and continue to do so as a managed game species (Stone 1985; Cuddihy and Stone 1990). A survey conducted in 2004 of the Kahuku section of Hawaii Volcanoes National Park estimated that there were more than 2,500 sheep within the unit, and that without removals, the population doubling time would occur within 3 to 4 years (Hess et al. 2006). Cattle eat native vegetation, trample roots and seedlings, cause erosion, create disturbed areas into which alien plants invade, and spread seeds of alien plants in their feces and on their bodies. The forest in areas grazed by cattle becomes degraded to grassland pasture, and plant cover is reduced for many years following removal of cattle from an area. In addition, several alien grasses and legumes intentionally introduced for cattle forage have become invasive, noxious weeds that outcompete and replace native plants (Tomich 1986; Cuddihy and Stone 1990; Wagner et al. 1999a).

Stressor: Predation: Feral pigs, mouflon sheep, and cattle

Exposure:

Response:

Consequence:

Narrative: Predation by feral pigs, mouflon sheep, and cattle is a likely threat to *Sicyos macrophyllus* (HBMP 2008; Plant Extinction Prevention (PEP) Program 2008, p. 109). Evidence of browsing on and removal of *S. macrophyllus* by feral cattle has been observed at the population at Hakalau NWR-Kona Unit (PEP Program 2008, p. 109).

Stressor: Habitat degradation and competition: Nonnative plants

Exposure:

Response:

Consequence:

Narrative: *Sicyos macrophyllus* is threatened by alien plant species that degrade habitat and outcompete native plants (HBMP 2008; PEP Program 2008, p. 109). Competition may be for space, light, water, or nutrients, or there may be a chemical produced that inhibits growth of other plants (Smith 1985; Cuddihy and Stone 1990). In addition, nonnative pest plants found in habitat similar to that of this species have been shown to make the habitat less suitable for native species (Smathers and Gardner 1978; Smith 1985; Loope and Medeiros 1992; Medeiros et al. 1992; Ellshoff et al. 1995; Meyer and Florence 1996; Medeiros et al. 1997; Loope et al. 2004). In particular, alien pest plant species degrade habitat by modifying availability of light, altering soil water regimes, modifying nutrient cycling, or altering fire characteristics of native plant communities (Smith 1985; Cuddihy and Stone 1990; Vitousek et al. 1997). Because of demonstrated habitat modification and resource competition by nonnative plant species in habitat similar to the wet forest and subalpine forest habitat of *S. macrophyllus*, the Service believes nonnative plant species are a threat to this species.

Stressor: Stochastic events (USFWS, 2016b)

Exposure:

Response:**Consequence:**

Narrative: Stochastic events such as fire are also reported as a threat to *S. macrophyllus* (HBMP 2010) (USFWS, 2016b).

Stressor: Low genetic variability (USFWS, 2016b)

Exposure:**Response:****Consequence:**

Narrative: This species experiences reduced reproductive vigor due to low levels of genetic variability, leading to diminished capacity to adapt to environmental changes, thereby lessening the probability of its long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361) (USFWS, 2016b).

Stressor: Climate change (USFWS, 2016b)

Exposure:**Response:****Consequence:**

Narrative: Fortini et al. (2013, p. 89) found that, as environmental conditions are altered by climate change, *S. macrophyllus* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions (USFWS, 2016b).

Recovery**Recovery Actions:**

- Survey for populations of *Sicyos macrophyllus* in areas of potentially suitable habitat.
- Remove feral pigs, sheep, and cattle from areas occupied by *S. macrophyllus* and maintain control through exclusion fencing.
- Remove and control nonnative plants.
- Conduct propagation efforts for maintenance of genetic stock.
- Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.

Conservation Measures and Best Management Practices:

- Remove feral pigs, sheep, and cattle from areas occupied by *S. macrophyllus* and maintain control through exclusion fencing.
- Remove and control nonnative plants.
- Conduct propagation efforts for maintenance of genetic stock.
- Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.

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USFWS. 2016b. Endangered and Threatened Wildlife and Plants

Endangered Status for 49 Species From the Hawaiian Islands

Final rule. 81 Federal Register 190. September 30, 2016. Pages 67786 - 67860.

SPECIES ACCOUNT: *Sidalcea keckii* (Keck's Checker-mallow)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A slender, bristly-hairy, annual herb, 1.5-3.5 dm tall. A few deep pink flowers bloom April-May. (NatureServe, 2015)

Taxonomy

A distinct species in a genus of about 22 species of western North America. (NatureServe, 2015)

Historical Range

At the time of listing, the Mine Hill *Sidalcea keckii* population existed within a 0.73 acre area. The population occurred on a privately owned 700-acre parcel of land that was used for livestock 5 grazing. The occurrence of *S. keckii* at Mine Hill in Tulare County may have been extirpated when orange groves were planted on the property. (USFWS, 2012)

Current Range

Tulare and Fresno counties (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/18/2003.

Legal Description

On March 18, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Sidalcea keckii* (Keck's Checker-mallow) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in California (68 FR 12863-12880).

Critical Habitat Designation

The critical habitat designation for *Sidalcea keckii* includes three CHUs in Fresno and Tulare counties, California. This species critical habitat encompasses approximately 1,085 acres (ac) (438 hectares (ha)) (68 FR 12863-12880).

Unit 1: Piedra: Unit 1 is on the western slopes of Tivy Mountain in the Piedra area of southern Fresno County. It contains 206 ha (510 ac), of which 203 ha (503 ac) are privately owned and 3 ha (7 ac) are managed by the BOR (R. Faubion, pers. comm., 2002). Of the privately owned land, 77 ha (189 ac) of proposed critical habitat is on the Tivy Mountain Reserve which is owned by SFC and established for the conservation of *Sidalcea keckii* and other rare plants. SFC uses managed grazing as a tool to reduce competing non-native grasses from *S. keckii* sites, and monitors the plant as well (SFC 2001). Another 6.5 ha (16 ac) of this unit occurs on a conservation easement held by SFC on privately owned land adjacent to the reserve. Recent surveys of the areas containing documented populations of *Sidalcea keckii* were conducted in 1998, 2000, and 2001. In 1998, surveys coordinated by the BOR found 500 to 1,000 plants in the area (Cypher 1998). Surveys conducted in 2000 and 2001 by the SFC found eight separate patches of *S. keckii* growing on both Fancher and Cibo soils (C. Peck, in litt., 2002). This unit is essential to the conservation of

the species because it is one of the two sites at which the species has been observed since the 1930s. When the number of populations or geographic distribution of a species are severely limited, as is the case when plants have only been observed recently at two locations, possible extinction or extirpation due to random events become a concern. Examples of random events that are a concern include fire and disease (Shaffer 1981, 1987; Primack 1993, Meffe and Carroll 1994). This unit is also essential because it includes the most northerly location known for *S. keckii*, and is the only location where above-ground plants with maroon-centered flowers have been documented (Cypher 1998).

Unit 2: Mine Hill: Unit 2 is about 3 km (2 mi) south of Success Dam and 5 km (3 mi) east of Porterville in Tulare County and contains 86 ha (213 ac), all of which are on privately owned land. Unit 2 encompasses a single known patch of *Sidalcea keckii*, which contained approximately 60 plants when last surveyed in 1992. At the request of the landowner, it has not been surveyed since that time. However, based on information from public comment, the standing population at Mine Hill may have been extirpated by conversion of the habitat to an orange grove. We currently do not know how much habitat may have been converted, although we believe that much of the habitat around the original population remains potentially viable and may contain a seed bank or standing plants. The Coarsegold rock outcrop soils of the area are best suited to rangeland (SCS 1982), which is the current use of the area where not converted to orchard. However the site is also zoned for mobile home development (R. Brady, Tulare County Planning Department, pers. comm., 1997). This unit is essential to the conservation of the species because it is presumably one of the two known locations where *Sidalcea keckii* plants have been observed since the 1930s. As is the case with Unit 1, when the number of populations or geographic distribution of a species are severely limited, possible extinction or extirpation due to random events become a concern. Examples of random events that are a concern include fire and disease (Shaffer 1981, 1987; Primack 1993, Meffe and Carroll 1994).

Unit 3: White River: Unit 3 is located near the town of White River in southern Tulare County. It contains 146 ha (362 ac), all of which is private land. Unit 3 contains the “type” location, specimens from which were used to first describe the species in 1940 (Wiggins 1940). This site is the only one not closely associated with serpentine rock, but contains the primary constituent elements that would support the species. This may be due to the presence of currently unknown and unmapped serpentine areas, or it may be due to an increased ability to compete on non-serpentine Cibo soils. As noted above, the White River site is one of the extremely few locations where *Sidalcea keckii* has ever been observed and may be occupied by a seed bank. *Sidalcea keckii* plants may still occur here, but none have been documented recently. Even if the species is not rediscovered at the White River site, we believe the site is essential to the conservation of the species. Because *S. keckii* has been observed at the site, it is the most appropriate site at which a reestablishment effort might be attempted. The combination of small range, few populations, and restricted habitat makes *S. keckii* susceptible to extinction or extirpation from a significant portion of its range due to random events, such as fire, disease, or other occurrences (Shaffer 1981, 1987; Primack 1993, Meffe and Carroll 1994). Such events are a concern when the number of populations or geographic distribution of a species are severely limited, as is the case with *S. keckii*. Establishment of a third location for *S. keckii* is likely to be an important component in reducing the risk of extinction due to such catastrophic events. This location also represents the southernmost extent of the known historical range of the species.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Sidalcea keckii* critical habitat consists of two components (68 FR 12863-12880):

- (i) Minimally shaded annual grasslands in the foothills of the Sierra Nevada Mountains containing open patches in which competing vegetation is relatively sparse; and
- (ii) Serpentine soils or other soils that tend to restrict competing vegetation.

Life History**Food/Nutrient Resources****Habitat Type**

Adult: Gressy slopes (Natureserve, 2015)

Dependencies on Specific Environmental Elements

Adult: Serpentine soils (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (inferred from NatureServe, 2015)

Environmental Specificity

Adult: High (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Found on grassy slopes from 120 to 425 m elevation. The extant population is in a sparsely vegetated annual grassland on red or white-colored clay soils with 2-40 percent slopes. The clay substrates are thought to be derived from serpentine. (NatureServe, 2015)

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Decreasing (NatureServe, 2015)

Resiliency:

Low (NatureServe, 2015)

Representation:

Low (NatureServe, 2015)

Redundancy:

Low (NatureServe, 2015)

Population Growth Rate:

Loss of populations because of development. Decline of 50-70% (NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Loss of populations because of development. Decline of 50-70% Known historically from 3 populations in Tulare and Fresno counties, California, but the species has potentially been extirpated from each location. A new location discovered in 1998 had approximately. 900 individuals. Historical occurrence at White River near Glenville, Tulare County, California. (NatureServe, 2015). Low resiliency, representation and redundancy are based on the low number of known populations and restricted habitat requirements.

Threats and Stressors

Stressor: Agricultural conversion (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Agricultural development is listed as a threat to this species (USFWS, 2012).

Stressor: Potential development (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Critical Habitat Unit KECK-1 includes 205 acres of land protected by the Sierra Foothill Conservancy, federally managed lands, and some private land. There is a single unprotected parcel within the Piedra population that could potentially be developed (Stebbins 2004). However, there are no imminent plans for development at this time. The Service is not aware of any activities that would have caused destruction or modification habitat within Critical Habitat Unit KECK-1 since the last 5-Year Review in 2007 (USFWS, 2012).

Stressor: Grazing (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: At the time of listing, cattle (*Bos taurus*) grazing was discussed as a potential threat to the species; there has been no known change since the final listing. Cattle grazing may limit encroachment of non-native grasses (C. Peck, in litt., 2002; Weiss 1999). However, cattle have been observed to cause damage to *S. keckii* by eating or trampling it, although the damage was barely noticeable a week later (Cypher 1998). Increased grazing during months of flowering, seed-set, or seed maturation could potentially reduce local population viability and negatively affect long-term conservation of this species. Summary of Factor C: Diseases do not appear to be

a threat at this time. Overgrazing by cattle may threaten the long-term conservation of this species (USFWS, 2012).

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Summary of Factor D: In summary, the Endangered Species Act is the primary Federal law that has provided protection for this species since the dates of its listing as endangered in 2000. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent their status under the Act. Therefore, we continue to believe other laws and regulations have limited ability to protect the species in absence of the Endangered Species Act (USFWS, 2012).

Stressor: Small population size (USFWS, 2012)

Exposure:

Response:

Consequence: Threat of extinction/lack of genetic variability

Narrative: Small population size increases the susceptibility of a population to extirpation from random demographic, environmental, and/or genetic events, affecting survival and reproduction of individuals (Shaffer 1981, 1987; Lande 1988; Groom et al. 2006). Small populations of annual species, such as *Sidalcea keckii*, may be more vulnerable to random environmental events such as extreme weather, disease, fire, or insect infestations (Shaffer 1981, 1987; Menges 1991; Groom et al 2006). For example, if a fire should occur before plants bloom or during the blooming season, the fire could destroy the individual plants as well as deplete the seed bank. The threat from random natural events has increased since *S. keckii* was listed because the plant now is found only at one location (USFWS, 2012).

Stressor: Altered fire regime (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The absence of *Sidalcea keckii* from dense grasslands, even those on serpentine clay soils, suggests that it is a poor competitor (Stebbins 1992; J. Stebbins, pers. comm. 2001). Thus, aggressive, nonnative grasses such as *Bromus madritensis* ssp. *rubens*, and *Bromus hordeaceus* could potentially outcompete *S. keckii* if conditions changed to favor these grasses. For example, soil disturbances, increased availability of soil nutrients (e.g., nitrogen deposition) from cattle feces and other sources, and absence of fire may provide ideal conditions that would allow these nonnative grasses to outcompete *S. keckii*. Non-native grasses may generate increased fuel sources that could increase intensity of fires above the normal range of variability in serpentine grasslands that support *S. keckii* (E. Cypher, California Department of Fish and Game, pers. comm. 2006). However, an appropriate fire regime may reduce the presence of nonnative grasses and benefit serpentine endemic species such as *S. keckii* (Harrison et al. 2003) (USFWS, 2012).

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:**Consequence:** Loss of habitat

Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to particular species at this time (USFWS, 2012).

Recovery**Recovery Actions:**

- There is no approved final or draft recovery plan for the species (USFWS, 2012).

Conservation Measures and Best Management Practices:

- Continue to protect property with suitable habitat for *Sidalcea keckii*. Acquisition of additional habitat through fee title or conservation easements is needed for the recovery of the species (USFWS, 2012).
- Survey additional serpentine and gabbro soil areas in Tulare and Fresno Counties to discover additional populations of *Sidalcea keckii* (USFWS, 2012).
- If additional populations of *Sidalcea keckii* are not discovered through systematic surveys, the species should be reintroduced into protected land within critical habitat units (USFWS, 2012).
- Continue monitoring the status and trend of *Sidalcea keckii* to determine whether this species is stable, increasing, or declining (USFWS, 2012).
- Continue genetic studies to confirm the species identity of plants preliminarily identified as *Sidalcea keckii* so that we can more accurately determine the actual number of populations, the geographic range, and types of habitats that support this species (USFWS, 2012).

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SPECIES ACCOUNT: *Sidalcea nelsoniana* (Nelson's checker-mallow)

Species Taxonomic and Listing Information

Listing Status: Threatened; 03/15/1993; Pacific Region (R1)

Physical Description

It has tall, lavender to deep pink flowers that are borne in somewhat open clusters 50 to 150 cm (19.2 to 48 inches) tall at the end of short stalks (USFWS 1993). Plants are partially dioecious, in that they have either perfect flowers (male and female) or pistillate flowers (female only) (USFWS, 2016).

Taxonomy

Nelson's checkermallow is a perennial herb in the mallow family (Malvaceae) (USFWS, 2016).

Current Range

Nelson's checkermallow primarily occurs in Oregon's Willamette Valley, but is also found at several sites in Oregon's Coast Range and at two sites in the Puget Trough of southwestern Washington. The plant's range extends from southern Benton County, Oregon, north to Cowlitz County, Washington, and from central Linn County, Oregon, west to the crest of the Coast Range. In the late 1990s, the species was known to occur in 65 occurrences within five relict population centers in Oregon and Washington and occupy approximately 273 acres (USFWS 1998) (USFWS, 2016).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (USFWS, 2016)

Breeding Season

Adult: Flowering typically occurs from late May to mid-July, but may extend into September in the Willamette Valley (USFWS, 2016).

Reproduction Narrative

Adult: The plant can reproduce vegetatively, by rhizomes, and by seeds, which drop near the parent plant. Flowering typically occurs from late May to mid-July, but may extend into September in the Willamette Valley. Fruits have been observed as early as mid-June and as late as mid-October. Coast Range populations generally flower later and produce seed earlier, probably because of the shorter growing season. Seed production for a Nelson's checkermallow plant is typically high. An average plant may produce between 300 and 3000 seeds, but could potentially exceed 10,000 seed. The limiting factor of Nelson's checkermallow seed production is weevil damage. Weevils typically associated with the plants in the wild often infest flowers and eat flowers. Early in seed production, weevils often consume developing embryos and may

account for 80 to 100% loss of pre-dispersal seed. In the Willamette Valley, Nelson's checkermallow begins flowering as early as mid-May, and continues through August to early September, depending upon the moisture and climatic conditions of each site. Coast Range populations experience a shorter growing season and generally flower later and senesce earlier. Nelson's checkermallow inflorescences are indeterminate, and often simultaneously exhibit fruits, open flowers, and unopened buds. Seeds are deposited locally at or near the base of the parent plant and may be shed immediately or persist into winter within the dry flower parts that remain attached to the dead stems. Above-ground portions of the plant die back in the fall, usually followed by some degree of regrowth at the base, with the emergence of small, new leaves that persist through the winter directly above the root crown. It is not uncommon for some plants to continue producing some flowers into the fall and early winter, although this is usually limited to one or two small stems per plant, consequently with little seed production (USFWS 1998). Perfect-flowered Nelson's checkermallow are protandrous, with complete temporal separation of male and female phases in individual flowers (Gisler and Meinke 1998). This prevents self-fertilization. The bottom-to-top foraging observed among most bee visitors also encourages outcrossing because pollinators leave male-phase flowers at the top of one raceme and then fly to female phase flowers on the bottom of the next raceme. Nelson's checkermallow is pollinated by a variety of insects, including at least 17 species of bees, 3 species of wasps, 9 species of flies, 6 species of beetles, and 5 species of butterflies/moths (Gisler 2003). Pre-dispersal seed predation by weevils (*Macrorhoptus sidalceae*) is extremely high in many populations, and may severely curtail, if not virtually eliminate, seed survival in many populations (Gisler and Meinke 1998). The weevils appear to be restricted to Willamette Valley, southwestern Washington and lower Coast Range populations (around Grand Ronde), but do not infest the Coast Range populations in Yamhill, Tillamook, and Washington counties. The weevils are native, host-specific, and are themselves parasitized by tiny undescribed wasps (Gisler and Meinke 1998) (USFWS, 2016).

Habitat Type

Adult: Wet prairies and stream sides (USFWS, 2016)

Habitat Narrative

Adult: In the Willamette Valley, Nelson's checkermallow is known from wet prairies and stream sides (USFWS 2010). Nelson's checkermallow populations occur at low elevations (below 200 m (650 feet)) within a mosaic of urban and agricultural areas, with concentrations around the cities of Corvallis and Salem. Although occasionally occurring in the understory of *Fraxinus latifolia* (Oregon ash) woodlands or among woody shrubs, Willamette Valley populations usually occupy open habitats supporting early seral plant species. These native prairie remnants are frequently found at the margins of sloughs, ditches, and streams; roadsides; fence rows; drainage swales; and fallow fields. Soil textures of the occupied sites vary from gravelly, well drained loams to poorly drained, hydric clay soils (CH2MHill 1986, Glad et al.1994). Some of the native plants commonly associated with *Sidalcea nelsoniana* in the Willamette Valley include: *Achillea millefolium* (yarrow), *Juncus effusus* (common rush), *Carex* spp. (sedge), *Spiraea douglasii* (western spiraea), *Crataegus douglasii* (Douglas' hawthorn), *Geum macrophyllum* (large-leaved avens), and *Fraxinus latifolia* (Oregon Department of Agriculture 1995). Most sites have been densely colonized by invasive weeds, especially introduced forage grasses. Common non-native species found with Nelson's checkermallow include *Festuca arundinacea*, *Rosa* spp. (rose), *Cirsium arvense* (Canada thistle), *Hypericum perforatum* (common St. John's wort), *Rubus* spp. (blackberry), *Phleum pratense* (timothy), *Holcus lanatus* (velvet grass), *Vicia* spp.,

Chrysanthemum leucanthemum (oxeye-daisy), *Agrostis capillaris*, *Alopecurus pratensis*, *Phalaris arundinacea*, *Geranium* spp. (geranium), *Lotus corniculatus* (bird's-foot trefoil) and *Daucus carota* (Oregon Department of Agriculture 1995). Coast Range Nelson's checkermallow populations typically occur in open, wet to dry grassy meadows, intermittent stream channels, and along margins of coniferous forests, with clay to loam soil textures (Glad et al. 1987) at elevation ranging from 490 to 600 m (1,610 to 1,970 feet). These areas generally support more native vegetation than Willamette Valley sites. Native plants commonly associated with Nelson's checkermallow in the Coast Range include *Senecio triangularis* (spear-head senecio), *Fragaria Virginiana*, *Juncus* spp., *Carex* spp., and *Achillea millefolium*; non-native associated species often include *Senecio jacobaea* (tansy ragwort), *Holcus lanatus*, and *Phleum pratense*. A variety of animal species are associated with Nelson's checkermallow. Stems and inflorescences are commonly eaten by deer and elk. Nelson's checkermallow flowers are visited by a diverse assemblage of insects, including leafcutter bees (Megachilidae), honey bees (Apidae), bumble bees (Bombidae), hover flies (Syrphidae), butterflies (Hesperiidae), and pollen-foraging beetles (Cerambycidae and Meloidae). The species is also a host for various phytophagous insects such as aphids (Aphididae), stinkbugs (Pentatomidae), scentless plant bugs (Rhopalidae), spotted cucumber beetles (Chrysomelidae), plant bugs (Miridae), milkweed bugs (Lygaeidae), spittlebugs (Cercopidae), butterfly larvae (Lycaenidae: *Strymon melinus*; Nymphalidae: *Vanessa anabella*), and in the Willamette Valley, weevils (Curculionidae: *Macrohoptus sidalcae*) (USFWS, 2016).

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Unknown (USFWS, 2016)

Number of Populations:

~90 (USFWS, 2016)

Population Size:

10,000 - 100,000 individuals (NatureServe, 2015)

Population Narrative:

The species' high susceptibility to pre-dispersal seed predation by weevils may eventually lead to recruitment problems, particularly in small populations already subject to other stresses such as competition with dense stands of invasive species. However, the ease of propagating this species by both seeds and rhizomes (Gisler 2004) suggests that its rarity may be more related to the significant destruction and degradation of its habitat rather than to any intrinsic vulnerability of the plants themselves. Prior to European settlement, the moist, open habitats preferred by this species were likely maintained by natural wildfires, fires set by Native Americans, and sporadic flooding. These landscape processes have been dramatically suppressed since that time, resulting in successional woody overgrowth of many formerly open sites. In addition, livestock grazing, agricultural and urban land conversion, and stream channel alterations have greatly reduced the quantity and quality of this species' preferred habitat, especially in the Willamette Valley; Bartels and Wilson (2003) state that land use changes over the past 150 years have altered or destroyed more than 99% of Willamette Valley wetland habitats. Although there is no direct evidence of this species' abundance prior to European

settlement, the vast declines in its preferred habitat strongly suggest that plants historically occurred more extensively throughout native Willamette Valley grasslands. In the Coast Range, habitat decline since European settlement does not appear to have been as severe, although habitat quality impacts (e.g. aggressive introduced species) are still apparent. Interestingly, some sources have suggested that this species may have been more recently introduced into Coast Range mountain meadows via livestock feed originating in the Willamette Valley (CH2M Hill 1986 cited in USFWS 1998). Decline of >10% Many known occurrences contain few plants. Based on occurrence data, total population size appears to be approximately 20,000 - 35,000 individuals. Guerrant (2001) estimated a total of around 26,500 individuals as of 1997; since then, an additional 25 occurrences have been documented, but many of these are small. 85 occurrences are currently believed extant, 83 in Oregon and 2 in Washington. Of the 83 Oregon occurrences, 3 are re-introductions and 4 are introductions. In Oregon, an additional 13 occurrences are ranked as historical/unknown, and a further 4 are believed extirpated. (NatureServe, 2015). In the late 1990s, the species was known to occur in 65 occurrences within five relict population centers in Oregon and Washington and occupy approximately 273 acres (USFWS 1998). The 2010 Recovery Plan states that Nelson's checkermallow was known from about 90 sites, comprising about 1,277 acres of total cover (USFWS 2010). Data collection for a range-wide inventory of Nelson's checkermallow was completed in 2014 (Curran, Institute for Applied Ecology, pers. comm. 2015). Results indicated that 71 populations composed of 214,111 individual plants in Oregon that have potential to contribute towards achieving recovery goals. Other smaller populations exist, but are unlikely to contribute to recovery. Of the 71 populations, 21 populations were less than 100 plants; 36 populations had 100 to 2,499 plants; and 14 populations had more than 2500 plants. Of those 14 populations, five contained over 10,000 plants (USFWS, 2016).

Threats and Stressors

Stressor: Development (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Agricultural and urban development have modified and destroyed habitats, fragmenting populations into small, widely scattered patches (USFWS 2010). In the Willamette Valley, extirpation is an ongoing threat to many Nelson's checker-mallow occurrences on private lands, roadsides, and undeveloped lots zoned for industrial and residential development. Within the genus *Sidalcea*, the actual sex ratio (the number of functionally pistillate to perfect flowers) of a population may be a strong contributing factor to its genetic vigor or vulnerability such that the ratio of pistillate to perfect flowers may ultimately control the amount and quality of seeds produced regardless of habitat quality. Likewise, seed predation by weevils prior to seed dispersal may also be a factor controlling seed production (USFWS, 2016).

Stressor: Hybridization (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of individuals/extinction

Narrative: There is a strong potential for interspecific hybridization among Nelson's checkermallow and other species of checkermallows in the region, although there are some ecological and genetic reproductive barriers to prevent it from occurring (Gisler 2003, 2004).

Nelson's checkermallow flowers later in the year than sympatric populations of *Sidalcea malviflora* ssp. *virgata* (rose checkermallow), but allopatric populations sometimes overlap in flowering periods. The two species are sexually compatible, thus human-mediated movement of the plants could result in formation of hybrids. Nelson's checkermallow and *S. cusickii* (Cusick's checker-mallow) are also fully compatible, and they also share pollinators and flowering times, but their geographic ranges are parapatric, with nearest populations narrowly separated by less than 1.6 km (1 mile) at the south end of Finley National Wildlife Refuge (Gisler 2004). If these species come into contact through human-mediated dispersal, hybridization could easily occur. Nelson's checkermallow is frequently found growing together with *S. campestris*, and they also share pollinators and flowering times, but they exhibit very low sexual compatibility (Gisler 2004). Reproductive barriers among the checker-mallows in the Willamette Valley likely evolved in response to selective pressure against hybridization (Gisler 2003, 2004); managers should be aware of the potential for hybridization as plants are moved around within the region (USFWS, 2016).

Stressor: Fire suppression (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Suppression of natural fire regimes is a threat to this species (USFWS, 2016).

Stressor: Woody vegetation (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Woody vegetation (via succession) is listed as a threat to this species (USFWS, 2016)

Recovery

Reclassification Criteria:

Not applicable.

Delisting Criteria:

Delisting will be considered when all of the following conditions have been met: (USFWS, 2010)

1. Distribution and abundance. The distribution of populations should reflect the extent of the species' historical geographic distribution to the extent practicable. See Table IV-6 in the Recovery Plan for distribution and abundance goals for this species. (USFWS, 2010)

2. Population trend and evidence of reproduction. The area of foliar cover shall have been stable or increasing over a period of at least 15 years. Stable does not mean that the population size is static over time; over a period of 15 years, the number of individuals in the population may exhibit natural year-to-year variability, but the trend must not be declining. Populations must show evidence of reproduction by seed set or presence of seedlings. (USFWS, 2010)

3. Habitat quality and management. Sites supporting populations of listed plants considered in Criterion 2 above must meet these criteria: (a) Prairie quality. Same as Downlisting Criterion 1.

(b) Security of habitat. Same as Downlisting Criterion 1. (c) Management, monitoring, and control of threats. Same as Downlisting Criterion 1. (USFWS, 2010)

4. Genetic material is stored in a facility approved by the Center for Plant Conservation. The stored genetic material in the form of seeds must represent the species' geographic distribution and genetic diversity through collections across the full range of the species. Collections from large populations are particularly important as reservoirs of genetic variability within the species. (USFWS, 2010)

5. Post-delisting monitoring plans and agreements to continue post-delisting monitoring are in place and ready for implementation at the time of delisting. Monitoring of populations following delisting will verify the ongoing recovery of the species, provide a basis for determining whether the species should be again placed under the protection of the Endangered Species Act, and provide a means of assessing the continuing effectiveness of management actions. (USFWS, 2010)

Recovery Actions:

- Details of the Recovery Actions are available in the 2010 Recovery Plan. Presented below is the introductory paragraph only. (USFWS, 2010)
- 1. Preserve, restore, and manage populations and habitat for the listed prairie species covered by this plan. The listed prairie species of western Oregon and southwestern Washington addressed by this plan are now found only in small, highly fragmented upland and wet prairie habitat remnants. The first step in the recovery of these species is to identify and protect the remaining populations with the greatest potential for restoration. The next step is to augment and, if necessary, reintroduce populations to restore connectivity between those that are currently isolated from one another to restore gene flow and create a population structure that provides for resiliency in a dynamic natural environment. Recovery for all of these species will depend upon the successful establishment of a network of protected populations in managed, suitable prairie habitats distributed across their historical range. As a large portion of the remnant prairie habitats within the range of these species is in private ownership, recovery will to a large extent depend upon the successful development of partnerships with private landowners and support of their efforts to protect, restore and manage native prairie habitats in the region. (USFWS, 2010)
- 2. Coordinate recovery actions to benefit other listed species and nonlisted prairie species of conservation concern. The extensive loss of both wet and upland prairie habitats throughout the geographic region addressed by this draft recovery plan has resulted in the concurrent declines of many of the native plants and animals associated with these ecosystems. In this plan we have attempted to focus not only on the recovery of the listed prairie species, but to extend these recovery efforts to the ecosystems upon which they depend. The recommended actions for restoring and reconnecting prairie habitats in western Oregon and southwestern Washington are intended to extend benefits beyond the threatened or endangered species addressed in the plan to all of the native prairie species in these regions, including nonlisted prairie species that are recognized as in decline. Proactive efforts to restore prairie systems should contribute to the arrest or reversal of these declines, thereby preventing the need to list these species in the future. Particularly on sites where listed species co-occur with nonlisted species of conservation concern, landowners or managers should be made aware so as to tailor management actions to avoid inadvertent negative impacts on any such species. Coordination with other agencies, private

landowners, or other interested parties will help ensure that the recovery actions outlined in this plan benefit the habitat and populations of other native prairie species. (USFWS, 2010)

- 3. Promote protection of listed species and prairie restoration on private lands. More than 90 percent of the land in the Willamette Valley is in private ownership. The restoration of prairie systems and their native plant and animal communities can therefore only be successful with the participation of private landowners. Without active management, populations of both listed and nonlisted species endemic to prairie habitats are almost certain to experience further declines. Working with private landowners and providing incentives to participate in the recovery effort for these species are critical elements of the recovery strategy. (USFWS, 2010)
- 4. Cultivate partnerships with both public and private agencies and organizations to promote the conservation of prairie ecosystems and listed prairie species. A diverse group of agencies and organizations are involved in recovery activities for the native prairies in western Oregon and southwestern Washington, including, but not limited to, the U.S. Fish and Wildlife Service, the Willamette Valley National Wildlife Refuge Complex, the U.S. Bureau of Land Management, U.S. Army Corps of Engineers, Confederated Tribes of Grand Ronde, Oregon Department of Transportation, City of Eugene, The Nature Conservancy, Oregon State University, Institute for Applied Ecology, Greenbelt Land Trust, McKenzie River Land Trust, Oregon Oak Communities Working Group, Washington Native Plant Society, Oregon Native Plant Society, Heritage Seedlings, and Berry Botanic Garden. Information regarding the recovery efforts for the prairie species should be shared with city and county planning, parks, and natural resource departments throughout the region covered by this recovery plan. City and county governments are the primary agencies that determine future land uses, and their participation is important for the recovery and restoration of the prairies and their associated listed species. Some local agencies are already making significant contributions toward prairie restoration; the West Eugene Wetlands are an excellent example of a significant conservation accomplishment achieved through a partnership of federal and local governments and private landowners/organizations. Plans, data, and information pertinent to the recovery of the prairie species must be synthesized and shared effectively between all agencies, groups, and individuals to leverage collective conservation efforts and achieve recovery. (USFWS, 2010)
- 5. Revise and update recovery plan as needed. Based on the results of the recommended research and monitoring efforts and the evaluation of the relative success or failure of different management techniques, the recovery plan should be revised periodically as needed to reflect this increased knowledge and improve the efficacy of future recovery actions. The scientific validity of the recovery criteria should also be reviewed and refined, if necessary, as more accurate species-specific data become available to assist with refining recovery criteria. (USFWS, 2010)
- 6. Develop post-delisting monitoring plans for each listed species prior to delisting. To ensure the continuing recovery of the listed species and adequacy of management actions to maintain the species at viable levels into the foreseeable future, a post-delisting monitoring plan must be developed and ready for implementation prior to delisting of any threatened or endangered species. Such a monitoring plan must be designed to be continued for a minimum of 5 years following the delisting action. (USFWS, 2010)

Conservation Measures and Best Management Practices:

- All of the General Plant Conservation Measures (Section 3.13.1) apply for Nelson's checkermallow. Nelson's checkermallow does not senesce completely in the fall like many other prairie plant species, and additional protections include: Burning: at any site with a population of this species, no more than one half of the occupied habitat may be burned in any year (USFWS, 2016).
- Herbicide use: protect Nelson's checkermallow plants from herbicide drift or overspray:
 - o When treating target plants with triclopyr, glyphosate or 2,4-D amine, apply by hand (e.g., with a backpack sprayer wand) when working near Nelson's checker-mallow to ensure protection of the listed plant.
 - o For all herbicide applications not excluded below, cover or otherwise protect (e.g., by clipping leaves to remove exposed green tissue) individual Nelson's checker-mallow plants to ensure that no herbicide comes in contact with the plant. Means of coverage may include 5-gallon buckets, tree protection tubes or other suitable shielding or covering material. Immediately after herbicide treatment, remove coverings.
 - o When applying glyphosate with a weed wiper in areas with Nelson's checkermallow, no covering of individual Nelson's checker-mallow is necessary. Apply glyphosate at a height to target upper grass stems, and avoid shorter Nelson's checkermallow plants.
 - o No covering of Nelson's checkermallow is required if treating target plants with sethoxydim or clethodim.
 - o Broadcast application of grass-specific herbicides may be used in on up to half of an area occupied by Nelson's checkermallow between February 15 and April 15. If using a weed wiper to apply a grass-specific herbicide for a particular listed plant during the growing season, the herbicide will be applied to the upper grass stems of targeted non-native plants, thus avoiding the shorter listed plant species.
 - o All other broadcast applications will only occur after August 15.
 - o All other herbicides will only be applied from August 15 to October 31 when the species is dormant.

References

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NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

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USFWS. 2010. Final Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington. U.S. Fish and Wildlife Service, Portland, Oregon. xi + 241 pp.
https://ecos.fws.gov/docs/recovery_plan/100629.pdf

SPECIES ACCOUNT: *Sidalcea oregana ssp. valida* (Kenwood Marsh checker-mallow)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/21/1997; Pacific Southwest (R8)

Physical Description

A perennial herb in the mallow family (Malvaceae). The plants are 1 to 2 m (3 to 6 ft) tall. The leaves are rounded. Lower leaves have 5 to 7 shallow lobes; upper leaves are generally smaller and divided into 3 to 5 entire, lanceolate segments. The compound inflorescence consists of densely flowered, spike-like racemes 2 to 5 cm (0.8 to 2.0 in) long. Petals are 1.0 to 1.5 cm (0.4 to 0.6 in) long, notched at the apex, and deep pink-mauve. The flowers appear from late June to September. *Sidalcea oregana ssp. valida* differs from *S. oregana ssp. eximia* in having a hairless calyx. (USFWS, 1997)

Taxonomy

Edward L. Greene (1897) first described *Sidalcea oregana ssp. valida* in June, 1894, based on material he collected from Knight's Valley, Sonoma County, California. Since then, this taxon has been known as *S. maxima* (Baker), *S. oregana* var. *spicata* (Jepson), *S. eximia* (Baker) and *S. spicata ssp. valida* (Wiggins) (CNPS 1988b). C. L. Hitchcock (1957) studied the genus *Sidalcea* and recognized four subspecies, including *S. oregana ssp. valida*, a treatment accepted by Steven Hill (1993). (USFWS, 1997)

Historical Range

See current range/distribution.

Current Range

Freshwater marshes approximately 150 m (490 ft) in elevation, at Kenwood Marsh and Knight's Valley, Sonoma County, California. (USFWS, 1997)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Flowers appear from late June to September (USFWS, 2009).

Reproduction Narrative

Adult: Flowers appear from late June to September (USFWS, 2009).

Habitat Type

Adult: Marsh (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits the edges of freshwater marsh. (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat needs of this species and the low number of known populations.

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Unknown (USFWS, 2019)

Number of Populations:

2 (USFWS, 2019)

Population Size:

Varies from 24 to 500 per population (USFWS, 2019)

Additional Population-level Information:

At the time of listing, two occurrences of Kenwood Marsh checker-mallow were known to exist with 130 plants between them. In 2018, biologists observed a small population (less than 100 individuals) at Deerfield Ranch Winery but no abundance survey was done (K. Symonds, pers. comm. 2018). Based on new observations from scientists and volunteers the threats to Kenwood Marsh Checker-mallow have marginally increased since the last status review. However, there has been no change to our understanding of threats to the species, or its distribution. (USFWS, 2019)

Population Narrative:

There are two locations with extant populations: Kenwood Marsh and Deerfield Ranch Winery. During the previous status review (2009) there were two main sites within Kenwood Marsh where the Kenwood Marsh checker-mallow remained extant: at Deerfield Ranch Winery and on an adjacent property. Today, the only confirmed, extant population exists at the Deerfield Ranch Winery. Botanists have not surveyed the additional population at Kenwood Marsh for nearly 20 years (Service 2009) and the status of the plant remains unknown at this location. Likewise, no botanical surveys have been done at Knight's Valley in 30 years. In 2009, only three colonies existed at the Deerfield Ranch Winery (USFWS; A. Rex, in litt. 2017). Kenwood Marsh checker-

mallow abundance at this location has continued to decline in recent years (A. Rex, in litt. 2017; Appendix A). Over the past 25 years, the abundance at the winery has fluctuated from as many as 550 individuals, to as few as 24 (Appendix B; CNDDDB 2018; USFWS 2009). (USFWS, 2019)

Threats and Stressors

Stressor: Grazing (USFWS, 1998)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: This species is adversely affected at both of its locations by reduced seed set resulting from cattle grazing (CNPS 1988b). Populations of *Lilium pardalinum* ssp. *pitkinense* have been enclosed with various types of wire fencing in an attempt to prevent grazing or browsing by cattle, horses, and deer, but most of the fences have failed to prevent grazing completely. The plants continue to suffer from herbivory by cattle, deer, and perhaps gophers and other herbivores, resulting in loss of flowers and seeds (L. Lozier, in litt. 1990). (USFWS, 1997)

Stressor: Water diversion (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Both permitted and unauthorized water diversions are listed as a threat to this species (USFWS, 2009).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Regulatory mechanisms are deemed as inadequate to protect this species. Including those that require a 10-day advance notice to officials before private landowners change the land use in areas populated with this species. (USFWS, 2009).

Stressor: Small population size (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: The small population size of this plant species increases the susceptibility to extirpation from random events. Population sizes of 100 or fewer are known for one or more populations of *Sidalcea oregana* ssp. *valida*. This species may also be subject to increased genetic drift and inbreeding as a consequence of their small population sizes (Menges 1991, Ellstrand and Elam 1993). Increased homozygosity resulting from genetic drift and inbreeding may lead to a loss of fitness (ability of individuals to survive and reproduce) in small populations. In addition, reduced genetic variation in small populations may make any species less able to successfully adapt to future environmental changes (Ellstrand and Elam 1993). This species is threatened by potential loss of fitness and/or genetic variability associated with small population sizes. (USFWS, 1997)

Stressor: Naturally-occurring events (USFWS, 1997)

Exposure:**Response:****Consequence:**

Narrative: The potential for loss of the only population of *Sidalcea oregana* ssp. *valida* from naturally occurring events, because of the small population size, is exacerbated by drought and water diversions. In addition, this population is being encroached upon by invasive weeds, including yellow star-thistle and blackberry (A. Howald, pers. comm. 1993). One of the subpopulations was damaged by an off-road vehicle during maintenance of a local aqueduct, which passes through the marsh. The maintenance activity occurred late in the season when the soil was relatively dry, resulting in minimal damage to the plants. If such maintenance activities occur during a time when the soil is saturated, they pose a threat to the plants (A. Howald, pers. comm. 1993). (USFWS, 1997)

Stressor: Climate change (USFWS, 2009)

Exposure:**Response:****Consequence:**

Narrative: Climate change is listed as threat to this species. (USWS, 2009)

Recovery**Reclassification Criteria:**

Not defined. A Recovery Plan has not been prepared. (USFWS, 2019)

Delisting Criteria:

Not defined. A Recovery Plan has not been prepared. (USFWS, 2019)

Recovery Actions:

- Not defined. A Recovery Plan has not been prepared. (USFWS, 2019)

Conservation Measures and Best Management Practices:

- Removing thatch and invasive species from exclosures: Kenwood Marsh checker-mallows grow in full sun on the margins of riparian areas (K. Symonds, pers. comm. 2018). The species is currently threatened by thatch buildup from annual sedges, as well as invasive plants, both of which shade habitat (K. Symonds, pers. comm. 2018; R. Rex, pers. comm. 2018). Manual removal of invasive plants and thatch might be necessary to increase Kenwood Marsh checker-mallow survival. In 2018, Deerfield Ranch Winery staff and volunteers removed thatch and invasive plants from browsing exclosures (A. Rex, pers. comm. 2018). These efforts should take place annually to ensure the survival of Kenwood Marsh checker-mallow. (USFWS, 2019)
- Locate appropriate areas for new colony establishment: The Kenwood Marsh checker-mallow probably once existed in riparian zones between Kenwood Marsh and Knight's Valley. Today, the dispersal of this species is restricted by land-use conversion to agriculture and urban areas. However, there might be areas within the historical range where the species could be re-established with seeding and outplanting. Private landowners should be contacted and, if landowners are willing, a management plan should be developed and implemented by the Service or CDFW. Research and public outreach would be needed to determine the feasibility of establishing new colonies in the area. (USFWS, 2019)

- Population monitoring: Population estimates of Kenwood Marsh checker-mallow are sporadic (CNDDDB; Appendix B). Establishing a protocol for continual, annual population monitoring would help us better understand the species needs and recovery potential. (USFWS, 2019)

References

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SPECIES ACCOUNT: *Sidalcea oregana* var. *calva* (Wenatchee Mountains checkermallow)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

Plant has several stems, 2-15 dm tall; leaves thick and fleshy, without hairs; flowers light to deep pink. Flowers June through July. (NatureServe, 2015)

Taxonomy

The taxon was first recognized as a distinct variety named *Sidalcea oregana* ssp. *oregana* var. *calva* by Hitchcock and Kruckeberg (1957). Hitchcock and Cronquist (1973) later simplified the nomenclature by eliminating the subspecies *oregana*, and all subordinate taxa of *S. oregana* became varieties of the species. No further revisions have been made for *S. oregana* var. *calva* related to either taxonomy or relevant nomenclature for the species (USFWS, 2011).

Current Range

Occurs in a small area within Chelan County, Washington.

Critical Habitat Designated

Yes; 9/6/2001.

Legal Description

On September 6, 2001, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Sidalcea oregana* var. *calva* (Wenatchee Mountains checkermallow) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Washington (66 FR 76536-76548).

Critical Habitat Designation

The critical habitat designation for *Sidalcea oregana* var. *calva* includes one CHU in Chelan County, Washington. This species critical habitat encompasses approximately 6,135 acres (ac) (2,484 hectares (ha)) (66 FR 76536-76548).

Washington, Chelan County. From USGS 7.5' quadrangle maps Peshastin and Tip Top, Washington. T. 23 N., R 18 E., beginning at a point on Camas Creek in the NW1/4 of NW1/4 of section 35 at approximately 47°26'52" N latitude and 120°38'57" W longitude proceeding downstream (northwesterly), expanding in all directions to include the entire wetland complex that comprises the Camas Meadow Natural Area Preserve, to a point approximately 0.4 km (0.25 mi) from the confluence of Pendleton Creek and Peshastin Creek, located at 47°31'06" and 120°37'18" W longitude. From this last point, the western boundary of the designated critical habitat parallels Peshastin Creek to a point at the southwest of the designated area located at 47°28'46" N latitude and 120°38'57" W longitude. The maximum elevation of the designated critical habitat is 1,000 m (3,300 ft) and the lowest elevation is 488 m (1,600 ft). Critical habitat within this area includes watercourses and wetland habitat out to the beginning of upland vegetation.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Sidalcea oregana* var. *calva* critical habitat consists of three components (66 FR 76536-76548):

The known primary constituent elements of critical habitat for *Sidalcea oregana* var. *calva* include: surface water or saturated upper soil profiles; a wetland plant community dominated by native grasses and forbs, and generally free of woody shrubs and conifers that would produce shade and competition for *Sidalcea oregana* var. *calva*;

seeps and springs on fine-textured soils (clay loams and silt loams), which contribute to the maintenance of hydrologic processes necessary to support meadows that remain moist into the early summer;

and elevations of 488–1,000 m (1,600–3,300 ft).

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Insect (bee) pollinated. Other pollinators unknown (USFWS, 2004)

Breeding Season

Adult: Flowering begins in the middle of June and peaks in the middle to end of July, although some individuals may have flowers present in mid-August (USFWS, 2004).

Reproduction Narrative

Adult: Hymenoptera (NatureServe, 2015). Pollination of the species is not well understood. In her studies of *S. oregana* var. *calva*, Tara Goldsmith reported that the colonial ground-nesting bee *Diadasia nigrifrons* is most likely the dominant pollinating insect (Goldsmith 2003). Honey bees (*Apis mellifera*), although present, were not observed to visit *S. oregana* var. *calva*. Interestingly, Goldsmith found no significant difference in the rate of flower to fruit success (about 36 percent) between flowers that were excluded from insect pollination and those that were not, indicating that insects are not the sole vector for pollination. Goldsmith pointed to the need for further study of the pollination mechanisms of *S. oregana* var. *calva* to potentially improve the plant's reproductive output. The species likely reproduces only from seed and, based on examination of seed capsules, the production of seed appears to be high (Gamon 1987). The somewhat clumped distribution of mature *S. oregana* var. *calva* plants suggests that seed dispersal is restricted to the areas near mature plants, unless the seeds are moved by animals or transported by water (Caplow 2002). Reproductive individuals produce flowers on one to several stems. Flowering begins in the middle of June and peaks in the middle to end of July, although some individuals may have flowers present in mid-August. Welldeveloped fruits are present by early August (Hitchcock et al. 1961; Washington Natural Heritage Program and U.S. Bureau of Land Management 1998). Investigations have suggested the species is not rhizomatous (D. Wilderman, pers. comm. 2004). The species likely reproduces only from seed and, based on examination of seed capsules, the production of seed appears to be high (Gamon

1987). The somewhat clumped distribution of mature *S. oregana* var. *calva* plants suggests that seed dispersal is restricted to the areas near mature plants, unless the seeds are moved by animals or transported by water (Caplow 2002). (USFWS, 2004).

Habitat Type

Adult: Meadows (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (NatureServe, 2015)

Site Fidelity

Adult: High (NatureServe, 2015)

Habitat Narrative

Adult: *S. oregana* var. *calva* is restricted to wetlands and moist meadows of the Wenatchee Mountains of central Washington on the east side of the Cascades. This species is found at midelevations, ranging from 488 to 1,000 meters (1,600 to 3,300 feet). Populations of *S. oregana* var. *calva* are generally concentrated in the wetter portions of open forest-moist meadow habitats, in slight topographic depressions. The plant may also be found in open conifer forests dominated by *Pinus ponderosa* (ponderosa pine) and *Pseudotsuga menziesii* (Douglas-fir), on the perimeter of shrub and hardwood thickets dominated by quaking aspen (*Populus tremuloides*), along permanent or intermittent streams in sparsely forested draws, and near seeps, springs, or small drainages. The presence of surface water or saturated upper soil profiles in the spring and early summer is the feature common to the variety of habitats where the species is found (USFWS, 2004). High ecological integrity of the community and site fidelity as well as low tolerance ranges are based on the low number of known populations and the relatively restricted range.

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: The somewhat clumped distribution of mature *S. oregana* var. *calva* plants suggests that seed dispersal is restricted to the areas near mature plants, unless the seeds are moved by animals or transported by water (Caplow 2002) (USFWS, 2004).

Population Information and Trends**Population Trends:**

Decreasing (NatureServe, 2015)

Resiliency:

Low (NatureServe, 2015)

Representation:

Low (NatureServe, 2015)

Redundancy:

Low (NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Narrative:

The extremely small range and general lack of suitable habitat may make the taxon more vulnerable to chance environmental or human-caused events. The historic range of *Sidalcea oregana* var. *calva* was approximately 11 miles by 3 miles; there has been significant loss of potential habitat in this area due to agricultural and residential development (WANHP 1998; USFWS 2004). Of the five extant populations, one has approximately 11,000 individuals (estimated in 2000) but the rest are small (ranging from approximately 8 to 300 individuals each in 2001) (USFWS 2004). Five extant populations are known (USFWS 2004). There are approximately seven historic occurrences (NatureServe, 2015). Low resiliency, representation and redundancy are based on the species low number of known populations in a relatively restricted (small) geographic area.

Threats and Stressors

Stressor: Wetland conversion (USFWS, 2004)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The primary threats to *S. oregana* var. *calva* include habitat fragmentation, degradation, or loss due to conversion of native wetlands to orchards and other agricultural uses and rural residential development (USFWS, 2004).

Stressor: Altered hydrology (USFWS, 2004)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Altered hydrology is considered a major threat to this species (USFWS, 2004).

Stressor: Competition from native and nonnative plants (USFWS, 2004)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Competition from native and nonnative plants is listed as a major threat to this species (USFWS, 2004).

Stressor: Recreational impacts (USFWS, 2004)

Exposure:

Response:

Consequence: Loss of habitat/Loss of individuals

Narrative: Recreational impacts are considered a major threat to this species. Seeds of the full species *Sidalcea oregana* are collected by horticulturists. Some populations are small enough that even limited collecting pressure could have adverse impacts. *S. oregana* var. *calva* is an attractive plant and may be sought for collection. All perennial species in the genus are considered attractive plants with horticultural potential (Hitchcock and Cronquist 1961; Gamon 1987). Wild-collected seed of the species *S. oregana* (no variety given) is available through a seed exchange program offered by the International Gardening Society, North American Rock Garden Society (North American Rock Garden Society 1996). Although seed collection does not pose a key threat to *S. oregana* var. *calva* currently, the potential of harm through such activity should be considered when developing management plans for the species (USFWS, 2004)

Stressor: Woody plant encroachment (USFWS, 2004)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: In the absence of fire woody plant encroachment can happen as part of natural succession and is considered a major threat to this species (USFWS, 2004).

Stressor: Seed predation (USFWS, 2004)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Seed predation by weevils is considered a major threat to this species (USFWS, 2004).

Stressor: Fire suppression activities (USFWS, 2004)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The Mountain Home Meadow site was adversely impacted by fire suppression activities associated with the Rat Creek Fire during 1994 (Harrod 1995). A fire line was constructed in the drainage area supporting a population of *S. oregana* var. *calva*. Blading of the area by a bulldozer destroyed approximately 50 percent of the population (more than 100 plants), disturbed the soil, and altered the hydrology of this wet meadow. This types of activity is considered a major threat to this species (USFWS, 2004).

Stressor: Road construction (USFWS, 2004)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Road construction may alter hydrology by modifying surface and subsurface runoff, changing water flows, and increasing the potential for erosion and sedimentation and is considered a threat to this species (USFWS, 2004).

Stressor: Timber harvest (USFWS, 2004)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Timber harvest may alter hydrology by modifying surface and subsurface runoff, changing water flows, and increasing the potential for erosion and sedimentation and is considered a threat to this species (USFWS, 2004).

Stressor: Naturally occurring events (flooding, land slides, etc.) (USFWS, 2004)

Exposure:

Response:

Consequence: Loss of habitat/extinction

Narrative: The species is highly vulnerable to extirpation from demographic factors or random, naturally occurring events due to the small size of most of the remaining populations (USFWS, 2004).

Recovery

Reclassification Criteria:

There are at least four stable, self-sustaining populations in each of the 5th field watersheds (Peshastin Creek and Icicle Creek) where the species currently occurs. Alternatively, there could be three stable, self-sustaining populations in each of these two watersheds and at least three stable, self-sustaining populations in another drainage if additional populations are discovered in the future. Additional populations may be identified through surveys or established through reintroductions. To be considered separate, each population must be geographically and hydrologically separated, such that events resulting in the extinction of one population are not likely to result in the extinction of another population. To be considered stable and self-sustaining, a population should maintain a 5-year average of at least 500 adult plants, show evidence of positive or neutral population growth over the same 5-year period, and show evidence of natural reproduction and establishment (USFWS, 2004).

2. All of the stable, self-sustaining populations are on protected sites secure from threats. For a site to be considered protected, it must be owned or managed by a government agency or private conservation organization that identifies perpetual maintenance of the species as the primary management objective for the site, or the site must be protected by a permanent conservation easement or covenant that commits present and future landowners to the conservation of the species (USFWS, 2004).

3. Genetic material is stored in a facility approved by the Center for Plant Conservation. The stored genetic material in the form of seeds must adequately represent the species' geographic distribution and genetic diversity (USFWS, 2004).

4. Adequate population and habitat monitoring has been established for all of the known populations. Population monitoring must be statistically sound and should be able to detect a 20 percent change in the population with a 90 percent degree of certainty. Habitat monitoring should include monitoring of shrub and tree cover, nonnative species, and hydrology (USFWS, 2004).

5. Management plans have been developed and implemented for all State and federally owned populations. Management plans will include provisions for monitoring, research, and habitat maintenance and restoration, including hydrologic restoration. These plans will also define actions designed to reduce or control threats to the species (USFWS, 2004).

Delisting Criteria:

Criteria for delisting the species remain the same as those for downlisting, with the following exceptions: 1. The populations that meet downlisting criterion #1 above will be naturally reproducing, stable or increasing in number with a minimum of 500 adult plants, secure from threats, and will have persisted an additional 5 years, for a total of 10 years. All other details of criterion #1 remain unchanged (USFWS, 2004).

One additional criterion is added for delisting: 6. Post-delisting monitoring plans and agreements to continue post-delisting monitoring are in place and ready for implementation at the time of delisting. Monitoring of populations following delisting will verify the ongoing recovery of the species and provide a means of assessing the continuing effectiveness of management actions (USFWS, 2004).

Conservation Measures and Best Management Practices:

- Collect, distribute, and store seed in an approved Center for Plant Conservation Seed Bank facility for later grow-out and reintroduction. The need for this action is considerable, given the current accessions are ageing, do not represent the Mountain Home population, and are located only in a single seed bank location, at the Berry Botanic Garden in Portland, Oregon. The currently stored collections date from 1986 to 1999. We would like to expand this to more than one seed bank location by adding the Miller Seed Vault at the University of Washington's Center for Urban Horticulture, Seattle, Washington (USFWS, 2011).
- Census and monitor all populations. Despite the best of intentions by responsible agencies, monitoring has been somewhat inconsistent between populations since publishing of the recovery plan. There has not been a full species census conducted in a single year to serve as a baseline for future comparisons and to allow the detection of trends. It is important to design a census that is efficient and comprehensive, yet be flexible to continue into the future in the face of uncertain funding. Cooperative development of a new monitoring plan is a challenge for the Technical Team (USFWS, 2011).
- Continue research into insect predation. Arnett and Birkhauser (2008) recommend repeating the proposed weevil protocol at several sites in order to develop an understanding of annual variation in level of insect infestation and to gain a better understanding of the annual variation in phenology. Trial runs early and late in the season may yield a better understanding of the different behavior of the two weevil species. A single late season monitoring was also suggested, as it may give the best estimate of the total level of insect damage, if it is conducted before seed dispersal begins. Arnett and Birkhauser (2008) suggested conducting prescribed fire at one of the *Sidalcea oregana* var. *calva* populations. This offers an opportunity to use this methodology to measure the effects of this action as a management treatment as the plant and the weevil likely evolved together under conditions of a higher fire frequency than current. Because *Sidalcea oregana* var. *calva* is historically located in areas where late season, low-intensity burns occurred frequently (Caplow 2003, Goldsmith 2005), it could be predicted that the plant species would respond positively to fire, as it would reduce competition with encroaching shrubs and trees and increase plant vigor, as well as possibly keep populations of the weevil and other harmful insects in check (USFWS, 2011).
- Complete hydrologic restoration in Camas Meadows. The success of a pilot hydrologic restoration project at Camas Meadows has improved wetland function and increased the amount of habitat in the largest population of *Sidalcea oregana* var. *calva*. In addition, the project was shown to improve native plant diversity and reduce the threat of altered hydrology within in the Camas Meadow population. This project demonstrated a successful method for restoring the hydrologic function to

the wetland and provided benefits to the species. Several areas of headcutting still require attention in remnant drainage ditches and should be completed to help alleviate threats to *Sidalcea oregana* var. *calva*. Invasive species control and native restoration planting should accompany any hydrologic restoration undertaken with *S. oregana* var. *calva* (USFWS, 2011).

- Reconsider value of Mountain Home population to survival and recovery With the discovery of a much larger, increasing and more stable Mountain Home population than previously thought, the Technical Team may reconsider the value of this population to the recovery of the species and we may elect to pursue a conservation agreement with the landowners. Such an action would allow the population to “count” toward recovery criteria # 1: a minimum of 500 plants, stable, and in a protected status; all for a period of at least five years. Additionally, this population is thought to represent a significant source of genetic variability for *S. oregana* var. *calva*, and therefore elevates its importance as a potential source of seed collection to propagate seedlings for reintroduction efforts or the species (USFWS, 2011).
- Complete and refine reintroduction planning In the Spotlight Species Action Plan (USFWS 2009) is a list of actions, that if implemented, would make substantial gains toward the recovery of *Sidalcea oregana* var. *calva*. The Technical Team should review this document, update it to reflect the new information and insight from this status review and use it to guide the reintroduction of the species. The Action Plan was developed primarily by using information and actions directly taken from the recovery plan (USFWS 2004), and would likely benefit from a revision (USFWS, 2011).

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SPECIES ACCOUNT: *Sidalcea pedata* (Pedate checker-mallow)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial herb from a fleshy taproot. The inflorescence is spike-like with deep rose-pink flowers; the upper flowers are crowded. (NatureServe, 2015)

Taxonomy

The genus *Sidalcea*, of the mallow (Malvaceae) family, comprises approximately 22 species located throughout western North America, mostly Oregon and California. A thorough description of the perennial members of this genus can be found in Hitchcock (1957). The perennial herb of interest, *Sidalcea pedata* A. Gray, was first described by Asa Gray (1887) based on a 1886 collection made by Samuel B. Parish from "Bear Valley in the San Bernardino Mountains, S. California" (Parish 1917). Jepson (1925) relegated the taxon to the variation *Sidalcea spicata* var. *pedata*. However, C. L. Hitchcock (1957) returned the taxon to full species status as *Sidalcea pedata* in his revision of the perennial species of the genus *Sidalcea*. *Sidalcea pedata* is distinguished from other sister species by its smooth carpels, mostly leafless stem, and the three- to five-lobed leaves that are then dissected into short, linear segments. Additional species of *Sidalcea* that occur in the San Bernardino Mountains include *S. malvaeflora* ssp. *dolosa* (distinguished by the presence of additional stem leaves, few-flowered racemes, and net-veined carpels), *S. hicknianji* ssp. *parishii* (shallowly-lobed leaves and coarse, gray pubescence), and *S. neomexicana* (fleshy leaves and netveined carpels). Colloquial names commonly used for this species are pedate checkermallow, bird-footed checkerbloom, bird-footed checkermallow, and Bear Valley checkermallow. Voucher specimens of *Sidalcea pedata* are held at the University of California, Riverside Herbarium; Jepson Herbarium at the University of California, Berkeley; Pomona College Herbarium; and in the Dudley Stanford collection of the California Academy of Sciences.

Historical Range

See current range/distribution.

Current Range

California endemic, occurs in the Big Bear Basin of San Bernardino County, California. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (USFWS, 2011)

Reproduction Narrative

Adult: *Sidalcea pedata* is gynodioecious, meaning there are plants with both female and hermaphrodite flowers and plants with female flowers only. Research findings indicate that female and hermaphrodite plants differ substantially in their reproductive biology and pollination ecology (Leong 2006, p. 24). Hermaphrodites can produce seeds through outcrossing (pollen transfer between separate plants) and geitonogamy (pollen transfer between separate flowers on the same plant), whereas females appear to produce seeds solely through outcrossing. The most common visitors to *S. pedata* appear to be generalist bees, predominantly in the genus *Osmia*. *Sidalcea pedata* also attracts one specialist pollinator, the female of the bee species *Diadasia nigrifrons* (Anthrohoridae). Other visitors include flies, butterflies, and beetles. Bee visitors appear to distinguish between the two sex morphs and are more highly attracted to hermaphrodite flowers when initially flying to a new group of stems (Leong 2006, p. 24). Female plants also appear to be much more productive than hermaphrodites. *Sidalcea pedata* seeds are small and dispersal appears to be limited to the area surrounding the parent plant (USFS 2000a, p. 37). Research indicates that *S. pedata* does not reproduce in or near severely impacted areas and that noncompacted soils are important to the reproductive success and persistence of this species (Krantz 1981, p. VI) (USFWS, 2011).

Habitat Type

Adult: Meadows (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (inferred from NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits loamy clay of annually-moist pebble plain meadows, and occasionally in dry meadows at 1600-2500 m (Pearson, 1989) (NatureServe, 2015). High ecological integrity of the community, site fidelity and low tolerance ranges are inferred based on the specific habitat needs of this species, the relatively small number of populations and its limited geographic range.

Dispersal/Migration**Dispersal**

Adult: Low (USFWS, 2011)

Dispersal/Migration Narrative

Adult: *Sidalcea pedata* seeds are small and dispersal appears to be limited to the area surrounding the parent plant (USFS 2000a, p. 37) (USFWS, 2011).

Population Information and Trends**Population Trends:**

Decreasing (NatureServe, 2015)

Resiliency:

Low (NatureServe, 2015)

Representation:

Low (NatureServe, 2015)

Redundancy:

Low (NatureServe, 2015)

Number of Populations:

6 - 20 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Wetland plant in open, flat habitat (Bittman 1998). The majority of this taxon's habitat was flooded in the 1890s. More recent development continues to threaten the taxon. Decline of 70-90%. Not many plants left due to multiple threats (Bittman 1998). Known from ten recent occurrences (seen during the last 20 years) and four historical (NatureServe, 2015).

Threats and Stressors

Stressor: Development (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The threat of development remains high because the majority of *Sidalcea pedata* occurrences are on private land (10 of 16 EOs). Two of these occurrences are currently posted for sale: Metcalf Creek at the Drive-in and Flea market (EO 17) and the YMCA camp at Bluff Lake (EO 6) (Eliason, pers. obs. 2010). Impacts of development pressures on private land are evident at a number of occurrences: the east side of Baldwin Lake (EO 9, 30) has been highly developed to the extent that populations may become extirpated or too small to persist, and populations at Metcalf Creek (EO 17), Eagle Point (EOs 19, 21), and the south shore of Baldwin Lake (EO 8) have also been impacted by development. The only *S. pedata* occurrence that is considered fully protected is at the north shore of Baldwin Lake (EO 1) on the Baldwin Lake Ecological Reserve (managed by CDFG). The direct threat of development to *S. pedata* habitat therefore remains substantial and is currently impacting habitat at 10 of the 16 extant occurrences (Appendix 1) (USFWS, 2011).

Stressor: Off-Highway Vehicles (USFWS, 2011)

Exposure:

Response:**Consequence:** Loss of individuals

Narrative: The listing rule indicated that OHV activity eliminated colonies and damaged *Sidalcea pedata* habitat (USFWS 1984, p. 34499). In 2000, a review by the USFS found that approximately 1.1 miles (1.7 kilometers (1.3 ha (3.3 ac))) of unauthorized roads bisect or are adjacent to known occupied meadow plant occurrences and that the unauthorized network of roads allow for an “unknown, though likely high, level of random and on-going impacts to threatened/endangered meadow plant habitat (USFS 2000a, p. 99).” OHV use continues to impact moist meadow habitat by altering hydrology, compacting soil, and degrading habitat. Preventing OHV use within *Sidalcea pedata* habitat has been difficult because much of the activity is either on private land or is unauthorized. Occurrences at the north and south shores of Baldwin Lake (EOs 1, 6) are particularly vulnerable to OHV use. At the south shore of Baldwin Lake (EO 6), OHV trails bisect the *S. pedata* occurrence, connecting private land to the shoreline (USFS 2000, p. 62). Fencing that may provide protection to the occurrence at the north shore of Baldwin Lake (EO 1)—at the side of State Route 18, which could prevent unauthorized OHVs from entering—has been knocked down or has fallen down due to heavy snow drifts (Eliason, pers. obs. 2010). In 2010, the USFS placed boulders at the entrance of these roads to prevent illegal OHV activity, which appears successful in reducing impacts from this threat (Eliason, pers. obs. 2010) on USFS land. Currently 10 of the 16 known extant occurrences are subject to impacts from OHV activity (USFWS, 2011).

Stressor: Alteration of hydrology (USFWS, 2011)**Exposure:****Response:****Consequence:** Loss of habitat

Narrative: Alteration of soil hydrology or existing drainage patterns may have impacted several *Sidalcea pedata* occurrences including Eagle Point (EO 21) and the north shore of Baldwin Lake (EO 1). At each of these locations, efforts were made to prevent hydrology-related impacts to the habitat and to the species. For instance, CDFG’s purchase of private lands containing the watershed for the north shore of the Baldwin Lake occurrence (EO 1; Baldwin Lake Ecological Reserve) in 1992 has helped to maintain natural hydrologic patterns. The Pan Hot Springs occurrence (EO 12) is found on deed restricted land; however, the water source for the habitat is not included in the deed restriction. Without control of water availability, the plants and their habitat at this occurrence remain threatened (USFS 2002, p. 25). While protection measures have lessened the threat of altered hydrology at several occurrences, it remains a rangewide threat to 14 of the 16 known extant occurrences (Appendix 1) (USFWS, 2011).

Stressor: Invasive nonnative plants (USFWS, 2011)**Exposure:****Response:****Consequence:** Loss of habitat

Narrative: *Thinopyrum intermedium* (previously *Elytrigia intermedia*) (intermediate wheatgrass) has been identified as a threat to occurrences at Baldwin Lake (EOs 1, 8, 9, 23, 24, 30), Eagle Point (EOs 19 and 21), and in the south of Pan Hot Springs (EO 12). An entire population at the northern end of the Pan Hot Springs occurrence (EO 12) has been extirpated from the meadow edge since the early 1990s by a dense invasion of *T. intermedium* (Krantz 2008, p. 11; Eliason, pers. comm. 2011). *Thinopyrum intermedium* invades *Sidalcea pedata* habitat and outcompetes it for space. It also produces a thatch that *S. pedata* seedlings cannot penetrate. Control methods

such as burning or mowing have proven ineffective as both grasses are perennial and that returns in subsequent years (Eliaison, pers. obs. 2010). Nonnative plants are a threat to 14 of the 16 known extant occurrences of *S. pedata* (Appendix 1) (USFWS, 2011).

Stressor: Predation (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Since the time of listing, horse grazing and pasturing activities have been identified as threats that are impacting occurrences at Pan Hot Springs (EO 12), Metcalf Creek (EO 17), and Bluff Lake (EO 6). Voluntary landowner agreements resulted in the relocation of equestrian activities away from rare plant habitat in the areas, and in 1987, horse corrals were removed from Pan Hot Springs. These efforts were successful and recovery of *Sidalcea pedata* populations has been observed at that location (USFS 2002, p. 19). Horse grazing and pasturing activities remains a threat to only 3 of 16 *S. pedata* occurrences at the east and south shores of Baldwin Lake (EOs 8, 9, 30). These occurrences are on private lands and there are no protective measures in place to reduce this threat (USFWS, 2011).

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: In summary, the Act is the primary Federal law that has provided protection for *Sidalcea pedata* since its listing as endangered in 1984. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for *S. pedata* absent its status under the Act. One occurrence at Baldwin Lake (EO 1) is considered fully protected; however, even this population is impacted by recreational activities and illegal trespass. Two of the 16 extant *S. pedata* occurrences are afforded protection through local agencies by protecting land to conserve rare plant populations. There are also unresolved conflicts between State protections afforded under CESA and NPPA and county weed abatement provisions. Therefore, State and other Federal laws and regulations have limited ability to protect the species in absence of the Act. Inadequacies in provisions or implementation in regulatory mechanisms are not considered threats to the species, although these inadequacies may permit or precipitate actual threats that are described under Factors A, B, C, and E (USFWS, 2011).

Stressor: Recreational activities (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of individuals/loss of habitat

Narrative: Impacts associated with recreational activities have been identified as a rangewide threat to *Sidalcea pedata* (Appendix 1). Recreational activities include but are not limited to: hiking, camping, fishing, horse riding, mountain biking, and dog walking. The primary impact from recreational activities is trampling that can crush and kill individual plants. Additional impacts include soil compaction, devegetation, escaped campfire threats, introduction or spread of nonnative species, and burial of plants with litter (USFS 2002, p. 23). Fencing and signage indicating the presence of sensitive species have proven effective at reducing the threat of recreational activities at the north and south shore of Baldwin Lake. Moderate success has also

been made in educating the public and heightening the awareness of the need for the protection and recovery of *S. pedata* and numerous other listed and rare species near Big Bear Lake. The Big Bear Discovery Center at San Bernardino National Forest regularly presents public education programs on a variety of subjects, including threatened and endangered species (USFS 2000b, p. 80). Though recreational activities are a rangewide threat, the resulting impacts have been reduced at Pan Hot Springs (EO 12) and Bluff Lake (EO 6) through coordination with private landowners (USFS 2002, p. 23) (USFWS, 2011).

Stressor: Fire suppression measures (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Implementation of fire suppression measures has been identified as a threat at 11 of 16 extant *Sidalcea pedata* occurrences. The San Bernardino County Land Use/Fire Hazard Abatement Division (see Factor D discussion) requires that owners must remove weeds and grasses in areas where this vegetation acts as fuel that may pose a fire threat. Weeds and grasses are described by the County of San Bernardino generally as annuals that grow and dry out each year, and thus removal activities do not discriminate for rare plants (County of San Bernardino 2010). Weed and grass removal generally involves mowing, which damages or destroys individual *S. pedata* plants. If removal activities are conducted before or during *S. pedata* flowering and fruit development, the plants reproductive output and germination may be significantly impacted. While *S. pedata* appears to be a robust species and has been observed in mowed, vacant lots (Eagle Point (EO 21), Metcalf Creek (EO 17)), these populations (or in many cases just individual perennial plants) may be “hanging on” and not reproducing (Eliason, pers. obs. 2010). If mowing is to continue, effort should be made to time this activity to avoid impacting *S. pedata* germination and the persistence of the populations (USFWS, 2011).

Stressor: Reduced populations (USFWS, 2011)

Exposure:

Response:

Consequence: Lack of genetic variability

Narrative: Fragmentation and isolation can adversely impact small populations of plants that are already reduced in distribution such as *Sidalcea pedata* resulting in increased vulnerability to extirpation (Barrett and Kohn 1991, pp. 3–30). These effects may be the result of several factors, including small areas of suitable habitat, local extirpations, or ongoing natural or artificial factors limiting establishment and survival of the taxon. The small numbers of *Sidalcea pedata* occurrences is a concern because it increases the possibility that impacts from urban development or other activities near moist meadow habitat could destroy all or a significant portion of the species’ population. *Sidalcea pedata* is distributed on less than 8.1 ha (20 ac) of moist meadow habitat (USFWS 1998, p. iii). Stochastic events outside the natural range of frequency and severity (such as floods, fires, contamination, or drought) can substantially reduce or eliminate species such as *S. pedata* with a restricted range and small population, and increase the likelihood of its extinction (Lande 1993, p. 912). Genetic effects may further influence population demography via inbreeding depression and genetic drift (Barrett and Kohn 1991, pp. 3–30; Menges 1991, pp. 58–61). Allee (1931, pp. 17– 50) suggested small, single populations are vulnerable to extirpation when opportunities for reproduction diminish because of reduced opportunity of individuals to reproduce (Allee effect or depensation) (Courchamp et al. 2008, pp. vi–216). Stephens et al. (1999, pp. 185–190), Dennis (2002, pp. 389–401) and Courchamp et al.

(2008, pp. vi–216) suggest that the Allee effect is a density-dependent event that is inversely related to population size (USFWS, 2011).

Stressor: Climate change and drought (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to particular species (including *Sidalcea pedata*) or sites at this time. It seems likely that *S. pedata*, a species restricted to montane meadows in a single small portion of a mountain range found on clay soils with particular hydrological needs, would be threatened rangewide by any differences in climatic regimes brought on by changes to the climate. A changing climate with spatial and temporal shifting of temperature and precipitation may cause this species-specific adaptations to climate to work against its survival. A changing climate may also provide advantages to other native and nonnative plant species. Sharing information between scientists, land managers, and decision makers will increase our ability to address these threats. Increasing the success with which we address current threats to *S. pedata* will increase our success of handling the uncertain effects of future climate change (USFWS, 2011).

Recovery

Reclassification Criteria:

Populations of *Sidalcea pedata* and adjacent suitable habitat are fully protected through land management agreements, land ownership by resource agency or conservation organization, conservation easement, or other permanent means of protection (USFWS, 2011).

Populations are stable or increasing with allowances for natural fluctuations (USFWS, 2011).

Recovery Actions:

- Overall, while some steps have been made in achieving recovery, progress towards reclassifying and eventually delisting *Sidalcea pedata* has been largely unsuccessful and there are indications—such as two extirpations, and the significant habitat degradation at the east and south shores of Baldwin Lake (EOs 8, 9, 30), Metcalf Creek (EO 17) and Eagle Point (EO 21)—that *S. pedata* is facing an increasing threat of extirpation. The recovery plan was not threats based; consequently, action items necessary to meet the plan's recovery criteria are insufficient to reduce or eliminate the threats identified in the five-factor analysis and recover the species.

Conservation Measures and Best Management Practices:

- Work with partners, in particular private landowners, to help conserve *Sidalcea pedata*. Identify opportunities through the Service's Partners for Fish and Wildlife Programs to implement conservation opportunities on private lands (USFWS, 2011).
- Conduct monitoring to inventory actual occurrences and update the status of *Sidalcea pedata* occurrences throughout the species range. While the occurrences on the east side of Baldwin Lake (EOs 9, 30) are presumed extant, surveys should occur because they have not been conducted at this species location for many years (USFWS, 2011).

- Establish a seed bank focusing first on small, isolated populations that have the greatest potential to become extirpated (USFWS, 2011).
- Work with the State and San Bernardino County to resolve conflicts with the weed abatement plan (USFWS, 2011).
- Develop a threats-based recovery plan or outline to guide conservation actions for the species (USFWS, 2011).

References

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U.S. Fish and Wildlife Service. 2011. *Sidalcea pedata* pedate checker-mallow 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Carlsbad, CA.

SPECIES ACCOUNT: *Sideroxylon reclinatum* ssp. *austrofloridense* (Everglades bully)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/6/2017; Southeast Region (R4) (USFWS, 2017)

Physical Description

Everglades bully is a single to many-stemmed shrub, 3 to 6 feet (ft) (1 to 2 meters (m)) tall (Corogin and Judd 2014, pp. 410-412). The branches are smooth, slightly bent, and somewhat spiny. The leaves are thin, oval-shaped, 0.8 to 2 inches (in) (2 to 5 centimeters (cm)) long, evergreen, lance-shaped, and fuzzy on their undersides. The flowers are in axillary clusters. This subspecies is distinguished from the similar subspecies *S. reclinatum* ssp. *reclinatum* in Florida by its leaves, which are persistently pubescent (fuzzy) on their undersides, rather than smooth or pubescent only along the leaf midvein. In addition, the two subspecies are more reliably distinguished by differences in the micromorphology of the leaf epidermis. (USFWS, 2017)

Taxonomy

The genus *Sideroxylon* is represented by eight species in Florida. All of these plants were previously assigned to the genus *Bumelia*. *Sideroxylon reclinatum*, the Florida bully, is represented by three subspecies that range nearly throughout Florida and into neighboring states. The Everglades subspecies was first recognized by Whetstone (1985, pp. 544-547) as *Bumelia reclinata* var. *austrofloridense*, then transferred to the genus *Sideroxylon* (Kartesz and Gandhi 1990, pp. 421-427). *Sideroxylon reclinatum* ssp. *austrofloridense* was made a subspecies rather than a variety (Kartesz and Gandhi 1990, pp. 421-427); in plant nomenclature, the ranks of variety and subspecies are interchangeable. *Sideroxylon reclinatum* ssp. *austrofloridense* is used in the current treatment of the Florida flora (Wunderlin and Hansen 2016, p. 1). The online Atlas of Florida Vascular Plants (Wunderlin and Hansen 2016, p. 1), Integrated Taxonomic System (ITIS 2016, p. 1), NatureServe (2016, p. 1), and the Florida Department of Agriculture and Consumer Services (FDACS) (Coile and Garland 2003, p. 19) indicate that *Sideroxylon reclinatum* ssp. *austrofloridense* is the accepted taxonomic status. (USFWS, 2017)

Historical Range

The historical range of *Sideroxylon reclinatum* ssp. *austrofloridense* is limited to Collier, Miami-Dade, and Monroe Counties, Florida. In Miami-Dade County, the plant was known from central and southern Miami-Dade County along the Miami Rock Ridge, which extends from Long Pine Key in the Everglades northward through urban Miami to the Miami River. In Monroe County, the plant is known from Big Cypress National Preserve on the mainland, and was collected as far south as Key Largo, in the Florida Keys. In Collier County, the subspecies has been recorded only within Big Cypress National Preserve. The subspecies is apparently extirpated from Key Largo, and has not been found in surveys of pine rocklands on Key Largo, Big Pine Key, Cudjoe Key and Lower Sugarloaf Key. (USFWS, 2017)

Current Range

The current range of *Sideroxylon reclinatum* ssp. *austrofloridense* is in Miami-Dade and Monroe Counties, Florida, in Big Cypress National Preserve, the Long Pine Key region of Everglades

National Park, and pine rocklands adjacent to Everglades National Park. The current range is approximately 42 mi (67.5 km). (USFWS, 2017)

Critical Habitat Designated

Yes;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (USFWS, 2017)

Reproduction Narrative

Adult: Little is known about the life history of *Sideroxylon reclinatum* ssp. *austrofloridense*, including pollination biology, seed production, or dispersal. Reproduction is sexual, with new plants generated from seeds. The subspecies produces flowers from April to May, and fruit ripens from June to July. (USFWS, 2017)

Habitat Type

Adult: Pine rockland habitat, marl prairie habitat, and within the ecotone between both habitats (USFWS, 2017)

Dependencies on Specific Environmental Elements

Adult: Periodic fire is extremely important to maintaining habitat for this subspecies (USFWS, 2017)

Tolerance Ranges/Thresholds

Adult: The plants can stand partial inundation with fresh water for a portion of the year, but do not tolerate salinity. (USFWS, 2017)

Dependency on Other Individuals or Species for Habitat

Adult: The species frequently has numerous stem galls, but these galls do not appear to cause mortality to the plant and may in fact be an important part of the subspecies' natural history. In addition, the stem galls are often inhabited by acrobat ants. (USFWS, 2017)

Habitat Narrative

Adult: *Sideroxylon reclinatum* ssp. *austrofloridense* grows in pine rockland habitat, marl prairie habitat and within the ecotone between both habitats. These habitats are maintained by regular fire, and are prone, particularly marl prairie, to annual flooding for several months during the wet season. The species also grows on the sunny edges of rockland hammock habitat, which is fire-resistant. Everglades bully occurs in sparsely vegetated, well-lit, open areas that are maintained by disturbance. (USFWS, 2017)

Dispersal/Migration**Dispersal**

Adult: Unknown (USFWS, 2017)

Population Information and Trends**Population Trends:**

Unknown (USFWS, 2017)

Number of Populations:

13 extant populations (USFWS, 2017)

Population Size:

10,000 to 100,000 plants, mostly occurring at Long Pine Key (USFWS, 2017)

Population Narrative:

The largest population occurs at Long Pine Key in Everglades National Park (ENP). The population at Long Pine Key is estimated at between 10,000-100,000 plants. Recent surveys of ENP have identified 14 occurrences of *Sideroxylon reclinatum* ssp. *austrofloridense* in Long Pine Key, expanding the known range in ENP. In Miami-Dade County, outside ENP, pine rocklands tracts are orders of magnitude smaller and exist in a matrix of agricultural, commercial, and residential development. Approximately 73 plants were observed at Larry and Penny Thompson Park, within the Richmond Pine Rocklands. Extant populations have been found at Quail Roost Pineland (two plants), Navy Wells Pineland Preserve (four plants), and Sunny Palms Pinelands (two plants). The subspecies has been observed in pine rocklands at Grant Hammock and Pine Ridge Sanctuary. The subspecies no longer occurs at the Nixon-Smilely Preserve. Surveys in the Gum Slough region of Lostmans Pines in Big Cypress National Park reported finding *Sideroxylon reclinatum* ssp. *austrofloridense* with limited distribution within the study area (USFWS, 2017)

Threats and Stressors

Stressor: Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range

Exposure:

Response:

Consequence:

Narrative: Habitat loss, fragmentation and degradation, and associated pressures from increased human population are major threats this species. These threats are expected to increase as remaining pine rocklands and other habitats are lost to development, placing these plants at greater risk. This species may be impacted when pine rocklands are converted to other uses or when lack of fire causes the conversion to hardwood hammocks or other unsuitable habitats. On public lands, including National Park Service lands and Miami-Dade County-owned lands, implementation of prescribed fire has not been sufficient because of legal constraints (permitting requirements) and inadequate funding. Any populations of this species found on private property could be destroyed due to development. Although efforts are being made to conserve natural areas and apply prescribed fire, most pine rocklands remain in poor fire condition, and the long-term effects of large-scale and wide-ranging habitat modification, destruction, and curtailment will last into the future, while ongoing habitat loss due to population growth, development, and agricultural conversion continues to pose a threat to this species outside of conservation lands.

Stressor: Inadequacy of Existing Regulatory Mechanisms

Exposure:

Response:**Consequence:**

Narrative: This species is found on Federal, State and County lands. NPS regulations provide protection at Everglades National Park and Big Cypress National Preserve. These two sites continue to support the largest and best managed populations. State regulations provide protection against trade, but allow private landowners or their agents to clear or remove species on the Florida Regulated Plant Index. State Park regulations provide protection for plants within Florida State Parks. The Natural Forest Communities program in Miami is designed to protect rare and important upland (non-wetlands) habitats in south Florida; however, this regulatory strategy has several limitations that reduce its ability to protect this plant and its habitat. Although many populations of this species are afforded some level of protection because they are on public conservation lands, especially Federal lands, existing regulatory mechanisms vary in strength and scope, and do not provide substantive protection of habitat at this time. They have not led to a sufficient reduction of threats posed to these plants by a wide array of sources. (USFWS, 2017)

Stressor: Other Natural or Manmade Factors Affecting Its Continued Existence

Exposure:**Response:****Consequence:**

Narrative: Threats from other natural or manmade factors to this species include nonnative, invasive plants; management practices (such as mowing); recreation (including off-road vehicle use), effects from small population size and isolation; limited geographic range; and stochastic events including hurricanes, storm surges, and wildfires. Additionally, this plant is particularly vulnerable to the effects of climate change, including sea level rise, as changes in the water table, increased soil salinity from partial inundation, and storm surge will likely result in vegetation shifts in the decades prior to the fully anticipated sea level rise. Some of these threats (e.g., nonnative species) may be reduced on public lands due to active programs by Federal, State, and County land managers. Many of the remaining populations of this plant are small and geographically isolated, and genetic variability is likely low, increasing the inherent risk due to overall low resilience of these plants. The threats act together to impact populations of this species. (USFWS, 2017)

Recovery**Reclassification Criteria:**

Not defined.

Delisting Criteria:

Not defined.

Recovery Actions:

- Recovery actions have not been defined.

Conservation Measures and Best Management Practices:

- Conserve pine rocklands and suitable habitat through purchase or conservation easements.
- Provide regular prescribed burns to maintain suitable habitat conditions.
- Remove exotic plants and hardwoods to restore understories.

- Monitor and manage remaining small populations in Miami-Dade County.
- Locate new occurrences within Everglades National Park through additional surveys.
- Establish the limits of this species habitat requirements through additional surveys within Everglades National Park.
- Determine effects (positive or negative) from Everglades restoration and other hydrologic manipulations and changes through monitoring at Long Pine Key.

References

USFWS. 2017. Endangered Species Status for *Dalea carthagenensis* var. *floridana* (Florida Prairie-clover), and Threatened Species Status for *Sideroxylon reclinatum* ssp. *austrofloridense* (Everglades Bully), *Digitaria pauciflora* (Florida Pineland Crabgrass), and *Chamaesyce deltoidea* ssp. *pinetorum* (Pineland Sandmat). Final Rule. 82 FR 46691-46715 (October 6, 2017).

USFWS. 2017. Endangered Species Status for *Dalea carthagenensis* var. *floridana* (Florida Prairie-clover), and Threatened Species Status for *Sideroxylon reclinatum* ssp. *austrofloridense* (Everglades Bully), *Digitaria pauciflora* (Florida Pineland Crabgrass), and *Chamaesyce deltoidea* ssp. *pinetorum* (Pineland Sandmat). Final Rule. 82 FR 46691-46715 (October 6, 2017).

USFWS 2013. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for *Sideroxylon reclinatum* ssp. *austrofloridense* (Everglades Bully). U.S. Fish and Wildlife Service, Region 4 (Southeast Region)

March 20, 2013

16 p.

SPECIES ACCOUNT: *Silene alexandri* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/08/1992; Pacific Region (R1) (USFWS, 2016)

Physical Description

A subshrub 3-6 dm tall. Flowers are white. (NatureServe, 2015)

Taxonomy

Silene alexandri was described by Hillebrand (1888) based upon a specimen he discovered on Molokai (USFWS 1992) (USFWS, 1996).

Historical Range

See current range/distribution

Current Range

Current range: central Molokai; historically no additional range.

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Silene alexandri* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one detailed critical habitat unit (CHU), in Maui County in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Silene alexandri* includes one CHU in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Molokai—Lowland Mesic—Unit 1 (and) *Palmeria dolei*—Unit 37—Lowland Mesic (and) *Pseudonestor xanthophrys*—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Ctenitis squamigera*, *Cyanea dunbariae*, *C. mannii*, *C. profuga*, *Cyperus fauriei*, *Cyrtandra filipes*, *Gouania hillebrandii*, *Labordia triflora*, *Neraudia sericea*, *Santalum haleakalae* var. *lanaiense*, *Schiedea lydgatei*, *S. sarmentosa*, *Silene alexandri*, *S. lanceolata*, *Spermolepis hawaiiensis*, and *Zanthoxylum hawaiiense*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Mesic—Unit 1 is not known to be occupied by *Asplenium dielerectum*, *Bonamia menziesii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea procera*, *C. solanacea*, *Diplazium molokaiense*, *Festuca molokaiensis*, *Flueggea neowawraea*, *Isodendron pyriformis*, *Kadua laxiflora*, *Melicope mucronulata*, *M. munroi*, *M. reflexa*, *Phyllostegia haliakalae*, *P. mannii*, *P. pilosa*, *Sesbania*

tomentosa, *Stenogyne bifida*, or *Vigna o-wahuensis*, or the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Silene alexandri* critical habitat consists of one component. Lowland mesic (Molokai) (81 FR 17790-18110):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further

degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkii*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources**Reproductive Strategy**

Adult: Unknown (USFWS, 1996)

Reproduction Narrative

Adult: Currently, no life history information is available for this species (USFWS, 1996).

Habitat Type

Adult: Shrubland/Dry forest (USFWS, 1996)

Habitat Narrative

Adult: Species inhabits moist shrublands on steep rocky slopes. (NatureServe, 2015). The two known populations are found in remnant dry forest and shrubland at an elevation between 610 and 760 meters (2,000 and 2,500 feet). Associated plant species include aalii, ohia, pukiawe, and uluhe (USFWS 1992) (USFWS, 1996).

Dispersal/Migration**Motility/Mobility**

Adult: Unknown (USFWS, 1996)

Dispersal/Migration Narrative

Adult: Currently, no life history information is available for this species (USFWS, 1996).

Population Information and Trends**Population Trends:**

Increasing (USFWS, 2014)

Resiliency:

Low (USFWS, 2014)

Representation:

Low (USFWS, 2014)

Redundancy:

Low (USFWS, 2014)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Fragility unknown. A total of fewer than 50 plants observed. 1 current (between 1982 and 1997) and 1 historical occurrence. (NatureServe, 2015). Surveys conducted by the Plant Extinction Prevention Program (2009) discovered four new individuals of *Silene alexandri* at Kewela in a population containing 17 individuals previously. In 2012, the single population contained 25 mature wild individuals of *S. alexandri* (PEPP 2012). Overall, the numbers of individuals have increased from approximately 6 individuals reported in the previous 5-year review to approximately 25 individuals in 2012 (PEPP 2012). The increase in numbers resulted from additional surveys (USFWS, 2014). Low resiliency, representation and redundancy are based on the species being known from a single population with few individuals and its specific habitat requirements.

Threats and Stressors

Stressor: Climate change (USFWS, 2014)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Climate change destruction or degradation of habitat – Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Silene alexandri* is highly vulnerable to the impacts of climate change. Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2014).

Stressor: Feral deer (USFWS, 2014)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Ungulate degradation of habitat – Axis deer (*Axis axis*) populations have increased on Molokai and are now found in areas occupied by *S. alexandri* (PEPP 2011, 2013) (USFWS, 2014).

Stressor: Landslides/flooding (USFWS, 2014)

Exposure:

Response:

Consequence: Extinction

Narrative: Landslides and flooding destruction or degradation of habitat – The single population is threatened by landslides and erosion (PEPP 2009, 2013) (USFWS, 2014).

Stressor: Stochastic events (USFWS, 2014)

Exposure:

Response:

Consequence: Extinction/loss of habitat

Narrative: Stochastic events – Drought mortality or reduced viability – Drought may exacerbate the effects of ungulates and has direct adverse impacts on *S. alexandri* (PEPP 2013). In addition, fire is a threat to the single known population of this species (USFWS, 2014).

Stressor: Slug herbivory (USFWS, 2014)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Slug herbivory – Herbivory by slugs (unidentified species) have been reported as a new threat to this species (PEPP 2012, 2013) (USFWS, 2014).

Stressor: Rodent predation and herbivory (USFWS, 2014)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Rodent predation and herbivory – Rats (*Rattus* sp.) are considered a threat to *S. alexandri* (PEPP 2010, 2012) (USFWS, 2014).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: We previously reported that climate change may pose a threat to this species, anticipating an analysis by 2013. The assessment conducted by Fortini et al. (2013) concluded that *S. alexandri* is extremely vulnerable to the impacts of climate change, with a vulnerability score of 0.991 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this species has no overlap between current and future climate envelopes, and is unlikely to tolerate expected changes in climate at its current location. This means that this species must persist within suitable microrefugia, or move to newly available climate-compatible areas to avoid extinction. Therefore, additional management actions, including potential for assisted translocations, are needed to conserve this taxon into the future (USFWS, 2018).

Recovery

Reclassification Criteria:

For downlisting, a total of at least five populations, with at least 300 plants each (a total of 1,500 mature plants) must be sustained for five years (USFWS, 1996).

Delisting Criteria:

For delisting, a total of at least five populations, with at least 300 plants each (a total of 1,500 mature plants) must be sustained for ten years (USFWS, 1996).

Conservation Measures and Best Management Practices:

- Ungulate monitoring and control – Maintain fencing to exclude browsing by ungulates (USFWS, 2014).
- Invasive plant monitoring and control – Continue control of invasive introduced plant species within fenced areas (USFWS, 2014).
- Captive propagation for genetic storage and reintroduction o Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. o Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change (USFWS, 2014).

- Reintroduction/translocation – Augment populations as genetically appropriate individuals become available in nurseries and as habitat is protected (USFWS, 2014).
- Surveys / inventories – Survey the geographical and historical range of *Silene alexandri* for a thorough current assessment of the species' status (USFWS, 2014).
- Fire monitoring and control – Develop and implement a fire management plan at the existing exclosure (USFWS, 2014).
- Climate change adaptation strategy – Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change (USFWS, 2014).
- Alliance and partnership development – Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2014).
- New Management Actions:
 - Captive propagation for genetic storage and reintroduction—
 - o The Lyon Arboretum Micropropagation Laboratory reported 164 containers of propagules representing seven individuals from Kawela. The Lyon Arboretum Seed Conservation Laboratory reported almost 22,000 seeds in storage representing 19 plants from one population at Kawela; almost 11,000 seeds in storage representing 11 plants from a second population at Kawela; and over 1,000 seeds representing crosses of individuals at Mākolelau (Lyon Arboretum 2017).
 - o The University of California—Irvine (2014) reported six plants in storage representing three wild individuals.
 - Stochastic events—Build resiliency and redundancy—In 2015, the Plant Extinction Prevention Program (PEPP) outplanted 28 individuals at Kawela and 13 individuals at Mākolelau. In 2016, PEPP outplanted 358 individuals at Kawela (21 founders represented). In 2017, PEPP outplanted 321 individuals at Kawela and 20 individuals at Kamiloloa gulch (PEPP 2015, 2016, 2017a, 2017b) (USFWS, 2018).

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SPECIES ACCOUNT: *Silene hawaiiensis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Threatened; 03/04/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

Silene hawaiiensis is in the Caryophyllaceae, or pink family. It is a sprawling, short-lived shrub with slanting or climbing stems approximately 15 to 40 centimeters (6 to 16 inches) long that arise from an enlarged root, and are generally covered with short, sticky hairs. Leaves are slender, often recurved, and stalkless. The stems are 6 to 15 millimeters (0.2 to 0.6 inch) long and 0.5 to 0.8 millimeters (0.02 to 0.03 inch) wide. Flowers are borne in loosely arranged, elongate, sticky clusters. The calyx is fused, five-toothed, purple-tinged, and 11 to 14 millimeters (0.02 to 0.03 inch) long. Petals are green-white above and sometimes maroon or maroon-streaked below. Each petal is divided into two parts, a two-lobed expanded blade and a long narrow, stalk-like base (U.S. Army 2003a).

Historical Range

See current range/distribution

Current Range

Silene hawaiiensis is endemic to the island of Hawaii. The species can be found on the western slopes of Mauna Kea; the Hualalai summit and Humuula saddle; the northern, western, and northwestern slopes of Mauna Loa; and near the Kilauea Crater. Currently more than 50 occurrences are known in a 200-square kilometer (77-square mile) area (U.S. Army 2003a).

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Silene hawaiiensis* on the island of Hawaii (68 FR 39623 - 39722).

Critical Habitat Designation

The critical habitat designation for *Silene hawaiiensis* includes two units totaling 6,908 acres in Hawaii county, Hawaii. The units are Hawaii 25—*Silene hawaiiensis*—a and Hawaii 27—*Silene hawaiiensis*—b. Each unit is essential to the conservation of *S. hawaiiensis* because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population. Each unit provides habitat for a population that is geographically separated from other recovery populations of this islandendemic species within its historical range in order to reduce the likelihood of all recovery populations being destroyed by one naturally occurring catastrophic event. The two units designated provide habitat for a total of three populations, each with 300 mature, reproducing individuals. The excluded lands at PTA provide habitat for seven additional populations.

Hawaii 25—*Silene hawaiiensis*—a [854 ha (2,110 ac)]: This unit contains a portion of Kipuka Kulalio, it is completely within the Kapapala watershed, and it lies completely within HVNP. The

unit provides habitat for 1 population of 300 individuals of *S. hawaiiensis*, and is currently occupied by about 1,800 individuals.

Hawaii 27—*Silene hawaiiensis*—b [1,942 ha (4,798 ac)]: This unit contains Uwekahuna Bluff; portions of the lava flows of 1919, 1921, and 1961; a portion of Kilauea Crater; and all of Halemaumau Crater. The unit is entirely in the Kapapala watershed and lies completely within HVNP. This unit provides habitat for 2 populations of 300 individuals of *S. hawaiiensis* and is currently occupied by 3,851 to 3,951 individuals. This unit provides the southeasternmost critical habitat within the species' historical range.

Primary Constituent Elements/Physical or Biological Features

Habitat features that are essential for this species include, but are not limited to, montane and subalpine dry shrubland on weathered lava, on variously aged lava flows, and cinder substrates.

Special Management Considerations or Protections

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for this species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Life history information is limited. Flowering has been observed in August and September. Most plants surveyed have been adults. The species is considered short-lived; however, the plant may be longer lived than originally thought because it can sprout from a large, woody taproot. The species has also been documented to resprout following fire (U.S. Army 2003a).

Habitat Type

Adult: montane and subalpine dry shrublands

Habitat Narrative

Adult: *Silene hawaiiensis* typically grows in montane and subalpine dry shrublands on decomposed lava and ash, as well as on all ages of lava and cinder substrates at elevations from 900 to 1,300 meters (2,953 to 4,265 feet). The species is found on barren lava, on disturbed

sites, and in Sparse *Metrosideros* Treelands, Open *Metrosideros* Treelands with sparse shrub understory, Open *Metrosideros* Treelands with dense shrub understory, *Chenopodium* Shrublands, Open *Dodonaea* Shrublands, *Dodonaea* Mixed Shrublands, *Sophora-Myoporum* Shrublands with forb understory, *Leptecophylla-Dodonaea* Shrublands, and *Eragrostis* Grasslands.

Dispersal/Migration

Population Information and Trends

Population Size:

> 50

Population Narrative:

Currently more than 50 occurrences are known in a 200-square kilometer (77-square mile) area (U.S. Army 2003a).

Threats and Stressors

Stressor:

Exposure:

Response:

Consequence:

Narrative: Threats to *Silene hawaiiensis* include sheep, goats, and pigs browsing and trampling (browsing can be severe to the base of the plant, as mouflon sheep and feral pigs are known to root up and consume the fleshy taproot); competition by non-native plant species such as *Pennisetum setaceum*; disturbances associated with military exercises; fire; and property development (U.S. Army 2003a).

Stressor: Collecting impacts

Exposure:

Response:

Consequence:

Narrative: Illegal collection for scientific, horticultural or other purposes threatens the populations of *S. hawaiiensis*, as well as possible excessive visitation. For instance, in 2013, two reintroduced individuals of *S. hawaiiensis* were uprooted in the Mauna Kea area and those two plants were stolen along with other common and federally listed plants (P. Peshut and S. Evans, U.S. Army, pers. comm. 2013). This incident was reported to the State of Hawaii's Division of Conservation and Resource Enforcement (DOCARE) and the U.S. Fish and Wildlife Service's Office of Law Enforcement (OLE) (P. Peshut and S. Evans, pers. comm. 2013) (USFWS, 2015).

Recovery

Delisting Criteria:

To be considered for delisting, the taxon must be managed to control threats (e.g., fenced, weeding, etc.) in the five largest populations and be represented in an ex situ (off-site) collection. In addition, a minimum of eight to ten populations should be documented on island where the species now occur or occurred historically. Each of these populations must be

naturally reproducing and increasing in number, with a minimum of 300 mature individuals per population. Each population should persist at this level for a minimum of five consecutive years before delisting is considered. The delisting goals for this species have not been met, as only two of the known populations contain more than 300 mature individuals (Table 1). In addition, not all threats are being sufficiently managed throughout all of the populations (Table 2). This species is likely to become endangered in the foreseeable future throughout all or a significant portion of its range, and therefore, continues to meet the definition of threatened (USFWS, 2015).

Conservation Measures and Best Management Practices:

- Important conservation actions needed for *Silene hawaiiensis* include the following: construction of fenced exclosures around important occurrences to reduce impacts from feral ungulates and control and/or eradication of non-native plants, particularly *Pennisetum setaceum* to reduce threats from competition, habitat degradation, and fire (Service 1996a). In addition, a State-wide management plan that identifies areas and landscapes for the long-term conservation of all known occurrences of *S. hawaiiensis* is needed. As part of this management plan, landowners and managers should delineate management units to conserve this species and other native species through threat control and habitat restoration. Ongoing Conservation Actions: The Volcano Rare Plant Facility has 13 plants in cultivation that were propagated from a population at the Mauna Loa Radio Facility and about 100 seeds still germinating from that same location (Service 2003a). The Center of Environmental Management of Military Lands, Colorado State University is documenting all locations and condition (e.g., vigor, browse, disease) of this species. Research has been proposed to establish population distribution and genetic diversity of this species on the island of Hawaii (C. Bern, pers. comm.).
- Recommendations for Future Actions: ☐ Surveys / inventories – Survey geographical and historical range for a current assessment of the species' status. ☐ Captive propagation for genetic storage and reintroduction – Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. ☐ Ungulate monitoring and control – Maintain existing exclosures and monitor for potential incursions. ☐ Invasive plant monitoring and control – Eradicate invasive introduced plants within ungulate exclosures and maintain exclosures free of invasive plants. ☐ Population viability monitoring and analysis – Continue monitoring wild and reintroduced individuals. ☐ Fire monitoring and control – Develop and implement a fire management plan at the existing exclosures. ☐ Climate change adaptation strategy – Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. ☐ Alliance and partnership development – Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2015).

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SPECIES ACCOUNT: *Silene lanceolata* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

Silene lanceolata, a member of the Caryophyllaceae (pink) family, is a short-lived perennial. Flowers are white with deeply lobed, clawed petals, and stems are 15 to 50 cm (6 to 20 in) long and woody at the base. Leaves are narrow, smooth and fringed with hairs. This species is distinguished from other Hawaiian members of the genus by its erect stem, terminal inflorescence, and length of the calyx, clawed petals, and carpophore (ovary structure) (Wagner et al 1999) (USFWS, 2016).

Historical Range

Historically, *Silene lanceolata* was found on Kauai, in Makua Valley on Oahu, below Puu Kolekole in east Molokai, Maunalei on Lanai, and on Mauna Kea on Hawaii (USFWS, 2016).

Current Range

Current range: Molokai, Oahu, and Hawaii (USFWS, 2016)

Critical Habitat Designated

Yes; 3/19/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Silene lanceolata* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one detailed critical habitat units (CHUs), in Maui County in Hawaii (81 FR 17790-18110).

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Silene lanceolata* under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Silene lanceolata* (77 FR 57648-57862). The critical habitat designation includes 8 critical habitat units, which encompass approximately 1,449 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Silene lanceolata* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Silene lanceolata* includes one CHUs in Maui County, Hawaii with detailed unit information. There are also an unknown number of units on Lanai that contain this species (number of units is unknown because detailed unit descriptions for Lanai are not available) (81 FR 17790-18110).

Molokai—Lowland Mesic—Unit 1 (and) *Palmeria dolei*—Unit 37—Lowland Mesic (and) *Pseudonestor xanthophrys*—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of

State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Ctenitis squamigera*, *Cyanea dunbariae*, *C. mannii*, *C. profuga*, *Cyperus fauriei*, *Cyrtandra filipes*, *Gouania hillebrandii*, *Labordia triflora*, *Neraudia sericea*, *Santalum haleakalae* var. *lanaiense*, *Schiedea lydgatei*, *S. sarmentosa*, *Silene alexandri*, *S. lanceolata*, *Spermolepis hawaiiensis*, and *Zanthoxylum hawaiiense*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Lowland Mesic—Unit 1 is not known to be occupied by *Asplenium dielirectum*, *Bonamia menziesii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea procera*, *C. solanacea*, *Diplazium molokaiense*, *Festuca molokaiensis*, *Flueggea neowawraea*, *Isodendrion pyriformis*, *Kadua laxiflora*, *Melicope mucronulata*, *M. munroi*, *M. reflexa*, *Phyllostegia haliakalae*, *P. mannii*, *P. pilosa*, *Sesbania tomentosa*, *Stenogyne bifida*, or *Vigna o-wahuensis*, or the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat designation for *Silene lanceolata* includes 8 critical habitat units, covering one ecosystem type, which encompasses approximately 1,449 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac (105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Silene lanceolata* critical habitat consists of two components. Lowland dry (Lanai) and Lowland mesic (Molokai) (81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*. Subcanopy: *Chamaesyce*, *Dodonaea*, *Leptecophylla*, *Osteomeles*, *Psydrax*, *Scaevola*, *Wikstroemia*. Understory: *Alyxia*, *Artemisia*, *Bidens*, *Chenopodium*, *Nephrolepis*, *Peperomia*, *Sicyos*.

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Silene lanceolata* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Silene lanceolata* occurs within the indicated ecosystem in the Waianae Mountain caldera complex:

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. Dry Cliff. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: *Antidesma*, *Chamaesyce*, *Diospyros*, *Dodonaea*. (F) Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Schiedea*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be

currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium*

molokaiense, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Silene lanceolata* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Information on the reproductive cycles, longevity, specific environmental requirements, and limiting factors for this species are unknown (68 FR 35950) (USFWS, 2016).

Habitat Type

Adult: Cliff faces and ledges of gullies (USFWS, 2016)

Habitat Narrative

Adult: On Oahu, *Silene lanceolata* grows on cliff faces and ledges of gullies in dry to mesic shrublands at elevations between 351 and 978 m (1,151 to 3,208 ft). Associated native plant species include *Artemisia australis*, *Bidens* sp., *Carex* sp., *Chamaesyce* sp., *Dodonaea viscosa*, *Lysimachia* sp., *Osteomeles anthyllidifolia*, *Schiedea mannii*, or *Tetramolopium filiforme*. Information on the reproductive cycles, longevity, specific environmental requirements, and limiting factors for this species are unknown (68 FR 35950) (USFWS, 2016).

Dispersal/Migration

Population Information and Trends

Population Trends:

Unknown (USFWS, 2016)

Number of Populations:

6 (USFWS, 2016)

Population Size:

2,640 individuals (NatureServe, 2015)

Population Narrative:

Silene lanceolata is currently known from a total of 2,640 individuals on the islands of Molokai, Oahu, and Hawaii. On Molokai, a single occurrence of approximately 100 individuals was reported in 1987 on private land near Puu Kolekole. On Hawaii, it is found on the Army's Pohakuloa Training Area in Kipuka Kalawamauna, Puu KeeKee, and Kipuka Alala. These three occurrences are distributed over a distance of approximately 15 km (9 mi) and total more than 2,500 individuals. On Oahu, this species has increased from approximately 40 known individuals in five occurrences in mid to late 1990s to 157 known individuals in two occurrences in 2006 (U.S. Army Garrison 1999a, U.S. Army Garrison 2006c) (Table SB 37). Thus, *S. lanceolata* is characterized by two population units at low numbers, and an overall abundance on Oahu that appears to be increasing but is due in part to increased monitoring efforts.

Threats and Stressors

Stressor: Feral ungulates (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Habitat destruction by feral goats, pigs, and sheep is listed as a threat to this species (USFWS, 2016).

Stressor: Fire (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Fire from military activities is listed as a threat to this species (USFWS, 2016).

Stressor: Non-native plants (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Competition with non-native plants is listed as a threat to this species (USFWS, 2016).

Stressor: Low numbers (USFWS, 2016)

Exposure:

Response:

Consequence: Extinction/loss of populations

Narrative: Almost half of individuals (98 percent) are located outside the action area, *S. lanceolata* has a moderate background risk of species extinction range wide and high background risk of species extinction (because of low numbers of individuals) on Oahu without protection from existing and additional threats (USFWS, 2016).

Stressor: Climate Change

Exposure:

Response:

Consequence:

Narrative: Climate change adaptation strategy – Fortini et al. (2013) conducted a landscapebased assessment of climate change vulnerability for native plants of Hawaii using high resolution

climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *S. lanceolata* is moderately vulnerable to the impacts of climate change. Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2015).

Stressor: Predator - Argentine Ants

Exposure:

Response:

Consequence:

Narrative: – In 2010, evidence of recent herbivory were present on approximately 9 percent of the monitored individuals of *S. lanceolata* at PTA, with the majority due to insect herbivory at 94 percent (U.S. Army 2010). Argentine ants (*Linepithema humile*) were noted once again in ASR 18; however, without further studies the direct and indirect impacts of Argentine ant to this species is unknown (U.S. Army 2010) (USFWS, 2015).

Recovery

Reclassification Criteria:

For downlisting, a total of five to seven populations of *Silene lanceolata* should be documented on islands where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. The downlisting goals for this species have not been met, as only two of the known populations contain more than 300 mature individuals (Table 1). In addition, all threats are not being sufficiently managed throughout all of the populations (Table 2). Therefore, *Silene lanceolata* meets the definition of endangered as it remains in danger of extinction throughout its range (USFWS, 2015).

Delisting Criteria:

Due to the limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1999a). Conservation actions required for stabilization are described in the “Stabilization” section of the project description for this opinion. However, *S. lanceolata* is not included as a target taxon for stabilization under the Makua Implementation Plan Addendum. The Army does not actively manage this species on Oahu (Service 2003a) (USFWS, 2016).

Conservation Measures and Best Management Practices:

- The recovery plan for *Silene lanceolata* identifies several conservation actions that should be implemented for its recovery. Fenced exclosures should be constructed at all known occurrences to reduce impacts from ungulates. Subsequent control of ungulates and rats from all occupied sites will remove their impact on this species and its habitat. Control measures for non-native plant species that threaten *S. lanceolata* should be implemented. Augmentation of existing occurrences and the establishment of new occurrences should be done by outplanting when adequate propagated materials are available. Control of highly flammable vegetation and maintenance of fuelbreaks is also needed, for plant occurrences found growing in areas of high risk from fire (USFWS, 2016).

- A State-wide strategic plan is being developed by the Hawaii and Pacific Plants Recovery Coordinating Committee that will address the long-term conservation of *Silene lanceolata* (Hawaii and Pacific Plant Recovery Coordinating Committee 2007). This plan will include broader landscape actions that are needed for the recovery of this plant throughout its range. This species is also being propagated at Pahole Mid-Elevation Rare Plant Facility, Pohakuloa Training Area Plant Facility, and the Volcano Rare Plant Facility (Service 1999a; Service 2005b). In addition occurrences of this species occur in two management units where they may benefit from stabilization management of other species and/or ecosystem-level protection. The management units are Ohikilolo, which is fenced; and Waianae Kai Management Unit, which are not fenced (USFWS, 2016).
- Recommendations for Future Actions:
 - ▣ Surveys / inventories – Survey geographical and historical range for a current assessment of the species' status.
 - ▣ Captive propagation for genetic storage and reintroduction
 - o Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range.
 - o Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change.
 - ▣ Ungulate monitoring and control – Maintain existing exclosures and monitor for potential incursions.
 - ▣ Invasive plant monitoring and control – Eradicate invasive introduced plants within ungulate exclosures and maintain exclosures free of invasive plants.
 - ▣ Population viability monitoring and analysis – Continue monitoring wild and reintroduced individuals.
 - ▣ Fire monitoring and control – Develop and implement a fire management plan at the existing exclosures.
 - ▣ Climate change adaptation strategy – Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change.
 - ▣ Alliance and partnership development – Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2015).

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SPECIES ACCOUNT: *Silene perlmanii* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/29/1991; Pacific Region (R1) (USFWS, 2016)

Physical Description

A subshrub, usually many-branched from base, often forming clumps. Stems are erect to ascending, and 3-5 dm long. Flowers are white. (NatureServe, 2015)

Historical Range

See current range/distribution

Current Range

Current range: Waianae Mountains of Oahu; historically no additional range.

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Silene perlmanii* under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Silene perlmanii* (77 FR 57648-57862). The critical habitat designation includes 11 critical habitat units, which encompass approximately 7,332 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Silene perlmanii* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Silene perlmanii* includes 11 critical habitat units, covering two ecosystem types, which encompass approximately 7,332 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). Oahu—Lowland Mesic—Units 1, 2, 3; Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley.

Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo.

Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge.

Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys.

Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua.

Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea.

Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea.

Oahu—Dry Cliff—Unit 8 [259 ac (105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawana, and partially within the Nanakuli Forest Reserve.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Silene perlmannii* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Silene perlmannii* occurs within the Lowland mesic and Dry cliff ecosystems in the Waianae Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (F) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. (F) Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Silene perlmannii* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History**Food/Nutrient Resources****Breeding Season**

Adult: *Silene perlmanii* flowers in the spring, depending on climatic conditions (USFWS, 1998)

Reproduction Narrative

Adult: Early fruiting *Silenes* are disseminated by wind. Birds also disperse seeds of *Silene*. It is not clear if this is secondary dispersal (NatureServe, 2015). *Silene perlmanii* flowers in the spring, depending on climatic conditions. Flowers last for a day. Fruits develop in a few weeks (USFWS 1995) (USFWS, 1998).

Habitat Type

Adult: Mesic forest cliff face (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 1998)

Environmental Specificity

Adult: Narrow/specialist (USFWS, 1998)

Tolerance Ranges/Thresholds

Adult: Low (USFWS, 1998)

Site Fidelity

Adult: High (USFWS, 1998)

Habitat Narrative

Adult: Species inhabits cliff face in diverse mesic forest (NatureServe, 2015). *Silene perlmanii* typically grows on cliff faces in diverse mesic forest at an elevation of 790 meters (2,600 feet) (USFWS 1995; Wagner et al. 1990). Associated species include *Plantago princeps* (laukahi kuahiwi) (USFWS 1995) (USFWS, 1998). Species was presumed extirpated. In 2003 15 individuals were outplanted in the Honolulu preserve, as of 2007 only 3 were known to survive (USFWS, 2012).

Dispersal/Migration**Dispersal**

Adult: Wind and bird dispersal (USFWS, 1998)

Dispersal/Migration Narrative

Adult: Early fruiting *Silenes* are disseminated by wind. Birds also disperse seeds of *Silene*. It is not clear if this is secondary dispersal.; (NatureServe, 2015)

Population Information and Trends

Resiliency:

Fragility unknown. (NatureServe, 2015)

Representation:

Fragility unknown. (NatureServe, 2015)

Redundancy:

Fragility unknown. (NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Adaptability:

Fragility unknown. (NatureServe, 2015)

Population Narrative:

Fragility unknown. Currently only two plants are known. One occurrence with 20 plants was discovered in 1987 and has since been reduced to a single plant. Two current (between 1982 and 1997) and no historical occurrences. (NatureServe, 2015)

Threats and Stressors

Stressor: Feral pigs (USFWS, 1998).

Exposure:

Response:

Consequence: Habitat loss/loss of individuals

Narrative: Habitat degradation and predation by feral pigs are a threat to this species (USFWS, 1998).

Stressor: Competition from invasive plants (USFWS, 1998).

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Competition from invasive plants is listed as a threat to this species (USFWS, 1998).

Stressor: Natural occurring event/reduced vegetative vigor (USFWS, 1998).

Exposure:

Response:

Consequence: Extinction

Narrative: Naturally occurring events (fire, landslides, etc) and reduced vegetative vigor are listed as threats to this species (USFWS, 1998).

Recovery

Reclassification Criteria:

For downlisting, a total of five to seven populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1998).

Delisting Criteria:

A total of 8 to 10 populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1998).

Conservation Measures and Best Management Practices:

- Captive propagation for genetic storage and reintroduction - Collect cuttings or seed from tagged individuals, keeping close track of the maternal source for use in ex situ propagation (USFWS, 2013).
- Reintroduction / translocation o While surveying for new populations or reintroduced populations, determine which sites are least invaded by invasive introduced plant species and which appear to have the highest likelihood of maintaining new reintroductions. o Continue to reintroduce the species back into its known historical range (USFWS, 2013).
- Ungulate exclosures - Construct, maintain, and monitor ungulate-proof exclosures around each population (USFWS, 2013).
- Ungulate control – Protect all populations against disturbances from feral ungulates (USFWS, 2013).
- Ecosystem-altering invasive plant species control – Control invasive introduced plant species around all populations (USFWS, 2013).
- Surveys / inventories – Survey geographical and historical range for a thorough current assessment of the species status (USFWS, 2013).
- Alliance and partnership development - Enhance coordination and collaboration among other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2013).
- Genetic research – Assess genetic variability within extant individuals (USFWS, 2013).
- Population biology research – Study *Silene perlmannii* with regard to geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2013).
- Threats research – Assess the modeled effects of climate change on this species, and use the results to determine future landscape needed for the recovery of the species (USFWS, 2013).

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SPECIES ACCOUNT: *Silene polypetala* (Fringed campion)

Species Taxonomic and Listing Information

Listing Status: Endangered; 2/19/1991; Southeast Region (R4)

Physical Description

Fringed campion is a perennial herb that forms mats by spreading vegetatively, with long, slender stolon-like rhizomes and leafy offshoots, both of which terminate in overwintering clusters of leaves (rosettes). Leaves of the rosette and stem are opposite, widest toward the tip, mostly 1-4 inches long. Each rosette produces one to several erect flowering shoots, each of which is unbranched or sparingly branched, up to 16 inches tall. The flowers are arranged in groups of 3-5 at the top of the flowering shoot. The calyx is tubular and covered with long, weak hairs. The 5 separate petals are each divided into a lower part about as long as the calyx and a triangular upper part that extends 1-11/2 inch from the calyx. The wide apex of each petal is divided into slender segments, giving the flower a fringed appearance. The petals are pink or white. Flowering is from late March to May (Kral 1983, Hitchcock and Maguire 1947, Faust 1981). The plant is easily recognized by its distinctive flowers. (USFWS, 1996)

Taxonomy

Research by Ward (2006) proposed an official change in nomenclature for the species, from *Silene polypetala* to *Silene catesbaei*. Ward's (2006) historical research found that the name *Silene polypetala*, formed in 1948 by Fernald and Schubert, based on their assessment of Thomas Walter's 1788 *Flora Caroliniana*, was erroneously applied to a fragmentary herbarium specimen they believed to be labeled by Walter as *Cucubalus polypetalus*. Ward (2006) proposes that the species and fragmentary herbarium specimen Thomas Walter referred to as *Cucubalus polypetalus* was either of two introduced species, *Silene cucubalus* or *Lychnis alba*--these two exotic species having been established in mountains of North Carolina by the eighteenth century. When Ward (2006) cross-referenced Thomas Walter's Latin prescriptions to specimen labels, he found a prescription for a new species termed by Walter as *Silene catesbaei*, a plant for which no herbarium specimen could be located in the *Flora Caroliniana*. Walter's Latin prescription appeared to Ward (2006) to be a better match to the species named by Fernald and Schubert and considered today as *Silene polypetala*. Since no type specimen matched Walter's prescription of *Silene catesbaei*, the International Code of Botanical Nomenclature guidelines allows for an author [Ward] to select a new type specimen, a neotype, to match the accepted name and prescription of *Silene catesbaei*, for which Ward (2006) did, selecting a specimen formerly and widely known as *Silene polypetala*. The neotype is a specimen of *Silene catesbaei*/*Silene polypetala* collected along Pobiddy Road in Talbot County, Georgia. USFWS accepts the name of *Silene catesbaei* for future documentation. However, to formally make this change in 50 CFR 17.12, it will require notice in the Federal Register (USFWS, 2015).

Historical Range

In six counties in Georgia: Bibb, Crawford, Decatur, Talbot, Taylor, and Upson Counties; in two counties in Florida: Gadsden and Jackson Counties. (USFWS, 1996)

Current Range

In eight counties in Georgia: Bibb, Crawford, Decatur, Houston, Talbot, Taylor, Twiggs, and Upson Counties; in two counties in Florida: Gadsden and Jackson Counties. (USFWS, 2015)

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual and asexual (USFWS, 1996)

Breeding Season

Adult: Flowering begins in late March at the Florida locales, and ends sometime in May at the sites near the Fall Line in Georgia, with fruits maturing a month later (NatureServe, 2015).

Reproduction Narrative

Adult: Although no studies of the reproductive biology of *Silene polypetala* are known to the author, the large, showy, nectariferous flowers are indicative of a sexually reproducing species dependent on insects for pollination, perhaps supplemented by hummingbirds. In the genus *Silene*, the nectar is concealed at the base of the calyx tube, and the flowers are probed by larger bees and lepidoptera (Zomlefer 1994). Flowering begins in late March at the Florida locales, and ends sometime in May at the sites near the Fall Line in Georgia, with fruits maturing a month later. Some, if not all, plants in cultivation exhibit male sterility as evidenced by flattened anther sacs and the production of few, if any well-formed pollen grains. Lack of sexual reproduction may, therefore, be one reason for this species not persisting in cultivation. Sexual reproduction is supplemented by, and quite possibly exceeded by asexual reproduction. *Silene polypetala* produces runners, nearly leafless basal, procumbent stems terminating in rooted rosettes of leaves. In time, the rosettes produce flowering stems and the connection to the original plant decays. Thus a colony that appears to be composed of numerous individuals may, in fact, harbor only one or very few genetic individuals. The clonal nature of this species creates difficulties for monitoring its status and progress towards recovery. Counting individuals seems impossible without genetic testing. There is no clear reason to examine the genetic structures of the populations if they are stable. Possibly, the best approach for monitoring of populations is by detailed mapping using permanent stakes (metal stakes driven into the ground can be relocated with a metal detector) combined with geographic positioning systems, which are useful relocating populations. While plants can be mapped precisely, use of the mapping methods is limited by the need for trained individuals and costly equipment (USFWS, 1996). This species spreads vegetatively and the number of genotypes is far fewer than the number of clusters of plants at a site (USFWS 1991) (NatureServe, 2015).

Habitat Type

Adult: Deciduous woods

Habitat Narrative

Adult: *Silene polypetala* occurs in various situations within hardwood forests. It is often on fairly steep slopes of deep ravines or north-facing hillsides, sometimes on nearly level ground, particularly in flatwoods developed on Iredell soils. The great majority of populations of *Silene polypetala* occur in the watershed of the Apalachicola River and its- tributary, the Flint River.

One factor that the sites seem to have in common is a circumneutral soil reaction, due to the nature of the parent material. In the Coastal Plain occurrences (Florida and Decatur County, Georgia) the parent material is limestone. In the Piedmont localities the parent material is a magnesium-rich rock, hornblende gneiss. (USFWS, 1996)

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Stable short term population trend (NatureServe, 2015)

Number of Populations:

40 (USFWS, 2015)

Population Size:

1500 - 2000 plants in Florida; no estimate for Georgia, but most sites are more extensive than the Florida sites (USFWS, 2015)

Resistance to Disease:

Plants in the wild appear to exhibit no apparent symptoms of disease. (USFWS, 2015)

Population Narrative:

Silene catesbaei is currently known from 40 sites in Georgia and Florida. No comparable, long-term data exists to determine trends for the species, but overall, available habitat appears to be degrading over much of its range. Jenkins and Baker (2006) estimated that approximately 1500-2000 plants occurred among 12 element occurrences in Florida. No abundance estimates exist for Georgia but most of the central Georgia sites are more extensive in size, in both the area *Silene catesbaei* occupies and the numbers of plants present (Pete Pattavina, pers. obs. 2006). Many *Silene catesbaei* populations are composed of only a few patches, can be overlooked when plants are not in flower, and often occur over only a few acres. New populations are periodically discovered during field status surveys, when new areas are explored in the vicinity of known sites. However, without public ownership of sites to remove the primary threat of clear-cutting of forest, in concert with specific management to ensure habitat stability on existing sites, the periodic discovery of new populations will do little to offset the risk of extinction to this species. Three sites are considered extirpated: (1) Rivoli Lakes, Bibb County, Georgia; (2) Colaparchee Creek, Bibb County, Georgia; and (3) Lumpkin Road, Talbot County, Georgia. None of these sites was very large but each was situated at the fringes of the species' range and could have represented genetically unique populations. (USFWS, 2015)

Threats and Stressors

Stressor: Habitat loss and/or degradation (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Habitat loss continues for *Silene catesbaei* as areas are clear-cut and other forested parcels suffer from infestation by exotic, invasive plant species that out-compete *Silene*

catesbaei. The largest known site (40 acres) in the Ocmulgee River drainage (Piedmont area) is at risk of losing *Silene catesbaei*, if English ivy continues to spread up the small stream courses where the species grows. Hundreds of acres of habitat in the Apalachicola River drainage are being impacted by invasive plants, many sites where other endangered plants occur, such as *Torreya taxifolia*. (USFWS, 2015).

Stressor: Predation by herbivores (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: One increased threat to the species is the burgeoning population of white-tailed deer (*Odocoileus virginianus*) that, on some sites, excessively browse the plants, preventing fruit development and seed set (Steve Bowling, pers. comm. 2004)(Wilbur Duncan, pers. comm. 2004)(Pete Pattavina, pers. obs. 2004). Steve Bowling observed an increase in deer pressure on *Silene catesbaei* populations, beginning in the early-to-mid 1980s. This observation is supported by data that shows rapid expansion of Georgia's white-tailed deer population since 1972, when the State deer herd expanded from 253,000 to approximately 990,000 in 2013, peaking in 1997 at 1,460,000 individuals (GDNR 2014). Although no data is available to prove that the increase in deer population has a negative effect on *Silene catesbaei* populations, deer modified population structure and plant robustness in other forest herbs (Anderson 1994)(Leege et al. 2010), caused declines in species richness in forests, evenness and species diversity (Rawinski 2008)(Webster et al. 2005). (USFWS, 2015)

Stressor: Inadequacy of existing regulation (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: State laws do not restrict private landowners from any lawful activity that would modify or destroy threatened or endangered plants. Therefore neither the Preservation of Native Plants of Florida Act nor the Georgia Wildflower Preservation Act has had a significant effect in minimizing habitat degradation or fragmentation on private lands, the primary threat to the listed species. Georgia's Wildflower Preservation Act of 1973 provides protection for this species, especially on state-owned land. Sites owned by the U.S. Army Corps of Engineers should be considered protected, although close communication with land managers is necessary to ensure *Silene catesbaei*'s needs are included in approved management protocols. The Endangered Species Act prohibits deliberate removal of endangered plants from these areas, and all Federal agencies have a responsibility to conserve endangered plants. (USFWS, 2015)

Recovery

Reclassification Criteria:

1. Reclassification of *Silene polypetala* to Threatened will be considered if 10 viable and geographically distinct populations are protected from foreseeable threats (USFWS, 1996).

Delisting Criteria:

1. Delisting of *Silene polypetala* will be considered if 20 of the known populations (including at least 16 in Georgia and 4 in Florida) are protected. Population viability should be confirmed

through periodic monitoring for at least a 10-year period (including at least 5 years of monitoring after delisting) (USFWS, 1996).

Recovery Actions:

- 1. Protect populations. *Silene polypetala* has an inherently narrow geographic and ecological distribution. In the absence of active conservation efforts, sites with this plant will gradually be lost or degraded for reasons described above. This plan emphasizes the conservation of existing populations rather than the creation of new ones. The plan assumes that most owners of sites with this plant are interested in its conservation and that they may be receptive to offers of biological monitoring and assistance with conservation measures such as honeysuckle control. Planning of exotic pest plant control is important enough to be a separate recovery task (4). (USFWS, 1996)
- 2. Preserve genetic stock from acutely threatened populations. Due to the scarcity of extant populations, conservation of the genetic diversity that remains in the species is a high priority. Therefore, some living material of the species should be moved from any population facing imminent local extinction (i.e., where protection is not feasible or cannot be initiated in time to prevent extirpation). At the time of writing, this is necessary for the Crawford County, Georgia population. It is not known whether seed can be stored, which would be less costly than maintaining plants in cultivation. (USFWS, 1996).
- 3. Monitor populations to determine trends and developing threats. All sites supporting *Silene polypetala* should be monitored, if landowners grant permission. Arrangements with landowners to allow monitoring are included in Task 1. (USFWS, 1996)
- 4. Plan control of exotic pest plants. - Assess threats. When sites are visited, the nature and extent of pest plant infestations must be noted. Information from *Silene* sites must be combined with information from similar habitats in central Georgia and the Apalachicola Bluffs region of Georgia, Florida, and Alabama. - Identify control methods. A great deal of information is available on exotics control, as well as practical experience by land managers. As threats are identified, possible control methods need to be sought and tried, then modified with experience. Herbicide treatments have the potential to destroy native forest species. (USFWS, 1996)
- 5. Search for additional populations. As indicated above, this species has been searched for previously. However, additional potential habitat exists which has not been checked. Just one example: areas in Monroe County, Georgia indicated on the state geological map as underlain by hornblende gneiss, the same mapping unit as nearby Bibb County localities for the species. (USFWS, 1996)
- 6. Reestablish populations and augment populations at protected locations, if deemed necessary. The feasibility of (re)introduction has not been demonstrated, nor will introductions be necessary if other recovery actions are successful. (USFWS, 1996).
- 7. Manage sites to maintain and/or enhance populations. As *Silene polypetala* is adapted to an environment in which successional change is relatively slow, maintenance of populations chiefly requires protection from disturbance. Results of the monitoring program (Task 3) should indicate whether human manipulation might benefit *Silene polypetala* in certain natural or experimental microhabitats. Because exotic pest plants can invade otherwise pristine habitats, controlling them may become the main management action. (USFWS, 1996)
- 8. Educate the public about the value and fragility of this species and its habitat. Since most of the landscape of the Piedmont and Coastal Plain is developed, in cultivation, or in a

successional state, relatively undisturbed hardwood forest can provide an all-too-rare primeval experience. They also have the potential to serve as outdoor classrooms for studying important ecological and/or evolutionary concepts such as succession, competition, endemism, and ecotypic differentiation. (USFWS, 1996)

- 9. Apply laws protecting endangered plant species. Employ local, State, and Federal regulations when they are appropriate to protect the sites where this plant occurs. (USFWS, 1996)

Conservation Measures and Best Management Practices:

- Update the most recent, draft recovery plan (USFWS 1996b), to incorporate genetic information and new populations (USFWS, 2015).
- Revisit and assess all known sites for viability and other population variables at least every two years (USFWS, 2015).
- Promote and/or fund long-term population and/or demographic monitoring projects through partnerships (USFWS, 2015).
- Acquire private forestry tracts and bring into public ownership for proper management of the species and its habitat. Land tracts in the Chattahoochee River basin should be given top priority for purchase because of the genetic and habitat diversity found there. Since the species generally occurs over small areas, purchasing large portions of the global range would be relatively inexpensive, since only several thousand acres may require purchase to ensure long-term protection and survival of the species. Formal conservation agreements and conservation easements may also be effective at protecting *Silene catesbaei* habitat (USFWS, 2015).
- Perform new searches for the species in the Ocmulgee River basin and Chattahoochee River drainage. Habitat modeling using one-meter Lidar data may be useful for this exercise (USFWS, 2015).
- Continue to fund long-term invasive species control at sites in the Apalachicola and Ocmulgee sites (USFWS, 2015).
- Monitoring needs to be standardized for the species to ensure that data collected from different parties is comparable. *Silene catesbaei* is clonal and patch-forming, posing difficulties for estimating the number of plants at occupied sites (USFWS, 2015).
- Identify sites within the species range for establishment of new sites and/or population augmentation. (USFWS, 2015)

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SPECIES ACCOUNT: *Silene spaldingii* (Spalding's Catchfly)

Species Taxonomic and Listing Information

Listing Status: Threatened; Pacific Region (R1) (USFWS, 2016)

Physical Description

A perennial herb with stout stems, 2-8 dm tall. White flowers, forming a tight, leafy flower head, bloom from late June to August. (NatureServe, 2015)

Taxonomy

Spalding's catchfly produce one to several vegetative or flowering stems that arise from a simple or branched persistent underground stem (caudex), which surmounts a long, narrow taproot. Plants range from 20 to 40 cm in height. Each stem typically bears 4 to 7 pairs of simple, opposite leaves that are 5 to 8 cm in length and 2 to 4 cm in width. Similar to the majority of plants in this family, Spalding's catchfly has distinctly swollen nodes located where the leaves are attached to the stem. Reproductive individuals produce 3 to 20 cream to pink or light green flowers that are borne in a branched, terminal inflorescence. All green portions of the plant (foliage, stem, and flower bracts) are covered in dense sticky hairs that frequently trap dust and insects, giving this species the common name 'catchfly' (USFWS, 2016).

Current Range

Regional endemic restricted to remnants of the Poulouse Prairie grasslands of eastern Washington, northeastern Oregon, northern Idaho, and western Montana (barely extending into British Columbia, Canada) (NatureServe, 2015). The species is endemic to the Palouse region of south-east Washington and adjacent Oregon and Idaho, and is disjunct in northwestern Montana and British Columbia, Canada (USFWS, 2016).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Food/Nutrient Narrative

Adult: All green portions of the plant (foliage, stem, and flower bracts) are covered in dense sticky hairs that frequently trap dust and insects, giving this species the common name 'catchfly' (USFWS, 2016).

Breeding Season

Adult: Flowering typically occurs from mid-July through August, but may occasionally continue into October (USFWS, 2016).

Reproduction Narrative

Adult: Plants (both vegetative and reproductive) emerge in mid- to late May. Flowering typically occurs from mid-July through August, but may occasionally continue into October. Rosettes are formed the first and possibly the second year, followed by the formation of vegetative stems.

Above-ground vegetation dies back at the end of the growing season and plants either emerge in the spring or remain dormant below ground for one to several consecutive years. Spalding's catchfly reproduces solely by seed. It lacks rhizomes or other means of reproducing vegetatively (USFWS, 2016). *Silene spaldingii* is a partially self-compatible, hermaphroditic perennial. Reproduction is apparently via seed only, as rhizomes or other means of vegetative propagation are lacking. Seeds appear to require cold stratification, so germination occurs mainly in the spring. Rosettes are formed the first year and flowering may occur during or after the second season. Flowers are protandrous (Lesica and Heidel 1996). Anthers mature and dehise pollen first. During this time, the styles are unexpanded, and the unexposed stigmatic surfaces are held well below the level of the anthers. After the anthers shrivel and fall from the filaments, the three styles expand and the stigmas become receptive. Each flower persists for two to several days, and two or more flowers may be in bloom on the same plant, so geitonogamous pollination is possible. This system promotes outcrossing while allowing the possibility of self-pollination (Lesica 1991; 1993). The bumblebee, *Bombus fervidus*, appears to be the only significant pollination vector for *S. spaldingii* throughout its range (Lesica and Heidel 1996). At least at some populations, *S. spaldingii* appears to be subject to pollinator limitations, inbreeding depression, and a large genetic load (Lesica 1991; 1993).; *Silene spaldingii* most frequently occurs in relatively intact climax or successional advanced mesic grassland communities (Lorain 1991). It does not occur at sites where the native vegetation has been displaced by aggressive weeds. It is apparently tolerant of light to moderate grazing (Schassberger 1988). In areas where grazing occurs, it does not appear to be preferred by cattle, but these populations also are much smaller than those in mature grassland habitats. Lesica (1994) found that prescribed burning at a site in Montana increased growth, recruitment and flowering of *Silene spaldingii*.; Perfect; Predominantly outcrossing; SEXUAL; ABIOTIC; Self-dispersing; Hymenoptera; (NatureServe, 2015)

Habitat Type

Adult: Palouse Prairie (NatureServe, 2015)

Habitat Narrative

Adult: The 2007 Recovery Plan describes occupied habitat within five physiographic regions; 1) the Palouse Grasslands in west-central Idaho and southeastern Washington; 2) the Channeled Scablands in eastern Washington; 3) the Blue Mountain Basins in northeastern Oregon; 4) the Canyon Grasslands of the Snake River and its tributaries in Idaho, Oregon, and Washington; and 5) the Intermontane Valleys of northwestern Montana. These regions are distinctive from one another in climate, plant composition, historical fire frequencies, and soil characteristics. These differences are significant in that they may translate into differences in life histories, habitat trends, consequences of fire suppression, and types of weed control as they apply to conservation of catchfly (USFWS, 2016). Restricted to Palouse Prairies, sometimes extending into areas where the grasslands are intermingled with ponderosa pine (*Pinus ponderosa*) woodlands. Soils are almost always a productive, deep loess. Elevation range is 580-1,220 m. *Silene spaldingii* is restricted to *Festuca idahoensis* habitat types and phases throughout its range. These areas are often referred to as Palouse prairie. Sites are often near lower treeline, or near scattered ponderosa pine trees. Populations have been found on all aspects, but there seems to be a preference for northerly-facing aspects. It occurs at elevations ranging from about 1,900 to 3,600 feet, and on flat to steep slopes. Soils are almost always productive silt/loams (loess) that are moderately deep and sometimes gravelly (Gamon 1991; Lorain 1991). The soils

are depositional materials from catastrophic floods of glacial Lake Missoula that extend from Montana across Idaho into eastern Oregon and Washington. (NatureServe, 2015)

Dispersal/Migration

Population Information and Trends

Population Trends:

Increasing (USFWS, 2016)

Number of Populations:

~99 (USFWS, 2016)

Population Size:

~28,750 (USFWS, 2016)

Population Narrative:

When catchfly was initially listed in 2001, it was known from 58 populations if the element occurrence records within 1.6 km (1 mile) of one another are grouped together (USFWS 2007). There were 7 populations in Idaho, 6.5 in Montana, 9 in Oregon, 35 in Washington, and 0.5 in British Columbia, Canada. Some 16,500 individual plants were estimated at the time of listing. As of 2007, there were 99 populations: 22 in Idaho, 10.33 in Montana, 17 in Oregon, 49 in Washington, and 0.66 in British Columbia, Canada (USFWS 2007). The number of individual plants in each population ranged from one to several thousand. Several new sites within the Canyon Grasslands have expanded our knowledge of the range of the species by 80.4 (50 miles) from those locations known in 2001. New occurrences are likely a result of increased survey effort, not an increase in actual plant distribution or vigor. In 2007, the estimated number of plants was approximately 28,750 individuals in the United States. The ten largest populations are each made up of more than 500 plants. Approximately 78% of the total known individuals of catchfly are found within these few large populations. Of the 99 known populations, two-thirds (66 populations, or 67%) are small populations, each made up of fewer than 100 individuals (USFWS 2007). Much of the remaining habitat occupied by Spalding's catchfly is fragmented by roads, agricultural fields, and other developments. Additional plants and populations have been found throughout its range since 2007, but range-wide population numbers and trends have not been summarized to date (K. Colson, USFWS, pers. comm. 2015). The 2007 Recovery Plan describes occupied habitat within five physiographic regions; 1) the Palouse Grasslands in west-central Idaho and southeastern Washington; 2) the Channeled Scablands in eastern Washington; 3) the Blue Mountain Basins in northeastern Oregon; 4) the Canyon Grasslands of the Snake River and its tributaries in Idaho, Oregon, and Washington; and 5) the Intermontane Valleys of northwestern Montana. These regions are distinctive from one another in climate, plant composition, historical fire frequencies, and soil characteristics. These differences are significant in that they may translate into differences in life histories, habitat trends, consequences of fire suppression, and types of weed control as they apply to conservation of catchfly. The long-lived nature of Spalding's catchfly, in conjunction with sporadic and rare recruitment, delayed maturity, cryptic rosettes that may disappear before monitoring, prolonged dormancy, and difficulties identifying seedlings, make it challenging to measure changes in numbers of individuals of this species (USFWS 2007). For plants exhibiting prolonged dormancy, population trend monitoring needs to occur for 3 or more consecutive

years every 5 to 20 years to adequately assess trends at a given site (USFWS 2007). Long-term demographic monitoring occurred at a number of sites, including two in eastern Washington, two in northwest Montana, and two in the canyon grasslands of the Snake and Salmon Rivers surrounding Craig Mountain, Idaho (USFWS 2007, Hill 2012, Lesica 2012, Hill et al. 2014). Population trend data is also still collected at numerous sites in Washington and Oregon (K. Colson, USFWS, pers. comm. 2015). In 2012, guidelines for monitoring trend of catchfly populations in Key Conservation Areas were developed to encourage the development of consistent and statistically relevant monitoring methodologies across the range of the species. Across the range of the species, the number of populations of Spalding's catchfly have increased since it was first listed. In Idaho, there are 34 populations; these populations vary from 1 to over 500 individuals (K. Colson, USFWS, pers. comm. 2015). In Montana, there are 15 populations, including the largest known population, which is over 16,000 plants (A. Pipp, Montana Natural Heritage Program, pers. comm. 2015). Many of these populations are relatively small, and only 2 populations exceed 500 plants. In Oregon, there are approximately 21 populations; these populations vary from a few to over 40,000 individual plants documented on the Zumwalt preserve (Sausen, USFWS, pers. comm. 2015; Taylor et al. 2012). On Federal lands in Oregon, this species occurs on the Wallowa-Whitman NF, BLM lands, and National Park Service Lands (Old Chief Joseph Gravesite and Cemetery). Of these 21 populations in Oregon, as of 2015, there are approximately 16 populations in the Blue Mountains Physiographic Region and approximately five populations in the Canyon Grasslands Physiographic Region. In Washington, there are 53 populations composed of 563 site locations as of 2013; these populations vary from just a few individuals to several thousand plants (Arnett, 2014). On Federal lands in Washington this species occurs on the Umatilla NF. (Sausen, USFWS, pers. comm. 2015). Overall, *Silene spaldingii* populations are not secure from threats identified in the Plan including invasive nonnative plants; problems associated with small, geographically isolated populations; changes in the fire regime and fire effects; land conversion associated with urban and agricultural development; adverse livestock grazing and trampling; adverse grazing (herbivory) and trampling by wildlife species; off-road vehicle use; insect damage and disease; impacts from prolonged drought and climate change; and the inadequacy of existing regulatory mechanisms (USFWS, 2016).

Threats and Stressors

Stressor: Development (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Human development (habitat loss) is listed as a threat to this species (USFWS, 2016).

Stressor: Grazing (USFWS, 2016)

Exposure:

Response:

Consequence: Habitat degradation

Narrative: Habitat degradation associated with adverse grazing and trampling by domestic livestock and wildlife is listed as a threat to this species (USFWS, 2016).

Stressor: Nonnative plants (USFWS, 2016)

Exposure:

Response:**Consequence:** Loss of habitat**Narrative:** Invasions of aggressive nonnative plants are listed as threats to this species (USFWS, 2016).**Stressor:** Loss of genetic variability (USFWS, 2016)**Exposure:****Response:****Consequence:** Extinction/loss of genetic variability**Narrative:** Loss of genetic fitness (the loss of genetic variability and effects of inbreeding) is a problem for many small, fragmented populations where genetic exchange is limited (USFWS, 2016).**Stressor:** Fire frequency and seasonality (USFWS, 2016)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** Fire frequency and seasonality is listed as a threat to this species (USFWS, 2016).**Stressor:** Off-road vehicle use (USFWS, 2016)**Exposure:****Response:****Consequence:** Loss of individuals/habitat degradation**Narrative:** Off-road vehicle use is listed as a threat to this species (USFWS, 2016).**Stressor:** Herbicides (USFWS, 2016)**Exposure:****Response:****Consequence:** Loss of individuals**Narrative:** Herbicide spraying and drift is listed as a threat to this species (USFWS, 2016).**Recovery****Recovery Actions:**

- Ongoing conservation efforts include research, Palouse Grassland conservation actions, invasive nonnative plant control, and land acquisition. Monitoring efforts continue, the technical team has worked towards developing a standardized monitoring protocol, and new monitoring has been initiated (USFWS, 2016).

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SPECIES ACCOUNT: *Solanum conocarpum* (Marron bacora)

Species Taxonomic and Listing Information

Listing Status: Proposed Endangered

Physical Description

Solanum conocarpum is a dry-forest shrub of the Solanaceae or tomato family, which may attain 3 m (9.8 ft) height. Its leaves are oblong-elliptic or oblanceolate (broader at the distal third than the middle), ranging from 3.5-7 cm (0.62-1.5 in) wide. The leaves are coriaceous (leathery texture) and glabrous (no hairs), and have a conspicuous yellowish mid-vein. The flowers are usually paired in nearly sessile (not stalked) lateral or terminal cymes (flat-topped flower cluster). The corolla consists of five separate petals that are light violet, greenish at the base, and about 2 cm (0.78 in) wide. The fruit, a berry, is ovoid-conical (teardrop shaped), 2-3 cm (0.78-1.2 in) long, and turns from green with white striations to golden yellow when ripe (Acevedo-Rodríguez 1996).

Taxonomy

Solanum conocarpum belongs to the Solanaceae family. The genus *Solanum* includes about 1,200 species mostly of herbs and shrubs with a worldwide distribution (Liogier and Martorell 1995). Liogier and Martorell (1982) recognized about 24 species of *Solanum* from the Puerto Rican platform, and 10 species occurring within the island of St. John (Acevedo-Rodríguez 1996).

Historical Range

U.S. Virgin Islands, Island of St. John. *Solanum conocarpum* was originally known from a type specimen collected by L.C. Richard at Coral Bay, St. John, USVI, in 1787 (Acevedo-Rodríguez 1996). No population estimates are available from Richards discovery, nor are there any known population estimates prior to 1992. However, the species was presumed to be near extinction, as two mature plants were believed to be the only specimens left in the wild, one in NPS land, and the other on private land (B. Kojis and R. Boulon, pers comm., 1996, Vilella and Palumbo 2010). The species was rediscovered in 1992 by P. Acevedo-Rodríguez on the island of St. John (Ray and Stanford 2003). After 1992, six additional populations of *Solanum conocarpum* were identified and reported to occur on dry, poor soils (Ray and Stanford 2005). Acevedo-Rodríguez (1996) referenced the possibility of the species being present on St. Thomas, and mentioned a collection of one sterile specimen from Virgin Gorda (British Virgin Islands; BVI). Pedro Acevedo-Rodríguez (pers comm., 2002) believes that the specimen from Virgin Gorda belongs to a different species, *Cestrum laurifolium*. Omar Monsegur, USFWS, conducted a site visit to the John Folly population in 2010 and identified several *C. laurifolium* adjacent to individuals of *S. conocarpum*. Both plants (*C. laurifolium* and *S. conocarpum*) look very similar and are easy to misidentify (O. Monsegur, pers comm., 2010).

Current Range

Solanum conocarpum is currently known from eight localities in the Island of St. John, USVI. Two locations are found in the north side of the Island (Base Hill and Brown Bay Trail), and six towards the southeast side Nanny Point, Friis Bay, Reef Bay, John Folly, Sabbath Point, and Europa Ridge). All of the eight known localities of *S. conocarpum* are wild populations each ranging from 1 to 144 individuals. The majority of individuals are found within the NPS

boundaries, leaving only two populations on private lands (Friis Bay and Sabbat Point). The largest population of *S. conocarpum* is located at Nanny Point. Due to potential urban and tourism development at Nanny Point, most of the natural population has been transferred to NPS lands. The owners of the private properties that harbor the Nanny Point natural population agreed to protect an additional area corresponding to Parcel 30-3 by donating it to the NPS (Carper and Selengut 2003, Ray and Carper 2009). Thus, the entire Nanny Point population now lies within a protected area. Populations located on Base Hill, Brown Bay Trail, Europa Ridge, and Reef Bay, lie within NPS lands.

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Obligate outcrosser

Dependency on Other Individuals or Species

Adult: Species requires other individuals of the same species to outcross (obligate outcrosser).

Reproduction Narrative

Adult: Little is known about the natural history, reproductive biology, and effects of herbivory on *S. conocarpum* (Ray and Stanford 2003). It has been suggested that this species might be functionally dioecious (requiring male and female flowers from different plants to outcross). However, P. Acevedo-Rodríguez (pers comm., 2002) documented flowers and fruits in a solitary wild plant he discovered in the White Cliff area (Reef Bay general area). He further suggested that *S. conocarpum* may have less reproductive fitness due to selfing (self-pollination). Later, Ray and Stanford (2005) conducted some pollination studies in a controlled environment, which indicated that the species might be an obligate outcrosser with complete self-incompatibility (plant has both male and female parts, but it needs to outcross with other individuals to produce fruits due to self-incompatibility). These studies were conducted because prior to 2003 a lack of natural recruitment was observed in the wild (Ray and Stanford 2003, J. Saliva, USFWS, pers obs., 2004, O. Monsegur, USFWS, pers obs., 2010, Vilella and Palumbo 2010). DNA sampling of the majority of *S. conocarpum* populations suggests that most populations have been long isolated (Ray and Stanford 2005). Additionally, genetic work performed at the University of the Virgin Islands by A. Stanford has shown low heterozygosity (a measure of the allele frequency or genetic diversity) (G. Ray, pers comm., 2010). Further, when compared with its close relative *S. polygamum*, it appears to show a significant reduction in genetic diversity (G. Ray, pers comm., 2010).

Habitat Narrative

Adult: Acevedo-Rodríguez (1996) described the habitat of *S. conocarpum* as a dry, deciduous forest. The species also has been reported to occur on dry, poor soils (Ray and Stanford 2005). It can be locally abundant in exposed topography on sites disturbed by erosion (depositional zones at the toe of the slopes), areas that have received moderate grazing, and around ridgelines as an understory component in diverse woodland communities (Carper and Ray 2008). A habitat

suitability model suggests that the vast majority of *S. conocarpum* habitat is found in the lower elevation coastal scrub forest (Vilella and Palumbo 2010).

Dispersal/Migration

Motility/Mobility

Adult: Sessile

Dispersal

Adult: Low due to a lack of seed dispersers and pollinators

Dependency on Other Individuals or Species for Dispersal

Adult: As an obligate outcrosser, the species requires seed dispersers and pollinators.

Dispersal/Migration Narrative

Adult: The nature of the relationships between *S. conocarpum* and different pollinators and seed dispersers that have interacted with the species over its evolutionary history, is an important factor to consider. Controlled pollination studies concluded that this species is an obligate outcrosser (reproduction requires pollen from another plant) with complete self-incompatibility (Ray and Stanford 2005). As plant populations become reduced and spatially segregated, important life-history needs provided by pollinators and seed dispersers may be compromised (Kearns and Inouye 1997). It is possible that natural fruit dispersers of *S. conocarpum* had targeted other food sources as the populations of this shrub became increasingly patchy, as a result of deforestation and introduction of exotic plant species. The absence of a fruit disperser may also indicate that the disperser of the species is extinct or that the populations are too small to attract the disperser (Roman 2006).

Population Information and Trends

Number of Populations:

8 site localities with populations ranging from 1-144 individuals.

Population Size:

~144 individuals

Population Narrative:

No population estimates of *S. conocarpum* are available prior to 1992. The species was presumed to be near extinction, as two mature plants were believed to be the only specimens left in the wild (B. Kojis and R. Boulon, pers comm., 1996, Vilella and Palumbo 2010). The known wild populations of currently occur in eight localities in the island of St. John, and range from 1 to 144 individuals. The original natural population of *S. conocarpum* located at Nanny Point consisted of 184 individuals. About 40 of these plants were located within a 30-ft access corridor to a private property and were transplanted to an adjacent location within the same population in the national park (property donated by Mike Carper to the NPS) to avoid potential impacts from development (M. Carper, pers comm., 2010). During a site visit to Nanny Point in May 2010 it was observed that approximately 90 percent of the transplanted material was dead or stressed due to lack of water (O. Monsegur, USFWS, unpubl. data, 2010). Death was also observed in the non-transplanted individuals (144), apparently resulting from competition with

edge vegetation (vines). Thus, the current number of natural individuals at Nanny Point is estimated at 144 individuals. Combined deaths (transplanted and competition) of plants has resulted in an overall population decline of 25 percent. The second largest natural population of *S. conocarpum* is located at Friis Bay and consists of 33 individuals (Ray and Stanford 2005). The natural populations found in Base Hill, Brown Bay Trail, Europa Ridge, and Sabbat Point consist of one individual each, whereas that in Reef Bay consists of six individuals. Though more recently, the population at Reef Bay has been reported as extirpated (G. Ray, pers comm., 2010), but no official confirmation of the extirpation has been made. The current status of introduced seedlings at Reef Bay, which initially experienced high rates of survival, is also unknown. The individual in Brown Bay is located on the edge of the Brown Bay Trail, and shows evidence of damage due to trail maintenance. A new population was recently recorded in Johns Folly Bay adjacent to Road 107, just along the boundaries of the NPS (M. Carper, pers comm., 2010). This population is approximately 11 adult individuals and shows signs of human disturbance (O. Monsegur, USFWS, unpubl. data, 2010). *Solanum conocarpum* suffers from the lack of natural recruitment, absence of dispersers, fragmented distribution, and lack of genetic variation. These factors are evidenced by the predominance of old individuals in the populations, reduced number of individuals, low number of populations, and lack of connectivity between populations, any or all of which may result in an increased risk of genetic drift. Furthermore, four of the currently known localities consist of a single individual, which may not be sustainable, as the species has been identified as an obligate outcrosser. One natural population has been reported as extirpated, the largest population has suffered a reduction of approximately 25 percent of the natural individuals, and low genetic variability has been reported for the species.

Threats and Stressors

Stressor: Human development

Exposure:

Response:

Consequence:

Narrative: Habitat modification may result in irreversible damage to the species natural habitat, decreasing the number of individuals of already small populations. In addition, the current sale of private housing lots adjacent to currently known populations suggests future urban developments that could lead to the extirpation of unknown populations.

Stressor: Non-native mammal species

Exposure:

Response:

Consequence:

Narrative: Exotic mammal browsers are found throughout the range of *S. conocarpum* in St. John Island. These include feral goats (*Capra aegagrus hircus*), pigs (*Sus scrofa*), Key deer (*Odocoileus virginianus clavium*), and donkeys (*Equus asinus*) (Vilella and Palumbo 2010; O. Monsegur, USFWS, pers obs., 2010). Feral donkeys, pigs, deer, and goats could directly and indirectly affect *S. conocarpum* populations by uprooting and eating seedlings, destabilizing slopes, and dispersing exotic plant species, thus preventing or reducing the sustainability of its populations. It is expected that these exotic mammals are modifying the structure of the vegetation, and therefore, the environmental conditions in these areas. This may imply changes on microhabitat conditions that are necessary for seed germination and seedling recruitment of *S. conocarpum*.

Stressor: Lack of natural recruitment

Exposure:

Response:

Consequence:

Narrative: Lack of natural recruitment represents one of the major threats to *S. conocarpum*. An example is the structure of the populations of Nanny Point and John Folly, which are predominantly comprised by old individuals. This is also true for the Brown Bay Trail individual. Seedling and sapling stages are missing in these populations, and old individuals are dying due to competition with other species such as vines. Without natural recruitment or successful augmentation from captive propagated individuals, these populations are likely to become extirpated as older individuals die.

Stressor: Absence of dispersers

Exposure:

Response:

Consequence:

Narrative: The nature of the relationships between *S. conocarpum* and different pollinators and seed dispersers that have interacted with the species over its evolutionary history, is an important factor to consider. Controlled pollination studies concluded that this species is an obligate outcrosser (reproduction requires pollen from another plant) with complete self-incompatibility (Ray and Stanford 2005). As plant populations become reduced and spatially segregated, important life-history needs provided by pollinators and seed dispersers may be compromised (Kearns and Inouye 1997). It is possible that natural fruit dispersers of *S. conocarpum* had targeted other food sources as the populations of this shrub became increasingly patchy, as a result of deforestation and introduction of exotic plant species. The absence of a fruit disperser may also indicate that the disperser of the species is extinct or that the populations are too small to attract the disperser (Roman 2006).

Stressor: Population fragmentation

Exposure:

Response:

Consequence:

Narrative: The loss of potential breeding partners, reduction or loss of pollinators, and the loss of seed dispersers are examples of negative impacts due to habitat fragmentation (Kearns and Inouye 1997, Murren 2002). As an obligate outcrosser, *S. conocarpum* encounters another challenge in that isolated and relic individuals may no longer reproduce unless enhancement and artificial propagation projects are conducted. Along with a decreasing population size, negative impacts of habitat fragmentation may result in erosion of genetic variation through the loss of alleles by random genetic drift (Honney and Jacquemyn 2007). Habitat fragmentation may also limit the ability of a species to respond to a changing environment (Booy et al. 2000).

Stressor: Lack of genetic variation

Exposure:

Response:

Consequence:

Narrative: Research conducted on *S. conocarpum* shows a reduction in its genetic diversity (Ray and Stanford 2005). The population with the greatest genetic diversity is the one located at

Nanny Point, which also has the largest number of individuals. In addition to attempts to safeguard the genetic diversity of the species, the survival of reintroduced individuals needs to be monitored as well as their development into mature individuals capable of contributing to the natural recruitment of the species. Consequently, the protection and monitoring of known adult individuals should be considered as a high priority for the conservation of the species.

Recovery

Recovery Actions:

- Surveys should continue to update status and distribution of the species, including in St. Thomas and the British Virgin Islands. Surveys should consider the habitat suitability model prepared by Vilella and Palumbo (2010).
- Threats to *S. conocarpum* as well as the magnitude or the imminence of such threats should be monitored on an annual basis.
- Attempts to safeguard the genetic diversity of the species, the survival of reintroduced individuals, as well as their development into mature individuals need to continue.
- Due to lack of natural recruitment, protection and monitoring of known adult individuals should be considered a high priority for the conservation of the species.
- Efforts to protect *S. conocarpum* populations on privately-owned lands should be initiated.
- Public education and outreach programs regarding the status of *S. conocarpum* should be reinforced.

Conservation Measures and Best Management Practices:

- Surveys should continue to update status and distribution of the species, including in St. Thomas and the British Virgin Islands. Surveys should consider the habitat suitability model prepared by Vilella and Palumbo (2010).
- Threats to *S. conocarpum* as well as the magnitude or the imminence of such threats should be monitored on an annual basis.
- Attempts to safeguard the genetic diversity of the species, the survival of reintroduced individuals, as well as their development into mature individuals need to continue.
- Due to lack of natural recruitment, protection (e.g., fencing) and monitoring of known adult individuals should be considered a high priority for the conservation of the species.
- Efforts to protect *S. conocarpum* populations on privately-owned lands should be initiated.
- Public education and outreach programs regarding the status of *S. conocarpum* should be reinforced.

References

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SPECIES ACCOUNT: *Solanum drymophilum* (Erubia)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/26/1988; Southeast Region (R4) (USFWS, 2015)

Physical Description

A spiny shrub that may reach 18 feet (5.5 meters) in height. The leaves and petioles have minute, white, star-shaped hairs whereas young twigs, inflorescences and flowers have long, whitish star-shaped hairs. Spines, sharp and stiff, yellowish, 5/16 to 7/16 of an inch (.8 to 1.1 centimeters) long, are found primarily along the mid-vein of the leaves and occasionally along the twigs. The leaves, alternate, lanceolate to lanceolate-oblong and entire, are 5 1/2 to 7 1/2 inches (14 to 19 centimeters) long and 5/8 to 1 1/4 inches (1.5 to 3.2 centimeters) wide (Vivaldi and Woodbury 1981). Inflorescences are lateral, subterminal, many-flowered racemes which may reach 3 to 3 1/2 inches (8 to 9 centimeters) in length. The pedicels are slender and short when in flower but become longer and curved when in fruit. Flowers are perfect with a 5-lobed, bell-shaped calyx. The corolla is 5-lobed, white, folded like a fan, with the lobes united one-third to one-half of their length. The superior ovary is 2-celled and the ovules numerous. The fruit is a glabrous, round, shiny—black berry approximately 3/16 to 5/16 of an inch (5 to 8 centimeters) in diameter. Seeds are numerous, circular, creamy—yellow in color, and about 1/16 of an inch (1.5 millimeters) in diameter (USFWS, 1992).

Taxonomy

Solanum ensifolium has long been known as *S. drymophilum*, based on a misinterpretation of the original provenance of the type of *S. ensifolium*. Both names refer to the same species, but *S. ensifolium* is an older name (1852) than *S. drymophilum* (1909). However, *Solanum ensifolium* is the name that is accepted in the recent checklists for Puerto Rico (Axelrod 2011) and the West Indies (Acevedo-Rodríguez and Strong 2012) (USFWS, 2015).

Historical Range

Known from an area known as Piedras del Collado in the Sierra de Cayey, in Salinas in east-central Puerto Rico (USFWS, 1992). Believed to be extirpated from historic sites in Naguabo in eastern Puerto Rico, and Lares in the west-central mountain region of Puerto Rico (USFWS, 2015).

Current Range

Known from the Salinas site in east-central Puerto Rico, and at sites in the municipalities of Florida and Arecibo in northern Puerto Rico (USFWS, 2015). 2019 refinements: Currently, erubia is known from three (3) populations: Las Piedras def Collado (previously known as Las Tetas de Cayey) in the municipality of Salinas (this was the only known population at the time of listing); Rio Abaja Commonwealth Forest in the municipality of Arecibo; and two localities near road PR-140 in the municipality of Florida. (USFWS, 2019).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources**Reproductive Strategy**

Adult: Biotic (EPA, 2016)

Breeding Season

Adult: In flower and fruiting year-round (USFWS, 1992)

Key Resources Needed for Breeding

Adult: Insects for pollination (EPA, 2016)

Other Reproductive Information

Adult: Seed production is abundant (USFWS, 1992)

Reproduction Narrative

Adult: Species is insect-pollinated; potential fruit type is berry (sometimes enclosed by inflated persistent calyx)/ speticidal capsule (EPA, 2016). Little is known about the pollination mechanism. Species is in flower and fruiting throughout the year; seed production is abundant (USFWS, 1992).

Habitat Type

Adult: Terrestrial (USFWS, 1992)

Habitat Vegetation or Surface Water Classification

Adult: Subtropical wet forest life zone (USFWS, 1992)

Geographic or Habitat Restraints or Barriers

Adult: Elevation 1,000 - 3,000 ft (EPA, 2016)

Habitat Narrative

Adult: Erubia is endemic to evergreen forests of the subtropical wet forest life zone, on volcanic soils at elevations from 1,000 to 3,000 feet. The habitat has been described as subtropical wet forest in an area of volcanic outcrops (USFWS, 1992). The most recent information indicates that erubia occurs in disturbed sites with poor soils and exposed topography (USFWS, 2015).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Little is known about the dispersal mechanisms for this species (USFWS, 1992).

Population Information and Trends**Population Trends:**

Not available.

Species Trends:

Unknown (USFWS, 2015)

Number of Populations:

1 (USFWS 2015)

Population Size:

150 - 200 (USFWS, 2015)

Population Narrative:

No new comprehensive surveys of this plant have been completed since the 1992 recovery plan, which reported that 150 plants were known from one locality at Las Piedras del Collado (also known as Las Tetas de Cayey) in the municipality of Salinas. It was thought at that time that this plant occurred in the Lares area as well, but it could not be confirmed. Although other individuals have been documented in other municipalities, all populations have been poorly monitored and their current status is unknown (USFWS, 2015).

Threats and Stressors

Stressor: Habitat modification or destruction (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Although some erubia populations occur on protected areas, most of the known populations occur on privately-owned lands that could be affected directly or indirectly by urban development or lack of appropriate habitat management. Potential urban development or expansion of existing constructions, habitat modification caused by road maintenance, landslides, overgrowth of vegetation and the lack of site management are threats to erubia. However, these threats are non-imminent and of low magnitude (USFWS, 2015).

Stressor: Natural or manmade factors (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Due to its limited distribution and number of natural populations, the cumulative effects of human induced fire, exotic invasive plant species, and climate change are considered detrimental to erubia as a whole (USFWS, 2015)

Recovery**Reclassification Criteria:**

1. The privately-owned population site is given protected status (USFWS, 1992)
2. At least two new self-sustaining populations in Commonwealth forest units or otherwise protected lands have been established (USFWS, 1992)

Delisting Criteria:

1. The two (2) existing populations on privately owned lands (i.e., Salinas and Florida) are protected through conservation mechanisms (addresses Factors A and E). (USFWS, 2019).

2. Existing three (3) populations on Las Piedras de/ Collado, Rio Abajo Commonwealth Forest, and the municipality of Florida show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factors A and E). (USFWS, 2019).

3. Establish three (3) new populations on lands protected by conservation mechanisms within the known geographical range of the species that demonstrate a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factors A and E). (USFWS, 2019).

4. Threat reduction and management activities have been implemented to a degree that the species will remain viable into the foreseeable future (addresses Factor E). (USFWS, 2019).

Recovery Actions:

- Protect the privately-owned “Tetas de Cayey” site (USFWS, 1992)
- Monitor all known individuals (USFWS, 1992)
- Enforce existing Commonwealth and Federal regulations (USFWS, 1992)
- Continue to search for new populations
- Assess habitat requirements (USFWS, 1992)
- Assess phenology and pollination mechanisms (USFWS, 1992)
- New in 2019: Develop and implement a monitoring protocol to adaptively manage the species and its habitat. Additional monitoring should occur after major disturbances (e.g., fires, hurricanes, and landslides) as recommended in the 2015 5-year review status. This recovery action should be coordinated with PRDNER and be included within Task 112: Monitor all known individuals of the approved recovery plan. (USFWS, 2019).

Conservation Measures and Best Management Practices:

- The recovery of the species should focus primarily on the protection of the known populations and their habitat. The area where erubia exists in Las Piedras del Collado should be incorporated into the already designated natural reserve.
- Comprehensive field surveys on erubia should be conducted within historical sites and in non-traditional sites with suitable habitat to determine the existence and distribution of the species and its current status.
- Enhance existing populations with propagated individuals.
- Studies should be conducted of the species’ phenology and reproductive biology to figure out another way to effectively propagate the species.
- Studies should be conducted on the patterns of genetic variation, in order to develop a plan to preserve the species’ germplasm.
- All the populations should be monitored on a regular basis, and additional visits should be made after fires, hurricanes, landslides, or other major disturbances.

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SPECIES ACCOUNT: *Solanum guamense* (Berenghenas halomtano)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/02/2015; Pacific Region (R1) (USFWS, 2016)

Physical Description

Solanum guamense (Biringenas halumtanu, birengenas halom tano), a small shrub in the nightshade family (Solanaceae). (USFWS, 2015)

Historical Range

Historically, *S. guamense* was reported from Guam, Rota, Saipan, Tinian, Asuncion, Guguan, and Maug (Stone 1970, p. 521; GBIF 2012e—Online Database; Bishop Museum 2014—Online Database). (USFWS, 2015)

Current Range

Solanum guamense (Biringenas halumtanu, birengenas halom tano), is known only from the Mariana Islands (Merrill 1914, pp. 139–140; Stone 1970, p. 521; Costion and Lorence 2012, p. 89). (USFWS, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (USFWS, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest (USFWS, 2015)

Habitat Narrative

Adult: Currently, *S. guamense* is known from a single occurrence of one individual on Guam, in the forest ecosystem (Perlman and Wood 1994, pp. 135–136) (USFWS, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Resiliency:

Very low (USFWS, 2015)

Redundancy:

Very low (USFWS, 2015)

Number of Populations:

1 (USFWS, 2015)

Population Size:

1 (USFWS, 2015)

Population Narrative:

Currently, *S. guamense* is known from a single occurrence of one individual on Guam, in the forest ecosystem (Perlman and Wood 1994, pp. 135–136). (USFWS, 2015)

Threats and Stressors

Stressor: Alien species and fire (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: Major threats include alien species and fire. (NatureServe, 2015)

Stressor: Small population size (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: *Solanum guamense* is now highly vulnerable to extinction, as there is only one known extant individual of this species. (USFWS, 2015)

Stressor: Habitat loss and destruction from agriculture, urban development, animals, and typhoons (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: *Solanum guamense*, and habitat for its recovery on Guam, Rota, Saipan, and Tinian, are at risk, due to continued habitat loss and destruction from agriculture, urban development, nonnative animals and plants, and typhoons. (USFWS, 2015)

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: The Service anticipates the effects of climate change will further exacerbate many of these threats in the future. (USFWS, 2015)

Stressor: Herbivory by pigs and deer (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Herbivory by pigs and deer, combined with the effects of low numbers of individuals, which results in loss of vigor and genetic representation, and limits its ability to compete with other species and adapt to changes in environmental conditions, contribute to the decline of *S. guamense*. (USFWS, 2015)

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

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SPECIES ACCOUNT: *Solanum incompletum* (Popolo ku mai)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/10/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

Solanum incompletum is a woody shrub which reaches heights of up to 3 meters (10 feet). Its stems and lower leaf surfaces are covered with prominent reddish prickles and, sometimes, on younger plants yellow fuzzy hairs. Leaf margins are one to four-lobed on each side. Leaves are oval to elliptic, 10 to 15 centimeters (4 to 6 inches) long and 7 centimeters (2.8 inches) wide and found on petioles of up to 7 centimeters (2.8 inches) in length. There are prominent veins on the lower leaf surface. Inflorescences are loose clusters of single-stalked flowers. The white petals form a star that is approximately 2 centimeters (0.8 inch) in diameter. Fruits are round berries, yellow-orange to black in color and approximately 1.5 centimeters (0.6 inch) in diameter (U.S. Army 2003a). *Solanum incompletum* differs from others in the genus by the presence of prickles, loose flower clusters, curved anthers, and berry size (U.S. Army 2003a)

Taxonomy

– *Solanum incompletum* is a member of the Solanaceae, or nightshade family. In 1888, two varieties, *S. incompletum* var. *glabrum* and *S. incompletum* var. *mauiense*, were described. In 1969 a collection from Maui was described and named as *S. haleakalaense*. *Solanum haleakalaense* and *S. incompletum* were synonymized by David Symon in the Manual of Flowering Plants of Hawaii (1999) into *S. incompletum*. No varieties of this species are now recognized.

Historical Range

Historically, *Solanum incompletum* was known from the islands of Lanai, Maui, and Hawaii. It is believed that the distribution of *S. incompletum* may also have included the islands of Kauai and Molokai.

Current Range

Currently, it is only known from the island of Hawaii at PTA (U.S. Army 2003a).

Critical Habitat Designated

Yes; 7/2/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Solanum incompletum* (Popolo ku mai) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes five detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Solanum incompletum* on the island of Hawaii (68 FR 39623 - 39722).

Critical Habitat Designation

The critical habitat designation for *Solanum incompletum* includes five CHUs in Maui County, Hawaii with detailed unit information. There are also an unknown number of units on Lanai that contain this species (number of units is unknown because detailed unit descriptions for Lanai are not available) (81 FR 17790-18110).

Maui—Lowland Dry—Unit 1 consists of 11,465 ac (4,640 ha) of State land, 2,069 ac (837 ha) of federally owned land, and 3 ac (1 ha) of privately owned land, from Kanaio to Kahualau Gulch on the southern slopes of east Maui. This unit is occupied by the plants *Bonamia menziesii*, *Cenchrus agrimonioides*, *Flueggea neowawraea*, *Melicope adscendens*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 1 is not known to be occupied by *Alectryon macrococcus*, *Bidens micrantha* ssp. *kalealaha*, *Canavalia pubescens*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Sesbania tomentosa*, *Solanum incompletum*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 2 consists of 1,851 ac (749 ha) of State land at Keokea on the southern slopes of east Maui. This unit is occupied by the plants *Bonamia menziesii*, *Canavalia pubescens*, and *Hibiscus brackenridgei*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 2 is not known to be occupied by *Alectryon macrococcus*, *Bidens micrantha* ssp. *kalealaha*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 3 consists of 188 ac (76 ha) of privately owned land, at Keauhou on the southern slopes of east Maui. This unit is occupied by the plant *Canavalia pubescens*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 3 is not known to be occupied by *Bidens micrantha* ssp. *kalealaha*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*,

Ctenitis squamigera, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 4 consists of 1,266 ac (512 ha) of State land (including the Department of Land and Natural Resources) at Ahihi-Kinohiwa Natural Area Reserve on the southern slopes of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Maui—Lowland Dry—Unit 4 is not currently occupied by *Bidens micrantha* ssp. *kalealaha*, *Bonamia menziesii*, *Canavalia pubescens*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Mesic—Unit 1 consists of 1,147 ac (464 ha) of State land, 241 ac (97 ha) of privately owned land, and 494 ac (200 ha) of federally owned land (Haleakala National Park), from Manawainui Valley to Kukuiula on the eastern slopes of east Maui. This unit is occupied by the plants *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, and *Huperzia mannii*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Mesic—Unit 1 is not known to be occupied by *Ctenitis squamigera* or *Solanum incompletum*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat designation for *Solanum incompletum* includes two units totaling 1,882 acres in Hawaii County, Hawaii. The units are Hawaii 10—*Solanum incompletum*—a and Hawaii 11—*Solanum incompletum*—b. Both units currently are unoccupied by this species. Each unit is essential to the conservation of the species because it supports habitat that is necessary for the establishment of additional populations in order to reach recovery goals. Each unit is geographically separated from other critical habitat for this multi-island species within its historical range in order to reduce the likelihood of all recovery populations being destroyed by

one naturally occurring catastrophic event. The two units designated provide habitat for a total of four populations, each with 300 mature, reproducing individuals.

Hawaii 10—*Solanum incompletum*— a [705 ha (1,741 ac)]: This unit contains no named natural features, it is entirely in the Kiholo watershed, and is completely within the Puuwaawaaa Wildlife Sanctuary; provides habitat for 3 populations of 300 individuals of *S. incompletum*; and is currently unoccupied.

Hawaii 11—*Solanum incompletum*— b [57 ha (141 ac)]: This unit contains no named natural features, it is entirely in the Waiaha watershed, and is completely within the Honuauulu Forest Reserve; provides habitat for 1 population of 300 individuals of *S. incompletum*; and is currently unoccupied. This unit provides the southernmost critical habitat within the species' historical range.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Solanum incompletum* critical habitat consists of two components. Lowland dry (east Maui and Lanai) and Lowland mesic (east Maui and Lanai)(81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: Diospyros, Myoporum, Pleomele, Santalum. Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Sicyos.

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Habitat features that are essential for this species include, but are not limited to, dry to mesic forest, diverse mesic forest, and subalpine forest.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight

plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; MauiWet

Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for these species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Habitat Narrative

Adult: Historically, *Solanum incompletum* occurred in dry to mesic forests, diverse mesic forests, and subalpine forests. On Army lands at the Pohakuloa Training Area (PTA) on the island of Hawaii, the species is found on lava flows of various ages in Sparse *Metrosideros* Treelands and *Myoporum* Shrublands at an elevation of 1,425 meters (4,675 feet). Associated species include *Sophora chrysophylla* and *Myoporum sandwicense* (U.S. Army 2003a).

Dispersal/Migration

Population Information and Trends

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Fragility unknown. 6 individuals were recently rediscovered. Previous to this, the species was last seen in 1949 and thought possibly extinct. 1 current (between 1982 and 1997) and 13 historical occurrences. (NatureServe, 2015). New status information: ☐ In 2009, there were 14 individuals at Puu Anahulu on Hawaii Island (PEPP 2009). In 2010, there were 15 plants at Puu Anahulu and Puu Waawaa (PEPP 2010). In 2011, an estimated 75 individuals of *Solanum incompletum* was known from Pohakuloa Training Area (PTA), Puu Anahulu, and Puu Waawaa (PEPP 2011). However, approximately 10 individuals were lost in the Puu Waawaa region apparently due to drought conditions (PEPP 2011). In 2014, two populations containing approximately 30 to 75 mature wild individuals of *S. incompletum* were known (PEPP 2014). In 2014, there were five individuals at Puu Anahulu (PEPP 2014). ☐ In 2010, there were 158 wild individuals (72 mature and 86 immature) of *Solanum incompletum* at PTA (U.S. Army Garrison [U.S. Army 2010]). Quantifying abundance for this species has proven difficult at PTA given its tendency for below ground clonal reproduction and the formation of above ground root sprouts (U.S. Army 2010). When uncertainty exists as to whether an above ground structure is an individual or a clone from another individual, it is tagged and marked as a possible clone and tallied accordingly. Nevertheless, there is likely some error in counts representing the actual number of individual plants present in a given area. In August 2013, there were an estimated 81 individuals, including an estimate of all potential clones (U.S. Army 2014). ☐ Overall, the numbers of individuals have increased from the approximately 83 wild mature individuals reported in the previous 5-year review to approximately 86 wild individuals in 2015. The number of reintroduced individuals decreased from the estimated 950 individuals reported in the previous 5-year review to more than 554 individuals in 9 populations. Natural recruitment was observed at two reintroduced sites at PTA with a total of 46 mature and 68 immature individuals. Natural recruitment of approximately 68 mature and 121 immature individuals of *S. incompletum* was also observed at outplanting sites located on State-owned lands outside of PTA (USFWS, 2015).

Threats and Stressors**Stressor:****Exposure:****Response:****Consequence:**

Narrative: *Solanum incompletum* is threatened primarily by browsing and habitat degradation by feral ungulates, competition from non-native plant species, wildfire, reduced reproductive vigor (e.g., limited gene pool), and extinction as a result of a single environmental disturbance (U.S. Army 2003a).

Stressor: Climate change adaptation strategy

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscapebased assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *S. incompletum* has a low vulnerability to the impacts of climate change (USFWS, 2015).

Stressor: Stochastic events

Exposure:

Response:

Consequence:

Narrative: Drought mortality or reduced viability – Drought may exacerbate the effects of ungulates and has direct adverse impacts on *S. incompletum* (PEPP 2010, 2014; U.S. Army 2010) (USFWS, 2015).

Stressor: Collecting impacts

Exposure:

Response:

Consequence:

Narrative: Illegal collection for scientific, horticultural or other purposes threatens the populations of *S. incompletum*, as well as possible excessive visitation. For instance, on two incidents in 2013, seven reintroduced individuals of *S. incompletum* were uprooted in the Mauna Kea area and those plants were stolen along with other common and federally listed plants (P. Peshut and S. Evans, pers. comm. 2013) (USFWS, 2015).

Recovery

Conservation Measures and Best Management Practices:

- The Seed Storage Facility at Lyon Arboretum and the University of Kentucky, School of Biological Sciences are conducting research on the seed storage requirements of an unspecified number of seeds of *Solanum incompletum* collected from PTA. Additionally, the Lyon Micropropagation Facility has, in vitro, tissue collected from plants at PTA. This material, to date, has not produced any plants. At PTA, the propagation facility has 160 plants that were propagated from two individuals collected at this installation. In addition, there are also 5,000 seeds in storage that were collected from eight individuals at PTA. Two hundred *S. incompletum* were outplanted in Kipuka Alala; however, only six have survived. Twenty-one plants outplanted by the State of Hawaii are surviving on Puu Huluhulu (Service 2003a; S. Gleason pers. comm., 2003).
- New management actions:
 - Surveys / inventories o A single new location of *S. incompletum* was recorded within the installation wide survey area in the Kipuka Kalawamauna West Fence Unit (U.S. Army 2014). This new discovery significantly benefits this species because there are only four known locations of this species at PTA (U.S. Army 2014).
 - Ungulate monitoring and control o In 2009, seven fenced enclosures approximately 3 meters by 3 meters (10 feet by 10 feet) were constructed to protect wild individuals of *S. incompletum* at Puu Anahulu (PEPP 2009).
 - In 2010, extreme drought conditions throughout PTA led to an increase in ungulate pressure to rare plants and their habitat. Consequently, emergency fences constructed of lightweight materials (plastic orange fencing) were breached and significant browse damage was observed on individuals of *S. incompletum* within Areas of Species Recovery (ASRs) 24 and 40 (U.S. Army 2010). The emergency fences were replaced with small-scale fences constructed from metal t-posts and hog wire fencing

to ensure the plants were protected from ungulates. o The *Solanum incompletum* Fence Unit and the external perimeter of the Mixed Tree Fence Unit were completed in 2010 (U.S. Army 2010). All known individuals of *S. incompletum* at PTA are protected by large-scale fence units and ungulate control commenced in 2011. As of 2013, the *Solanum incompletum* Fence Unit was ungulate-free (U.S. Army 2014). o In May 2014, a damaged 10-acre enclosure in Upper Puu Anahulu/Puuwaawaa was repaired (State of Hawaii Department of Land and Natural Resources [DLNR] 2014). The enclosure will provide protected habitat for outplanting the following endangered species *Zanthoxylum hawaiiense*, *Neraudia ovata*, *Solanum incompletum*, *Haplostachys haplostachya*, *Stenogyne angustifolia*, *Portulaca sclerocarpa*, and other dry to mesic species (DLNR 2014). □

Invasive plant monitoring and control – Manual hand clearing and maintenance spraying of weeds is ongoing around individuals of *S. incompletum* at PTA (U.S. Army 2010, 2014). □

Rodent predation or herbivory control – Snap traps and rodenticides are used to control rodents at PTA (U.S. Army 2010). As of 2013, rodent control was suspended pending a review of control methods and efficacy (U.S. Army 2014). In 2014, primarily work will identify which rodent species is responsible for damaging plants, and species-specific control methods will be developed and implemented (U.S. Army 2014). □

Captive propagation for genetic storage and reintroduction o The Volcano Rare Plant Facility (2013) had 10 individuals growing in their nursery from the Puu Anahulu population and propagated 11 plants for reintroductions next year. The Volcano Rare Plant Facility (2014) had 10 individuals growing in their nursery from the Puu Anahulu population. o The Lyon Arboretum's Seed Conservation Laboratory (2014) has 550 seeds in storage. o The National Tropical Botanical Garden (2014) propagated 37 seeds in 2012 from PTA. There are three plants outplanted at the Visitor's Center in Lawai and one plant at McBryde Lower Valley Conservation and Horticulture Center (National Tropical Botanical Garden 2015) for genetic storage and education. o In 2010, four more founders of *S. incompletum* were added to the three founders already in cultivation at the Rare Plant Propagation Facility at PTA (U.S. Army 2010). Two of the seven founders at the Rare Plant Propagation Facility are no longer extant at PTA. o In 2013, there were more than 13,000 seeds from 117 accessions representing three groups and 57 founders of *S. incompletum* in long-term storage at PTA (U.S. Army 2014). In 2015, nine fruits from four founders were collected and placed into long-term storage at PTA (U.S. Army 2015). o In 2014, fruit from *S. incompletum* was collected from Upper Puu Anahulu and Puu Waawaa Forest Reserve (DLNR 2014). □

Captive propagation protocol development – Propagation trials were conducted to determine appropriate storage and propagation techniques for *S. incompletum*. The trials indicated that seeds from *S. incompletum* had a low germination rate over an extended period of years (the number of years was not specified) and the seeds remained viable for more than 15 years (U.S. Army 2015). □

Population viability monitoring and analysis o In 2009, 13 of the 14 known wild individuals at Puu Anahulu were monitored for reproductive development (PEPP 2009). Fruit was collected from one founder and delivered to Volcano Rare Plant Facility. o In 2010, the populations at Puu Anahulu and Puu Waawaa were monitored for reproductive development and overall health of the plants (PEPP 2010). Fifteen plants were observed and cuttings were collected from five individuals. Most of the plants were noted as wilting from the effects of severe drought. o In 2010, no mature plants were reproductively active at the time of monitoring (U.S. Army 2010). This differs from 2009 when more than half (58%) of mature individuals were reproductive. Based on field observations, this may be driven primarily by drought conditions experienced in 2010. o In 2011, there was a substantial decline of 10 plants in the Puu Waawaa region, apparently due to the recent droughts (PEPP 2011). It is likely this species suffered similar declines across its entire range, including on adjacent federal lands at PTA (PEPP 2011). o Careful and closer analysis is needed to determine whether wild individuals are indeed separate individuals or are they actually attached underground and the root shoots represent a single individual (PEPP 2014). If this is true, staff at PTA estimated that they may have 25 distinct

individuals with an additional 5 plants located outside PTA (PEPP 2014). o In 2013, five of the 12 known individuals at Puu Anahulu were monitored (PEPP 2014). Fruit was collected from a single individual and four cuttings were collected (PEPP 2014). In 2014, the five individuals were monitored again (PEPP 2014). o At site 209 in the Kipuka Kalawamauna east fence unit, 27 reintroduced individuals (84 percent) survived of the 32 planted in 2003 (U.S. Army 2015). Although a few seedlings have been observed over the last 4 years, none have persisted (U.S. Army 2015). This may be due to insufficient rain or insect predation. In 2014, eight naturally recruited seedlings were observed at the site (U.S. Army 2015). o At site 214 within the Kipuka Alala South fence unit, monitoring of the site in 2014 tallied 123 reintroduced individuals and 46 naturally recruited mature and approximately 60 immature individuals at the site (U.S. Army 2015). o Near Saddle Road on State-owned lands, natural recruitment of 30 seedlings and/or suckers was observed in 2014 (U.S. Army 2015). o In North Kona on State-owned lands, natural recruitment of three adults and two immature individuals were observed in 2014 (U.S. Army 2015). o At Puu Waawaa Cone Unit on State-owned lands monitoring conducted in 2014 revealed natural recruitment of 19 mature and 21 immature individuals (U.S. Army 2015). □ Reintroduction / translocation o In 2010, 10 individuals of *S. incompletum* were reintroduced at three sites at PTA (U.S. Army 2010). o In 2014, 8 individuals were added to site 209 of the Kipuka Kalawamauna east fence unit (U.S. Army 2015). o In 2014, 16 individuals of *S. incompletum* were reintroduced at Mixed Tree fence unit (U.S. Army 2015). o During 2002 to 2012 at site 214 within the Kipuka Alala south fence unit, 152 individuals were reintroduced to the site (U.S. Army 2015). In 2014, an additional 18 individuals were reintroduced to the site. o At site 219 within the Kipuka Alala South fence unit, four individuals were reintroduced in 2014 (U.S. Army 2015). o In 2014, at site 220 within the Kipuka Kalawamauna north fence unit three individuals were reintroduced (U.S. Army 2015). o Near Saddle Road on State-owned lands, 445 individuals were reintroduced during 2002 to 2012, 10 individuals were added in 2014, and 209 plants remained in 2014 (U.S. Army 2015). o In North Kona on State-owned lands, 225 individuals were outplanted during 2004 to 2009 and only 4 individuals remained in 2014 (U.S. Army 2015). o At Puu Waawaa Cone Unit on State-owned lands, 391 individuals were reintroduced during 2005 to 2012 and additional 15 individuals were reintroduced in 2014 (U.S. Army 2015). In 2014, 138 reintroduced individuals remained. o On County-owned lands in North Kona, nine individuals were reintroduced during 2008 to 2012 with an additional two individuals reintroduced in 2014. Only four plants survived in 2014 (U.S. Army 2015). □ Stochastic events – Build resilience and redundancy – In 2010, all individuals of *S. incompletum* within ASRs 24 and 40 at PTA were watered (U.S. Army 2010). Plants located in ASR 24 were visited monthly, due to its remote location, and provided approximately 0.5 gallons of water. Plants located in ASR 40 were visited once a week and each plant was given approximately 0.5 gallons of water. The frequency of watering in ASR 40 was reduced to once every two weeks, then once every four weeks. Supplemental monitoring was conducted following the watering and plants were photo documented. After supplemental watering was initiated in ASR 40, invasive ants and scale were observed on and around individuals of *S. incompletum*. As a result, ant control was implemented at six of the seven plant locations (one location was excluded because the plant had died). □ Listing and critical habitat designation – Seven units of critical habitat for *S. incompletum* was proposed in the lowland dry, lowland mesic, and subalpine ecosystems on Maui (USFWS 2012). On Lanai, critical habitat for *S. incompletum* was proposed in six units in the coastal, lowland dry, lowland mesic, and dry cliff ecosystems. The final rule for critical habitat designations has not been published at the time of this review (USFWS, 2015).

- Recommendations for Future Actions: • Surveys / inventories – Survey geographical and historical range for a current assessment of the species' status. • Captive propagation for genetic storage and reintroduction – Continue collection of genetic resources for storage, propagation, and

reintroduction into protected suitable habitat within historical range. • Ungulate monitoring and control – Maintain existing exclosures and monitor for potential incursions. • Invasive plant monitoring and control – Eradicate invasive introduced plants within ungulate exclosures and maintain exclosures free of invasive plants. • Population viability monitoring and analysis – Continue monitoring wild and reintroduced individuals. • Fire monitoring and control – Develop and implement a fire management plan at the existing exclosures. • Alliance and partnership development – Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2015).

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SPECIES ACCOUNT: *Solanum nelsonii* (Popolo (Nelson's Horse-nettle))

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2016)

Physical Description

Solanum nelsonii is a sprawling or trailing shrub which grows up to 3.3 feet (ft) (1 meter (m)) tall, forming clumps up to 4.9 ft (1.5 m) in diameter. Young stems and leaves are densely pubescent and do not have spines. Leaves are grayish green, have entire margins, are arranged alternately along the stems, and are broadly ovate. Flowers are perfect and have a white tubular corolla that is tinged with lavender to pale purple. Round berries are usually black when mature with numerous seeds. *S. nelsonii* is unusual in the genus with its doubly curved, purple anthers, which possibly suggest different pollinators than bees (Symon 1999, pp. 1,273-1,274).

Taxonomy

Kingdom: Plantae; Phylum: Anthophyta; Class: Dicotyledoneae; Family: Solanaceae (potatoes). *Solanum nelsonii* was described by Dunal (1852). This species is recognized as a distinct taxon in the Manual of Flowering Plants of Hawaii (Symon 1999, pp. 1,273-1,274), the most recently accepted Hawaiian plant taxonomy.

Historical Range

Historically, *Solanum nelsonii* was known from the island of Hawaii at South Point and South Kona; the island of Niihau at Kealea Bay, Kawaewaae, and Leahi; Pearl and Hermes on North Island, Seal-Kittery Island, and Grass Island; and on Green Island (Kure). This species was last collected on Niihau in 1949 (HBMP 2008). The only plant on Maui was reported to have disappeared in the mid-1990s after cattle had been allowed to graze in its last known habitat (HBMP 2008).

Current Range

The species is known from populations on the islands of Molokai and Hawaii, and the northwestern Hawaiian Islands (NWHI), Hawaii. The current populations in the NWHIs are found on Kure, Midway (Sand, Eastern, and Spit islands), Laysan, Pearl and Hermes, and Nihoa (Vanderlip, in litt. 2010).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Habitat Type

Adult: Typical habitat is coral rubble or sand in coastal sites up to 490 ft (150 m) in elevation (Symon 1999, p. 1,273).

Habitat Vegetation or Surface Water Classification

Adult: Grassland/herbaceous, Sand/dune, Shrubland/chaparrall

Environmental Specificity

Adult: Unknown

Habitat Narrative

Adult: The species is found on the main Hawaiian Islands and on all of the Northwestern Hawaiian Islands except Nihoa in coastal dry shrublands and grasslands on unconsolidated coral sand dunes, lithified dunes, or in coral rubble. On Niho, it is found on rocky ridges and in gulches with soil of basaltic (volcanic rock) origin (NatureServe 2014).

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Decline (NatureServe 2014)

Species Trends:

Decline (NatureServe 2014)

Number of Populations:

Represented on 7 of the Hawaiian islands (Molokai, Hawaii, Kure, Midway, Laysan, Pearl and Hermes, and Nihoa)

Population Size:

Molokai, including Ilio Point (~47) and Moomomi Preserve (4); Hawaii (5); Kure (?); Midway (~260); Laysan (~490); Pearl and Hermes (?); and Nihoa, including (8,000 to 15,000); also represented in ex situ collections.

Population Narrative:

Solanum nelsonii is known from populations in the Northwestern Hawaiian Islands on Kure (unknown number of individuals), Midway (approximately 260 plants), Laysan (approximately 490 plants), Pearl and Hermes (unknown number of individuals), Nihoa (8,000 to 15,000 adult plants); in the main Hawaiian Islands from an unknown number of plants on Molokai including Ilio Point (47 individuals) and Moomomi Preserve (4 individuals down from 50 known previously); and from individuals seen at Kaalualu, Kamilo, and Kaulana Bay, South Point (5 fence-enclosed individuals) on the island of Hawaii (Bio, in litt. 2008; Tangalin, in litt. 2006; Rehkemper, in litt. 2006; Aruch, in litt. 2006; Moses, in litt. 2005; Vanderlip, in litt. 2010; Conry, in litt. 2012; Plant Extinction Prevention Program (PEPP), in litt. 2013). We are unaware of additional surveys conducted to date.

Threats and Stressors

Stressor: Feral ungulates (pigs, goats, cattle, sheep, deer)

Exposure: Habitat degradation and destruction

Response:

Consequence:

Narrative: On Molokai, *S. nelsonii* is moderately threatened by feral ungulates that degrade and destroy habitat.

Stressor: Human impacts

Exposure: Habitat degradation and destruction

Response:

Consequence:

Narrative: On Hawaii, human impacts from four-wheel drive and all-terrain vehicles continue to be the biggest threat to the population at South Point (Agorastos, in litt. 2011).

Stressor: Nonnative plants

Exposure: Competition and displacement

Response:

Consequence:

Narrative: On Molokai and the NWHI, this species is exposed to threats from nonnative plants that outcompete and displace it.

Stressor: Feral ungulates and a nonnative grasshopper

Exposure: Predation

Response:

Consequence:

Narrative: On Molokai, *S. nelsonii* is moderately threatened by feral ungulates that may eat individuals. In the NWHI, the species is exposed to threats by herbivory by a nonnative grasshopper (*Schistocera nitens*). Its presence on Pearl and Hermes is unknown. This insect is a recent invader in the northwestern Hawaiian Islands, and was observed to cause widespread destruction of native plants on Nihoa by defoliation (Wegman et al. 2002).

Stressor: Tsunamis

Exposure: Habitat and population destruction

Response:

Consequence:

Narrative: Overwash from tsunami is a potential threat to populations on Kure, Midway (Sand, Eastern, and Spit Islands), Laysan, Pearl, and Hermes, and other low-lying coastal areas occupied by *S. nelsonii*. The Pacific tsunami generated by the magnitude 9.0 earthquake off the northeast coast of Japan on March 11, 2011, resulted in overwash 100 feet inland on Kure, complete overwash of Spit Island, over 60 percent overwash of Eastern Island, and overwash of the entire coastline of Sand Island (FWS 2011; Starr, in litt. 2011; Vanderlip, in litt. 2011). Tsunami waves may dislodge *S. nelsonii* individuals; however, the impacts of brief submergence in sea water alone may not result in the loss of *S. nelsonii* individuals or its habitat requirements. Starr (in litt. 2011) estimates that the 2011 tsunami swept over almost all of the *S. nelsonii* plants mapped on Midway in 2008.

Stressor: Climate change

Exposure: Habitat degradation and destruction

Response:

Consequence:

Narrative: Climate change may pose a threat to the ecosystem that supports this species. Fortini et al. (2013, pp. 1134) conducted a landscape-based assessment of climate change vulnerability

for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013, p. 89) concluded that *Solanum nelsonii* is extremely vulnerable to the impacts of climate change. Therefore, additional management actions may be needed to conserve this taxon into the future.

Recovery

Recovery Actions:

- Build ungulate exclusion fencing and conduct routine fence monitoring and maintenance.
- Conduct nonnative plant control using physical, mechanical, and biological control methods, as well as herbicides when necessary.
- Develop and implement a grasshopper control program on the northwestern Hawaiian Islands.
- Conduct propagation in ex situ collections for maintenance of genetic stock.
- Survey for populations of *Solanum nelsonii* in historical locations on Maui and the island of Hawaii.
- Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.

Conservation Measures and Best Management Practices:

- Build ungulate exclusion fencing and conduct routine fence monitoring and maintenance.
- Conduct nonnative plant control using physical, mechanical, and biological control methods, as well as herbicides when necessary.
- Develop and implement a grasshopper control program on the northwestern Hawaiian Islands.
- Conduct propagation in ex situ collections for maintenance of genetic stock.
- Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.

References

USFWS 2014. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for *Solanum nelsonii* (popolo)

Pacific Region, 14 p.

USFWS. 2014. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for *Solanum nelsonii* (popolo)

SPECIES ACCOUNT: *Solanum sandwicense* (ʻAiakeakua, popolo)

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/25/1999; Pacific Region (R1) (USFWS, 2016)

Physical Description

A sprawling shrub up to 5 m tall. All parts are covered with yellowish brown hairs. Flowers are white and faint purple (NatureServe, 2015).

Taxonomy

A member of the nightshade family (Solanaceae) (USFWS, 2003). The genus is cosmopolitan, this species is endemic to Kauai & Oahu. Original taxonomy maintained by Wagner et al. (NatureServe, 2015).

Historical Range

Historically, *Solanum sandwicense* was known from both Kauai and Oahu. On Kauai, it was historically reported from locations in the Kokee region bounded by Kalalau Valley, Milolii Ridge, and Kawaikoi, and extending to the Hanapepe River. On Oahu, *S. sandwicense* occurred in both the Waianae and Koolau Ranges (USFWS 1994; 2009).

Current Range

This species was last seen on Oahu in 2000 (USFWS, 2003). It currently occurs in Kokee State Park, Kuia Natural Area Reserve, and Na Pali-Kona Forest Reserve at Kahuamaa Flats, Honopu, Awaawapuhi, Nualolo, Kumuwela Ridge, Kawaiiki, Waialae Valley, and Mokuone Stream (Kauai) (USFWS, 2009).

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Solanum sandwicense* (ʻAiakeakua, popolo) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Solanum sandwicense* (77 FR 57648-57862). The critical habitat designation includes 7 critical habitat units, which encompass approximately 7,823 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Solanum sandwicense* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Solanum sandwicense* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Solanum sandwicense* includes 7 critical habitat units, covering one ecosystem type, which encompasses approximately 7,823 acres on the Island of

Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

The critical habitat designation for *Solanum sandwicense* includes two units totaling 6,651 acres in Kauai County, Hawaii. The units are Kauai 11—*Solanum sandwicense*—a, b.

Kauai 11—*Solanum sandwicense*—a: This unit is critical habitat for *Solanum sandwicense* and is 2,442 ha (6,039 ac) on State land (Kuia NAR, Kokee and Na Pali Coast State Parks). This unit contains portions of the Awaawapuhi, Berry Flat, Nualolo and Honopu Trails, Kahuamaa Flat, Kainamanu and Kalahu Summits, and Kaunuohua and Kumuwela Ridges. This unit provides habitat for five populations of 300 mature, reproducing individuals of the short-lived perennial *Solanum sandwicense* and is currently occupied with eight to nine plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. It provides habitat for the westernmost range of the species that is unique to Kauai. The habitat features contained in this unit that are essential for this species include, but are not limited to, forest canopies in diverse lowland or montane *Acacia koa* or *Acacia koa*-*Metrosideros polymorpha* mesic or wet forests. This unit provides for five populations within this multiisland species' historical range on Kauai that are some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Kauai 11—*Solanum sandwicense*—b: This unit is critical habitat for *Solanum sandwicense* and is 249 ha (614 ac) on State land, containing portions of Kawaiiki Ridge. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Solanum sandwicense* and is currently unoccupied. This unit is essential to the conservation of the taxon

because it supports habitat that is important to the establishment of additional populations on Kauai in order to reach recovery goals. It provides habitat for the westernmost range of the species that is unique to Kauai. The habitat features contained in this unit that are essential for this species include, but are not limited to, forest canopies in diverse lowland or montane *Acacia koa* or *Acacia koa*-*Metrosideros polymorpha* mesic or wet forests. This unit provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Solanum sandwicense* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Solanum sandwicense* occurs was known historically (last observed > 20 yrs ago) from the Lowland mesic ecosystem in the Koolau Mountain caldera complex and the Waianae caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Under forest canopies in diverse lowland or montane *Acacia koa* or *Acacia koa*-*Metrosideros polymorpha* mesic or wet forests and containing one or more of the following associated plant species: *Alphitonia ponderosa*, *Athyrium sandwicense*, *Bidens* spp., *Carex meyenii*, *Coprosma* spp., *Cryptocarya mannii*, *Dianella sandwicensis*, *Dicranopteris linearis*, *Dubautia* spp., *Hedyotis* spp., *Ilex anomala*, *Melicope* spp., *Poa* spp., *Pouteria sandwicensis*, *Psychotria* spp., *Syzygium sandwicensis*, or *Xylosma hawaiiense*; and

(ii) Elevations between 540 and 1,290 m (1,770 and 4,232 ft).

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Solanum sandwicense* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their

immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: self-pollination (USFWS, 2009)

Lifespan

Adult: 4 - 8 years (USFWS, 2009)

Breeding Season

Adult: February - March, May - September (USFWS, 2009)

Reproduction Narrative

Adult: Herbarium vouchers at Bernice P. Bishop Museum (C. Imada, pers. comm. 2008), the herbarium database at the National Tropical Botanical Garden (2008a), and data from Hawaii Biodiversity and Mapping Program (2007) reveal that the species was observed in flower on Kauai from February to March and from May to September; fruiting was observed in all months except for April and November. TNC (2006) reports that plants appear quite capable of self-fertilization, and that plants are relatively short-lived, with outplants and nursery stock surviving for only three years in less-than-ideal habitat. However, the last wild plant on Oahu was at least six years old, and wild plants probably live for four to eight years. Outplantings start producing large amounts of fruit in about two years, but under nursery conditions with heavy fertilization can mature and produce fruit in five months (USFWS, 2009).

Habitat Type

Adult: Terrestrial (NatureServe, 2015); riparian (USFWS, 2003)

Habitat Vegetation or Surface Water Classification

Adult: Diverse lowland to montane mesic and wet forest (USFWS, 1995)

Dependencies on Specific Environmental Elements

Adult: Oahu: open sunny areas (USFWS, 2003)

Geographic or Habitat Restraints or Barriers

Adult: Oahu: 430 - 3,300 ft. elevation (USFWS, 2003); 2,500 - 4,000 ft. elevation (USFWS, 1995)

Habitat Narrative

Adult: Inhabits moist forest in gulches and on flats (NatureServe, 2015). *Solanum sandwicense* was found on Oahu on talus slopes and in streambeds in open, sunny areas at elevations between 131 and 1,006 m (430 and 3,300 ft.) (USFWS, 2003). This species is typically found in open, sunny areas at elevations between 760 and 1,220 meters (2,500 and 4,000 feet) in diverse lowland to montane mesic forests and occasionally in wet forests (USFWS, 1995).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: The genus is bird dispersed (NatureServe, 2015).

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Number of individuals stable, number of populations declining (USFWS, 2009)

Resiliency:

Low (inferred from USFWS, 2009; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2009)

Number of Populations:

12 (USFWS, 2017)

Population Size:

24-36 wild (USFWS, 2017)

Population Narrative:

Currently, there are five wild populations on Kauai. There are 18 - 20 wild individuals and 446 outplanted individuals. When *S. sandwicense* was federally listed as endangered, only four of 12 known populations were still extant on both islands (one on Oahu and three on Kauai), totaling about 20 individuals (USFWS 1994) (USFWS, 2009). At the time of the last 5-year review in 2009 there were five populations totaling 18 to 20 individuals from Kahuamaa Flats, Honopu, Awaawapuhi, Nualolo, Kumuwela ridge, Kawaiiki, Waialae Valley, Mokuone stream on the island of Kauai. The last known individual at Palawai Gulch on Oahu died in the 1990s. Currently, there

are seven to 12 wild populations totaling 24 and 36 individuals on Kauai (NTBG 2010a-b, 2012a-d, 2014a-c, 2015a; PEPP 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017) (USFWS, 2017).

Threats and Stressors

Stressor: Ungulates (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Habitat degradation by feral pigs (*Sus scrofa*), goats (*Capra hircus*), mule deer (*Odocoileus hemionus*) (USFWS, 2009).

Stressor: Predation (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: On Kauai: predation from rats (*Rattus* spp.). On Oahu: predation on seedlings by various species of introduced invasive slugs (USFWS, 2009).

Stressor: Invasive plants (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: On Kauai: competition with introduced invasive plant species such as *Hedychium gardnerianum* (kalihi ginger), *Lonicera japonica* (Japanese honeysuckle), *Passiflora tarminiana* (banana poka), *Psidium cattleianum* (strawberry guava), *Kalanchoe pinnata* (air plant), *Erigeron karvinskianus* (daisy fleabane), *Grevillea robusta* (silk oak), *Myrica faya* (fire tree), *Mariscus meyenianus* (Meyen's flatsedge), *Lantana camara* (lantana), *Setaria parviflora* (perennial foxtail), and *Rubus argutus* (Florida prickly blackberry). On Oahu: competition with the introduced invasive plant species *Passiflora suberosa* (corky passionflower), *Clidemia hirta* (Koster's curse), *Toona ciliata* (Australian red cedar), *Lantana camara*, *Psidium* spp. (guavas), and *Schinus terebinthifolius* (Christmasberry) (USFWS, 2009).

Stressor: Fire (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Because Hawaiian plants were subjected to fire during their evolution only in areas of volcanic activity and from occasional lightning strikes, they are not adapted to recurring fire regimes and are unable to recover well following a fire. The most prominent threat is fires caused by people pursuing recreational activities, and prevailing winds spreading fires to inland areas. Fire could destroy seeds as well as plants, even on steep cliffs (Clarke and Cuddihy 1980, Corn et al. 1979, Cuddihy and Stone 1990) (USFWS, 1995).

Stressor: Human activity (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Collection, disturbance, development (USFWS, 2009).

Stressor: Small population size (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The species continues to be vulnerable to extinction caused by randomly occurring natural events (e.g., landslides or hurricanes) or reduced reproductive vigor due to small population size and a limited number of populations (USFWS, 2009).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Solanum sandwicense* is vulnerable to the impacts of climate change, with a vulnerability score of 0.563 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery

Reclassification Criteria:

1. A total of five to seven populations should be documented on Kauai and at least one other island where they now occur or occurred historically (USFWS, 1995).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population for short-lived perennials (USFWS, 1995).
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 1995).

Delisting Criteria:

1. A total of eight to ten populations should be documented on Kauai and at least one other island where they now occur or occurred historically (USFWS, 1995).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population for short-lived perennials (USFWS, 1995).
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 1995).

Recovery Actions:

- Protect current populations, control threats and monitor (USFWS, 1995).
- Expand current populations (USFWS, 1995).
- Conduct research essential to conservation of the species (USFWS, 1995).
- Establish new populations as needed to reach recovery objectives (USFWS, 1995).
- Validate and revise recovery objectives (USFWS, 1995).
- Devise and implement a public education program (USFWS, 1995).
- In order to prevent this taxon from going extinct, propagation efforts and the maintenance of adequate genetic stock ex situ should be undertaken immediately, as well as the protection of remaining wild individuals from feral pigs and alien weed threats (USFWS, 1995).
- Management actions necessary to protect the remaining wild individual on Oahu include selective weeding of Christmas berry and *Passiflora suberosa*, as well as regular monitoring (J. Crummer, personal communication 1995) (USFWS, 1995).

Conservation Measures and Best Management Practices:

- Continue collection of fruit and plant material from wild individuals on Kauai and reintroduced individuals on Oahu for future reintroductions (USFWS, 2009).
- Construct enclosure fences to protect individuals from the negative impacts of feral ungulates on Kauai, and eradicate invasive introduced plant species within the enclosures on Kauai and Oahu (USFWS, 2009).
- Establish reintroduced populations within protected habitats (USFWS, 2009).
- Augment current natural populations (USFWS, 2009).
- Initiate planning and contribute to implementation of ecosystem-level management and restoration to benefit this species (USFWS, 2009).
- Survey geographical and historical range for a thorough current assessment of the species (USFWS, 2009).
- Assess genetic variability within extant populations (USFWS, 2009).
- Study *Solanum sandwicense* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, specific environmental requirements, limiting factors, and threats (USFWS, 2009).
- New Management Actions: • PEPP botanists collected seeds and cuttings for propagation at Lyon Arboretum, DOFAW, and NTBG (PEPP 2010, 2011, 2012, 2013, 2014, 2015, 2016). NTBG has seeds from 15 collections from Makaha (at least three founders), Puu o Kila (at least one founder), and Berry Flats (at least two founders). NTBG also has over a hundred plants in their nursery and dozens of plants throughout their gardens (NTBG 2017). Kokee Rare Plant Facility has 60 plants representing two founders from Kaunuohua and one founder from Berry Flats. Seven founders from Waialae are currently being established at the Lyon Arboretum Micropropagation Lab. There is one founder in the Lyon Arboretum seed bank from Mohihi, two founders from Berry Flats, one founder from Puu o Kila, three founders from Waialae, and one founder from Nualolo Trail (Lyon Arboretum 2017). • Waimea Arboretum has six plants from the Oahu *S. sandwicense* (2017). Pahole Rare Plant Facility on Oahu has four potted plants (PEPP 2016). There are thousands of seeds representing the Oahu founder via fruit collected from outplants (Lyon Arboretum 2017). • PEPP, NTBG, and The Nature Conservancy outplanted *Solanum sandwicense* into monitored enclosures at Limahuli (65 individuals), Lapa (35 individuals), Nualolo (30 individuals) and Kalalau (16 individuals) on Kauai (PEPP 2015, 2017). • PEPP on Oahu have been outplanting in three locations. Currently there are 29 outplants in Makaha, 97 outplants in Palikea, and 20 outplants in Pualii, all representing the last wild plant on Oahu (PEPP 2017). • PEPP on Kauai monitors wild populations of *Solanum sandwicense* at

Kumuwela, Berry Flats, Puu o Kila, Mohihi-Waialae Trail, Kawaiiki, Kaunuohua, and Makaha ridge (PEPP 2010, 2011, 2012, 2013, 2014, 2015). • In 2015, this species was not recorded from the Kaluaa and Waieli Management Units on Oahu where it had been previously recorded in 2010 (US Army Garrison 2016) (USFWS, 2017).

- Recommendations for Future Actions: No new threats and no other significant new information regarding the species' biological status have been reported since the last 5-year review in 2009. Therefore, the following recommendations for future actions are reiterated for the 5-year review for 2017. • Surveys and inventories—Survey geographical and historical range for a thorough assessment of the species. • Ungulate monitoring and control—Continue to construct enclosure fences to protect individuals from the negative impacts of feral ungulates. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control nonnative plant species in the immediate vicinity of *Solanum sandwicense* populations that compete with this species. • Captive propagation for genetic storage and reintroduction—Continue collection of seeds and cuttings, and propagation for reintroduction. • Reintroduction and translocation— o Continue to reintroduce individuals into suitable habitat within historical range that is being managed for known threats to this species. o Augment current natural populations. • Population biology research— o Study *Solanum sandwicense* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. o Assess genetic variability within extant populations (USFWS, 2017).

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SPECIES ACCOUNT: *Solidago houghtonii* (Houghton's goldenrod)

Species Taxonomic and Listing Information

Listing Status: Threatened; 07/18/1988; Great Lakes-Big Rivers Region (R3) (USFWS, 2016)

Physical Description

A perennial herb. Stems are frequently tufted or clumped, up to 7.5 dm high. Leaves become linear upwards on the stems. The inflorescence is a terminal, more-or-less flat-topped cluster of relatively few, large flower heads, each consisting of about 6-9 pale to bright yellow ray flowers and several yellow disk flowers. The branches of the inflorescence are smooth, but the stalks of the flower heads are finely but distinctly hairy. Blooms in August. (NatureServe, 2015)

Taxonomy

FNA (vol. 20, 2006) transfers *Oligoneuron houghtonii* to *Solidago houghtonii*. The disagreements concerning the origin of *S. houghtonii* and, more importantly, the true identities of populations within the currently circumscribed range, argue strongly for considering the species in the broad sense now (USFWS, 1997; NatureServe, 2015)

Current Range

Solidago houghtonii is primarily an endemic of the Upper Great Lakes region, occurring principally on the northern shores of Lakes Michigan and Huron in Michigan and Ontario; peripheral range extends north to Canadian shores of Georgian Bay, also 1 disjunct site in New York. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Dependency on Other Individuals or Species

Adult: Jolls' preliminary findings from the 1993 research indicate that *S. houghtonii* is self-incompatible and thus dependent on insect vectors for successful pollination. Potential pollen vectors include bees (Hymenoptera), butterflies (Lepidoptera), flies (Diptera), moths (Lepidoptera), and wasps (Hymenoptera). (USFWS, 1997)

Breeding Season

Adult: August to October (USFWS, 1997)

Reproduction Narrative

Adult: Flowering occurs primarily in August and early September but may occur as early as late July and not uncommonly well into October. Fruiting and seed dispersal appears to occur mostly from August through November and undoubtedly later (MNH 1993). Jolls' preliminary findings from the 1993 research indicate that *S. houghtonii* is self-incompatible and thus dependent on insect vectors for successful pollination. Potential pollen vectors include bees

(Hymenoptera), butterflies (Lepidoptera), flies (Diptera), moths (Lepidoptera), and wasps (Hymenoptera). (USFWS, 1997)

Habitat Type

Adult: Terrestrial and palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Bog/fen, herbaceous wetland, riparian, barrens, sand/dune (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Prefers cool, moist areas (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found in sparsely vegetated areas at elevations between 100 and 400 m (NatureServe, 2015)

Environmental Specificity

Adult: Narrow. Specialist or community with key requirements common. (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Medium (USFWS, 1997)

Habitat Narrative

Adult: *Solidago houghtonii* occurs primarily along the northern shores of Lakes Huron and Michigan and is restricted to calcareous beach sands, rocky and cobbly shores, beach flats, edges of marl ponds, and especially the shallow, trough-like interdunal wetlands that parallel shoreline areas (MNEI 1993). Much less commonly, *S. houghtonii* occurs in wet prairie-like habitats in Lower Michigan and locally in a New York marl fen. It also occurs on seasonally wet limestone pavement, which is the species' more typical habitat in the eastern portion of its range. *S. houghtonii* was collected from open limestone pavements in moist rock crevices (D.F. Brunton 3352, CAN). In sand dune areas, it tends to occur on the lee side of low foredunes and on low stabilized dunes adjacent to interdunal wetlands, especially in moist to saturated sands within and around interdunal depressions. The restriction of *S. houghtonii* to calcareous sands and dolomitic limestone areas of the Niagaran Escarpment suggests that the species requires a relatively high amount of calcium and magnesium (and possibly sodium and potassium) in its substrate. Dune sands in the region of the Niagaran Escarpment generally have a calcareous component of about 1 to 5 percent that is composed primarily of ground mollusk shells (Collins 1989). The sands in which it grows are circumneutral (pH 7.0) to alkaline (pH 8.0) and may occasionally have a thin covering of organic material (Collins 1989). *Solidago houghtonii* usually occurs where there is a relatively low density of competing vegetation at elevations between 100 and 400 meters. The species' apparent establishment in the better drained portions of dunes, such as along the backside of foredunes, may indicate it has some resistance to desiccation. Often associated with *Solidago ohioensis*, *Lobelia kalmii*, and other calciphiles; occasionally associated with two other rare species: Pitcher's thistle (*Cirsium pitcherii*) and dwarf lake iris (*Iris lacustris*). (USFWS, 1997; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends**Population Trends:**

Long-term trends suggest declines of 30-70%, whereas short-term trends indicate a decline of <30% to relatively stable (NatureServe, 2015)

Resiliency:

Medium (inferred from USFWS, 1997)

Representation:

Low (inferred from USFWS, 1997)

Redundancy:

Medium (inferred from USFWS, 1997)

Population Growth Rate:

Slowly declining (NatureServe, 2015)

Number of Populations:

~90 (NatureServe, 2015)

Population Narrative:

Long-term population trends suggest declines of 30-70%, whereas short-term trends indicate a decline of <30% to relatively stable. There are approximately 90 occurrences known (Penskar et al. 1996). (NatureServe, 2015)

Threats and Stressors

Stressor: Narrow habitat range (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: *Solidago houghtonii*, like several of its associated endemics, is particularly vulnerable to extirpation because of its restriction to narrow shoreline habitats of the Great Lakes. In a 1981 status survey, D.C. Nepstad considered habitat destruction to be the greatest threat to populations of *S. houghtonii* and cited the desirability of shoreline areas for residential housing and the escalating pressure for this type of development as a principal cause of this habitat destruction. The rate of residential development continues to accelerate, and it is highly unlikely that there will be any abatement of this trend in the near future. Nepstad (1981) also noted that some major occurrences of *S. houghtonii* have been considerably altered and fragmented by private development such that their long-term viability has been severely diminished. This has been a view supported by subsequent field surveys (MNFI 1993). There are many causes of habitat alterations that have adversely affected *S. houghtonii* populations. Construction of beach retaining walls and other emergency erosion control measures (e.g. rip-rap and bulkhead installation) prevents or inhibits dune formation. Excessive foot and off-road vehicle (ORV) traffic

destabilizes dune and beach flats. Marina construction, road construction, sand mining, and home and cottage construction where improved lake views are desired, have resulted in leveling of dune ridges (Collins 1989). Driveway installation or permitted work performed by utilities and railroads near interdunal wetlands have fragmented colonies and altered the hydrology. Residential development further potentially threatens habitat by altering hydrology with the placement and construction of septic systems whose nutrient loading degrade adjacent interdunal wetlands. Finally, both foot and ORV traffic have caused the direct destruction of plants. (USFWS, 1997)

Stressor: Modification of groundwater (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Disjunct populations, located in calcareous fens and dependent upon calcium rich groundwater flowing through them, face additional threats. Modifications or contamination of the groundwater could cause these sites to become unsuitable for Houghton's goldenrod and could lead to extirpation of this species. As such, this species could be also be threatened by off-site activities. (USFWS, 2011)

Stressor: Invasive species (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Invasive species control efforts are underway in three of the four Michigan State Parks with Houghton's goldenrod. New York has had limited success with control efforts at Bergen Swamp. Common reed grass (*Phragmites australis*) is the non-native invasive species most likely to affect Houghton's goldenrod at Bergen Swamp (Drake, pers. comm. 2010), although encroachment by false brome (*Brachypodium sylvaticum*) may pose a threat to Houghton's goldenrod also (Steve Young, NYNHP, pers. comm., 2010). Almost all occurrences are threatened by the increase in invasive plant species, such as baby's breath (*Gypsophila paniculata*), *Phragmites australis*, purple loosestrife (*Lythrum salicaria*) and false brome (*Brachypodium sylvaticum*). If not removed or controlled, these invasive species may threaten the Houghton's goldenrod habitat by outcompeting native species, shading the habitat or altering the hydrology. (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Climate change models predict the climate of the Great Lakes region will grow warmer and drier over the next century, with precipitation increasing in winter and decreasing in summer (AMEC 2006; Anton Reznicek, University of Michigan, pers. comm. 2004; Kling et al. 2003). Average temperatures in the Great Lakes region could increase by 3 to 7°C in winter and 3 to 11°C in summer by the year 2100. While average annual precipitation could increase by 10–20 percent, significant changes in the seasonal precipitation cycle are likely, with winter and spring rain increasing and summer rain decreasing by up to 50 percent (Kling et al. 2003). A warmer, drier summer will affect surface and groundwater levels, as well as soil moisture, which is projected to decrease by 30 percent in summer (Kling et al. 2003). Increased water temperatures

will also result in decreased ice cover that when combined with an expected intensity of winter storms, will leave coastal areas more vulnerable to the effects of winter storms and flooding (Fang and Stefan 2000; AMEC 2006), altering Houghton's goldenrod habitat. A warmer climate could also bring about a northward shift and an even greater increase in invasive species that may be more problematic in the dunes and lakeshore systems, thus increasing competition with native plant species (Malcolm et al. 2002; AMEC 2006; Penskar, pers. comm. 2009). (USFWS, 2011)

Stressor: Roads and highways (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: Several *S. houghtonii* occurrences in Michigan are within or along rights-of-way administered by MDOT. Records in the MNFI show that there are at least 11 occurrences partially within or along MDOT rights-of-way, representing nearly 20 percent of the known occurrences in Michigan. Kim D. Herman (1988) notes that *S. houghtonii* is more vulnerable to disturbance than two other endemics of Great Lakes shorelines, dwarf lake iris and Pitcher's thistle, because of its restriction to narrow bands of interdunal wetland habitats, many of which occur between coastal roads and lakeshores. In some of these sites, highways may be severely fragmenting *S. houghtonii* populations or preventing them from expanding and colonizing suitable habitat available further inland. Herman (1988) further states that the MDOT activities which resulted in the most adverse effects to this species and other Great Lakes endemics are projects along two major State roadways, US-2 and US-23, located in the Upper Peninsula and Lower Peninsula, respectively. These activities included culvert extensions, pavement recycling, shoulder widening, and other types of safety work. (USFWS, 1997)

Stressor: Road maintenance (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: A number of common road maintenance activities, including emergency repairs on eroding shoreline areas, herbicide application, mowing, road salting, shoulder grading, snow removal, and tree removal, have affected populations of *S. houghtonii* (Herman 1988). A number of illegal activities which have occurred on or near MDOT rights-of-way have also affected this species and its habitat. Illegal use of sites by commercial fishermen and encroachments by ORV operators and other recreationists have had adverse effects (MNFI 1993). (USFWS, 1997)

Stressor: Off-road vehicles (ORVs) (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: Habitat damage resulting from ORV traffic is one of the major threats to *S. houghtonii*. The restriction of this species to a very limited, narrow expanse of shoreline habitat renders it particularly vulnerable to destruction and habitat fragmentation. Off-road-vehicles are in widespread use and are very difficult to exclude from most kinds of natural areas, particularly beaches and coastal dunes. Their use and resulting effects on these sites are well documented throughout Michigan (MNFI 1993). Off-road-vehicle traffic or evidence of it has been observed in areas of exemplary *S. houghtonii* occurrences, such as Crow River Mouth (Mackinac County),

Grass Bay (Cheboygan County), and Wilderness State Park (Emmet County) (MNFI 1993), and probably occurs in many and perhaps most other sites throughout the range of the species. (USFWS, 1997)

Stressor: Natural disturbances (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: The restriction of *S. houghtonii* to low-lying, linear coastal zone habitats also causes it to be highly susceptible to natural disturbance. Rises in lake levels, such as the record highs attained in 1986, may severely reduce population numbers throughout the entire range of the species (Voss 1987). It is thus very important that destructive human activities are minimized or eliminated so as not to exacerbate the effects of natural disturbance (Voss 1987). (USFWS, 1997)

Stressor: Artificial stabilization of lake levels (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: It is unlikely that the range of *S. houghtonii* will expand because of the accelerating habitat loss and fragmentation due to development, increasing human-caused habitat disturbance, and the restriction of nearly all individuals of the species to shores of the Great Lakes. Therefore, essential habitat must be protected. Any artificial stabilization of Great Lakes levels could markedly change the natural dynamics of shoreline habitats and be highly detrimental to *S. houghtonii*, as well as to many other sensitive species and significant natural communities. Stabilization of the Great Lakes at low water levels might initially benefit *S. houghtonii* by temporarily exposing maximum suitable habitat. However, unless lake levels are continually lowered, stabilized *S. houghtonii* habitat is likely to be altered and will become unsuitable through plant succession. As a relatively poor competitor restricted to dynamic shoreline areas, this species depends on the cyclical fluctuations of the Great Lakes. It suffers local extirpations during high water years, but later exploits and colonizes newly exposed habitat as it becomes available again. (USFWS, 1997)

Stressor: Over-collection (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: Like many rare species, *S. houghtonii* can potentially be over-collected by individuals with legal collecting permits, such as those who desire specimens for herbaria in which this taxon is poorly represented. Despite the good intentions of removing live plants for propagation and exhibition in rare plant collections, such activities, if done excessively or without proper permits, also represent a threat to populations. Permits granted for the taking of this species should be issued only after careful consideration and consultation with appropriate, knowledgeable individuals. Permits should stipulate that collections may be made only when an occurrence (i.e., a "population") would not be significantly diminished or adversely affected by removal of individuals. (USFWS, 1997)

Recovery

Reclassification Criteria:

Reclassification criteria are not available.

Delisting Criteria:

1. Protect a minimum of 30 of the most viable occurrences of Houghton's goldenrod and preserve the species' essential habitat and the natural environmental processes that maintain it. (USFWS, 1997)

Recovery Actions:

- Protect all known occurrences, with priority given to the most viable occurrences and the species' essential habitat. (USFWS, 1997)
- Survey suitable habitat for additional occurrences and verify the status of historic occurrences. (USFWS, 1997)
- Educate and notify land managers and the public. (USFWS, 1997)
- Monitor occurrences for population demographics, viability, and threats. (USFWS, 1997)
- Conduct biosystematic research throughout the species' range. (USFWS, 1997)

Conservation Measures and Best Management Practices:

- Report survey results and habitat and population conditions to the Michigan Natural Features Inventory and the East Lansing Field Office and update element occurrence records. (USFWS, 2011)
- Plan and implement regular surveys and monitoring of occurrences, including better documentation of habitat conditions and populations trends. (USFWS, 2011)
- Reassess ranks of known occurrences. (USFWS, 2011)
- Provide education and outreach to stakeholders and the public. (USFWS, 2011)
- Monitor approach of non-native species and control as appropriate. (USFWS, 2011)

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SPECIES ACCOUNT: *Solidago shortii* (Short's goldenrod)

Species Taxonomic and Listing Information

Listing Status: Endangered; 9/5/1985; Southeast Region (Region 4) (USFWS, 2016)

Physical Description

A perennial herb with one to several erect or ascending stems 0.5 to 1.3 m tall, arising from a creeping rhizome. Stems are terete in cross section, slightly ribbed, and minutely scabrid-puberulent at least above the middle. Leaves are alternate, crowded, 5-10 cm long and 0.6 to 1.5 cm wide. Individual leaves are firm, oblong-lanceolate to narrowly elliptic, remotely serrulate and glabrous on both sides. The leaves are largest near the middle of the stem and become progressively smaller towards the inflorescence. Lower leaves are reduced and usually absent during flowering time. The inflorescence is terminal and ranges from racemose to paniculate with divergent, secund branches. Heads are 10-14 flowered on puberulent stalks usually 5 mm or less in length. The involucre is 4-6 mm long and 3 mm wide with imbricate, coriaceous and glabrous phyllaries. Ray florets number from 4 to 8 and are 2.5-3.0 mm long. The corollas are elliptic-linear with bright yellow ligules about 2 mm long. The disc florets are also bright yellow with a short tube, funnel form throat and five linear spreading lobes about equaling the throat in length. The white papus is capillary and about 2 mm long. Achenes are cuneate-cylindric, about 2 mm long, and pale brown with appressed, silky pubescence (USFWS, 1988).

Taxonomy

In the Aster family (Asteraceae)(USFWS, 1988).

Historical Range

Historically known from Jefferson, Robertson, Nicholas, and Fleming Counties in Kentucky (USFWS, 1988).

Current Range

Known from Robertson, Nicholas, and Fleming Counties in Kentucky (the vicinity of Blue Licks, Kentucky) and along the Blue River in Harrison County, Indiana (USFWS, 2007).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect (USFWS, 1988)

Breeding Season

Adult: Flowers from mid-August to early November (USFWS, 1988).

Key Resources Needed for Breeding

Adult: Insects for pollination, probably bees (USFWS, 1988)

Reproduction Narrative

Adult: Flowers from mid-August to early November, and fruits mature several weeks after the flowers wither. Specific pollinators have not been documented; sweat bees have been observed visiting the flowers. Germination rates in the field are unknown (USFWS, 1988).

Habitat Type

Adult: Terrestrial (USFWS, 1988)

Habitat Vegetation or Surface Water Classification

Adult: A variety of dry, mostly open habitats, in full sun or partial shade (USFWS, 1988).

Dependencies on Specific Environmental Elements

Adult: Natural disturbance (USFWS, 1988)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Habitat Narrative

Adult: Habitat is full sun or partial shade in a variety of dry, mostly open habitats. These include limestone cedar glades, open eroded areas, edges of dry, open oak-hickory woods, cedar thickets, pastures, old fields, power rights-of-way, and rock ledges along highway rights-of-way. This species does not appear to compete well and does best in areas with a low density of other plants. It will not grow in full shade (as in closed canopy woods). Soils are described as flaggy, silty clay texture with 20-30% rock fragments, and slightly acid to moderately alkaline, with slow permeability and rapid runoff (USFWS, 1988). In the long term, it appears that the species can survive only in early successional, short-term habitats (resulting from some disturbance), natural openings associated with animal movements or rock outcrops, or dynamic rocky shorelines along rivers (Indiana occurrence) (USFWS, 2007).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Although goldenrod fruits are normally wind dispersed, there is no evidence that this species is expanding its range by this method. It has been suggested that bison may be a dispersal vector (USFWS, 1988).

Population Information and Trends**Population Trends:**

Stable to declining (USFWS, 2007)

Species Trends:

Decline of 10-30% (NatureServe, 2015)

Resiliency:

Medium (inferred from USFWS, 2007)

Representation:

Medium (inferred from USFWS, 2007)

Redundancy:

Low (inferred from USFWS, 2007)

Number of Populations:

14 (USFWS, 2007)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Adaptability:

The plant is clonal and is capable of persisting after some disturbance. Survivorship curves are typical of other herbaceous perennials (Walck et al. 1999b). Does not produce a long-lived seed bank (Walck et al. 1999a) (NatureServe, 2015).

Population Narrative:

Based on the results of numerous surveys and investigations over the past 25 years, the current distribution of *S. shortii* is restricted to 13 occurrences within a 2-mile radius of Blue Licks Battlefield State Resort Park in Fleming, Nicholas, and Robertson counties, Kentucky and one occurrence along the Blue River in Harrison County, Indiana (Harrison-Crawford State Forest). Despite numerous, intensive searches of similar habitats, only two occurrences (one within Sho1i's Goldenrod SNP in Fleming County, Kentucky and the Indiana occurrence) have been discovered since completion of the recovery plan in 1988. At present, eight Kentucky occurrences (numbers 1, 2, 5, 7a, Sa, 11, 12a, and Short's Goldenrod SNP) and the Indiana occurrence appear to be stable, and some level of protection has been achieved for all but one of these occurrences (number 11). The remaining Kentucky occurrences have shown declines in the number of stems and surface area since 1989 (Smith et al. 2004; Buchele et al. 1989). The reason for these declines is unknown, but competition from exotics and land-clearing activities on private property appear to be the primary causes (USFWS, 2007).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: The Kentucky occurrences are most threatened by competition from exotics such as crown vetch, tall fescue, and other species described above, habitat disturbance on private property, and highway and powerline maintenance activities. The Indiana occurrence is most threatened by competition from exotics. The potential raising of the Ohio River's pool level is a possible threat but is unlikely to occur (USFWS, 2007).

Stressor: Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2007)

Exposure:

Response:**Consequence:**

Narrative: Recent park improvements in Blue Licks Battlefield State Resort Park are expected to increase the recreational use of the park and could lead to adverse impacts to *S. shortii* individuals if recreational activities (e.g., hiking) are not directed away from *S. shortii* occurrences. The species' small range and low number of individual plants makes it vulnerable to overcollecting for scientific purposes. Plants within Blue Licks Battlefield State Resort Park cannot be collected without a permit from the Kentucky Department of Parks and KSNPC; these permits are only issued for valid scientific purposes. Plants occurring on private property are not afforded this protection. The Indiana occurrence is also potentially threatened by recreational use (trampling by fishermen, canoeists, hikers). At present, though, recreational use does not appear to be a significant threat in Indiana. In addition, these plants occur on state property and cannot be collected without a permit (USFWS, 2007).

Stressor: Predation (USFWS, 2007)

Exposure:**Response:****Consequence:**

Narrative: Over-grazing by cattle on private property has the potential to adversely affect the species by eliminating flower production, but this effect has not been observed directly (USFWS, 2007).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2007)

Exposure:**Response:****Consequence:**

Narrative: Occurrences at Blue Licks Battlefield State Resort Park are protected from unauthorized taking; permits administered by the Kentucky Department of Parks and KSNPC are only issued for valid scientific purposes. Portions of occurrences 7a and 12a are protected through an MOU between KSNPC and KYTC (KSNPC 1989) that restricts habitat disturbance within these road rights-of-way. The Indiana occurrence occurs on state property (Harrison-Crawford State Forest) and is also protected from unauthorized taking. No such protection is available for occurrences located on private property in Kentucky or Indiana (USFWS, 2007).

Stressor: Other natural and manmade factors affecting its continued existence (USFWS, 2007)

Exposure:**Response:****Consequence:**

Narrative: The species has been reduced to a small number of occurrences with a limited number of individuals. Consequently, the species is vulnerable to natural or human-induced factors (fire suppression) that might directly destroy individuals and further reduce population size (Federal Register 1985). Natural (secondary) succession can eliminate potential habitat for *S. shortii* through changes in vegetational composition. As old-field habitats and closed canopy woodlands develop, potential *S. shortii* habitat is lost (USFWS, 2007).

Recovery**Reclassification Criteria:**

1. Adequate protection is obtained for the nine high priority occurrences and the habitat they occur in (USFWS, 1988).
2. Protected occurrences are determined to be self-sustaining and maintaining current population levels or above (USFWS, 1988).
3. Species biology and ecological requirements are sufficiently understood to determine and implement long-term management strategies (USFWS, 1988).

Delisting Criteria:

1. Adequate protection is obtained for the nine high priority occurrences and the habitat they occur in (USFWS, 1988).
2. Protected occurrences are determined to be self-sustaining and maintaining current population levels or above (USFWS, 1988).
3. Species biology and ecological requirements are sufficiently understood to determine and implement long-term management strategies (USFWS, 1988).
4. At least nine additional protected occurrences, equal in size and significance to the high priority occurrences mentioned above, are discovered in the vicinity of the Blue Licks population or at a currently unknown location (USFWS, 1988).

Recovery Actions:

- Protect existing occurrences and essential habitat. Prioritize occurrences for protection. Contact landowners and negotiate highest or most appropriate level of protection possible (USFWS, 1988).
- Conduct systematic searches for additional occurrences and populations. Identify potential habitat. Conduct ground searches (USFWS, 1988).
- Conduct studies of life history and ecological requirements. Delineate existing occurrences and establish permanent study plots. Analyze physical habitat and characterize habitat factors. Study phenology, pollination, and seed dispersal. Perform ex situ germination study and long-term demographic study. Determine management practices and develop recommendations to maintain health, vigor, and survivability of species (USFWS, 1988).
- Develop management plan and implement recommended management practices if determined beneficial. Conduct controlled burns, if determined beneficial. Remove overstory and/or aggressive competing vegetation if determined beneficial. Implement controlled rotational grazing system, if determined beneficial. Monitor results of management practices and re-evaluate needs as data on management results are obtained (USFWS, 1988).
- Maintain viable seeds. Collect and deposit seeds into seed banks. Make seeds available to organizations or institutions for propagation (USFWS, 1988).
- Continue management and monitoring of naturally occurring and reintroduced occurrences in Kentucky and Indiana, with consideration of intensified management at selected sites (USFWS 2017).
- Consider expansion of reintroduction efforts, with careful consideration of seed origin and genetics (USFWS 2017).

- Investigate and compare the genetic diversity/structure of Kentucky and Indiana populations, including the reintroduced occurrences in Harrison County, Kentucky (USFWS 2017).
- Investigate potential impacts of the bacterial leaf spot observed on occurrences in the Blue Licks area of Kentucky (USFWS 2017).
- Explore the potential threat posed by the horticultural cultivar *S. shortii* 'Solar Cascade' (USFWS 2017).

Conservation Measures and Best Management Practices:

- Continue searches for new occurrences in the Blue Licks area, especially near known buffalo traces (USFWS, 2007).
- Conduct searches for new occurrences in riparian outcrop habitats of central Kentucky and southern Indiana or in upland areas of the region with suitable habitat (USFWS, 2007).
- Continue to investigate the life history and ecological requirements of the species (e.g., seedling establishment, seed and pollen dispersal distances) (USFWS, 2007).
- Continue to pursue permanent protection (through registry agreements, easements, or land purchases) of occurrences located on private property (USFWS, 2007).
- Expand the size of extant occurrences through habitat management and augmentation (USFWS, 2007).
- Establish viable occurrences in areas within the historical range that have suitable habitat, especially the Blue Licks Area of Fleming, Nicholas, and Robertson counties; develop criteria for establishing experimental populations in Kentucky (USFWS, 2007).
- Acquire potentially suitable but currently unoccupied habitat for the species where the species can be introduced and managed (USFWS, 2007).
- Continue implementation of management actions for permanently protected occurrences; develop a management strategy for the Indiana occurrence (USFWS, 2007).
- Revise the recovery plan (USFWS, 2007).

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SPECIES ACCOUNT: *Solidago spithamea* (Blue Ridge goldenrod)

Species Taxonomic and Listing Information

Listing Status: Threatened; Southeast Region (R4) 03/28/1985

Physical Description

A perennial herb with solitary or tufted, erect, unbranched stems, usually 1-3 dm tall. A flat- or round-topped terminal cluster of yellow flower heads, each containing 20-30 flowers, blooms from July to September. This is 1 of only a few southern goldenrods with close affinities to plants now abundant in more northern areas. Populations are thought to be relict in nature, persisting on mountain-tops as the regional climate became warmer and drier. (NatureServe, 2015)

Taxonomy

Blue Ridge goldenrod is a member of a large and taxonomically complex genus which contains over 100 species native chiefly to North America, reaching its greatest complexity in the Eastern United States. The name of the genus comes from the Latin solidus and ago meaning solid and firm, referring to the healing qualities of the members of this genus (Britton and Brown 1970). The genus is within the large and complex family (Asteraceae) (USFWS, 1987).

Historical Range

Only three populations of Blue Ridge goldenrod are known to exist; two are in Avery County, North Carolina, on Grandfather Mountain and Hanging Rock, and one is on the border between Mitchell County, North Carolina, and Carter County, Tennessee, on Roan Mountain (USFWS, 1987).

Current Range

Endemic to three mountains, Grandfather Mountain and Hanging Rock Mountain in North Carolina, and Roan Mountain on the North Carolina-Tennessee border (Weakley 2008) (NatureServe, 2015).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: rhizomes and seeds? Pollinators unknown (USFWS, 1987)

Breeding Season

Adult: Flowering occurs from July to September (USFWS, 1987).

Reproduction Narrative

Adult: Flowering occurs from July to September. The fruit, which is present from July to October, is a cypsela (referred to by some as an achene or nutlet) 2.5 to 3 millimeters long (Kral 1979, Massey et al, 1980, Cronquist 1980). Various hymenopterns have been seen visiting the flowers,

but pollinators have not been identified. The plants appear to spread vegetatively by extending rhizomes and presumably reproduce by seed; however, the importance of each mode of reproduction to the species is unknown. Information on seed set, germination and survival of seedlings, flowering frequency, and response of populations to climatic extremes and various forms of disturbance are not available for this species (USFWS, 1987).

Habitat Type

Adult: Rocky outcrops, ledges, cliffs and balds (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Rocky places such as outcrops, ledges, cliffs, and balds at elevations above 1400 m (NatureServe, 2015).

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: High (NatureServe, 2015)

Site Fidelity

Adult: High (NatureServe, 2015)

Habitat Narrative

Adult: Rocky places such as outcrops, ledges, cliffs, and balds at elevations above 1400 m. Sites occupied by the species are generally exposed to full sun. Common associates include grasses and sedges, as well as other rare, high-elevation species such as Heller's blazing star (*Liatris helleri*), Roan Mountain bluet (*Houstonia montana*) and spreading avens (*Geum radiatum*) (NCHP 2001) (NatureServe, 2015).

Dispersal/Migration**Motility/Mobility**

Adult: Low (inferred from USFWS, 1987)

Dispersal

Adult: Low/Slow (inferred from USFWS, 1987)

Population Information and Trends**Population Trends:**

Three historical populations were extirpated by extensive recreational and residential development (NatureServe, 2015).

Resiliency:

Low (inferred from NatureServe, 2015)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

over 1,800 total 'clumps' (NatureServe, 2015)

Additional Population-level Information:

Stable. The known range of *Solidago spithamaea* (Hanging Rock, Roan Mountain, and Grandfather Mountain) has remained the same since the species was listed in 1985 (Service 1985). As stated in the 2012 5-year review, the Hanging Rock population may consist of fewer than 10 clumps, the Roan Mountain population consists of several hundred clumps, and the Grandfather Mountain population consists of several hundred to 1,000 clumps (Service 2012). It should be noted, at the time of the 2012 population estimate, the species had not been monitored since 2001 and determining consistency of monitoring methods among observers was not possible (Service 2012). A recent range-wide survey, conducted in 2016 and 2017, noted 24 clumps at Hanging Rock, 420 clumps at Roan Mountain, and 1,814 clumps at Grandfather Mountain (Thompson 2018b). Inconsistent and infrequent monitoring prior to 2016 increases uncertainties associated with the species' status and trends; however, current population estimates are consistent with estimates derived from 2001 monitoring which indicates stability from 2001 to 2016. (USFWS 2019)

Population Narrative:

Three historical populations were extirpated by extensive recreational and residential development. As of 2009 (USFWS), two populations contained no more than 300 and 1500 patches respectively, and no estimates were available for two populations (USFWS 2009). Estimating population size is difficult due to clonal growth (USFWS 2009). Five populations known in North Carolina. (NatureServe, 2015). Low resiliency, representation and redundancy are inferred based on specific habitat requirements and low population numbers for this species.

Threats and Stressors

Stressor: Recreational Use (USFWS, 2012)

Exposure:

Response:

Consequence: Degradation of habitat

Narrative: The principal source of habitat destruction affecting *S. spithamaea* is recreational use by people who venture out into the species' habitat in search of high-elevation views or adventurous rock climbing, boulder hopping, or other activities. Trampling compacts the plant's rhizome and can shear plants from the rocks in which they are anchored. In the process, fragile soils that have developed over geologic time frames can also be destroyed, making recolonization of these sites by *S. spithamaea* exceedingly difficult. Trampling has contributed to declines in at least one subpopulation of the species² and continues to threaten the long-term viability of several others (USFWS, 2012).

Stressor: Development (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: A related concern stems from the construction of facilities intended to control or direct visitor use. These facilities must be sited and constructed appropriately in order to avoid impacts to *S. spithamea* (USFWS, 2012).

Stressor: Woody succession (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The listing rule identified woody succession as a threat to this species. As soils accumulate and other types of vegetation are able to populate areas where *S. spithamea* had been growing, the taller successional species may outcompete *S. spithamea*, which would negatively impact its ability to thrive (USFWS, 2012).

Stressor: Rock slides (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Natural rock slides were also described as an additional threat to the species, but natural rock slides may also serve to open up additional areas of newly available habitat for an early-successional species like *S. spithamea*. Thus, as with many factors, the frequency and severity of these disturbance events needs to be better understood for a meaningful evaluation of their effects on the continued existence of this species (USFWS, 2012).

Stressor: Climate Change (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Accelerated global climate change is likely to disrupt patterns of climate variability to which *S. spithamea* has become adapted; thus, it is likely to exacerbate the threats already mentioned. However, the current scale of most global models of climate change offers little insight into the changes that will likely occur on the high peaks of the Southern Appalachians (USFWS, 2012).

Recovery

Delisting Criteria:

Criterion 1: The three populations at Roan Mountain, Grandfather Mountain, and Hanging Rock are protected (USFWS, 2012).

Criterion 2: Any necessary management actions have been undertaken for these populations by landowners or cooperating agencies and it has been documented that this management is successfully ensuring the continued survival of these populations (USFWS, 2012).

Criterion 3: Through introduction and/or discovery of new populations, two additional self-sustaining populations exist within the species' historical range (it is believed that at least two additional populations are required to ensure that the species will not become extinct in the foreseeable future) (USFWS, 2012).

Criterion 4: All five populations and their habitat are protected from present and foreseeable human-related and natural threats that may interfere with the survival of any of the population (USFWS, 2012).

Recovery Actions:

- The population at Grandfather Mountain occurs on property that, until 2009, was owned by Grandfather Mountain, Inc., a private corporation with a long history of working with the USFWS and other conservation partners toward the conservation of the rare species and habitats found there. The first measures of formal protection occurred in 1979, when this landowner placed portions of its land on a voluntary Registry of Natural Heritage Areas maintained by the North Carolina Natural Heritage Program (NCNHP) (The Nature Conservancy 1996). The landowner signed a Cooperative Agreement with the USFWS and the North Carolina Department of Agriculture in 1983; in 1991, this owner granted the North Carolina Chapter of The Nature Conservancy a perpetual conservation easement on more than 1,000 acres of the property. In 2009, the State of North Carolina announced the purchase of 2,456 acres formerly owned by Grandfather Mountain, Inc., for inclusion in the North Carolina State Park system. Some portions of the *S. spithamaea* population were retained by Grandfather Mountain, Inc., which has converted to a nonprofit organization--the Grandfather Mountain Stewardship Foundation--and is devoted to education, outreach and environmental stewardship (Jesse Pope, Grandfather Mountain Stewardship Foundation, 2009, personal communication). The population at Roan Mountain occurs on land managed by the U.S. Forest Service (USFS), Pisgah and Cherokee National Forests. This population receives protection under provisions of the Endangered Species Act that require federal agencies to assist in recovery efforts for federally listed species and to consult with the USFWS before undertaking actions which may affect the continued existence of such species. The USFWS has a long history of working with the USFS toward the conservation of Roan Mountain and the rare species that occur there (including six federally listed plants and animals). The Grandfather Mountain and Roan Mountain populations are protected from overt forms of habitat destruction, such as land-use conversion and large-scale commercial or residential development. However, both areas are open to the public and managed (at least in part) for recreational uses, which is an acknowledged threat to *S. spithamaea*. Additional comments on this threat and efforts to manage it are provided below. The population at Hanging Rock is in private ownership and remains unprotected. (USFWS, 2012).
- Grandfather Mountain, Inc., has a long history of implementing appropriate management actions on behalf of the rare species that occur on its properties. The numerous rock cliffs and outcrops which support *S. spithamaea* and numerous other rare and endemic plant species have long been closed to climbing and rappelling. Another site was formally closed to the public (and specifically to hang gliding activities) in the early 1990s, due in large part to concerns over impacts to rare species (including *S. spithamaea*). However, portions of the Grandfather Mountain *S. spithamaea* population occur in areas that receive considerable visitation by the public for recreational purposes. Documentation that management actions are effectively controlling impacts to *S. spithamaea* is currently lacking. The USFS closed two

Roan Mountain sites containing this species (protecting five of the six *S. spithamea* subpopulations supported there) to the public in the early 1990s, primarily in response to concerns that public access was or could result in impacts to the rare species found there. The one Roan Mountain subpopulation that is not closed to the public is in Tennessee, is not visible from a trail, and does not appear to be impacted by recreational visitors (Gary Kauffman, USFS, 2012, personal communication). The population at Hanging Rock is not protected and is not receiving any form of management (USFWS, 2012).

- One additional population has been tentatively identified at The Peak in Ashe County, North Carolina. No other new populations have been discovered or introduced (USFWS, 2012).
- To date, there are three extant populations of the species and a fourth population awaits further confirmation. Threats related to trampling are being managed at the two largest populations of the species (Grandfather Mountain and Roan Mountain); however, some impacts continue to occur at both populations as a result of recreational visitors who disregard signs and established barricades. Vegetation succession and habitat desiccation (both of which may be exacerbated by accelerated global climate change) remain as threats to all populations (USFWS, 2012).
- *Solidago spithamea* co-occurs with other federally listed species. Impacts from monitoring could inadvertently occur if field staff conducting monitoring are unaware of other species present or how to identify them. Pre-monitoring, tailgate meetings should occur prior to each monitoring event when species co-occur. Field staff should be briefed on species present, how to identify them, and strategies for avoidance. (USFWS 2019)
- Work with Thompson to document the monitoring protocol and threats assessment used during the 2016 and 2017 field seasons. Share this information with land managers and property owners to ensure consistency during future monitoring events. (USFWS 2019)
- Work with Thompson, or find an appropriate partner, to continue range-wide monitoring and threats assessment according to the protocol used in 2016 and 2017 so that consistent data can be meaningfully compared. (USFWS 2019)

Conservation Measures and Best Management Practices:

- Confirm the taxonomic identity of the putative population of *S. spithamea* reported at The Peak, in Ashe County, North Carolina (Recovery Task 1.2) (USFWS, 2012).
- Develop a taxonomic key distinguishing co-occurring immature *S. glomerata* from *S. spithamea* (Recovery Task 1.2) (USFWS, 2012).
- Work with appropriate partners to evaluate protection alternatives at Hanging Rock, including the use of voluntary landowner agreements (Recovery Task 1.4) (USFWS, 2012)
- Develop interim research and management plans in conjunction with the USFS; North Carolina Division of Parks and Recreation; and Grandfather Mountain, Inc. (Recovery Task 1.1) (USFWS, 2012).
- Implement monitoring at a representative number of subpopulations across Grandfather Mountain and Roan Mountain (and The Peak, if confirmed) (Recovery Tasks 2, 2.1, 2.3, and 2.6) (USFWS, 2012).
- Compile quantitative data summarizing transplant survivorship across all previously attempted introduction or augmentation efforts involving this species, and evaluate causes for success/failure (Recovery Task 2.8) (USFWS, 2012).
- Evaluate long-term storage requirements for this species, and work with appropriate partners to place representative genetic material in long-term storage (Recovery Task 3) (USFWS, 2012).

- Collaborate with appropriate partners to begin stepping down global climate change models to a meaningful scale for purposes of projecting impacts to high-elevation Southern Appalachian rocky summit and cliff habitats, then devise and evaluate potential adaptation scenarios for *S. spithamea* (Recovery Tasks 1.3 and 1.4) (USFWS, 2012).

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SPECIES ACCOUNT: *Spermolepis hawaiiensis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

Spermolepis hawaiiensis, a member of the Apiaceae (parsley) family, is a slender annual herb with few branches. Its leaves are dissected into narrow, lance-shaped divisions. *Spermolepis hawaiiensis* is the only member of the genus native to Hawaii. It is distinguished from other members of the family by being a non-succulent annual with an umbrella-shaped inflorescence (68 FR 35950) (USFWS, 2016).

Historical Range

Historically, *Spermolepis hawaiiensis* was known from (Waimea) Kauai, (Koko Head) Oahu, (Paomai and Kahinahina) Lanai, and (Apua) Hawaii (USFWS, 2016).

Current Range

Currently, a total of 12 occurrences of *S. hawaiiensis* are known on Kauai, Oahu, Molokai, Lanai, West Maui, and Hawaii (USFWS, 2016)

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Spermolepis hawaiiensis* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes eight detailed critical habitat units (CHUs), in Maui County in Hawaii (81 FR 17790-18110).

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Spermolepis hawaiiensis* under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Spermolepis hawaiiensis* (77 FR 57648-57862).

The critical habitat designation includes 15 critical habitat units, which encompass approximately 2,225 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Spermolepis hawaiiensis* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Spermolepis hawaiiensis* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Spermolepis hawaiiensis* includes eight CHUs in Maui County, Hawaii with detailed unit information. There are also an unknown number of units on Lanai that

contain this species (number of units is unknown because detailed unit descriptions for Lanai are not available) (81 FR 17790-18110).

Molokai—Lowland Mesic—Unit 1 (and) *Palmeria dolei*—Unit 37—Lowland Mesic (and) *Pseudonestor xanthophrys*—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Ctenitis squamigera*, *Cyanea dunbariae*, *C. mannii*, *C. profuga*, *Cyperus fauriei*, *Cyrtandra filipes*, *Gouania hillebrandii*, *Labordia triflora*, *Neraudia sericea*, *Santalum haleakalae* var. *lanaiense*, *Schiedea lydgatei*, *S. sarmentosa*, *Silene alexandri*, *S. lanceolata*, *Spermolepis hawaiiensis*, and *Zanthoxylum hawaiiense*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Mesic—Unit 1 is not known to be occupied by *Asplenium dielerectum*, *Bonamia menziesii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea procera*, *C. solanacea*, *Diplazium molokaiense*, *Festuca molokaiensis*, *Flueggea neowawraea*, *Isodendron pyriformis*, *Kadua laxiflora*, *Melicope mucronulata*, *M. munroi*, *M. reflexa*, *Phyllostegia haliakalae*, *P. mannii*, *P. pilosa*, *Sesbania tomentosa*, *Stenogyne bifida*, or *Vigna o-wahuensis*, or the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 1 consists of 11,465 ac (4,640 ha) of State land, 2,069 ac (837 ha) of federally owned land, and 3 ac (1 ha) of privately owned land, from Kanaio to Kahualau Gulch on the southern slopes of east Maui. This unit is occupied by the plants *Bonamia menziesii*, *Cenchrus agrimonoides*, *Flueggea neowawraea*, *Melicope adscendens*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 1 is not known to be occupied by *Alectryon macrococcus*, *Bidens micrantha* ssp. *kalealaha*, *Canavalia pubescens*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Sesbania tomentosa*, *Solanum incompletum*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 2 consists of 1,851 ac (749 ha) of State land at Keokea on the southern slopes of east Maui. This unit is occupied by the plants *Bonamia menziesii*, *Canavalia pubescens*, and *Hibiscus brackenridgei*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or

biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 2 is not known to be occupied by *Alectryon macrococcus*, *Bidens micrantha* ssp. *kalealaha*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 3 consists of 188 ac (76 ha) of privately owned land, at Keauhou on the southern slopes of east Maui. This unit is occupied by the plant *Canavalia pubescens*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 3 is not known to be occupied by *Bidens micrantha* ssp. *kalealaha*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 4 consists of 1,266 ac (512 ha) of State land (including the Department of Land and Natural Resources) at Ahihi-Kinau Natural Area Reserve on the southern slopes of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Maui—Lowland Dry—Unit 4 is not currently occupied by *Bidens micrantha* ssp. *kalealaha*, *Bonamia menziesii*, *Canavalia pubescens*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 5 consists of 3,615 ac (1,463 ha) of State land, and 43 ac (17 ha) of privately owned land, from Panaewa to Manawainui on the western and southern slopes of west

Maui. This unit is occupied by the plants *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, *Cenchrus agrimonioides*, *Gouania hillebrandii*, *Kadua coriacea*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and *Tetramolopium capillare*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 5 is not known to be occupied by *Ctenitis squamigera*, *Cyanea obtusa*, *Hesperomannia arbuscula*, *Hibiscus brackenridgei*, *Lysimachia lydgatei*, *Neraudia sericea*, *Schiedea salicaria*, *Sesbania tomentosa*, or *T. remyi*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 6 consists of 3 ac (1 ha) of State land, and 237 ac (96 ha) of privately owned land, from Paleaahu Gulch to Puu Hona on the southern slopes of west Maui. This unit is occupied by the plants *Hibiscus brackenridgei* and *Schiedea salicaria*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 6 is not known to be occupied by *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, *Cenchrus agrimonioides*, *Ctenitis squamigera*, *Cyanea obtusa*, *Gouania hillebrandii*, *Hesperomannia arbuscula*, *Kadua coriacea*, *Lysimachia lydgatei*, *Neraudia sericea*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Spermolepis hawaiiensis*, *Tetramolopium capillare*, or *T. remyi*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Mesic—Unit 1 (and) *Palmeria dolei*—Unit 42—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 42— Montane Mesic This area consists of 257 ac (104 ha) of State land, and 559 ac (226 ha) of privately owned land from Kamiloloa to Makolelau in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Bidens wiebkei*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Montane Mesic—Unit 1 is not known to be occupied by *Asplenium dielerectum*, *Cyanea dunbariae*, *C. mannii*, *C. procera*, *C. solanacea*, *Cyperus fauriei*, *Kadua laxiflora*, *Melicope mucronulata*, *Neraudia sericea*, *Plantago princeps*, or *Stenogyne bifida*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations

within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat designation for *Spermolepis hawaiiensis* includes 15 critical habitat units, covering two ecosystem types, which encompass approximately 2,225 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Dry—Units 1, 2, 7, 8, 9, 10, 11; Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Lowland Dry—Unit 1 [102 ac (41 ha)]; This area consists of 49 ac (20 ha) of State land and 53 ac (22 ha) of privately owned land in the Waianae Mountains, extending from Haili Gulch to Kawaipahai. Oahu—Lowland Dry—Unit 2 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland dry ecosystem in the Waianae Mountains, on Federal land within Kaena Point State Park. Oahu—Lowland Dry—Unit 7 [15 ac (6 ha)]. This area consists of 15 ac (6 ha) of State land in the lowland dry ecosystem, in Leahi (Diamond Head) Crater within Diamond Head State Monument. Oahu—Lowland Dry—Unit 8 [99 ac (40 ha)]. Oahu—This area consists of 96 ac (40 ha) of privately owned land and 3 ac (1 ha) of State land as part of the old railroad right-of-way in the lowland dry ecosystem, at the Kalaeloa Barber's Point Harbor area. Oahu—Lowland Dry—Unit 9 [37 ac (15 ha)]. This area consists of 17 ac (7 ha) of City and County land, 3 ac (1 ha) of privately owned land, 1 ac (0.5 ha) of State land, and 16 ac (6 ha) of Federal (Pearl Harbor NWR) land in the lowland dry ecosystem at Kalaeloa. Oahu—Lowland Dry—Unit 10 [43 ac (17 ha)]. This area consists of 43 ac (17 ha) of State land (DHHL) in the lowland dry ecosystem at Kalaeloa. Oahu—Lowland Dry—Unit 11 [166 ac (67 ha)]. This area consists of 166 ac (67 ha) of federal land (U.S. Navy) in the lowland dry ecosystem at Kalaeloa.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac (105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

The critical habitat designation for *Spermolepis hawaiiensis* includes two units totaling 452 acres in Kauai County, Hawaii. The units are Kauai 11—*Spermolepis hawaiiensis*— a, Kauai 13—*Spermolepis hawaiiensis*— b.

Kauai 11—*Spermolepis hawaiiensis*—a: This unit is critical habitat for *Spermolepis hawaiiensis* and is 95 ha (237 ac) on State land (Puu Ka Pele Forest Reserve), containing portions of Kawaiiki Valley. This unit provides habitat for one population of 500 mature, reproducing individuals of the annual *Spermolepis hawaiiensis* and is currently occupied with two plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. It provides habitat for the westernmost range of the species that is unique to Kauai. The habitat features contained in this unit that are essential for this species include, but are not limited to, *Metrosideros polymorpha* forests or *Dodonaea viscosa* lowland dry shrubland. This unit provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Kauai 13—*Spermolepis hawaiiensis*—b: This unit is critical habitat for *Spermolepis hawaiiensis* and is 87 ha (215 ac) on State land, containing portions of Waimea Canyon. This unit provides habitat for one population of 500 mature, reproducing individuals of the annual *Spermolepis hawaiiensis* and is currently occupied with three plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. It provides habitat for the westernmost range of the species that is unique to Kauai. The habitat features contained in this unit that are essential for this species include, but are not limited to, *Metrosideros polymorpha* forests or *Dodonaea viscosa* lowland dry shrubland. This unit provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Spermolepis hawaiiensis* critical habitat consists of two components. Lowland dry (east Maui, west Maui and Lanai) and Lowland mesic (Lanai and Molokai) (81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*. Subcanopy: *Chamaesyce*, *Dodonaea*, *Leptecophylla*, *Osteomeles*, *Psydrax*, *Scaevola*, *Wikstroemia*. Understory: *Alyxia*, *Artemisia*, *Bidens*, *Chenopodium*, *Nephrolepis*, *Peperomia*, *Sicyos*.

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Molokai—Montane Mesic: The physical and biological features of critical habitat are: (A) Elevation: 3,300 to 6,500 ft (1,000 to 2,000 m). (B) Annual precipitation: 50 to 75 in (130 to 190 cm). (C) Substrate: Deep ash deposits, thin silty loams. (D) Canopy: *Acacia*, *Ilex*, *Metrosideros*, *Myrsine*, *Nestegis*, *Nothocestrum*, *Pisonia*, *Pittosporum*, *Psychotria*, *Sophora*, *Zanthoxylum*. (E) Subcanopy: *Alyxia*, *Charpentiera*, *Coprosma*, *Dodonaea*, *Kadua*, *Labordia*, *Leptecophylla*, *Phyllostegia*, *Vaccinium*. (F) Understory: *Ferns*, *Carex*, *Peperomia*.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Spermolepis hawaiiensis* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Spermolepis hawaiiensis* occurs within the Lowland dry and Dry cliff ecosystems in the Waianae Mountain caldera complex and the Lowland dry ecosystem in the Koolau Mountain caldera complex:

Oahu—Lowland Dry—Units 1, 2, 7, 8, 9, 10, 11. (A) Elevation: <3,300 ft (<1,000 m). (B) Annual Precipitation: <50 in (<130 cm). (C) Substrate: Weathered silty loams to stony clay, rocky ledges, little weathered lava. (D) Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*, *Sapindes*. (E) Subcanopy: *Chamaesyce*, *Dodonaea*, *Leptecophylla*, *Osteomeles*, *Psychotria*, *Scaevola*, *Wikstroemia*. (F) Understory: *Alyxia*, *Artemisia*, *Bidens*, *Chenopodium*, *Nephrolepis*, *Peperomia*, *Plumbago*, *Sicyos*, *Sida*, *Waltheria*.

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: *Antidesma*, *Chamaesyce*, *Diospyros*, *Dodonaea*. (F) Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Schiedea*.

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) *Metrosideros polymorpha* forests or *Dodonaea viscosa* lowland dry shrubland and containing one or more of the following associated plant species: *Bidens sandwicensis*, *Doryopteris* spp., *Eragrostis variabilis*, *Erythrina sandwicensis*, *Lipochaeta* spp., *Schiedea spargulifolia*, or *Sida fallax*; and

(ii) Elevations between 56 and 662 m (184 and 2,172 ft).

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for

125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–

66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Spermolepis hawaiiensis* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Associated plant species include *Doryopteris* sp., *Gouania hillebrandii*, and *Sida fallax*.

This species is an annual, and numbers fluctuate greatly from year to year, depending on climatic conditions and other unknown factors. Little else is known about the life history of this taxon. Reproductive cycles, specific environmental requirements, and limiting factors are unknown (Makua Implementation Team 2003) (USFWS, 2016).

Habitat Type

Adult: Lowland dry shrubland, cultivated fields, and pastures (USFWS, 2016)

Habitat Narrative

Adult: *Spermolepis hawaiiensis* is known from various vegetation types, including *Metrosideros polymorpha* forests, *Dodonaea viscosa* lowland dry shrubland, cultivated fields, and pastures between about 300 and 600 m (1,000 and 2,000 ft) in elevation (USFWS, 2016).

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Unknown (USFWS, 2016)

Number of Populations:

12 (USFWS, 2016)

Population Size:

5,000 - 10,000 individuals (USFWS, 2016)

Population Narrative:

Currently, a total of 12 occurrences of *S. hawaiiensis* are known on Kauai, Oahu, Molokai, Lanai, West Maui, and Hawaii. The total number of individuals State-wide is estimated between 5,000 and 10,000 individuals. On Kauai, this species has been observed in the Koaie branch and other unspecified locations within Waimea Canyon, Hanapepe at Kapahili Gulch, and Hipalau on State and private land. The total number of plants on Kauai is a few thousand. On Oahu, this species is known from a total of fewer than 60 individuals at Diamond Head and Makua-Keaau ridge on State and Federal lands, respectively. On Molokai, about 600 plants were reported from Kamalo, on private land. On Lanai, two occurrences of *S. hawaiiensis* are known: east of Puu Manu with 50 to 100 individuals and Kaa Gulch with about 300 individuals, both on private lands. On West Maui, *S. hawaiiensis* is known from two occurrences in the Lihau section of the West Maui Natural Area Reserve with 60 to 100 individuals and several hundred to thousands of plants, respectively; and, above Lahainaluna School with about 100 individuals. On the island of Hawaii, three occurrences of about 500 individuals are found on the U.S. Army's Pohakuloa Training Area in Kipuka Alala, Puu Anahulu, and an unnamed kipuka within the 1859 lava flow (Makua Implementation Team 2003) (Table SB 38) (USFWS, 2016).

Threats and Stressors

Stressor: Feral ungulates (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Habitat degradation by feral goats, axis deer, and mouflon sheep is listed as a threat to this species (USFWS, 2016).

Stressor: Non-native plants (USFWS, 2016)

Exposure:**Response:****Consequence:** Loss of habitat**Narrative:** Competition with various non-native plants is listed as a threat to this species (USFWS, 2016).**Stressor:** Fire (USFWS, 2016)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** Fire is listed as a threat to this species (USFWS, 2016).**Stressor:** Military activities (USFWS, 2016)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** Military activities are listed as a threat to this species (USFWS, 2016).**Stressor:** Habitat destruction (USFWS, 2016)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** Habitat destruction is listed as a threat to this species (USFWS, 2016).**Stressor:** Stochastic events (USFWS, 2016)**Exposure:****Response:****Consequence:** Loss of individuals**Narrative:** Direct destruction of individual plants by erosion, landslides, and rockslides are listed as threats to this species (Service 1999a; 68 FR 35950) (USFWS, 2016).***Recovery*****Delisting Criteria:**

Due to the limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1999a). However, *S. hawaiiensis* is not included as a target taxon for stabilization pursuant to the Makua Implementation Plan Addendum. The Army does not actively manage this species in the Makua action area (Service 2003a) (USFWS, 2016)

Conservation Measures and Best Management Practices:

- The recovery plan for this species identifies the following important conservation actions. Fenced exclosures should be constructed around all known occurrences to reduce impacts from feral ungulates. Control of non-native plant species within the exclosures is also needed. Collection, storage, and propagation of representative genetic stock are needed, as well as augmentation of existing occurrences and establishment of additional occurrences (Service 1999a) (USFWS, 2016).

- Ongoing Conservation Actions A State-wide strategic plan is being developed by the Hawaii and Pacific Plants Recovery Coordinating Committee that will address the long-term conservation of *Spermolepis hawaiiensis*. This plan will also include broader landscape actions that are needed for the recovery of this plant throughout its range. This species is being propagated at the Pohakuloa Training Area Rare Plant Facility. Currently, no other management actions are known for this species (Service 1999b; Service 2005b; Durand, pers. comm. 2004, Koob1996) (USFWS, 2016).
- New management actions:
 - ▣ Surveys / inventories
 - o In 2009, a new population containing several 100 individuals of *S. hawaiiensis* was found in Olowalu Valley on West Maui while surveying for *Tetramolopium capillare* (Plant Extinction Prevention Program [PEPP] 2009).
 - o In 2009, a new population of *S. hawaiiensis* (number of individuals not provided) was discovered on Molokai while surveying for *Pritchardia munroi* (PEPP 2010).
 - o During 2011 to 2012, approximately 18.25 square kilometers (300 acres) were surveyed at PTA (U.S. Army 2013). Surveys were completed within the following fence units: *Haplostachys haplostachya* (67 hectares [165 acres]), *Kadua coriacea* (393 hectares [969 acres]), Kipuka Alala North (431 hectares [1,066 acres]), Puu Nohona O Hae (79 hectares [195 acres]), Puu Papapa (28 hectares [68 acres]), and *Silene hawaiiensis* (18 hectares [44 acres]). During that survey, approximately 389 locations were recorded of *Spermolepis hawaiiensis* (U.S. Army 2013).
 - o The survey of the Infantry Platoon Battle Course alternative was completed in September 2012 and 332 locations of *S. hawaiiensis* were recorded (U.S. Army 2012).
 - o Approximately 173 locations of *S. hawaiiensis* were recorded within the installation wide survey area (U.S. Army 2014). Most of the locations were found within the Kipuka Alala Fence Units. Additionally, approximately 302 new locations were recorded within the impact area during surveys for the U.S. Army's proposed Infantry Platoon Battle Area (U.S. Army 2014). These new locations greatly increase the previously documented distribution for this species.
 - o In 2014, surveys conducted in previously un-surveyed areas and previously surveyed areas discovered approximately 160 locations of *S. hawaiiensis* (U.S. Army 2015).
 - ▣ Ungulate monitoring and control
 - o All known individuals of *S. hawaiiensis* at PTA are protected within the Kipuka Alala north and south fence units and the Puu Papapa fence unit (U.S. Army 2010, 2014). The Kipuka Alala north and south fence units are considered ungulate-free (U.S. Army 2014).
 - o The fences at Puu Waawaa Forest Reserve were monitored in 2013 (State of Hawaii Department of Land and Natural Resources [DLNR] 2014). Additional fencing was added to gates to prevent the ingress of ungulates into the fenced unit (DLNR 2014).
 - ▣ Invasive plant monitoring and control
 - o A management plan for control of *Passiflora tarminiana* (banana poka) in habitat occupied by *S. hawaiiensis* within the Kipuka Alala south fence unit was developed and implemented in 2008 at PTA (U.S. Army 2010). In 2010, transects were surveyed and all individuals of *P. tarminiana* located along transects were controlled.
 - o During 2013 to 2014 at the Puu Waawaa Forest Reserve, invasive plants removed around reintroduced plants included *Cenchrus setaceus* (fountain grass), *Lantana camara* (lantana), *Ricinus communis* (castor bean), and *Chenopodium murale* (nettleleaf goosefoot) (DLNR 2014). Small invasive tree seedlings were also removed, including *Grevillea robusta* (silver oak), *Schinus molle* (pepper tree), *Olea europaea* subsp. *europaea* (European olive), and *Jacaranda mimosifolia* (jacaranda) (DLNR 2014).
 - ▣ Captive propagation for genetic storage and reintroduction
 - o There are three individuals and one seed flat containing numerous individuals of *S. hawaiiensis* in the nursery at Hawaii Volcanoes National Park (2014).
 - o There are hundreds of seeds in storage and 23 plants growing at Maui Nui Botanical Gardens (2014).
 - o The Lyon Arboretum's Seed Conservation Laboratory (2014) has more than 3,500 seeds in storage.
 - o The Lyon Arboretum's Micropropagation Laboratory (2013) has approximately 56 propagules in storage.
 - o The National Tropical Botanical Garden (2014) has approximately 1,495 seeds in storage from Kauai and Maui.
 - o There are more than 5,000 seeds in storage at the Volcano Rare Plant Facility from founders at PTA (2014).
 - o During 2011 to 2012, 132 seeds were collected from a single founder located within the Infantry Platoon Battle Area at PTA

for genetic storage (U.S. Army 2013). o During 2012 to 2013, more than 29,000 seeds from 5 accessions representing 3 groups and 5 founders of *S. hawaiiensis* were collected and placed in long-term storage at PTA (U.S. Army 2014). There are now more than 559,000 seeds in storage from 69 accessions representing 3 groups and 42 founders in long-term storage at PTA (U.S. Army 2014). Field collections of genetic resources at PTA are usually small and infrequent due to the ephemeral nature of the species. The vast majority of seed in ex situ storage is from plant growing in the greenhouse (U.S. Army 2014). ¶ Captive propagation protocol development – Propagation trials were conducted at PTA to determine appropriate storage and propagation techniques for *S. hawaiiensis*. The trials indicated that seeds of *S. hawaiiensis* germinate readily at a rate of more than 50 percent (U.S. Army 2015). Seed longevity for *S. lanceolata* is unknown (U.S. Army 2015). ¶ Population viability monitoring and analysis o In 2010, a new monitoring methodology was implemented at PTA where previously known locations of *S. hawaiiensis* were sampled on a monthly basis to determine if there is a seasonal component that leads to this species germination or if there are specific moisture availability thresholds that elicit germination (U.S. Army 2010). If plants were found during the monthly sampling period a more intensive distributional survey would be conducted to determine the extent of the species' occurrence and to estimate abundance. Unfortunately, no plants were found in 2010 and the new monitoring methodology was not utilized. The lack of plants may have been due to prolonged drought conditions that have affected most species at PTA throughout 2010 (U.S. Army 2010). o At site 214 within the Kipuka Alala South fence unit, monitoring of the site in 2014 tallied a single reintroduced individual and approximately 10 naturally recruited immature individuals (U.S. Army 2015). o Near Saddle Road on State-owned lands, natural recruitment of approximately 25 mature individuals was observed in 2014 (U.S. Army 2015). o At Puu Waawaa Cone Unit on State-owned lands monitoring conducted in 2014 recorded natural recruitment of more than 500 mature individuals of *S. hawaiiensis* (U.S. Army 2015). o On County-owned lands in North Kona, natural recruitment was not observed at this site in 2014 (U.S. Army 2015). ¶ Reintroduction / translocation o In 2013, approximately 4,300 seeds were broadcasted at Puu Waawaa Cone Unit on State-owned lands (U.S. Army 2014). o During 2002 to 2012 at site 214 within the Kipuka Alala south fence unit, 20 individuals were reintroduced to the site (U.S. Army 2015). In 2014, a single individual of *S. hawaiiensis* was reintroduced at the site (U.S. Army 2015). o Near Saddle Road on State-owned lands, 4 individuals were reintroduced during 2002 to 2012, no individuals were added in 2014, and no plants remained in 2014 (U.S. Army 2015). o At Puu Waawaa Cone Unit on State-owned lands, three individuals were reintroduced during 2005 to 2012 (U.S. Army 2015). In 2014, no reintroduced individuals remained. o On County-owned lands in North Kona, eight individuals were reintroduced during 2008 to 2012 and no reintroduced individuals remained in 2014 (U.S. Army 2015). o During 2013 to 2014, 118 individuals of *S. hawaiiensis* were reintroduced at Puu Waawaa Forest Reserve (DLNR 2014). ¶ Listing and critical habitat designation o Sixteen units of critical habitat were designated in the lowland dry and dry cliff ecosystems on Oahu for *S. hawaiiensis* (USFWS 2012a). o Two units of critical habitat for *S. hawaiiensis* were proposed in the lowland mesic and montane mesic ecosystems on Molokai (USFWS 2012b). On Maui, critical habitat for *S. lanceolata* was proposed in six units in the lowland dry ecosystem. On Lanai, three units of critical habitat for *S. hawaiiensis* were proposed in the lowland dry and lowland mesic ecosystems. The final rule for critical habitat designations has not been published at the time of this review. ¶ Climate change adaptation strategy – Fortini et al. (2013) conducted a landscapebased assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *S. hawaiiensis* has a low vulnerability to the impacts of climate change (USFWS, 2015).

References

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

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SPECIES ACCOUNT: *Sphaeralcea gierischii* (Gierisch mallow)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/12/2013; Southwest Region (Region 2) (USFWS, 2016)

Physical Description

A perennial herb with few to many stems from a woody caudex (short, thickened, woody stem, subterranean or at ground-level). Stems are 43-103 cm tall, sparingly leafy, often dark red-purple, and in tall, open clumps. The foliage is bright green and essentially hairless. The leaf blades are 1.2-4 cm long, 1-5 cm wide; usually longer than wide. The leaves are egg-shaped or somewhat heart-shaped, the base heart-shaped to even-ended, with 3-5 lobes. The flowering stem is open, usually with more than one flower per node. The calyx is 5-10 mm long, green, essentially hairless, and the orange petals are 15-25 mm long (Atwood and Welsh 2002 cited in Falk 2008). Blooms April - early June. (NatureServe, 2015)

Taxonomy

Sphaeralcea gierischii is a species described in 2002 from Utah and Arizona (Atwood and Welsh 2002. Novon 12: 159-166). This species is similar to *S. rusbyi* but has glabrous or glabrescent herbage with few or no stellate hairs. (NatureServe, 2015)

Current Range

Endemic to a small area straddling the Utah-Arizona state line, in northwestern Mohave County, Arizona (vicinity of Black Rock Gulch, Black Knolls, and Pigeon Canyon) and closely adjacent Washington County, Utah (Little Round Valley). (USFWS 2010).

Critical Habitat Designated

Yes; 8/13/2013.

Legal Description

On August 13, 2013, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Sphaeralcea gierischii* (Gierisch mallow) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in Arizona and Utah (78 FR 49165-49183).

Critical Habitat Designation

The critical habitat designation for *Sphaeralcea gierischii* includes two CHUs in Mohave County, Arizona, and Washington County, Utah. This species critical habitat encompasses approximately 12,822 acres (ac) (5,189 hectares (ha)) (78 FR 49165-49183).

Unit 1: Starvation Point: This unit consists of 1,339 ha (3,308.7492 ac) in Arizona and Utah, and occurs on land managed by Arizona BLM (220.31 ha; 544.40 ac) and Utah BLM (802.11 ha; 1,982.07 ac), SITLA in Utah (67.73 ha; 167.38 ac), and ASLD in Arizona (248.83 ha; 614.87 ac). This unit was occupied at the time of listing and contains the features essential to the conservation of the species. Unit 1 contains two Gierisch mallow populations, including the second largest population. Unit 1 is located west of I-15 as this highway crosses the State line of Arizona and Utah, and is bounded by the Virgin River to the west and I-15 to the south and east. The features essential to the conservation of the species may require special management considerations or

protection to control invasive plant species, to control habitat degradation due to the recreation and mining activities that disrupt the soil composition, and to maintain the identified associated vegetation and pollinators essential to the conservation of the species. The portion of habitat that occurs on ASLD occurs within the footprint of the Georgia-Pacific Mine, which could resume gypsum mining operations in the near future. Grazing, which can modify the primary constituent elements and may require special management, typically occurs outside of the growing season for Gierisch mallow in the one pasture on Utah BLM and SITLA lands within this unit; however, recent wildfires in adjacent pastures in this allotment have resulted in livestock grazing occurring into the spring growing season for Gierisch mallow. These recently burned pastures have since been rehabilitated, and livestock grazing is anticipated to return to its normal grazing rotation of November 1 to February 28 in the future (Douglas 2012, p. 1).

Unit 2: Black Knolls This unit consists of approximately 3,850 ha (9,513 ac) in Arizona, and occurs on land managed by both Arizona BLM (3,586.28 ha; 8,861.90 ac) and ASLD (263.62 ha; 651.41 acres). This unit is occupied at the time of listing and contains the features essential to the conservation of the species. Unit 2 contains the remaining 16 Gierisch mallow populations, including the largest population. Unit 2 is located south of I-15 as this highway crosses the State line of Arizona and Utah, and is bounded by Black Rock Gulch to the west and Mokaac Mountain to the south and east. The features essential to the conservation of the species may require special management considerations or protection to control invasive plant species, to control habitat degradation due to mining activities that disrupt the soil composition, and to maintain the identified associated vegetation and pollinators essential to the conservation of the species. The largest population of Gierisch mallow occurs in the area of the proposed expansion of the Black Rock Gypsum Mine. As described in the final listing rule published elsewhere in today's Federal Register, grazing on BLM lands in Arizona typically occurs during the growing season for Gierisch mallow on all three BLM allotments within this critical habitat designation and is expected to modify the primary constituent elements, although some of the pastures are in a rest/rotation system in which a pasture may see an entire year of rest before being grazed again.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Sphaeralcea gierischii* critical habitat consists of five components (78 FR 49165-49183):

- (i) Appropriate geological layers or gypsiferous soils, in the Harrisburg Member of the Kaibab Formation, that support individual Gierisch mallow plants or their habitat, within the elevation range of 775 to 1,148 meters (2,477 to 3,766 feet). Appropriate soils are defined as: (A) Badland, (B) Fluvaquents and Torrifluvents, (C) Riverwash, (D) Cave-Harrisburg-Grapevine complex, (E) Grapevine-Hobcan complex, (F) Nikey-Ruesh complex, (G) Gypill-Hobog complex, (H) Hobog-Tidwell complex, (I) Hobog-Grapevine complex, (J) Grapevine-Shelly complex, and (K) Hindu-Rock outcrop-Gypill complex.
- (ii) Appropriate Mojave desert scrub plant community and associated native species for the soil types at the sites listed in paragraph (2)(i) of this entry.
- (iii) Biological soil crusts within the soil types listed in paragraph (2)(i) of this entry.

(iv) The presence of insect visitors or pollinators, such as the globemallow bee and other solitary bees. To ensure the proper suite of pollinators are present, this includes habitat that provides nesting substrate for pollinators in the areas described in paragraph (2)(ii) of this entry.

(v) Areas free of disturbance and areas with low densities or absence of nonnative, invasive plants, such as red brome and cheatgrass.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographic area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. The features essential to the conservation of this species may require special management considerations or protection to reduce the direct and indirect effects associated with the following threats: Habitat loss and degradation from mining operations; livestock grazing; recreation activities; and invasive plant species. Please refer to the final listing rule published elsewhere in today's Federal Register for a complete description of these threats. Special management to protect the features essential to the conservation of the species from the effects of gypsum mining include creating managed plant preserves and open spaces, limiting disturbances to and within suitable habitats, and evaluating the need for (and conducting restoration or revegetation of) native plants in open spaces or plant preserves containing similar gypsum soils. Management activities that could ameliorate these threats include (but are not limited to) seed collection from the Gierisch mallow throughout its range, including those plants within the footprint of each mine. These seeds could be used to begin propagation studies to determine the long-term viability of plants growing in reclaimed soils. Additionally, these seeds could be used to begin propagating plants to be planted in other gypsum deposits and to augment existing populations. In addition to collecting seeds directly from plants, the seed bank could be collected from the top 1 inch of soil before the surface disturbance occurs as long as soils are properly handled during seed bank collection (Scoles-Sciulla and DeFalco 2009, entire). Special management may be necessary to protect features essential to the conservation of the Gierisch mallow from livestock grazing, including fencing populations; avoiding activities, such as water trough placement, that might concentrate livestock near or in occupied habitat; and removing livestock from critical habitat during the species' growing and reproductive seasons, especially during periods of flowering and fruiting. Special management that may be necessary to protect the features essential to the conservation of the Gierisch mallow from recreational activities includes directing recreational use away from and outside of critical habitat, fencing small populations, removing or limiting access routes, ensuring land use practices do not disturb the hydrologic regime, and avoiding activities that might concentrate water flows or sediments into critical habitat. Additionally, threats related to both control of nonnative, invasive species and fire suppression and fire-related activities resulting from the spread of nonnative, invasive species include: • Crushing and trampling of plants from fire suppression and treatment activities; • Damage to seedbank as a result of fire severity; • Soil erosion; and • An increase of invasive plant species that may compete with native plant species as a result of wildfires removing non-fire-adapted native plant species or as a result of fire suppression equipment introducing invasive plant species.

Life History

Food/Nutrient Resources

Breeding Season

Adult: April to early June (NatureServe, 2015)

Reproduction Narrative

Adult: Flowers bloom between April and early June. The Service does not know how the flowers are pollinated, the pollination system (self-pollinated or obligate out crosser), seed dispersal mechanisms, or the conditions under which seeds germinate. (NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Desert (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at elevations between 700 to 1,300 m (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Habitat Narrative

Adult: Found mainly on gypsiferous outcrops of the Harrisburg Member of the Kaibab Formation (considered to be essentially an obligate gypsophile); also collected on the Moenkopi Formation and on limestone rock/soil. Tends to occur on low terraces with clay to gravelly soil, on north-facing slopes of 5-30% at elevations between 700 and 1,300 m. Plant community is warm desert shrub (Mohave desertscrub), with dominants including creosote bush (*Larrea tridentata*), blackbrush (*Coleogyne ramosissima*), saltbush (*Atriplex* sp.), *Yucca* sp., *Ambrosia* sp., and *Ephedra* sp. Other associated genera and species include: *Chrysothamnus*, *Dalea* (prairie-clover), *Hilaria jamesii* (James' galleta), *Hymenoclea salsola* (burrow-brush), *Lycium andersonii* (desert-thorn), *Opuntia*, *Petalonyx* (sandpaper-plant), *Psoralea* (indigo bush), *Purshia* (cliffrose), and gypsiferous biological soil crust species. (NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Long-term trends are unknown but short-term trends indicate a decline of 10-30% (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Population Growth Rate:

Unknown (NatureServe, 2015)

Number of Populations:

5 (NatureServe, 2015)

Population Size:

16,000 to 26,000 (NatureServe, 2015)

Population Narrative:

Long-term population trends are unknown but short-term trends indicate a decline of 10-30%. A plant of limited range and distribution, including being found in a specific soil composition (gypsum outcrops), it is highly susceptible to habitat destruction and modification. Surveys by Hughes (2012a in USFWS 2013) estimate total population size to be between 11,000 and 18,000 individuals in Arizona. Hughes (2008a, p. 12; Highes 2009, p. 15; in USFWS 2013) conducted more extensive surveys of gypsiferous soils in Utah and estimated the population to be between 5,000 and 8,000 individuals. There are 4 occurrences in a small area of northwest Mohave County, Arizona, while 1 occurrence occurs across the border in Utah. All occurrences are restricted to less than approximately 186 ha (460 ac). Since surveys began, no new populations have been found outside of known areas. (USFWS, 2013). (NatureServe, 2015)

Threats and Stressors

Stressor: Climate change and drought (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Because of the threats of mining, grazing during drought years, recreation, and nonnative species, the cumulative effects of climate change and drought may be of concern for this species in the future. At this time, the state of knowledge concerning the localized effects of climate change and drought is too speculative to determine whether climate change and drought are a threat to these species in the future (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation (herbivory, along with some related trampling) by livestock is a threat that has moderate impacts only during drought years or during the reproductive period. Livestock herbivory during the reproductive period can lead to the flowering stalks being eaten, thus preventing adult Gierisch mallow plants from reproducing (USFWS, 2013).

Stressor: Habitat destruction and modification (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: Factors adversely affecting habitat of Gierisch mallow, which are anticipated to result in a significant decrease in both the range of the species and the size of the population of the species, include mining activities, livestock grazing, nonnative plant species, and fire. All of the populations and most of the habitat are located on BLM and ASLD lands, which have an extensive history of, and recent successful exploration activities for, gypsum mining. Although livestock do not typically eat Gierisch mallow, livestock grazing can affect Gierisch mallow habitat more significantly during drought years, as livestock move into the Gierisch mallow habitat searching for forage. Additionally, livestock have been implicated in spreading nonnative, invasive species, such as red brome and cheatgrass, although the extent to which livestock contribute to the spread of these two nonnative grasses is not known. Red brome and cheatgrass are documented to occur in all 18 populations of the Gierisch mallow, although mostly after wet years. The threat of fire caused by annual invasions of nonnative species is exacerbated by mining activities, livestock grazing, and recreation activities (USFWS, 2013).

Stressor: Small populations (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: Small population size and restricted range intrinsic vulnerabilities to the Gierisch mallow that may not rise to the level of a threat on their own. However, the small population sizes and restricted range of this species increase the risk of extinction to the Gierisch mallow populations in conjunction with the effects of global climate change and the potential for stochastic extinction events such as mining and invasive species. Therefore, the small, localized population size are considered to exacerbate the threats of mining, invasive species, and climate change to the species (USFWS, 2013).

Recovery**Reclassification Criteria:**

Reclassification criteria are not available.

Delisting Criteria:

Delisting criteria are not available.

Recovery Actions:

- Recovery actions are not available.

Conservation Measures and Best Management Practices:

- Conservation measures are not available.

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SPECIES ACCOUNT: *Spigelia gentianoides* (Gentian pinkroot)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/26/1990; Southeast Region (R4)

Physical Description

This small perennial herbaceous species possesses a single, erect, sharply ridged stem 10-30 centimeters (cm) (3.9-11.8 inches (in.)) long. The leaves are opposite, sessile, and in pairs at right angles to the next set of leaves. The leaves are largest at the top of the stem, 3-5 cm long, with lower leaves smaller. Flowers are borne in a short, few-flowered, terminal, determinate cyme. The flower consists of a narrow corolla tube of about 2.5-5 cm long, with five triangular lobes, each 5-6 mm long. The corolla is pale to dark pink; slightly darker at the margins of the lobes for the var. *gentianoides*. The stamens are within the flower, and the pollen grains are deposited along the bristles of the style (secondary pollen presentation). At anthesis, the corolla lobes of var. *gentianoides* are partially open, occasionally fully reflexed; whereas the corolla lobes of var. *alabamensis* are always fully reflexed. The green sepals are 4-6 cm long. The fruit is a capsule with two conspicuous round lobes. Peak flowering season occurs between May and June, however, plants have been seen flowering as early as April and as late as October. In a greenhouse, individual flowers last 2 to 5 days before wilting. Most seeds can be collected in June or July. (USFWS, 2012)

Taxonomy

At the time the Recovery Plan was issued, the species was comprised of two varieties located in Jackson and Calhoun counties (Florida), and Geneva and Bibb counties (Alabama). Morphological and molecular studies reassessed the appropriate ranks of these varieties and elevated variety *alabamensis* to species (USFWS 2018, Weakley et al. 2011). Consequently, *Spigelia gentianoides alabamensis* is now a different species. (USFWS, 2019) *Spigelia gentianoides* var. *gentianoides* was first collected in north Florida by Alvan Wentworth Chapman in 1837, probably from the west side of the Apalachicola River, in either Jackson or Calhoun counties. He identified the plant as *S. floridana*, later Alphonse de Candolle (1845) established the current epithet, *S. gentianoides*. *S. gentianoides alabamensis* was first found in 1992 by James R. Allison (Georgia Natural Heritage Program, Georgia Department of Natural Resources) with Timothy Stevens, Jim Rodgers, and Debbie Rodgers while exploring the Little Cahaba River in Bibb County, Alabama. (USFWS, 2012)

Historical Range

Var. *gentianoides*: Washington, Calhoun, and Jackson counties in Florida, and Geneva County in Alabama. Var. *alabamensis*: Bibb County, Alabama. (USFWS, 2012)

Current Range

Spigelia gentianoides var. *gentianoides* is present in Washington, Calhoun, and Jackson counties in Florida, and Geneva County in Alabama. *Spigelia gentianoides* var. *alabamensis* is present in Bibb County, Alabama. (USFWS, 2019)

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Abiotic, Biotic, Self-pollination

Breeding Season

Adult: Peak flowering season occurs between May and June; However, plants have been seen flowering as early as April and as late as October. (USFWS, 2018)

Other Reproductive Information

Adult: *Spigelia gentianoides* can be propagated vegetatively and from seeds. Affolter (2005) successfully propagated *S. alabamensis*: by transplanting entire plants from the field to well drained potting mix; from stem cuttings, and by germinating seeds using cold stratification (2°C) or gibberellic acid (500-1000 ppm) treatments. Eight weeks of cold stratification provided excellent germination rates. (USFWS, 2018)

Reproduction Narrative

Adult: Secondary pollen presentation, a mechanism presenting the pollen on a structure other than the anther, appears to be present in *S. gentianoides* (Negrón-Ortiz, 2007, pers. observ.) and *S. alabamensis*; pollen was observed in the short bristles of the style. At the Geneva SF population, small Halictidae bees (sweat bees) were observed entering and exiting the flower of the *S. gentianoides*. (USFWS, 2018)

Habitat Type

Adult: Terrestrial (USFWS, 2012)

Habitat Vegetation or Surface Water Classification

Adult: well drained upland pinelands (var. *gentianoides*); glades (var. *alabamensis*) (USFWS, 2012)

Dependencies on Specific Environmental Elements

Adult: Fire-dependent ecosystems (USFWS, 2012)

Spatial Arrangements of the Population

Adult: Solitary individual or in small clumps (USFWS, 2012)

Habitat Narrative

Adult: *Spigelia alabamensis* is found in glades (open, almost treeless areas within woodland) that have developed over an ancient rock formation known as Ketona Dolomite. The Ketona formation contains a pure form of dolomite, crystalline in texture with only about 2% of siliceous impurities (Garland 2008). The glades vary in size from about 0.1 to 5 hectares with soil high in magnesium and calcium, low in phosphorus and potassium, and a pH ranging from 7.4 to 7.6 (Grossman et al. 1994). The topography varies from flat to sometimes very strongly sloping. There are patches of exposed rock and thin-soiled areas dominated by grasses and other herbaceous vegetation. The plants in these glades are exposed to extreme heat and drought. At

these sites, plants are quite abundant, and mainly found in small clumps adjacent to rocks.
(USFWS, 2018)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: The mechanism of seed dispersal is unknown, but the fruit does not appear to be adapted for long-distance dispersal (USFWS, 2009).

Population Information and Trends

Population Trends:

Unknown (USFWS, 2018)

Number of Populations:

Var. gentianoides: 7; var. alabamensis: 17 (USFWS, 2018)

Population Size:

Var. gentianoides: ~3,900 individuals; var. alabamensis: unknown ("seems to be abundant")
(USFWS, 2018)

Additional Population-level Information:

Very narrow distribution, low population density. (USFWS, 2018)

Population Narrative:

Spigelia gentianoides var. *gentianoides* is currently restricted to seven extant sites within four counties west of the Apalachicola River: Calhoun, Jackson, and Washington counties in Florida, and Geneva County in Alabama. These sites support about 3,900 plants. The species was originally recorded from nine sites but two sites are considered extirpated. Of the seven extant sites, two new were noted in 2013. *Spigelia alabamensis* (*S. gentianoides* var. *alabamensis*, sensu Gould 1996) is restricted to the Ketona Dolomite formation and glades of Bibb County, AL. This species seems to be abundant but the current number of individuals at these glades is unknown; therefore, population trends are also unknown for *S. alabamensis*. Some of the 17 glades where this species is found are owned and protected by TNC. (USFWS, 2018)

Threats and Stressors

Stressor: Habitat loss or modification (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Conversion of much of the upland forest land in the four counties to pulpwood plantations (clearcutting, mechanical site preparation, and pine plantations) has possibly extirpated other populations. Clearcutting and/or selective thinning are of concern since typical silviculture operations often result in soil disturbance and compaction. In particular, site preparation practices resulting in soil disturbance, change in canopy cover from tree harvest, and change in fire frequency and seasonality are of concern. Land conversion coupled with disruption of pre-historical and historical fire regimes of the longleaf pine-wiregrass ecosystem is

responsible for the rapid decline of the ecosystem where *S. gentianoides* is found. Several studies have shown that frequent prescribed fire regimes are important for maintenance of longleaf pine-wiregrass ecosystem (Hiers et al. 2007). Prescribed burnings at 3 – 5 year intervals seem to maintain optimal *S. gentianoides* populations. However, areas at Apalachee WMA are on a 2-year fire rotation where the largest population of *S. gentianoides* appears to be stable (A. Jenkins, FNAI, 8/15/2018, pers. comm.). However, it is unknown 1) if frequent fires is detrimental to recruitment, and 2) the implications of fire seasonality to *S. gentianoides* survival. Habitats converted to pine plantation, and managed without fire have created a shaded canopy. In addition, pine plantation management induces severe soil disturbance. According to Kral (1983), *S. gentianoides* would not survive the mechanical site preparation used in pine monoculture. This observation seems accurate due to the fragile nature of these plants, but the population located at the Spigelia Preserve seems to have survived, at least over the short term, after cutting and planting. Nevertheless, the population exhibited a decline immediately after the last timber harvest. Similarly, the population in Jackson Co. on land owned by Guy Anglin emerged in a former pine plantation. Urban development also threaten *S. gentianoides*. Conversion of much of forest land to residential development has possibly extirpated many populations. More than a third of Florida's land is projected to be developed by 2070 along with a growth of about 33.7 million residents—almost 15 million more people than in 2010 (University of Florida GeoPlan Center 2017). *Spigelia alabamensis* is restricted to one county in northern Alabama. It is found in 17 glades, and TNC owns and protects about a dozen larger glades and some smaller glades. Populations on private property are threatened by future development for home-sites, agriculture, logging of associated hardwoods, recreational facilities, or other purposes. (USFWS, 2018)

Stressor: Disease or Predation (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Neither diseases nor predation are currently known to be major threats to *S. gentianoides* or *S. alabamensis*. However, minor herbivore damage was noted at Three Rivers SRA and Geneva SF (B. Chowdhury, AU, 6/11/2018, pers. comm.) populations. (USFWS, 2018)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: The Endangered Species Act (Act) of 1973, as amended prohibits the removal of federally listed threatened and endangered plants or the malicious damage of such plants on areas under federal jurisdiction, or the destruction of endangered plants on non-federal areas in violation of state law or regulations or in the course of any violation of a state criminal trespass law. However, the Act does not provide protection for plants on non-federal lands unless it is in violation of state law. In Florida, *S. gentianoides* is listed as endangered under the Preservation of Native Plant Flora of Florida Act (PNPFF Act) (Rule: 5B-40.0055, Section 581.185-187, Florida Statutes; <https://www.flrules.org/gateway/RuleNo.asp?ID=5B-40.0055>). The PNPFF Act addresses the protection of endangered, threatened, or "commercially exploited" plants (http://www.sfrc.ufl.edu/Extension/florida_forestry_information/planning_and_assistance/threatened_and_endangered_species.html). The removal of protected plants from a property, whether for transplant, sale, or any other purpose, requires both the written permission of the

landowner and a permit from the Florida Department of Agriculture and Consumer Services. In Alabama, the Alabama State Constitution provided the necessary authority to add plants to Alabama's section 6 cooperative agreement. Department of Conservation and Natural Resources has a policy to protect, conserve and increase the wildlife of the state [Ala. Code 9-2-2 (1)], but provides little direction as to how this is to be accomplished. While the state's Natural Heritage Program maintains lists of non-game species considered endangered, threatened, of special concern or poorly known, it does not apply penalties for taking listed species or for altering their habitats. The Nongame Wildlife Program, which was started in 1984, helps administer endangered and threatened species projects on federally and state-listed species, and also issues scientific collecting permits to enable a wide range of projects and collect the data for fishes, amphibians, reptiles, birds, and mammals (USFWS, 2018)

Stressor: Non-native plant interactions (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Currently, non-indigenous plants within or near extant populations of *S. gentianoides* do not pose a threat. However, *Lygodium japonicum* (Thunb. ex Murr.) Sw. (Japanese climbing fern) and *Lonicera japonica* Thunb. (Japanese honeysuckle) have been found in the vicinity of *S. gentianoides*, and both are becoming problematic in areas of the Southeast. (USFWS, 2018)

Recovery

Reclassification Criteria:

Downlisting of *S. gentianoides* from endangered to threatened status will be considered when (Criterion 5 was removed per USFWS 2019): (USFWS, 2012; USFWS, 2019)

1. Extant populations and newly discovered sites are identified and mapped (USFWS, 2012; USFWS, 2019).
2. Inventories (i.e., the total number of individuals, number of flowering vs. non-flowering plants, presence of pollinators, and whether seedling recruitment is occurring) have been conducted across the species' historic sites and/or on new locations; (USFWS, 2012)
3. Monitoring programs and management protocols on selected populations (e.g., largest populations) are established for 15 years to track threats to the species and its habitat (e.g., control exotic species, minimize site disturbance, urban development); (USFWS, 2012)
4. For var. *alabamensis*: the extant populations (including subpopulations at the Ketona Glades, Bibb Co., Alabama) located on public land are stable. (USFWS, 2012)
6. Research on key aspects related to demography (e.g., density, effect of fire on seedling establishment), reproductive biology, and seed ecology is accomplished (USFWS, 2012)
7. Viable germplasm representing > 50% of the populations for each variety is maintained in ex-situ. (USFWS, 2012)

Var. *gentianoides*: (1) sizes of populations in the Apalachee WMA, Three Rivers State Park, Calhoun Spigelia Preserve in Florida and the Geneva State Forest in Alabama are increased via prescribed burns until plant numbers are stabilized over a period of 15 years; (2) at least one new population is found, and; (3) at least one population is re-established within the historic range, specifically at sites where the plants are currently known to be extirpated. (USFWS, 2012)

Var. *alabamensis*: (1) 50 % the Bibb Co. glades known to support the variety on private land are protected through conservation agreements, easements, and/or land acquisition. (USFWS, 2012)

Delisting Criteria:

The following Delisting Criteria are applicable to var. *gentianoides*: (USFWS, 2019)

1. Existing core populations [Apalachee WMA, TNC Spigelia Preserve, Three Rivers SRA, Rock Hill TNC Preserve, and Geneva SF] are restored and properly managed, and monitoring demonstrates that the populations are stable or increasing over multiple prescribed burn cycles, evidenced by a type of natural recruitment and/or multiple size-classes (addresses Factors A, D, and E). (USFWS, 2019)
2. At least five (5) new populations are discovered or established within the historic range of the species on lands protected by a conservation mechanism. These populations should exhibit stable or increasing trends over multiple prescribed burn cycles, evidenced by a type of natural recruitment and/or multiple size-classes (addresses Factors A and E). (USFWS, 2019)
3. Threats to *S. gentianoides* and its habitat (e.g., exotic species, site disturbance, urban development, hurricanes) have been managed and reduced to ensure the persistence of *S. gentianoides* into the foreseeable future (addresses Factors A, D, and E). (USFWS, 2019)

Delisting criteria for var. *alabamensis* have not been developed. (USFWS, 2012)

Recovery Actions:

- 1. Protect, manage, and secure existing populations and habitat. The distribution of *Spigelia gentianoides* is limited to a few areas in Northwest Florida extending into central Alabama (Fig. 2), thus it is important to secure and stabilize current and any newly discovered populations to prevent further decline of this plant. (USFWS, 2012).
- 2. Conduct surveys/inventories. Inventory of current and new populations; field surveys and species distribution modeling to determine survey sites. (USFWS, 2012).
- 3. Establish new occurrences within the historic range of var. *gentianoides*, specifically in the sites where the plants are known to be extirpated (USFWS, 2012).
- 4. Maintain the species ex-situ in a protected facility. Ex-situ populations will serve as an important component for storage of germplasm and reintroducing *S. gentianoides* populations within the species range. (USFWS, 2012).
- 5. Conduct long-term monitoring and research; establish and implement a long-term monitoring program on selected sites, to include population biology/demographic studies and phenological studies. Conduct research into reproduction, pollination ecology, and breeding systems. Conduct research on seed bank, germination, and seedling survival. Conduct taxonomic and genetic studies. (USFWS, 2012)

- 6. Outreach: Develop and distribute information to the general public about *S. gentianoides*, how to protect and manage it for its recovery, and how lands can be managed to benefit the plant along with meeting landowner needs. Promote the implementation of the recovery actions via private landowners, academia, and public agencies. (USFWS, 2012)
- 7. Review and track recovery progress. (USFWS, 2012)
- Recommended Action from 2018 5-Year Review: Establish protection and management agreements with landowners. (USFWS, 2018)
- Recommended Action from 2018 5-Year Review: Conduct surveys/inventories on each known population. For each extant population, the following data should be collected once a year: the total number of individuals, number of flowering vs. non-flowering plants, presence of visitors to the flowers, and whether seedling recruitment is occurring. (USFWS, 2018)
- Conduct a long-term study using populations distributed throughout the species' historical range Recommended Action from 2018 5-Year Review: for 10 years to document both distribution and abundance changes. Observations of flowering and fruiting are important and should be integrated with variables such as plant size and seedling data. Since gentian pinkroot occurs in fire prone habitats, the effect of this disturbance (including winter vs. growing season prescribed fire, fire frequency, intensity, duration, and timing) on survival and fecundity should be also monitored. Such studies should be conducted on large populations. Plants should be monitored several times during a 12-month cycle (e.g., flowering and fruiting seasons) the first year, then annually or biannually over an extended number of years. (USFWS, 2018)
- Recommended Action from 2018 5-Year Review: Investigate if there is a soil seed bank persistence of *S. gentianoides* seeds throughout the species' geographic range. (USFWS, 2018)
- Recommended Action from 2018 5-Year Review: Conduct germination studies and investigate whether seedling recruitment is occurring. (USFWS, 2018)
- Recommended Action from 2018 5-Year Review: Monitoring and managing for invasive species: Frequent inventories or surveys of the Florida populations for invasive plant species should be established, which will help with the early detection and eradication of small patches of exotic invasive plants within the sites. This is an ongoing action for the Three Rivers SRA population conducted by the Park staff. (USFWS, 2018)
- Recommended Action from 2018 5-Year Review: Conduct surveys/inventories on potentially new sites in Northern Florida and Alabama. This action can include the use of aerial photographs and species distribution models to determine potential sites, with subsequent field inventory of the site using a consistent, statistically valid, repeatable inventory method. If new populations are discovered, protection should be sought. (USFWS, 2018)
- Recommended Action from 2018 5-Year Review: Reintroduce plants within the historic range, specifically in the sites where the plants have been extirpated. (USFWS, 2018)
- Recommended Action from 2018 5-Year Review: Conduct reproductive studies Since site disturbance occurs within the populations of *S. gentianoides*, it may pose problems to pollinator diversity (Kevan and Phillips 2001). Therefore, it is important to determine which insects are pollinators, and understand the value and pollinators' requirements so that actions can be taken to incorporate specific management or protection plans. Knowledge of the type of mating systems is essential for conservation of rare plant taxa because mating systems affect genetic diversity within and among populations (Navarro and Guitian 2002).

- Therefore, floral morphological analysis and experimental hand-pollinations are all recommended. (USFWS, 2018)
- Recommended Action from 2019 Amended Recovery Plan: Conduct research on key aspects related to (1) demography (e.g., density, effect of fire on seedling establishment), (2) reproductive biology, (3) levels and distribution of genetic diversity, (4) seed ecology to facilitate better understanding of this species' biology and potential impacts of threats such as low density, and changes in fire regime and (5) effects of catastrophic events such as hurricanes on populations and habitat of *S. gentianoides* (addresses Factor E, and resiliency, and inform representation). (USFWS, 2019)
 - Recommended Action from 2019 Amended Recovery Plan: The effects of forest management practices (e.g., logging) on long-term persistence of *S. gentianoides* is assessed and a standardized monitoring technique is in place (addresses Factor D and resiliency). (USFWS, 2019)
 - Recommended Action from 2019 Amended Recovery Plan: Inventories (i.e., the total number of individuals, number of flowering vs. non-flowering plants, presence of pollinators, and whether seedling recruitment is occurring) have been conducted across the species' historic sites and/or on new locations where appropriate habitat exists (addresses Factors A and D). (USFWS, 2019)
 - Recommended Action from 2019 Amended Recovery Plan: A living collection of viable germplasm, collected from genetically distinct sites, is maintained in protected facilities (ex-situ) for research, recovery, and public outreach (addresses Factors A and E, and representation). (USFWS, 2019)

References

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SPECIES ACCOUNT: *Spiraea virginiana* (Virginia spiraea)

Species Taxonomic and Listing Information

Listing Status: Threatened; 06/15/1990; Northeast Region (Region 5) (USFWS, 2015)

Physical Description

Colonial shrub up to 1.2 m high; largest stems 3-4 cm in diameter, dark gray, often arching or nearly horizontal; young stems upright, greenish-yellow to reddish-brown; branching often profuse in older specimens; leaves alternate, very variable in shape, size and degree of serration, generally mucronate-tipped, glaucous beneath, simply and singly serrate to entire, ranging from ovate to lanceolate; flowers 6 mm wide, bright to creamy white in tightly packed corymbs; corymbs variable in size, ranging from 5-22 cm, wide; follicles small, 2.0 mm long, 1.5 mm wide; seeds rarely produced. Fruit is a follicle. Flowering in June and July. Fruiting in August and September. (NatureServe, 2015)

Taxonomy

The two varieties sometimes recognized (var. *serrulata* and var. *virginiana*) are not maintained by Kartesz (1994 and 1999), nor are they recognized by any Heritage Program in the species' range, or by the U.S. Fish and Wildlife Service. *Spiraea virginiana* is distinguished from most other *Spiraea* by its creamy white flowers in corymbs, and its leaves which have an acute apex (Weakley 2004). (NatureServe, 2015)

Historical Range

Known historically in Pennsylvania. (NatureServe, 2015)

Current Range

Pennsylvania and Ohio south to Georgia and Tennessee. Records for Pennsylvania are historic. It occurs on streams that drain into the Ohio River and primarily within the Appalachian (Cumberland) Plateau and Blue Ridge physiographic regions, with at least one outlier in the Bluegrass Region of Kentucky. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual (vegetative) and sexual (NatureServe, 2015)

Breeding Season

Adult: June to July (NatureServe, 2015)

Key Resources Needed for Breeding

Adult: The species' flowers are visited by a host of insects, most commonly beetles. Identified insects, which are common and widespread, include flower long—horn beetles, a flower beetle, and a soldier beetle (R.L. Hoffman pers. comm.). (USFWS, 1992)

Reproduction Narrative

Adult: Although this element may flower profusely, it is clonal and almost exclusively reproduces vegetatively. Sexual reproduction will occur when genets are placed in close proximity but is rare in the native habitat (D.W. Ogle, pers. comm., 1996). Flowers bloom in June and July. The species' flowers are visited by a host of insects, most commonly beetles. Identified insects, which are common and widespread, include flower long—horn beetles, a flower beetle, and a soldier beetle (R.L. Hoffman pers. comm.). (USFWS, 1992)

Habitat Type

Adult: Riverine, Palustrine, and terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: High gradient, herbaceous wetland, riparian, scrub-scrub wetland, bare rock/talus/scree (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 850 to 2,400 feet (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Colonies (USFWS, 1992)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: High (USFWS, 1992)

Habitat Narrative

Adult: *Spiraea virginiana* is found at elevations between 850 to 2,400 feet in periodically flood-scoured banks of high-gradient mountain streams, meander scrolls, point bars, natural levees, and braided features of lower stream reaches, and occasionally near disturbed rights-of-way (Ogle 1992). Plants often found on geologically active areas with erosion, deposition, and slumping, along rivers with dynamic flooding regimes, sandbars, scoured river shore and flatrock habitat with crevices. These areas also are associated with cobbles, boulders, and massive rock outcrops with sandy or clay soils. The areas can be periodically xeric. Plants are often seen in silt mud and sand. The growth, spread, and subsequent fragmentation of modular colonies are important processes in moving individuals within the environment. *S. virginiana* survives several types of stochastic events, and its phenotypic plasticity has much to tell us about temporal adaptation. (NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Seeds seem to be rarely produced. The seeds are very small (> 2 mm long x ca. 0.5 mm wide) and could be dispersed by wind or water. (USFWS, 1992)

Population Information and Trends

Population Trends:

Short-term trends indicate a decline of 10 to 30% (NatureServe, 2015)

Resiliency:

High (USFWS, 1992)

Representation:

Moderate (USFWS, 1992)

Redundancy:

Moderate (USFWS, 1992)

Number of Populations:

31 (NatureServe, 2015)

Adaptability:

Moderate (USFWS, 1992)

Population Narrative:

Shor-term population trends indicate a 10 to 30% decline. There are approximately 31 populations in seven states, down from 39 populations in eight states (Ogle 1992). *S. virginiana* survives several types of stochastic events, and its phenotypic plasticity has much to tell us about temporal adaptation. (NatureServe, 2015)

Threats and Stressors

Stressor: Impoundments (USFWS, 1992)

Exposure:

Response:

Consequence:

Narrative: Impoundments are a double threat to the species: clones are not only destroyed by rising water, but the impoundment may also serve as a “death trap” for propagules washed down-stream. The probability of being washed into a suitable habitat may decrease from slim to none, thus breaking any possible continuity in downstream motility. (USFWS, 1992)

Stressor: Road-building and water release regulation (USFWS, 1992)

Exposure:

Response:

Consequence:

Narrative: A site on the Cheoah River in Graham County, North Carolina was probably destroyed by road-building and water release regulation (erosion control) below a dam. (USFWS, 1992)

Stressor: Industry development (USFWS, 1992)

Exposure:**Response:****Consequence:**

Narrative: Areas along Hominy Creek in Buncombe County, North Carolina have been extensively developed by industries. (USFWS, 1992)

Stressor: Watershed management (USFWS, 1992)

Exposure:**Response:****Consequence:**

Narrative: Cumulative and more subtle problems could occur from lack of watershed management and uncontrolled development of rivers. Bowles and Apfelbaum (1989) illustrate the effects of stochastic environmental events on another riverine species and graphically describe necessary conditions for survival. "Extinction possibility is increased by low disturbance, which favors plant succession and competition, or by high disturbance, which exceeds levels of ... population maintenance." (USFWS, 1992)

Stressor: Reproduction and genetics (USFWS, 1992)

Exposure:**Response:****Consequence:**

Narrative: "Weak points" in the species' biology may be a threat to its survival. Paucity of sexual reproduction dramatically decreases the intrinsic rate of reproduction and the dispersal potential of the plant's small seeds. Genetic "fixation" of the clonal material may have adverse effects on the future breeding potential of the species, and the small number of genetically different individuals may constitute a threat. (USFWS, 1992)

Stressor: Insect predation (USFWS, 1992)

Exposure:**Response:****Consequence:**

Narrative: Various insect pests have been seen on virginiana plants. Aphids of several types cluster at the rapidly growing shoot tips. Most of these are tended by ants, which move the aphids from place to place on the same plant, or from plant to plant. Aphids are most common on plants growing away from the water's edge. On the beneficial side, lady bug beetles are regularly seen on these same stem tips. In another case, K. Walton (pers. comm.) identified a copper underwing moth caterpillar, a common and widespread species, that was doing damage in one population. However, for the most part, there is little evidence of anything other than local damage by insect pests. (USFWS, 1992)

Stressor: Introduced plants (USFWS, 1992)

Exposure:**Response:****Consequence:**

Narrative: Introduced alien plant species (e.g., *Polygonatum cuspidatum*, *Liquidum sinense*, *Spiraea japonica*, and *Rosa multiflora*) are another, almost uncontrollable, detriment. (USFWS, 1992)

Recovery**Reclassification Criteria:**

Reclassification criteria are not available.

Delisting Criteria:

1. Three stable populations are permanently protected in each drainage where populations are currently known. (USFWS, 1992)
2. Stable populations are established on protected sites in each drainage where documented vouchers have been collected. (USFWS, 1992)
3. Potential habitat in the states with present or past collections has been searched for additional populations. (USFWS, 1992)
4. Representatives of each genotype are cultivated in a permanent collection. (USFWS, 1992)

Recovery Actions:

- Protect existing populations and essential habitat through landowner cooperation and land acquisition. (USFWS, 1992)
- Search for additional populations. (USFWS, 1992)
- Conduct site-specific habitat manipulation as needed to maintain populations. (USFWS, 1992)
- Distinguish between N and n individuals and identify genetically different populations. (USFWS, 1992)
- Maintain cultivated sources for reproduction studies as well as conservation and reintroduction activities. (USFWS, 1992)
- Study the species' environmental tolerances and habitat characteristics. (USFWS, 1992)
- Re-establish populations within the historic range of the species. (USFWS, 1992)
- Inform land owners and managers about the plant's recovery needs. (USFWS, 1992)
- Monitor populations and evaluate effectiveness of recovery efforts. (USFWS, 1992)

Conservation Measures and Best Management Practices:

- Protect existing populations and essential habitat. (USFWS, 1992)
- Conduct rangewide searches in areas of suitable habitat for additional populations. (USFWS, 1992)
- Conduct site-specific manipulation to maintain existing populations. (USFWS, 1992)
- Distinguish between N and n individuals. (USFWS, 1992)
- Maintain representative material from each known genotype in permanent cultivation. (USFWS, 1992)
- Investigate the species environmental tolerances and habitat characteristics. (USFWS, 1992)
- As appropriate, reintroduce *S. virginiana* in additional drainage systems within the species' historical range. (USFWS, 1992)
- Develop an information packet for landowners and land managers. (USFWS, 1992)
- Evaluate the effectiveness of protection and management programs and redirect efforts as necessary. (USFWS, 1992)

References

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<http://ecos.fws.gov/speciesProfile/>. Accessed July 2016

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SPECIES ACCOUNT: *Stahlia monosperma* (Cobana negra)

Species Taxonomic and Listing Information

Listing Status: Threatened; Southeast Region (R4) 04/05/1990

Physical Description

Stahlia monosperma (cobana negra) is a medium-sized, evergreen tree that reaches 25 to 50 feet in height, and 1 to 1.5 feet in diameter. It is a member of the Family Fabaceae, easily identified by (1) pinnately compound leaves with 6 to 12 opposite, lance-shaped to ovate leaflets on red stalks and with scattered black raised dots on lower surface; (2) clusters of pale yellow flowers about one-half of an inch across the five petals; (3) odd. elliptic, thick and fleshy, red pods 2 inches or less in length; and (4) yellow-green and slightly pendulous foliage (Little and Wadsworth 1964). Flowers are yellow and are produced between March and May, depending on rainfall. Flower clusters are terminal, 3 to 6 inches long, and unbranched. The slightly hairy flowers have a funnel-shape, broad base, 10 stamens and a one-celled, slender and curved ovary. A thin, red, fleshy fruit is produced during late June and mid-July. Fruit pods are about 1.5 inches broad and three-fourths of an inch thick, with an odor of ripe apples, light brown tasteless flesh, and one large seed (Little and Wadsworth 1964). Fruits mature in summer and fall. The sapwood is light brown, and the heartwood is dark brown. The wood is very hard, heavy, strong, durable, and resistant to attack by dry wood termites (USFWS, 1996).

Taxonomy

Stahlia monosperma belongs to a monotypic Genus endemic to Puerto Rico and Hispaniola (USFWS, 1996).

Historical Range

Stahlia monosperma (cobana negra) is a tree currently known from parts of the southwestern and northeastern coasts of Puerto Rico and the island of Vieques (USFWS, 1996).

Current Range

At present, natural populations of Cóbana negra are found in nine areas: Punta Ventana, Punta Guaniquilla, Laguna Joyuda, Punta Melones, Road PR 307 (Boquerón Country Club), near Villa Taina, Sierra Bermeja, Punta Picúa, and Vieques Island (Table 2). Additionally, based on a propagation effort conducted for more than 13 years, the species has been planted at least 18 municipalities throughout Puerto Rico (Figure 3). This information does not include those individuals that have been planted as part of reforestation efforts and public education, and those that have been planted island-wide around public parks, and along state and rural roads and private parcels (USFWS, 2014).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Dispersal/Migration

Population Information and Trends**Population Trends:**

Increasing (USFWS, 2014)

Resiliency:

Low (inferred from USFWS, 2014)

Representation:

Low (inferred from USFWS, 2014)

Redundancy:

Low (inferred from USFWS, 2014)

Number of Populations:

Nine (USFWS, 2014)

Population Size:

~200 total individuals (USFWS, 2014)

Population Narrative:

There are three known populations and a total of 34 individuals. Population level trends tend to be increasing due to re-introduction (USFWS, 2014). Low resiliency, redundancy and representation are inferred based on the low number of populations and the specific habitat needs of the species.

Threats and Stressors

Stressor: Illegal dumping (USFWS, 2014)

Exposure:

Response:

Consequence: Loss/degradation of habitat

Narrative: Some of the wetland areas are commonly used as illegal dumping sites where used tires, mattresses, refrigerators, and other kind of trash are left in suitable areas for the species (USFWS, 2014).

Stressor: Human development (USFWS, 2014)

Exposure:

Response:

Consequence: Loss/degradation of habitat

Narrative: The development of these areas has resulted in habitat modification and fragmentation, and has limited the natural expansion of currently known populations of *Cóbana negra* (USFWS, 2014).

Stressor: Predation (USFWS, 2014)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: At the time of listing, browsing of seedlings was considered a threat to the species especially in the first year following establishment. Currently, Sierra Bermeja, Villa Taina and Laguna Joyuda, are areas where livestock may still graze on Cóbana negra. The individuals in grazing areas grow sparse and only reach adulthood where cattle are limited. (USFWS, 2014). Because most of the wild individuals are in protected areas restricted from livestock, and some have conservation measures for the protection of the species, we believe that the threat of predation is low (USFWS, 2014).

Stressor: Lack of individual recruitment (USFWS, 2014)

Exposure:

Response:

Consequence: Limited population growth

Narrative: The Cóbana negra populations have been affected by lack of natural recruitment despite the abundant fruit production and the fact that seeds germinate very well under nursery conditions. The best information available indicates that little recruitment is occurring on natural populations, and when present, seedlings and saplings are located just below the parent tree, suggesting problems of seed dispersal. Due to the lack of long term monitoring efforts, it remains unknown if these individuals will develop as mature plants capable of reproduction. Thus, the Service is unable to determine if the natural populations are actually stable or improving. In the case of reintroduced material, a rapid assessment conducted by the Service on individuals planted since 1998 at Laguna Cartagena NWR, identified several size classes, which suggests some recruitment (USFWS 2014a). However, a thorough assessment of the entire population at Laguna Cartagena is needed to determine if natural recruitment is actually occurring. Also, other reintroduced individuals have been planted in private and public lands, which are not suitable natural habitats for the species (e.g. pasturelands and urban areas). Hence, we do not consider these plantings self-sustaining and the chances for these populations to be expanding are very limited. Therefore, we believe that the factors mentioned above are a threat to the species (USFWS, 2014).

Stressor: Hurricanes and climate change (USFWS, 2014)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Disturbances such as hurricanes may affect small relic populations of Cóbana negra. These populations are very important as they may harbor an important genetic stock of the species. Cóbana negra may be further threatened by climate change, which is predicted to increase the frequency and strength of tropical storms and can cause severe droughts (Hopkinson et al. 2008). Even if Cóbana negra resists adverse effects of hurricanes, the cumulative effects of severe storms, soil erosion and increased sediment runoff may compromise the establishment of seedlings along drainages, which usually provide suitable habitat for the species. Habitat modification may result in irreversible damage to the species' natural habitat, decreasing the number of individuals in already small populations. However, the current frequency of severe hurricanes is low, therefore, the Service considers severe tropical storms as a low and non-imminent threat to the species (USFWS, 2014).

Stressor: Human induced fires (USFWS, 2014)

Exposure:

Response:**Consequence:**

Narrative: Caribbean ecosystems are vulnerable to natural and anthropogenic events. Native plants and endemic species with limited distribution are particularly susceptible to human induced fires. Restoring native plant communities is challenging where invasive plants have altered fire regimes and ecosystem properties (Brooks et al. 2004). In Puerto Rico, the native plant community of subtropical dry forests is not fire-adapted; hence, it has been affected by human induced fires (Wolfe 2008). These fires may lead to destruction of the native vegetation seed bank, and usually favor conditions for the establishment of exotic plant species (e.g., *Leucaena leucocephala* and *Megathyrus maximus*). Moreover, exotic plants increase direct competition for resources and limit native plant species recruitment in highly degraded areas (Wolfe 2008). The possibility of severe droughts triggered by climate change may contribute to an increase in the number and frequency of fires on Puerto Rico. These cumulative factors may reduce the number of individuals and further reduce populations of *Cóbana negra*. The Service is aware of natural populations of *Cóbana negra* being directly affected by human induced fires and the associated habitat modification in the area of Sierra Bermeja (USFWS 2014b). Moreover, areas managed for conservation, and where the species have been widely planted, have been recently affected by fires (i.e., Cabo Rojo NWR and Laguna Cartagena NWR). Nonetheless, we consider the threat of human-induced fires to be low and non-imminent because their effect is local and they do not threaten all populations of *Cóbana negra* at once (USFWS, 2014).

Stressor: Genetic variation (USFWS, 2014)

Exposure:**Response:**

Consequence: Limited population viability

Narrative: *Cóbana negra* occurs in small natural populations with a limited geographic distribution. These factors along with habitat fragmentation, and the fact that planted individuals come from propagated material from the same seed source, may result in the erosion of genetic variation of the species (Honnay and Jacquemyn 2007). Such genetic erosion also may limit the species' ability to respond to environmental changes (Booy et al. 2000). As previously mentioned under the section about new genetic information, *Cóbana negra* may be facing a population bottleneck due to a severe reduction in population size in the recent past. Based on the above information, we consider the low genetic variation as a high, but non-imminent threat to the species (USFWS, 2014).

Recovery**Delisting Criteria:**

1. Self-sustaining new populations (following the appropriate ecological and genetic studies to determine self-sustainability) are established within protected areas (USFWS, 2014).
2. Specimens or populations found on privately-owned lands are placed under protective status (USFWS, 2014).

Recovery Actions:

- Criteria 1 has been initiated with the introduction of individuals in protected areas (USFWS, 2014).

- Criteria 2 has been partially met as most natural individuals (80%) are in areas managed for conservation by governmental and non-governmental organizations (USFWS, 2014).

Conservation Measures and Best Management Practices:

- The Service, in cooperation with PRDNER and academia, needs to determine how many individuals constitute a self-sustaining population. After this work, the recovery plan should be revised to establish objective, measurable delisting criteria (USFWS, 2014).
- Genetic studies should be conducted to determine the genetic variation of planted individuals (USFWS, 2014).
- Efforts to protect privately-owned populations should be started. Areas like Punta Melones, near Villa Taina, Laguna Joyuda and Sierra Bermeja are susceptible to development. Hence, working with the private landowners to conserve these natural areas is essential. Private-lands initiatives such as Partners for Fish and Wildlife and Coastal Programs are needed to further protect the areas where Cóbana negra is known to occur naturally (USFWS, 2014).
- The Service should continue the efforts to promote the collection of seed material from natural populations and not from plantations. This actions help to increase the genetic variation of Cóbana negra (USFWS, 2014).
- Conduct periodic surveys of introduced populations to assess the success of planting efforts and determine if recovery actions are effective (USFWS, 2014).

References

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U.S. Fish and Wildlife Service. 2014. *Stahlia monosperma* (Cóbana negra) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Southeast Region Caribbean Ecological Services Field Office, Boquerón, Puerto Rico.

SPECIES ACCOUNT: *Stenogyne angustifolia angustifolia* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/29/1979; Pacific Region (R1) (USFWS, 2016)

Physical Description

Stenogyne angustifolia is a member of the Lamiaceae, or mint family. Although six varieties have been described, none are currently accepted by Weller and Sakai in the Manual of Flowering Plants of Hawaii (Wagner et al. 1999). It is a prostrate, trailing plant with four-sided, smooth stems which are occasionally pubescent at the nodes. Leaves are undivided, contracted at the base into a petiole approximately one centimeter (0.4 inch) in length, and smooth. The leaf blade is oblong to linear, wavy to serrate, and between 2 and 6 centimeters (0.8 and 2.4 inches) long and 6 and 12 millimeters (0.2 and 0.5 inch) wide. Flowers are tubular, distinctly veined, and 8 to 13 millimeters (0.3 to 0.5 inch) long. The upper lip of the flower is twice as long as the lower and petals are yellow to dull brownish-pink and finely pubescent (U.S. Army 2003a).

Historical Range

Historically, *Stenogyne angustifolia* was known from the islands of Molokai, Maui, and Hawaii.

Current Range

Currently, an estimated 5,000 to 7,500 individuals occur only on the island of Hawaii (U.S. Army 2003a).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Habitat Type

Adult: Semi-arid shrublands and *Metrosideros* Woodlands

Habitat Narrative

Adult: *Stenogyne angustifolia* grows on relatively flat, ash-veneered lava and shallow soils in semi-arid shrublands and *Metrosideros* Woodlands at an elevation of 1,555 meters (5,102 feet). The species also occurs at an elevation of 1,035 meters (3,396 feet) in the transition zone between pastureland and the Keamuku lava flow. The species has been described as abundant on various-aged lava or rock outcrops that support the following diversity of plant communities: *Eragrostis* Grassland, *Chenopodium* Shrubland, *Chamaesyce* Treelands, Open *Metrosideros* Treelands with sparse and dense shrub understory, Intermediate *Metrosideros* Mixed Treelands, Open and Mixed *Dodonaea* Shrublands, *Myoporum*-*Dodonaea* Shrublands, *Myoporum*-*Sophora* Mixed Shrublands, *Myoporum* Shrublands, and *Leptecophylla* Mixed Shrublands (U.S. Army 2003a).

Dispersal/Migration***Population Information and Trends*****Number of Populations:**

6 - 20 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Population estimates are difficult to make because of vegetative reproduction. 9 CURRENT POPULATIONS; APPROXIMATELY 12 HISTORICAL RECORDS. (NatureServe, 2015)

Threats and Stressors**Stressor:****Exposure:****Response:****Consequence:**

Narrative: The threats to *Stenogyne angustifolia* include habitat competition from non-native plants, particularly *Pennisetum setaceum*; and conversion of habitat to a fire-based vegetation community. Army training such as mounted and dismounted off-road maneuvers, bivouac, and live-fire training increase the risk of fire, habitat fragmentation and alien plant seed spread. Off-road and on-road driving and training increases the level of dust (which can compromise plant health and vigor) due to the fine soils in the northern Pohakuloa Training Area (PTA) on the island of Hawaii. In addition, due to the very limited distribution of this species, a single natural or human-caused environmental disturbance could be catastrophic. The taxon does not appear palatable to feral sheep and goats, and appears to be consumed only during dry periods or after a fire (U.S. Army 2003a).

Recovery***Conservation Measures and Best Management Practices:***

- Important conservation actions needed for *Stenogyne angustifolia* include the following: control of non-native plant species and feral ungulates; reduction of fire; and research on habitat requirements, population structure, reproductive biology, and seed biology. Multiple occurrences that replicate the existing density and distribution for *S. angustifolia* should be established to increase species abundance and density (U.S. Army 2003a). In addition, a State-wide management plan that identifies areas and landscapes for the long-term conservation of all known occurrences of *S. angustifolia* is needed. As part of this management plan, landowners and managers should delineate management units to conserve this species and other native species through threat control and habitat restoration. Ongoing Conservation Actions: Aside from specific actions occurring at PTA (and discussed in a subsequent section), the Service is unaware of species-specific conservation actions being conducted for *Stenogyne angustifolia*.

References

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SPECIES ACCOUNT: *Stenogyne bifida* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/08/1992; Pacific Region (R1) (USFWS, 2016)

Physical Description

A trailing perennial herb. Flowers are pale yellowish green and pale brown. (NatureServe, 2015)

Taxonomy

Stenogyne bifida, a nonaromatic member of the mint family (Lamiaceae), is a climbing, short-lived perennial herb, with smooth or slightly hairy, four-angled stems. The long, narrow calyx teeth and the deep lobe in the upper lip of the yellow corolla separate this species from others of the genus (Weller and Sakai 1999) (USFWS, 2003).

Historical Range

See current range/distribution

Current Range

Current range: Eastern Molokai; also known historically from western Molokai (NatureServe, 2015).

Critical Habitat Designated

Yes; 3/16/2016.

Legal Description

On March 18, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Stenogyne bifida* (no common name) under the Endangered Species Act of 1973, as amended (Act) (68 FR 12982 13141). On March 30, 2016, the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Stenogyne bifida* (81 FR 17789-18110). The critical habitat designation includes 11 critical habitat units, which encompass approximately 27,051 acres on the Island of Molokai, Hawaii.

The critical habitat designation for *Stenogyne bifida* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Stenogyne bifida* includes 11 critical habitat units, covering four ecosystem types, which encompass approximately 27,051 acres on the Island of Molokai, Hawaii (81 FR 17789 - 18110). The designated critical habitats include: Molokai - Lowland Mesic - Unit 1; Molokai--Lowland Wet - Unit 1, 2, 3; Molokai - Montane Wet--Unit 1, 2, 3; Molokai--Montane Mesic--Unit 1; Molokai - Wet Cliff - Unit 1, 2, 3.

Molokai—Lowland Mesic—Unit 1 [8,770 ac (3,549 ha)]: This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai.

Molokai—Lowland Wet—Unit 1 [2,949 ac (1,193 ha)]: This area consists of 2,195 ac (888 ha) of State land, and 754 ac (305 ha) of privately owned land (partly within The Nature Conservancy's Pelekunu Preserve), from Pelekunu Valley to Wailau Valley, in north-central Molokai. Molokai—Lowland Wet—Unit 2 [1,950 acres (789 ha)]: This area consists of 1,356 ac (549 ha) of State land and 594 ac (241 ha) of privately owned land, from Kahanui to Pelekunu Valley, in north-central Molokai. Molokai—Lowland Wet—Unit 3 [3,219 acres (1,303 ha)]: This area consists of 94 ac (38 ha) of State land, and 3,125 ac (1,265 ha) of privately owned land, from Waiahookalo gulch to Moaula stream and Puniuohua, on eastern Molokai.

Molokai—Montane Wet—Unit 1 [3,397 ac (1,375 ha)]: This area consists of 1,545 ac (625 ha) of State land, and 1,851 ac (749 ha) of privately owned land, from the headwaters of Waialeia Stream and above Pelekunu Valley, eastward along the summit area to Mapulehu, in northcentral Molokai. Molokai—Montane Wet—Unit 2 [910 ac (368 ha)]: This area consists of 871 ac (353 ha) of State land, and 39 ac (16 ha) of privately owned land, from Honukaupu to Olokui (between Pelekunu and Wailau valleys), in north-central Molokai. Molokai—Montane Wet—Unit 3 [803 ac (325 ha)]: This area consists of 77 ac (31 ha) of State land, and 726 ac (294 ha) of privately owned land, above the east rim of Wailau Valley on eastern Molokai.

Molokai - Montane Mesic - Unit 1 [816 ac (330 ha)]: This area consists of 257 ac (104 ha) of State land, and 559 ac (226 ha) of privately owned land from Kamiloloa to Makolelau in central Molokai.

Molokai—Wet Cliff —Unit 1 [1,607 ac (651 ha)]: This area consists of 1,395 ac (565 ha) of State land, and 212 ac (86 ha) of privately owned land, and encircles the plateau between Pelekunu and Wailau valleys, in north-central Molokai. Molokai—Wet Cliff —Unit 2 [1,268 ac (513 ha)]: This area consists of 462 ac (187 ha) of State land, and 806 ac (326 ha) of privately owned land (partly within The Nature Conservancy's Pelekunu Preserve), along the rim of Pelekunu Valley from Kipapa Ridge to Mapulehu, in central Molokai. Molokai—Wet Cliff —Unit 3 [1,362 ac (551 ha)]: This area consists of 1,137 ac (460 ha) of State land, and 225 ac (91 ha) of privately owned land, along the rim of Wailau Valley from Mapulehu to Kahiwa Gulch, in eastern Molokai.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Stenogyne bifida* critical habitat consists of the following components according to ecosystem type (81 FR 17789 - 18110):

"(i) Molokai - Lowland Mesic - Unit 1(A) Elevation: Less than 3,300 ft (1,000 m).(B) Annual precipitation: 50 to 75 in (130 to 190 cm).(C) Substrate: Shallow soils, little to no herbaceous layer.(D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum.(E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax.(F) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia."

(ii) Molokai - Lowland Wet - Units 1, 2, 3 (A) Elevation: Less than 3,300 ft (1,000 m). (B) Annual precipitation: Greater than 75 in (190 cm). (C) Substrate: Clays; ashbeds; deep, well-drained soils; lowland bogs. (D) Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. (E) Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. (F) Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepidia.

(iii) Molokai - Montane Wet - Units 1, 2, 3 (A) Elevation: 3,300 to 6,500 ft (1,000 to 2,000 m). (B) Annual precipitation: Greater than 75 in (190 cm). (C) Substrate: Well-developed soils, montane bogs. (D) Canopy: Acacia, Charpentiera, Cheiropendron, Metrosideros. (E) Subcanopy: Broussaisia, Cibotium, Eurya, Ilex, Myrsine. (F) Understory: Ferns, Carex, Coprosma, Leptecophylla, Oreobolus, Rhynchospora, Vaccinium.

(iv) Molokai - Montane Mesic - Unit 1 (A) Elevation: 3,300 to 6,500 ft (1,000 to 2,000 m). (B) Annual precipitation: 50 to 75 in (130 to 190 cm). (C) Substrate: Deep ash deposits, thin silty loams. (D) Canopy: Acacia, Ilex, Metrosideros, Myrsine, Nestegis, Nothocestrum, Pisonia, Pittosporum, Psychotria, Sophora, Zanthoxylum. (E) Subcanopy: Alyxia, Charpentiera, Coprosma, Dodonaea, Kadua, Labordia, Leptecophylla, Phyllostegia, Vaccinium. (F) Understory: Ferns, Carex, Peperomia.

(v) Molokai - Wet Cliff - Units 1, 2, 3 (A) Elevation: Unrestricted. (B) Annual precipitation: Greater than 75 in (190 cm). (C) Substrate: Greater than 65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: Broussaisia, Cheiropendron, Leptecophylla, Metrosideros. (F) Understory: Bryophytes, ferns, Coprosma, Dubautia, Kadua, Peperomia.

Special Management Considerations or Protections

For all plants and remaining snails: Special management considerations or protections are necessary throughout the critical habitat areas designated for *Stenogyne bifida* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of this species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Unknown (USFWS, 2003)

Reproduction Narrative

Adult: Little is known about the life history of this species. Its flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown (Service 1996a) (USFWS, 2003).

Habitat Type

Adult: moist-wet forests (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Wet and moist-wet forests on gulch slopes and on ridgetops. (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Wet and moist-wet forests on gulch slopes and on ridgetops. (NatureServe, 2015)

Habitat Narrative

Adult: Wet and moist-wet forests on gulch slopes and on ridgetops. (NatureServe, 2015)

Dispersal/Migration**Motility/Mobility**

Adult: Unknown (USFWS, 2003)

Dispersal/Migration Narrative

Adult: Little is known about the life history of this species. Its flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown (Service 1996a) (USFWS, 2003).

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Adaptability:

Fragility unknown. (NatureServe, 2015)

Population Narrative:

Fragility unknown. Currently about 9 plants observed, estimate less than 100 plants. 3 current and 9 historical occurrences. (NatureServe, 2015). New Status Information: • *Stenogyne bifida* may be extinct in the wild. The last known individual died in 2013 (PEPP 2014). • In 2016, 11 critical habitat units in five ecosystems (lowland mesic, lowland wet, montane wet, montane mesic, and wet cliff) were designated on Moloka'i for *S. bifida* (27,050 ac; 10,948 ha) (81 FR 17790, March 30, 2016) (USFWS, 2018).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (deer, goats, and pigs), nonnative plants, human activities, and landslides. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative

plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The remaining population of *Stenogyne bifida* is located near a hiking trail at Kawela and has the potential of being trampled or collected. Landslides destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. In addition, climate change may pose a threat (USFWS, 1996 and 2012).

Stressor: Limited populations (USFWS, 1996)

Exposure:

Response:

Consequence:

Narrative: The Recovery Plan reported a single population of *Stenogyne bifida* consisting of 12 plants. The small number of populations and individual plants increases the potential for extinction from random naturally occurring events. The limited gene pool may depress reproductive vigor, or a single human-caused or natural environmental disturbance could destroy a significant percentage of the individuals or the only extant population. The remaining population of *Stenogyne bifida* is located near a hiking trail at Kawela and has the potential of being trampled or collected (USFWS, 1996).

Stressor: Predation (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Predation by rats is reported as a threat to this species by the Plant Extinction Prevention Program (USFWS, 2014).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: An assessment conducted by Fortini et al. (2013) concluded that *S. bifida* is vulnerable to the impacts of climate change, with a vulnerability score of 0.564 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions may be needed to conserve this taxon into the future (USFWS, 2018).

Recovery

Reclassification Criteria:

Downlisting criteria for this species is at least five populations of at least 300 plants each (1,500 mature plants) sustained for 5 years (USFWS, 1996).

Delisting Criteria:

Downlisting criteria for this species is at least five populations of at least 300 plants each (1,500 mature plants) sustained for 10 years (USFWS, 1996).

Conservation Measures and Best Management Practices:

- Continue to collect seeds and/or cuttings from cultivated individuals for genetic storage and propagation (USFWS, 2010).

- Treat plants with systemic fungicide and pesticide solution, if the plants can tolerate it, before reintroducing into natural habitat settings (USFWS, 2010).
- Grow a percentage of the plants to maturity in a nursery setting before reintroduction to improve survival and shorten time until flowering and to generate additional seeds, if possible (USFWS, 2010).
- As adequate material becomes available, outplant propagules into a minimum of two reintroduction sites and an easily accessible site where the plants can be intensively managed for threats from invasive introduced plants, disease, and insects (USFWS, 2010).
- Monitor all wild and reintroduced individuals frequently to discover any negative impacts and manage them as quickly as possible (USFWS, 2010).
- Continue to propagate from cuttings, leaving some plants in ex situ collections to maintain material for replacement plants (USFWS, 2010).
- Work with Hawaii Division of Forestry and Wildlife and The Nature Conservancy to contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2010).
- New Management Actions:
 - Captive propagation for genetic storage and reintroduction—The Lyon Arboretum Micropropagation Laboratory reported 250 containers of propagules representing at least four individuals of *S. bifida* from Kawela (Lyon Arboretum 2017) (USFWS, 2018).
- Recommendations for Future Actions: We are not aware of any new threats or significant new information regarding the species' biological status since the last 5-year review 2014. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2018.
 - Surveys and inventories—Survey geographical and historical range for a current assessment of the species' status.
 - Ungulate monitoring and control—Fence any new occurrences to protect them from the impacts of feral ungulates.
 - Invasive plant monitoring and control—Control established ecosystemaltering nonnative invasive plant species around all populations of *S. bifida*.
 - Landslides and flooding destruction or degradation of habitat—Build resilience and redundancy with propagation and reintroduction.
 - Captive propagation for genetic storage and reintroduction—
 - o Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range.
 - o Evaluate genetic resources currently in storage to determine the need to place additional resources in long-term storage due to this species' vulnerability to climate change.
 - Reintroduction and translocation—Reintroduce individuals into suitable habitat protected from threats.
 - Rodent predation and herbivory—Control rats in the vicinity of all individuals.
 - Invertebrate predation and herbivory—Develop and implement methods to control slugs.
 - Climate change adaptation strategy—Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change.
 - Alliance and partnership development—Initiate planning and contribute to ecosystem-level restoration and management to benefit this species (USFWS, 2018).

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SPECIES ACCOUNT: *Stenogyne campanulata* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/1992; Pacific Region (R1) (USFWS, 2016)

Physical Description

Stenogyne campanulata is a member of the mint family (Lamiaceae), described as a vine with four-angled, hairy stems. The hairy leaves are broadly oval, about 5 centimeters (2 inches) long and 3 centimeters (1 inch) wide. The flowers occur in clusters of about six per leaf axil. The very broadly bell-shaped, hairy calyces are about 13 millimeters (0.5 inches) long, with teeth that are 3 millimeters (0.1 inches) long and 5 millimeters (0.2 inches) wide at the base. The petals are fused into a straight, hairy, white tube about 13 millimeters (0.5 inches) long, with short purple lobes. The fruits of this species have not been seen, but the fruit of all other members of this genus are fleshy nutlets. *Stenogyne campanulata* is distinguished from closely related species by its large and very broadly bell-shaped calyces that nearly enclose the relatively small, straight corollas, and by small calyx teeth that are half as long as wide (Weller and Sakai 1990) (USFWS, 1995).

Taxonomy

Stenogyne campanulata was discovered in 1986 by Steven Montgomery on sheer, virtually inaccessible cliffs below the upper rim of Kalalau Valley on Kauai. In 1989, Stephen Weller and Ann Sakai described the plant as a new species, naming it for the flowers' bell-shaped calyces (USFWS, 1995).

Current Range

Stenogyne campanulata is known only from the single population which was originally discovered on the cliffs of Kalalau to below Puu o Kila (USFWS, 1995).

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Stenogyne campanulata* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Stenogyne campanulata* includes one unit totaling 1,050 acres in Kauai County, Hawaii. The unit is Kauai 11—*Stenogyne campanulata*—a.

Kauai 11—*Stenogyne campanulata*—a: This unit is critical habitat for *Stenogyne campanulata* and is 424 ha (1,050 ac) on State land (Kokee and Na Pali Coast State Parks). This unit contains the Kahuamaa Flats. This unit provides habitat for three populations of 300 mature, reproducing individuals of the short-lived perennial *Stenogyne campanulata* and is currently occupied with 51 to 66 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit

that are essential for this species include, but are not limited to, rock faces of nearly vertical, northfacing cliffs in diverse lowland or montane mesic forest. Although the service does not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is at an appropriate size to avoid their destruction by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Within this unit, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

- (i) Rock faces of nearly vertical, northfacing cliffs in diverse lowland or montane mesic forest and containing one or more of the following associated native plant species: *Lepidium serra*, *Lobelia niihauensis*, *Lysimachia* spp., *Melicope pallida*, *Metrosideros polymorpha*, *Neraudia kauaiensis*, *Nototrichium divaricatum*, *Poa mannii*, *Remya montgomeryi*, or *Wilkesia gymnoxiphium*; and
- (ii) Elevations between 335 and 1,290 (1,100 and 4,232 ft).

Special Management Considerations or Protections

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species in paragraph (b) of this section and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Unknown (USFWS, 1995)

Reproduction Narrative

Adult: Little is known about the life history of *Stenogyne campanulata*. Flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown (USFWS, 1995).

Habitat Type

Adult: Moist forest cliff (NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits moist forests on steep rocky slopes. (NatureServe, 2015). *Stenogyne campanulata* grows on the rock face of a nearly vertical, north-facing cliff at an elevation of 1,085 meters (3,560 feet). The associated shrubby vegetation includes native species such as *ahinahina*, *Lepidium serra* (anaunau), *Lysimachia glutinosa*, *olomea*, and *Remya montgomeryi*, and alien species such as prickly Florida blackberry and daisy fleabane (USFWS 1992a) (USFWS, 1995).

Dispersal/Migration**Motility/Mobility**

Adult: Unknown (USFWS, 1995)

Dispersal/Migration Narrative

Adult: Little is known about the life history of *Stenogyne campanulata*. Flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown (USFWS, 1995).

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Resiliency:

Low (NatureServe, 2015)

Representation:

Low (NatureServe, 2015)

Redundancy:

Low (NatureServe, 2015)

Number of Populations:

1 (USFWS, 2017)

Population Size:

20 (USFWS, 2017)

Population Narrative:

Fragility unknown. About 50 plants known. 5 current (between 1982 and 1997) and no historical occurrences. (NatureServe, 2015). Low resiliency, representation and redundancy are based on the fact that this species has one known population with ~50 individuals and a restricted habitat type (NatureServe, 2015). New Status Information: In addition to those populations cited in the previous 5-year review, new observations include the following: • At the time of the last 5-year review in 2009 there was assumed to be one population with an unknown number of individuals on inaccessible cliffs at Kalalau on the island of Kauai. Currently, it is estimated that there are 20 individuals in the same area (PEPP 2014; Clark 2016) (USFWS, 2017).

Threats and Stressors

Stressor: Feral goats and pigs (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Herbivory and habitat degradation by feral goats and habitat disturbance by feral pigs is listed as a major threat to this species (USFWS, 2009).

Stressor: Invasive plants (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Competition from introduced invasive plant species is listed as a major threat to this species (USFWS, 2009).

Stressor: Small population size (USFWS, 2009)

Exposure:

Response:

Consequence: Extinction

Narrative: Species like *Stenogyne campanulata* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, flooding and disease outbreaks (Factor E) (USFWS, 2009).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: —Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Stenogyne campanulata* is extremely vulnerable to the impacts of climate change, with a vulnerability score of 0.83 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery**Reclassification Criteria:**

Stenogyne campanulata is a shortlived perennial, and to be considered stabilized, which is the first step in recovering the species, the taxon must be managed to control threats (e.g., fenced) and be represented in an ex situ (off-site) collection (USFWS, 2009).

A minimum of three populations should be documented on the island of Kauai. Each of these populations must be naturally reproducing and increasing in number, with a minimum of 50 mature individuals per population (USFWS, 2009).

Recovery Actions:

- Recommendations for Future Actions: No new threats and no other significant new information regarding the species' biological status have been reported since the last 5-year review in 2009. Therefore, the following recommendations for future actions are reiterated for the 5-year review for 2017.
- Surveys and inventories—Survey geographical and historical range for a thorough current status of the species.
- Ungulate monitoring and control—Protect all occurrences against browsing and disturbances from feral ungulates. Construct and maintain small-scale fenced exclosures around all populations to prevent imminent extinction.
- Invasive plant monitoring and control—
 - o Control established ecosystem-altering nonnative invasive plant species around all populations.
 - o Control invasive nonnative plant species around all populations that compete with the species.
- Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock.
- Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historical range that is being managed for known threats to this species.
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered throughout historic range to reduce impacts from landslides.
- Population biology research—Study *Stenogyne campanulata* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Continue collection of genetic resources for storage, future propagation and reintroducing into protected suitable habitat within historical range (USFWS, 2009).
- Construct exclosure fences to protect individuals from the negative impacts of feral pigs, and eradicate introduced invasive plant species within the exclosures (USFWS, 2009).
- Enhance current natural populations with appropriate genetic individuals (USFWS, 2009).
- Monitor success or failure of reintroductions (USFWS, 2009).
- Work with the Hawaii Division of Forestry and Wildlife to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species in Kalalau Valley (USFWS, 2009).
- Survey geographical and historical range for a thorough current status of the species (USFWS, 2009).
- Assess genetic variability within extant and ex situ populations (USFWS, 2009).
- Study *Stenogyne campanulata* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2009).

- New Management Actions: • Individuals were outplanted in a fenced enclosure at Kalalau in 2012 and 2013 (PEPP 2012, 2013). Cuttings were taken for propagation at the Kokee Rare Plant Facility, which currently propagates six plants in its nursery (Clark 2016; DOFAW 2016; PEPP 2016). • NTBG has two individuals outplanted (which produce seeds) at the garden as a living collection. Three of these seeds are in the NTBG seed bank (NTBG 2008, 2017) (USFWS, 2017).

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SPECIES ACCOUNT: *Stenogyne cranwelliae* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/29/2013; Pacific Region (R1) (USFWS, 2016)

Physical Description

A creeping vine. Leaves are ovate to suborbicular, 1.8 - 2.7 cm long. Flowers are 6 per verticillaster. Corollas are very pale pink (NatureServe, 2015).

Taxonomy

A member of the mint family (Lamiaceae) (USFWS, 2013). Belongs to the Hawaiian endemic genus of 20 species, this species is endemic to island of Hawaii (NatureServe, 2015).

Historical Range

Endemic to the Kohala Mountains on the island of Hawaii, Hawaiian islands (NatureServe, 2015). Historically, *S. cranwelliae* was known from the Kohala Mountains, in the montane wet and wet cliff ecosystems (Weller and Sakai 1999, p. 837) (USFWS, 2013).

Current Range

It currently occurs in the Kohala Mountains: roughly 1.5 sq. mi (2.5 sq. km) around the border between the Puu O Umi NAR and Kohala FR; Opaeha, in the Puu O Umi NAR; Puukapu, in the Puu O Umi NAR (6-by-6-ft (2-by-2- m) "patch" of individuals); the rim of Kawainui Gulch; along Kohakohau Stream, in the Puu O Umi NAR; and Waimanu Bog Unit in the Puu O Umi NAR (USFWS, 2013).

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available

Habitat Type

Adult: Terrestrial, riparian (USFWS, 2013)

Habitat Vegetation or Surface Water Classification

Adult: Montane wet forest, wet cliff forest (USFWS, 2013; NatureServe, 2015)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits wet forests. The environmental specificity is unknown (NatureServe, 2015). It occurs in the montane wet and wet cliff ecosystems, near streams and bogs (Perlman and Wood 1996, pp. 1–14; HBMP 2010k) (USFWS, 2013).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Unknown; rediscovered in 1995 (NatureServe, 2015)

Resiliency:

Very low (inferred from USFWS, 2013; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2013)

Number of Populations:

6 (USFWS, 2013)

Population Size:

< 160 (USFWS, 2013)

Population Narrative:

The long term population trend is unknown; this species was thought to be extinct until rediscovered during surveys of the Kohala Mountains in 1995 (USFWS 2004) (NatureServe, 2015). Currently, there are 6 occurrences of *S. cranwelliae* totaling fewer than 160 individuals (USFWS, 2013).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs), nonnative plants, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by

nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, rats, and slugs) is considered an ongoing threat to *Stenogyne cranwelliae* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- The State's PEP Program identified *Stenogyne cranwelliae* as priority species for collection, propagation, and outplanting; however, due to other workload priorities and limited funding, they have not been able to carry out all of these actions (PEPP 2012, pp. 1–169). While the actions they have been able to implement are a step toward increasing the overall numbers and populations in the wild, these actions are insufficient to eliminate the threat of limited numbers at this time (USFWS, 2013).

References

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USFWS. 2016. Environmental Conservation Online System (ECOS) – Species Profile. <http://ecos.fws.gov/ecp0/>. Accessed August 2016

USFWS 2013. Endangered and Threatened Wildlife and Plants

Determination of Endangered Species Status for 15 Species on Hawaii Island

Final Rule. 78 Federal Register 209. October 29, 2013. Pages 64637 - 64690.

USFWS. 2013. Determination of Endangered Species Status for 15 Species on Hawaii Island

Final Rule. 78 Federal Register 209, October 29, 2013. Pages 64638 - 64690.

SPECIES ACCOUNT: *Stenogyne kaalae* ssp. *sherffii* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2016)

Physical Description

A climbing vine. Stems are quadrangular, 3 to 7 ft. (1 to 2 m) long, either glabrous or pubescent in grooves. Leaves are glossy and 5 in (12 cm) long. Flowers are very dark maroon and narrowly bell-shaped. Nutlets are 0.2 in (4 mm) long, fleshy, and dark purple (Weller and Sakai 1999, p. 838; Wagner and Weller 1999, pp. 448–449) (USFWS, 2015).

Taxonomy

A member of the mint family (Lamiaceae) (USFWS, 2015). New combination published in Novon 9: 448-449. 1999. Previously, *Stenogyne sherffii* was treated as a full species, but Wagner and Weller treat as a subspecies of *S. kaalae*. Kartesz (1999) included *S. sherffii* in the synonymy of *S. kaalae* without recognizing any infraspecific taxa in that species (NatureServe, 2015).

Historical Range

It is historically known from diverse mesic forest in the Waianae Mountains of Oahu and from the lowland wet ecosystem of the Koolau Mountains (although it was believed to be a different species, *S. sherffii*, until the mid-1990s). This subspecies occurred within a very small range in the northern Koolau Mountains, at Opaepa and Kawaihoa, but is now extinct in the wild (USFWS, 2015).

Current Range

Stenogyne kaalae ssp. *sherffii* occurs in the Koolau Mountains of Oahu (USFWS, 2015).

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available

Habitat Type

Adult: Terrestrial (USFWS, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Wet forest (USFWS, 2015)

Dependencies on Specific Environmental Elements

Adult: Lowland wet ecosystem (USFWS, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 1,500 - 1,600 ft. elevation (USFWS, 2015)

Habitat Narrative

Adult: It occurs in diverse wet forest at 1,500 to 1,600 ft. (450 to 490 m), in the lowland wet ecosystem (Wagner and Weller 1999, pp. 448–449; HBMP 2010; U.S. Army 2014 database; TNCH 2007) (USFWS, 2015).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

No individuals are known to exist in the wild (USFWS, 2015)

Number of Populations:

1 outplanted (USFWS, 2014)

Population Size:

76 outplants (USFWS, 2014)

Population Narrative:

There are no known wild individuals; this species only exists in propagation (USFWS, 2015). Currently, *Stenogyne kaalae* ssp. *sherffii* is known only from cultivation at the Pahole Rare Plant Facility on Oahu and the University of California; and 76 outplanted individuals at Opaepa on Oahu (PEPP 2013, p. 194) (USFWS, 2014).

Threats and Stressors

Stressor: Feral pigs (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Feral pigs modify and destroy the habitat of *Stenogyne kaalae* ssp. *sherffii* on Oahu, with evidence of the activities of these animals reported in the areas where this subspecies occurred (HBMP 2010; PEPP 2014, p. 169) (USFWS, 2015).

Stressor: Nonnative plants (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Nonnative plants destroy and modify the native habitat of *S. kaalae* ssp. *sherffii*, and displace this subspecies and other native Hawaiian plants by competing for water, nutrients, light, and space, or they may produce chemicals that inhibit the growth of other plants (Smith 1985, pp. 180–250; Vitousek et al. 1987 in Cuddihy and Stone 1990, p. 74; HBMP 2010) (USFWS, 2015).

Stressor: Reduced reproductive vigor (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: This subspecies may experience reduced reproductive vigor due to low levels of genetic variability, leading to diminished capacity to adapt to environmental changes, thereby lessening the probability of its long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361) (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Climate change may result in alteration of the environmental conditions and ecosystems that support this species. *Stenogyne kaalae* ssp. *sherffii* may be unable to tolerate or respond to changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini et al. 2013, p. 90) (USFWS, 2015).

Stressor: Small population size/stochastic events (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: *Stenogyne kaalae* ssp. *sherffii* is threatened by having a small number of individuals and populations. Species that are endemic to single islands or small island groups are inherently more vulnerable to extinction than are widespread species, because of the increased risk of genetic bottlenecks, random demographic fluctuations, climate change effects, and localized catastrophes such as hurricanes, drought, rockfalls, landslides, and disease outbreaks (Pimm et al. 1988, p. 757; Mangel and Tier 1994, p. 607). These problems are further magnified when populations are few and restricted to a very small geographic area, and when the number of individuals in each population is very small. Populations with these characteristics face an increased likelihood of stochastic extinction due to changes in demography, the environment, genetics, or other factors (Gilpin and Soule 1986, pp. 2434) (USFWS, 2014).

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- PEPP efforts currently include propagation of *Stenogyne kaalae* ssp. *sherffii* for the purpose of restoration outplanting in its native range (PEPP 2013, pp. 8, 25, 194). Monitoring of habitat that could support this species is ongoing (PEPP 2013, pp. 8, 25, 194) (USFWS, 2014).
- Continue to survey for populations of *Stenogyne kaalae* ssp. *sherffii* in areas of potentially suitable habitat (USFWS, 2014).
- Continue propagation efforts for maintenance of genetic stock (USFWS, 2014).
- Reintroduce individuals into suitable habitat within historic range that is being managed for additional known threats (e.g., nonnative animals and plants) to this species (USFWS, 2014).

References

NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia.

USFWS. 2016. Environmental Conservation Online System (ECOS) – Species Profile. <http://ecos.fws.gov/ecp0/>. Accessed August 2016

USFWS 2015. Endangered and Threatened Wildlife and Plants

Endangered Status for 49 Species From the Hawaiian Islands

Proposed Rule. 80 Federal Register 189. September 30, 2015. Pages 58819 - 58909.

Proposed Rule. 80 Federal Register 189. September 30, 2015. Pages 58819 - 58909

USFWS 2014. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form. *Stenogyne kaalae* ssp. *sherffii*. Region 1 (Pacific Region).

USFWS. 2015. Endangered and Threatened Wildlife and Plants

USFWS. 2014. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form. *Stenogyne kaalae* ssp. *sherffii*. Region 1 (Pacific Region).

SPECIES ACCOUNT: *Stenogyne kanehoana* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/1992; Pacific Region (R1) (USFWS, 2016)

Physical Description

A perennial rambling vine with 1 - 2 m long stems. Flowers are whitish or pale yellow, with pinkish-purple lips (NatureServe, 2015).

Taxonomy

A member of the mint family (Lamiaceae) (USFWS, 2003).

Historical Range

Stenogyne kanehoana was known from the east ridge of Puu Kanehoa in the Waianae Mountains, near the summit of the ridge connecting Puu Kanehoa with Puu Hapapa to the north and Puu Kaua to the south, a distance totaling approximately 2.8 km (1.7 mi) (USFWS, 2003).

Current Range

Occurs in the southern Waianae Mountains (NatureServe, 2015). The population near the summit of Puu Kanehoa on privately owned land was found dead recently. An additional occurrence in Kaluaa Gulch was discovered in 2000 by Joan Yoshioka of TNCH (USFWS, 2003).

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Stenogyne kanehoana* under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Stenogyne kanehoana* (77 FR 57648-57862). The critical habitat designation includes 3 critical habitat units, which encompass approximately 5,884 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Stenogyne kanehoana* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Stenogyne kanehoana* includes 3 critical habitat units, covering one ecosystem type, which encompasses approximately 5,884 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole

NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Stenogyne kanehoana* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Stenogyne kanehoana* occurs within the indicated ecosystem in the Waianae Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Stenogyne kanehoana* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Asexual: vegetative (USFWS, 2013)

Lifespan

Adult: 7 - 12 (USFWS, 2003)

Breeding Season

Adult: Primarily February - March, sometimes January - April (USFWS, 2003)

Key Resources Needed for Breeding

Adult: Precipitation (USFWS, 2003)

Reproduction Narrative

Adult: This species is not setting seed or at least is not successfully reproducing (Herbst, 1992) (NatureServe, 2015). It is a short-lived perennial (fewer than 10 years). Three factors were

identified as affecting the rarity of *Stenogyne kanehoana*: Vegetative reproduction of *S. kanehoana* by long, rambling stems, which may root when contacting the ground, leading to the formation of additional plants; infrequent or inconsistent flowering; a large percentage of non-flowering or non-fruiting plants (U.S. Army Garrison 2008) (USFWS, 2013). *Stenogyne kanehoana* generally flowers from February through March, but flowering depends on precipitation, and flowers have been noted from January to as late as April. Fruits mature within six weeks. The lifespan of this species appears to be about seven to 12 years (USFWS, 2003).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Low mesic *Metrosideros*, *Eugenia*, *Osmanthus* and *Myrsine* forest (NatureServe, 2015; USFWS, 2003)

Geographic or Habitat Restraints or Barriers

Adult: 1,834 - 3,831 ft. elevation (USFWS, 2003)

Habitat Narrative

Adult: Inhabits diverse mesic forest under canopy of *Metrosideros*, *Eugenia*, *Osmanthus* and *Myrsine* (NatureServe, 2015). It is found in lowland mesic forest between 559 and 1,168 m (1,834 and 3,831 ft.) elevation (USFWS, 2003).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Very low (inferred from USFWS, 2013)

Representation:

Very low (inferred from USFWS, 2013)

Redundancy:

Very low (inferred from USFWS, 2013)

Number of Populations:

1 (USFWS, 2013)

Population Size:

1 (USFWS, 2013)

Population Narrative:

There is one wild individual and 124 outplanted individuals (USFWS, 2013).

Threats and Stressors

Stressor: Climate change (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species (USFWS, 2013).

Stressor: Disease (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: An undetermined species of powdery mildew has been identified as a new threat to *Stenogyne kanehoana* (U.S. Army Garrison 2008) (USFWS, 2013).

Stressor: Predation (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Invasive slugs have negatively impacted the regeneration of *Stenogyne kanehoana* (U.S. Army Garrison 2010) (USFWS, 2013).

Stressor: Nonnative plants (USFWS, 2003)

Exposure:

Response:

Consequence:

Narrative: Competition for space, water, light, and nutrients by the nonnative species *Clidemia hirta*, *Paspalum conjugatum*, *Passiflora suberosa*, *Psidium cattleianum*, and *Schinus terebinthifolius* (USFWS, 2003).

Stressor: Small population size (USFWS, 2003)

Exposure:

Response:

Consequence:

Narrative: The extremely small number of individual plants and their restricted distribution increases the potential for extinction from naturally occurring events (USFWS, 2003).

Stressor: Habitat degradation (USFWS, 2003)

Exposure:

Response:

Consequence:

Narrative: Habitat degradation by feral pigs, predation by the two spotted leafhopper, and trampling by hikers are also thought to be threats to this species (HINHP Database 2001; Service 1998b; 57 FR 20592) (USFWS, 2003).

Recovery

Reclassification Criteria:

1. A total of five to seven populations should be documented on Oahu and at least one other island where they now occur or occurred historically (USFWS, 1998).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1998).
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1998).

Delisting Criteria:

1. A total of 8 to 10 populations should be documented on Oahu and at least one other island where they now occur or occurred historically (USFWS, 1998).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1998).
3. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1998).

Recovery Actions:

- Protect habitat and control threats (USFWS, 1998).
- Expand existing wild populations (USFWS, 1998).
- Conduct essential research (USFWS, 1998).
- Develop and maintain monitoring plans (USFWS, 1998).
- Reestablish wild populations within historic range (USFWS, 1998).
- Validate and revise recovery criteria (USFWS, 1998).
- Conduct surveys (USFWS, 1998).
- Maintain adequate genetic stock (USFWS, 1998).
- Enhance wild populations and establish of new populations (USFWS, 1998).

Conservation Measures and Best Management Practices:

- Captive propagation for genetic storage and reintroduction: Collect cuttings or seed from tagged individuals, keeping close track of the maternal source for use in ex situ propagation. Manage nursery collections to promote flowering. Continue research in pollination and continue to hand-pollinate. This includes collecting pollen, testing pollen viability, and pollinating all flowering plants, both in situ and ex situ (USFWS, 2013).
- Reintroduction / translocation: While surveying for new populations or reintroduced populations, determine which sites are least invaded by invasive introduced plant species and which appear to

have the highest likelihood of maintaining new reintroductions. Continue to reintroduce the species back into its known historical range (USFWS, 2013).

- Ungulate exclosures – Construct, maintain, and monitor ungulate-proof exclosures around each population (USFWS, 2013).
- Ecosystem-altering invasive plant species control – Control invasive introduced plant species around all populations. Continue to target all canopy weeds along the catchment ridge of Kalauu to maintain native dominated matrix with care to avoid damaging the *Dicranopteris linearis* (uluhe) understory which is needed for successful growth of *Stenogyne kanehoana* (U.S. Army Garrison 2011) (USFWS, 2013).
- Threats research: Invasive slugs negatively impacted the regeneration of *Stenogyne kanehoana* (U.S. Army Garrison 2010). In 2009, slug control research using Sluggo, a slug and snail bait, began in the field at the Kahanahaiki population unit on U.S. Army lands (U.S. Army Garrison 2009, 2010). In October 2010, Sluggo was registered for use by the Hawaii Department of Agriculture (U.S. Army Garrison 2010) for control of slugs and nonnative snails in forested areas for the protection of native, threatened, and endangered plants of Hawaii. However, since native snails also exist in areas where threatened and endangered plants occur, additional research is need to find a control method that can be used in areas where native snail species co-occur with listed plants (USFWS, 2013).
- Surveys / inventories – Survey geographical and historical range for a thorough current assessment of the species status (USFWS, 2013).
- Site / area / habitat protection – Develop and implement effective measures to reduce the impact of military activities and hikers (USFWS, 2013).
- Fire protection – Develop and implement fire management plans for all wild and reintroduced populations (USFWS, 2013).
- Alliance and partnership development - Enhance coordination and collaboration among other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2013).
- Population biology research – Study *Stenogyne kanehoana* with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2013).
- Threats research: Assess the modeled effects of climate change on this species, and use the results to determine future landscape needed for the recovery of the species. Investigate appropriate controls for powdery mildew outbreaks. Implement controls for invasive slugs around *Stenogyne kanehoana* populations (USFWS, 2013).

References

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<http://ecos.fws.gov/ecp0/>. Accessed August 2016

USFWS 2003. Endangered and Threatened Wildlife and Plants

Final Designations or Nondesignations of Critical Habitat for 101 Plant Species From the Island of Oahu, HI. 68 Federal Register 116. June 17, 2003. Pages 35950 - 35998.

U.S. Fish and Wildlife Service. 2012. Endangered and Threatened Wildlife and Plants

Endangered Status for 23 Species on Oahu and Designation of Critical Habitat for 124 Species. Final Rule. 77 FR 57648-57862 (September 18, 2012)

USFWS 2013. *Stenogyne kanehoana* (no common name) 5-Year Review Short Form Summary. Region 1/Pacific Islands Fish and Wildlife Office (PIFWO), Honolulu, Hawaii

USFWS 2013. *Stenogyne kanehoana* (no common name) 5-Year Review Short Form Summary. Region 1/Pacific Islands Fish and Wildlife Office (PIFWO), Honolulu, Hawaii.

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USFWS. 2003. Endangered and Threatened Wildlife and Plants

U.S. Fish and Wildlife Service. 1998. Recovery Plan for Oahu Plants. U.S. Fish and Wildlife Service, Portland, Oregon. 207 pp., plus appendices.

SPECIES ACCOUNT: *Stenogyne kauaulaensis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (R1) (USFWS, 2016)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Stenogyne kauaulaensis* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Stenogyne kauaulaensis* includes four CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Montane Mesic—Unit 2 (and) *Palmeria dolei*—Unit 19—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 19— Montane Mesic This area consists of 124 ac (50 ha) of State land at Helu and the upper reaches of Puehuhunui on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Lysimachia lydgatei*, *Remya mauiensis*, and *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 2 is not known to be occupied by the plants *Geranium hillebrandii*, *Huperzia mannii*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 3 (and) *Palmeria dolei*—Unit 20—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 20— Montane Mesic This area consists of 174 ac (70 ha) of State land at Lihau on the southwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plant *Geranium hillebrandii*, and contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 3 is not known to be occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Huperzia mannii*, *Lysimachia lydgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the

akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 4 (and) *Palmeria dolei*—Unit 21—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 21— Montane Mesic This area consists of 72 ac (29 ha) of State land at Halepohaku on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5).

Although Maui—Montane Mesic—Unit 4 is not known to be occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Geranium hillebrandii*, *Huperzia mannii*, *Lysimachia lydgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 5 (and) *Palmeria dolei*—Unit 22—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 22— Montane Mesic This area consists of 170 ac (69 ha) of State land at the upper reaches of Manawainui Gulch on the southeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants *Remya mauiensis* and *Santalum haleakalae* var. *lanaiense*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 5 is not known to be occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Geranium hillebrandii*, *Huperzia mannii*, *Lysimachia lydgatei*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 3 (and) *Palmeria dolei*—Unit 20—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 20— Montane Mesic This area consists of 174 ac (70 ha) of State land at Lihau on the southwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plant *Geranium hillebrandii*, and contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 3 is not known to be occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium*

molokaiense, *Huperzia mannii*, *Lysimachia lydgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Stenogyne kauaulaensis* critical habitat consists of one component. Montane mesic (west Maui) (81 FR 17790-18110):

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: *Acacia*, *Ilex*, *Metrosideros*, *Myrsine*, *Nestegis*, *Nothocestrum*, *Pisonia*, *Pittosporum*, *Psychotria*, *Sophora*, *Zanthoxylum*. Subcanopy: *Alyxia*, *Charpentiera*, *Coprosma*, *Dodonaea*, *Kadua*, *Labordia*, *Leptecophylla*, *Phyllostegia*, *Vaccinium*. Understory: Ferns, *Carex*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent

elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkii*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: No information found

Habitat Type

Adult: Montane mesic ecosystem (USFWS, 2016)

Habitat Narrative

Adult: *Stenogyne kauaulaensis* (NCN), a short-lived perennial vine in the mint family (Lamiaceae), occurs on Maui. This recently described (2008) plant is found only along the southeastern rim of Kauaula Valley, in the montane mesic ecosystem on west Maui (USFWS, 2016).

Dispersal/Migration**Motility/Mobility**

Adult: No information found

Population Information and Trends**Population Trends:**

No information found.

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative plants, fire, drought, landslides, rockfalls, and hurricanes. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Fire can destroy dormant seeds and plants, even in steep and inaccessible areas. Successive fires can remove habitat for native species by altering microclimate conditions favorable to alien plants. Drought, landslides, and rockfalls destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:**Consequence:**

Narrative: Predation and herbivory by nonnative animal species (slugs) is considered an ongoing threat to *Stenogyne kauaulaensis* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor: Small populations (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: *Stenogyne kauaulaensis* faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). *Stenogyne kauaulaensis* is only known from three individuals. These plants face imminent threats from landslides and rockfalls because of their location on steep slopes, and from drought and fire in the montane mesic ecosystem on west Maui (USFWS, 2013).

Recovery**Recovery Actions:**

- There is no recovery plan for this species.

References

USFWS. 2016. Environmental Conservation Online System (ECOS) – Species Profile.
<http://ecos.fws.gov/ecp0/>. Accessed July 2016.

U.S. Fish and Wildlife Service. 2016. Endangered and Threatened Wildlife and Plants

Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

Final Rule . 81 FR 17790-18110 (March 30, 2016).

U.S. Fish and Wildlife Service. 2016. Endangered and Threatened Wildlife and Plants

Final Rule.

USFWS. 2013. Determination of Endangered Status for 38 Species on Molokai, Lanai, and Maui

Final Rule. 78 Federal Register 102, May 28, 2013. Pages 32014 - 32065.

SPECIES ACCOUNT: *Stenogyne kealiae* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (R1)

Physical Description

A trailing vine. Leaves are thinly to moderately coriaceous, broadly lanceolate to elliptic-lanceolate, 8 - 15 cm long. Flowers are 3 - 5 per verticillaster. Corollas are deep pinkish purple (NatureServe, 2015).

Taxonomy

A member of the mint family (Lamiaceae) (USFWS, 2010b). The supplement to the revised Manual of the Flowering Plants of Hawaii (Wagner et al. 1999) resurrects this species from synonymy of *S. purpurea*. Kartesz lists it in synonymy of *S. purpurea* in his 1994 checklist, but recognizes it as distinct in the 1999 Synthesis (NatureServe, 2015).

Historical Range

Historically, this species occurred at Pohakupili near Kealia in the Kealia Forest Reserve on the island of Kauai (USFWS, 2010b).

Current Range

Currently, this species occurs at Honopu, Kalalau, Malamalamaiki, Pohakupili, and Wainiha (Kauai) (USFWS, 2010b).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Stenogyne kealiae* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 11 critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Stenogyne kealiae* includes 11 CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Lowland Wet—Section 1: Lowland Wet—Section 1 consists of 1,164 ac (471 ha) in the lowland wet ecosystem (117 ac (47.4 ha) on State land; 1,047 ac (424 ha) on private land), including wet forest extending from Kulanalilia into Limahuli Valley to Honoanapali, in the Halelea Forest Reserve (Figure 2-A). The section includes 1,099 ac (445 ha) of State and privately owned land within previously designated critical habitat and 65 ac (26 ha) of newly designated critical habitat on private land. The area that falls within designated critical habitat lies within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and newly designated Critical Habitat Unit 20, Map 217c. This section is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Labordia helleri*, and *Phyllostegia renovans*. This section also contains unoccupied habitat that is essential to the conservation of these four species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section

includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet–Section 1 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Melicope paniculata*, *M. puberula*, *Platydesma rostrata*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 2: Lowland Wet–Section 2 consists of 172 ac (70 ha) in the lowland wet ecosystem, including wet forest extending from Alealau to Pohakea, within the Hono o Na Pali NAR and the Na Pali Coast State Park (Figure 2-A, above). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plant *Melicope puberula*. This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet–Section 2 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope paniculata*, *Phyllostegia renovans*, *Platydesma rostrata*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 3: Lowland Wet–Section 3 consists of 756 ac (306 ha) in the lowland wet ecosystem, including wet forest in upper Wainiha Valley, on privately owned land in the Halelea Forest Reserve (Figure 2-B). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyrtandra oenobarba*, *Melicope puberula*, *Phyllostegia renovans*, and *Stenogyne kealiae*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet–Section 3 is not known to be occupied by the species *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope paniculata*, *Platydesma rostrata*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 4: Lowland Wet—Section 4 consists of 591 ac (239 ha) in the lowland wet ecosystem, including wet forest at the head of Lumahai Valley, on State (10 ac, 4.1 ha) and privately owned (581 ac, 235 ha) land in the Halelea Forest Reserve (Figure 2-B, above). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyrtandra oenobarba*, *Melicope paniculata*, *Phyllostegia renovans*, and *Platydesma rostrata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 4 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope puberula*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population numbers of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 5: Lowland Wet—Section 5 consists of 1,541 ac (624 ha) in the lowland wet ecosystem, including wet forest extending from the headwaters of the Wailua River at “Blue Hole” south to Iole, on State (442 ac, 179 ha) and privately owned (1,099 ac, 445 ha) land in the Lihue-Koloa Forest Reserve (Figure 2-C). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36a, and is occupied by the plants *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Melicope paniculata*, *Phyllostegia renovans*, and *Platydesma rostrata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 5 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Labordia helleri*, *Melicope puberula*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 6: Lowland Wet—Section 6 consists of 789 ac (319 ha) in the lowland wet ecosystem, including wet forest extending from Kapalaoa to Kanaele Bog and Lauahihaihai in the Wahiawa Mountains, on State (134 ac, 54 ha) and privately owned (655 ac, 265 ha) land in the Lihue-Koloa Forest Reserve (Figure 2-D). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36a, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Platydesma rostrata*, and *Tetraplasandra bisattenuata*. This

section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 6 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Labordia helleri*, *Melicope paniculata*, *M. puberula*, *Phyllostegia renovans*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Montane Mesic—Section 1: Montane Mesic—Section 1 consists of 2,423 ac (980 ha) in the montane mesic ecosystem, including the area above Honopu Valley to Mahanaloa Valley, on State owned land in Kokee State Park, the Na Pali-Kona Forest Reserve, and Kuia NAR (Figure 3-A). The entire section is within previously designated critical habitat for the plant species, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70c, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Labordia helleri*, *Myrsine knudsenii*, *Platydesma rostrata*, *Psychotria grandiflora*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*. This section is also occupied by the akekee and the picture-wing fly; maps of critical habitat for these species can be found at 50 CFR 17.95(b) for the akekee and akikiki (Unit 1—Montane Mesic), and at 50 CFR 17.95(i) for the picture-wing fly (Unit 1—Montane Mesic). This section also contains unoccupied habitat that is essential to the conservation of these nine species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the montane mesic forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane mesic ecosystem (Table 3), as well as species-specific PCEs for the akekee and akikiki (arthropod prey) and picture-wing fly (the larval-stage host plants, *Cheirodendron* sp. and *Tetraplasandra* sp.). Although Montane Mesic—Section 1 is not known to be occupied by the species *Diellia mannii*, *Myrsine mezii*, and the akikiki, we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Montane Mesic—Section 2: Montane Mesic—Section 2 consists of 376 ac (152 ha) in the montane mesic ecosystem and includes a portion of the area surrounding a tributary of Nawaimaka Stream east to Kumuwela Ridge (Figure 3-A, above). The entire section is State-owned within Kokee State Park, and includes 8 ac (3 ha) of newly designated critical habitat. This section is occupied by *Diellia mannii* and the picture-wing fly *Drosophila sharpi*, and includes the montane mesic forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane mesic ecosystem (Table 3), as well as the larval-stage host plants (*Cheirodendron* sp. and *Tetraplasandra* sp.) associated with the picture-wing fly. This section also contains unoccupied habitat that is essential to the conservation of these two species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Montane Mesic—Section 2 is not known to be occupied by the

plants *Chamaesyce remyi* var. *remyi*, *Labordia helleri*, *Myrsine knudsenii*, *Myrsine mezii*, *Platydesma rostrata*, *Psychotria grandiflora*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*, or by the birds the akekee and akikiki, we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range, as well as species-specific PCEs for the akekee and akikiki (arthropod prey). Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, that portion of the section that overlies previously designated critical habitat falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70c. The previously undesignated land comprises Critical Habitat Unit 21 of 50 CFR 17.99(a)(1), Map 217d. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 2—Montane Mesic), and for the picture-wing fly at 50 CFR 17.95(i) (Unit 2—Montane Mesic).

Kauai—Montane Mesic—Section 3: Montane Mesic—Section 3 consists of 139 ac (56 ha) in the montane mesic ecosystem, including the upper portion of the Nawaimaka Valley up to Kapukapaia Ridge, on State-owned land in the Na Pali-Kona Forest Reserve (Figure 3-B). This section is not in previously designated critical habitat and includes the only montane mesic forest occupied by the plant *Myrsine mezii*, and the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. Although Montane Mesic—Section 3 is not known to be occupied by the plants *Chamaesyce remyi* var. *remyi*, *Labordia helleri*, *Myrsine knudsenii*, *Myrsine mezii*, *Platydesma rostrata*, *Psychotria grandiflora*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*; by the birds the akekee and akikiki; or by the picturewing fly *Drosophila sharpi*, we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. It also provides for the species-specific PCEs for the akekee and akikiki (arthropod prey) and the larval-stage host plants (*Cheirodendron* sp. and *Tetraplasandra* sp.) associated with *D. sharpi*. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, this section comprises Critical Habitat Unit 22 of 50 CFR 17.99(a)(1), Map 217e. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 3—Montane Mesic), and for the picturewing fly at 50 CFR 17.95(i) (Unit 3—Montane Mesic).

Kauai—Dry Cliff—Section 1: Dry Cliff—Section 1 consists of 404 ac (163 ha) in the dry cliff ecosystem, along cliffs from Kalanu to Pihea peak, within the Na Pali Coast State Park (Figure 5). The entire section is within previously designated critical habitat and is State-owned; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 67a. This section is occupied by the plants *Chamaesyce eleanoriae*, *Lysimachia scopulensis*, *Schiedea attenuata*, and *Stenogyne kealiae*. This section includes the dry cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the dry cliff ecosystem (Table 3).

Kauai—Dry Cliff—Section 2: Dry Cliff—Section 2 consists of 309 ac (125 ha) in the dry cliff ecosystem, including cliffs and ridges extending from Kanakou to Keanapuka and along Manono Ridge, surrounding the hanging valley Pohakuao, in the Na Pali Coast State Park (Figure 5, above).

The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 67a. This section is occupied by the plant *Chamaesyce eleanoriae* and includes the dry cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the dry cliff ecosystem (Table 3). Although Dry Cliff - Section 3 is not known to be occupied by the plants *Lysimachia scopulensis*, *Schiedea attenuata*, and *Stenogyne kealiae*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range of the species. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Stenogyne kealiae* critical habitat consists of three components (Lowland wet, Montane mesic and Dry cliff) (75 FR 18960-19165):

Ecosystem: Lowland Wet. Elevation: <3,000 ft (<914 m). Annual precipitation: >75 in (>190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Montane Mesic. Elevation: 3,300–5,243 ft (914–1,598 m). Annual precipitation: 50–75 in (127–190 cm). Substrate: weathered aa lava, rocky mucks, thin silty loams, deep volcanic ash soils. Canopy: *Acacia*, *Metrosideros*, *Psychotria*, *Tetraplasandra*, *Zanthoxylum*. Subcanopy: *Cheirodendron*, *Coprosma*, *Kadua*, *Ilex*, *Myoporum*, *Myrsine*. Understory: *Bidens*, *Dryopteris*, *Leptecophylla*, *Poa*, *Scaevola*, *Sophora*.

Ecosystem: Dry Cliff. Elevation: unrestricted. Annual precipitation: < 75 in (<190 cm). Substrate: >65 degree slope, rocky talus. Canopy: None. Subcanopy: *Antidesma*, *Chamaesyce*, *Diospyros*, *Dodonaea*. Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Schiedea*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include

habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Mesic to wet shrublands and forests (NatureServe, 2015); dry cliff, lowland wet, and montane mesic ecosystems (USFWS, 2010b)

Geographic or Habitat Restraints or Barriers

Adult: 2,231 - 4,100 ft. elevation (USFWS, 2010b)

Habitat Narrative

Adult: Inhabits mesic to wet shrublands and forests (NatureServe, 2015). It occurs in the dry cliff, lowland wet, and montane mesic ecosystems, in *Metrosideros polymorpha* forest, *M. polymorpha*-*Acacia koa* forest, and *M. polymorpha*-*Dicranopteris linearis* shrubland, at elevations between 3,550 and 4,100 ft. (1,082 and 1,250 m) (Wagner and Weller 1991, p. 51; TNCH 2007). One population (Wainiha), however, is reported between 2,231 and 2,707 ft. (680 and 825 m) elevation (HBMP 2007) (USFWS, 2010b).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Species Trends:

Declining (NatureServe, 2015)

Resiliency:

Low (inferred from USFWS, 2010b; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2010a)

Number of Populations:

5 (USFWS, 2010a)

Population Size:

18 (USFWS, 2017)

Population Narrative:

The long term population trend is unknown. Known declining due to numerous threats, exact percentage is unknown (HBMP 2007) (NatureServe, 2015). There are currently 18 wild individuals of *Stenogyne kealiae* in four locations. Propagation and outplanting efforts are ongoing (USFWS, 2017).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from non-native plants, pigs, goats, deer, fire, hurricanes, landslides, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Landslides destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. Fire can destroy dormant seeds and plants, even in steep in inaccessible areas. Successive fires can remove habitat for native species by altering microclimate conditions favorable to alien plants.

Stressor: Predation and herbivory (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species present an immediate and significant threat to *Stenogyne kealiae* throughout its range due to documented browsing and trampling by pigs, goats, and deer, and documented mechanical damage by rats (USFWS, 2010).

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor:

Exposure:

Response:

Consequence:

Narrative:

Stressor:

Exposure:

Response:**Consequence:****Narrative:*****Recovery*****Reclassification Criteria:**

Not available - recovery plan not yet developed.

Delisting Criteria:

Not available - recovery plan not yet developed.

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys (USFWS, 2010a).
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units (USFWS, 2010a).
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys (USFWS, 2010a).
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range (USFWS, 2010a).
- Conduct research on control methods for introduced slugs and avian malaria (USFWS, 2010a).
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction (USFWS, 2010a).
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security (USFWS, 2010a).
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems (USFWS, 2010a).
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations (USFWS, 2010a).
- RECOMMENDATIONS FOR FUTURE ACTIONS: • Surveys and inventories—Continue to survey for populations of *Stenogyne kealiae* in areas of potentially suitable habitat. • Ungulate monitoring and control—Protect all occurrences against browsing and disturbances from feral ungulates. Construct and maintain fenced exclosures around existing populations to prevent imminent extinction. • Invasive plant monitoring and control

o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative plant species around all populations that compete with the species. • Predator and herbivore monitoring and control—Implement effective measures to control rodents around all populations. • Invertebrate predation or herbivory control—Study *Stenogyne kealiae* populations to determine level of threat from invertebrate predation or herbivory, effective control actions, and any additional needed recovery actions. • Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Continue reintroduction of individuals into suitable habitat within historic range that is being managed for known threats to this species. • Population biology research—Study *Stenogyne kealiae* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered throughout historic range to reduce impacts from landslides and storms. • Based on the recovery criteria above, consider development of a recovery plan (USFWS, 2017).

Conservation Measures and Best Management Practices:

- This species is monitored by the Plant Extinction Prevention Program, which focuses on those plant species with fewer than 50 individuals remaining in the wild. The goal of the program is to achieve the general interim recovery guidelines set by the Hawaii and Pacific Plants Recovery Coordinating Committee (1994), which are: 3 populations of 25 (long-lived species), 50 (short-lived), or 100 (annual) mature, reproducing individuals; all threats to those populations being managed; and all individuals are represented in genetic storage (USFWS, 2010a).
- This species is currently in controlled propagation for genetic storage and/or reintroduction efforts (USFWS, 2010a).

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SPECIES ACCOUNT: *Stephanomeria malheurensis* (Malheur wire-lettuce)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/10/1982; Pacific Region (R1) (USFWS, 2016)

Physical Description

Stephanomeria malheurensis is an annual up to 50 cm tall, with a basal rosette of glabrous leaves; stem single, much branched, with scale-like leaves; heads numerous clustered or single on short peduncles; florets 5-11 per head, the ligules pink, white, or rarely orange-yellow. Pappus bristles are connate in groups of 2 to 4 at the base. (USFWS, 1990)

Taxonomy

At the time of listing, the Malheur wire lettuce was considered to be the species *S. malheurensis*. Malheur wire lettuce was first discovered in 1966 and subsequently described by Gottlieb in 1978 (Gottlieb 1978). Gottlieb used prior publications (Gottlieb 1973, 1973a, 1974, 1977, and 1978) to support the hypothesis that the diploid annual plant referred to as “*malheurensis*” evolved from the population of *S. exigua* subsp. *coronaria* (Greene). Gottlieb examined morphometric and meristic characters in samples and determined that the data supports classification of Malheur wire lettuce as a distinct species (Gottlieb 1978). Additional research and published results support the classification of Malheur wire lettuce as a species (Gottlieb 1977a, 1991, 2003, Gottlieb and Bennett 1983, Brauner and Gottlieb 1987, Brauner and Gottlieb 1989, and Joongku Lee et al. 2002). Malheur wire lettuce is accepted as a species by Integrated Taxonomic Information System (ITIS) and The International Compositae Alliance through the Smithsonian Institution in collaboration with the USDA National Plant Data Center and is listed on the ITIS website (Integrated Taxonomic Information System 2011). (USFWS, 2011)

Historical Range

The maximum historical range is unknown, (USFWS, 2011)

Current Range

Endemic to central Harney Co., Oregon, U.S.A., in an area called the Narrows, near Malheur and Harney lakes. (USFWS, 2011). Specifically, it is found on a broad hill top on BLM lands near Narrows, Oregon (south of Burns in Harney County), and has never been found outside of this one site despite efforts to locate potential additional populations. Critical habitat is designated on a 160-acre (65-hectare) area at this site, within what is now the South Narrows Area of Critical Environmental Concern. (USFWS, 2019).

Critical Habitat Designated

Yes; 12/10/1982.

Legal Description

On November 10, 1982, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective December 10, 1982), for *Stephanomeria malheurensis* (Malheur wire-lettuce) under

the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Oregon (47 FR 50881-50886).

Critical Habitat Designation

The critical habitat designation for *Stephanomeria malheurensis* includes one CHU in Harney County, Oregon. A description is presented below; a map is available in the Final Rule. This species' critical habitat encompasses approximately 160 acres (47 FR 50881-50886).

In Harney County, Oregon: the lands west of Highway 205 within the SE $\frac{1}{4}$ of the NE $\frac{1}{4}$ and the NE $\frac{1}{4}$ of the SE $\frac{1}{4}$, Section 11; and the W $\frac{1}{2}$ of the SW $\frac{1}{4}$ of the NW $\frac{1}{4}$, and the SE $\frac{1}{4}$ of the NE $\frac{1}{4}$ of the SW $\frac{1}{4}$, and the NW $\frac{1}{4}$ of the SW $\frac{1}{4}$ Section 12, T27S. R30E. Willamette Meridian.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Stephanomeria malheurensis* critical habitat consists were not defined in the Final Rule (47 FR 50881-50886).

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Self-pollinating (USFWS, 2010)

Lifespan

Adult: Annual plant (USFWS, 2010)

Breeding Season

Adult: Flowering typically occurs in July and August (USFWS, 2010).

Other Reproductive Information

Adult: Since the time of its discovery, Malheur wire-lettuce has been held forth as a rare example of sympatric speciation (e.g., Gottlieb 1973, p. 552; Gottlieb 1991, pp. 11-12). The species *Stephanomeria malheurensis* is thought to have arisen by way of a mutation event in a single plant from the obligate outcrossing parent species, *Stephanomeria exigua* subsp. *coronaria*, resulting in an individual capable of self-pollination. Originally differentiated from its putative progenitor by only a single allele, chromosomal rearrangement in the descendent inbreeding lineage likely resulted in reproductive isolation between the two *Stephanomeria* despite their lack of geographic isolation (Gottlieb 1973, pp. 550, 552; Gottlieb 1977, p. 879; Gottlieb 1978, entire). Malheur wire-lettuce was accepted as a valid species at the time of listing due to the combination of reproductive isolation and distinctive morphological characters (e.g., Gottlieb 1973, p. 552; Gottlieb 1978, entire; Gottlieb and Bennett 1983, p. 276), but it appears that the species was discovered in its nascency. The genome of Malheur wire-lettuce is a slender subset of the variability observed in the parent species, and its original discoverer, Dr. Leslie Gottlieb, described the species as "still within a bottleneck state having to do with its recent origin" (Gottlieb 1973, p. 553). Furthermore, the recently evolved species displayed several characteristics that Gottlieb (1973, p. 553) and later Sherman (2009, p. 81) described as "maladaptive." These include, among others, a relaxation of seed germination requirements

that can result in Malheur wire-lettuce sprouting in the fall rather than spring, with consequent high levels of seedling mortality over the cold winters (Gottlieb 1973, p. 553). Citing to the perennially low numbers of Malheur wire-lettuce and its potentially maladaptive traits, Sherman (2009, p. 81) states that the species “may be predisposed to extinction, as is the case with many neospecies.” Even relatively soon after its initial discovery, Dr. Gottlieb reflected “without additional genetic augmentation stemming from mutation or hybridization, and in its present harsh environment, the probability that “Malheurenensis” will persist seems small” (Gottlieb 1973, p. 553). (USFWS, 2019). All of these considerations pose a dilemma in the conservation of Malheur wire-lettuce. The researcher most intimately familiar with the species questioned its ability to survive over the long term, and another considered it predisposed to extinction. Concerted efforts over the years to reintroduce the species to its type locality after it has repeatedly gone extinct in the wild have failed, as have attempts to introduce the species to similar habitat nearby. We are thus left with a species that is of scientific interest as it represents one of the only known examples of sympatric speciation of a diploid species, but that species persists only in the form of stored seed, and it appears incapable of surviving independently in its natural habitat. (USFWS, 2019).

Reproduction Narrative

Adult: Malheur wirelettuce is an annual plant in the composite family (Asteraceae). It can reach 5 dm (20 inches) in height. This species forms a rosette of hairless leaves that arise from its base. The single stems are many-branched with scale-like leaves. Flower heads are either numerous and clustered, or solitary on short stems. The strap-shaped petals are pink, white, or rarely orange-yellow. Flowering typically occurs in July and August. The Malheur wirelettuce is co-located with an ancestral relative, small wirelettuce (*Stephanomeria. exiqua* ssp. *coronaria*); however, the two species do not interbreed. While the Malheur wirelettuce is self-pollinating, its ancestral relative is not (USFWS, 2010).

Habitat Type

Adult: Desert hill top (USFWS, 2010)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 2010)

Environmental Specificity

Adult: Narrow/specialist (USFWS, 2010)

Tolerance Ranges/Thresholds

Adult: Low (USFWS, 2010)

Site Fidelity

Adult: High (USFWS, 2010)

Habitat Narrative

Adult: Species inhabits a broad hilltop composed of volcanic tuff (in contrast to soils in the surrounding flats, which are primarily derived from basalt). The native vegetation is dominated by big sagebrush (*Artemesia tridentata*) and rabbit-brush (*Chrysothamnus* spp.). (NatureServe, 2015). Malheur wirelettuce occurs in the high desert of the northern portion of the Great Basin and is located in an area south of Burns, Oregon. It occurs on top of a dry, broad hill on volcanic

soil intermixed with layers of limestone. Dominant plants at the site are big sagebrush (*Artemisia tridentata*), gray rabbitbrush (*Chrysothamnus nauseosus*), green rabbitbrush (*Chrysothamnus viscidiflorus*), and, more recently, cheatgrass. Malheur wirelettuce may be one of the few species able to survive on and around the otherwise barren harvester ant hills at the site (USFWS, 2010). The species narrow environmental specificity, clumped spatial arrangement of the population, high ecological integrity of the community and site fidelity as well as low tolerance ranges are based on the narrow geography this species inhabits and its specific habitat requirements, as well as the few known populations that are known to occur.

Dispersal/Migration

Dispersal

Adult: Harvester ants appear to be a dispersal agent (USFWS, 2011)

Dispersal/Migration Narrative

Adult: Observations made by Brauner (1988, pp. 15, 16, and 20) and BLM (1987, no pagination) indicate harvester ants (*Pogonomyrmex owyheei*) contribute to loss of seed through granivory, but also may to a lesser extent contribute to seed dispersal. Additional observations of harvester ants collecting seed have been made by ODA staff during the ongoing restoration activity (Currin et al. 2009, pp. 29-30). Granivory could be a hindrance to seed recruitment, but it is possible that harvester ants facilitate seed burial or possibly facilitate seed germination. Further investigation on harvester ant influence on Malheur wire lettuce is recommended (Currin et al. 2009, p. 30) (USFWS, 2011).

Population Information and Trends

Population Trends:

Decreasing (NatureServe, 2015)

Resiliency:

Low ((USFWS, 2011)

Representation:

Low ((USFWS, 2011)

Redundancy:

Low ((USFWS, 2011)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

250 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Does not appear to compete well with exotic annual taxa. Presumed extinct in the wild in 1985. Decline of >90% 1028 plants transplanted in 2008, though the trend has been for these reintroduced populations to fail in a matter of years. Recruitment from previous years' seed is

low. Two EOs, one presumed extinct in the wild and another a novel reintroduction site. Both populations are maintained by transplants. (NatureServe, 2015). The Malheur wire lettuce population continues to be small and remains vulnerable to natural fluctuations. Cheat grass that invaded Malheur wire lettuce habitat in the early 1970s persists within the habitat and likely affects the site conditions for re-establishing Malheur wire lettuce (BLM 2005 and 2006). Between 1986 and 1990, over 1,300 seedlings were planted within the ACEC and designated critical habitat in an attempt to restore the plant in the wild. As of 1989, there were 939 seedlings established through these efforts. After 1990, the population was left to persist on its own and was extirpated in the wild after 13 years (Currin et al. 2007). The restoration project being implemented by the ODA has made progress toward meeting the recovery criteria for establishment of Malheur wire lettuce at a minimum of four locations within the designated critical habitat area described in the recovery plan (Fish and Wildlife Service 1991). Narrows 1, Narrows 2, and Narrows 3 sites have been installed, and currently support Malheur wire lettuce within the designated critical habitat (see section 2.3.1.1.). Over the past four years, nearly 4,000 seedlings have been planted, and 46,000 seeds have been sown within the Narrows ACEC. ODA estimates the planted seedlings have contributed over 154,000 seeds to the soil seed bank at the Narrows restoration sites (Currin and Meinke 2010, p. 33). Whether the seeds are able to successfully germinate, grow, reproduce and ultimately create a self-sustaining population of Malheur wire lettuce over time (for at least 15 years) without human assistance remains to be seen. The additional site known as the "Dunes" site was planted in 2007 and 2008, but is not within the designated critical habitat. An additional 5,000 seeds have been added to the conservation seed bank at Berry Botanical Garden (USFWS, 2011). Low resiliency, representation and redundancy are based on the species becoming extinct in the wild and having to be re-introduced. The re-introductions have resulted in three new populations that are being monitored. Between 2007 and 2011, an intensive multi-year restoration program for Malheur wire-lettuce took place in the protected 160-acre critical habitat location. More than 4,500 seedlings were planted and hand-watered for 8 weeks following planting. Approximately 46,000 seeds were directly sown, and more than 150,000 seeds produced by transplants were estimated to have been contributed to the soil seed bank at the restoration site (U.S. Fish and Wildlife Service 2011, p. 17; Oregon Department of Agriculture 2012, entire). Despite these efforts, annual surveys in 2016 found only three individuals in poor condition, leading the ODA to declare the species "functionally extinct" (Oregon Department of Agriculture 2017, p. 2). In a subsequent visit by Service biologists in 2017, again no representatives of the species were observed (Brumbelow and Mauer, pers. obs. 2017). (USFWS, 2019).

Threats and Stressors

Stressor: Surface mining (USFWS, 1991)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The lone population of this species is vulnerable to any substantial habitat alteration and faces the potential threat of surface mining for zeolites on and near the site where it occurs (USFWS, 1991).

Stressor: Cheat grass (USFWS, 1991)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: It is immediately threatened by competition with an exotic grass, *Bromus tectorum* (USFWS, 1991).

Stressor: Grazing (USFWS, 1991)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: It is immediately threatened by grazing of native herbivores (probably black—tailed jackrabbits) (USFWS, 1991).

Stressor: Insect predation (USFWS, 1991)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: The larvae of an unidentified insect may be foraging on the plant (USFWS, 1991).

Stressor: Small population size (USFWS, 1991)

Exposure:

Response:

Consequence: Extinction

Narrative: Natural fluctuations in small population size may lead to extinction (USFWS, 1991).

Stressor: Invasive plants, allelopathic affects (USFWS, 1991)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Possible allelopathic (inhibitory) affects by introduced plants, i.e. cheatgrass, (*Bromus tectorum*) (USFWS, 1991).

Recovery

Reclassification Criteria:

The 160-acre Critical Habitat is secure from the threats of fire (USFWS, 2011).

The 160-acre Critical Habitat is secure from the threats of mining (USFWS, 2011).

The 160-acre Critical Habitat is secure from the threats of grazing (USFWS, 2011).

The 160-acre Critical Habitat is secure from the threats of introduced exotic species for five years (USFWS, 2011).

Flowering plants produce seeds in at least four separate locations within the designated critical habitat (USFWS, 2011).

Recovery Actions:

- A buffer zone or fire lane was established and is being maintained around the critical habitat of Malheur wire lettuce to enhance the plant's survival (Fish and Wildlife Service 1991, p.

- 12). The BLM currently maintains native surface roads which roughly follow the boundary of the South Narrows Area of Critical Environmental Concern (ACEC) on three sides, with State highway 205 on the fourth side. Fire lines are generally successful in holding a fire (Meinick 2011) (USFWS, 2011).
- The ACEC was designated to incorporate the designated critical habitat into BLM management. All present and future mining claims have been withdrawn (Fish and Wildlife Service 1991, p. 12). All mining claim activity within the ACEC remains inactive (Meinick 2011) (USFWS, 2011).
 - The area was fenced to keep livestock from the ACEC. The fence is maintained by BLM. Plantings of Malheur wire lettuce conducted within the ACEC in 1987 and 1989 were protected by rodent proof fencing (Fish and Wildlife Service 1991, p. 12). Transplanting seedlings into plots surrounded by rabbit exclosure fencing had little effect on the survival and reproduction of the seedling transplants (Currin et al. 2007, p 47 and Currin and Meinke 2008, p. 15). The livestock fence is still maintained, but current restoration efforts do not rely on rodent fencing to protect seedlings from natural herbivory (Currin and Meinke 2008, p. 15; and Currin et al. 2009, p. 14) (USFWS, 2011).
 - Cheatgrass (*Bromus tectorum*), an exotic species, was identified as a threat to Malheur wire lettuce that competes for water, and is possibly allelopathic (inhibition of growth in one species of plant by chemicals produced by another species of plant). Reducing its influence was considered necessary in the recovery plan. The recovery plan recommended a study of allelopathy to determine the extent of impact cheat grass has on Malheur wire lettuce. A study was initiated in 1987 and preliminary results indicted a slight allelopathic affect from cheat grass on lettuce seeds, used as a proxy rather than using seeds of Malheur wire lettuce, and recommended continued investigation using Malheur wire lettuce seeds to test significance of allelopathy (Davidson and Bargaen 1987, pp. 4-5). No additional studies of allelopathy have been conducted for Malheur wire lettuce. The recovery plan also recommended rogueing (weeding out) of cheatgrass throughout the growing season within 1-2 ft. radius of existing Malheur wire lettuce plants. Before the Narrows fire in 1972, Malheur wire lettuce inhabited the open areas between shrubs and bunchgrasses (Currin and Meinke 2007, p. 8). After the fire, cheatgrass invaded the site and at times formed an almost complete groundcover in the open areas. Higher levels of cheatgrass corresponded with a decline in Malheur wire lettuce (Brauner 1988, pp. 4 and 21-23). Several treatments to reduce cheatgrass were conducted with varying results (Gottlieb 1991, p. 12). According to Taylor (1997), the act of weeding may have negative impacts on Malheur wire lettuce plants due to disturbance during weeding activities. No additional cheatgrass removal activities have been conducted (Fish and Wildlife Service 1991, p. 12). The BLM reported a reduction in the amount of cheat grass plants present at the designated critical habitat area in comparison with the amount reported after the Narrows Fire in 1972, but also noted an increase in other exotic annual forbs including burr buttercup (*Ranunculus testiculatus*), jagged chickweed (*Holosteum umbellatum*), pale alyssum (*Alyssum alyssoides*), and tumble mustard (*Sisymbrium altissimum*) (BLM 2005). During the restoration activities conducted from 2007 to present, selection of transplant site plots were located in areas observed to have reduced amounts of cheatgrass present. The designated critical habitat is not free from exotic species at this time. Additional restoration work, monitoring, and analysis is needed to determine if the exotic plants present at the site constitute a continued threat to Malheur wire lettuce (USFWS, 2011).
 - No Malheur wire lettuce plants were observed in surveys conducted in 2004 through 2007. The restoration efforts have focused on planting seedlings in plots scattered in two different

areas within the ACEC and the designated critical habitat. The success of the planting has varied from year to year and among the various plots. Currently there are three plots with reproducing plants located within the ACEC and designated critical habitat boundary (See section 2.3.1.1) (USFWS, 2011).

- 2019 recommended action 1: Continue seed bulking to retain current seed supply. (USFWS, 2019).
- 2019 - 2: Halt seedling planting at designated sites until we gain an improved understanding of habitat needs for the species. (USFWS, 2019).
- 2019 - 3: Monitor habitat of Malheur wire-lettuce for signs of survival of the species in the wild. (USFWS, 2019).
- 2019 - 4: Cooperate with The Nature Conservancy to develop an experimental seed planting of Malheur wire-lettuce using novel techniques they are developing for restoration in the harsh desert environments of the Great Basin. For example, they have developed a variety of “seed pods” that are designed to give plants a boost to overcome multiple barriers preventing establishment. (USFWS, 2019).
- 2019 - 5: Monitor planting of “seed pods” or other novel techniques to determine seed to maturation success at the native site. (USFWS, 2019).
- 2019 - 6: Continue “conservation reliant” management and restoration once experimental tactics are validated. (USFWS, 2019).
- 2019 - 7: Adapt techniques and reassess recovery goals as needed. (USFWS, 2019).

Conservation Measures and Best Management Practices:

- Continue to work with ODA, BLM, and Native Plant Society to accomplish restoration and monitoring activities benefitting Malheur wire lettuce. Plant seedlings and supplement seed on four sites within the designated critical habitat and ACEC site (recovery plan objectives 1 and 5) (USFWS, 2011).
- Continue to bulk seed for use in implementation of future recovery efforts as well as to increase and replace stored seed of Malheur wire lettuce (recovery plan objective 51) (USFWS, 2011).
- Continue annual census of Malheur wire lettuce. Sampling should occur starting in April when rosettes are observable and continue through July to detect flowering plants. Additional monitoring should be conducted during flowering to estimate seed production. Continuation of monitoring is needed to observe the demography of the species and to assess its responses to climate changes, particularly drought conditions, over time (USFWS, 2011).
- Work with the BLM and ODA to develop a long-term management and monitoring plan for the Malheur wire lettuce and its habitat. The plan should address the threats described in the original listing (restricted range, mining, herbivores, limited population, and cheatgrass) and recovery plan. Monitoring should be sufficient to track fluctuations in available habitat, and abundance of nonnative or invasive plant species (USFWS, 2011).
- Evaluate the potential for control of introduced non-native and competing plant species particularly cheat grass. Also consider potential for preventing introduction and spread of other invasive species (USFWS, 2011).
- Evaluate granivore – seed interactions related to harvester ants and dispersal of seed. Determine whether harvester ants are a hindrance to restoration or if they aid in recovery through caching and dispersal of viable seed (USFWS, 2011).

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SPECIES ACCOUNT: *Streptanthus albidus* ssp. *albidus* (Metcalf Canyon jewelflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An annual herb, up to 1+ m tall. Basal leaves are narrow, coarsely toothed, the upper leaves not toothed and becoming linear. Flowers (April-July) are borne in leafless terminal clusters; they have white to whitish-green sepals and white petals with purple-brown veins. The erect, flattened seed pods are 3-8 cm long. (NatureServe, 2015)

Taxonomy

Streptanthus albidus ssp. *albidus* (Metcalf Canyon jewelflower) was first collected in 1887 by Volney Rattan, a botany teacher and author, from hillsides a few miles south of San Jose (Greene 1887). Edward Greene described *Streptanthus albidus* ssp. *albidus* in 1887 (Greene 1887); later he redefined the limits of *Euclisia*, formerly a subgenus of *Streptanthus*, treating it as a genus in its own right (Greene 1904). *Streptanthus albidus* ssp. *albidus*, as a member of the *Euclisia* group, was included in this change. Jepson (1925) returned *Euclisia* to subsection status, and later authors followed his treatment. Jepson (1925) also treated *Streptanthus albidus* ssp. *albidus* as a subspecies of *Streptanthus glandulosus*. Kruckeberg published a revision of the *Streptanthus glandulosus* complex in which he recognized the close relationships among *Streptanthus glandulosus*, *Streptanthus albidus*, and *Streptanthus niger* (Kruckeberg 1958). In this paper, he notes that the “sharp genetic discontinuity between *Streptanthus albidus* and all other populations, coupled with the morphological distinctness and regional restriction of *Streptanthus albidus* warrant the restoration of this Greeneian species.” He recognized two subspecies: *Streptanthus albidus* ssp. *albidus* and *Streptanthus albidus* ssp. *perarnoenus* (Kruckeberg 1958). Recent research affirms the distinctiveness of *Streptanthus albidus* ssp. *albidus*. *Streptanthus albidus* ssp. *perarnoenus*, and *Streptanthus niger* (M. Mayer. in litt., 1998) (USFWS, 1998).

Current Range

Santa Clara county, California. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: *Streptanthus albidus* ssp. *albidus* flowers April to June (Kruckeberg 1977) (USFWS, 1998).

Reproduction Narrative

Adult: *Streptanthus albidus* ssp. *albidus* flowers April to June (Kruckeberg 1977). No detailed data on its reproductive biology or demography are available. Nine populations totaling approximately 20,000 to 25,000 plants have been recorded (McCarten 1992b) (USFWS, 1998).

Habitat Type

Adult: Outcrops

Spatial Arrangements of the Population

Adult: clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits serpentine outcrops with shallow soils (NatureServe, 2015). High ecological integrity and site fidelity as well as low tolerance ranges are inferred based on this species restricted habitat requirements and geography.

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Not available

Population Narrative:

Known from 22 total occurrences, but only nine presumed extant (NatureServe, 2015)

Threats and Stressors

Stressor: Development (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: At the time of listing, there were 13 documented sites, 9 of which still harbored plants. Two occurrences were known from herbarium records only. One of the historical records was visited in 1990, but no plants were found. *Streptanthus albidus* ssp. *albidus* was last observed at the other historical site in 1895. One population consisting of approximately 9,000 plants, approximately 45 percent of all known plants, occurred on the proposed site of the Cerro Plata residential and golf course project (also known as Ranch on Silver Creek Development). Although no direct destruction of any plants were planned at the time of listing, it was thought that construction activities, human disturbance, and habitat fragmentation would result in

significant impacts to the population. There was a proposed Valley Christian School and South Valley Christian Church that would destroy 61 percent of the 2,700 plants occurring on the site. The remaining 7 populations were also threatened by impending or potential development. The Ranch on Silver Creek Development (Cerro Plata) has been constructed since the time of listing. Although all direct impacts to *Streptanthus albidus* ssp. *albidus* were avoided as described in the biological opinion (Service 2000), the populations within the 580 acre parcel are intermixed with residential homes, golf course, and facilities. Ten years of monitoring (2001-2010) of the preserved populations within the on-site Hassler Ranch Preserve show that the Plant Conservation Areas are still occupied by *Streptanthus albidus* ssp. *albidus*. The total area occupied within the Plant Conservation Areas has increased slightly by 3.65 acres. The numbers of plants have drastically reduced from 75,000 plants in 1998 to an average of 11,266 plants over 10 years (2001-2010). This is a reduction of 85% percent of the baseline prior to construction of the Silver Creek Development. One location at Tulare Hill was covered by fill during construction of a housing development (CNDDDB 2012). Three sites within the Metcalf Energy Center Ecological Preserve are proposed for reintroduction (Whittall 2011). The reintroduction plan includes monitoring and preparation of a management plan (USFWS, 2013).

Stressor: Predation (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Herbivory was observed on approximately 8 individuals of *Streptanthus albidus* ssp. *albidus* at the Metcalf Motorcycle County Park. The herbivory was likely due to invertebrate herbivores since aphids and Pierid caterpillars have been observed in the populations there previously (Whittall, 2011) (USFWS, 2013).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: In summary, the Endangered Species Act is the primary Federal law that provides protection for these species since their listing as endangered in 1995. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act. Therefore, we continue to believe other laws and regulations have limited ability to protect the species in absence of the Endangered Species Act (USFWS, 2013).

Stressor: Nitrogen deposition (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: A relatively recently identified threat is nitrogen deposition into grasslands from air pollution sources and the resultant increase in productivity of the soils has facilitated increased invasion of nonnative species (ICF 2012). The main effect for Santa Clara Valley dudleya and Metcalf Canyon jewelflower is their vulnerability to annual grass overgrowth. Nonnative annuals are much less dominant in serpentine areas, although increasing nitrogen deposition from air pollution has increased the productivity of serpentine soils and allowed a greater number of nonnatives to invade (Evens and San 2004; Harrison et al. 2003; Weiss 1999). Santa Clara Valley

dudleya (*Dudleya setchellii*) lives on rock outcrops and is relatively immune from grass invasions except when extremely tall grasses smother small rock outcrops. The species persists on medium to large rock outcrops in ungrazed areas. Metcalf Canyon jewelflower can be a poor competitor against dense annual grasses, and some degree of grazing appears necessary to maintain populations (ICF 2012). Livestock grazing is an important management tool to combat increased invasive nonnative plants in serpentine grasslands due to atmospheric nitrogen deposition (Weiss 1999) (USFWS, 2013).

Stressor: Climate change (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: ICF (2012) summarized the potential effects of climate change to serpentine plant species and its relationship to the proposed permitted activities during the Santa Clara Valley Habitat Plan's proposed 50 year permit span. Serpentine plant distribution is restricted to highly specialized and localized habitat requirements that include species-specific microclimate conditions coincident with serpentine soil occurrence. Restriction to serpentine soils limits species range and distribution to this soil type. Climate change could change microclimate conditions so that species can no longer persist within their current range. Increase in favorable microclimate conditions could lead to an expansion of distribution and increase in abundance, both in terms of number of populations and number of plants within each population. Change in timing or intensity of seasonal events could have an effect on pollinator reproductive and plant flowering periods leading to phenological mismatches. The Santa Clara Habitat Plan (ICF 2012) includes a conservation strategy reserve design to reduce species vulnerability and provides opportunities for species and natural communities to adapt in response to climate changes (USFWS, 2013)

Recovery

Reclassification Criteria:

Secure and protect specified recovery areas. Occupied habitat along with adjacent unoccupied habitat and a 150-meter (500- foot) buffer at nine known sites. Management plan approved and implemented for recovery areas, including survival of the species as an objective. For all populations and any occupied or unoccupied habitat identified as essential to survival.

Delisting Criteria:

Secure and protect specified recovery areas. 18 populations representing entire historic range of the species. from incompatible uses:

Recovery Actions:

- Population monitoring in specified recovery areas shows: Downlist: Stable or increasing for a period of 20 years that include the normal precipitation cycle (or longer if suggested by the results of demographic monitoring). Delist: No decline after downlisting; if declining, determine cause and reverse trend.

Conservation Measures and Best Management Practices:

- Preserve, protect, manage, and monitor *Dudleya setchellii* CNDDb occurrence number 43. Occurrence number 43 was found in the year 2005, subsequent to listing of the species and the

Recovery Plan. The occurrence represents the most southwesterly extent of its current known range (USFWS, 2013).

- Confirm if the historic and current westernmost and southernmost occurrences for *Streptanthus albidus* ssp. *albidus* are valid. Perform additional surveys in suitable habitat around CNDDDB number 6 and 21 to confirm if the range of the species is smaller than previously understood (USFWS, 2013).
- Conservation measures should include focus on preserving, monitoring, and managing pollinator fauna as it appears to be essential for any significant fruit set in *Streptanthus albidus* ssp. *Albidus* (USFWS, 2013).
- *Streptanthus albidus* ssp. *albidus* plant numbers can fluctuate drastically from year to year (Whittall 2011). Reliable methods should be developed to evaluate when a population should be considered as stable and viable. The methods should include ways to measure and evaluate natural and human influenced variables

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SPECIES ACCOUNT: *Streptanthus bracteatus* (Bracted twistflower)

Species Taxonomic and Listing Information

Listing Status: Candidate; (USFWS, 2016); Proposed Threatened

Physical Description

Bracted twistflower (*Streptanthus bracteatus*) is a herbaceous annual plant of the Mustard Family (Brassicaceae) currently reported from five counties of south-central Texas. The seeds germinate in response to fall and winter rainfall, forming basal rosettes (clusters of leaves that radiate from the root crown); the young plants resemble radish seedlings. The waxy bluish-green basal leaves, up to 15 centimeters (cm) (5.9 inches (in)) long, have broadly lobed margins. Flower stalks emerge the following spring bearing showy lavender-purple flowers; often these stalks are un-branched and 46 to 61 cm (18 to 24 in) tall, but may reach 137 cm (54 in) in height, and have several long branches. The lower stem leaves have an elongated heart shape and the upper leaves are progressively shorter, ultimately reduced to very short, triangular bracts (modified leaves) at the base of each flower stem. Thin seed pods, known as siliques, are up to 12 cm (4.7 in) long and 4 millimeters (mm) (0.15 in) wide; they mature and dry during the summer, finally splitting open to release flattened seeds with narrow wings. The foliage withers as the fruits mature, and the plants die during the blazing heat of summer.

Taxonomy

Family: Brassicaceae (mustards). About 100 species of *Streptanthus* have been described, although many of these have more recently been placed in *Caulanthus*, *Boechera*, *Thelypodium*, or other genera (Tropicos 2011a, pp. 12). Gray (1848, p. 146) described *Streptanthus bracteatus* as a new species, based on specimens collected by Ferdinand Lindheimer near New Braunfels, Texas, in 1846. Kuntze (1891, p. 933, cited in Tropicos 2011c, p. 1) classified this taxon as *Erysimum bracteatum* (A. Gray) Kuntz. Nevertheless, the Flora of North America (Al-Shehbaz 2011, p. 706), Tropicos (2011b, p. 1), the Integrated Taxonomic Information Service (2011, p. 1), the International Plant Names Index (2011, p. 1), and the Plants Database (Natural Resources Conservation Service 2011, p. 1) treat this taxon as a valid species with the name *Streptanthus bracteatus*. Pepper (2010, p. 14) concluded that *S. bracteatus* is a morphologically and evolutionarily distinct species; its closest extant relative is the broadpod jewelflower, *S. platycarpus*, a west Texas endemic. Poole et al. (2007, p. 470) list bracted twistflower and bracted jewelflower as common names for this species. While the latter is also used by the Plants Database, the botanists and conservation organizations who work with this species primarily use the former name. For the purposes of this document, we will refer to *Streptanthus bracteatus* as bracted twistflower.

Historical Range

U.S., Texas. Historic collection records where the species has not been observed since 1989: Comal, Bandera/Kerr, Real, Bexar counties.

Current Range

U.S., Texas. Bexar, Hays, Medina, Travis, and Uvalde counties. Endemic to a small area of the Edwards Plateau of Texas.

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Bloom April and may continue to May and early June

Reproduction Narrative

Adult: Rosettes have been reported in October, November, and March, and presumably can be seen throughout the winter months. The relatively few rosette observations (five) reflects the difficulty of positive species identification at this life stage; prior to flowering, bracted twistflower is easily confused with another member of the mustard family, rock cress (*Arabis petiolaris*) (Damude and Poole 1990, p. 6). From 79 to 90 percent of seed germination occurs during October and November (Zippin 1997, p. 222). Flowering peaks in April and may continue into May and June. Fruits have been observed from April through June. Mature seeds have been collected most often in June, but occasionally as late as August. Dieringer (1991, pp. 341343) investigated the pollination ecology of one population of bracted twistflower. He determined that it is primarily an outcrossing species, although 6.3 percent of self-pollinated flowers set fruit. A locally common species of leafcutter bee, *Megachile comata* (family Megachilidae), was an effective pollinator. About 29 percent of un-manipulated flowers set fruit, 12 percent of fruiting plants were eaten by deer, and 11 percent of fruit capsules were damaged by seed-eating insects.

Habitat Type

Adult: Primarily in oak-juniper woodlands and associated openings on slopes and in canyon bottoms with shallow, well drained, gravelly clays and clay loams over limestone. Often found amid dense shrub growth where some protection from browsing animals is afforded, but is not ideal habitat.

Habitat Vegetation or Surface Water Classification

Adult: Forest/Woodland; Shrubland/Chaparral, Woodland - Mixed

Habitat Narrative

Adult: Bracted twistflowers are best adapted to sites with less than 50 percent cover of woody plants, and that severe herbivory by dense populations of white-tailed deer has largely extirpated the plant from its optimal habitats. It may persist for a time in the protection of dense thickets, or it may gradually decline. In addition, the germination of seeds and reproduction of bracted twistflower in the wild appears to respond to as-yet unknown triggers. This compels us to consider how historic vegetation changes may have affected bracted twistflower populations. Bray (1904, pp. 14, 22) described a very apparent, ongoing transition of Edwards Plateau uplands from grassland to woodland at the beginning of the twentieth century. At that time, the well-watered canyons supported dense forests with trees over 500 years old; stunted but continuous forest covered hills and bluffs; sparse trees were found on loose, stony slopes in the eastern Edwards Plateau (precisely where bracted twistflower populations currently occur); and trees were then invading the open prairies on the level plateau divides (uplands), which previously were free of woody vegetation (Bray 1904, pp. 1415). He attributed

this change to overgrazing and the consequent depletion of grasses, erosion, and cessation of wildfires, and stated that open prairies had been converted to dense oak scrub in a span of 25 years (Bray 1904, pp. 1415, 2223). These historic descriptions support a hypothesis that bracted twistflower is a relict of a woodland-grassland ecotone (transition zone) that occurred at or near the confluence of loose, stony slopes and prairie uplands. This savanna, in the broad sense of the term, would have been influenced periodically by wildfires of varying intensity and frequency. Some *Streptanthus* species, such as *S. heterophyllus* (San Diego wild cabbage), germinate following wildfires (Moreno and Oechel 1991, pp. 1999-2000), thus, fire may also be a trigger of bracted twistflower emergence.

Dispersal/Migration

Population Information and Trends

Number of Populations:

13 EOs (=populations); 9 with intact habitat, 4 with degraded or partially destroyed habitat

Population Size:

~6,200 individuals

Population Narrative:

Of the 16 EOs (Element Occurrences=geographic sites) observed since 1989, 9 EOs remain with intact habitat, 2 EOs are partially intact, 2 are on managed rights-of-way, and 3 sites have been developed and the populations are presumed extirpated. Only 7 of the intact EOs and portions of 2 EOs, representing 2,502 individuals (33 percent of the maximum populations observed since 1989), are on protected natural areas. Four EOs with 3,708 individuals (48 percent of the maximum populations) are intact but vulnerable to development and other impacts. Five EOs have been partially or completely developed, resulting in the loss of 1,449 individuals (19 percent of the maximum populations). Two EOs were destroyed in 2012 and 2013.

Threats and Stressors

Stressor: Urban development

Exposure: Degradation and destruction of habitat

Response:

Consequence:

Narrative: The greatest threat to bracted twistflower is habitat loss due to urban and residential land development (McNeal 1989, p. 17; Damude and Poole 1990, p. 51; Zippin 1997, p. 229; Fowler 2010, p. 2; Pepper 2010, p. 5). Our analysis of the 16 EOs reported since 1989 indicates that 3 have been extirpated, portions of 2 have been extirpated, 2 are in disturbed habitat, and 9 are intact. Of the intact EOs, 2 are vulnerable to development, and 7 intact EOs and portions of 2 EOs, representing 33 percent of the maximum populations recorded since 1989, occur in protected natural areas. The Rough Hollow population in Hays County was discovered in 2010; by 2012, the site had been bulldozed. The Cat Mountain population in Travis County, which was a core reservoir of the species genetic diversity (Pepper 2010, p. 12), was located on private land that was sold in 2011 (Bracted Twistflower Working Group 2010, pp. 34; Stewart 2012); this site was completely bulldozed in 2013 (Fowler 2014, p. 16). Habitat loss is an imminent threat

throughout the species range to the populations not on protected natural areas and is likely to continue.

Stressor: White-tailed deer, small mammals, exotic ungulates

Exposure: Browsing

Response:

Consequence:

Narrative: Severe herbivory by white-tailed deer is a major, imminent threat to bracted twistflower throughout the species' range, except where populations are protected from deer by fencing or intensive herd management (hunting) (McNeal 1989, p. 17; Damude and Poole 1990, pp. 5253; Dieringer 1991, p. 341; Zippin 1997, pp. 39197, 227; Leonard 2010a, pp. 3643; Fowler 2014, pp. 17, 19) and is exacerbated by the extremely high deer densities in the Edwards Plateau of Texas (Zippin 1997, p. 227). The foliage of bracted twistflower is very palatable to many browsing animals, including squirrels (Fowler 2010, p. 7), and even humans (Kral 1990 cited in Damude and Poole 1990, p. 51). Exotic ungulate species such as aoudad (*Ammotragus lervia*), which have been widely introduced on game ranches and now exist in self-sustaining feral populations in central Texas, present an additional potential threat (Damude and Poole 1990, pp. 52 - 53). It is also likely that bracted twistflower populations were impacted during historic periods of poor rangeland management in central Texas, particularly by herds of goats and sheep.

Stressor: Woody plant density

Exposure: Decreased habitat

Response:

Consequence:

Narrative: Changes in vegetation structure and composition, specifically the increased density of woody plant cover, appear to be detrimental to bracted twistflower (Pepper 2010, p. 5). The species benefits from higher light intensity and duration than it receives in many of the extant populations; its persistence in dense thickets may be due to increased herbivory of the plants growing in more open vegetation (Leonard 2010a, p. 63; Ramsey 2010, p. 22). The positive reproductive response of bracted twistflower to higher light levels is consistent with the hypothesis that it may also be a fire-adapted species (Fowler 2010, pp. 3, 10). Bray (1904, pp. 1415, 2324) documented the rapid transition of grasslands to woodlands in the Edwards Plateau occurring more than a century ago; he attributed this change to over-grazing, the depletion of grasses, and the cessation of wildfires. We conclude that bracted twistflower habitats were probably influenced by frequent wildfires and that the frequency of wildfires has decreased greatly since pre-settlement times; therefore, bracted twistflower may be a fire-adapted species, and the lack of wildfire may have contributed to its decline. The increase in density of woody plant cover has occurred incrementally over a span of decades, but affects most bracted twistflower populations, including those on protected natural areas, and may also have caused a gradual decline in population sizes. In addition, optimal vegetation management of bracted twistflower populations may be incompatible with the management of nesting habitat of the endangered golden-cheeked warbler.

Stressor: Powdery mildew fungus

Exposure: Disease infestation

Response:

Consequence:

Narrative: Bracted twistflower is highly susceptible to attack from a powdery mildew fungus (Ascomycota, family Erysiphaceae) which may be more severe when plants grow in dense, shaded thickets (Ramsey 2010, p. 21; Leonard 2010a, p. 53). The species of fungus has not yet been identified; it may be an introduced pathogen to which bracted twistflower has no resistance (Bracted Twistflower Working Group 2010, p. 2). We do not yet know the magnitude of this threat. However, Fowler (2014, p. 17) found that, contrary to expectation, the incidence of powdery mildew was positively associated with reproductive output (plants with greater degrees of powdery mildew infestation produced more viable seed).

Stressor: Recreation

Exposure: Erosion and trampling

Response:

Consequence:

Narrative:

Recovery

Recovery Actions:

- Search for new populations on public conservation land as well as private lands (with landowner permission).
- Provide technical guidance and material support to private landowners who voluntarily wish to conserve the species on their land.
- Manage the existing populations on protected natural areas more rigorously, including installation of deer exclosures, closing illicit foot and mountain bike trails, enforcing applicable regulations that protect the habitats on public property, and conducting public outreach.
- Maintain less than 50 percent cover of woody plants at occupied habitats to the extent allowed under the existing habitat management plans or applicable regulations.
- Protect multiple populations within each area of the species genetic diversity in Medina and Travis counties.
- Investigate the species ecology and optimal habitat requirements, particularly the fire ecology, geology, and associated vegetation structure.
- Conduct pilot reintroductions to determine effective methods of population reintroduction and augmentation. Reintroduction and augmentation must use seeds from ecotypes adapted to the sites. Avoid translocating propagules of an ecotype into sites that support a genetically distinct ecotype.
- Collect seeds from extant populations for seed bank storage and propagation. Propagate plants from the representative genetic ecotypes (genotypes that are specifically adapted to a specific ecological area) and produce seed for experimental and reintroduction efforts (to prevent excessive collection from wild sources and depletion of the soil seed bank at extant populations).

Conservation Measures and Best Management Practices:

- Manage the existing populations on protected natural areas more rigorously, including installation of deer exclosures, closing illicit foot and mountain bike trails, enforcing applicable regulations that protect the habitats on public property, and conducting public outreach.

- Maintain less than 50 percent cover of woody plants at occupied habitats to the extent allowed under the existing habitat management plans or applicable regulations.
- Protect multiple populations within each area of the species genetic diversity in Medina and Travis counties.
- Investigate the species ecology and optimal habitat requirements, particularly the fire ecology, geology, and associated vegetation structure.
- Conduct pilot reintroductions to determine effective methods of population reintroduction and augmentation. Reintroduction and augmentation must use seeds from ecotypes adapted to the sites. Avoid translocating propagules of an ecotype into sites that support a genetically distinct ecotype.
- Collect seeds from extant populations for seed bank storage and propagation. Propagate plants from the representative genetic ecotypes (genotypes that are specifically adapted to a specific ecological area) and produce seed for experimental and reintroduction efforts (to prevent excessive collection from wild sources and depletion of the soil seed bank at extant populations).

References

USFWS. 2014. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for *Streptanthus bracteatus* (Bracted Twistflower), Region 2, 24 p.

USFWS 2014. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for *Streptanthus bracteatus* (Bracted Twistflower), Region 2, 24 p.

SPECIES ACCOUNT: *Streptanthus niger* (Tiburon jewelflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 3/6/1995; Pacific Southwest (R8)

Physical Description

An annual herb of the mustard family (Brassicaceae) that reaches 30 to 60 centimeters (1 to 2 feet) in height. The lower leaves are toothed, the upper leaves less toothed or not at all. The sepals are a very dark purple; the petals have a purple claw and a white blade with a purple midvein. The pods are erect, almost straight and 4 to 7 centimeters (1.5 to 2.75 inches) long (Kruckeberg and Etienne 1977). The zig-zag inflorescence pattern (Kruckeberg and Etienne 1977) and the lack of hairs (Greene 1886b) distinguish *Streptanthus niger* from its near relative *Streptanthus glandulosus* (bristly jewelflower). (USFWS, 1998)

Taxonomy

Streptanthus niger was described by Edward L. Greene, from a type specimen he collected at St. Hilary's Church in the town of Tiburon in Marin County (Greene 1886). Greene later changed the genus to *Euclisia* (Greene 1904), but Jepson (1925) returned the genus to *Streptanthus*, and others followed. In 1959, Munz and Keck referred to the plant as a subspecies of *Streptanthus glandulosus*, but in 1968, Munz returned it to *S. niger*, following Kruckeberg (1958). Molecular genetic research in the 1990s concluded that *S. niger*, while genetically distinct, did not form a reciprocally monophyletic unit and was nested within the larger and more widespread *S. glandulosus* clade (Mayer and Soltis 1999). Based on these results, Al-Shehbaz and Mayer (2008) proposed a reclassification of *S. niger* to *Streptanthus glandulosus niger*. We originally listed the species as endangered under the name *S. niger* (U.S. Fish and Wildlife Service 1995). However, to remain up-to-date with current nomenclature, we will recommend that an amendment be submitted to change the listing to *Streptanthus glandulosus niger*. (USFWS, 2010)

Historical Range

Marin County, California. (USFWS, 2010)

Current Range

In California, on southwest facing slopes on the Tiburon Peninsula of Marin County. (USFWS, 2010)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Self-pollinated (USFWS, 1998)

Breeding Season

Adult: Seedlings of *Streptanthus niger* appear in March and April (Hunter 1 989b), and the plants flower from May to June (Kruckeberg and Etienne 1977) (USFWS, 1998).

Reproduction Narrative

Adult: Seedlings of *Streptanthus niger* appear in March and April (Hunter 1 989b), and the plants flower from May to June (Kruckeberg and Etienne 1977). The species is self-pollinated (Kruckeberg 1957). The seed capsules open in late June (Hunter 1989b). Populations have fluctuated from 50 to 2,000 plants (Hunter 1989b, A. Allen, in litt., 1991). A 1990 survey found a total of approximately 800 plants in the two occurrences together (E. Buxton, pers. comm. as cited in Morey and Hunter 1990). The known occurrences combined comprise approximately 5 hectares (12 acres) of habitat (Morey and Hunter 1990). No detailed data are available on the reproductive biology or demography of the species (USFWS, 1998).

Habitat Type

Adult: Grasslands (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Serpentine slopes (NatureServe, 2015)

Habitat Narrative

Adult: *Streptanthus niger* occurs at elevations of approximately 100 meters (350 feet) on the slopes of the southern Tiburon Peninsula on shallow rocky serpentine soils, which are formed from weathered volcanic (ultramafic) rocks such as serpentinite, dunite, and peridotite (Service 1998). These soils provide a harsh environment for plant growth, however, this species has adapted to this harsh environment and requires it for survival. Associated federally listed species are *Hesperolinon congestum* (Marin dwarf-flax) and *Castilleja affinis* ssp. *neglecta* (Tiburon paintbrush). Other associated plants include *Nassella lepida* (foothill needlegrass), *Eriophyllum confertiflorum* (golden yarrow), *Hemizonia congesta* ssp. *congesta* (hayfield tarweed), *Nassella pulchra* (purple needlegrass), *Calamagrostis ophitidis* (serpentine reedgrass), *Calycadenia multiglandulosa* (sticky calycadenia), and *Eriogonum luteolum* var. *caninum* (Tiburon buckwheat) (Service 1998). (USFWS, 2010)

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Decreasing (NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

250 - 2500 individuals (NatureServe, 2015)

Population Narrative:

Two populations are known from the southern end of the peninsula where they occur within 3 kilometers (2 miles) of one another (CNDDB, 2009). One is at the tip of the peninsula at Old St.

Hilary's Church Preserve (Preserve), and the other is along the Middle Ridge of the peninsula. No historical occurrences are known outside of the Tiburon Peninsula, and it is likely *S. niger* never occurred elsewhere (Morey and Hunter 1989). Both of the reported localities were known at the time of listing, and both populations are currently extant. However, population numbers fluctuate yearly and have been reported to include lows of 50 individuals and highs of 2,000 plants per population (Hunter 1989, Service 1998). During favorable growing conditions in 2009 the Middle Ridge site had a population of approximately 2,000 individuals (R. Brittman, California Department of Fish and Game, in litt. 2010). Current abundance information is not available for the Preserve site (E. Buxton, California Native Plant Society, in litt. 2010). (USFWS, 2010)

Threats and Stressors

Stressor: Residential development (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Of the two *Streptanthus niger* records present in the CNDDDB (2009), one is protected by Town of Tiburon Open Space (Middle Ridge) and the other is partially protected by Marin County Open Space (Old St. Hilary's Church Preserve) but a portion at the top of the hill is proposed for development (E. Buxton, California Native Plant Society, in litt. 2010) (Table 1). LSA Associates, Inc. (LSA) is currently writing a vegetation and fire management plan for the Town of Tiburon which includes conservation measures for this species in the area (USFWS, 2010).

Stressor: Foot traffic (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: The threat of trampling has intensified since the time of listing. Currently, *Streptanthus niger* is threatened by trampling from hikers, joggers, dog walkers, and off-trail bicyclists. The Middle Ridge and Preserve occurrences are adjacent to the Ring Mountain open space managed by the Marin Open Space District. Ring Mountain is a very popular site and heavily visited by the public whose activities extend into *S. niger* habitat. Dog walkers and off-leash dogs currently create the greatest impact, followed by hikers, joggers, and mountain bicyclists (G. Ngarangad, Marin County Open Space District, pers. comm. 2010). The Middle Ridge site is used extensively by professional dog walkers and dogs are frequently off-leash resulting in additional trampling of *S. niger* habitat (R. Brittman, California Department of Fish and Game, in litt. 2010; E. Buxton, California Native Plant Society, in litt. 2010). Trampling has also increased due to off trail hikers and illegal bicycle trails. Rangers from the Marin County Open Space District and a contracted Sheriff's deputy patrol the area and both educate individuals about the environment and issue citations (G. Ngarangad, Marin County Open Space District, pers. comm. 2010) (USFWS, 2010).

Stressor: Road construction (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Road construction is listed as a threat to this species (USFWS, 2010)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: At the time of listing, regulatory mechanisms thought to have some potential to protect *Streptanthus niger* included: (1) listing under the California Endangered Species Act (CESA); (2) the California Environmental Quality Act (CEQA) and the National Environmental Protection Act (NEPA); and (3) the Federal Endangered Species Act in those cases where *S. niger* occurs and is incidentally protected in habitat occupied by a listed wildlife species. The listing rule (60 FR 6671) provides an analysis of the level of protection that was anticipated from those regulatory mechanisms. This analysis appears to remain currently valid.(USFWS, 2010)

Stressor: Non-native plant species (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Competition with introduced species continues to be a serious threat to serpentine native plants (Service 1995, Service 1998). Competition and displacement from invasive plant species poses a potential threat to *Streptanthus niger*. Exotic and/or invasive, weedy plant species reduce native plant diversity and diminish the habitat suitability for native species; this is particularly the case in sensitive habitats (G. Cooley, California Department of Fish and Game, pers. comm. 2008). The consistent pattern of heavy growth of nonnative grasses when not controlled by grazing or other management can ‘smother’ native plants, resulting in the subsequent crowding out, outcompeting, or overshadowing of native annuals. A common consequence of such heavy annual grass growth is development of thatch, which adds to the strong smothering effect by inhibiting annuals’ germination and growth (Weiss et al. 2007). *S. niger* is particularly threatened by nonnative invasive species such as *Genista monspessulana* (French broom), *Cytisus scoparius* (Scotch broom), *Avena fatua* (wild oats), and *Cortaderia selloana* (pampas grass) (USFWS, 2010).

Stressor: Restricted range (USFWS, 2010)

Exposure:

Response:

Consequence: Extinction/lack of genetic variability

Narrative: *Streptanthus niger* is extremely restricted in its range, and known from only two occurrences on the Tiburon Peninsula in Northern California, each of which fluctuates between 50 and 2,000 individuals between years. The small population sizes and the restricted range of the species places *S. niger* at risk from catastrophic or stochastic events and loss of genetic variability. Potential future development of the areas surrounding the Preserve, and on the top of the hill at Old St. Hilary’s Church would have direct negative effects on this species and exacerbate the threat from low numbers of individuals. Since the total number of individuals per year fluctuates drastically (from 50 to 2000 individuals per locality), these populations are at risk of extirpation by a random event such as a disease outbreak, drought, fire, or other natural or human-caused factors. Additionally, few populations, low population numbers and, large population fluctuations among years increase the likelihood of loss of genetic variability which may lead to a decrease in average fitness and reduced resilience to environmental stressors such as disease and alterations in habitat (USFWS, 2010).

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat/extinction

Narrative: A modeling study completed by Loarie et al. (2008) provides an evaluation of potential trends to California's floristic communities under climate change scenarios. In general, plant diversity will shift in two divergent directions: along the coast and northwards at higher elevations; and southwards at higher elevations of the Sierra Nevada. The models suggest that climate change has the potential to break up local floras, resulting in new species combinations, with new patterns of competition and biotic interactions (Loarie et al. 2008). Based on these modeling results, *Streptanthus niger* may be unable to shift its range because of isolated, small populations, whose growth depend upon particular hydrological regimes and soil characteristics, and the limited available, suitable habitat surrounding extant occurrences (USFWS, 2010).

Recovery

Reclassification Criteria:

A/1: Occupied habitat at the Old St. Hilary's Preserve and Middle Ridge site is fully protected and managed with the primary intention of preserving the populations in perpetuity. In addition, secure and protect adjacent unoccupied habitat and a 150-meter (500- foot) buffer around protected occupied habitat, where possible. If additional individuals or populations are discovered on private lands that are not part of the Old St. Hilary's Preserve or protected land at Middle Ridge, they are secured through voluntary land acquisitions, conservation easements, or other means. (USFWS, 2019)

A/2: Management plan(s), approved by the Service, are developed and implemented for populations at Old St. Hilary's Preserve and Middle Ridge, and any other location(s) where the species may be discovered (see A/1). Management plans will include survival of the species as an objective and will include any adjacent occupied or unoccupied habitat identified as essential to survival. The plans include provisions for annual standardized monitoring of each population to determine demographic trends and actions to control invasive plant species. Adequate funding must be dedicated in order to implement the management plan in perpetuity. (USFWS, 2019)

E/1: As described in A/2, standardized population monitoring at Old St. Hilary's Preserve, Middle Ridge and any other location(s) where the species may be discovered (see A/1) shows stable or increasing populations over a period of 20 years that include two normal precipitation cycles (or longer if suggested by the results of demographic monitoring). If monitoring shows any population is declining, determine the cause of decline and reverse the trend. (USFWS, 2019)

E/2: Unless research shows otherwise, the St. Hilary's Preserve and any other population that may be discovered (see A/1) contain an average of at least 3,000 flowering individuals, and the Middle Ridge population contain an average of at least 2,000 flowering individuals. This will allow each population to maintain its breadth of genetic diversity and adaptive potential over the long-term, attract sufficient pollinators, and maintain a stable or increasing population. (USFWS, 2019)

E/3: Seeds stored in at least two Center for Plant Conservation certified facilities⁴⁸ and reliable seed germination and propagation techniques are understood. (USFWS, 2019)

Delisting Criteria:

A/1: A minimum of one new population is established in an area on the Tiburon peninsula that contains suitable protected habitat and appropriate plant associates. Each introduced population is maintained over a 20-year period that includes two normal precipitation cycles (or longer if suggested by the results of demographic monitoring). (USFWS, 2019)

A/2: Service-approved management plan(s) are developed and implemented for the introduced population(s) from A/1. Management plan(s) include survival of the species as an objective and include any adjacent occupied or unoccupied habitat identified as essential to survival. The plans include provisions for annual standardized monitoring to determine demographic trends and control invasive species. Adequate funding is dedicated to implement the management plan in perpetuity. (USFWS, 2019)

A/3: The population(s) described in A/1 is secured and protected, along with adjacent unoccupied habitat and a 150-meter (500- foot) buffer, where possible. The introduced population(s) is secured through voluntary land acquisitions, conservation easements, or other means. (USFWS, 2019)

E/1: Unless research shows otherwise, the introduced population described in A/1 contains an average of at least 3,000 plants. This will allow the introduced population to maintain its breadth of genetic diversity and adaptive potential over the long-term, attract sufficient pollinators, and to maintain a stable or increasing population. (USFWS, 2019)

E/2: Population monitoring of introduced populations under A/1 shows evidence of natural recruitment and contain a stable or increasing population over a 20-year monitoring period that include two normal precipitation cycles (or longer if suggested by the results of demographic monitoring). The other populations are stable or increasing after downlisting. (USFWS, 2019)

Recovery Actions:

- 1. Introduce and maintain one new Tiburon jewelflower population in an area on the Tiburon peninsula that contains suitable protected habitat and the appropriate plant associates. (Priority 1) (USFWS, 2019)
- 2. Work with Marin County Parks and Open Space to update their current management plan to include the Tiburon jewelflower. Institute a species-specific management plan to ensure a self-sustaining population over the long-term. (Priority 1) (USFWS, 2019)
- 3. Conduct research to better understand the relationship between genetic diversity and the species capacity for adaptive evolution (Priority 1). (USFWS, 2019)
- 4. Store seeds in at least two Center for Plant Conservation certified facilities. Unless storage techniques and/or research show otherwise, replenish seed stock every 10 years to ensure seed viability. (Priority 2) (USFWS, 2019)
- 5. Establish a Service-approved monitoring plan to cover a minimum of 5 years post-delisting of Tiburon jewelflower. The plan will be ready for implementation at the time of delisting to ensure the ongoing conservation of the species and the continued effectiveness of management actions. Adequate funding must be dedicated in order to implement the delisting management plan. (Priority 3) (USFWS, 2019)

References

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SPECIES ACCOUNT: *Styrax portoricensis* (Palo de jazmin)

Species Taxonomic and Listing Information

Listing Status: Endangered; 04/22/1992; Southeast Region (R4) (USFWS, 2016)

Physical Description

Styrax portoricensis is an evergreen tree of 10-12 m in height. The leaves are simple, alternate, exstipulate, and glabrous, measuring 6-12 cm long, and 3-5 cm wide. The leaf blades are elliptic, with a cuneate base, and an acute or acuminate apex; the petiole is 6- 12 long and lepidote. Both surfaces are finely reticulate-veined; the upper side is shiny dark green, the lower surface is pale green with scattered stellate scales. The axillary or terminal flower racemes are 2-5 cm long, bearing three to six perfect flowers with ferrugineolepidote, curved pedicles of 10-15 mm long. The calyx is cup-shaped, ferrugineo-lepidote, with five 4-5 mm long sepals. The white corolla is valvate, with five 12-25 mm long petals which are silvery lepidote inside. The 10 stamens present are free, with filaments as long as anthers, and with long stellate hairs at the base. The superior ovary contains numerous ovules. The pistil is as long as the corolla lobes, with a three-lobed stigma. The fruit is one-seeded, oblong-elliptic, lepidote, drupe of 2.5-3.5 cm long and 1.3-1.5 cm in diameter. The fruit apex is acuminate, and the fruit base maintains the calyx (persistent). The fruit bear only one seed, 19 mm long and 8-10 mm wide, which is pale reddish brown (USFWS, 1993).

Taxonomy

Styrax portoricensis (palo de jazmin) was described in 1892 by Krug and Urban from specimens collected by Sintenis in 1885 in the Sierra de Naguabo and Sierra de Yabucoa of eastern Puerto Rico. In October of 1935, the species was collected somewhere in the Luquillo Mountains by C. Horn and L. Holdridge (Vivaldi et al. 1981c). Fruits of the species were collected in 1954 in the El Verde area of the Luquillo Mountains (Little et al. 1974). Besides the collections mentioned, no record of the species was made until the early 1980's, when it was rediscovered in the Luquillo Mountains, being known at present from a single individual (USFWS, 1993).

Historical Range

See current range/distribution.

Current Range

All the currently known localities of *Callicarpa ampla*, *Ilex sintenisii*, *Styrax portoricensis*, *Ternstroemia luquillensis*, and *Ternstroemia subsessilis* occur within the Caribbean National Forest, which is administered by the USDA Forest Service. The following are known sites for the species: Barrio Guzman Arriba. Rio Grande municipality. Only a single tree is known, growing west of El Cacique (USFWS, 1993). Currently, palo de jazmin is only known to naturally occur within the palo colorado forest type at EYNF where 19 individuals have been documented at five locations (USFWS 2015). Palo de jazmin has been planted on other sites within EYNF, and in a land managed for conservation by Para La Naturaleza in the municipality of Barranquitas (USFWS 2015). (USFWS, 2019).

Critical Habitat Designated

Yes;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Unknown (USFWS, 2015)

Reproduction Narrative

Adult: Little is known about the reproductive biology of this species. Fruits are present in Sintenis herbarium specimen number 1169 of *Styrax portoricensis*, collected on April 26, 1885 (Vivaldi and Woodbury 1981c) (USFWS, 1993).

Habitat Type

Adult: Palo colorado forest (USFWS, 1993)

Habitat Vegetation or Surface Water Classification

Adult: Palo colorado forest (USFWS, 1993)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1993)

Site Fidelity

Adult: High (inferred from USFWS, 1993)

Habitat Narrative

Adult: The Luquillo Mountains region is of volcanic origin and of a rough topography, with cliffs and rock exposures at high elevations. Six major rivers are born in the mountains and waterfalls are numerous. Nineteen soils belonging to four soil associations have been identified within the Caribbean National Forest (Silander et al. 1986), of which the Los Guineos-Guayabota-Rock land association constitutes the most extensive one (USDA 1977). This association contains acidic, shallow to deep, well drained to poorly drained steep soils. The Caribbean National Forest holds four vegetation types: tabonuco forest, palo colorado forest, palma de sierra forest, and dwarf or elfin forest. All the known localities of *Callicarpa ampla* and *Styrax portoricensis*, and some localities of *Ternstroemia luquillensis* and *Ternstroemia subsessilis* occur within the palo colorado vegetation type. Some localities of *Ternstroemia luquillensis* and *Ternstroemia subsessilis*, and all the localities of *Ilex sintenisii* occur in the dwarf forest vegetation type (USFWS, 1993). High ecological integrity and site fidelity as well as low tolerance ranges are inferred based on species specific habitat needs and low number of populations.

Dispersal/Migration**Motility/Mobility**

Adult: Low (Inferred from USFWS, 1993)

Dispersal

Adult: Low (Inferred from USFWS, 1993)

Dependency on Other Individuals or Species for Dispersal

Adult: Low/Slow (inferred from USFWS, 1993)

Population Information and Trends

Population Trends:

Unknown (USFWS, 2015)

Species Trends:

Unknown (USFWS, 2015)

Resiliency:

Low (inferred from USFWS, 2015)

Representation:

Low (inferred from USFWS, 2015)

Redundancy:

Low (inferred from USFWS, 2015)

Number of Populations:

One (USFWS, 2015)

Population Size:

~19 individuals (USFWS, 2015)

Population Narrative:

Styrax portoricensis: Palo de jazmín is a tree only known from the Luquillo Mountains in eastern Puerto Rico (Liogier and Martorell 2000). At the time of listing (1992) palo de jazmín was known from a single individual growing in the Palo Colorado forest west of El Cacique in the Luquillo Mountains. The current number of individuals in the wild (natural populations) is estimated at about 19 trees (Table 2) within the following areas of El Yunque National Forest: Monte Cacique area (1-3 ind.), Río Espiritu Santo (2 ind.), Palo Hueco (8 ind.), Arboretum (2 ind.), and Cristal Trail (4 ind.) (Luis Rivera, USFS, 2011, pers. comm.). The USFS also reported a single planted individual in the Catalina area (USFS office at El Yunque National Forest). There are also unconfirmed records of the species in the area surrounding the Puerto Rican Parrot Aviary (Anastacio Gómez, USFS, 2012, pers. comm.). In addition, the PRCT planted about 5 individuals of this species within a property they manage in the municipality of Barranquitas. These trees have developed as reproductive individuals and are managed for conservation purposes. Despite the historical information, during the 2011 surveys no individuals of natural populations mentioned above were located at El Yunque National Forest. Since there is no long term monitoring of the natural populations and some of the historical populations seem to be lost or probably extinct, it is not possible to establish any trend about the population's status or demography (USFWS, 2015). In addition, Low resiliency, representation and redundancy are inferred based on low number of populations and individuals.

Threats and Stressors

Stressor: Forest management (USFWS, 2015)

Exposure:**Response:****Consequence:** Loss of habitat/Loss of individuals

Narrative: At the time of listing, forest management practices such as the establishment and maintenance of plantations, selective cutting, trails and roads construction and maintenance, and shelter construction may have affected these trees. Furthermore, the proposed reconstruction and reopening of Road PR 191 was considered as a direct threat to some populations of these species. The destruction of the dwarf or elfin forests for the construction and/or expansion of communication facilities by the U.S. Navy and private entities were also considered a threat. Based on the available information, the core of the known populations of *I. sintenisii*, *S. portoricensis*, *C. ampla*, *T. subsessilis*, and *T. luquillensis* occur within the boundaries of El Yunque National Forest. Since the time of listing the USFWS has not documented any case of an individual of an endangered species being affected by forest management practices (management of plantations, trail maintenance or road construction). Moreover, the plans to reopen Road PR 191 have been abandoned due to the potential for further landslides that may compromise the project. Nonetheless, the USFS consults with the Service under Section 7 of the ESA when proposing actions within the forest to ensure that possible adverse effects to listed species are avoided or minimized before any such project is implemented. In addition, the USFS conduct environmental reviews documents under NEPA for all actions in the forest. These consultation mechanisms are effective tools to minimize possible effects of management activities on species and their habitats. Based on the above, we consider the present or threatened destruction, modification, or curtailment of the species habitat or range as low in magnitude and not imminent threat to these species (USFWS, 2015).

Stressor: Overutilization (USFWS, 2015)**Exposure:****Response:****Consequence:** Loss of individuals

Narrative: Despite the fact that plant collection in El Yunque National Forest is prohibited, when the five species were listed, collection was considered a threat due to the ornamental potential of these species. However, there is no evidence indicating that the species has been affected by these factors. Based on the above, we believe that overutilization for commercial, scientific or educational purposes is no longer a threat to these species (USFWS, 2015).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2015)**Exposure:****Response:****Consequence:** Loss of habitat/Loss of individuals

Narrative: Since the currently known populations of these species are mostly restricted to El Yunque National Forest, and there are appropriate Commonwealth and Federal laws and regulations protecting these five species, we believe that the inadequacy of existing regulatory mechanisms should no longer be considered a threat to them. However, historical collections indicate that suitable habitat may extend to private properties adjacent to El Yunque. In fact, some of the known populations that occur within El Yunque National Forest are located just along the boundaries of the forest. Thus, it is important to note that enforcement on private lands continues to be a challenge as accidental damage or extirpation of individuals has occurred with other federally listed species due to lack of knowledge of the species by private land owners and law enforcement officers (USFWS, 2015).

Stressor: Hurricanes (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat/Loss of individuals

Narrative: Due to the low number of populations and individuals, hurricanes were identified as a threat to *I. sintenisii*, *S. portoricensis*, *C. ampla*, *T. subsessilis* and *T. luquillensis* in the final rule. As endemic to the Caribbean, these tree species should be well adapted to tropical storms disturbance. However, the low number of populations and individuals pose a threat to the species by making them more susceptible to stochastic events such as hurricanes. In fact, it is not clear to what extent populations of these species may have been affected by Hurricane Hugo (which devastated El Yunque National Forest in 1989) or Hurricane Georges (in 1998). The heavy rains associated with tropical storms and hurricanes in the mountains of Puerto Rico often lead to landslides. Despite the low number of populations and individuals, the USFWS considers hurricanes, landslides and climate change as a moderate and non-imminent threat to these species (USFWS, 2015).

Stressor: Landslides (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat/Loss of individuals

Narrative: Natural landslides are common as part of the forest dynamics of El Yunque and it is expected that the frequency of this disturbance increases as a result of severe extreme rain events or droughts. Given the steep slopes on which most of these species grow, massive landslides may extirpate entire populations. The USFWS is aware that an area of road PR 191 that formerly connected the municipalities of Río Grande and Naguabo, and that run across the forest has historically been affected by landslides. This area was the site of some populations that were not located by the interagency group in 2011. Due to the severity of landslides, it was determined that it was not logistically and economically feasible to repair this road. Based on the 2011 surveys, *I. sintenisii* seems to be the only species that is not imminently threatened by hurricanes and landslides. The prime habitat for *I. sintenisii* is associated with dwarf forest vegetation. Due to the low agricultural value and inaccessibility of this habitat, this vegetation was not cleared during the peak of the deforestation of the island, and thus some of the highest parts of El Yunque remain as pristine forest. This explains the relative abundance of the species along the summits of Pico El Yunque and Pico del Este. Despite the low number of populations and individuals, the USFWS considers hurricanes, landslides and climate change as a moderate and non-imminent threat to these species (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat/Loss of individuals

Narrative: This species may be further threatened by climate change, which is predicted to increase the frequency and strength of tropical storms and can cause severe droughts (Hopkinson et al. 2008). Vulnerability to climate change impacts is a function of sensitivity to those changes (e.g., changes rain regime and moisture availability), exposure to those changes, and adaptive capacity (Glick et al. 2011). Despite the relative abundance and apparently stability of the populations of *I. sintenisii*, its habitat is considered rare in Puerto Rico. These areas (dwarf

forest vegetation) are ecological islands that harbor unique vegetation and environmental conditions. Shifts of vegetation communities are expected as temperatures and moisture regimes are altered by climate change. Under this scenario populations of *I. sintenisii* as well as *S. portoricensis*, *C. ampla*, *T. subsessilis*, and *T. luquillensis* may be displaced or outcompeted by native or exotic species with wider environmental plasticity. Despite the low number of populations and individuals, the USFWS considers hurricanes, landslides and climate change as a moderate and non-imminent threat to these species (USFWS, 2015).

Stressor: Genetic variation (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of viability

Narrative: Along with a decreasing population size, negative impacts of habitat fragmentation may result in erosion of genetic variation through the loss of alleles by random genetic drift (Honnay and Jacquemyn 2007) and may also limit the ability of a species to respond to a changing environment (Booy et al. 2000). Given the extremely small population size and lack of connectivity between populations of *S. portoricensis*, *C. ampla*, *T. subsessilis* and *T. luquillensis* in Puerto Rico, it is highly likely that their genetic variability is extremely low. Based on the above, we consider the lack of genetic variation a high and imminent threat to *S. portoricensis*, *C. ampla*, *T. subsessilis* and *T. luquillensis*. Overall, we consider hurricanes, landslides, climate change and genetic variation as threats to *S. portoricensis*, *C. ampla*, *T. subsessilis* and *T. luquillensis*. Due to the small number of populations, the USFWS considers the above mentioned threats as high in magnitude and imminent for those species. In the case of *I. sintenisii*, the species is at least stable and probably improving, thus we consider the above mentioned threats as low and non-imminent (USFWS, 2015).

Recovery

Reclassification Criteria:

An agreement between the Fish and Wildlife Service and the USDA Forest Service concerning the protection of *Callicarpa ampla*, *Ilex sintenisii*, *Styrax portoricensis*, *Ternstroemia luquillensis*, and *Ternstroemia subsessilis* within the Caribbean. National Forest property has been prepared and implemented (USFWS, 1993).

An agreement between the Fish and Wildlife Service and the Department of Natural and Environmental Resources (DNER) concerning the protection of the three species in Commonwealth forests has been prepared and implemented, if the species is found within DNER properties (USFWS, 1993).

New populations (the number of which should be determined following the appropriate studies) capable of self perpetuation have been established within protected areas (USFWS, 1993).

Delisting Criteria:

1. Existing natural populations exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (addresses Factors E). (USFWS, 2019).

2. Establish or discover four (4) additional populations within the current range at EYNF that exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (addresses Factors A and E). (USFWS, 2019).
3. Establish or discover two (2) new populations outside the current range but within the historical range (e.g., Carite, Guilarte or Toro Negro Commonwealth Forests) that exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (addresses Factors A and E). (USFWS, 2019).
4. Threats have been addressed and/or managed to the extent that the species will remain viable into the foreseeable future (addresses Factor A and E). (USFWS, 2019).

Recovery Actions:

- Criterion 1 has been partially met. There is no formal agreement between the USFS and the USFWS for the implementation of a management plan to protect these five species. However, the El Yunque National Forest is managed by the USFS for conservation, and has an approved “Revised Land and Resource Management Plan” (1997), which is currently under revision. Moreover, Federal agencies are mandated to carry out programs for the conservation of endangered species under Section 7 of the Endangered Species Act (ESA) to ensure that any action authorized, funded or carried out by a Federal agency is not likely to jeopardize the continued existence of a federally listed species. Thus, the USFS continually consults with the USFWS to avoid and minimize impacts to listed species and their habitat at El Yunque National Forest. In addition, on July 26, 2005, the U.S. Congress enacted the Caribbean National Forest Act to designate approximately 10,000 acres of land in the El Yunque National Forest as wilderness and as a component of the National Wilderness Preservation System in accordance with the Wilderness Act (16 U.S.C. 1131 et seq.). This Act prohibits certain activities (e.g., timber harvest) within wilderness designated areas, although it does not preclude the installation and maintenance of facilities (e.g., data collection and remote transmission facilities) essential to the scientific and conservation purposes of the Forest Service. Therefore, the majority of the habitat upon which these species depend upon is essentially protected (USFWS, 2015).
- Criterion 2 has been partially met. Although there is no specific agreement between USFWS and the PRDNER concerning the protection of these three species in Commonwealth forests, there is an agreement between the two agencies under Section 6 of the Endangered Species Act, in which the PRDNER carries out conservation activities for the benefit of threatened and endangered species. Furthermore, these five species are listed by the PRDNER as endangered, and thus are protected by regulations of the Commonwealth of Puerto Rico (See factor D.). Therefore, special consideration is taken when considering actions within areas that harbor suitable habitat for these species (USFWS, 2015).
- Criterion 3 has been initiated. The Puerto Rico Conservation Trust (PRCT) is successfully propagating *Styrax portoricensis*. The USFWS has utilized some of this material and begun planting this species (approximately 50 individuals) at El Yunque National Forest. In addition, the PRDNER began planting *Styrax portoricensis* (approximately 5 individuals) in the Carite Commonwealth Forest. Furthermore, the USFS has propagated *Callicarpa ampla* by air layering (cloning by promoting rooting of branches using hormones), and has planted about three individuals at El Portal in El Yunque National Forest. However, little information is available about the reproductive biology and the ecology of these species. Further research and monitoring of reintroduced individuals is required to determine the success of these

actions. There is no information about the propagation of any of the remaining three species (*Ilex sintenisii*, *Ternstroemia luquillensis* and *Ternstroemia subsessilis*) (USFWS, 2015).

- New in 2019: 1. Establish long-term conservation mechanisms (e.g., land conservation easements and conservation agreements) for private lands outside/bordering EYNF since these lands share similar vegetation and habitat characteristics. This new action should be included within Recovery Task 11. (USFWS, 2019).
- 2019 - 2. A protocol for the propagation and reintroduction of all five species should be developed in collaboration with partners (e.g., University of Puerto Rico, KEW, Fairchild Tropical Botanic Garden, PRDNER, Para La Naturaleza and Natural Resources Conservation Service). The protocol should address the feasibility of seed banking these species, and if deemed necessary, seed material should be stored at the Millennium Seed Bank (KEW) and USDA National Laboratory for Genetic Resources Preservation in Ft. Collins. This new action should be included within Recovery Task 33. (USFWS, 2019).
- 2019 - 3. Studies in the species' population genetics should be conducted to determined patterns of genetic diversity across the species natural distribution, and to provide baseline information for sound management of these species. This new action should be included within Recovery Task 3. (USFWS, 2019).

Conservation Measures and Best Management Practices:

- 1. The USFS should establish a long term monitoring program for the populations of listed plants at El Yunque National Forest to determine population trends for these species. The guidelines for these monitoring should be included as part of the El Yunque National Forest Management Plan (USFWS, 2015).
- 2. Develop a comprehensive survey and assessment of the population of *I. sintenisii*. This survey must be standardized to ensure that the habitat (dwarf forest) is efficiently surveyed (USFWS, 2015).
- 3. Molecular studies should be conducted to determine the relationships within the genus *Ilex* in Puerto Rico (USFWS, 2015).
- 4. The USFS, PRDNER and the USFWS should develop an intensive survey program to inventory areas within and outside El Yunque National Forest with potential habitat for these species. This program should include training to field biologists to allow personnel to recognize listed species in the field (USFWS, 2015).
- 5. The populations that are actively producing seeds need to be identified and monitored to collect seed material for recovery purposes. A protocol to collect seed should be developed and implemented to avoid altering the natural recruitment of the species (USFWS, 2015).
- 6. Enhancement of natural populations should be considered a priority, particularly for *S. portoricensis*, *C. ampla*, *T. subsessilis* and *T. luquillensis*. The development of adequate propagation techniques is essential for the recovery of these species (USFWS, 2015).
- 7. Studies should be conducted to determine the patterns of genetic variation within and among populations, in order to develop a plan to preserve the species genetic variability (USFWS, 2015).
- 8. The recovery plan should be revised to establish measurable delisting criteria, including how many individuals constitute a self-sustainable population and how many populations would be needed to delist the species (USFWS, 2015).

References

U.S. Fish and Wildlife Service. 1993. *Callicarpa ampla*, *Ilex sintenisii*, *Styrax portoricensis*, *Ternstroemia luquillensis*, and *Temstroemia subsessilis* Recovery Plan. Prepared by Eugenio Santiago-Valentin and Marelisa Rivera for the U.S. Fish and Wildlife Service, Atlanta, Georgia. 26 pp

U.S. Fish and Wildlife Service. 2015. *Callicarpa ampla* / (Capá rosa) *Ilex sintenisii* / (no common name) *Styrax portoricensis* / Palo de jazmín *Ternstroemia luquillensis* / Palo colorado *Ternstroemia subsessilis* / (no common name) 5-Year Review: Summary and Evaluation U.S. Fish and Wildlife Service Southeast Region Caribbean Ecological Services Field Office Boquerón, Puerto Rico

USFWS. 2019. *Callicarpa ampla*, *Ilex sintenisii*, *Szyrax portoricensis*. *Ternstroemia luguillensis* and *Ternstroemia subsessilis* Recovery Plan. Prepared by Eugenio Santiago-Valentin and Marelisa Rivera for U.S Fish and Wildlife Service, Atlanta. Georgia. 25pp.

U.S. Fish and Wildlife Service. 2015. *Callicarpa ampla* / (Capá rosa) *Ilex sintenisii* / (no common name) *Styrax portoricensis* / Palo de jazmín *Ternstroemia luquillensis* / Palo colorado *Ternstroemia subsessilis* / (no common name) 5-Year Review: Summary and Evaluation U.S. Fish and Wildlife Service Southeast Region Caribbean Ecological Services Field Office Boquerón, Puerto Rico.

USFWS. 2019. *Callicarpa ampla*, *Ilex sintenisii*, *Szyrax portoricensis*. *Ternstroemia luguillensis* and *Ternstroemia subsessilis* Recovery Plan. Prepared by Eugenio Santiago-Valentin and Marelisa Rivera for U.S Fish and Wildlife Service, Atlanta. Georgia. 25pp.

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5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Southeast Region, Caribbean Ecological Services Field Office, Boquerón, Puerto Rico.

SPECIES ACCOUNT: *Styrax texanus* (Texas snowbells)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/12/1984; Southwest Region (Region 2) (USFWS, 2016)

Physical Description

A shrub, usually with several stems from the base, up to 4 m tall. The leaves are alternative, suborbicular, 4-8 cm long, and about as broad. The leaf margins are entire and the leaf bases are cuneate to truncate or rounded. The upper leaf surface is glabrous, bright green and smooth and the lower leaf surface is conspicuously white with a very fine and dense silky tomentum. Flowers are axillary, solitary or in 2-5 flowered racemes with puberulent pedicles 10-12 mm long. The calyx is 4-6 mm long, pale, densely puberulent, apex grandular, and 5-7 toothed. There are 10 stamens with bright orange-yellow anthers. Fruits are dry, globose to subglobose, 7-8 mm in diameter (Gonsoulin, 1974). Produces showy white flowers borne in clusters among the rounded, bright green leaves with white undersurfaces. Blooms primarily in April. (USFWS, 1987; NatureServe, 2015)

Taxonomy

Fritsch (1996, 1997) completed isozyme analysis and DNA sequencing on Texas snowbells. These two studies in addition to others completed on *Styrax* morphology by Fritsch led to the designation of *S. texana* as a subspecies of *S. platanifolius*, along with four other subspecies: *platanifolius*, *stellatus*, *youngiae*, and *mollis* (Fritsch 1997). Fritsch (1997) considered the morphological variation recognized by Cory (1943) and Gonsoulin (1974) to be taxonomically unreliable or inconsequential. Fritsch (1997) confirmed the ranges of three of the subspecies (*platanifolia*, *stellata*, and *texana*) did overlap, but genetically they are different enough to be subspecies. USFWS currently recognizes this plant as *S. platanifolius* ssp. *texanus* (USFWS, 2008; 2018).

Historical Range

At the time of listing, 25 Texas snowbell plants were known from Edwards, Real, and Kimble Counties, Texas however, a report of four individuals from Kimble County was later determined to be incorrect. Other plants thought to be Texas snowbells were reported in 1942 from Val Verde County, Texas, but have not been reconfirmed (49 FR 40036-40037, TPWD circa 1995). (USFWS, 2008)

Current Range

Endemic shrub of the Edwards Plateau of Texas. Since 1986, field surveyors have documented 400 mature and 452 immature Texas snowbells plants in 22 naturally occurring sites in Real, Edwards, and Val Verde counties (USFWS, 2018)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Obligate out-crosser; fertilization requires transfer of pollen between individuals that are not too closely related (USFWS, 2018).

Dependency on Other Individuals or Species

Adult: The known pollinators include native species of bumblebee and carpenter bee and the introduced honey bee (USFWS, 2018).

Breeding Season

Adult: Texas snowbells usually flowers in April, and if fertilized, flowers produce a typically single-seeded dry fruit that matures in August (USFWS, 2018).

Other Reproductive Information

Adult: Fruits usually have one seed, but may have up to four under the most favorable conditions (Poole et al. 2007, p. 476 in USFWS, 2017).

Reproduction Narrative

Adult: Texas snowbells usually flowers in April, and if fertilized, flowers produce a typically single-seeded dry fruit that matures in August. However, investigations of the breeding system of Texas snowbells and another closely related species of *Styrax* indicate that it is an obligate out-crosser; fertilization requires transfer of pollen between individuals that are not too closely related. The known pollinators include native species of bumblebee and carpenter bee and the introduced honey bee. High rates of fertilization probably require that Texas snowbells plants are separated by no more than 0.5 to 1.0 km (0.3 to 0.6 mi). Almost all documented reproduction of Texas snowbells in the wild, as indicated by the presence of immature plants, occurs among populations that have at least 56 mature individuals dispersed over a distance of 1.6 km (1.0 mi) or less. Little or no reproduction occurs among isolated individuals and small populations. Reproductive success depends on the size and distribution of populations for two reasons: , Texas snowbells is very likely to be obligately xenogamous and pollen must be transferred between genetically compatible individuals that are within the foraging range of suitable bee or butterfly pollinators (USFWS, 2017; 2018a).

Habitat Type

Adult: Populations occur in limestone bluffs, boulder slopes, cliff faces, and gravelly stream-beds, usually along perennial streams or intermittent drainages in canyon bottoms, in full sun or in partial shade of cliffs and/or sycamore-little walnut woodlands, oak-juniper woodlands, or mixed oak-shrublands (Poole et al., 2007 in USFWS, 2017).

Habitat Vegetation or Surface Water Classification

Adult: Sycamore-little walnut, oak, oak-juniper woodland; near river drainages, canyons, and draws (USFWS, 2008; NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Annual precipitation ranges from 51.3 centimeters (cm) (20.2 inches [in]) to 69.5 cm (27.4 in); average temperatures range from a minimum of 0.9° Celsius (C) (33.6° Fahrenheit [F]) in January to a maximum of 36.3° C (97.3° F) in July (USFWS, 2018b).

Geographic or Habitat Restraints or Barriers

Adult: Elevations range from 372 to 579 m (1,220 to 1,900 ft) (USFWS, 2018b).

Environmental Specificity

Adult: Narrow (USFWS, 2018b)

Habitat Narrative

Adult: Pockets of rocky clay soils or crevices in limestone cliffs, bluffs, and ledges above permanent streams or rivers or above rocky stream beds with high water tables. (The steep areas are probably not the plant's primary habitat, but are refuges from extreme livestock grazing pressure.) Texas snowbells occur in moist habitats such as river drainages, canyons, and draws, which are abundant in the Edwards Plateau (Correll and Johnston 1970, Vines 1984, Poole and Birnbaum 2005, Riskind and Diamond 1988). Most plants occur in areas where they receive at least partial shade from surrounding vegetation during the day (Poole and Cook 1996). This species is found at elevation ranges from 372 to 579 m (1,220 to 1,900 ft). The surrounding vegetation is sycamore-little walnut (*Platanus occidentalis*-*Juglans microcarpa*), oak, or oak-juniper woodland. Average precipitation ranges from 51.3 centimeters (cm) (20.2 inches [in]) to 69.5 cm (27.4 in); average temperatures range from a minimum of 0.9° Celsius (C) (33.6° Fahrenheit [F]) in January to a maximum of 36.3° C (97.3° F) in Jul. (NatureServe, 2015; USFWS, 2018b)

Dispersal/Migration**Dispersal**

Adult: Low (USFWS, 2008)

Dispersal/Migration Narrative

Adult: Most Texas snowbell seeds fall directly beneath the parent plant (Poole 1993). Those seeds may stay where they fall on the ground, be moved by water if growing over a stream or creek, or be carried off by small mammals such as rock squirrels (*Spermophilus variegates*) or wood rats (*Neotoma* sp.) (TPWD 1990, Poole 1993). (USFWS, 2008)

Population Information and Trends**Population Trends:**

Stable to increasing (USFWS, 2017)

Species Trends:

Stable to increasing (USFWS, 2017)

Resiliency:

Low (USFWS, 2018a)

Representation:

Low (USFWS, 2018a)

Redundancy:

Low (USFWS, 2018b)

Number of Populations:

22 (USFWS, 2018a)

Population Size:

<1,000 (USFWS, 2008a)

Minimum Viable Population Size:

900-1,200 individuals (USFWS, 2018a)

Population Narrative:

Since 1986, field surveyors have documented 400 mature and 452 immature Texas snowbells plants in 22 naturally occurring sites in Real, Edwards, and Val Verde counties. Fifteen of the documented sites had fewer than 10 individuals and 2 had at least 100. Fifteen naturally occurring populations are on private land, 5 are on private conservation land (Dolan Falls Preserve and conservation easements managed by The Nature Conservancy), and 2 are on public conservation land (Devil's River State Natural Area). The subspecies has also been reintroduced in 22 sites on private land and 2 sites at Dolan Falls Preserve. By comparing with other plant species that have similar, well-studied life histories, we estimate that the minimum viable size of metapopulations is from 900 to 1,200 individuals. The global population spans a range of 121 km (75 mi) east to west and 35 km (22 mi) north to south. The known populations occur along watercourses, on or near steep slopes, in exposed limestone and gravel of the upper reaches of the Nueces, West Nueces, and Devils River watersheds. We estimate that about 15,043 ha (37,172 ac) of potential habitat exist in these watersheds. An unconfirmed population has also been reported from the lower West Frio River. The number of mature, naturally occurring Texas snowbells plants documented in 2013 was 8 times greater than in 1984 when it was federally listed as an endangered species. However, this increase primarily reflects new discoveries of individuals and populations rather than actual population growth. Texas snowbells has a low level of resilience because all known populations are far below the estimated minimum viable population level. There are few populations, hence redundancy is low. The subspecies is endemic to a small area with little ecological differentiation, and has little genetic diversity and therefore has low representation. In synthesis, the viability of Texas snowbells is low (USFWS, 2017; 2018a; 2018b).

Threats and Stressors

Stressor: Browsing by white-tailed deer, goats, and introduced ungulates (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: White-tailed deer population density is very high in much of the Edwards Plateau. In addition, ranchers introduced large numbers of goats in Real County (and elsewhere) beginning in the early 20th century; by 1930 there were 137,000 goats in the county (Minton 2010, pp. 3-4). More recently, the introduction of exotic ungulates has been promoted as an economic opportunity for Texas landowners (Mungall and Sheffield 1994, pp. 188-194). Some introduced ungulates, including aoudads, blackbuck antelope (*Antelope cervicapra*), axis deer, and fallow deer (*Dama dama*), have escaped and established large breeding populations in the wild. All of these ungulates browse to some degree on woody plants (Huerta-P. et al. 2005, pp. 239-242). In many parts of the Edwards Plateau an abrupt browse line in trees and shrubs provides stark

evidence of the intensity of ungulate browsing. Poole (1993) demonstrated that browsing is a major cause of mortality to Texas snowbells seedlings. Fulton (2010, attachment) provided photographic documentation of feral aoudads eating Texas snowbells plants. Successful recruitment and reintroduction of Texas snowbells occurs where plants are protected from browsers with fencing or other barriers, or where population densities of ungulate browsers are lower. Barriers are useful, short-term solutions to the browsing problem; full recovery of Texas snowbells will require better management of deer and feral ungulate populations (USFWS, 2017).

Stressor: Severe floods (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: The steep, rocky terrain of the Edwards Plateau and frequent occurrence of heavy rainfall contribute to the severity of the region's flash floods (Eckhardt 2015, pp. 1-2). Texas snowbells seeds often fall on dry stream beds and may germinate and establish there, only to be swept away during flash floods. The vulnerability of young Texas snowbells plants was demonstrated when a flood washed away the seedlings that were initially planted at EO2. The incidence of flash flooding is a natural and unavoidable feature of the narrow riparian habitats of Texas snowbells. However, flash flooding could become more frequent or more severe as a result of climate change (USFWS, 2017).

Stressor: Drought (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Tree ring data indicate that severe, extended droughts have occurred repeatedly in the Edwards Plateau since the year 1500 (Cleaveland et al. 2011, all). At EO17, average annual mortality of Texas snowbells was 6%, but increased to about 22% during the exceptional drought of 2011 (Reemts et al. 2016, p. 1). Therefore, the intensity and duration of drought are factors that affect the survival of Texas snowbells. Since it is likely that the intensity and/or duration of droughts will increase on a regional to global scale due to climate changes (IPCC 2013, p. 23), the viability of Texas snowbells may decline as a result (USFWS, 2017).

Stressor: Land ownership (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: A large portion of the known individuals and populations of Texas snowbells occurs on privately owned land. This does not constitute a threat to the subspecies, and in fact many landowners have demonstrated interest and enthusiasm for conservation of Texas snowbells. However, private ownership makes conservation more challenging for several reasons. Access to populations and habitats is subject to the interests of hundreds of individual landowners. Consequently, our knowledge of the subspecies' actual status is far from complete. Establishing and maintaining cooperative relationships with large numbers of private landowners is time-consuming, and these important relationships may lapse when personnel of conservation organizations retire or pursue other career choices. The ownership of private lands changes hands over time, and future owners may choose not to continue conservation efforts that were supported by previous owners. Hence, it is difficult to assure permanent conservation on private

lands. These challenges underscore the importance of effective landowner outreach in the conservation of Texas snowbells (USFWS, 2017).

Stressor: Small population size (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Texas snowbells has been documented in 22 sites; 15 of these sites had less than 10 individuals. The entire global population of about 400 mature, reproductive individuals is less than an estimated MVP of 900 to 1,200 individuals. In addition to the lack of reproduction, small populations are more vulnerable to extirpation from stochastic (random) events. For example, it is more likely that a single landslide or flood could wipe out every individual of a small colony of Texas snowbells than a larger population with colonies spread out over a wider area (USFWS, 2017).

Stressor: Lack of genetic diversity (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Fritsch (1996, p. 350) found low levels of genetic diversity among the Texas subspecies of *Styrax platanifolius*, suggesting that the group had undergone a genetic bottleneck. Adams and Poole (2011, pp. 200-202) also found very little evidence of variation between individuals or among populations of Texas snowbells. This lack of genetic diversity may reduce the potential to adapt to new or existing diseases and parasites, extreme weather, and climate changes. Low genetic diversity may also reduce fertilization and seed production if remaining individuals are too closely related for out-crossing (USFWS, 2017).

Stressor: Population fragmentation and isolation (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Successful fertilization probably requires the transfer of pollen between individuals that are not closely related. In addition to low population size, the fragmentation and isolation of individuals and small colonies decreases the likelihood of successful reproduction. The progeny of small colonies may be too closely related to fertilize each other, so small colonies are more likely to die out than larger ones. An important factor for long-term management of the subspecies is the effective pollination range of its insect pollinators. We estimate that genetically diverse individuals should be not more than about 0.5 to 1.0 km (0.3 to 0.6 mi) apart for high fertilization rates to occur (USFWS, 2017).

Stressor: Pollinator deficiency (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: We currently do not have information on the population statuses of the known pollinators of Texas snowbells. However, many pollinator species, including bumblebees (Williams and Osborne 2009, pp. 368-374), have declined in many parts of the world. Since fertilization of Texas snowbells probably requires outcrossing, and depends on bumblebees and

other insect pollinators, declines in populations of these pollinators within the subspecies' habitats represents a potential threat to its viability (USFWS, 2017).

Stressor: Climate change (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) (IPCC 2013, p. 23) projects the following changes by the end of the 21st century, relative to the 1986 to 2005 averages: It is virtually certain that most land areas will experience warmer and/or fewer cold days and nights; it is virtually certain that most land areas will experience warmer and/or more frequent hot days and nights; it is very likely that the frequency and/or duration of warm spells and heat waves will increase in most land areas; it is very likely that the frequency, intensity, and/or amount of heavy precipitation will increase in mid-latitude land masses; it is likely that the intensity and/or duration of droughts will increase on a regional to global scale. The magnitude of projected changes varies widely, depending on which scenario of future greenhouse gas emissions is used. These scenarios are called Representative Concentration Pathways (RCPs). Under the best-case scenario of RCP2.6, the combined emissions of carbon dioxide, methane, and nitrous oxide, expressed as the carbon dioxide equivalent, will stabilize at 475 parts per million (ppm) by the year 2100. This figure rises to 630, 800, and 1,313 ppm under the RCP4.5, RCP6.0, and RCP8.5 scenarios, respectively (IPCC 2013, p.22). The report also states, "In many mid-latitude and subtropical dry regions, mean precipitation will likely decrease..." (p. 16). However, the Fifth Assessment does not simulate regional precipitation patterns well (p. 11). Furthermore, we do not know how Texas snowbells would respond to changes in temperatures and rainfall amounts and patterns. Since these changes could be detrimental to the subspecies, climate change represents a potential threat to its continued survival (USFWS, 2017).

Stressor: Endemism (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Texas snowbells is endemic to a very limited area. We estimate that only about 15,043 ha (37,172 ac) of potential habitat exist in the upper portions of three watersheds; the subspecies' global range spans 121 km (75 mi) east to west and 35 km (22 mi) north to south. While endemism is not a threat, per se, it increases the subspecies' vulnerability to other threats. For example, climate change could further reduce the amount of potential habitat, or a single prolonged drought or catastrophic rainfall and flooding could increase mortality throughout the subspecies' range (USFWS, 2017).

Recovery

Reclassification Criteria:

Texas snowbells may be reclassified as a threatened species when the following conditions have been met: Self-sustaining metapopulations have reached the MVP level of at least 500 individuals of reproductive age in each recovery unit (occupied watershed): The upper Nueces, West Nueces, and Devils River. If wild populations are discovered in other watersheds, this criterion must also be met in those watersheds. MVP is based only on mature, reproductive individuals since mortality of young Texas snowbells plants is very high, and apparent population

sizes can fluctuate wildly if immature plants are included. Metapopulations may be considered self-sustaining when: a) Unaided recruitment equals or exceeds mortality over a 10-year span, which is the expected minimum time to complete an entire generation (as defined in III.7); b) facilitated population augmentation and reintroduction are no longer necessary for successful recruitment; and c) fenced exclosures or other types of barriers are no longer necessary to reduce mortality from ungulate browsing. However, we anticipate that population management of white-tailed deer and introduced ungulates, pollinator conservation, and other habitat management practices will continue to be necessary in this region. The continuation of these practices will not preclude the attainment of this criterion (USFWS, 2018b).

Delisting Criteria:

Recovery will be signified by: Resilient, redundant, viable metapopulations in the Nueces, West Nueces, and Devils River watersheds (and possibly other watersheds, if other naturally-occurring populations are discovered), where spontaneous recruitment over time equals or exceeds mortality; and the conservation of its ecological and genetic representation through the restoration of gene flow throughout each extant metapopulation (USFWS, 2018b).

Texas snowbells may be removed from the endangered species list when: All downlisting criteria (IV.1.a, b, and c) have been met and sustained, and self-sustaining metapopulations have been established in each recovery unit (occupied watershed) and have remained stable or increasing for 20 additional years (2 additional generations, as described in III.7); this is a total of at least 30 years (3 generations). The completion of 3 generations would likely span multiple periods of high and low precipitation. This represents the minimum number of generations required to detect demographic trends; however, a longer time frame may be necessary if a clear trend has not yet been observed (USFWS, 2018b).

Recovery Actions:

- Priority 1(1): Promote awareness and conservation of Texas snowbells on private lands in the upper Nueces, West Nueces, and Devils River watersheds, as well as other watersheds if natural populations are discovered there (USFWS, 2018b).
- Priority 1(2). Protect remnant populations and individuals of Texas snowbells from ungulate browsers, and reduce browse intensity through population management of native white-tailed deer and introduced ungulates in the upper Nueces, West Nueces, and Devils River watersheds (USFWS, 2018b).
- Priority 1(3). Conduct scientific investigations to guide conservation efforts (USFWS, 2018b).
- Priority 2(4). Augment small populations and isolated individuals to increase reproductive rates, and reintroduce populations to restore gene flow between and among remnant populations in the upper watersheds of the Nueces, West Nueces, and Devils Rivers. Augmentation and reintroduction may also be appropriate in the Frio, West Frio, Dry Frio, and Sycamore Creek watersheds if natural populations are confirmed there, but is contraindicated if other subspecies of *Styrax platanifolius* occur there, since this could lead to hybridization between subspecies (USFWS, 2018b).
- Priority 3(5). Search for new populations in potential habitats throughout the subspecies' range. In particular, the discovery or confirmation of populations in the Frio, West Frio, Dry Frio, or Sycamore Creek watersheds would increase our knowledge of the subspecies' geographic range and adaptability, and might confer greater ecological and genetic diversity (representation) to the subspecies as a whole (USFWS, 2018b).

- Priority 3(6). Promote conservation and management of native bees, butterflies, and other pollinators in the upper Nueces, West Nueces, and Devils River watersheds (USFWS, 2018b)
- Priority 3(7). Verify that viable, self-sustaining populations occur within each recovery unit and have maintained stable or increasing population sizes for three or more generations (a minimum of 30 years). One generation has passed when individuals are successfully recruited through seed germination within habitats, survive to maturity, produce viable seed, and the second-generation seed germinates in the same habitats. Based on observed growth rates in the wild, a single generation takes at least 10 years to complete (USFWS, 2018b).

Conservation Measures and Best Management Practices:

- Update the Recovery Plan to include objective and measurable recovery criteria that address all of the five listing factors that are relevant to the species. (USFWS, 2008)
- Obtain information on all natural and reintroduced populations to adequately assess the status of the species. (USFWS, 2008)
- Map the amount and distribution of potential Texas snowbell habitat across the range. (USFWS, 2008)
- Conduct a population viability analysis. (USFWS, 2008)
- Draft a reintroduction plan to maximize efficiency and success for meeting recovery criteria. (USFWS, 2008)

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SPECIES ACCOUNT: *Suaeda californica* (California seablite)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An evergreen shrub that forms low mounds, leafy with fleshy, narrow leaves, each 5-35 mm long. The tiny flowers (2-3 mm across) are borne July-October. (NatureServe, 2015)

Taxonomy

Suaeda californica was first described by Sereno Watson in 1874, based on type material collected by Bolander and Kellogg in San Francisco Bay tidal marshes. Amos Heller published the name *Dondia californica* in 1898, recognizing the genus name used by Michel Adanson in 1763. However, the name *Suaeda* has been conserved (Abrams 1944). Munz (1959) recognized several previously recognized taxa as subspecies of *S. californica*, and described the range as extending from San Francisco Bay south to Lower (Baja) California. Ferren and Whitmore (1983) noted that much of what had been identified as *S. californica* in southern California was a distinct taxon, which they named *S. esteroa*. Further study revealed that the only extant populations of *Suaeda* that resemble the type specimen of *S. californica* are those that occur in the vicinity of Morro Bay. In his revision of the genus, Ferren (1993) recognized *S. californica* as a full species (USFWS, 2013).

Historical Range

See Current

Current Range

Extirpated from the San Francisco Bay area; now known only from Morro Bay, San Luis Obispo County. May have once occurred in Sonoma County as well (Skinner and Pavlik 1994). Does NOT occur in southern California or Baja California - plants of these areas are referable to *S. esteroa* &/or *S. taxifolia* (Skinner and Pavlik 1994, USFWS 1994). (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Wind pollinated? (USFWS, 2013)

Breeding Season

Adult: Flowers typically appear from May to October, but mostly in late summer. Occasional flowers may be found at other times of the year, sometimes emerging as early as late spring (McMinn 1939, Baye pers. observ.) (USFWS, 2013).

Reproduction Narrative

Adult: *Suaeda californica* produces seeds throughout its lifespan. Reproduction appears to be entirely by seed (sexual); there are no known reports of natural regeneration from vegetative fragments. The spread of individual plants can be extensive, and sometimes resembles clonal populations. However, they have not been observed to spread clonally. Vegetative stem cuttings of *S. californica* treated with synthetic auxins (hormones) are easily rooted for artificial propagation (P. Baye pers. observ. 1991-1999). Reproductive maturity may in some cases be reached in as little as one year (P. Baye unpubl. data 1998). Flowering occurs on portions of the current year's shoot growth, usually on lateral branches of older wood. Flowers typically appear from May to October, but mostly in late summer. Occasional flowers may be found at other times of the year, sometimes emerging as early as late spring (McMinn 1939, Baye pers. observ.). Differences in flowering phenology may be an indication of genetic variation. One entire colony of *Suaeda californica* on Pickleweed Island, Morro Bay, was observed to flower precociously in April, while adjacent plants and all other colonies were entirely vegetative (P. Baye unpubl. data 2000). The longevity of individual plants is unknown, but large woody plants in stable substrate appear to live for over a decade. Very little information is available on the breeding system of *Suaeda californica*; however, a predominantly outcrossing breeding system would be expected for this wind-pollinated, often colonial, shrub. Abundant seed (many hundreds per plant) is produced on fruiting plants at Morro Bay. The ability of isolated plants in cultivation to produce seed (P. Baye pers. observ. 1998) suggests that at least some individuals possess a degree of self-compatibility. Abundant seed set occurred spontaneously in outdoor container-grown nursery plants at the Golden Gate National Recreation Area nursery in San Francisco in 1998. These seeds were viable and produced vigorous seedlings (E. Heimbinder pers. comm. 1999). Based on observations by marsh ecologist Peter Baye, abundant seedling establishment at Morro Bay appears to be episodic, corresponding to storm events that cause both vegetation gaps and deposits of driftline debris with seeds. Seedlings were widespread and abundant along the backbarrier shoreline following the erosive winter storms of 1998. Many thousands of seedlings and multiple-branched juvenile plants had established in the erosion zone in driftlines and litter rafts by late April 1998. Seedlings rooted in debris rafts without roots in the marsh substrate were subject to high mortality. No evidence of long distance dispersal and colonization was observed. Re-survey of the extensive 1998 seedling colonies in April of 1999 and 2000 revealed only regeneration of remnant mature shrubs that survived erosion. No juvenile or young mature plants were detected, indicating extremely high mortality of the post-storm cohort of seedlings. In contrast, the colonies of mature *Suaeda californica* at the north end of Morro Bay were mostly unaffected by the 1998 storm. These narrow, dense colonies acted as a significant refugia for survival and seed production during the catastrophic mortality that affected most of the population along the bayshore of the central sand spit (USFWS, 2013).

Habitat Type

Adult: Salt marsh (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species is restricted to the upper intertidal zone of a coastal salt marsh along the perimeter of a bay (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species and the relatively low number of known populations.

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Seeds of *Suaeda californica* are somewhat hard-coated, and are enclosed in fleshy calyces that become spongy and buoyant upon drying, and which remain attached to the fruits after dehiscence and dispersal (USFWS, 2010).

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Low (inferred from NatureServe, 2015 and USFWS, 2013)

Representation:

Low (inferred from NatureServe, 2015 and USFWS, 2013)

Redundancy:

Low (inferred from NatureServe, 2015 and USFWS, 2013)

Number of Populations:

Nine (USFWS, 2013)

Population Size:

1 - 1000 individuals (NatureServe, 2015); ~500 (NatureServe, 2015)

Population Narrative:

< 500 genetic individuals estimated by McLeod (1991) as cited in USFWS 1994. (NatureServe, 2015). USFWS (2013) notes that there are nine known occurrences of this species 5 naturally occurring in Morro Bay and 4 re-introduced locations in San Francisco Bay. Low Resiliency, representation and redundancy are inferred based on the low number of occurrences and individuals as well as the small geographic range this species inhabits.

Threats and Stressors

Stressor: Alteration and Loss of Habitat (USFWS, 2013)

Exposure:

Response:**Consequence:** Loss of habitat

Narrative: The historical rarity of *Suaeda californica* in San Francisco Bay may have been due in part to the natural rarity of its sandy high marsh and beach habitat, but its extirpation seems related to the early spread of urban and port development over the East Bay shoreline from Richmond to Alameda, centered around Oakland (P. Baye pers. comm. 2004). This heavily urbanized area was the center of both the bay's sandy shorelines and *S. californica* distribution. Oakland and Alameda Marshes were filled and urbanized before the 20th century, eliminating populations there, but it was the destruction of Bay Farm Island for the construction of the Oakland International Airport in the 1950s and 1960s that probably destroyed the only remaining viable population in San Francisco Bay. Other species with affinity for sandy tidal marsh edges, such as *Atriplex californica*, were also described as occurring either along sandy beaches or sandy marsh edges within San Francisco Bay (Brewer et al. 1880, Jepson 1911, Greene 1894). These, too, have become extirpated. The Morro Bay population has suffered little habitat loss compared with San Francisco Bay, and has relatively abundant habitat there, despite declines following El Niño winter storm erosion. However, it is subject to strong fluctuations in abundance due to natural disturbances, particularly dune migration and shoreline erosion, and its regeneration following disturbance is vulnerable to numerous threats. Though the population has in the past been threatened by strong residential and commercial real estate development pressures on the east shore of Morro Bay, centered at Baywood Park and Los Osos, these pressures have been reduced drastically (J. Vanderweir pers. comm. 2009). Loss of habitat and individuals, and failed regeneration after natural catastrophes could cause extirpation of this population. Other threats include interference by non-native vegetation, trampling, oil spills, sea level rise associated with climate change, excessive dune mobilization, and alteration of shoreline dynamics due to stabilization and shoreline repair projects (USFWS, 2013).

Stressor: Recruitment failure (USFWS, 2013)**Exposure:****Response:****Consequence:** Loss of individuals/Weakening population

Narrative: Trampling of seedlings in Morro Bay may contribute to the failure of *Suaeda californica* regeneration following catastrophic shoreline erosion caused by major storms. Trampling results from both recreational activities (hiking) and by black-tail deer (*Odocoileus hemionus*) populations on the sand spit, and represents a relatively infrequent threat. However since seedling recruitment is episodic and local, impacts to seedlings (which are difficult to detect) could be severely detrimental at times. This is indicated by tracks and footprints along the Morro Bay shoreline in a devegetated zone nearly 0.5 meter (0.55 yd) wide (P. Baye pers. observ. 1997-1999). As recreational pressure on the Morro Bay shoreline increases with local residential population and increased visitor use at Montaña de Oro and Morro Bay State Parks, this impact is likely to become more severe (USFWS, 2013).

Stressor: Competition with non-native species (USFWS, 2013)**Exposure:****Response:****Consequence:** Loss of habitat

Narrative: Exotic invasive vegetation, primarily *Carpobrotus edulis* X *chilensis* hybrids (iceplant), *Eucalyptus globulus* (blue gum), and *Cupressus macrocarpa* (Monterey cypress; a native to the Monterey peninsula only), cause significant damage to *Suaeda californica* by direct interference

and indirect adverse habitat modification. *Carpobrotus edulis* establishes clonal colonies in adjacent uplands above saline influence, and can encroach by transporting nonsaline soil moisture from portions of the clone above the high tide line (P. Baye unpubl. data 1997). Most stands of *S. californica* along the perimeter road to Morro Beach State Park have been partially smothered by *C. edulis*, which grows through and over the *S. californica* colonies there. *Carpobrotus edulis* impacts are particularly significant for seedling regeneration along the backbarrier shore of Morro Bay spit. As the sandy backbarrier shoreline retreats into dense continuous stands of *C. edulis* on the dunes, *C. edulis* overhangs the erosional scarp and forms a canopy that drapes over the base of the scarp and upper shoreline. This sharply reduces or eliminates open seedling habitat for *S. californica*—its regeneration niche. It may also inhibit regeneration of storm-eroded remnants of *S. californica*. Therefore, spread of *C. edulis* along the dunes of the backbarrier shoreline is likely to reduce population resilience of *S. californica*. In fact, removal of *C. edulis* near *S. californica* populations has had a striking effect of recovery of the later (Baye in litt. 2009). Heavy leaf litter and canopy shade from non-native trees, *Cupressus macrocarpa* and *Eucalyptus globulus*, are detrimental to seedling habitats for *Suaeda californica*, and apparently cause decline in vigor of remnant stands of mature plants (e.g., near the entrance of Morro Bay State Park and in Baywood Park). Degradation of the ecological niche for seedling regeneration is probably a more severe long-term threat to the viability of the *S. californica* population than local disturbance of existing mature colonies. Stands of *S. californica* have been damaged directly by broken and fallen limbs of *E. globulus* adjacent to Morro Beach State Park (P. Baye unpubl. data 1997-2000). The persistence of suitable and restorable habitat for reintroduction of *Suaeda californica* to San Francisco Bay is also threatened by non-native vegetation. In San Francisco Bay, the spread of invasive *Spartina* (Daehler and Strong 1996) caused the conversion of open mudflat into stabilized tidal marsh that traps sediment and moderates estuarine wave energy. This invasive vegetation intercepted alongshore transport of sand in the middle and lower intertidal zone, and inhibited the wave deposition of the sandy higher elevation marsh-beach ecotone that is important for establishment of *S. californica*. Invasive *Spartina* eradication efforts have likely eliminated the further spread of the species which could have precluded the long-term viability of *S. californica* reintroduction (USFWS, 2013).

Stressor: Dredging (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Navigational dredging may threaten stands of *Suaeda californica* that have colonized the marina shoreline at Morro Bay State Park. Dredging of the inlet channel steepens the subtidal shore profile, probably resulting in shoreline erosion along the unarmored eroding south shore of the interior shoreline of the marina, which could threaten the *S. californica* colony there. The marina subpopulation of *S. californica* is particularly significant to the species' conservation because it is highly sheltered from storm wave erosion that threatens the main population along the spit's backbarrier shoreline (USFWS, 2013).

Stressor: Predation (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: In the absence of natural predators, hunting, or management in Morro Bay, deer populations are likely to forage intensively along the backbarrier shoreline where seeps provide fresh water, soft herbaceous vegetation, and flat travel corridors (USFWS, 2013).

Stressor: Small number of populations (USFWS, 2013)

Exposure:

Response:

Consequence: Extirpation

Narrative: *Suaeda californica* is vulnerable to extinction in the wild largely because it has been reduced to a very small number of populations distributed in a very narrow zone of the Morro Bay and San Francisco Bay shorelines. In Morro Bay, most of the colonies occur along the erodible backbarrier shore of the Morro Bay sand spit, which is susceptible to erosion by occasional extreme storm tides and high wind-generated waves, and rapid burial by migrating dunes. Severe storm erosion occurred along this shoreline in the winter of 1997-1998, creating an extensive erosional scarp in the narrow *S. californica* zone. The population has not yet rebounded from this event. Although this was a natural catastrophe and rebound may occur in time, erosion events may become a recurrent threat if climate change increases storm intensity, frequency, and sea level rise rates (USFWS, 2013).

Stressor: Climate change (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat/extirpation

Narrative: Extreme local fluctuations of climate (winter storms, high winds, summer drought) may be associated with global climate change. A series of severe winter storms followed by years of drought could cause catastrophic reproductive failure of the species. Global climate change and associated sea level rise may also cause long-term changes in the stability of sand beach and dune shorelines (SCOR Working Group 1991), such as those of Morro Bay spit. *Suaeda californica* occurs in abundance only where the backbarrier shoreline is adjacent to dune scrub vegetation that stabilizes dunes. It is sparse or absent where bare mobile dunes retreat over the backbarrier shoreline. Many of the remaining colonies are being encroached on by mobile dunes, and are not expected to survive more than a few years. The formation of new "marsh coves" (potential *S. californica* habitat) in the lee of stabilizing dunes may occur in the future, but none are foreseeable now. A combination of shoreline retreat and increased dune movement could significantly reduce the largest subpopulation of *S. californica*. Accelerated sea level rise and shoreline retreat could also force conflicts between natural movement of the *Suaeda californica* zone on the east shore of Morro Bay and landowner needs. Where costly residential developments are threatened by shoreline retreat, response typically involves armoring (structural stabilization) of the shoreline (e.g., revetments, seawalls, rip-rap, etc.). Currently, *S. californica* appears to be able to migrate with the slowly retreating shorelines of eastern Morro Bay (Baywood Park, heron rookery) (USFWS, 2013).

Stressor: Oil spills (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat/extirpation

Narrative: Oil spills and clean-up operations may have significant adverse effects on *Suaeda californica* populations at Morro Bay, particularly on seedlings. Spilled oil tends to accumulate

near the high tide line, the narrow marsh zone in which *S. californica* is largely restricted. Oil would probably cause high mortality of seedlings and juvenile plants during years of seedling regeneration by coating and smothering small plants with oil, and possibly by direct toxicity. Oil clean-up operations involving mechanical removal (raking, excavation) of oiled sand would also cause significant disturbance of *S. californica* habitat. Direct toxic effects of oil on older woody *S. californica* are uncertain, but are probably less damaging than effects of clean-up operations (USFWS, 2013).

Recovery

Delisting Criteria:

1) protection of the population at Morro Bay to ensure its long-term survival (USFWS, 2013).

2) re-establishment of suitable habitat with new populations in San Francisco Bay, the historical range of the species

Conservation Measures and Best Management Practices:

- 1. Any person collecting information on *Suaeda californica* as part of field surveys or research should be encouraged to submit occurrence information to the CNDDDB to provide a more comprehensive picture of this species distribution and status throughout its range (USFWS, 2010).
- 2. Potential re-introduction sites for *Suaeda californica* within the San Francisco Bay area and other sites within its historic range should continue to be evaluated by the Service (USFWS, 2010).
- 3. Land managers and the Service should work cooperatively to begin population surveys in all potentially suitable and legally-accessible habitat along the central coast to determine if there are yet undiscovered occurrences of *Suaeda californica* and to update the status of known occurrences (USFWS, 2010).
- 4. The CDPR and the Service should continue monitoring of existing outplanting efforts and seek to identify additional sites for outplanting of *Suaeda californica* on Federal, State, or otherwise conserved lands along the coastline in San Luis Obispo County (USFWS, 2010).
- 5. Establish site-specific and species monitoring protocols to identify potential impacts of sea-level rise and storm surge associated with climate change. This will assist in determining the effects of projected sea level rise and increased storm surge events on *Suaeda californica* and its habitat (USFWS, 2010).
- 6. The CDPR and Morro Coast Audubon Society should develop and implement active nonnative invasive species eradication programs for those occurrences of *Suaeda californica* under their management authority. Post-eradication, sites should be evaluated for their potential to re-establish occurrences of *S. californica* (USFWS, 2010).

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NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.”

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SPECIES ACCOUNT: *Tabernaemontana rotensis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/02/2015; Pacific Region (R1) (USFWS, 2016)

Physical Description

A small to medium-sized tree (USFWS, 2015). It grows to heights of perhaps 6 m (20 ft.) and is rather weak and spindly in appearance, with large, yellow-green to dark-green leaves and thin, milky sap. The inflorescence consists of a few to over 30 flowers with 5 spirally arranged, united white petals that appear slightly folded until they flare at the tips. The fruits occur singly or twinned and have one to three ridges. Each fruit is relatively small, 3 to 7 cm (1.2 to 2.8 in) long, dehiscent (they open at maturity) (USFWS, 2000).

Taxonomy

A member of the dogbane family (Apocynaceae). The genus is widespread throughout tropical and subtropical regions (USFWS, 2015). Kanehira (1936) first described the species as *Ervatamia rotensis* from his type collection from Rota (Kanehira 3666). Stone (1965, 1970) recognized the species from the Rota and Guam collections (Stone 5256, Kanehira 3666, Hosokawa 9832) as *Tabernaemontana rotensis* (USFWS, 2000).

Historical Range

It is historically known from Guam and Rota (USFWS, 2015). Historically, *Tabernaemontana rotensis* was known from lowland dry forest on Rota; on Guam, *T. rotensis* was known from individual specimens in the limestone forests along cliffhills at Asanite, on the University of Guam campus, and at the "Japanese Overlook" of the Naval Magazine (Raulerson and Rinehart 1997) (USFWS, 2000).

Current Range

It currently occurs on Guam and Rota (Mariana Islands) (USFWS, 2015).

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (inferred from USFWS, 2000)

Breeding Season

Adult: Guam: January, May, July (herbarium specimens); Rota: October - November (herbarium specimens) (USFWS, 2000)

Reproduction Narrative

Adult: Each fruit contains 4 to 10 seeds in a red pulp. Herbarium specimens show flowering in Guam plants has occurred in January, May, and July; specimens collected on Rota were in flower in October and November (USFWS, 2000).

Habitat Type

Adult: Terrestrial (USFWS, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest (USFWS, 2015)

Habitat Narrative

Adult: It occurs in the forest ecosystem (USFWS, 2015).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: On Guam, seeds have been observed to mold in the seed case without separating from the fruit, indicating that birds may be useful in distributing the seeds (G. Wiles, in litt. 1998) (USFWS, 2000).

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Increasing (USFWS, 2015)

Resiliency:

Low (inferred from USFWS, 2015)

Redundancy:

Low (inferred from USFWS, 2015)

Number of Populations:

Guam: 6; Rota: 1 (USFWS, 2015)

Population Size:

Guam: 21,000; Rota: 9 wild, 30 outplanted (USFWS, 2015)

Population Narrative:

In 2004, *T. rotensis* was known from 8 individuals on Rota, and at least 250 individuals on Guam (69 FR 1560; January 9, 2004). The best scientific data currently available indicate that on Guam, *T. rotensis* is known from 6 occurrences totaling approximately 21,000 individuals (M and E Pacific, Inc. 1998, p. 61; UOG 2007, pp. 32–42), and on Rota, *T. rotensis* is known from 9 individuals (CNMI DLNR 2014, in litt.). Additionally, there are 30 surviving outplanted individuals on Rota (USFWS, 2015).

Threats and Stressors

Stressor: Development, military training, urbanization (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: In their 2015 Final SEIS ([http:// guambuildupeis.us/](http://guambuildupeis.us/)) (see “Historical and Ongoing Human Impacts,” above), the U.S. Department of Navy states that approximately 5,000 Marines will be relocated from Okinawa to Guam, accompanied by approximately 1,300 dependents, with a concurrent introduction of support staff and development of infrastructure, and increased use of resources such as water (Berger et al. 2005, p. 347; JGPO– NavFac, Pacific 2015, p. ES–3). The current preferred alternative sites on Guam for cantonment and live-fire training include the Naval Computer and Telecommunications Station Finegayan and Northwest Field on Andersen AFB, where this species occurs. In November 2007, the people of Rota voted to legalize casino gambling to increase tourism, and two development projects have been proposed. Development around and within forested areas on Rota will also directly impact the forest habitat and individuals of this species (USFWS, 2015).

Stressor: Ungulates (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Several herds of Asiatic water buffalo or carabao roam southern Guam and the Naval Magazine area, and cause damage to the ecosystem that supports this species. Philippine deer have caused extensive damage resulting in changes in the forest structure, including erosion, grazing to the point of clearing the entire herbaceous understory, consumption of seeds and seedlings preventing regeneration of native plants and the spread of invasive plant species, and other physical damage (e.g., trunk rubbing) (Schreiner 1997, pp. 179–180; Wiles et al. 1999, pp. 193–215; Berger et al. 2005, pp. 36, 45–46, 100; CNMI– SWARS 2010, p. 24; JGPO–NavFac, Pacific 2010b, p. 3–33; SWCA 2011, pp. 35, 42; Harrington et al. 2012, in litt.). Feral pigs are extremely destructive and have both direct and indirect impacts on native plant communities. While rooting in the earth in search of invertebrates and plant material, pigs directly impact native plants by disturbing and destroying vegetative cover, and trampling plants and seedlings. Pigs may also reduce or eliminate plant regeneration by damaging or eating seeds and seedlings (USFWS, 2015).

Stressor: Fire (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Fire is a human-exacerbated threat to native species and native ecosystems throughout the Mariana Islands, particularly on the island of Guam. Fire can destroy dormant seeds of native species as well as plants themselves, even in steep or inaccessible areas. Successive fires that burn farther and farther into native habitat destroy native plants and remove habitat for native species by altering microclimate conditions to those favorable to alien plants (USFWS, 2015).

Stressor: Small population size/lack of reproduction (USFWS, 2000)

Exposure:**Response:****Consequence:**

Narrative: The primary threat to *Tabernaemontana rotensis* is the lack of reproductive vigor and seed distribution due to reduced numbers of individuals. This situation includes a lack of observed seed production on Rota, which may be due to either the lack of a pollinator or predation by insects, mice, or rats (G. Hughes, pers. comm. 1998) (USFWS, 2000).

Stressor: Nonnative plants (USFWS, 2000)

Exposure:**Response:****Consequence:**

Narrative: Competition with the nonnative vines *Momordica charantia* (balsam pear), *Mikania scandens* (mile-a-minute vine), and *Passiflora suberosa* (wild passionfruit) may threaten seedlings and saplings (G. Wiles, in litt. 1998) (USFWS, 2000).

Recovery**Reclassification Criteria:**

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- Area 50, a 59-ac (24-ha) enclosure on Andersen AFB on Guam containing a relictual patch of limestone forest, was created to exclude ungulates and the brown treesnake (Hess and Pratt 2006, p. 2). This enclosure was maintained for ecosystem and species experimental research. Several individuals of the tree *Tabernaemontana rotensis* occur within the enclosure, and would benefit from protection from predators and habitat disturbance (Hess and Pratt 2006, p. 7). However, researchers found the enclosure in a state of neglect, and invaded by nonnative plant species and pigs, with only 20 ac (8 ha) of undisturbed primary forest remaining by 2006 (Hess and Pratt 2006, p. 24) (USFWS, 2015).
- In 2014, the Navy funded a project to examine the distribution and abundance of *Tabernaemontana rotensis* on Joint Regional Marianas (JRM) lands (DON 2014, in litt.) (USFWS, 2015).
- Rota's Department of Fish and Wildlife constructed enclosures for two occurrences of *Tabernaemontana rotensis* in the Sabana Conservation Area, but only one enclosure remains, as the other burned in a fire (Hess and Pratt 2006, p. 33; 65 FR 35029, June 1, 2000) (USFWS, 2015).

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SPECIES ACCOUNT: *Taraxacum californicum* (California taraxacum)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial herb from a taproot. Leaves are all basal. Flower heads (May-August) are pale yellow, borne on leafless, hollow stalks, about 5-20 cm tall. (This species differs from the ubiquitous dandelion, *T. officinale*, in several ways including paler foliage and flower color and less deeply lobed leaves.) (NatureServe, 2015)

Taxonomy

Generally accepted as a distinct species endemic to California (San Bernardino Mountains only); accepted by all pertinent references: Munz (Flora of California, 1959), Stebbins in Jepson manual (Hickman, 1993), California Native Plant Society list (Skinner and Pavlik, 1994), California Natural Diversity Database (1999), and Kartesz (1994 checklist and 1999 Floristic Synthesis). Formally listed in 1998 as an endangered species by U.S. Fish and Wildlife Service. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Endemic to the San Bernardino Mountains, ranging from the Holcomb and Bear Valleys to South Fork Meadows in the Santa Ana River watershed (USFWS, 2013)

Critical Habitat Designated

Yes; 8/14/2008.

Legal Description

On August 14, 2008, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Taraxacum californicum* (California taraxacum) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes eleven critical habitat units (CHUs), in California (73 FR 47706-47767).

Critical Habitat Designation

The critical habitat designation for *Taraxacum californicum* includes eleven CHUs in San Bernardino County, California. This species critical habitat encompasses approximately 1,914 acres (775 ha) (73 FR 47706-47767).

Unit 2: North Baldwin Meadow We are designating Unit 2 as critical habitat for both *Poa atropurpurea* and *Taraxacum californicum*. Unit 2 consists of approximately 177 ac (72 ha) of non-degraded meadow occupied by both species at the time of listing; both species continue to occur within this unit. Unit 2 contains all of the features essential to the conservation of both species. It is located within the SBNF, on the north shore of Baldwin Lake, and northeast of Big Bear Lake. Approximately half of Unit 2 is federally owned and half is owned by CDFG. Habitat in Unit 2 was historically impacted by authorized and unauthorized vehicle use, mining activity, residential development, and grazing by burros (CNDDDB 2006a, p. 1; SBNF 2002a, p. 33; SBNF

2002b, p. 57). The meadow is protected, but it is adjacent to State Route 18 and accessible to the public (SBNF 2000, p. 57). Disruption of the hydrologic regime by upstream development, trampling during illegal woodcutting, and quartzite theft activities were identified as past threats in this unit (CNDDDB 2006b, p. 16). Additionally, *Poa atropurpurea* and *Taraxacum californicum* and their essential features are threatened in this unit by competition from invasion of nonnative, herbaceous annuals, and *T. officinale* has been reported to occur in this meadow (Krantz 2007, p. 2). Therefore, special management considerations or protection may be required to restore, protect, and maintain the essential features in Unit 2 due to the threats from upstream development, nonnative species invasion, hybridization, and human disturbance.

Unit 3: Belleville Meadow We are designating Unit 3 as critical habitat for both *Poa atropurpurea* and *Taraxacum californicum*. Unit 3 consists of an approximately 414-ac (168-ha) meadow occupied by both species at the time of listing; both species continue to occur within this unit. Unit 3 (also referred to as Upper Holcomb Valley) contains all of the features essential to the conservation of both species. Although most individuals of *P. atropurpurea* observed were reported to be male, both sexes are present (SBNF 2000, p. 47). In 1999, the *T. californicum* population in Unit 3 was reported to be “large” and “healthy” with no apparent *T. officinale* hybrids (SBNF 2000, p. 56). Although no hybrid individuals are reported from this meadow, recent reports indicate that *T. officinale* is present at this location and the two species could hybridize (Krantz 2007, p. 2). Unit 3 is located within the SBNF, north of Big Bear Lake, and east of Hitchcock Meadow (Unit 4). The majority of lands within this unit are federally owned (409 ac (166 ha)), with only 5 ac (2 ha) of meadow habitat privately owned by the Lithuanian Scouts Association. Meadow habitat in this Unit 3 may be impacted by recreational activities and nearby diffuse mining operations (CNDDDB 2006a, p. 6; Eliason 2007b); and placement of USFS roads has resulted in habitat loss and effects to meadow hydrology. Several areas of Belleville Meadow are currently heavily utilized for dispersed recreation, including vehicle use along the classified roads through the site, hiking and mountain biking along the Gold Fever Trail, and use of Holcomb Valley Campground near the western portion of the meadow. Additionally, several mining claims also exist in the meadow. Unauthorized vehicle activity and mountain biking off of classified roads and trails have caused devegetation and alteration of surface hydrology in some areas (SBNF 2002a, p. 36). Finally, *Poa atropurpurea* and *Taraxacum californicum* and their physical and biological features are threatened in this unit by invasion of nonnative, herbaceous annuals, and *T. officinale* has been reported to occur in this meadow (Krantz 2007, p. 2). The USFS erected signs and fencing and conducted outreach to protect occurrences in Unit 3 (SBNF 2002a, p. 37). For example, to reduce impacts to *Poa atropurpurea*, trails within Holcomb Valley Campground were disguised and rehabilitated, and the area was protected through barricading and signing (SBNF 2002a, p. 5). Nearby trails that did not pass through listed plant habitat were delineated and signed to encourage visitors to use those trails (SBNF 2002a, p. 5). However, special management considerations or protection may still be required to restore, protect, and maintain the essential features in Unit 3 due to the threats from human disturbance; current nearby mining activities; hybridization; and invasive, nonnative plant species.

Unit 4: Hitchcock Meadow We are designating Unit 4 as critical habitat for both *Poa atropurpurea* and *Taraxacum californicum*. Unit 4 consists of an approximately 497-ac (201-ha) meadow occupied by both species at the time of listing; both species continue to occur within this unit. Although *T. officinale* is present, no apparent hybrids have been reported (SBNF 2000, p. 56). We do not have any information about the ratio of male to female *P. atropurpurea* plants in this meadow. Unit 4 contains all of the features essential to the conservation of both species

and is located within the SBNF, north of Big Bear Lake, and west of Belleville Meadow (Unit 3). The majority of Unit 4 (also referred to as Holcomb Valley) is privately owned by the Boy Scouts of America (BSA) and used as a recreational and educational activity camp (BSA 2007, p. 1). Unit 4 has been historically impacted by OHV use, horse grazing, and other human disturbance (CNDDDB 2006b, p. 18). It is currently impacted by recreational and educational activities and horse grazing (SBNF 2000, p. 56; SBNF 2002a, p. 51). Additionally, *Poa atropurpurea* and *Taraxacum californicum* and their physical and biological features are threatened in this unit by invasion of nonnative, herbaceous annuals. Therefore, special management considerations or protection may be required to restore, protect, and maintain the essential features in Unit 4 due to the threats from past human disturbance; current camp activities; and invasive, nonnative plant species.

Unit 5: Bluff Meadow We are designating Unit 5 as critical habitat for both *Poa atropurpurea* and *Taraxacum californicum*. Unit 5 consists of an approximately 205-ac (83-ha) meadow occupied by both species at the time of listing; both species continue to occur within this unit. Although *T. officinale* is present, no hybrids are reported (SBNF 2000, p. 56). We do not have any information about the ratio of male to female *P. atropurpurea* plants in this meadow. Unit 5 contains all of the features essential to the conservation of both species. It is located within the SBNF, south of the west end of Big Bear Lake. The majority of Unit 5 is privately owned by the Wildlands Conservancy, and currently leased to the San Bernardino County Regional Parks Division as an outdoor science education camp (Wildlands Conservancy 2005). Unit 5 has been historically impacted by recreational activities, cattle grazing, and other human disturbance (CNDDDB 2006b, p. 12), although impacts are limited to recreational and educational activities (Eliason 2007b; SBNF 2000, p. 57; SBNF 2002a, p. 42). *Poa atropurpurea* and *Taraxacum californicum* and their physical and biological features are also threatened in this unit by invasion of nonnative, herbaceous annuals, including potential hybridization of *T. californicum* with *T. officinale* (SBNF 2000, p. 57; SBNF 2002a, p. 42). Therefore, special management considerations or protection may be required to restore, protect, and maintain the essential features in Unit 5 due to the potential impacts of past human disturbance; current camp activities; hybridization; and invasive, nonnative plant species.

Unit 6: North Shay Meadow We are designating Unit 6 as critical habitat for *Taraxacum californicum* only. Unit 6 consists of an approximately 21-ac (8-ha) meadow occupied by the species at the time of listing; the species continues to occur within this unit. Although occupancy of Unit 6 was documented one year after listing, we consider Unit 6 to be occupied at the time of listing because it contains approximately 12 percent of the total number of individuals reported since 1999 and has the second highest number of total individuals reported from any one unit, and therefore, we believe this area has been occupied for several years despite having been discovered in 1999 (see "Criteria Used to Identify Critical Habitat" section). Although *T. officinale* is present, no hybrids are reported (SBNF 2000, p. 56). This unit contains all of the features essential to the conservation of the species. It is located within the SBNF, east of Big Bear Lake, on the southern shore of Baldwin Lake, and north of Shay Road. The land in this unit is federally owned. This northern portion of Shay Meadow has been isolated by development from the southern meadow adjacent to East Big Bear Boulevard. Lakeshore habitat within Unit 6 is currently impacted by recreational activities due to the use of trails connecting private land to the lakeshore for OHV use, hiking, mountain biking, and horseback riding (SBNF 2000, p. 57; SBNF 2002a, p. 23). Additionally, *Taraxacum californicum* and features essential to its conservation are threatened in this unit by invasion of nonnative, herbaceous annuals, including potential

hybridization with *T. officinale* (CNDDDB 2006b, p. 36; SBNF 2000, p. 57). Therefore, special management considerations or protection may be required to restore, protect, and maintain the essential features in Unit 6 due to the impacts of human disturbance; hybridization; and invasive, nonnative plant species.

Unit 7: Horse Meadow We are designating Unit 7 as critical habitat for *Taraxacum californicum* only. Unit 7 consists of an approximately 74-ac (30-ha) meadow occupied by the species at the time of listing; the species continues to occur within this unit. Occupancy throughout the meadow was confirmed as recently as 2002 (Denslow et al. 2002, pp. 12 and 13). Although *T. officinale* is present, no hybrids have been reported (SBNF 2000, p. 56). Unit 7 contains all of the features essential to the conservation of the species. It is located within the SBNF, southwest of Big Bear Lake, and northwest of San Gorgonio Mountain. Unit 7 is federally owned and located in the San Gorgonio Wilderness Area of the SBNF. Recreational impacts from foot-traffic are reported in Unit 7 (Denslow et al. 2002, pp. 12 and 13; CNDDDB 2006b, p. 5; SBNF 2000, p. 57; SBNF 2002a, p. 54). Additionally, *Taraxacum californicum* and features essential to its conservation are threatened in this unit by invasion of nonnative, herbaceous annuals, including potential hybridization with *T. officinale* (SBNF 2000, p. 57). Therefore, special management considerations or protection may be required to restore, protect, and maintain the essential features in Unit 7 due to threats from human disturbance; hybridization; and invasive, nonnative plant species.

Unit 8: Fish Creek Meadow We are designating Unit 8 as critical habitat for *Taraxacum californicum* only. Unit 8 consists of an approximately 89-ac (36-ha) meadow occupied by the species at the time of listing; the species continues to occur within this unit. Although *T. officinale* is present, no hybrids are reported (SBNF 2000, p. 56). Unit 8 contains all of the features essential to the conservation of the species. It is located within the SBNF, southwest of Big Bear Lake, and northeast of San Gorgonio Mountain. Unit 8 is federally owned and occurs within the San Gorgonio Wilderness Area of the SBNF. Habitat conditions in Unit 8 are reported to be undisturbed, although diffuse recreational use impacts are likely due to trails around meadow in forested area (CNDDDB 2006b, p. 6; SBNF 2002a, p. 52). Additionally, *Taraxacum californicum* and features essential to its conservation are threatened in this unit by invasion of nonnative, herbaceous annuals, including potential hybridization with *T. officinale* (SBNF 2000, p. 58). Therefore, special management considerations or protection may be required to restore, protect, and maintain the essential features in Unit 8 due to the threats from human disturbance; hybridization and invasive; nonnative plant species.

Unit 9: Broom Flat Meadow We are designating Unit 9 as critical habitat for *Taraxacum californicum* only. Unit 9 consists of an approximately 188-ac (76-ha) meadow occupied by the species at the time of listing; the species continues to occur within this unit. Although *T. officinale* is present, no hybrids are reported (SBNF 2000, p. 56). Although occupancy of Unit 9 was documented 2 years after listing, we consider it to have been occupied at the time of listing because Unit 9 supports approximately 9 percent of the total number of *T. californicum* individuals reported since 1999, which is the fifth largest recorded population out of 35 and more than double the average recorded population size. This unit contains all of the features essential to the conservation of the species. Unit 9 is federally owned and located within the SBNF southeast of Big Bear Lake. Unit 9 is historically impacted by OHV activity, cattle and burro grazing, and other human disturbance (CNDDDB 2006b, p. 28; SBNF 2002b, p. 64). This unit and essential features therein are currently impacted by diffuse recreational activities and cattle

grazing (SBNF 2000, p. 58; SBNF 2002a, p. 46) and by invading, nonnative, herbaceous annuals, including potential hybridization with *T. officinale* (CNDDDB 2006b, p. 28; SBNF 2002a, p. 45). Therefore, special management considerations or protection may be required to restore, protect, and maintain the essential features in Unit 9 due to the potential impacts of human disturbance; hybridization; and invasive, nonnative plant species.

Unit 10: Wildhorse Meadow We are designating Unit 10 as critical habitat for *Taraxacum californicum* only. Unit 10 consists of an approximately 52-ac (21-ha) meadow occupied by the species at the time of listing; the species continues to occur within this unit. Although *T. officinale* is present, no hybrids are reported (SBNF 2000, p. 56). Although occupancy of Unit 10 was documented 1 year after listing, we consider Unit 10 to have been occupied at the time of listing because Unit 10 has the highest number of total documented individuals since the time of listing among all the units (SBNF 2000, p. 56; CNDDDB 2006b, pp. 30 and 31) and hosts approximately 20 percent of the total number of individuals reported since 1999, and therefore, we believe that this area was occupied for several years despite having been discovered in 1999 (see “Criteria Used to Identify Critical Habitat” section). Unit 10 was also reported to be occupied by *Poa atropurpurea* in 1981, although surveys in 1999 and 2000 did not locate any individuals (SBNF 2000, p. 47). Therefore, this unit is designated as critical habitat for *T. californicum* only. This unit contains all of the features essential to the conservation of the species. The land in this unit is federally owned and is located within the SBNF southeast of Big Bear Lake. Habitat in Unit 10 is reported to be of “excellent” quality and well protected, although some diffuse recreation impacts have been reported (SBNF 2000, pp. 56 and 58; SBNF 2002a, p. 69). *Taraxacum californicum* and features essential to its conservation are threatened in this unit by invasion of nonnative, herbaceous annuals, including potential hybridization with *T. officinale* (CNDDDB 2006b, p. 31; SBNF 2000, p. 56 and 58). Therefore, special management considerations or protection may be required to restore, protect, and maintain the essential features in Unit 10 due to the potential impacts of invasive, nonnative plant species; hybridization; and diffuse recreation impacts.

Unit 11: Cienega Seca Meadow We are designating Unit 11 as critical habitat for both *Poa atropurpurea* and *Taraxacum californicum*. Unit 11 consists of an approximately 81-ac (33-ha) meadow occupied by both species at the time of listing; both species continue to occur within this unit. Although *T. officinale* is present, no hybrids are reported (SBNF 2000, p. 56). We do not have any information about the ratio of male to female *P. atropurpurea* plants in this meadow. Unit 11 contains all of the features essential to the conservation of both species. It is located within the SBNF adjacent to State Route 38, southeast of Big Bear Lake, and northeast of San Geronio Mountain. The majority of Unit 11 (also referred to Blue Sky Meadow) is privately owned by the Los Angeles County Education Foundation (LACEF), and currently used as an outdoor science education camp (Wildlands Conservancy 2007; LACEF 2007). Unit 11 has been historically impacted by changes in the hydrologic regime due to recreational activities, cattle grazing, and other human disturbance (CNDDDB 2006a, p. 2, 2006b, p. 2). Water usage from a well and vehicle use on some access roads are current threats to meadow habitat (SBNF 2002a, p. 77). *Poa atropurpurea* and *Taraxacum californicum* and their essential features are also threatened in this unit by invasion of nonnative, herbaceous annuals, including potential hybridization of *T. californicum* with *T. officinale* (CNDDDB 2006b, p. 2; SBNF 2000, p. 58). Therefore, special management considerations or protection may be required to restore, protect, and maintain the essential features in Unit 11 due to the threats from past human disturbance; current camp activities; hybridization; and invasive, nonnative plant species.

Unit 12: South Fork Meadow We are designating Unit 12 as critical habitat for *Taraxacum californicum* only. Unit 12 consists of approximately 116-ac (47-ha) of meadows occupied by the species at the time of listing; the species continues to occur within this unit. Although *T. officinale* is present, no hybrids have been reported (SBNF 2000, p. 56). Unit 12 contains all of the features essential to the conservation of the species. It is located on Federal lands within the San Gorgonio Wilderness Area of SBNF, southwest of Big Bear Lake on the northern slope of San Gorgonio Mountain. Habitat in Unit 12 is reported to be virtually undisturbed, but possibly impacted by irregular and recreational use (CNDDDB 2006b, p. 1; Krantz 2007, p. 2; SBNF 2000, pp. 56 and 58). Threats include impacts of hikers, horseback riding, and camping; however, the meadows are minimally disturbed (SBNF 2002a, p. 66). Additionally, *Taraxacum californicum* and features essential to its conservation are threatened in this unit by invasion of nonnative, herbaceous annuals, including potential hybridization with *T. officinale* (SBNF 2000, pp. 56 and 58). Therefore, special management considerations or protection may be required to restore, protect, and maintain the essential features in Unit 12 due to the threats from human disturbance; hybridization; and invasive, nonnative plant species.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Taraxacum californicum* critical habitat consists of two components (73 FR 47706-47767):

- (i) Wet meadows subject to flooding during wet years and forest openings with seeps, springs, or creeks in the San Bernardino Mountains in San Bernardino County located at elevations of 6,700 to 9,000 feet (2,000 to 2,800 meters), that provide space for individual and population growth, reproduction, and dispersal; and
- (ii) Well-drained, loamy alluvial to sandy loam soils occurring in the wet meadow system or forest openings with seeps, springs, or creeks, with a 0 to 46 percent slope, to provide water, air, minerals, and other nutritional or physiological requirements to the species.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the areas occupied at the time of listing contain the features essential to the conservation of the species that may require special management considerations or protection. Major threats to *Poa atropurpurea* and *Taraxacum californicum*, and, therefore, to the features essential to their conservation, include development on private lands, grazing, off-highway vehicle (OHV) use, road maintenance activities, ground disturbance that affects surface hydrology, mining activities, recreational activities, habitat fragmentation, and the invasion of nonnative herbaceous plants. Please refer to the unit descriptions in the "Final Critical Habitat Designations" section for further discussion of special management considerations or protection of the physical and biological features related to geographically specific threats to *P. atropurpurea* and *T. californicum*. Special management considerations or protection of the wet meadows may be needed to address concerns such as reducing nonnative plant invasions and maintaining populations. Control and monitoring of nonnative, invasive plant species may be required to maintain wet meadows and or forest openings such that they can continue to support populations of *Poa atropurpurea* and or *Taraxacum californicum*. Nonnative species alter the meadow habitat by creating mats of thatch which cover bare ground needed for *P. atropurpurea* and *T. californicum* to become established,

and also use water resources that could be used by *P. atropurpurea* and *T. californicum*. The growth of nonnative species may adversely impact and change the physical and biological features of the meadow habitat. Implementing management actions that support fertilization and seed set of *P. atropurpurea* (Curto 1992, p. 11; Soreng 2000, pp. 1–4), and provide monitoring and protection of male *P. atropurpurea* clones may be required to maintain populations of *P. atropurpurea*. Special management considerations or protections for wet meadow habitat may need to be implemented to control the impacts associated with direct competition and hybridization caused by the nonnative *Taraxacum officinale*. This nonnative species occupies open niches, which can reduce the bare ground needed for *T. californicum* to become established, and may alter the physical and biological features of the meadow habitat. Management may include the removal of *T. officinale* from montane meadows where this species co-occurs with *T. californicum*. Additionally, it may be appropriate to remove hybridized individuals; however, we believe this course of action warrants further investigation. There are two USFS management guides that address conservation of *Poa atropurpurea* and *Taraxacum californicum*: (1) The CNF Habitat Management Guide for the Sensitive Plant Species: *Delphinium hesperium* ssp. *cuyamaca*, *Lilium parryi*, *Limnanthes gracilis* var. *parishii*, and *P. atropurpurea*, in Riparian Montane Meadows (CNF 1991, pp. 1–36) addresses conservation of *P. atropurpurea*; and (2) the SBNF Meadow Habitat Management Guide (SBNF 2002a pp. 1–155) addresses conservation of both species. In some cases, significant management actions have been implemented by the USFS (for example, cattle exclosures in Laguna Meadow (CNF 1991, p. 17), recreational trail closures in Belleville Meadow near Big Bear Lake (SBNF 2002a, p. 5)).

Life History**Food/Nutrient Resources****Habitat Type**

Adult: Alpine meadows (NatureServe, 2014)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits edges of moist meadows at 1620–2800 m elevation (NatureServe, 2015). *Taraxacum californicum* occurs in moist meadow habitats in the San Bernardino Mountains at elevations from 2,000 to 2,800 m (6,700 to 9,000 ft) and is often associated with *Poa atropurpurea*. These taxa are restricted to the relatively open edges apart from more mesic plants such as *P. pratensis*, *Carex* spp. or *Juncus* spp. (Krantz 1981b). The perimeter of such meadows often intergrades with sagebrush scrub dominated by sagebrush or pine forest (Krantz

1981b) (USFWS, 1998). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species and it's the relatively narrow geographic range it inhabits.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: We have no information on age class structure, pollen and seed dispersal, seedling establishment, persistence of seed in the soil, or adult mortality of any of the occurrences (USFWS, 2013).

Population Information and Trends

Population Trends:

Decreasing (NatureServe, 2015)

Resiliency:

Low (inferred from USFWS, 2013)

Representation:

Low (inferred from USFWS, 2013)

Redundancy:

Low (inferred from USFWS, 2013)

Population Growth Rate:

Decline of 10-90% (NatureServe, 2015)

Number of Populations:

20 (USFWS, 2013)

Population Size:

2 to 300 individuals/occurrence (USFWS, 2013)

Population Narrative:

Decline of 10-90% (NatureServe, 2015). Low resiliency, representation and redundancy are inferred based on the small number of occurrences and individual plants known to exist. USFWS (2013) notes that there are 20 known occurrences with each occurrence having between 2 and 300 individuals.

Threats and Stressors

Stressor: Alteration of hydrological conditions (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The listing rule identified alteration of hydrological conditions as a significant threat to *Taraxacum californicum* habitat, noting potential impacts from roads and OHV activity (USFWS

1998, pp. 49012–49013). As discussed in the 2008 review, the SBNF identified alteration of hydrological conditions as a threat in their Meadow Habitat Management Guide (SBNF 2002). According to the management guide, meadows exist as a function of hydrology. Alteration of the local hydrology is, therefore, perhaps the greatest threat to this type of habitat. Any activities that affect site hydrology (e.g., lowering of water table, water diversion, overgrazing, off-road driving, roads, trails, mining, and historical or recent grazing) pose threats to meadow habitat and meadow plants (SBNF 2002, pp. 22, 24) (USFWS, 2013).

Stressor: Urbanization (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The listing rule identified the relatively unrestricted development of privately-owned parcels in the Big Bear area outside the boundaries of the SBNF as a continuing threat. Half of the *Taraxacum californicum* occurrences at the time of listing—10 out of 20—were reported to be located within, or adjacent to, urbanized areas such as Big Bear City, Big Bear Lake Village, and Sugarloaf (USFWS 1998, p. 49009). Of these, four occurrences located at Metcalf Meadows (north occurrence), China Gardens/Eagle Point Meadows, Pan Hot Springs Meadow, and Rathbun (also known as Moonridge) Meadow fell within areas depicted as residential, commercial, or flood plain on a zoning map for the City of Big Bear Lake (USFWS 1998, p. 49013). The listing rule noted the apparent extirpation of the occurrence at Rathbun Meadow (T. Krantz, Environmental Consultant, 1993, pers. comm.). Development currently remains a threat to meadow habitat of five *Taraxacum californicum* occurrences on private land in the Big Bear area. Another six *T. californicum* occurrences are located in meadow habitat adjacent to developed areas and are threatened by indirect effects related to urbanization. In addition to directly removing meadow habitat, development degrades meadow habitat by altering site hydrology, increasing access to foot and vehicular traffic, and introducing nonnative plant species (USFWS, 2013).

Stressor: Roads and unauthorized Off Highway Vehicular (OHV) Use (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat/Habitat degradation

Narrative: Roads and unauthorized OHV use has been ameliorated at two occurrences through management actions of the SBNF (fencing, etc.), but continues to be a moderate threat to meadow habitat at 13 of 23 *Taraxacum californicum* occurrences. Nine of these occurrences are within or partially within CDFW and SBNF lands, though they continue to pose management challenges. Four occurrences entirely within private land in the Big Bear area are threatened by roads and unauthorized OHV use due to lack of protection and close proximity to roads (USFWS, 2013).

Stressor: Developed and dispersed recreation (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat/Habitat degradation

Narrative: Developed and dispersed recreation remains a moderate threat to meadow habitat at 17 of 23 *Taraxacum californicum* occurrences (Appendix 1). Since listing, developed and dispersed recreation due to close proximity to campgrounds has been identified as a threat at five additional meadows (in addition to North Shore Meadows identified at listing): Bluff

Meadow, Hitchcock Meadow and Belleville Meadow in Holcomb Valley, Red Ant Meadow, and Merriman Meadow. Additionally, a popular dispersed campsite on the SBNF (referred to as Yellow Post Site 25) threatens adjacent *T. californicum* habitat in Metcalf Meadow. Dispersed recreation has the potential to affect all occurrences of *T. californicum*, including occurrences entirely within private land in the Big Bear area. Seven, or nearly one-third of *T. californicum* occurrences, are recognized by the SBNF as particularly vulnerable to these threats due to their close proximity to campgrounds and concentrated use areas (USFWS, 2013).

Stressor: Mining activities (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat/Habitat degradation

Narrative: We have not received any new information to change our conclusion from the 2008 5-year review that mining is a current threat to *Taraxacum californicum* habitat at one occurrence (USFWS 2008a, p. 14) (USFWS, 2013).

Stressor: Grazing (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat/Habitat degradation/Loss of individuals

Narrative: Grazing is a moderate threat to 26 percent (6 of 23) of *Taraxacum californicum* occurrences. Horse grazing continues to threaten *T. californicum* and its habitat at three occurrences on private land. Significant steps were taken by the BLM and SBNF to reduce cattle and wild burro grazing within habitat occupied by *T. californicum* such that cattle grazing is not a substantial threat at this time. Although burro grazing has been reduced, it still threatens *T. californicum* and its habitat at four occurrences (USFWS, 2013).

Stressor: Competition with other plant species (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Alteration of habitat, through competition with other plant species continues to be a rangewide and moderate threat to meadow habitat at all 23 *Taraxacum californicum* occurrences (USFWS, 2013).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: In summary, the Act provides the greatest regulatory protection to *Taraxacum californicum*. Many occurrences (13 in whole and 4 in part) are on USFS lands, and 1 occurrence is on both USFS and State land, where protection is afforded through land management plans. The NFMA in conjunction with the requirements of NEPA provides important guidance and policy for maintaining ecosystem and species-specific biodiversity on USFS lands via the development and implementation of land management plans (and environmental impact statements). This includes amendments or revisions to the land management plans, as well as conservation recommendations provided in the Meadow Habitat Management Guide (SBNF 2002). CDFW manages one occurrence within the Baldwin Lake Ecological Reserve. Finally, one occurrence on

private land is owned and managed by TWC in their Bluff Lake Reserve. Thus, 15 occurrences in whole and 4 in part currently have some protections provided by Federal and State agencies, and private organizations. However, these protections are discretionary and subject to funding availability (USFS 2012a, p. 93). Therefore, current conservation measures are not sufficient to reduce all threats and are largely dependent on the federally listed status of *T. californicum*. As a result, regulatory mechanisms provided by other Federal, State, and local laws and ordinances do not independently or collectively provide adequate regulatory protection to *T. californicum* (USFWS 2013).

Stressor: Hybridization (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of genetic viability

Narrative: Since our 2008 review, we received information indicating that hybridization with another nonnative dandelion, *Taraxacum erythrospermum* (red-seeded dandelion), may be a threat. Similar to *T. officinale*, it has a range of chromosome counts, including a count of 16 ($2n=16$, 32) (Brouillet 2006, pp. 245–246). This species has been identified at three occurrences in Big Meadow, Horse Meadow, and Holcomb Valley (CCH 2011, pp. 1–3; Eliason 2011a, pers. comm.) (USFWS, 2013).

Stressor: Limited numbers of *Taraxacum californicum* individuals (USFWS, 2013)

Exposure:

Response:

Consequence: Lack of genetic diversity

Narrative: In the listing rule, we identified the limited number of *Taraxacum californicum* individuals as a threat to *T. californicum*; however, no specific meadow areas or population densities were identified (USFWS 1998, pp. 49016–49017). Barrett and Kohn (1991) have discussed the consequences of small population size in plants. They stress the need for maintaining genetic diversity, especially for rare alleles (different forms of a gene). Maintaining diversity of alleles in self-incompatible (outcrossing) plants is important to ensure production of fertile seeds, and thus is important for the survival of plant populations. The likelihood of maintaining diversity decreases in smaller populations (Barrett and Kohn 1991, pp. 9, 10, 13). Thus, factors that negatively affect *Taraxacum californicum* individuals are more likely to threaten the survival of the species as a whole. The limited number of *Taraxacum californicum* individuals is a substantial threat of particular concern at 18 of 23 occurrences (78 percent), and possibly rangewide (USFWS, 2013).

Stressor: Fire suppression measures (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Since 2008, implementation of fire suppression measures has been identified as a new threat at 9 of 23 extant *Taraxacum californicum* occurrences. The San Bernardino County Land Use/Fire Hazard Abatement Division (see FACTOR D discussion) requires that owners must remove weeds and grasses in areas where this vegetation acts as a fuel that may pose a fire threat. Weeds and grasses are described by the County of San Bernardino generally as annuals that grow and dry out each year, and they did not discriminate for rare plants (County of San Bernardino 2011a, pp. 3–4; County of San Bernardino 2011b, p. 1). Weed and grass removal

generally involves mowing, which damages or destroys individual *T. californicum* plants. If removal activities are conducted before or during *T. californicum* flowering and fruit development, the plants reproductive output and germination may be significantly impacted (USFWS, 2013).

Stressor: Climate change and drought (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Although there is uncertainty in climate change projections and the effects of climate change on this particular species, it seems likely that *Taraxacum californicum*, a species restricted to montane meadows in a single small portion of a mountain range found on particular soils with particular hydrological needs, would be threatened rangewide by differences in climatic regimes brought on by changes to the climate in the future. Therefore, based on the best available scientific data at this time, we believe climate change and drought is likely a significant threat to this species (USFWS, 2013).

Recovery

Recovery Actions:

- No recovery plan (USFWS, 2013)

Conservation Measures and Best Management Practices:

- 1. Continue to work with the State to purchase *Taraxacum californicum* habitat from willing sellers (e.g., Shay Meadow, Metcalf Meadow) (USFWS, 2013).
- 2) Continue to work with the Big Bear City Community Services District to adopt and implement the draft Pan Hot Springs Habitat Management Plan and record the Restrictive Covenant per the plan (USFWS, 2013).
- 3) Continue to work with local partners to identify an appropriate entity or entities to hold and manage conservation easements that protect *Taraxacum californicum* habitat (USFWS, 2013).
- 4) Expand the existing seed bank at Rancho Santa Ana Botanic Garden to include samples from populations determined to be key by the SBNF and the Service to buffer the species from genetic loss, should small populations become extirpated (USFWS, 2013).
- 5) Recommendation specific to threats from limited numbers of *Taraxacum californicum* individuals and hybridization: 1) Determine the breeding system of *T. californicum* and confirm the nature and extent of introgression with *T. officinale* and *T. erythrospermum*. Determine accurate rangewide chromosome counts of *T. californicum*, local *T. officinale* and *T. erythrospermum*. 2) Support SBNF efforts to conduct a prescribed burn of Juniper Meadow and study whether this burn will facilitate germination of any existing *T. californicum* seed in the soil (USFWS, 2013).
- 6) Recommendation specific to threats from competition with other plant species: Promote research and work with partners to determine the extent to which buildup of thatch contributes to the decline of *Taraxacum californicum* and to conduct comparative work on thatch removal methods (i.e., study the benefits and risks of fire, mowing, and any other thatch removal methods). Support SBNF efforts to conduct a prescribed burn of Juniper Meadow (USFWS, 2013).
- 7) Recommendation specific to threats from roads and unauthorized OHV use, and developed and dispersed recreation: Support SBNF efforts to identify additional key areas to close to human access (e.g., Yellow Post Site YP25 at Metcalf Meadows) (USFWS, 2013).

- 8) Recommendation specific to threats from inadequacy of existing regulatory mechanisms: Work with the State and San Bernardino County to help facilitate implementation of the weed abatement plan while minimizing impacts to rare plants including *Taraxacum californicum*. (USFWS, 2013).

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SPECIES ACCOUNT: *Ternstroemia luquillensis* (Palo colorado)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) 04/22/1992

Physical Description

Ternstroemia luquillensis is an evergreen tree of up to 20 meters in height, with dark gray smooth bark. The elliptic to oblong-elliptic entire, extipulate, and coriaceous leaves are about 6-12 cm long and 2.5-4 cm wide. The leaves are acute at both ends, with the midvein sunken; they are black punctate below, with stout petioles of 6-12 mm long. The perfect, actinomorphic flowers are fragrant and solitary, congregating at the end of the branches. The flowers measure about 2.5 cm in diameter, with a slender pedicel of 2.5-9 cm long. The flowers contain five 9 mm long imbricated sepals, and five 12 mm long creamy white petals. Flowers bear numerous stamens, adnate to the base of the corolla, and a two-celled superior ovary with 16-20 ovules in each cell. The fruit is an ovoid capsule with a persistent style, which contain several small bright red seeds of 3 mm long (USFWS, 1993).

Historical Range

See current range/distribution.

Current Range

Ternstroemia luquillensis (palo colorado) is an evergreen tree only known from six individuals within the palo colorado and dwarf forests of the Luquillo Mountains (USFWS, 1993). As of 2019, there is a botanical voucher that reports the presence of palo colorado in the municipality of Maricao on the opposite side of the Island (interior west of Puerto Rico; USFWS 2015). However, no further information is known from this site. (USFWS, 2019).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Unknown (USFWS, 2015)

Reproduction Narrative

Adult: Little is known about the reproductive biology. *Ternstroemia luquillensis* has been collected with flowers in June and July (USFWS, 1993).

Habitat Type

Adult: Palo colorado forest (USFWS, 1993)

Habitat Vegetation or Surface Water Classification

Adult: Palo colorado forest; dwarf/elfin forest (USFWS, 1993)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1993)

Site Fidelity

Adult: High (inferred from USFWS, 1993)

Habitat Narrative

Adult: The Luquillo Mountains region is of volcanic origin and of a rough topography, with cliffs and rock exposures at high elevations. Six major rivers are born in the mountains and waterfalls are numerous. Nineteen soils belonging to four soil associations have been identified within the Caribbean National Forest (Silander et al. 1986), of which the Los Guineos-Guayabota-Rock land association constitutes the most extensive one (USDA 1977). This association contains acidic, shallow to deep, well drained to poorly drained steep soils. The Caribbean National Forest holds four vegetation types: tabonuco forest, palo colorado forest, palma de sierra forest, and dwarf or elfin forest. All the known localities of *Callicarpa ampla* and *Styrax portoricensis*, and some localities of *Ternstroemia luquillensis* and *Ternstroemia subsessilis* occur within the palo colorado vegetation type. Some localities of *Ternstroemia luquillensis* and *Ternstroemia subsessilis*, and all the localities of *Ilex sintenisii* occur in the dwarf forest vegetation type (USFWS, 1993). High ecological integrity and site fidelity as well as low tolerance ranges are inferred based on species specific habitat needs and low number of populations.

Dispersal/Migration**Motility/Mobility**

Adult: Low (Inferred from USFWS, 1993)

Dispersal

Adult: Low (inferred from USFWS, 1993)

Dependency on Other Individuals or Species for Dispersal

Adult: Low/Slow (inferred from USFWS, 1993)

Population Information and Trends**Population Trends:**

Unknown (USFWS, 2015)

Species Trends:

Unknown (USFWS, 2015)

Resiliency:

Low (inferred from USFWS, 2015)

Representation:

Low (inferred from USFWS, 2015)

Redundancy:

Low (inferred from USFWS, 2015)

Number of Populations:

Four (USFWS, 2015)

Population Size:

Six total individuals (USFWS, 2015)

Population Narrative:

When the recovery plan was approved in 1995, the number of individuals of *T. luquillensis* was known to be 6 individuals in 4 populations, and 37 individuals in 4 populations for *T. subsessilis*, all within the Luquillo Mountains (USFWS 1995) In addition to the populations of El Yunque National Forest, there are two specimen collections of *T. luquillensis* at the herbarium of the University of Puerto Rico at Mayaguez (MAPR) that were collected within the Maricao Commonwealth Forest. However, the herbarium specimens do not contain any information about the abundance of the species in the area. Based on the above, the USFWS does not have enough data to accurately determine the status of these two species at this time. Because of the absence of sightings, it is possible that the species' status may be declining or that some of their populations are extinct, but further monitoring is needed to support this conclusion (USFWS, 2015). In addition, Low resiliency, representation and redundancy are inferred based on low number of populations and individuals.

Threats and Stressors

Stressor: Forest management (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat/Loss of individuals

Narrative: At the time of listing, forest management practices such as the establishment and maintenance of plantations, selective cutting, trails and roads construction and maintenance, and shelter construction may have affected these trees. Furthermore, the proposed reconstruction and reopening of Road PR 191 was considered as a direct threat to some populations of these species. The destruction of the dwarf or elfin forests for the construction and/or expansion of communication facilities by the U.S. Navy and private entities were also considered a threat. Based on the available information, the core of the known populations of *I. sintenisii*, *S. portoricensis*, *C. ampla*, *T. subsessilis*, and *T. luquillensis* occur within the boundaries of El Yunque National Forest. Since the time of listing the USFWS has not documented any case of an individual of an endangered species being affected by forest management practices (management of plantations, trail maintenance or road construction). Moreover, the plans to reopen Road PR 191 have been abandoned due to the potential for further landslides that may compromise the project. Nonetheless, the USFS consults with the Service under Section 7 of the ESA when proposing actions within the forest to ensure that possible adverse effects to listed species are avoided or minimized before any such project is implemented. In addition, the USFS conduct environmental reviews documents under NEPA for all actions in the forest. These consultation mechanisms are effective tools to minimize possible effects of management activities on species and their habitats. Based on the above, we consider the present or threatened destruction, modification, or curtailment of the species habitat or range as low in magnitude and not imminent threat to these species (USFWS, 2015).

Stressor: Overutilization (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Despite the fact that plant collection in El Yunque National Forest is prohibited, when the five species were listed, collection was considered a threat due to the ornamental potential of these species. However, there is no evidence indicating that the species has been affected by these factors. Based on the above, we believe that overutilization for commercial, scientific or educational purposes is no longer a threat to these species (USFWS, 2015).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat/Loss of individuals

Narrative: Since the currently known populations of these species are mostly restricted to El Yunque National Forest, and there are appropriate Commonwealth and Federal laws and regulations protecting these five species, we believe that the inadequacy of existing regulatory mechanisms should no longer be considered a threat to them. However, historical collections indicate that suitable habitat may extend to private properties adjacent to El Yunque. In fact, some of the known populations that occur within El Yunque National Forest are located just along the boundaries of the forest. Thus, it is important to note that enforcement on private lands continues to be a challenge as accidental damage or extirpation of individuals has occurred with other federally listed species due to lack of knowledge of the species by private land owners and law enforcement officers (USFWS, 2015).

Stressor: Hurricanes (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat/Loss of individuals

Narrative: Due to the low number of populations and individuals, hurricanes were identified as a threat to *I. sintenisii*, *S. portoricensis*, *C. ampla*, *T. subsessilis* and *T. luquillensis* in the final rule. As endemic to the Caribbean, these tree species should be well adapted to tropical storms disturbance. However, the low number of populations and individuals pose a threat to the species by making them more susceptible to stochastic events such as hurricanes. In fact, it is not clear to what extent populations of these species may have been affected by Hurricane Hugo (which devastated El Yunque National Forest in 1989) or Hurricane Georges (in 1998). The heavy rains associated with tropical storms and hurricanes in the mountains of Puerto Rico often lead to landslides. Despite the low number of populations and individuals, the USFWS considers hurricanes, landslides and climate change as a moderate and non-imminent threat to these species (USFWS, 2015).

Stressor: Landslides (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat/Loss of individuals

Narrative: Natural landslides are common as part of the forest dynamics of El Yunque and it is expected that the frequency of this disturbance increases as a result of severe extreme rain events or droughts. Given the steep slopes on which most of these species grow, massive

landslides may extirpate entire populations. The USFWS is aware that an area of road PR 191 that formerly connected the municipalities of Río Grande and Naguabo, and that run across the forest has historically been affected by landslides. This area was the site of some populations that were not located by the interagency group in 2011. Due to the severity of landslides, it was determined that it was not logistically and economically feasible to repair this road. Based on the 2011 surveys, *I. sintenisii* seems to be the only species that is not imminently threatened by hurricanes and landslides. The prime habitat for *I. sintenisii* is associated with dwarf forest vegetation. Due to the low agricultural value and inaccessibility of this habitat, this vegetation was not cleared during the peak of the deforestation of the island, and thus some of the highest parts of El Yunque remain as pristine forest. This explains the relative abundance of the species along the summits of Pico El Yunque and Pico del Este. Despite the low number of populations and individuals, the USFWS considers hurricanes, landslides and climate change as a moderate and non-imminent threat to these species (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat/Loss of individuals

Narrative: This species may be further threatened by climate change, which is predicted to increase the frequency and strength of tropical storms and can cause severe droughts (Hopkinson et al. 2008). Vulnerability to climate change impacts is a function of sensitivity to those changes (e.g., changes rain regime and moisture availability), exposure to those changes, and adaptive capacity (Glick et al. 2011). Despite the relative abundance and apparently stability of the populations of *I. sintenisii*, its habitat is considered rare in Puerto Rico. These areas (dwarf forest vegetation) are ecological islands that harbor unique vegetation and environmental conditions. Shifts of vegetation communities are expected as temperatures and moisture regimes are altered by climate change. Under this scenario populations of *I. sintenisii* as well as *S. portoricensis*, *C. ampla*, *T. subsessilis*, and *T. luquillensis* may be displaced or outcompeted by native or exotic species with wider environmental plasticity. Despite the low number of populations and individuals, the USFWS considers hurricanes, landslides and climate change as a moderate and non-imminent threat to these species (USFWS, 2015).

Stressor: Genetic variation (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of viability

Narrative: Along with a decreasing population size, negative impacts of habitat fragmentation may result in erosion of genetic variation through the loss of alleles by random genetic drift (Honnay and Jacquemyn 2007) and may also limit the ability of a species to respond to a changing environment (Booy et al. 2000). Given the extremely small population size and lack of connectivity between populations of *S. portoricensis*, *C. ampla*, *T. subsessilis* and *T. luquillensis* in Puerto Rico, it is highly likely that their genetic variability is extremely low. Based on the above, we consider the lack of genetic variation a high and imminent threat to *S. portoricensis*, *C. ampla*, *T. subsessilis* and *T. luquillensis*. Overall, we consider hurricanes, landslides, climate change and genetic variation as threats to *S. portoricensis*, *C. ampla*, *T. subsessilis* and *T. luquillensis*. Due to the small number of populations, the USFWS considers the above mentioned threats as high in magnitude and imminent for those species. In the case of *I. sintenisii*, the species is at least stable

and probably improving, thus we consider the above mentioned threats as low and non-imminent (USFWS, 2015).

Recovery

Reclassification Criteria:

An agreement between the Fish and Wildlife Service and the USDA Forest Service concerning the protection of *Callicarpa ampla*, *Ilex sintenisii*, *Styrax portoricensis*, *Ternstroemia luquillensis*, and *Ternstroemia subsessilis* within the Caribbean. National Forest property has been prepared and implemented (USFWS, 1993).

An agreement between the Fish and Wildlife Service and the Department of Natural and Environmental Resources (DNER) concerning the protection of the three species in Commonwealth forests has been prepared and implemented, if the species is found within DNER properties (USFWS, 1993).

New populations (the number of which should be determined following the appropriate studies) capable of self perpetuation have been established within protected areas (USFWS, 1993).

Delisting Criteria:

1. Existing natural populations exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (addresses Factors E). (USFWS, 2019).
2. Establish or discover four (4) additional populations within the current range at EYNF that exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (addresses Factors A and E). (USFWS, 2019).
3. Establish or discover two (2) new populations outside the current range but within the historical range (e.g., Carite, Guilarte or Toro Negro Commonwealth Forests) that exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (addresses Factors A and E). (USFWS, 2019).
4. Threats have been addressed and/or managed to the extent that the species will remain viable into the foreseeable future (addresses Factor A and E). (USFWS, 2019).

Recovery Actions:

- 1. Establish long-term conservation mechanisms (e.g., land conservation easements and conservation agreements) for private lands outside/bordering EYNF since these lands share similar vegetation and habitat characteristics. This new action should be included within Recovery Task 11. (USFWS, 2019).
- 2. A protocol for the propagation and reintroduction of all five species should be developed in collaboration with partners (e.g., University of Puerto Rico, KEW, Fairchild Tropical Botanic Garden, PRDNER, Para La Naturaleza and Natural Resources Conservation Service). The protocol should address the feasibility of seed banking these species, and if deemed necessary, seed material should be stored at the Millennium Seed Bank (KEW) and USDA National Laboratory for Genetic Resources Preservation in Ft. Collins. This new action should be included within Recovery Task 33. (USFWS, 2019).

- 3. Studies in the species' population genetics should be conducted to determined patterns of genetic diversity across the species natural distribution, and to provide baseline information for sound management of these species. This new action should be included within Recovery Task 3. (USFWS, 2019).

References

U.S. Fish and Wildlife Service. 1993. *Callicarpa ampla*, *Ilex sintenisii*, *Styrax portoricensis*, *Ternstroemia luquillensis*, and *Ternstroemia subsessilis* Recovery Plan. Prepared by Eugenio Santiago-Valentin and Marelisa Rivera for the U.S. Fish and Wildlife Service, Atlanta, Georgia. 26 pp

U.S. Fish and Wildlife Service. 2015. *Callicarpa ampla* / (Capá rosa) *Ilex sintenisii* / (no common name) *Styrax portoricensis* / Palo de jazmín *Ternstroemia luquillensis* / Palo colorado *Ternstroemia subsessilis* / (no common name) 5-Year Review: Summary and Evaluation U.S. Fish and Wildlife Service Southeast Region Caribbean Ecological Services Field Office Boquerón, Puerto Rico

USFWS. 2019. *Callicarpa ampla*, *Ilex sintenisii*, *Szyrax portoricensis*. *Ternstroemia luguillensis* and *Ternstroemia subsessilis* Recovery Plan. Prepared by Eugenio Santiago-Valentin and Marelisa Rivera for U.S Fish and Wildlife Service, Atlanta. Georgia. 25pp.

U.S. Fish and Wildlife Service. 2015. *Callicarpa ampla* / (Capá rosa) *Ilex sintenisii* / (no common name) *Styrax portoricensis* / Palo de jazmín *Ternstroemia luquillensis* / Palo colorado *Ternstroemia subsessilis* / (no common name) 5-Year Review: Summary and Evaluation U.S. Fish and Wildlife Service Southeast Region Caribbean Ecological Services Field Office Boquerón, Puerto Rico.

USFWS. 2019. *Callicarpa ampla*, *Ilex sintenisii*, *Szyrax portoricensis*. *Ternstroemia luguillensis* and *Ternstroemia subsessilis* Recovery Plan. Prepared by Eugenio Santiago-Valentin and Marelisa Rivera for U.S Fish and Wildlife Service, Atlanta. Georgia. 25pp.

SPECIES ACCOUNT: *Ternstroemia subsessilis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) 04/22/1992

Physical Description

Ternstroemia subsessilis is an evergreen shrub or small tree of up to 5 m height. The leaves are alternate, exstipulate, and thick, measuring 3-7 cm long and 1.5-2.8 wide. The leaf blade is obovate to oblanceolate, with an obtuse and sometimes apiculate apex, and a cuneate base. The leaves are revolute, with a punctate lower leaf surface. Petioles are stout, measuring 6.6 mm long. The flower is perfect, actinomorphic and solitary, growing axillary from the end of the branches. The short pedicel, of 1-2 mm long, makes the flower appear sessile or subsessile, as the specific epithet of this plant suggests. The calyx consists of five glandular, imbricate sepals, 2-5 mm long. The corolla contains five white, connate, orbicular or concave petals, 10 mm long. The stamens are numerous, being adnate at the base of the corolla. The ovary is superior and probably two-celled. The fruit is an ovoid-conical capsule of 10 mm long, with a sharp point (USFWS, 1993).

Historical Range

Ternstroemia subsessilis (no common name) is an evergreen shrub or small tree which has been reported from the Luquillo Mountains and the Maricao Forest. It is currently known only from a population that consists of 37 individuals from nine sites at the Luquillo Mountains (USFWS, 1993).

Current Range

USFWS (2015) notes that there are 4 populations, all within the Luquillo Mountains.

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Unknown (USFWS, 2015)

Reproduction Narrative

Adult: Little is known about the reproductive biology of this species. Ripe fruits were observed on various individuals of *Ternstroemia subsessilis* in May 1991 (Garcia and Laboy 1991) (USFWS, 1993).

Habitat Type

Adult: Palo colorado forest (USFWS, 1993)

Habitat Vegetation or Surface Water Classification

Adult: Palo colorado forest; dwarf/elfin forest (USFWS, 1993)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1993)

Site Fidelity

Adult: High (inferred from USFWS, 1993)

Habitat Narrative

Adult: The Luquillo Mountains region is of volcanic origin and of a rough topography, with cliffs and rock exposures at high elevations. Six major rivers are born in the mountains and waterfalls are numerous. Nineteen soils belonging to four soil associations have been identified within the Caribbean National Forest (Silander et al. 1986), of which the Los Guineos-Guayabota-Rock land association constitutes the most extensive one (USDA 1977). This association contains acidic, shallow to deep, well drained to poorly drained steep soils. The Caribbean National Forest holds four vegetation types: tabonuco forest, palo colorado forest, palma de sierra forest, and dwarf or elfin forest. All the known localities of *Callicarpa ampla* and *Styrax portoricensis*, and some localities of *Ternstroemia luquillensis* and *Ternstroemia subsessilis* occur within the palo colorado vegetation type. Some localities of *Ternstroemia luquillensis* and *Ternstroemia subsessilis*, and all the localities of *Ilex sentenisi* occur in the dwarf forest vegetation type (USFWS, 1993). High ecological integrity and site fidelity as well as low tolerance ranges are inferred based on species specific habitat needs and low number of populations.

Dispersal/Migration**Motility/Mobility**

Adult: Low (Inferred from USFWS, 1993)

Dispersal

Adult: Low (inferred from USFWS, 1993)

Dependency on Other Individuals or Species for Dispersal

Adult: Low/Slow (inferred from USFWS, 1993)

Population Information and Trends**Population Trends:**

Unknown (USFWS, 2015)

Species Trends:

Unknown (USFWS, 2015)

Resiliency:

Low (inferred from USFWS, 2015)

Representation:

Low (inferred from USFWS, 2015)

Redundancy:

Low (inferred from USFWS, 2015)

Number of Populations:

Four (USFWS, 2015)

Population Size:

37 total individuals (USFWS, 2015)

Population Narrative:

There are four known populations with a total of 37 individuals. Species level and population level trends are unknown based on lack of data (USFWS, 2015). In addition, Low resiliency, representation and redundancy are inferred based on low number of populations and individuals.

Threats and Stressors

Stressor: Forest management (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat/Loss of individuals

Narrative: At the time of listing, forest management practices such as the establishment and maintenance of plantations, selective cutting, trails and roads construction and maintenance, and shelter construction may have affected these trees. Furthermore, the proposed reconstruction and reopening of Road PR 191 was considered as a direct threat to some populations of these species. The destruction of the dwarf or elfin forests for the construction and/or expansion of communication facilities by the U.S. Navy and private entities were also considered a threat. Based on the available information, the core of the known populations of *I. sintenisii*, *S. portoricensis*, *C. ampla*, *T. subsessilis*, and *T. luquillensis* occur within the boundaries of El Yunque National Forest. Since the time of listing the USFWS has not documented any case of an individual of an endangered species being affected by forest management practices (management of plantations, trail maintenance or road construction). Moreover, the plans to reopen Road PR 191 have been abandoned due to the potential for further landslides that may compromise the project. Nonetheless, the USFS consults with the Service under Section 7 of the ESA when proposing actions within the forest to ensure that possible adverse effects to listed species are avoided or minimized before any such project is implemented. In addition, the USFS conduct environmental reviews documents under NEPA for all actions in the forest. These consultation mechanisms are effective tools to minimize possible effects of management activities on species and their habitats. Based on the above, we consider the present or threatened destruction, modification, or curtailment of the species habitat or range as low in magnitude and not imminent threat to these species (USFWS, 2015).

Stressor: Overutilization (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Despite the fact that plant collection in El Yunque National Forest is prohibited, when the five species were listed, collection was considered a threat due to the ornamental potential of these species. However, there is no evidence indicating that the species has been affected by

these factors. Based on the above, we believe that overutilization for commercial, scientific or educational purposes is no longer a threat to these species (USFWS, 2015).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat/Loss of individuals

Narrative: Since the currently known populations of these species are mostly restricted to El Yunque National Forest, and there are appropriate Commonwealth and Federal laws and regulations protecting these five species, we believe that the inadequacy of existing regulatory mechanisms should no longer be considered a threat to them. However, historical collections indicate that suitable habitat may extend to private properties adjacent to El Yunque. In fact, some of the known populations that occur within El Yunque National Forest are located just along the boundaries of the forest. Thus, it is important to note that enforcement on private lands continues to be a challenge as accidental damage or extirpation of individuals has occurred with other federally listed species due to lack of knowledge of the species by private land owners and law enforcement officers (USFWS, 2015).

Stressor: Hurricanes (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat/Loss of individuals

Narrative: Due to the low number of populations and individuals, hurricanes were identified as a threat to *I. sintenisii*, *S. portoricensis*, *C. ampla*, *T. subsessilis* and *T. luquillensis* in the final rule. As endemic to the Caribbean, these tree species should be well adapted to tropical storms disturbance. However, the low number of populations and individuals pose a threat to the species by making them more susceptible to stochastic events such as hurricanes. In fact, it is not clear to what extent populations of these species may have been affected by Hurricane Hugo (which devastated El Yunque National Forest in 1989) or Hurricane Georges (in 1998). The heavy rains associated with tropical storms and hurricanes in the mountains of Puerto Rico often lead to landslides. Despite the low number of populations and individuals, the USFWS considers hurricanes, landslides and climate change as a moderate and non-imminent threat to these species (USFWS, 2015).

Stressor: Landslides (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat/Loss of individuals

Narrative: Natural landslides are common as part of the forest dynamics of El Yunque and it is expected that the frequency of this disturbance increases as a result of severe extreme rain events or droughts. Given the steep slopes on which most of these species grow, massive landslides may extirpate entire populations. The USFWS is aware that an area of road PR 191 that formerly connected the municipalities of Río Grande and Naguabo, and that run across the forest has historically been affected by landslides. This area was the site of some populations that were not located by the interagency group in 2011. Due to the severity of landslides, it was determined that it was not logistically and economically feasible to repair this road. Based on the 2011 surveys, *I. sintenisii* seems to be the only species that is not imminently threatened by hurricanes and landslides. The prime habitat for *I. sintenisii* is associated with dwarf forest

vegetation. Due to the low agricultural value and inaccessibility of this habitat, this vegetation was not cleared during the peak of the deforestation of the island, and thus some of the highest parts of El Yunque remain as pristine forest. This explains the relative abundance of the species along the summits of Pico El Yunque and Pico del Este. Despite the low number of populations and individuals, the USFWS considers hurricanes, landslides and climate change as a moderate and non-imminent threat to these species (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat/Loss of individuals

Narrative: This species may be further threatened by climate change, which is predicted to increase the frequency and strength of tropical storms and can cause severe droughts (Hopkinson et al. 2008). Vulnerability to climate change impacts is a function of sensitivity to those changes (e.g., changes rain regime and moisture availability), exposure to those changes, and adaptive capacity (Glick et al. 2011). Despite the relative abundance and apparently stability of the populations of *I. sintenisii*, its habitat is considered rare in Puerto Rico. These areas (dwarf forest vegetation) are ecological islands that harbor unique vegetation and environmental conditions. Shifts of vegetation communities are expected as temperatures and moisture regimes are altered by climate change. Under this scenario populations of *I. sintenisii* as well as *S. portoricensis*, *C. ampla*, *T. subsessilis*, and *T. luquillensis* may be displaced or outcompeted by native or exotic species with wider environmental plasticity. Despite the low number of populations and individuals, the USFWS considers hurricanes, landslides and climate change as a moderate and non-imminent threat to these species (USFWS, 2015).

Stressor: Genetic variation (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of viability

Narrative: Along with a decreasing population size, negative impacts of habitat fragmentation may result in erosion of genetic variation through the loss of alleles by random genetic drift (Honnay and Jacquemyn 2007) and may also limit the ability of a species to respond to a changing environment (Booy et al. 2000). Given the extremely small population size and lack of connectivity between populations of *S. portoricensis*, *C. ampla*, *T. subsessilis* and *T. luquillensis* in Puerto Rico, it is highly likely that their genetic variability is extremely low. Based on the above, we consider the lack of genetic variation a high and imminent threat to *S. portoricensis*, *C. ampla*, *T. subsessilis* and *T. luquillensis*. Overall, we consider hurricanes, landslides, climate change and genetic variation as threats to *S. portoricensis*, *C. ampla*, *T. subsessilis* and *T. luquillensis*. Due to the small number of populations, the USFWS considers the above mentioned threats as high in magnitude and imminent for those species. In the case of *I. sintenisii*, the species is at least stable and probably improving, thus we consider the above mentioned threats as low and non-imminent (USFWS, 2015).

Recovery

Reclassification Criteria:

An agreement between the Fish and Wildlife Service and the USDA Forest Service concerning the protection of *Callicarpa ampla*, *Ilex sintenisii*, *Styrax portoricensis*, *Ternstroemia luquillensis* ,

and *Ternstroemia subsessilis* within the Caribbean. National Forest property has been prepared and implemented (USFWS, 1993).

An agreement between the Fish and Wildlife Service and the Department of Natural and Environmental Resources (DNER) concerning the protection of the three species in Commonwealth forests has been prepared and implemented, if the species is found within DNER properties (USFWS, 1993).

New populations (the number of which should be determined following the appropriate studies) capable of self perpetuation have been established within protected areas (USFWS, 1993).

Delisting Criteria:

1. Existing natural populations exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (addresses Factors E). (USFWS, 2019).
2. Establish or discover four (4) additional populations within the current range at EYNF that exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (addresses Factors A and E). (USFWS, 2019).
3. Establish or discover two (2) new populations outside the current range but within the historical range (e.g., Carite, Guilarte or Toro Negro Commonwealth Forests) that exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (addresses Factors A and E). (USFWS, 2019).
4. Threats have been addressed and/or managed to the extent that the species will remain viable into the foreseeable future (addresses Factor A and E). (USFWS, 2019).

Recovery Actions:

- Criterion 1 has been partially met. There is no formal agreement between the USFS and the USFWS for the implementation of a management plan to protect these five species. However, the El Yunque National Forest is managed by the USFS for conservation, and has an approved "Revised Land and Resource Management Plan" (1997), which is currently under revision. Moreover, Federal agencies are mandated to carry out programs for the conservation of endangered species under Section 7 of the Endangered Species Act (ESA) to ensure that any action authorized, funded or carried out by a Federal agency is not likely to jeopardize the continued existence of a federally listed species. Thus, the USFS continually consults with the USFWS to avoid and minimize impacts to listed species and their habitat at El Yunque National Forest. In addition, on July 26, 2005, the U.S. Congress enacted the Caribbean National Forest Act to designate approximately 10,000 acres of land in the El Yunque National Forest as wilderness and as a component of the National Wilderness Preservation System in accordance with the Wilderness Act (16 U.S.C. 1131 et seq.). This Act prohibits certain activities (e.g., timber harvest) within wilderness designated areas, although it does not preclude the installation and maintenance of facilities (e.g., data collection and remote transmission facilities) essential to the scientific and conservation purposes of the Forest Service. Therefore, the majority of the habitat upon which these species depend upon is essentially protected (USFWS, 2015).
- Criterion 2 has been partially met. Although there is no specific agreement between USFWS and the PRDNER concerning the protection of these three species in Commonwealth forests,

there is an agreement between the two agencies under Section 6 of the Endangered Species Act, in which the PRDNER carries out conservation activities for the benefit of threatened and endangered species. Furthermore, these five species are listed by the PRDNER as endangered, and thus are protected by regulations of the Commonwealth of Puerto Rico (See factor D.). Therefore, special consideration is taken when considering actions within areas that harbor suitable habitat for these species (USFWS, 2015).

- Criterion 3 has been initiated. The Puerto Rico Conservation Trust (PRCT) is successfully propagating *Styrax portoricensis*. The USFWS has utilized some of this material and begun planting this species (approximately 50 individuals) at El Yunque National Forest. In addition, the PRDNER began planting *Styrax portoricensis* (approximately 5 individuals) in the Carite Commonwealth Forest. Furthermore, the USFS has propagated *Callicarpa ampla* by air layering (cloning by promoting rooting of branches using hormones), and has planted about three individuals at El Portal in El Yunque National Forest. However, little information is available about the reproductive biology and the ecology of these species. Further research and monitoring of reintroduced individuals is required to determine the success of these actions. There is no information about the propagation of any of the remaining three species (*Ilex sintenisii*, *Ternstroemia luquillensis* and *Ternstroemia subsessilis*) (USFWS, 2015).
- New in 2019: 1. Establish long-term conservation mechanisms (e.g., land conservation easements and conservation agreements) for private lands outside/bordering EYNF since these lands share similar vegetation and habitat characteristics. This new action should be included within Recovery Task 11. (USFWS, 2019).
- 2019 - 2. A protocol for the propagation and reintroduction of all five species should be developed in collaboration with partners (e.g., University of Puerto Rico, KEW, Fairchild Tropical Botanic Garden, PRDNER, Para La Naturaleza and Natural Resources Conservation Service). The protocol should address the feasibility of seed banking these species, and if deemed necessary, seed material should be stored at the Millennium Seed Bank (KEW) and USDA National Laboratory for Genetic Resources Preservation in Ft. Collins. This new action should be included within Recovery Task 33. (USFWS, 2019).
- 2019 - 3. Studies in the species' population genetics should be conducted to determined patterns of genetic diversity across the species natural distribution, and to provide baseline information for sound management of these species. This new action should be included within Recovery Task 3. (USFWS, 2019).

Conservation Measures and Best Management Practices:

- 1. The USFS should establish a long term monitoring program for the populations of listed plants at El Yunque National Forest to determine population trends for these species. The guidelines for these monitoring should be included as part of the El Yunque National Forest Management Plan (USFWS, 2015).
- 2. Develop a comprehensive survey and assessment of the population of *I. sintenisii*. This survey must be standardized to ensure that the habitat (dwarf forest) is efficiently surveyed (USFWS, 2015).
- 3. Molecular studies should be conducted to determine the relationships within the genus *Ilex* in Puerto Rico (USFWS, 2015).
- 4. The USFS, PRDNER and the USFWS should develop an intensive survey program to inventory areas within and outside El Yunque National Forest with potential habitat for these species. This program should include training to field biologists to allow personnel to recognize listed species in the field (USFWS, 2015).

- 5. The populations that are actively producing seeds need to be identified and monitored to collect seed material for recovery purposes. A protocol to collect seed should be developed and implemented to avoid altering the natural recruitment of the species (USFWS, 2015).
- 6. Enhancement of natural populations should be considered a priority, particularly for *S. portoricensis*, *C. ampla*, *T. subsessilis* and *T. luquillensis*. The development of adequate propagation techniques is essential for the recovery of these species (USFWS, 2015).
- 7. Studies should be conducted to determine the patterns of genetic variation within and among populations, in order to develop a plan to preserve the species genetic variability (USFWS, 2015).
- 8. The recovery plan should be revised to establish measurable delisting criteria, including how many individuals constitute a self-sustainable population and how many populations would be needed to delist the species (USFWS, 2015).

References

U.S. Fish and Wildlife Service. 1993. *Callicarpa ampla*, *Ilex sintenisii*, *Styrax portoricensis*, *Ternstroemia luquillensis*, and *Ternstroemia subsessilis* Recovery Plan. Prepared by Eugenio Santiago-Valentin and Marelisa Rivera for the U.S. Fish and Wildlife Service, Atlanta, Georgia. 26 pp

U.S. Fish and Wildlife Service. 2015. *Callicarpa ampla* / (Capá rosa) *Ilex sintenisii* / (no common name) *Styrax portoricensis* / Palo de jazmín *Ternstroemia luquillensis* / Palo colorado *Ternstroemia subsessilis* / (no common name) 5-Year Review: Summary and Evaluation U.S. Fish and Wildlife Service Southeast Region Caribbean Ecological Services Field Office Boquerón, Puerto Rico.

USFWS. 2019. *Callicarpa ampla*, *Ilex sintenisii*, *Szyrax portoricensis*. *Ternstroemia luguillensis* and *Ternstroemia subsessilis* Recovery Plan. Prepared by Eugenio Santiago-Valentin and Marelisa Rivera for U.S Fish and Wildlife Service, Atlanta. Georgia. 25pp.

USFWS. 2015. *Callicarpa ampla* / (Capá rosa) *Ilex sintenisii* / (no common name) *Styrax portoricensis* / Palo de jazmín *Ternstroemia luquillensis* / Palo colorado *Ternstroemia subsessilis* / (no common name)

5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Southeast Region, Caribbean Ecological Services Field Office, Boquerón, Puerto Rico.

SPECIES ACCOUNT: *Tetramolopium arenarium* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/04/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

Tetramolopium arenarium ssp. *arenarium* is an erect tufted shrub 0.8 to 1.3 meters (2.6 to 4.3 feet) tall. Plants are covered with tiny glands and straight hairs. Leaves are alternate, shallowly toothed (or toothless), and lance-shaped. They range in length from 15 to 35 millimeters (0.6 to 1.5 inches) and in width from 3 to 9 millimeters (0.1 to 0.4 inch). Inflorescences are terminal with 5 to 10 heads. Each head has 20 to 34 bracts beneath a single series of white florets (male ray florets) on the outside and fewer than 15 inner bisexual maroon-petalled disk florets. The fruits are compressed achenes (U.S. Army 2003a).

Taxonomy

Tetramolopium arenarium is a member of the Asteraceae, or sunflower family. Current classification recognizes three intraspecific taxa: *T. arenarium* ssp. *arenarium* var. *arenarium*, *T. arenarium* ssp. *arenarium* var. *confertum*, and *T. arenarium* ssp. *laxum*. These are distinguished from other members of the genus by its erect habit; presence and types of glands and hairs on the plant; few-flowered head clusters; large male ray florets; few, bisexual, maroon-petalled disk florets; and wide achenes (U.S. Army 2003a).

Historical Range

Historically, *Tetramolopium arenarium* ssp. *arenarium* was known from the islands of Maui and Hawaii.

Current Range

Currently, between 292 and 296 individuals occur only on the island of Hawaii (see Figure 49 in the Transformation Biological Assessment) (U.S. Army 2003a).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Habitat Type

Adult: Shrublands

Habitat Narrative

Adult: *Tetramolopium arenarium* ssp. *arenarium* occurs in *Dodonaea viscosa* dominated lowland and montane dry shrublands at elevations from 800 and 1,500 meters (2,625 and 4,921 feet). At the Pohakuloa Training Area (PTA) on the island of Hawaii the species is found in the *Dodonaea* Mixed Shrubland at elevations between 1,300 and 1,700 meters (4,265 and 5,577 feet). *Tetramolopium arenarium* ssp. *arenarium* is extremely rare on very old Mauna Kea flows (greater than 10,000 years old) (U.S. Army 2003a).

Dispersal/Migration***Population Information and Trends*****Resiliency:**

Fragility unknown. (NatureServe, 2015)

Representation:

Fragility unknown. (NatureServe, 2015)

Redundancy:

Fragility unknown. (NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Adaptability:

Fragility unknown. (NatureServe, 2015)

Population Narrative:

Fragility unknown. Currently fewer than 500 plants known. Three current (between 1982 and 1997) and three historical occurrences. (NatureServe, 2015)

Threats and Stressors**Stressor:****Exposure:****Response:****Consequence:**

Narrative: The primary threats to *Tetramolopium arenarium* ssp. *arenarium* are feral ungulates that browse on the plant; rooting by feral pigs; competition from non-native plant species such as *Pennisetum setaceum*; and conversion of habitat to a fire-based vegetation community. Army training such as mounted and dismounted off-road maneuvers, bivouac, and live-fire training, increase the risk of fire, habitat fragmentation and alien plant seed spread. Off-road and on-road driving and training increases the level of dust (which can compromise plant health and vigor) due to the fine soils in northern PTA. In addition, due to the very limited distribution of this species, a single natural or human-caused environmental disturbance could be catastrophic (U.S. Army 2003a).

Stressor:**Exposure:****Response:****Consequence:**

Narrative: If the species is still extant in the general area in which it was originally collected, it is threatened by alien plants, introduced ungulates, and fire. (NatureServe, 2015)

Stressor:

Exposure:

Response:

Consequence:

Narrative: Threats include fire, military activities, sheep, goats, and pigs. (NatureServe, 2015)

Recovery

Conservation Measures and Best Management Practices:

- The following important conservation actions are needed for *Tetramolopium arenarium* ssp. *arenarium*: control of non-native plant species and feral ungulates; reduction of fire risk; and research on habitat requirements, population structure, reproductive biology, and seed biology. Augmentation of small populations and re-establishment of new populations within the historical range of the species are also expected to benefit the species (U.S. Army 2003a). In addition, a State-wide management plan that identifies areas and landscapes for the long-term conservation of all known occurrences of *T. arenarium* ssp. *arenarium* is needed. As part of this management plan, landowners and managers should delineate management units to conserve this species and other native species through threat control and habitat restoration. Ongoing Conservation Actions: Aside from specific actions occurring at PTA (and discussed below), the Service is unaware of species-specific conservation actions being conducted for *Tetramolopium arenarium* ssp. *arenarium*.

References

USFWS 2016. Status of the Species and Critical Habitat: *Tetramolopium arenarium* (no common name). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016.

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.”

SPECIES ACCOUNT: *Tetramolopium capillare* (Pamakani)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/30/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

Tetramolopium capillare are is a slender, low-growing or sprawling shrub in the aster family (Asteraceae). Stems are 50-80 cm (19.7-31.5 in) long and densely glandular when young. The leaves are slender (10-25 x 0.3-0.4 mm [0.4-1x 0.01-0.02 in]) with pointed tips. The leaves are involute—that is, the leaf edges strongly roll toward the top surface of the leaf. The leaves, attached directly to the main stem of the plant, are firm and resistant to signs of wilting. The leaves are hairless or with small hairs near the base. Glandular flower heads occur singly on stalks and measure 7-10 mm (0.3-0.4 in) in diameter with 30-50 petal-like white, 3.5-4.3 mm (0.1-0.2 in) ray florets and 15-25 red-tinged greenish-yellow 3.6 mm (0.1 in) disk florets; the bases of the heads are covered with 45-50 small grasslike appendages (bracts). The dry fruits (achenes) are under 3 mm (0.1 in) long and under 1 mm (0.04 in) wide. (USFWS, 1997)

Taxonomy

This taxon can be readily distinguished from the apparently related *Tetramolopium remyi* by its shorter flower stalk, smaller heads, and lax or sprawling habit (Wagner et al. 1990). Despite the close relationship with *Tetramolopium remyi*, *T. capillare* is readily distinguished by its shorter peduncle, smaller heads, and lax or sprawling habit (Wagner et al. 1990). (USFWS, 1997)

Historical Range

Regarding *Tetramolopium capillare*, Lowrey in Wagner et al. (1990) states, “known only from dry forest and shrubland among rocks in the foothills, West Maui from Lahainaluna to Wailuku. (USFWS, 1997)

Current Range

Endemic to West Maui. Thus, *Tetramolopium capillare* is currently known only from Halepohaku and Kauaula Valley, West Maui. (USFWS, 1997)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Tetramolopium capillare* (Pamakani) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes seven detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Tetramolopium capillare* includes seven CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Lowland Dry—Unit 5 consists of 3,615 ac (1,463 ha) of State land, and 43 ac (17 ha) of privately owned land, from Panaewa to Manawainui on the western and southern slopes of west

Maui. This unit is occupied by the plants *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, *Cenchrus agrimonoides*, *Gouania hillebrandii*, *Kadua coriacea*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and *Tetramolopium capillare*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 5 is not known to be occupied by *Ctenitis squamigera*, *Cyanea obtusa*, *Hesperomannia arbuscula*, *Hibiscus brackenridgei*, *Lysimachia lydgatei*, *Neraudia sericea*, *Schiedea salicaria*, *Sesbania tomentosa*, or *T. remyi*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 6 consists of 3 ac (1 ha) of State land, and 237 ac (96 ha) of privately owned land, from Paleaahu Gulch to Puu Hona on the southern slopes of west Maui. This unit is occupied by the plants *Hibiscus brackenridgei* and *Schiedea salicaria*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 6 is not known to be occupied by *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, *Cenchrus agrimonoides*, *Ctenitis squamigera*, *Cyanea obtusa*, *Gouania hillebrandii*, *Hesperomannia arbuscula*, *Kadua coriacea*, *Lysimachia lydgatei*, *Neraudia sericea*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Spermolepis hawaiiensis*, *Tetramolopium capillare*, or *T. remyi*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 5 (and) *Palmeria dolei*—Unit 29—Dry Cliff (and) *Pseudonestor xanthophrys*—Unit 29— Dry Cliff This area consists of 1,298 ac (525 ha) of State land, from Helu and across Olowalu to Ukumehame Gulch, on west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). They are occupied by the plant *Tetramolopium capillare*, and contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Dry Cliff—Unit 5 is not currently occupied by the plants *Bonamia menziesii*, *Diplazium molokaiense*, *Hesperomannia arbuscula*, *Isodendron pyriformum*, *Kadua laxiflora*, or *Neraudia sericea*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 6 consists of 279 ac (113 ha) of State land along the east wall of Ukumehame Gulch on west Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). Although Maui—Dry Cliff—Unit 6 is not currently occupied by the plants *Bonamia menziesii*, *Diplazium molokaiense*, *Hesperomannia arbuscula*, *Isodendron pyriformis*, *Kadua laxiflora*, *Neraudia sericea*, or *Tetramolopium capillare*, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 6 (and) *Palmeria dolei*—Unit 35—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 35—Wet Cliff This area consists of 1,858 ac (752 ha) of State land, and 253 ac (102 ha) of privately owned land, at the summit ridges of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plants *Alectryon macrococcus*, *B. conjuncta*, *Ctenitis squamigera*, *Cyrtandra munroi*, *Remya mauiensis*, and *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 6 is not known to be occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Bonamia menziesii*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyriformis*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, or *Tetramolopium capillare*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 7 (and) *Palmeria dolei*—Unit 36—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 36—Wet Cliff This area consists of 556 ac (225 ha) of State land along Honokowai ridge on the northwestern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units are occupied by the plants *Cyrtandra filipes* and *C. munroi*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 7 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyriformis*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation

and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 8 consists of 337 ac (137 ha) of State land along Kahakuloa ridge on the north side of west Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff— Unit 8 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendrion pyrifolium*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Tetramolopium capillare* critical habitat consists of three components. Lowland dry (west Maui), Dry cliff (west Maui) and Wet cliff (west Maui)(81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*. Subcanopy: *Chamaesyce*, *Dodonaea*, *Leptecophylla*, *Osteomeles*, *Psydrax*, *Scaevola*, *Wikstroemia*. Understory: *Alyxia*, *Artemisia*, *Bidens*, *Chenopodium*, *Nephrolepis*, *Peperomia*, *Sicyos*.

Ecosystem: Dry Cliff. Elevation: unrestricted. Annual precipitation: <75 in (<190 cm). Substrate: >65 degree slope, rocky talus. Canopy: None. Subcanopy: *Antidesma*, *Chamaesyce*, *Diospyros*, *Dodonaea*. Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Schiedea*.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. Understory: *Bryophytes*, *Ferns*, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is

not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species

such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylothea* ssp. *pentamera*, *B. campylothea* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mcelandowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Shrubland/chaparral (NatureServe, 2015)

Habitat Narrative

Adult: Presumably, the species grew in dryland forest and shrubland of lowland, leeward West Maui. Associated species within the presumed potential habitat of this species include *Metrosideros polymorpha*, *Styphelia tameiameia*, *Dodonaea viscosa*, *Machaerina angustifolia*, *Gahnia gahniiformis*, *Dubautia scabra*, *Lysimachia remyi*, *Deschampsia nubigena*, *Bidens menziesii*, *Lipochaeta lavarum*, *Heteropogon contortus*, *Dubautia linearis*, *Myoporum sandwicensis*, *Achyranthes splendens*, *Argemone glauca*, and *Waltheria indica* (HPCC 1994). Associated alien species include *Leucaena leucocephala*, *Conyza*, *Buddleja asiatica*, *Prosopis pallida*, and *Rhynchetrum repens* (HPCC 1994). (USFWS, 1997)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Resiliency:

Very low (inferred from USFWS, 2012)

Redundancy:

Very low (inferred from USFWS, 2012)

Number of Populations:

1-5 (NatureServe, 2015)

Population Size:

<200 (USFWS, 2012)

Population Narrative:

In 2010, there were no known genuine populations of *Tetramolopium capillare* (USFWS 2010). Meanwhile, population numbers for *Tetramolopium* species stands at around 120 individuals, with 19 individuals located at Hahakea and about 100 individuals at the lower (north fork) Kauaula Valley site (Plant Extinction Prevention Program 2010). A revisit of the upper Kauaula site in 2010 revealed no individuals of *T. capillare*, despite the presence of good habitat (H. Oppenheimer, pers. comm. 2010). (USFWS, 2012). New Status Information: • *Tetramolopium capillare* may be extinct in the wild (Oppenheimer 2018, in litt.). • In 2016, seven critical habitat units in three ecosystems (lowland dry, dry cliff, and wet cliff) were designated on west Maui for *T. capillare* (8,479 ac; 3,431 ha) (81 FR 17790, March 30, 2016) (USFWS, 2018).

Threats and Stressors

Stressor: Non-native plants (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: Non-native plants threatening this species include *Leucaena leucocephala*, *Conyza*, *Buddleja asiatica*, *Prosopis pallida*, and *Rhynchetrum repens* (HPCC 1994). Established ecosystem-altering invasive plant species degradation of habitat (Plant Extinction Prevention Program 2008, 2009; Oppenheimer 2006; USFWS 1994, 1997, 2003) results from *Cortaderia jubata* (pampas grass), *Erigeron karvinskianus* (daisy fleabane), *Lantana camara* (lantana), *Leucaena leucocephala* (koa haole), *Melinis repens* (natal redtop), and *Rubus rosifolius* (thimbleberry). Established invasive plant species compete for resources including (Oppenheimer 2006; H. Oppenheimer, pers. comm. 2010; USFWS 1994, 1997, 2003) *Adiantum raddianum* (maidenhair fern), *Blechnum appendiculatum* (palm fern), *Buddleia asiatica* (dog tail), *Lythrum maritimum* (loosestrife), *Sonchus oleraceus* (sow thistle), and *Verbena litoralis* (seashore verbena). (USFWS, 1997; USFWS, 2012)

Stressor: Fire (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: Fire is a continuing threat to this species and its habitat. (USFWS, 1997)

Stressor: Small population size (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: Because this species occurs at such low population levels and in such a restricted area, a single severe environmental disturbance could result in its extinction. (USFWS, 1997)

Stressor: Degradation of habitat by ungulates (USFWS, 1997)

Exposure:

Response:

Consequence:

Narrative: Ungulate degradation of habitat (Hawaii Biodiversity and Mapping Program 2010; Plant Extinction Prevention Program 2008, 2009) from axis deer (*Axis axis*) and feral goats (*Capra hircus*). (USFWS, 2012)

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. We anticipate high spatial resolution climate outputs by 2013. (USFWS, 2012)

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: We previously reported that climate change may pose a threat to this species, anticipating an analysis by 2013. The assessment conducted by Fortini et al. (2013) concluded that *T. capillare* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.61 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions may be needed to conserve this taxon into the future (USFWS, 2018).

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)

3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1997)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)

2. Each population must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)

3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1997)

Recovery Actions:

- Use seed from existing (and any additionally discovered) populations to outplant into protected areas on West Maui, such as at Lihauor Manawainui Plant Sanctuary, providing necessary management to maximize chances of successful establishment and long-term survival. (USFWS, 1997)
- Recommendations for Future Actions: We are not aware of any new threats or significant new information regarding the species' biological status since the last 5-year review in 2012. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2018. • Surveys and inventories—Continue to conduct thorough surveys of the Halepōhaku area in habitat where *Tetramolopium capillare* was last observed, especially within *Dodonaea* dry shrubland and *Heteropogon* grassland. • Ungulate monitoring and control—Fence any new occurrences to protect them from the impacts of feral ungulates. • Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around any new populations of *T. capillare*. • Fire destruction or degradation of habitat—Develop and implement a fire management plan for any wild or reintroduced populations. • Landslides and flooding destruction or degradation of habitat—Build resilience and redundancy with propagation and reintroduction. • Captive propagation for genetic storage and reintroduction—
 - o Propagate seeds collected from the Halepohaku population.
 - o Collect soil from areas of previously known individuals for germination trials. • Reintroduction and translocation—Reintroduce individuals into suitable habitat protected from threats. • Taxonomy research—Determine the taxonomic status of the Kaua'ula and Hāhākea populations. • Climate change adaptation strategy—Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. • Alliance and partnership development—Initiate planning and contribute to ecosystem-level restoration and management to benefit this species (USFWS, 2018).

Conservation Measures and Best Management Practices:

- Propagate a portion of the 140 seeds from the Hale Pohaku population in genetic storage at National Tropical Botanical Garden. (USFWS, 2012)
- If sites are relocated, collect soil from known locations of *T. capillare* and take to the Olinda Rare Plant Facility in the hope of germinating a seed bank that will include sprouts of the taxon. (USFWS, 2012)
- Continue to conduct thorough surveys of the Hale Pohaku area in habitat where *Tetramolopium capillare* was last seen, especially in *Dodonaea* dry shrubland and *Heteropogon* grassland. (USFWS, 2012)
- Monitor the taxonomic status of the Kauaula and Hahakea populations. If not classifiable under *T. capillare*, it may be described as a new taxon that will need to be tracked. (USFWS, 2012)
- Continue to construct fenced enclosure around existing and reintroduced populations to provide protection from feral ungulates. (USFWS, 2012)
- Monitor fenced enclosures for evidence of breaching by feral ungulates. (USFWS, 2012)
- Develop and implement fire management plans for all wild and reintroduced populations. (USFWS, 2012)
- Work with Hawaii Division of Forestry and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2012)

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SPECIES ACCOUNT: *Tetramolopium filiforme* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

A dwarf shrub 5-15 cm tall. The flowers are maroon or rarely yellow. (NatureServe, 2015)

Historical Range

See current range/distribution

Current Range

Current range: northern Waianae Mountains, Oahu; historically no additional range.

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Tetramolopium filiforme* under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Tetramolopium filiforme* (77 FR 57648-57862). The critical habitat designation includes 8 critical habitat units, which encompass approximately 1,499 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Tetramolopium filiforme* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Tetramolopium filiforme* includes 8 critical habitat units, covering one ecosystem type, which encompasses approximately 1,449 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley.

Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo.

Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge.

Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys.

Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry

cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac(105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Tetramolopium filiforme* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Tetramolopium filiforme* occurs within the indicated ecosystem in the Waianae Mountain caldera complex:

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: *Antidesma*, *Chamaesyce*, *Diospyros*, *Dodonaea*. (F) Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Schiedea*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Tetramolopium filiforme* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Capable of self-pollination/probably is insect-pollinated (USFWS, 2016)

Breeding Season

Adult: Flowering usually occurs in the late winter and spring (USFWS, 2016).

Reproduction Narrative

Adult: Flowering usually occurs in the late winter and spring. Although capable of self-pollination, *T. filiforme* probably is insect-pollinated, as are most species in the sunflower family with conspicuous flowers. The seeds of *T. filiforme* are presumed to be wind-dispersed, as bristle-bearing achenes also are characteristic of wind-dispersed members of the sunflower family. Birds may also disperse the seeds because the bristles may adhere the achenes to their

feathers (Makua Implementation Team 2003). This species is relatively short-lived, usually less than five years. Other demographic information for *T. filiforme* in the wild is unknown, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, pollination and seed dispersal, vegetative reproduction and specific environmental requirements (USFWS, 2016).

Habitat Type

Adult: Rocky ridges/vertical cliffs (USFWS, 2016)

Habitat Narrative

Adult: *Tetramolopium filiforme* occurs in dry habitat at the seaward end of the Ohikilolo population unit and in dry-mesic and mesic habitats at higher, more inland locations. In general, the plants are found on exposed rocky ridges and sparsely vegetated, nearly vertical cliffs, often rooted in cracks in the rock, at elevations of 340 to 900 m (1,116 to 2,953 ft) (Makua Implementation Team 2003) (USFWS, 2016).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: The seeds of *T. filiforme* are presumed to be wind-dispersed, as bristle-bearing achenes also are characteristic of wind-dispersed members of the sunflower family. Birds may also disperse the seeds because the bristles may adhere the achenes to their feathers (Makua Implementation Team 2003) (USFWS, 2016).

Population Information and Trends**Population Trends:**

Decreasing (USFWS, 2016)

Number of Populations:

7 (USFWS, 2016)

Population Size:

~3,500 (USFWS, 2016)

Population Narrative:

Three of the existing population units have exceeded minimum criteria for stabilization population (at least 50 mature, reproducing individuals for short-lived perennials). Trends in numbers since listing indicate increases until 2003 and decreasing numbers since then in all population units except Keaau and Waianae Kai. In 2003, the last plant in the Waianae Kai population unit was reported as dead (Makua Implementation Team 2003). By 2004, a new population had appeared there, presumably from viable seeds in the soil seed bank (U.S. Army Garrison 2004a). Plants in the Kahanahaiki, Keaau, Makaha/Ohikilolo Ridge, and Ohikilolo population units are located in zones at risk from training-related wildfire. Thus, *T. filiforme* is characterized by seven population units and an overall decreasing trend in numbers since 2003, including three stabilization population units with relatively large numbers that are located in all fire risk zones (USFWS, 2016).

Threats and Stressors

Stressor: Fire (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Fire is listed as a threat to this species (USFWS, 2016).

Stressor: Non-native insects (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Infestations of at least two species of non-native scale insects have been observed on *T. filiforme* and need further research (Makua Implementation Plan 2003) (USFWS, 2016).

Recovery**Delisting Criteria:**

Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve management of stabilization populations and abatements to threats (Service 1995a, 1998a) (USFWS, 2016).

Conservation Measures and Best Management Practices:

- The Makua Implementation Team (2003) has developed stabilization protocols for *Tetramolopium filiforme*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). In addition, this species occurs in two management units where it will benefit from population unit and/or ecosystem-level protection. The management units include Puu Kumakalii, which is not fenced and for which no fence construction is planned, and Ohikilolo, which is fenced. *Tetramolopium filiforme* seeds store well for several years, but viability is poor. The Army is focusing on collecting seed from fire-threatened sites in the lower Ohikilolo population unit. Plants can be propagated from both seed and cuttings. Cuttings are more than 90 percent successful, and The Nature Conservancy of Hawaii has successfully propagated the related *T. lepidotum* from seed. Outplanting has yet been attempted for *T. filiforme* in the wild because this species commonly grows in shallow cracks on exposed rocky ledges and cliffs; transitioning greenhouse plants to such sites may be difficult (U.S. Army Garrison 2005b). Current ex situ collections for this species include 31,000 seeds in seed storage (Lyon Arboretum Seed Storage Facility) (Service 2005b) (USFWS, 2016).

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SPECIES ACCOUNT: *Tetramolopium lepidotum* ssp. *lepidotum* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/29/1991; Pacific Region (R1) (USFWS, 2016)

Physical Description

A shrub 12-36 cm tall. Flower heads with center maroon to pale salmon, and rays white to pinkish lavender. (NatureServe, 2015)

Historical Range

Historically, *Tetramolopium lepidotum* ssp. *lepidotum* was known from nearly the entire length of the Waianae Mountains, from Makua Valley to Cachexia Ridge, as well as from the island of Lanai (Lowrey 1990, USFWS 1995). (USFWS, 1998)

Current Range

Range includes Waianae Mountains, Oahu. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Tetramolopium lepidotum* ssp. *lepidotum* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Tetramolopium lepidotum* ssp. *lepidotum* under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Tetramolopium lepidotum* ssp. *lepidotum* (77 FR 57648-57862). The critical habitat designation includes 11 critical habitat units, which encompass approximately 7,332 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Tetramolopium lepidotum* ssp. *lepidotum* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Tetramolopium lepidotum* ssp. *lepidotum* includes two CHUs in Maui County, Hawaii. Approximately 10,705 ac (4,332) ha) of private land on the Island of Lanai are being designated as critical habitat for *Tetramolopium lepidotum* ssp. *lepidotum*. (81 FR 17790-18110).

Both Critical Habitat Units are on Lanai and no data is specified except that they are owned by Lanai Resorts, LLC and Castle and Cooke Properties, Inc.

The critical habitat designation for *Tetramolopium lepidotum* ssp. *lepidotum* includes 11 critical habitat units, covering two ecosystem types, which encompass approximately 7,332 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3; Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac (105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Tetramolopium lepidotum* ssp. *lepidotum* critical habitat consists of one component (81 FR 17790-18110):

Lowland Dry Ecosystem: Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*. Subcanopy: *Chamaesyce*, *Dodonaea*, *Leptecophylla*, *Osteomeles*, *Psydrax*, *Scaevola*, *Wikstroemia*. Understory: *Alyxia*, *Artemisia*, *Bidens*, *Chenopodium*, *Nephrolepis*, *Peperomia*, *Sicyos*.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Tetramolopium lepidotum* ssp. *lepidotum* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Tetramolopium lepidotum* ssp. *lepidotum* occurs within the Lowland mesic and Dry cliff ecosystems in the Waianae Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: *Antidesma*, *Chamaesyce*, *Diospyros*, *Dodonaea*. (F) Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Schiedea*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further

degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkii*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Tetramolopium lepidotum* ssp. *lepidotum* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual: self-pollination (USFWS, 1998; 2009)

Lifespan

Adult: 2-4 years (USFWS, 2009)

Breeding Season

Adult: April through July (USFWS, 1998)

Reproduction Narrative

Adult: *Tetramolopium lepidotum* ssp. *lepidotum* is a short-lived perennial that has been observed producing fruit and flowers from April through July (USFWS 1995). *Tetramolopium lepidotum* ssp. *lepidotum* is a short-lived perennial, with a two- to four-year lifespan (The Nature Conservancy 2006). The taxon is capable of self-fertilization, with high rates of viable seed set. (USFWS, 1998; USFWS, 2009)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Rocky ridges, shrublands, cliffs, (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations from 370 to 940 meters (1,200 to 3,000 feet) (USFWS, 1998)

Habitat Narrative

Adult: This species is found on windswept, dry rocky ridges on steep, exposed slopes. On Oahu, moist shrublands on ridgecrests and cliffs. On Lanai, dry shrublands on plateau lands. (NatureServe, 2015) *Tetramolopium lepidotum* ssp. *lepidotum* typically grows on grassy ridgetops, slopes, or west-facing cliffs in mesic forest at an elevation of 370 to 940 meters (1,200 to 3,100 feet) (USFWS 1995). Associated species include kookoolau, and ohia (USFWS 1995). (USFWS, 1998)

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 2009)

Dispersal/Migration Narrative

Adult: Seeds have the potential for being wind-dispersed, but tend to fall near the parent plants. (USFWS, 2009)

Population Information and Trends**Population Trends:**

Declining (USFWS, 2013)

Resiliency:

Very low (inferred from USFWS, 2009)

Redundancy:

Very low (inferred from USFWS, 2009)

Number of Populations:

1 (USFWS, 2009)

Population Size:

147 (USFWS, 2013)

Population Narrative:

Overall, this represents a decline from the approximately 250 individuals reported in the last five year review to 147 individuals currently (USFWS, 2013). Previously, about 250 individuals, consisting of 75 mature and 175 seedlings, are within a single population located along the Ekahanui crestline (The Nature Conservancy 2006; USFWS 2008). The Nature Conservancy of Hawaii surveyed historical locations of the taxon in 2006, but only found new individuals at the extant Ekahanui crestline area (The Nature Conservancy 2006). Six individuals, resulting from previous outplantings, are also known to occur near a fenced exclosure within Honouliuli Preserve (USFWS 1998, 2008). (USFWS, 2009)

Threats and Stressors

Stressor: Trampling (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: Threats include trampling near trail and invasion by alien vegetation. (NatureServe, 2015)

Stressor: Climate change (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) funded climate modeling that will help resolve these spatial limitations. High spatial resolution climate outputs are expected in 2013. (USFWS, 2013)

Stressor: Invasive introduced plants (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The primary threat to the habitat of the taxon is competition from invasive introduced plant species such as *Melinis minutiflora* (molasses grass), and secondarily from *Conyza bonariensis* (horsetail weed), *Schinus terebinthifolius* (Christmasberry) and *Erigeron karvinskianus* (daisy fleabane) (The Nature Conservancy 2006). (USFWS, 2009)

Stressor: Habitat degradation by ungulates (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Feral ungulates, namely goats (*Capra hircus*) and pigs (*Sus scrofa*) also continue to threaten the taxon and its surrounding habitat through their degradation of habitat. (USFWS, 2009)

Stressor: Ants (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Young seedlings of the taxon are susceptible to scales spread by various species of ants (The Nature Conservancy 2006). (USFWS, 2009)

Stressor: Rockslides and landslides (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The only extant population of *Tetramolopium lepidotum* ssp. *lepidotum* is susceptible to rockslides and large landslides (The Nature Conservancy 2006). (USFWS, 2009)

Stressor: Drought (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Drought is a major limiting factor for recruitment and survival of mature plants. (USFWS, 2009)

Stressor: Fire (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Fire is a low threat risk given the remote location, moisture level and ongoing grass control in the area. (USFWS, 2009)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1998)

Recovery Actions:

- Construct enclosures or strategic barrier fence to protect populations against feral ungulates. (USFWS, 1998)
- Control competing alien plant species within enclosures. Populations that have only a few remaining individuals (Kuma Kakii and Waianae Kai Forest Reserve) should immediately be weeded and protected where accessible. (USFWS, 1998)
- A coordinated fire protection plan for endangered plant species on State forest reserves (Waianae Kai), Federal (Schofield Barracks—West Range), and private lands (Honouliuli Preserve) should be developed and implemented. (USFWS, 1998)

Conservation Measures and Best Management Practices:

- Continue collection of genetic resources for storage, future propagation and reintroducing into protected suitable habitat within historical range. (USFWS, 2009)
- Establish additional populations within protected historical range and suitable habitat. (USFWS, 2009)
- Expand enclosure fences to protect all individuals from the negative impacts of feral ungulates, and eradicate introduced invasive plant species within the enclosures. (USFWS, 2009)
- Determine impacts from and control methods for ant predation. (USFWS, 2009)

- Survey geographical and historical range for a thorough current assessment of the species. (USFWS, 2009)
- Assess genetic variability within wild and outplanted individuals. (USFWS, 2009)
- Collect cuttings or seed from tagged individuals, keeping close track of the maternal source for use in ex situ propagation. (USFWS, 2013)
- While surveying for new populations or reintroduced populations, determine which sites are least invaded by invasive introduced plant species and which appear to have the highest likelihood of maintaining new reintroductions. (USFWS, 2013)
- Reintroduce the species back into its known historical range. (USFWS, 2013)
- Construct, maintain, and monitor ungulate-proof exclosures around each population. (USFWS, 2013)
- Control invasive introduced plant species around all populations. (USFWS, 2013)
- Implement effective control methods for rodents. (USFWS, 2013)
- Survey geographical and historical range for a thorough current assessment of the species status. (USFWS, 2013)
- Develop and implement effective measures to reduce the impact of landslides and flooding and military activities. (USFWS, 2013)
- Develop and implement fire management plans for all wild and reintroduced populations. (USFWS, 2013)
- Initiate planning and contribute to implementation of ecosystem-level management and restoration to benefit this species. (USFWS, 2013)
- Implement genetic studies to assess viability of remaining populations. (USFWS, 2013)
- Study *Tetramolopium lepidotum* subsp. *lepidotum* with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. (USFWS, 2013)
- Assess the modeled effects of climate change on this species, and use the results to determine future landscape needed for the recovery of the species. (USFWS, 2013)

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SPECIES ACCOUNT: *Tetramolopium remyi* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/20/1991; Pacific Region (R1) (USFWS, 2016)

Physical Description

A decumbent or occasionally erect shrub, 1-4 dm tall. Flower heads are solitary on long, leafless stalks. (NatureServe, 2015)

Historical Range

It was known historically from dry exposed ridges and flats in the foothills of southwest Maui, but has not been reported from there in many years. It was last seen on Maui in 1944 (USFWS 2003b). (USFWS, 2011)

Current Range

Tetramolopium remyi was listed as endangered in 1991. At that time, it was known from a single population of 35 plants on Lanai (USFWS 1991). (USFWS, 2011)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Tetramolopium remyi* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Tetramolopium remyi* includes two CHUs in Maui County, Hawaii with detailed unit information. There are also an unknown number of units on Lanai that contain this species (number of units is unknown because detailed unit descriptions for Lanai are not available) (81 FR 17790-18110).

Maui—Lowland Dry—Unit 5 consists of 3,615 ac (1,463 ha) of State land, and 43 ac (17 ha) of privately owned land, from Panaewa to Manawainui on the western and southern slopes of west Maui. This unit is occupied by the plants *Asplenium dielerectum*, *Bidens campylotheca* ssp. pentamera, *Cenchrus agrimonioides*, *Gouania hillebrandii*, *Kadua coriacea*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and *Tetramolopium capillare*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 5 is not known to be occupied by *Ctenitis squamigera*, *Cyanea obtusa*, *Hesperomannia arbuscula*, *Hibiscus brackenridgei*, *Lysimachia lydgatei*, *Neraudia sericea*, *Schiedea salicaria*, *Sesbania tomentosa*, or *T. remyi*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations

within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 6 consists of 3 ac (1 ha) of State land, and 237 ac (96 ha) of privately owned land, from Paleaahu Gulch to Puu Hona on the southern slopes of west Maui. This unit is occupied by the plants *Hibiscus brackenridgei* and *Schiedea salicaria*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 6 is not known to be occupied by *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, *Cenchrus agrimonoides*, *Ctenitis squamigera*, *Cyanea obtusa*, *Gouania hillebrandii*, *Hesperomannia arbuscula*, *Kadua coriacea*, *Lysimachia lydgatei*, *Neraudia sericea*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Spermolepis hawaiiensis*, *Tetramolopium capillare*, or *T. remyi*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Tetramolopium remyi* critical habitat consists of one component. Lowland dry (west Maui and Lanai) (81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*. Subcanopy: *Chamaesyce*, *Dodonaea*, *Leptecophylla*, *Osteomeles*, *Psydrax*, *Scaevola*, *Wikstroemia*. Understory: *Alyxia*, *Artemisia*, *Bidens*, *Chenopodium*, *Nephrolepis*, *Peperomia*, *Sicyos*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The

125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant

species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Dependency on Other Individuals or Species

Adult: Pollination is hypothesized to be possibly by butterflies, bees, or flies (Lowrey 1986). (USFWS, 1994)

Breeding Season

Adult: April to January (USFWS, 1994)

Key Resources Needed for Breeding

Adult: Precipitation (USFWS, 1994)

Reproduction Narrative

Adult: *Tetramolopium remyi* flowers between April and January (Lowrey 1986). Field observations suggest that the population size of the species can be profoundly affected by variability in annual precipitation; the adult plants may succumb to prolonged drought, but apparently there is a seedbank in the soil that can replenish the population during favorable conditions (Lowrey 1986; T. Lowrey, personal communication 1992). Pollination is hypothesized to be possibly by butterflies, bees, or flies (Lowrey 1986). (USFWS, 1994)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Shrubland/chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 150 to 770 meters (500 to 2,500 feet) (USFWS, 2011)

Environmental Specificity

Adult: Low, with few key requirements (USFWS, 2011)

Habitat Narrative

Adult: The habitat where *Tetramolopium remyi* occurs is lowland dry shrubland on dry, exposed ridges or flats at 150 to 770 meters (500 to 2,500 feet) elevation. The only known extant population occurs at about 200 meters (660 feet) elevation, on nearly barren red soils in a highly overgrazed area in *Heteropogon contortus* (pili grass) and *Dodonaea viscosa* (aalii) shrubland. Associated native plant species include *Argemone glauca* (pua kala), *Bidens mauiensis* (kookoolau), *Doryopteris decipiens* (kumuniu), *Eragrostis variabilis* (kawelu), *Heteropogon contortus* (pili grass), *Lipochaeta heterophylla* (nehe), *L. lavarum* (nehe), *Myoporum sandwicense* (naio), *Panicum fauriei* (no common name [NCN]), *Sida fallax* (ilima), *Waltheria indica* (uhaloa), and *Wikstroemia oahuensis* (akia) (Oppenheimer 2010; USFWS 1995; Wood 2010). (USFWS, 2011)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Resiliency:

Very low (inferred from USFWS, 2011)

Redundancy:

Very low (inferred from USFWS, 2011)

Number of Populations:

1 (USFWS, 2011)

Population Size:

<10 (USFWS, 2011)

Population Narrative:

In March 2008, only three mature individuals and 10 seedlings were observed (Perlman 2010). In May 2008, all the seedlings were reported dead due to drought conditions. In January 2009, the three adults were still alive. During the same year in July, there were only two adults and approximately 15 seedlings. As of March 2010, a single adult and a single seedling remains, despite efforts of hand watering each individual two to three times a year in 2008, 2009, and continuing into 2010 (Oppenheimer 2010). (USFWS, 2011). New Status Information: • There are 147 individuals of *Tetramolopium remyi* in one population on Lānaʻi (Oppenheimer 2018, in litt.; PEPP 2017a, 2018). • In 2012, the Service revised critical habitat for *Tetramolopium remyi*, and the proposed rule identified two critical habitat units on Lānaʻi in the lowland dry ecosystem (10,705 ac, 4,332 ha) (77 FR 34464, July 11, 2012). In the final rule, the Service excluded critical habitat for this species on the island of Lānaʻi because, as demonstrated by the ongoing conservation activities by the private landowner, their commitment to develop the Lānaʻi Natural Resources Plan, and a memorandum of understanding with the Service, exclusion from critical habitat would provide greater long-term benefits to the species than designation of

critical habitat (USFWS 2015; 81 FR 17790, March 30, 2016). • In 2016, two critical habitat units in the lowland dry ecosystem designated on west Maui for *T. remyi* (8,479 ac; 3,431 ha) (81 FR 17790, March 30, 2016) (USFWS, 2018).

Threats and Stressors

Stressor: Trampling by deer and sheep (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Trampling by feral axis deer (*Axis axis*) and mouflon sheep (*Ovis musimon*) is a threat to the habitat of *Tetramolopium remyi*. The area where *T. remyi* occurs was severely degraded by grazing and browsing of livestock in the past. Much of the native vegetation was removed because of grazing, thus increasing wind erosion of the fragile soils and creating opportunities for invasion by introduced plant species. (USFWS, 2011)

Stressor: Introduced invasive plants (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: These introduced invasive plant species include *Vachellia farnesiana* (klu), *Acacia mearnsii* (black wattle), *Andropogon virginicus* (broomsedge), *Cenchrus ciliaris* (buffelgrass), *Chamaecrista nictitans* (partridge pea), *Conyza bonariensis* (hairy horseweed), *Grevillea robusta* (silk oak), *Lantana camara* (lantana), *Melinis minutiflora* (molasses grass), *Melinis repens* (Natal grass), *Opuntia ficus-indica* (panini), *Pennisetum setaceum* (fountain grass), *Pluchea carolinensis* (marsh fleabane), *Prosopis pallida* (kiawe), and *Urochloa maxima* (Guinea grass). (USFWS, 2011)

Stressor: Fires (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: These introduced plant species also creates a fuel load, which increases the risk of fires (Oppenheimer 2010; USFWS 1995; Wood 2010). (USFWS, 2011)

Stressor: Drought (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Drought is a serious threat to this species (Oppenheimer 2010). (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to *Tetramolopium remyi*. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently

funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2011)

Stressor: Stochastic events (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: In addition to all of the other threats, species like *Tetramolopium remyi* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding, and disease outbreaks. (USFWS, 2011)

Stressor: Habitat loss from human development and introduced species (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The extent of these natural processes on this single island endemic are exacerbated by anthropogenic threats, such as habitat loss for human development or predation by introduced species (USFWS 2010). (USFWS, 2011)

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: We previously reported that climate change may pose a threat to this species, anticipating an analysis by 2013. The assessment conducted by Fortini et al. (2013) concluded that *T. remyi* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.868 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this species has no overlap between current and future climate envelopes, and is unlikely to tolerate expected changes in climate at its current location. This means that this species must persist within suitable microrefugia, or move to newly available climate-compatible areas to avoid extinction. Therefore, additional management actions are needed to conserve this taxon into the future, such as locating key microsites that overlap with current and future climate envelopes for outplanting efforts.

Recovery

Reclassification Criteria:

1. A total of five to seven populations are documented on Lanai and at least one other island where they now occur or occurred historically. (USFWS, 1994)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1994)

3. Each of these populations must persist at this level for at least 5 consecutive years before downlisting is considered. (USFWS, 1994)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Lanai and at least one other island where they now occur or occurred historically. (USFWS, 1994)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1994)
3. Each population should persist at this level for at least 5 consecutive years before delisting is considered. (USFWS, 1994)

Recovery Actions:

- Secure and manage current populations and their habitat. (USFWS, 1994)
- Conduct essential research to the conservation of the species. (USFWS, 1994)
- Expand current populations. (USFWS, 1994)
- Establish new populations as needed to reach recovery objectives. (USFWS, 1994)
- Validate and revise recovery objectives. (USFWS, 1994)
- Recommendations for Future Actions: We are not aware of any new threats or significant new information regarding the species' biological status since the last 5-year review in 2011. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2018. • Surveys and inventories—Continue to conduct thorough surveys to determine the current status of the species and for additional populations. • Ungulate monitoring and control—Construct and maintain enclosure fencing at all occurrences to protect them from the impacts of feral ungulates. • Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around populations of *T. remyi*. • Drought and fire destruction or degradation of habitat—Develop and implement a fire management plan for any wild or reintroduced populations. • Captive propagation for genetic storage and reintroduction—
 - o Collect fruit from any wild and reintroduced individuals that set seed to add to the genetic diversity collections. Propagate seeds collected from the Halepōhaku population.
 - o Collect soil from areas of previously known individuals for germination trials.
 - o Test the viability of the seeds in storage at the National Tropical Botanical Garden and Lyon Arboretum and determine if storage methods need modification.• Reintroduction and translocation—Reintroduce individuals into suitable habitat protected from threats. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for the recovery of the species. • Alliance and partnership development—Work with the Hawai'i Division of Forestry and Wildlife, the PEPP, and other land managers to initiate planning and contribute to ecosystem-level restoration and management to benefit this species (USFWS, 2018).

Conservation Measures and Best Management Practices:

- Continue monitoring and watering individual wild plants. (USFWS, 2011)

- Maintain the small fence around the last mature individual at the Mauna o Umi to prevent trampling by axis deer and mouflon sheep. (USFWS, 2011)
- Construct large-scale fences around all naturally occurring and reintroduced individuals to control feral ungulates. (USFWS, 2011)
- Collect material for genetic storage and propagation for reintroduction. (USFWS, 2011)
- Test the viability of the seeds in storage at National Tropical Botanical Garden and Lyon Arboretum and determine if storage method needs to be modified. (USFWS, 2011)
- Reintroduce into protected suitable habitat within the species historical range. (USFWS, 2011)
- Collect fruit from any reintroduced individuals that set seed to add to the genetic diversity of the ex situ material. (USFWS, 2011)
- Control introduced invasive plant species around all populations. (USFWS, 2011)
- Conduct surveys to determine the current status of the species and for additional populations. (USFWS, 2011)
- Develop and implement a wildfire management plan. (USFWS, 2011)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2011)
- Work with Hawaii Division of Forestry and Wildlife, Plant Extinction Prevention Program, and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2011)
- New Management Actions: • Surveys and inventories—The Plant Extinction Prevention Program (PEPP) surveys for new populations and monitors the known population of *Tetramolopium remyi* on Lānaʻi (PEPP 2010, 2011, 2012, 2013, 2016, 2017b, 2018). Soil samples are tested for a possible seed bank. • Ungulate monitoring and control—The only known population of *T. remyi* may be provided protection by construction of fencing by Pūlama Lānaʻi planned to begin in 2017 (Donoho 2016, in litt.; USFWS 2015). • Invasive plant monitoring and control—PEPP monitors the known population of *T. remyi* (2010, 2011, 2012, 2013, 2016, 2017a, 2018). • Captive propagation for genetic storage and reintroduction— o The Lyon Arboretum Seed Conservation Laboratory reported 281 seeds in storage from the ʻĀwehi population in 2012; 30,349 seeds in storage in 2016; and 17,279 seeds in storage in 2018, for a total of over 50,000 seeds likely representing over a dozen founders (Lyon Arboretum 2018). o The Olinda Rare Plant Facility (ORPF) reported four plants in propagation representing three individuals from ʻĀwehi (ORPF 2013, 2014, 2017). o The National Tropical Botanical Garden (NTBG) has seeds from five different collections from ʻĀwehi, but these collections are old (from 2001-2006) and it is uncertain how many individuals are represented and how many viable seeds remain (NTBG 2018).

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SPECIES ACCOUNT: *Tetramolopium rockii* (No common name)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/08/1992; Pacific Region (R1) (USFWS, 2017)

Physical Description

Tetramolopium rockii, a member of the aster family, is a glandular, hairy, prostrate shrub, which forms complexly branching mats 5 to 10 cm (2 to 4 in) tall and 8 to 40 cm (3 to 16 in) in diameter. Leaves of variety *calcisabulorum* are 2 to 3 cm (0.8 to 1.2 in) long and 5 to 7 mm (0.2 to 0.3 in) wide, have slightly inrolled edges, and are whitish due to the long silky hairs on their surfaces. Variety *rockii* has smaller, less hairy, flat, yellowish-green leaves, 1.5 to 2.1 cm (0.6 to 0.8 in) long and about 0.4 to 0.6 cm (0.2 in) wide. The leaves of both varieties are spatula shaped with glands and smooth margins. Flowerheads, arranged singly at the ends of flowering stalks 4 to 12 cm (1.6 to 4.7 in) long, have a hemispherical involucre 4 to 8 mm (0.2 to 0.3 in) high and 10 to 18 mm (0.4 to 0.7 in) in diameter. Approximately 60 to 100 white ray florets, 3 to 4.5 mm (0.1 to 0.2 in) long and 0.5 to 1 mm (0.02 to 0.04 in) wide, surround 30 to 55 functionally male, yellow, funnel-shaped disk florets. Fruits are achenes, 2 to 2.5 mm (0.08 to 0.1 in) long and about 0.7 to 0.9 mm (0.03 in) wide when fertile, and are topped with white bristles 2.5 to 4 mm (0.1 to 0.2 in) long. This species differs from others of the genus by its growth habit, its hairy and glandular surfaces, its spatulate leaf shape, and its yellow disk florets (USFWS 1992). (USFWS, 1996)

Taxonomy

A member of the sunflower family (Asteraceae) (USFWS, 2016). St. John (1974) described a new genus, *Luteidiscus*, for the species of *Tetramolopium* with yellow disk flowers. He transferred *T. rockii* to the new genus and also described a new species, *L. calcisabulorum*. The current treatment reduces St. John's two species to varieties of *Tetramolopium rockii*: the nominative variety and var. *calcisabulorum* (USFWS 1992). (USFWS, 1996)

Historical Range

Tetramolopium rockii var. *rockii* was first discovered on West Molokai at Moomomi about 80 years ago. (USFWS, 2011)

Current Range

Tetramolopium rockii var. *rockii* remains in two areas: from Kapalauoa to Kahinaakalani on West Molokai, and north of Kalawao on Kalaupapa Peninsula on East Molokai. (USFWS, 1996)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Tetramolopium rockii* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes seven detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Tetramolopium rockii* includes seven CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Molokai—Coastal—Unit 1 consists of 70 ac (28 ha) of privately owned land, and 54 ac (22 ha) of federally owned land (U.S. Coast Guard) at Laau Point, from Kahaiawa to Keawakalani, along the western coast of Molokai. This unit is occupied by the plant *Marsilea villosa*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 1 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 2 consists of 263 ac (106 ha) of State land, and 710 ac (287 ha) of privately owned land, from Ilio Point to Kaa Gulch, along the northwestern coast of Molokai. This unit is occupied by the plant *Marsilea villosa* and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 2 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 3 consists of 794 ac (321 ha) of State land, and 3 ac (1 ha) of federally owned land (Kalaupapa National Historical Park), from Kahi Point to Wainene, along the north-central coast of Molokai. This unit is occupied by the plants *Pittosporum halophilum*, *Schenkia sebaeoides*, and *Tetramolopium rockii*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 3 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Marsilea villosa*, *Peucedanum sandwicense*, or *Sesbania tomentosa*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small

numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 4 consists of 10 ac (4 ha) on Mokapu Island on the northern coast of Molokai. This area is State-owned, and is classified as a State Seabird Sanctuary. This unit is occupied by the plants *Peucedanum sandwicense* and *Pittosporum halophilum*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 4 is not known to be occupied by *Bidens wiebkii*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Marsilea villosa*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 5 consists of 1 ac (0.5 ha) on Huelo islet on the northern coast of Molokai. This area is State-owned, and is classified as a State Seabird Sanctuary. This unit is occupied by the plants *Brighamia rockii*, *Peucedanum sandwicense*, and *Pittosporum halophilum*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 5 is not known to be occupied by *Bidens wiebkii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrone*, *Marsilea villosa*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 6 consists of 190 ac (77 ha) of State land, and 1,685 ac (682 ha) of privately owned land, from Kaholaiki Bay to Halawa Bay, on the northeastern coast of Molokai. This unit is occupied by the plants *Bidens wiebkii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, and *Ischaemum byrone*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 6 is not known to be occupied by *Brighamia rockii*, *Hibiscus brackenridgei*, *Marsilea villosa*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low

population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 7 consists of 49 ac (20 ha) of privately owned land from Alanuihipaka Ridge to Kalanikaula, on the northeastern coast of Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). Although Molokai—Coastal—Unit 7 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrnei*, *Marsilea villosa*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Tetramolopium rockii* critical habitat consists of one component. Coastal (Molokai) (81 FR 17790-18110):

Ecosystem: Coastal. Elevation: <980 ft (<300 m). Annual precipitation: <20 in (<50 cm). Substrate: Well-drained, calcareous, talus slopes; dunes; weathered clay soils; ephemeral pools; mudflats. Canopy: *Hibiscus*, *Myoporum*, *Santalum*, *Scaevola*. Subcanopy: *Gossypium*, *Sida*, *Vitex*. Understory: *Eragrostis*, *Jacquemontia*, *Lyceum*, *Nama*, *Sesuvium*, *Sporobolus*, *Vigna*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be

currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mcelandowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium*

molokaiense, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Shrubland/chaparral (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Coastal ecosystem (USFWS, 2016)

Geographic or Habitat Restraints or Barriers

Adult: Found between 10 to 200 meters (30 and 650 feet) in elevation (USFWS, 1996)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1996)

Habitat Narrative

Adult: Inhabits dry coastal shrubland on solidified calcareous sand dunes (NatureServe, 2015). *Tetramolopium rockii* is restricted to hardened calcareous sand dunes or ash-covered basalt in the coastal spray zone or Coastal Dry Shrublands and Grasslands between 10 to 200 meters (30 and 650 feet) in elevation. Associated native species such as *Boerhavia repens* (alena), *Cassytha filiformis* (kaunaoa pehu), *Chenopodium oahuense* (aheahea), *Cuscuta sandwichiana* (kaunaoa), *Euphorbia degeneri* (akoko), *Euphorbia skottsbergii* var. *skottsbergii* (akoko), *Heliotropium anomalum* var. *argenteum* (hinahina-ku-kahakai), *Ipomoea indica* (koali awa), *Ipomoea pes-caprae* subsp. *brasiliensis* (pohuehue), *Jacquemontia ovalifolia* subsp. *sandwicensis* (pau-o-Hiiaka), *Melanthera integrifolia* (nehe), *Scaevola taccada* (naupaka), *Sesbania tomentosa* (ohai), *Sesuvium portulacastrum* (akulikuli), and *Waltheria indica* (uhaloa) with various lichens including *Buellia* sp. and *Caloplaca* sp. and grasses and sedges including *Fimbristylis cymosa* (mauu aki aki), *Panicum torridum* (kakonakona), and *Sporobolus virginicus* (aki aki) (Canfield 1990; Perlman 2010; Tangalin 2009). (USFWS, 1996; USFWS, 2011) Occurrences are in the coastal ecosystem (USFWS, 2016).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends

Population Trends:

Stable (USFWS, 2016)

Resiliency:

Medium (NatureServe, 2015)

Redundancy:

Low (inferred from USFWS, 2015)

Number of Populations:

4 (USFWS, 2016)

Population Size:

~94,000 (NatureServe, 2015)

Population Narrative:

In 2003, *T. rockii* was known from four occurrences totaling thousands of individuals (68 FR 12982, March 18, 2003). *Tetramolopium rockii* var. *calcisabulorum* was reported from Kaiehu Point to Kapalauoa, intergrading with var. *rockii*. *Tetramolopium rockii* var. *rockii* occurred from Kalawao to Kahinaakalani, Kaiehu point to Kapalauoa, and Moomomi to Kahinaakalani. Currently, numbers fluctuate considerably from year to year but remain in the thousands (USFWS, 2016). Approximately 94,000 plants known. There are 3 current (between 1982 and 1997) and no historical occurrences. (NatureServe, 2015). New Status Information: • There are at least 10,000 individuals of *Tetramolopium rockii* var. *rockii*, and 2,000 of variety *calcisabulorum* along the northwest coast of Moloka'i from Ka'a Gulch to Kahina'akalani, and from 'Ālau to Makali'i in the Kalaupapa National Historical Park. Numbers vary widely depending on rainfall (Bakutis 2018a, in litt.; Bakutis 2018b, in litt.; Haase 2018, in litt.; National Park Service (NPS) 2015). • In 2016, the IUCN reported extreme fluctuations in population size for both varieties (Chau 2016). • In 2016, seven critical habitat units in the coastal ecosystem designated on Moloka'i for *T. rockii* (4,222 ac; 1,549 ha) (81 FR 17790, March 30, 2016) (USFWS, 2018).

Threats and Stressors

Stressor: Trampling by deer (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Feral deer (*Axis axis*) trample native plants including *Tetramolopium rockii* var. *calcisabulorum* at Moomomi Preserve (Ed Misaki, The Nature Conservancy Hawaii, pers. comm. 2010). Deer are also a threat to *Tetramolopium rockii* var. *rockii* wherever the species is not protected by fenced exclosures at Kalaupapa (G. Hughes, pers. comm. 2010). (USFWS, 2011)

Stressor: Invasive introduced plants (USFWS, 2011)

Exposure:**Response:****Consequence:**

Narrative: Invasive introduced plant species modify the habitat and compete for resources with both varieties of the species. These invasive plants include *Atriplex semibaccata* (Australian saltbush), *Cenchrus ciliaris* (buffelgrass), *Chenopodium murale* (lamb's quarters), *Cynodon dactylon* (Bermuda grass), *Dactyloctenium aegyptium* (beach wiregrass), *Digitaria ciliaris* (Henry's crabgrass), *Lantana camara* (lantana), *Leucaena leucocephala* (haole koa), *Urochloa maximum* (Guinea grass), *Melinis repens* (Natal redtop), *Prosopis pallida* (kiawe), *Setaria parviflora* (perennial foxtail), and *Sporobolus indicus* (smutgrass). *Lantana camara* grows in dense patches. *Prosopis pallida* forms dense thickets in this coastal zone. Weedy grasses can also out-compete *Tetramolopium rockii* (Canfield 1990; Perlman 2010; Tangalin 2009). The introduced invasive plant species are a threat to *Tetramolopium rockii* because they compete with the species for water, light, and nutrients. (USFWS, 2011)

Stressor: Browsing by deer, rats, goats, and cattle (USFWS, 2011)

Exposure:**Response:****Consequence:**

Narrative: Deer, rats (*Rattus* spp.), and feral goats (*Capra hircus*) are considered threats at Moomomi, and deer are considered a threat at Kalaupapa (Perlman 2010; E. Misaki, pers. comm. 2010). Although deer have not been observed to directly browse on this species, however deer do browse on other native plants at Moomomi, including the endangered *Sesbania tomentosa*, and trample all native plants (E. Misaki, pers. comm. 2010). Cattle (*Bos taurus*) browsing was reported to be a threat to *Tetramolopium rockii* in 1991 (Wood 2010) but cattle have since been removed from Moomomi Preserve (E. Misaki, pers. comm. 2010). (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)

Exposure:**Response:****Consequence:**

Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2011)

Stressor: Climate change loss or degradation of habitat

Exposure:**Response:****Consequence:**

Narrative: We previously reported that climate change may pose a threat to this species, anticipating an analysis by 2013. The assessment conducted by Fortini et al. (2013) concluded that *Tetramolopium rockii* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.893 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this species has no overlap between current and future climate envelopes, and is unlikely to tolerate expected changes in climate at its current location. This means that this species must persist within suitable microrefugia, or move to newly available

climate-compatible areas to avoid extinction. Therefore, additional management actions are needed to conserve this taxon into the future, such as locating key microsites that overlap with current and future climate envelopes for outplanting efforts (USFWS, 2018).

Stressor: Hybridization

Exposure:

Response:

Consequence:

Narrative: This species may hybridize in a narrow zone of contact along the dunes (Lowrey in Wagner et al. 1999).

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Molokai and at least one other island where they now occur or occurred historically. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1996)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1996)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Molokai and at least 1 other island where they now occur or occurred historically. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1996)
3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1996)

Recovery Actions:

- The highest priority for the recovery of the Molokai plant cluster taxa is the implementation of immediate recovery actions needed to keep “on-the-brink” species (those that number fewer than 100 individuals in the wild) from going extinct. These actions include propagation and maintenance of genetic stock ex situ, and protection of remaining wild individuals from threats. (USFWS, 1996)
- Secondly, the plan proposes the delineation of management units to conserve not only these taxa, but their habitats as well. These units should be managed to preserve as many native species (flora and fauna) as possible, through threat-control and forest-restoration programs. (USFWS, 1996)

- The next step in the recovery of these species is augmentation of small populations and re-establishment of new populations within the historical range of the species. This includes selection of areas for augmentation and reestablishment, determination of the best methods for ex situ propagation and transplanting, selection of the best genetic stock for each area, propagation of suitable stock, preparation of sites for seeding and/or transplanting, and monitoring and maintenance of new individuals and populations as they are established. (USFWS, 1996)
- A research program is also recommended to study the growth and reproductive viability of each taxon, determine the parameters of viable populations of each taxon, study the reproductive strategy and pollinators of each taxon, and study possible pests and diseases. (USFWS, 1996)
- Finally, the recovery criteria should be refined and revised as new information becomes available. (USFWS, 1996)
- Recommendations for Future Actions: Hybridization is reported as a possible threat to these varieties; however, we are not aware of any significant new information regarding the species' biological status since the last 5-year review in 2011. Thus, the following recommendations for future actions are added or reiterated for the 5-year review for 2018.
 - Surveys and inventories—Continue to monitor populations using the baseline survey to track how the populations change over time.
 - Ungulate monitoring and control—Remove feral ungulates from within existing large-scale fences surrounding naturally occurring individuals.
 - Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around populations of *T. rockii*.
 - Captive propagation for genetic storage and reintroduction—
 - o Collect material for genetic storage and propagation for reintroduction.
 - o Propagate for augmentation of existing populations if needed.
 - Reintroduction and translocation—
 - o Reintroduce individuals into suitable habitat protected from threats.
 - o Research weather conditions and possible conservation actions most favorable for natural regeneration in the wild.
 - o Research effects of possible hybridization between the two varieties.
 - Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for the recovery of the species.
 - Alliance and partnership development—Work with land managers to initiate planning and contribute to ecosystem-level restoration and management to benefit this species (USFWS, 2018).

Conservation Measures and Best Management Practices:

- Collect material for genetic storage and propagation for reintroduction. (USFWS, 2011)
- Propagate for augmentation of existing populations if needed. (USFWS, 2011)
- Research weather conditions and possible conservation actions most favorable for natural regeneration in the wild. (USFWS, 2011)
- Establish a baseline survey to determine the current population census of the species and track, if and how, the populations are changing over time. (USFWS, 2011)
- Control introduced invasive plant species around wild plants. (USFWS, 2011)
- Control rats in the vicinity of these populations. (USFWS, 2011)
- Remove feral ungulates from within existing large-scale fences surrounding naturally occurring individuals. (USFWS, 2011)
- Conduct taxonomic study to determine if this is a valid species. (USFWS, 2011)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2011)

- New Management Actions: • Surveys and inventories—PEPP (Plant Extinction Prevention Program) and The Nature Conservancy (TNC) conducted recent surveys to determine the approximate range and numbers of individuals of both varieties of *Tetramolopium rockii* (Bakutis 2018b, in litt.). • Ungulate monitoring and control— o A portion of the known population at Mo'omomi Preserve area is within the fence; however, axis deer are still present within the fenced area (TNC 2018; Bakutis 2018, in litt.). o Individuals are within a fence in the Kalaupapa National Historical Park (NHP) (NPS 2015). • Invasive plant monitoring and control—Both the Mo'omomi Preserve and Kalaupapa NHP are monitored with nonnative plant removal (NPS 2015; TNC 2018). • Captive propagation for genetic storage and reintroduction— o Kalaupapa NHP reported thousands of seeds in storage (Kalaupapa NHP 2014). o The National Tropical Botanical Garden (NTBG) reported 2,000 seeds collected from Mo'omomi in 1990; 100 seeds collected from plants east of Mo'omomi in 2009, and 250 seeds collected from plants along the coastal strand of Kalaupapa peninsula in 2001 (NTBG 2017). • Stochastic events—Build resiliency and redundancy— o Currently, no individuals will be reintroduced in Mo'omomi Preserve until all axis deer are removed from the fenced area (TNC 2018). o Mokio Land Trust plans to outplant *Tetramolopium rockii* into the Mokio management area in the near future (Haase 2018, in litt.). o Kalaupapa NHP reported reintroduction of five individuals and dispersal of seeds at five locations in 2014.

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SPECIES ACCOUNT: *Thalictrum cooleyi* (Cooley's meadowrue)

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/07/1989; Southeast Region (R4) (USFWS, 2017)

Physical Description

A small, rhizomatous, perennial herb with erect to lax stems, up to 1 m tall. Loose clusters of flowers are borne in June. The unisexual flowers lack petals, but the sepals are white, pale yellow, or pale green with lavender filaments. The leaves are narrow and lance-shaped. The fruits are single-seeded and winged. Phenology: Flowers appear mid to late June and fruit mature in August or September (NatureServe, 2015).

Taxonomy

Thalictrum cooleyi is distinguished from other such members of the genus, *Thalictrum revolutum* in particular, by the combination of leaflet narrowness (4 to 26 times as long as wide), lack of lobing in the majority of the leaflets, and absence of hairs, glands, or papillae on lower leaflet surfaces, petioles, peduncles, and achenes (Park 1992) (USFWS, 1994).

Historical Range

Three historic North Carolina populations--Brunswick, Columbus, and Pender Counties--are assumed extirpated, because recent surveys showed habitat destruction at the sites and no plants were found (North Carolina Natural Heritage Program 1992). Cooley's meadowrue has been reported from New Hanover County, North Carolina (Radford et al. 1968), but without documentation (USFWS, 1994).

Current Range

All of the known *Thalictrum cooleyi* populations occur in the Coastal Plain Province in NC, GA, and FL (USFWS, 2009).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, wind- and insect-pollinated (NatureServe, 2015)

Breeding Season

Adult: Flowering in June (Radford et al, 1968) (NatureServe, 2015)

Reproduction Narrative

Adult: Flowering in June (Radford et al, 1968). The winged, single-seeded fruits mature in August and September (Lowe et al. 1990), but the seed life is presumably short. A dioecious species, *Thalictrum cooleyi* has separate male and female flowers that are wind- and insect-pollinated (NatureServe, 2015).

Habitat Type

Adult: Pine Savanna (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Wetlands/intermittent fire (NatureServe, 2015; USFWS, 1994); soil pH 5.8-6.6 (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (Inferred from NatureServe, 2015 and USFWS, 1994)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (Inferred from NatureServe, 2015 and USFWS, 1994)

Site Fidelity

Adult: High (NatureServe, 2015)

Habitat Narrative

Adult: Sunny, moist places such as open, savanna-like forest edges and clearings, wet savannas over calcareous clays, and ecotones between wet savannas and non-riverine swamp forests. Soils are basic, sandy loams. Also on roadsides and power line rights-of-way in former savannas. It grows on circumneutral soils in wet pine savannas, grass-sedge bogs, and savanna-like areas, often at the border of intermittent drainages or swamp forests. Boggy savannah-like borders of low woodlands, roadside ditches, and power line rights-of-way. Usually associates with some type of disturbance, e.g., clearings, the edges of frequently burned savannas, power line right-of ways which are maintained either by fire or mowing, and roadside edges. Typically on Grifton soil. This plant is found on fine sandy loams that are at least seasonally (winter) moist or saturated and are only slightly acidic (pH 5.8-6.6). Sufficient moisture is critical to plant vigor and reproductive effort. This plant occupies a narrow hydrological niche, where soil is moist to saturated but water does not stand above the soil surface. This species occurs in moist to wet bogs and savannas and savanna-like openings on circumneutral soils and is dependent upon some form of disturbance to maintain the open quality of its habitat. Currently, artificial disturbances, such as power line and road right-of-way maintenance, and plowed firebreaks, are maintaining some of the openings historically provided by naturally occurring periodic fires (Murdock 1989). This species grows in circumneutral soil in moist to wet savannas and savanna-like areas kept open by frequent fire or other disturbance. "This borderline type of habitat would have been disturbed historically by naturally occurring savanna fires moving through at 1- to 5-year intervals, clearing litter from the soil surface and causing the cyclical advance and retreat of woody growth. A typical population of Cooley's meadowrue has robust reproductive plants among shrubs and in adjacent open savanna and repressed individuals in nearby dense shade" (Boyer 1994) (NatureServe, 2015; USFWS, 1994). Low tolerance range and clumped spatial arrangement are inferred based on the specific habitat needs of this species and the relatively low number of populations (NatureServe, 2015; USFWS, 1994).

Dispersal/Migration

Motility/Mobility

Adult: Low (USFWS, 1994)

Dispersal/Migration Narrative

Adult: Possibly propagate by breaking off and dispersal of vegetative parts in aquatic habitat (USFWS, 1994).

Population Information and Trends**Population Trends:**

Decreasing (NatureServe, 2015)

Species Trends:

Stable (USFWS, 2009)

Resiliency:

Moderate (inferred from USFWS, 2009)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Moderate (inferred from USFWS, 2009)

Number of Populations:

12 (USFWS, 2009)

Population Size:

1 - 1000 total individuals (NatureServe, 2015)

Population Narrative:

Thalictrum cooleyi is intrinsically vulnerable in several ways. It is rhizomatous, so the number of ramets is far greater than the number of genets. It is dioecious, so the populations where only one sex persists are particularly vulnerable. It produces few seeds and apparently does not have a seed dispersal mechanism (USFWS 1989). (NatureServe, 2015) The total number of individuals is estimated at between 1 and 1000 and the number of populations between 6 and 20. In addition, the short-term population trend indicates a decline of 10-30% (NatureServe, 2015). Low representation, resiliency and redundancy are inferred based on species specific habitat needs, low number of populations and fragmentation of suitable habitat (NatureServe, 2015). In the 2008 Recovery Data Call, the status of *Thalictrum cooleyi* was listed as stable. Between 2005 and 2007, NCNHP staff or other knowledgeable botanists have visited 12 of 25 North Carolina subpopulations (representing 10 populations) of *Thalictrum cooleyi*. As of 2008, there were 9 extant populations in NC; 2 in GA; and 1 in FL (USFWS, 2009).

Threats and Stressors

Stressor: Agriculture (USFWS, 1994)

Exposure:**Response:****Consequence:** Loss of habitat**Narrative:** USFWS (1994) notes that land clearing for agriculture is a threat to this species.**Stressor:** Succession (USFWS, 1994)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** USFWS (1994) notes that succession (due to lack of disturbance/fire) is a threat to this species.**Stressor:** Forestry (USFWS, 1994)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** USFWS (1994) notes that forestry/logging is a threat to this species.**Stressor:** Mining and Development**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** USFWS (1994) notes that mining and development are threats to this species.**Stressor:** Draining (USFWS, 1994)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** USFWS (1994) notes that draining (for development/road construction) is a threat to this species.**Stressor:** Road construction (USFWS, 1994)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** USFWS (1994) notes that highway construction is a threat to this species.**Stressor:** Inadequacy of regulatory mechanisms (USFWS, 2009)**Exposure:****Response:****Consequence:****Narrative:** There are no known populations on federal lands (USFWS, 2009).***Recovery*****Reclassification Criteria:**

Not available

Delisting Criteria:

Cooley's meadowrue (*Thalictrum cooleyi*) will be considered for delisting when there are at least 16 self-sustaining, geographically distinct populations in existence that are protected to such a degree that the species no longer qualifies for protection under the Endangered Species Act (see criteria below). A self-sustaining population is a reproducing population that is large enough to maintain sufficient genetic variation to enable it to survive and respond to natural habitat changes. The number of individuals necessary and the quantity and quality of habitat needed to meet this criterion will be determined as one of the recovery tasks (USFWS, 1994).

Recovery Actions:

- Protect existing populations and essential habitat. Develop interim research and management plans in conjunction with landowners and managers. Search for additional populations and potential habitat. Rank populations for focus of protection efforts. Evaluate habitat protection alternatives (USFWS, 1994).
- Determine and implement management necessary for long-term reproduction, establishment, maintenance, and vigor. Determine population size, stage-class distribution and sex ratios for all populations. Study abiotic and biotic features of the species' habitat. Conduct long-term demographic studies. Determine the effects of past and ongoing habitat disturbance. Define criteria for self-sustaining populations and develop appropriate habitat management guidelines based upon the data obtained from Tasks 2.2 through 2.4. Implement appropriate management techniques as they are developed from previous tasks. Develop techniques and reestablish populations in suitable habitat within the species' historic range (USFWS, 1994).
- Maintain and expand cultivated sources for the species and provide for long-term maintenance of selected populations in cultivation (USFWS, 1994).

Conservation Measures and Best Management Practices:

- Revisit known populations that have not been visited in the past three years; monitor the habitat condition of each site including threats; discuss conservation options with landowners where appropriate; update Natural Heritage Program files with this information (USFWS, 2009).
- Search for additional populations (USFWS, 2009).
- Prioritize known sites for protection (USFWS, 2009).
- Protect additional populations (USFWS, 2009).
- Develop management plans for all protected populations (USFWS, 2009).
- Develop monitoring protocols, initiate long term population monitoring and determine the criteria for sustaining populations (USFWS, 2009).
- Conduct research on general biology of the species including life history and reproductive biology (breeding systems, seed production and seedling survivorship) (USFWS, 2009).
- Compare, genetically, the populations of questionable taxonomy in Georgia with those known from North Carolina and Florida (USFWS, 2009).
- Work with North Carolina Botanical Garden to conserve seeds and develop propagation protocols (USFWS, 2009).

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SPECIES ACCOUNT: *Thelypodium howellii spectabilis* (Howell's spectacular thelypody)

Species Taxonomic and Listing Information

Listing Status: Threatened; Pacific Region (R1) (USFWS, 2016)

Physical Description

Howell's spectacular thelypody is an herbaceous biennial that reaches approximately 60 cm (24 inches) tall, with branches arising from near the base of the stem. The basal leaves are approximately 5 cm (2 inches) long with wavy edges and are arranged in a rosette. Stem leaves are shorter, narrow, and have smooth edges. It is a root forming plant and is pollinated by insects. Flowers appear in loose spikes at the ends of the stems. Flowers have four purple petals approximately 1.9 cm (0.75 inches) in length, each of which is borne on a short stalk. Fruits are long, slender pods (Kagan 1986). The plant begins actively growing in April, flowers in May, fruits in June and goes dormant in August (USFWS, 2016).

Current Range

Endemic to the northeastern corner of Oregon, occurring in the Baker-Powder River valley in Baker and Union Counties (Fish and Wildlife Service 1999). Generalized current range of about 175 sq. km.

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (USFWS, 2016)

Breeding Season

Adult: Flowers in May (USFWS, 2016)

Reproduction Narrative

Adult: It is a root forming plant and is pollinated by insects. Flowers appear in loose spikes at the ends of the stems. Flowers have four purple petals approximately 1.9 cm (0.75 inches) in length, each of which is borne on a short stalk. Fruits are long, slender pods (Kagan 1986). The plant begins actively growing in April, flowers in May, fruits in June and goes dormant in August (USFWS, 2016).

Habitat Type

Adult: Wet alkaline meadows (USFWS, 2016)

Habitat Narrative

Adult: The thelypody occurs in wet alkaline meadows in valley bottoms, usually in and around woody shrubs that dominate the habitat on the knolls and along the edge of the wet meadow habitat between the knolls. Soils are pluvial-deposited alkaline clays mixed with recent alluvial silts, and are moderately well-drained (Kagan 1986). Associated species include *Sarcobatus vermiculatus* (greasewood), *Distichlis stricta* (alkali saltgrass), *Elymus cinereus* (giant wild rye), *Spartina gracilis* (alkali cordgrass), and *Poa juncifolia* (alkali bluegrass) (Kagan 1986). The thelypody may be dependent on periodic flooding since it appears to rapidly colonize areas adjacent to streams that have flooded (Kagan 1986). Abundance fluctuates widely from year to year in response to annual climate and soil moisture (USFWS 2010, p. 4). Thelopody is readily consumed by cows. Thus, thelopody is typically only found under shrubs in areas that are intensively grazed during the growing season (USFWS 2010). In addition, this taxon does not compete well with encroaching weedy vegetation such as *Dipsacus fullonum* (teasel) (Davis and Youtie 1995) (USFWS, 2016).

Dispersal/Migration

Population Information and Trends

Population Trends:

Unknown (USFWS, 2016)

Number of Populations:

~16 (USFWS, 2016)

Population Size:

10,000 - 100,000 individuals (USFWS, 2016)

Population Narrative:

This taxon was thought to be extinct until rediscovered by Kagan in 1980 near North Powder (Kagan 1986a). The Recovery Plan identifies 11 different occurrences that are grouped into five separate “populations” The labeling of these geographically-clustered occurrences as “populations” is a loose application of the term, since we do not know the extent of genetic interchange among occurrences. The 2008 update of the Oregon Natural Heritage Information Center’s (ORNHC) database documents 15 Howell’s thelypody occurrences (USFWS 2010). The known occurrences vary substantially in size and plant abundance. Some are small patches just several hundred square feet in size, while others extend over 10 to 20 acres. One additional population has been established since the subspecies was listed. Staff from ODA’s Native Plant Conservation Program translocated thelypody plants to three locations near Baldock Slough on a property that has a permanent conservation easement through the Wetland Reserve Program (Currin et al.2008). All of the known thelypody occurrences are on private land and many are not accessible for monitoring. Since Federal listing in 1999, population monitoring efforts have focused on three sites where there are mechanisms in place that allow for thelypody monitoring: 1) the Haines Rodeo Grounds site, 2) the Miles Ranch Easement, and 3) the Baldock Slough introduction site (USFWS 2010). At all of the monitored sites, the number of flowering plants tends to vary widely from year-to-year. The amount of early spring precipitation appears to be an important driver of annual abundance, with high precipitation levels correlated with increased plant abundance. The biennial habit of thelypody also appears to play a role, with spikes in abundance tending to occur every two years (J. Stephenson, USFWS, pers. comm.,

2015). In one ½-acre plot at the Haines Rodeo Grounds that was intensively monitored from 2008 to 2010, thelypody abundance fluctuated from 3,011 plants in 2008 to 25,600 plants in 2009, and back down to 3,135 plants in 2010 (EcoWest Consulting 2011). As this is a protected site, no livestock grazing or other land use activities occur that might negatively affect plant development. The inherent year-to-year variability in plant numbers make it difficult to assess long-term population trends, particularly since quantitative surveys are not conducted every year (J. . Stephenson, USFWS, pers. comm., 2015). During good years, the Haines Rodeo Grounds population is quite large (> 50,000 plants in 2009), however few plants were found during qualitative surveys in June 2014 leading to concerns that this population is declining. There is concern that the spread of invasive weeds, particularly cheatgrass, is outcompeting thelypody in this area. There is less quantitative survey data for the Miles Ranch Easement, but it is also a large population in good years (> 35,000 plants in 2009). The Baldock Slough introduced population contained approximately 400 plants in 2009, distributed in 7 small areas. By 2013, plants were found at only 3 of the 7 areas, and a survey in June 2014 tallied only 20 plants in those 3 remaining areas (D. Trochlell, Natural Resource Conservation Service, pers. comm. 2014). The other known thelypody locations are all located on private lands have either very limited or no access to the occupied sites (USFWS 2010). Where occurrences are visible from public roads, occasional presence/absence surveys have been done in June/early July (when flowering plants are highly visible) to document that the occurrence is still extant, while the less visible sites have not been observed in many years. Much uncertainty remains given the inability to access and monitor the majority of populations on private lands that have no special management protections. However, the overall status of thelypody has improved since listing because additional populations have been found and 3 populations have some protections in place for thelypody. The protection of these sites and some modest progress in developing compatible livestock grazing management practices have moved these subspecies further away from the threat of extinction (USFWS 2010) (USFWS, 2016). Surveys 0 Additional population information was collected in 201 1 (Oregon Department of Transportation 2013), where State highway crews documented approximately 35 plants growing on the side of Highway 84. This population had been documented previously in 2009, 1997 and 1996, is within the previously described range, and is located 0.15 miles from another population. 0 USDA-NRCS conducted a survey of seven sites on June 25, 2014. In four of the . seven experimental sites where the Oregon Department of Agriculture Native Plant Conservation Program had conducted transplants in 2002 and 2007, no *T. howellii* ssp. *spectabilis* were found. USDA-NRCS attributed this decline to a competition from nonnative species including intermediate wheatgrass (*Thinopyrum intermedium*) and whitetop (*Cardaria draba*), which were thought to be outcompeting *T. howellii* ssp. *spectabilis* (U.S. Department of Agriculture- Natural Resource Conservation Service 2014) (USFWS, 2018). Research 0 In 2014, EcoWest Consulting Inc. and the USFWS finished an experiment titled “The influence of Population Dynamics, Grazing, and Precipitation Patterns on the Restoration of a Threatened Riparian Mustard to Former Habitat” (2014). *Thelypodium howellii* ssp. *spectabilis* was the subject of this Before/After Control/Impact (BACI) design study, which began in 2008 and concluded in 2014. The results of the study were largely inconclusive due to the life history and moisture and soil sensitivity of *T. howellii* ssp. *spectabilis*, which resulted in highly variable results. However, the researchers suggest that changes in grazing practice to late season grazing after post-seed dispersal may allow these plants to expand into other areas (USFWS, 2018).

Threats and Stressors

Stressor: Development (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Habitat loss due to urban and agricultural development is listed as a threat to this species (USFWS, 2016).

Stressor: Habitat degradation (USFWS, 2016)

Exposure:

Response:

Consequence: Habitat loss/habitat degradation

Narrative: Habitat degradation due to livestock grazing and hydrological modification is listed as a threat to this species (USFWS, 2016).

Stressor: Grazing (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Consumption by livestock is listed as a threat to this species (USFWS, 2016).

Stressor: Herbicides (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Use of herbicides or mowing during the growing season is listed as a threat to this species (USFWS, 2016).

Stressor: Competition (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Competition with exotic species such as teasel (*Dipsacus fullonum*), bull thistle (*Cirsium vulgare*), Canada thistle (*C. canadensis*), and yellow sweet clover (*Melilotus officinalis*) is listed as a threat to this species (USFWS, 2016).

Recovery

Delisting Criteria:

The thelpody recovery plan calls for the protection of five self-sustaining thelpody populations throughout its extant and historic range. Each of the five populations should have management plans providing for the plant's long-term protection and have stable or increasing trends for 10 years. Currently, three populations of thelpody receive some level of protection from development and are managed for conservation (USFWS 2010). The Haines Rodeo Grounds is a purchased mitigation site specifically for thelpody conservation, and has a completed management plan for this species. The other two sites (the Miles Ranch Easement and the Baldock Slough introduction site) are easements managed for wetlands protection. While the Baldock slough will remain protected in the Wetland Reserve Program, it is not clear if the reintroduced population will become self-sustaining. In addition, there are also three small

roadside populations managed by ODOT under a State Management Area. In the past, there were two populations on private lands near North Powder that were managed via conservation easements: the BLM has managed a population for several years until about 2006, and the TNC managed another population for 15 years. At this time there are no agreements for the management of these two populations and their status is unknown (USFWS, 2016).

Recovery Actions:

- Landowner Outreach — Work with local officials in Baker and Union counties to develop a Thelypody Conservation Proposal that includes participation incentives that would then be taken to landowners in thelypody habitat for their consideration. Such a proposal would likely include provisions for establishment of pastures with special management elements for thelypody conservation (e.g., rest or reduced grazing during the growing season) (USFWS, 2018).
- Grazing Research — Continue controlled studies to determine the response of thelypody to livestock grazing outside the plant's primary growing season, as well as the potential to use grazing as a tool to control competing vegetation (USFWS, 2018).
- Manage Haines Rodeo Grounds Site — Work with the Baker County Road Department to reinstate implementation of the management plan for this site. Of particular concern at this site is control of competing vegetation in thelypody-occupied areas (USFWS, 2018).
- Management Plan for Miles Easement — Finalize a management plan for the Miles Easement and actively pursue its successful implementation (USFWS, 2018).
- Succeed at Baldock Slough — Continue the effort to successfully establish a thelypody population at Baldock Slough. Control of invasive weeds will need to be a key component of this effort (USFWS, 2018).
- Monitoring Plan — Develop and use a practical, standardized methodology for monitoring thelypody populations so that we can obtain comparable data across sites and across years. This methodology would also serve as the basis for a subsequent Post Delisting Monitoring Plan, satisfying one of the delisting criteria in the Recovery Plan (USFWS, 2018).

Conservation Measures and Best Management Practices:

- All of the General Plant Conservation Measures (Section 3.13.1) apply for thelypody. In addition, livestock grazing will not be used to control or remove invasive and non-native vegetation at project sites occupied by Howell's spectacular thelypody, unless approved by the local Service office (USFWS, 2016).

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SPECIES ACCOUNT: *Thelypodium stenopetalum* (Slender-petaled mustard)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A biennial herb, glabrous, glaucous. Basal leaves oblanceolate to oblong, entire or wavy-margined, thickish; cauline leaves ascending, sessile, oblong-lanceolate, sagittate, entire to few-toothed or shallowly lobed. Petals linear, lavender, rarely white, blades crinkled at base. (NatureServe, 2015)

Taxonomy

Thelypodium, a genus in the mustard family (Brassicaceae), contains approximately 20 species located throughout western North America, with 8 species occurring in California (Rollins 1993). The biennial *Thelypodium stenopetalum* S. Wats., was first described in 1887 by Sereno Watson from a collection made by Samuel B. Parish the same year from Bear Valley, San Bernardino Mountains, California (Watson 1887). Schulz (1933) transferred the taxon into the genus *Thelypodopsis*, subsequently changing the name to *Thelypodopsis stenopetala*. *Thelypodium stenopetalum* is distinguished from other members of the genus by the sessile (attached directly to the stem), clasping leaves, paired filaments that are free, and the linear petals. No other species of *Thelypodium* occur within the range of *Thelypodium stenopetalum* (USFWS, 1998).

Historical Range

See current range/distribution.

Current Range

California endemic, restricted to meadows of Big Bear Basin in San Bernardino County (Skinner, 1997). The full range extent covers no more than 49 sq mi. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: 2 years? (USFWS, 2011)

Breeding Season

Adult: Mature plants produce an inconspicuous flower stalk with flowers arranged in an open raceme in May or June; flowers may be present on the stalk through July (USFWS, 2011).

Reproduction Narrative

Adult: Thelypodium stenopetalum is typically considered to be a biennial species, although this has not been verified (see Species-specific research section below) (Henderson 2003, p. 57), with individual plants completing their life cycle in 2 years. First year plants generally produce leaf rosettes only and rarely flower that year. Observations of T. stenopetalum during drier years have found that with less water the species can act as an annual and produce smaller flowers that fall off the plant earlier than during wet years (S. Eliason, U.S. Forest Service, pers. obs. 2010). Mature plants produce an inconspicuous flower stalk with flowers arranged in an open raceme in May or June; flowers may be present on the stalk through July. Pollination studies have not been conducted on this species. No information is available on seed dispersal though it appears that the small seeds do not disperse very far from the parent plant (USFS 2000b, p. 41) (USFWS, 2011).

Habitat Type

Adult: Meadow (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 2011)

Environmental Specificity

Adult: Narrow/specialist (Natureserve, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015 and USFWS, 2011)

Site Fidelity

Adult: High (inferred from NatureServe, 2015 and USFWS, 2011)

Habitat Narrative

Adult: Species inhabits mesic, alkaline meadows (Skinner, 1997) (NatureServe, 2015). Thelypodium stenopetalum is primarily found on vernal moist alkaline meadows at elevations. High ecological integrity of the population and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species and restricted range in which it is found. from 1,600 to 2,500 meters (m) (5,250 to 8,200 feet (ft)) in the Big Bear Valley, San Bernardino Mountains of California. Alkaline flats and lakeshores are also considered suitable habitat (USFS 2000b, p. 41) (USFWS, 2011).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: No information is available on seed dispersal though it appears that the small seeds do not disperse very far from the parent plant (USFS 2000b, p. 41) (USFWS, 2011).

Population Information and Trends**Population Trends:**

Decreasing (NatureServe, 2015)

Resiliency:

Low (inferred form NatureServe, 2015)

Representation:

Low (inferred form NatureServe, 2015)

Redundancy:

Low (inferred form NatureServe, 2015)

Number of Populations:

6 - 20 (NatureServe, 2015)

Population Size:

2500 - 10,000 individuals (NatureServe, 2015)

Population Narrative:

Extremely fragile due to occurrence in only a few wet meadows in one area (Bittman 1998). Long term trend is probably one of moderate decline. Decline of <50% to Relatively Stable Only a few occurrences have population numbers and they add up to 7470 plants (CNDDDB 2005). Known from three recent and seven historical occurrences (Bittman 1998) (NatureServe, 2015). Low resiliency, representation and redundancy are inferred based on the relatively low number of known populations and individuals and the limited geography within which this species occurs.

Threats and Stressors

Stressor: Development (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Development of the Big Bear Lake Reservoir (1884) and the Big Bear Dam (1911) destroyed almost all of the natural meadowland within Big Bear Valley. As a result, habitat occupied by *Thelypodium stenopetalum* was reduced from 2,800 ha (7,000 ac) to about 400 ha (1,000 ac) (USFWS 1984, p. 34498). This construction appears to have affected the extinction of some of the plants, which formerly grew in the valley (Parish 1917, p. 164) and likely eliminated some *T. stenopetalum* populations. Residential and commercial development led to the extirpation of three known historical occurrences of *T. stenopetalum* (EOs 8, 9, and 11) in the decades prior to listing (Appendix 1). At the time of listing, about 80 percent of the remaining *T. stenopetalum* habitat (approximately 400 ha (1,000 ac)) was considered vulnerable to development (USFWS 1984, p. 34499). The threat of development remains high because the majority of *Thelypodium stenopetalum* occurrences are on private land (four of six EOs). Impacts of development pressures on private land are evident at a number of occurrences: the subdivision and development of the land for the Hamilton Ranch Erwin Lake Estates at the east end of Erwin Lake (EO 3) has significantly impacted *T. stenopetalum* and its habitat, some *T. stenopetalum* habitat east of Eagle Point (EO 2 not in parcel K) has been lost to housing development, the occurrence at the south shore of Baldwin Lake (EO 6) has been impacted by development, and the Belleville Meadow occurrence (EO 10) has been impacted by upstream development. The only *T. stenopetalum* occurrence that is considered fully protected from development impacts is at the north shore of Baldwin Lake (EO 1) on the Baldwin Lake Ecological

Reserve (managed by CDFG), and residential construction activities are occurring adjacent to this reserve. There are no conservation measures in place that offer protection of these occurrences on private land from future development. The direct threat of development to *T. stenopetalum* therefore remains substantial and is currently impacting habitat at four of six extant occurrences (Appendix 1) (USFWS, 2011).

Stressor: Off-highway vehicles (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat/Loss of individuals

Narrative: The listing rule indicated that OHV activity eliminated colonies and damaged *Thelypodium stenopetalum* habitat (USFWS 1984, p. 34499). In 2000, a review by the Forest Service found that approximately 1.1 miles (1.7 kilometers) (1.3 ha (3 ac)) of unauthorized roads bisect or are adjacent to known occupied meadow plant occurrences and that the unauthorized network of roads allow for an “unknown, though likely high, level of random and on-going impacts to threatened/endangered meadow plant habitat” (USFS 2000b, p. 99). Unauthorized routes are closed when they are found; however, illegal OHV use continues to impact moist meadow habitat by altering hydrology, compacting soil, and degrading habitat. Controlling OHV use within *Thelypodium stenopetalum* habitat has been difficult because much of the activity is either on private land or is unauthorized. Occurrences at the north and south shores of Baldwin Lake (EOs 1, 6) are particularly vulnerable to OHV use. At the south shore of Baldwin Lake (EO 6), OHV trails bisect the *T. stenopetalum* occurrence, connecting private land to the shoreline (USFS 2000b, p. 62). Fencing that may have provided protection to the occurrence at the north shore of Baldwin Lake (EO 1)—at the side of State Route 18, which could prevent unauthorized OHVs from entering—has been knocked down or has fallen down due to heavy snow drifts (Eliason, pers. obs. 2010). In 2010, the Forest Service placed boulders at the entrance of these roads to preclude OHV activity, which appears to be successful in reducing this threat on Forest Service lands (Eliason, pers. obs. 2010). At Belleville Meadow (EO 10), OHV activity in unauthorized areas has been observed on a closed road that bisects the area (USFS 2000b, p. 62) and has caused devegetation and alteration of surface hydrology in some areas (USFS 2005, p. 37). The Forest Service has closed and rehabilitated unauthorized roads at this occurrence (USFWS 2005, p. 220). Despite fencing and barriers, unauthorized OHV use still occurs at Belleville Meadow (USFWS 2005, p. 37). Currently, we believe OHV activity is negatively impacting *T. stenopetalum* rangewide (USFWS, 2011).

Stressor: Alteration of hydrology (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: *Thelypodium stenopetalum* is susceptible to changes of the natural hydrological conditions within its habitat due to its apparent dependence on soil moisture (USFS 2000b, p. 37). Alteration of hydrology poses a threat to all *T. stenopetalum* occurrences (Eliason, pers. obs. 2010). Alteration of drainages and swales, depletion of groundwater, and conversion of drainages to flood control channels all have the potential to significantly impact populations of *T. stenopetalum*. In extreme cases, alteration of hydrology may result in the dewatering of the habitat by lowering the water table (USFS 2000b, p. 43). An increase in residential development and the subsequent installation of a large number of private wells has the potential to lower the water table and thereby alter the hydrology of moist meadow habitat (Krantz 1979, p. iv; Eliason,

pers. obs. 2010). Additionally, development, roads, and OHV activity may alter the hydrology of an area by creating gullies, which can cut off the water supply to a meadow aquifer downstream by intercepting, concentrating, and diverting runoff (USFS 2002 p. 22). Alteration of soil hydrology or existing drainage patterns may have impacted several *Thelypodium stenopetalum* occurrences including Eagle Point (EO 2) and the north shore of Baldwin Lake (EO 1). At each of these locations, efforts were made to prevent hydrology-related impacts to the habitat and to the species. For instance, CDFG's purchase of private land containing the watershed for the north shore of the Baldwin Lake occurrence (EO 1; Baldwin Lake Ecological Reserve) in 1992 has helped to maintain natural hydrologic patterns. The Pan Hot Springs occurrence (EO 7) is found on deed restricted land; however, the water source for the habitat is not included in the deed restriction. Without control of water availability, the plants and their habitat at this occurrence remain threatened (USFS 2002, p. 25). While protection measures have lessened the threat of altered hydrology at several occurrences, it remains a rangewide threat to five of six extant occurrences (Appendix 1) (USFWS, 2011).

Stressor: Invasive nonnative plants (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Since listing, invasive nonnative plants have been identified as a threat to five of six *Thelypodium stenopetalum* occurrences (Appendix 1). Nonnative species of grasses and forbs invade many plant communities often as an indirect result of habitat disturbance (Vitousek et al. 1997, p. 1). Development, roads, and other threats that disturb moist meadow habitat allow invasive nonnative plants to occupy and replace *T. stenopetalum*, and may decrease the amount of soil nutrients available to co-existing *T. stenopetalum* and eliminate natural pollinators (Levine et al. 2003, p. 777). Nonnative grasses may impact *T. stenopetalum* habitat by decreasing community water availability, which is often mediated by the displacement of species that use more water (Levine et al. 2003, p. 778). Invasion by nonnative grasses, may make it more difficult for *T. stenopetalum* to thrive because these grasses have a highly diffuse root system that is well positioned in the soil horizon to remove moisture that otherwise could support seedlings of *T. stenopetalum* (Levine et al. 2003, p. 778). Additionally, dead grasses may create a mat or thatch that impedes or prevents seedlings from becoming established. *Thinopyrum intermedium* (previously *Elytrigia intermedia*) (intermediate wheatgrass) has been identified as a threat to occurrences at the north and south shores of Baldwin Lake (EOs 1, 6), East of Eagle point (EO 2), Erwin meadows (EO 3), and in the south end of Pan Hot Springs (EO 7) (Eliaison pers. comm. 2011). *Thinopyrum intermedium* invades *T. stenopetalum* habitat and outcompetes it for space. It also produces a thatch that *T. stenopetalum* seedlings cannot penetrate. Control methods, such as burning or mowing, have proven ineffective because the grass is a perennial that returns in subsequent years (Eliaison pers. obs. 2010) (USFWS, 2011).

Stressor: Grazing/herbivory (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Since the time of listing, horse grazing and pasturing activities have been identified as threats that are impacting occurrences at Pan Hot Springs (EO 7), the south shore of Baldwin Lake (EO 6), and the east end of Erwin Lake (EO 3). Voluntary landowner agreements resulted in the relocation of equestrian activities away from rare plant habitat at Pan Hot Springs. These

efforts were successful and recovery of *Thelypodium stenopetalum* populations has been observed at this location (USFS 2002, p. 19). Horse grazing and pasturing activities remain a threat at the east end of Erwin Lake (EO 3) and south Baldwin Lake (EO 6). These occurrences are on private lands and there is no formal protection in place to control this threat. As described in the species biology, Andrew's marble butterfly feed on members of Brassicaceae (mustard family) including *Thelypodium stenopetalum*. The extent that feeding by Andrew's marble butterfly impacts *T. stenopetalum* populations is unknown. Further research is necessary to determine the status of this threat (USFWS, 2011).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: In summary, the Act is the primary Federal law that has provided protection for *Thelypodium stenopetalum* since its listing as endangered in 1984. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for *T. stenopetalum* absent its status under the Act. There are also unresolved conflicts between State protections afforded under CESA and NPPA and county weed abatement provisions. Therefore, we believe that State and other Federal laws and regulations have limited ability to protect the species in absence of the Act. Two of the six extant *T. stenopetalum* occurrences are however, afforded protection through local agencies by protecting land to conserve rare plant populations. Inadequacies in provisions or implementation in regulatory mechanisms are not considered threats to the species, although these inadequacies may permit or precipitate actual threats that are described under Factors A, B, C, and E (USFWS, 2011).

Stressor: Recreational activities (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Impacts associated with recreational activities have been identified as a rangewide threat to *Thelypodium stenopetalum* (Appendix 1). Recreational activities include, but are not limited to: hiking, dispersed camping, fishing, horse riding, mountain biking, and dog walking. The primary impact from recreational activities is trampling, which can crush and kill individual plants. Additional impacts include soil compaction, devegetation, escaped campfire threats, introduction or spread of nonnative species, and burial of plants with litter (USFS 2002, p. 23). Fencing and signage indicating the presence of sensitive species have proven effective at reducing the threat of recreational activities at the north and south shore of Baldwin Lake (EOs 1, 6). Moderate success has also been made in educating the public and heightening the awareness of the need for the protection and recovery of *T. stenopetalum* and numerous other listed and rare species in the vicinity of Big Bear Lake. The Big Bear Discovery Center at San Bernardino National Forest regularly presents public education programs on a variety of subjects, including threatened and endangered species (USFS 2000b, p. 80) (USFWS, 2011).

Stressor: Fire suppression measures (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Implementation of fire suppression measures has been identified as a threat at four of six extant *Thelypodium stenopetalum* occurrences. The San Bernardino County Land Use/Fire Hazard Abatement Division (see Factor D discussion) requires that owners must remove weeds and grasses in areas where this vegetation acts as a fuel that may pose a fire threat. Weeds and grasses are described by the County of San Bernardino generally as annuals that grow and dry out each year, and they did not discriminate for rare plants (County of San Bernardino 2010a, 2010b). Weed and grass removal generally involves mowing, which damages or destroys individual *T. stenopetalum* plants. If removal activities are conducted before or during *T. stenopetalum* flowering and fruit development, the plants reproductive output and germination may be significantly impacted (USFWS, 2011).

Stressor: Reduced populations (USFWS, 2011)

Exposure:

Response:

Consequence: Localized extinction and lack of genetic variability

Narrative: Fragmentation and isolation can adversely impact small populations of plants that are already reduced in distribution such as *Thelypodium stenopetalum* resulting in increased vulnerability to extirpation (Barrett and Kohn 1991, pp. 3–30). These effects may be the result of several factors, including small areas of suitable habitat, local extirpations, or ongoing natural or artificial factors limiting establishment and survival of the taxon. The small number of *Thelypodium stenopetalum* occurrences is a concern because it increases the possibility that impacts from urban development or other activities near moist meadow habitat could destroy all or a significant portion of the species' population. *Thelypodium stenopetalum* is distributed on less than 8.5 ha (21 ac) of moist meadow habitat (USFWS 1998, p. iii). Stochastic events outside the natural range of frequency and severity (such as floods, fires, contamination, or drought) can substantially reduce or eliminate species such as *T. stenopetalum* with a restricted range and small population, and increase the likelihood of extinction (Lande 1993, p. 912). Genetic effects may further influence population demography via inbreeding depression and genetic drift (Barrett and Kohn 1991, pp. 3–30; Menges 1991, pp. 58–61). Allee (1931, pp. 17– 50) suggested small, single populations are vulnerable to extirpation when opportunities for reproduction diminish because of reduced opportunity of individuals to reproduce (Allee effect or depensation) (Courchamp et al. 2008, pp. vi–216). Stephens et al. (1999, pp. 185–190), Dennis (2002, pp. 389–401) and Courchamp et al. (2008, pp. vi–216) suggest that the Allee effect is a density-dependent event that is inversely related to population size (USFWS, 2011).

Stressor: Climate change and drought (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to particular species (including *Thelypodium stenopetalum*) or sites at this time. It seems likely that *T. stenopetalum*, a species restricted to montane meadows in a single small portion of a mountain range found on particular soils with particular hydrological needs, would be threatened rangewide by any differences in climatic regimes brought on by changes to the climate. A changing climate with spatial and temporal shifting of temperature and precipitation may cause this species specific adaptations to climate to work against its survival. A changing climate may also provide advantages to other native and nonnative plant species.

Sharing information between scientists, land managers, and decision makers will increase our ability to address these threats. Increasing the success with which we address current threats to *T. stenopetalum* will increase our success of handling the uncertain effects of future climate change (USFWS, 2011).

Recovery

Reclassification Criteria:

Six populations of *Thelypodium stenopetalum* and adjacent suitable habitat are fully protected through land management agreements, land ownership by resource agency or conservation organization, conservation easement, or other permanent means of protection (USFWS, 2011).

Populations are stable or increasing with allowances for natural fluctuations (USFWS, 2011).

Recovery Actions:

- Four of the six extant occurrences are located, in part, on private land and receive no formal protection. Development on private land remains the predominant threat to *Thelypodium stenopetalum*. As the majority of occurrences receive no protection, the conservation efforts described above are not enough to meet reclassification criterion 1 for *T. stenopetalum* from endangered to threatened status (USFWS, 2011).
- The populations of *Thelypodium stenopetalum* are declining overall, with extirpation of two occurrences (EOs 4 and 5) since listing. All occurrences are impacted by multiple threats and though some populations are presumed extant, surveys are needed to verify their status (e.g., east end of Erwin Lake (EO 3)). Surveys are necessary to determine the status of all occurrences on private land, but observations in the field suggest that *T. stenopetalum* are not increasing and may be declining; therefore, reclassification criterion 2 has not been met (USFWS, 2011).

Conservation Measures and Best Management Practices:

- Work with partners, in particular private landowners, to help conserve *Thelypodium stenopetalum*. Identify opportunities through the Service's Partners for Fish and Wildlife Programs to implement conservation opportunities on private lands (USFWS, 2011).
- Conduct monitoring to inventory actual occurrences and update the status of *Thelypodium stenopetalum* occurrences throughout the species range. While the occurrence on the east end of Erwin Lake (EO3) is presumed extant, surveys should occur because they have not been conducted at this species location for many years (USFWS, 2011).
- Conduct research on life history characteristics (e.g., pollination studies) and more specific habitat requirements. This information may be used for unoccupied habitat identification and potential reintroduction experiments (USFWS, 2011).
- Establish a seed bank focusing first on small, isolated populations that have the greatest potential to become extirpated (USFWS, 2011).
- Work with the State and San Bernardino County to resolve conflicts with the weed abatement plan (USFWS, 2011).
- Develop a threats-based recovery outline to guide conservation actions for the species (USFWS, 2011).

References

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NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.”

SPECIES ACCOUNT: *Thlaspi californicum* (Kneeland Prairie penny-cress)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial herb. Blooms May-June. Fruits on ascending stalks. (NatureServe, 2015)

Taxonomy

A distinct entity separated from related taxa by its ascending long slender silicles that are acute at the apex. The USFWS lists this taxon as *Thlaspi californicum*, which is also the name in Kartesz (1999) and Rollins (1993). Kartesz (1994) had treated this taxon as *T. montanum* var. *californicum*. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Known global distribution of *Noccaea fendleri* ssp. *californica* is restricted to three small patches of serpentine outcrop (total 2.8 acres) located between 200 and 500 feet from each other within Kneeland Prairie, approximately 15 miles east of the Pacific Ocean, Humboldt County, California (USFWS 2011).

Critical Habitat Designated

Yes; 10/9/2002.

Legal Description

On October 9, 2002, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Thlaspi californicum* (Kneeland Prairie penny-cress) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in California (67 FR 62897-62910).

Critical Habitat Designation

The critical habitat designation for *Thlaspi californicum* includes one CHU in Humboldt County, California. This species critical habitat encompasses approximately 74 acres (ac) (30 hectares (ha)) (67 FR 62897-62910).

Critical habitat unit. Humboldt County, California. (i) From USGS. 1:24,000 scale laqua Buttes quadrangle.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Thlaspi californicum* critical habitat consists of four components (67 FR 62897-62910):

- (i) Thin rocky soils that have developed on exposures of serpentine substrates;
- (ii) Plant communities that support a relatively sparse assemblage of serpentine indicator, or facultative serpentine indicator, species, including various native forbs and grasses, but not trees or shrubs, such that competition for space and water (both above and below ground) and light is reduced, compared to the surrounding habitats. Known associated species include the following: *Festuca rubra* (red fescue), *Koeleria macrantha* (junegrass), *Elymus glaucus* (blue wildrye), *Eriophyllum lanatum* (woolly sunflower), *Lomatium macrocarpum* (large-fruited lomatium), and *Viola hallii* (Hall's violet);
- (iii) Serpentine substrates that contain 15 percent or greater (by surface area) of exposed gravels, cobbles, or larger rock fragments, which may contribute to alteration of factors of microclimate, including surface drainage and moisture availability, exposure to wind and sun, and temperature; and
- (iv) Prairie grasslands and oak woodlands located within 30 m (100 ft) of the serpentine outcrop area on Ashfield Ridge. Protection of these habitats is essential to the conservation of *Thlaspi californicum* in that it will provide connectivity among the serpentine sites, help to maintain the hydrologic and edaphic integrity of the serpentine sites, and support populations of pollinators and seed dispersal organisms.

Special Management Considerations or Protections

As noted in the Critical Habitat section, “special management considerations or protection” is a term that originates in the definition of critical habitat. We believe the critical habitat area may require special management considerations or protection because *Thlaspi californicum* occupies an extremely localized range. Potential threats to the habitat of *T. californicum* include: expansion of Kneeland Airport and CDFFP helitack base; road realignment; fires caused by airplane or vehicular accidents; contaminant spills; erosion; application of herbicides and pesticides; livestock grazing; and introduction and spread of exotic species. Additional special management is not required if adequate management or protection is already in place. Adequate special management considerations or protection are provided by a legally operative plan or agreement that addresses the maintenance and improvement of the primary constituent elements important to the species and manages for the long-term conservation of the species. Currently, no plans meeting these criteria have been developed for *Thlaspi californicum*.

Life History

Food/Nutrient Resources

Breeding Season

Adult: *Thlaspi californicum* normally begins blooming in March, with seed set in April or May and dehiscence of fruits (release of seeds) beginning in June (USFWS, 2003)

Reproduction Narrative

Adult: The biology and ecology of *Thlaspi californicum* are poorly understood. The three semi-isolated colonies are all separated from each other by Mountain View Road and/or the Kneeland Airport runway. We do not know if the colonies are reproductively isolated. *Thlaspi californicum* normally begins blooming in March, with seed set in April or May and dehiscence of fruits

(release of seeds) beginning in June. Approximately 86 percent of the individual plants were reproductive in 1997 and 2001 (SHN Consulting Engineers & Geologists 2001). Absence of flowering was attributed to either grazing or immaturity (USFWS, 2003).

Habitat Type

Adult: Rock outcrops (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (inferred from NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits serpentine rock outcrops in coastal prairie habitat; 760 m in elevation (Federal Register, 9 Feb. 2000; cf. Skinner and Pavlik 1997) (NatureServe, 2015). High ecological integrity of the population and site fidelity, clumped spatial arrangement of the population as well as low tolerance ranges are inferred based on the specific habitat requirements of this species.

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: The predominant wind direction in late spring and summer is northwest to northeast, when seed dispersal occurs. These results suggest future efforts to augment or introduce new colonies could be designed to effectively use natural dispersal patterns (USFWS, 2011).

Population Information and Trends**Population Trends:**

Decreasing (USFWS, 2011)

Resiliency:

Low (inferred from NatureServe, 2015)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Narrative:

11,000 plants in about 1997, with the population bisected by development; 200-500 plants seen at the site when visited in 1984. One occurrence, in Humboldt County (Kneeland Prairie); a purported 1942 collection south of Hoopa Valley was misidentified. Mendocino County sites reported in Skinner and Pavlik (1994, rev. 1997) also are now considered erroneous (Federal Register final listing, 9 Feb. 2000) (NatureServe, 2015). USFWS (2011) notes that populations are declining at a number of sites. Low resiliency, representation and redundancy are inferred based on the low number of known populations and the relatively small geographic area this species inhabits.

Threats and Stressors

Stressor: Construction/land modifications (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: The Kneeland Airport serves as the primary backup airport when weather conditions preclude landing at other Eureka area airports (Humboldt County 2005). The final listing rule discussed proposed upgrades and slope stabilization efforts related to the Kneeland Airport, and possible realignment of Mountain View Road to accommodate the airport upgrade. Those improvements are yet to be initiated. Since the last 5-year review, Humboldt County completed an update to the airport master plan, which summarized past and future expected use, and reviewed design, safety, environmental and other issues related to operating the airport (Humboldt County 2005). The Master Plan predicts use of the airport to increase perhaps 15 percent by the year 2021, over 2001 levels. Three primary constraints were identified for expansion of the airport to meet future growth demand: *Noccaea fendleri* ssp. *californica*; the steep topography; and the helitack base. Expanding runway length and width, runway safety areas and aircraft parking, and creating obstacle free zones were all judged to either have significant impacts on *N. f. ssp. californica*, the critical habitat designated for the species, or be excessively expensive. As a result, the Master Plan recommends: maintenance and stabilization of the existing runway configuration, continuation of existing nonstandard setbacks, such as obstacle free zones; and foregoing expansion of some facilities, such as aircraft parking. Under these recommendations, realignment of Mountain View Road would not be necessary. However, Humboldt County has recently sought funding to implement a Phase 1 Runway Safety Area Improvement Study, which would reassess options for bringing the airport into compliance with FAA standards (H. Seeman, Humboldt County Environmental Services Manager, pers. comm. 2011). Subsequent phases of work would include environmental assessment, design, and implementation. No schedule for implementation of the work phases was available. The Service to date has not received any specific design proposals, nor issued a formal opinion regarding the impacts of any specific proposal on *N. f. ssp. californica* and its designated critical habitat. *Noccaea fendleri* ssp. *californica* habitat is also vulnerable to destruction as a result of its unobstructed, close proximity to the county road. Observations made from the county road overlooking the West colony in May 2011, indicated a substantial amount of large rock had been removed and displaced within the upper portion of the habitat (Imper unpublished data 2011). Large rocks are a key feature of the habitat for *N. f. ssp. californica*, undoubtedly influencing moisture and temperature regimes at the scale of the plant, and perhaps other factors important

to the species. Due to an inability to access the property, the impact of the rock removal could not be quantified. In addition, the landowner has not indicated an interest in discussing habitat protection measures for the species. Therefore, the species remains vulnerable to habitat destruction and modification (USFWS, 2011).

Stressor: Grazing (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of individuals/habitat degradation

Narrative: Population monitoring conducted since 2005 has indicated, as high as 40 percent of the flowering plants in some areas were negatively affected by grazing. Plants located closer to cattle trails, the serpentine/pasture interface, or on moderate slopes were more likely to be grazed (Imper unpublished data 2011). Although these impacts may be important, we do not know at this time if the impacts of grazing are affecting the rate of population mortality or recruitment, or limiting recovery of the population in any way (USFWS, 2011).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: There has been no change in the imminence of this threat factor. *Noccaea fendleri* ssp. *californica* is not listed by the State of California. Therefore, protections under the California Endangered Species Act and Native Plant Protection Act do not apply. The California Environmental Quality Act (CEQA) (chapter 2, section 21050 et seq. of the California Public Resources Code) affords the primary protection for the species under state law. The CEQA requires review of any project that is undertaken, funded, or permitted by the State or a local governmental agency. If significant effects are identified, the lead agency has the option of requiring mitigation through changes in the project or deciding that overriding considerations make mitigation infeasible (CEQA section 21002). Protection of listed species through CEQA is, therefore, dependent upon the discretion of the lead agency involved. With the exception of eight plants located on the CDFFP site in 2011, the entire distribution of *Noccaea fendleri* ssp. *californica* is currently located on privately owned grazing land. CEQA does not regulate grazing or many other activities on private land that could negatively affect the species. The primary protections under Federal law are afforded by the Endangered Species Act of 1973 (Act), as amended. Since all habitat occupied by *Noccaea fendleri* ssp. *californica* is either private or State-owned, the prohibitions on take afforded under Section 9 of the Act do not apply to otherwise legal activities. However, under Section 7(a)(2) of the Act, Federal agencies must consult with the Service to ensure any project they fund, authorize, or carry out does not jeopardize a listed plant species. This section would apply to any project funded by the Federal Aviation Administration (FAA) that potentially could affect the species, or its occupied habitat. In addition, the airport occurs within the designated critical habitat for the species. Any airport project funded by the FAA that affects any portion of designated critical habitat is covered under Section 7 of the Act (USFWS, 2011).

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999; Cayan et al. 2005; IPCC 2007). However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. The available data suggests *Noccaea fendleri* ssp. *californica* may prefer relatively cool soil temperatures during the growing season, at least compared to conditions typical of the outcrops located near the airport (SHN Consulting Engineers and Geologists 2001). Therefore, if a warming trend is associated with climate change, the limited range in elevation and aspect available to *N. f. ssp. californica* nearby could hinder the ability of the species to escape detrimental changes in climate (USFWS, 2011).

Recovery

Reclassification Criteria:

The population as a whole, and all presently extant colonies, are protected and stable. Protected sites are defined as either 1) sites owned and/or managed by a government agency or private conservation organization that identifies maintenance of the species as the primary management objective for the site, or 2) sites protected by a permanent conservation easement or covenant that commits present and future landowners to the conservation of the species. To be deemed stable, the present largest population must maintain a running average population size (mean of annual mean population estimates) of at least 7,000 individuals, and the two other presently extant colonies must maintain a running average population size of at least 500 individuals each. Running averages will be determined over the most recent 10 years, or an appropriate period justified on the basis of population research (USFWS, 2011).

Reliable seed germination and propagation techniques for the species are understood and demonstrated (USFWS, 2011).

Genetic material, in the form of seeds adequately representing the genetic diversity within the species, is stored in a facility approved by the Center for Plant Conservation (USFWS, 2011).

Delisting Criteria:

The running average for the entire population is 10,000 or more individuals over a period of 10 years, or an appropriate period justified on the basis of population research (USFWS, 2011).

At least five protected and stable colonies (populations on distinct serpentine outcrops) are distributed throughout the current and historic range of the species. For a site to be considered protected, it must be either owned by a government agency or private conservation organization that identifies maintenance of the species as the primary management objective for the site, or the site must be protected by a permanent conservation easement or covenant that commits present and future landowners to the conservation of the species. To be deemed stable, the largest presently extant colony must maintain a running average population size of at least 7,000 individuals, and colonies on 4 additional outcrops must be shown to be naturally reproducing and maintain a running average population size of at least 500 individuals each for a period of 10 years, or an appropriate period justified on the basis of population research (USFWS, 2011).

Monitoring of population size, trends, other pertinent characteristics, and habitat quality has begun and will continue for the post-delisting monitoring period (USFWS, 2011).

Recovery Actions:

- Access has been denied to the largest colony (West colony) since 2003. Therefore, we cannot assess any progress made toward achievement of this criterion (USFWS, 2011).
- There has been no change in the protection status of the three extant colonies, or nearby suitable habitat since the recovery plan was completed. The two largest colonies (West and East colonies) are not protected. The CDFFP colony is covered under a draft protective policy implemented by the CDFFP. Access has been denied to monitor the West colony since 2003. Therefore, the information necessary to assess the stability of that colony is not being collected. Two other historical (and extant) occurrences are known, both of which have naturally reproduced since completion of the recovery plan. However, only the East colony exceeds the numerical threshold set in this criterion as of 2011 (see Section C below). The CDFFP colony has declined, and is on the verge of extirpation. As a result, this criterion has not been achieved (USFWS, 2011).
- Population-based monitoring of the two smaller colonies has been conducted since 2001. However, the large West colony has not been monitored since 2002 because due to an inability to access the property. This criterion has been partially achieved. Currently, all downlisting and delisting criteria are considered adequate and appropriate with respect to recovery of the species. The conservation strategy outlined by these criteria addresses all the currently known threats to the species. Components of the conservation strategy and criteria include habitat protection and management secured by appropriate agreements (such as conservation easements, covenants) to address listing factors A (habitat loss or modification, etc.); C (possible threat of predation); D (inadequate regulatory mechanisms); and E (other natural or manmade factors – specifically manmade random events, such as contaminant spills associated with the airport, that can be prevented or contained by appropriate management). Population sizes and number of protected populations included in the criteria in part address the threat of stochastic events under listing factor E. Seed banking also addresses the threat of stochastic events under listing factor E by ensuring that genetic material is available to reestablish any populations that become extirpated due to stochastic events (USFWS, 2011).

Conservation Measures and Best Management Practices:

- Virtually all habitat occupied by *Noccaea fendleri* ssp. *californica*, or suitable for the species within Kneeland Prairie occurs on private property owned by a single landowner. Therefore, recovery of the species is almost entirely dependent on being permitted to access the population, and to implement protective measures and management on private lands. The highest priority action for this species is to continue efforts to secure a working relationship with the landowner (USFWS, 2011).
- Continued periodic monitoring of the portion of the population for which access is authorized is also crucial in order to: measure progress toward meeting the numerical recovery criteria; provide an early warning of threats to the population; provide further evidence of the importance of climate to the health of the population; and enable at least a gross assessment of habitat in the area for which access is not authorized (USFWS, 2011).
- Since the recovery criteria for *Noccaea fendleri* ssp. *californica* contain specific goals with respect to the number of individuals, research is needed to determine the degree of clonal growth within the

population and develop a method to standardize identification of individuals for the purpose of population estimation (USFWS, 2011).

- Lastly, future efforts by Humboldt County to expand or maintain the airport may present opportunities for experimental restoration of serpentine substrate buried during past construction, or exposed where it is (naturally) situated near the ground surface. Those efforts, while not assured of success, are worth pursuing in order to expand the overall distribution of the species (USFWS, 2011).

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SPECIES ACCOUNT: *Thymophylla tephroleuca* (Ashy dogweed)

Species Taxonomic and Listing Information

Listing Status: Endangered; 07/19/1984; Southwest Region (R2) (USFWS, 2016)

Physical Description

Ashy dogweed is endemic to South Texas and occurs in open flat areas of shrubby grasslands and deep sandy pockets of fine sandy loam soils. Ashy dogweed is a short, woody-based, perennial sub-shrub plant, growing 3.9 – 11.8 inches in height and belongs to the Asteraceae (sunflower) family. It has mostly alternate, linear leaves with ashy-white pubescence due to fine, short hair glands that emit a pungent odor when crushed (U. S. Fish and Wildlife Service 1988). Flower heads are yellow to bright yellow and flowering typically occurs between March and May; however, such events are dependent on rainfall (USFWS 1984) and can occur as early as February (Correll and Johnston 1979). Ashy dogweed is an obligate out-crosser that has non-specialist pollinators from members of the families Buprestidae (beetles), Bombyliidae (bee flies), and Megachilidae (bees) (Dodson 2001, Williamson 2002, Poole et al. 2007).

Current Range

Several ashy dogweed populations are considered meta-populations based on relative distance between sites. Surveys conducted in the years since listing have identified five other extant populations in addition to the one known at the time of listing. These populations have increased the known range of the species from Webb to southern Zapata County. The loss, fragmentation and/or alteration of habitat may be increased at these meta-population sites as opposed to plants in populations that are farther apart. Ashy dogweed was first recorded in Starr County in 1932, near Rio Grande City, but is now considered extirpated from this area. This species was federally listed as endangered on July 19, 1984 and a recovery plan for the species was completed in 1988. At the time of listing, the ashy dogweed population was estimated to be 25 acres in size and contained approximately 1,300 individuals (USFWS 1984, 1987). Since then five additional populations have been found and the species' known range has expanded from Webb County into Zapata County, Texas (USFWS 2011). One of the six extant populations is partially on state-owned ROW lands that are maintained by TxDOT. The five remaining populations are found on private lands and three of the land owners have entered into Voluntary Conservation Agreements with TPWD (USFWS 2011). No critical habitat has been designated for ashy dogweed.

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Flower heads are yellow to bright yellow and flowering typically occurs between March and May; however, such events are dependent on rainfall (USFWS 1984) and can occur as early as February (Correll and Johnston 1979). Ashy dogweed is an obligate out-crosser that has non-

specialist pollinators from members of the families Buprestidae (beetles), Bombyliidae (bee flies), and Megachilidae (bees) (Dodson 2001, Williamson 2002, Poole et al. 2007).

Habitat Type

Adult: Grasslands

Habitat Narrative

Adult: Fine sand or sandy-loam soils on level or rolling grasslands that are often shrub-invaded. Freer mixed brush thorn woodland. Mesquite-Acacia thorn woodland. (NatureServe, 2015). Ashy dogweed is endemic to South Texas and occurs in open flat areas of shrubby grasslands and deep sandy pockets of fine sandy loam soils.

Dispersal/Migration***Population Information and Trends*****Number of Populations:**

Six

Population Narrative:

Several ashy dogweed populations are considered meta-populations based on relative distance between sites. Surveys conducted in the years since listing have identified five other extant populations in addition to the one known at the time of listing. These populations have increased the known range of the species from Webb to southern Zapata County. The loss, fragmentation and/or alteration of habitat may be increased at these meta-population sites as opposed to plants in populations that are farther apart. Ashy dogweed was first recorded in Starr County in 1932, near Rio Grande City, but is now considered extirpated from this area. This species was federally listed as endangered on July 19, 1984 and a recovery plan for the species was completed in 1988. At the time of listing, the ashy dogweed population was estimated to be 25 acres in size and contained approximately 1,300 individuals (USFWS 1984, 1987). Since then five additional populations have been found and the species' known range has expanded from Webb County into Zapata County, Texas (USFWS 2011). One of the six extant populations is partially on state-owned ROW lands that are maintained by TxDOT. The five remaining populations are found on private lands and three of the land owners have entered into Voluntary Conservation Agreements with TPWD (USFWS 2011). No critical habitat has been designated for ashy dogweed.

Threats and Stressors**Stressor:****Exposure:****Response:****Consequence:**

Narrative: Primary threats to the survival of the ashy dogweed have been identified as certain ranching activities, including invasion by non-native grasses planted to improve range conditions. Oil and gas development, highway development and roadside projects, and climate change (e.g. more frequent and/or extended droughts) also threaten the species.

Stressor: Habitat Loss

Exposure:

Response:

Consequence:

Narrative: Habitat loss for ashy dogweed has been largely due to the introduction of non-native pasture grass during the conversion of native rangeland to improved pasture; overgrazing; and ground disturbance activities associated with urban development, construction or improvement of highways and utility transmission systems necessary to support urban infrastructures

Stressor: Introduction of non-natives

Exposure:

Response:

Consequence:

Narrative: Many areas in South Texas are dominated by the introduced buffelgrass (*Pennisetum ciliaris*), an aggressive, exotic grass. Kleberg bluestem grass (*Dicanthium annulatum*), used for erosion control on roadway ROWs, also invades natural areas and is present at all ashy dogweed sites although not as extensively as buffelgrass (USFWS 2011).

Stressor: Drought

Exposure:

Response:

Consequence:

Narrative: Drought conditions can reduce plant populations and population size, decreasing genetic variability and viability, thus reducing the species ability to cope with a wide range of environmental stressors (USFWS 2011).

Stressor: Grazing

Exposure:

Response:

Consequence:

Narrative: Seedling establishment can be decreased by chaining, blading, dozing and disking activities that cause deep soil disturbance, along with surface compaction (Williamson 2002) potentially caused by heavy grazing pressures (USFWS 1988). Dodson's (2001) and Williamson's (2002) research suggests that some disturbance may be important for this species' colonization, spread, and/or growth; however, the level of preferred disturbance is unclear.

Stressor: Highway construction and improvements

Exposure:

Response:

Consequence:

Narrative: Highway construction and improvements may adversely impact ashy dogweed populations (USFWS 2011). Since the largest, extant meta-population of ashy dogweed occurs along US 83, roadway improvement projects, highway maintenance, and potential urban development have the potential to continue to impact the species.

Stressor: Development

Exposure:

Response:

Consequence:

Narrative: The potential for development exists on private lands. An increase in development projects may increase the rate at which these populations are exposed to disturbance activities.

Stressor: Pesticides

Exposure:

Response:

Consequence:

Narrative: The use of herbicides to maintain ROW and control noxious weeds could directly harm a plant and could indirectly kill ashy dogweed pollinators or their host plants (USFWS 2011). Pesticide application to control crop pests, particularly aerial spraying and drift impacts, could also potentially impact populations if they are situated near agricultural areas.

Stressor: Oil and Gas Activity

Exposure:

Response:

Consequence:

Narrative: When ashy dogweed was listed in 1984, oil and gas activity was not mentioned as a threat to the species. Since 1984, oil and natural gas activities have steadily increased in both Webb and Zapata counties impacting land cover and soils with the development of oil wells, well pads, oil and gas roads, vehicular traffic and/or hydraulic fracturing ("fracking"). The Environmental Protection Agency (EPA) is conducting a study examining the pollution effects of fracking on ground and surface water. Oil and gas activities do not currently occur within the US 83 ROW, but do occur on private lands and are considered significant threats to the ashy dogweed (USFWS 2011).

Stressor: Climate Change

Exposure:

Response:

Consequence:

Narrative: Climate change is considered to be a potential threat to ashy dogweed. "Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level" (Intergovernmental Panel on Climate Change (IPCC) 2007). For the next two decades a warming of about 0.2°C (0.4°F) per decade is projected. After that time, temperature projections increasingly depend on specific emission scenarios (IPCC 2007). Various emissions scenarios suggest that by the end of the 21st century, average global temperatures are expected to increase 0.6°C to 4.0°C (1.1°F to 7.2°F) with the greatest warming expected over land (IPCC 2007). Localized projections suggest the southwest United States may experience the greatest temperature increase of any area in the lower 48 states. The IPCC describes the likelihood that hot extremes, heat waves, and heavy precipitation events will increase in frequency. There is also high confidence that many semi-arid areas like the western United States will suffer a decrease in water resources due to climate change (IPCC 2007). Climate change may act alone or synergistically with the invasion of non-native invasive species to increase their spread and their ability to out-compete native varieties (Archer and Predick 2008). Temperature and precipitation changes, along with increases in atmospheric carbon dioxide and nitrogen, can enhance dispersal pathways for non-natives (Smith et al. 2000), allowing exotic plants to invade new areas and causing range reductions or possibly local extirpations of rare plant populations.

Invasion of ashy dogweed habitat by buffelgrass has been described earlier. Due to its limited geographic distribution, and the fact that the largest number of individual plants occur in one meta-population, ashy dogweed is vulnerable to localized catastrophic events, such as flooding or drought, as well as to broader climate changes that could decrease suitable habitat, while simultaneously making conditions conducive to further exotic grass invasion. Extended periods of drought, becoming more common in South Texas also play a role in fire ecology by increasing the frequency, and potentially severity, of fires. Ashy dogweed's response to fire is unknown. However, most of the invasive grass species in south Texas appear to be positively fire adapted, so consequences of increasing drought conditions may include increasing the competitiveness of these non-natives (Kuvlesky et al. 2002). Intensified and more frequent fire regimes can allow exotic grasses to form dense monocultures, including in areas where native species are able to persist. The increased amount of biomass and understory produced by these non-native grasses adds to the fuel load, and combined with a lack of precipitation forecast by potential climate change, could affect fire regime characteristics in ashy dogweed habitat including frequency, intensity, extent, type, and seasonality of fires (USFWS 2011). Climate change may also alter pollinator phenology (USFWS 1988). Since ashy dogweed appears to be insect pollinated, alterations in environmental conditions related to climate change, including precipitation and temperature, could alter the phenology of ashy dogweed such that the current blooming and fruiting patterns may not match the timing of pollinators that currently visit these plants, thereby stalling pollination (Sherry et al. 2007). Although it is reasonable to assume that ashy dogweed may be affected by climate change, we lack sufficient certainty to know how climate change will affect the species, and if so, to what extent.

Recovery

Recovery Actions:

- The primary objective of the recovery plan for ashy dogweed is to protect this species and its habitat from further destruction from human activities and to establish healthy populations in their natural habitat at levels that would allow the species to be down-listed to threatened and eventually delisted (USFWS 1987).

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- NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

SPECIES ACCOUNT: *Thysanocarpus conchuliferus* (Santa Cruz Island fringe pod)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2009)

Physical Description

A delicate annual herb with a slender stem, usually 6-15 cm tall, and with narrow, lobed leaves. A dense cluster of small pink-lavender flowers blooms in March and April, followed by fruits with a rounded top, fringed with wings that are strongly incurved towards the flat or concave lower side. (NatureServe, 2015)

Taxonomy

It was once recognized as a variety of *Thysanocarpus laciniatus* (Jepson 1925); however, it has been recognized as a distinct species since 1944 (Abrams 1944, Rollins 1993) (USFWS, 2009).

Historical Range

See current range/distribution.

Current Range

Species is endemic to Santa Cruz Island. Junak et al. (1995) reported that it occurs from the north slopes of the island between Lady's and Prisoner's Harbors, the Central Valley near Lagunitas Secas in Cañada de la Portezuela, and on the south side of the island on Sierra Blanca Ridge (USFWS, 2009).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Habitat Type

Adult: Rocky Outcrops (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits dry canyon slopes, rocky ridges, and rock outcrops. Mostly on shaded n-facing rock faces, slopes, and canyon bottoms; chaparral, oak woodland; 800-1800 ft (245-550m) (Junak et al. 1995) (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the species specific habitat needs and relatively low number of known populations.

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Not available

Threats and Stressors

Stressor: Competition with non-native species (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Past grazing and trampling by non-native animals has resulted in the conversion of native plant communities to non-native plant communities (Minnich 1980, Hobbs 1983). In the past, sources of incidental introductions of seed included wind-blown seed from the mainland and introductions from restocking non-native animals and operational equipment (vehicles and construction materials) (60 FR 37993). At the time of listing, several species of non-native, aggressive plant species were considered problematic invaders on the Channel Islands, including Australian fireweed (*Erechtites glomerata*), several species of iceplant (*Carpobrotus* spp., *Mesembryanthemum* spp.), several thistle species (*Centaurea* spp., *Cirsium* spp., *Silybum* sp.), German ivy (*Delairea odorata*), hoary cress (*Cardaria draba*), and Russian thistle (*Salsola iberica*). Santa Cruz Island has at least 170 non-native invasive plant species recorded. In particular, non-native annual grasses inhibit the establishment of *Thysanocarpus conchuliferus* individuals and expansion of populations (McEachern, pers. comm. 2007) (USFWS, 2009).

Stressor: Conservation actions (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The Santa Cruz Island Restoration Plan proposed to remove large stands of fennel (by burning and subsequently applying herbicide) to help with the eradication of feral pigs because acres of dense stands of fennel complicate the eradication effort (McEachern 2004), and to benefit the native plant communities on the island; however, the efficacy of such a program is still being discussed (Wolstenholme, pers. comm. 2007). Currently, limited removal of fennel occurs along dirt roads and within 10 feet of the roads; *Thysanocarpus conchuliferus* does not occur within the roadside treatment areas (Cory, pers. comm. 2009). Additionally, both TNC and the NPS are taking precautions to minimize the spread of invasive species through visitor education programs because seeds of non-native plants can be spread by hikers and campers during recreational activities. The Service has been working with TNC, the NPS, and the County of

Santa Barbara to eradicate both woody and herbaceous non-native plant species from the island. The Service has provided funding to the County of Santa Barbara, through the Partners for Fish and Wildlife and Private Stewardship Grant programs, to implement a program that would remove non-native woody species. In addition, the County of Santa Barbara proposed to remove approximately 24 acres (9.7 hectares) of incipient weeds and enhance approximately 2 acres (0.81 hectare) of habitat for three federally endangered plants, including *Thysanocarpus conchuliferus* (Service 2007) (USFWS, 2009).

Stressor: Small population size (USFWS, 2009)

Exposure:

Response:

Consequence: Threat of extinction

Narrative: At the time of listing, *Thysanocarpus conchuliferus* was threatened by the risk of stochastic extinction due to its small population size. Conservation biology notes the vulnerability of taxa known from one or very few locations and/or from small and highly variable populations (Shaffer 1981, 1987; Primack 2006; Groom et al. 2006). In particular, *T. conchuliferus* is subject to catastrophic environmental events, such as storms, drought, fire, or landslides that could destroy a significant percentage of individuals (62 FR 40954). Although more populations are known now than at the time of listing, the number of populations and the total number of individuals are still small, and remain as a concern for the species (USFWS, 2009).

Stressor: Change in fire frequencies (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Fire has been precluded as an ecological process on the Channel Islands for over 150 years. The life history requirements of *Thysanocarpus conchuliferus* are based upon the occurrence of fires to promote reproduction and reduce competition with other species. Due to ranching activities, characteristic fire intensities and durations have shifted from long duration and high intensity with brush fuels to short duration and light intensity with grass fuels because the fuel load (the amount of standing and downed vegetation) has changed from brush (heavy) to grass (light). The absence of fire created an imbalance in recruitment and regeneration of ecosystem components, including *T. conchuliferus*. Many of the brushland species will not regenerate without fire and with age will die. In addition, browsing and grazing animals had reduced the probability of survival for these fire-adapted species by removing seeds and seedlings, which could be devastating to recruitment following a fire event. Consumption of *T. conchuliferus* seedlings could effectively terminate the subsequent generation needed to re-establish the seed bank (60 FR 37993) (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, Intergovernmental Panel on Climate Change 2007). However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in

a warmer trend with localized drying, higher precipitation events, or other effects. While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to particular species at this time (USFWS, 2009).

Recovery

Delisting Criteria:

1. Discover or establish 5 additional populations on Santa Cruz Island (addresses Listing Factors A, C, and E). This criterion has not been met. This criterion is relevant with respect to the recovery of the species. However, the exact number, size, and configuration of the populations needed to assure recovery may need to be refined in the future based on the results of the longterm conservation and recovery research program described above (USFWS, 2009).

2. No decline after 10 years of downlisting (addresses Listing Factors A, C, and E). This criterion has not been met. This criterion is relevant with respect to the recovery of the species; however, what constitutes a “decline” over this period of time should be refined (USFWS, 2009).

Conservation Measures and Best Management Practices:

- 1. Continue to support restoration of the native habitats on Santa Cruz Island through existing partnerships and exploration of new opportunities (USFWS, 2009).
- 2. Assist the USGS-BRD, the NPS, and TNC to obtain additional funding to continue field surveys, demographic monitoring, outplantings, and population viability analyses to assess the overall health of the population. Additional information could reveal a trend in the status of *Thysanocarpus conchuliferus* and determine if this species is moving toward recovery or if more recovery efforts should be implemented. Additional research could further define life history strategies and population dynamics necessary to refine the delisting criteria and guide recovery efforts (USFWS, 2009).
- 3. Work cooperatively with NPS and USGS-BRD to refine the general downlisting criteria. Securing several populations of *Thysanocarpus conchuliferus* that each contains a minimum of 2,000 plants is an unrealistic goal and is not an accurate recovery target for this species (USFWS, 2009).

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SPECIES ACCOUNT: *Tinospora homosepala* (No Common Name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/02/2015; Pacific Region (R1) (USFWS, 2016)

Physical Description

Tinospora homosepala (NCN), a vine in the moonseed family (Menispermaceae). (USFWS, 2015)

Taxonomy

Tinospora homosepala differs from *T. glabra* in having equal-sized sepals (petal-like structures of the calyx) as opposed to the outer sepals being much smaller than inner sepals as in *T. glabra*. (USFWS, 2015)

Historical Range

Tinospora homosepala (NCN) is historically known only from Guam (Merrill 1914, p. 83; Stone 1970, pp. 27, 277; Costion and Lorence 2012, pp. 92–93). (USFWS, 2015)

Current Range

Known only on Guam (USFWS, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual (USFWS, 2015)

Reproduction Narrative

Adult: All known individuals of *T. homosepala* on Guam are said to be males that reproduce clonally (Yoshioka 2008, p. 15; Gawel et al. 2013, in litt.). (USFWS, 2015)

Habitat Type

Adult: Terrestrial (USFWS, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Shrublands, forests (USFWS, 2015)

Habitat Narrative

Adult: Currently, *T. homosepala* is known from the forest ecosystem (Yoshioka 2008, p. 15; Gawel et al. 2013, in litt.). This species is found in dry, moist, and wet shrublands on ridgecrests and steep slopes. (USFWS, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (USFWS, 2015)

Redundancy:

Very low (USFWS, 2015)

Number of Populations:

3 (USFWS, 2015)

Population Size:

30 (USFWS, 2015)

Population Narrative:

Currently, *T. homosepala* is known from 3 occurrences totaling approximately 30 individuals, in the forest ecosystem (Yoshioka 2008, p. 15; Gawel et al. 2013, in litt.). (USFWS, 2015)

Threats and Stressors**Stressor:****Exposure:****Response:****Consequence:****Narrative:**

Stressor: Limited genetic diversity (USFWS, 2015)

Exposure:**Response:****Consequence:**

Narrative: Clonal reproduction limits genetic diversity, reducing the ability of the species to form new genetic combinations to fit changing environmental conditions (Stebbins 1957, p. 352). (USFWS, 2015)

Stressor: Lack of female plants (USFWS, 2015)

Exposure:**Response:****Consequence:**

Narrative: *T. homosepala*, a single island endemic, has been reduced to roughly 30 individuals on Guam, and it is possible that no female representatives of this species remain. (USFWS, 2015)

Stressor: Small population size (USFWS, 2015)

Exposure:**Response:****Consequence:**

Narrative: These few remaining individuals of the species are at risk of extinction, due to continued habitat loss and destruction from nonnative animals and plants, and typhoons, and by genetic limitations as a result of the possible loss of potential sexual reproduction. (USFWS, 2015)

Stressor: Climate change (USFWS, 2015)

Exposure:**Response:****Consequence:**

Narrative: The Service anticipates the effects of climate change will further exacerbate many of these threats in the future. (USFWS, 2015)

Recovery**Reclassification Criteria:**

Not available.

Delisting Criteria:

Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

References

USFWS. 2015. Endangered and Threatened Wildlife and Plants

Endangered Status for 16 Species and Threatened Status for 7 Species in Micronesia. Federal Register 80(190): 59424-59497

USFWS. 2016. Environmental Conservation Online System (ECOS) – Species Profile.
<http://ecos.fws.gov/ecp0/>. Accessed September 2016

U.S. Fish and Wildlife Service. 2015. Endangered Status for 16 Species and Threatened Status for 7 Species in Micronesia

Final Rule. 80 Federal Register 190, October 1, 2015. Pages 59424-59497.

SPECIES ACCOUNT: *Townsendia aprica* (Last Chance townsendia)

Species Taxonomic and Listing Information

Listing Status: Threatened; 08/21/1985; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

Last Chance townsendia (*Townsendia aprica*) is a small, stemless, mound-forming perennial plant in the sunflower family (Cronquist et al. 1994, Welsh et al. 2008). The species was first described in 1968 and is named for the yellow to apricot color of the flowers which distinguish it from other members of the *Townsendia* genus (USFWS 1993, Welsh et al. 2008). Plants measure less than 2.5 cm (one inch) tall and 2.5-5 cm (1-2 inches) wide with narrow leaves measuring about 1.25 cm (0.5 inch) long and covered with fine hairs. Leaves and flowers are borne at ground level. *Townsendia* flowers from mid-March through May and reproduces solely by seed (USFWS 1993, Welsh et al. 2008). Fruits are achenes and are compressed and ribbed with one seed. For a technical description of the species, see Welsh et al. (2008).

Current Range

Populations occur on BLM, National Forest, and NPS lands in Emery, Sevier, and Wayne counties of south-central Utah. Last Chance townsendia is endemic to the Colorado Plateau and occurs primarily in a long, narrow band, approximately 8 kilometers (5 miles) wide by 48 kilometers (30 miles) long, from near Interstate 70 in the north, southwest to the Fremont Junction area, then south to CRNP. Most localities appear to be isolated and less than an acre in size (USFWS 1993).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Reproduction in Last Chance townsendia is primarily sexual.

Reproduction Narrative

Adult: Reproduction in Last Chance townsendia is primarily sexual. Flowering occurs from mid-March to May and fruiting occurs May to June (USFWS 1993). Self-pollination is virtually non-existent (USFWS 1993). Pollination is accomplished by several species of native solitary bees and a few species of flies. Tepedino et al (2004) provide a complete list of known pollinators. Wind pollination may also occur.

Habitat Type

Adult: Mancos shale

Habitat Narrative

Adult: Last Chance townsendia occurs over a wide range of elevations and on a variety of soil substrates. The published elevation range of the species is 1,860 to 2,440 m (6,102 to 8,005 ft) (Welsh et al. 2008), but new populations of Last Chance townsendia have increased the upper

elevation limit to 2,773 m (9,100 ft) (Clark 2011). The species occurs on a variety of geologic substrates with most populations found on soils within the Moenkopi Formation, Morrison Formation, Carmel Formation, Mancos Shale Group, and the San Rafael Group. However, the species appears to be restricted to fine-textured shale soils within each formation (Clark 2011). The plants often grow in association with volcanic ash strata within the Mancos shale (Welsh et al. 2008). Due to its wide elevational range, Last Chance townsendia occurs within several plant communities including the Castle Valley saltbush (*Atriplex gardneri* var. *cuneata*) plant community in the San Rafael Swell, openings of pinyon-juniper woodlands within the Fishlake Plateau, and in ponderosa pine woodlands in the upper Deep Creek mountains (Fertig and Beer 2005, Welsh et al. 2008). Commonly associated plant species include galleta grass (*Pleuraphis jamesii*), Utah Juniper (*Juniperus osteosperma*), blue grama (*Bouteloua gracilis*) and shadscale (*Atriplex confertifolia*) (Clark 2002). The presence of a well-developed cryptobiotic crust was documented at Last Chance townsendia populations in Sevier and Emery counties (Armstrong and Thorne 1991). Several other rare, endemic species also occur in the same habitat as Last Chance townsendia and include *Pediocactus despainii*, *Pediocactus winkleri*, *Sclerocactus wrightiae*, and *Gilia tenuis* (Armstrong and Thorne 1991).

Dispersal/Migration

Population Information and Trends

Number of Populations:

23

Population Size:

total population estimates from 2008 (7,215 individuals) and 2009 (4,000 – 4,500 individuals)

Population Narrative:

We have determined that there are 23 populations of Last Chance townsendia. We use the number of known individuals (6,848) as our best range-wide estimate for the total population of Last Chance townsendia. This estimate uses the latest plant count data for each population. We determine the actual plant count data is the best indicator of total population size at this time because it is consistent with total population estimates from 2008 (7,215 individuals) and 2009 (4,000 – 4,500 individuals) (Clark 2009b). We recognize the actual plant count likely under-represents the total population size for the species because of the difficulty of detecting seedlings and non-flowering individuals in the field, and may be considered a conservative estimate of abundance (USFWS 2013). Overall abundance of Last Chance townsendia has declined over the last 13 years and climate conditions are believed to be the primary cause of the decline (Clark 2008d, RMER 2011). Precipitation data from 1997 until 2011 show below average annual precipitation from 1997 to 2009, with 2002 and 2009 recording the lowest precipitation amounts during that time period (RMER 2011, USGS 2003). Sharp declines in abundance were documented during the 1999 – 2004 period at a number of populations on BLM and CRNP lands. The decline appeared to be more severe at lower elevations BLM and CRNP lands compared to higher elevations on USFS land (Clark 2002, Clark 2009b, RMER 2004). Survey and monitoring results since 2000 indicate sharp declines at many monitoring sites, with 80 – 90% mortality of mature plants in Capitol Reef in 2001 (Clark 2002). On USFS land, the population trend of Last Chance townsendia is less apparent because of infrequent monitoring; however, these populations appear to be stable (USFWS 2013). Annual monitoring efforts on

BLM land provide the best documentation of the decline in abundance for the species. A long-term demography plot established in 1996 documents the decline from 232 individuals to 33 plants in 2009 (Clark 2009b). Mortality was equal to or greater than recruitment every year during the study period except for 2004 which was the only year with high recruitment. Mortality was greatest from 2000–2002, and in 2009. Additionally, the BLM has performed annual monitoring since 2002 with 114 monitoring sites within 14 populations (RMER 2011). The monitoring results document two periods of decline: 2002–2004 and 2009–2011 (RMER 2004, RMER 2011). The BLM annual monitoring data indicate the lower elevation populations of the species are sensitive to drought conditions. There are concerns that the species may now be extirpated at many of the monitoring sites, particularly at sites which supported less than 10 individuals in favorable years. Further study is required to document if there is a sufficiently large and long-lived seedbank such that the species can persist during long periods of drought conditions. A detailed look at the BLM annual monitoring data does show the species was dormant and not detectable for one to seven consecutive years at 11 monitoring sites. Thus, multiple years of monitoring may be necessary for a site to be considered extirpated. Furthermore, multiple years of surveys may be necessary to determine if Last Chance townsendia is present within suitable habitat (USFWS 2013). Last Chance townsendia begins to flower in the second year of life when they achieve a size of approximately 0.6–0.8 of an inch (1.5–2.0 cm) in diameter (Tepedino et al. 2004). Larger plants can produce up to 10 flowers (Tepedino et al. 2004). The number of flowers produced per plant is directly related to plant size and the larger the plant, the more flowers the plant is likely to produce (Tepedino et al. 2004, Clark 2008c). Tepedino et al. (2004) found that few individuals survived and grew larger than 1.6 inches (4 cm) in diameter. Clark (2008d) studied longevity of 232 Last Chance townsendia individuals at a demography plot. Most of the individuals did not survive past six years of age and the three longest-lived individuals in the plot had a minimum known age of 13 years (Clark 2008d). In the long-term plot, reproduction was positively correlated with the number of leaf rosettes. Over a ten year period, individuals with one leaf rosette flowered 35% of the time, individuals with four leaf rosettes flowered 80% of the time, and individuals with 16 or more leaf rosettes flowered 100% of the time (Clark 2008d). Reproduction in Last Chance townsendia is primarily sexual. Flowering occurs from mid-March to May and fruiting occurs May to June (USFWS 1993). Self-pollination is virtually non-existent (USFWS 1993). Pollination is accomplished by several species of native solitary bees and a few species of flies. Tepedino et al (2004) provide a complete list of known pollinators. Wind pollination may also occur. Low seed production in Last Chance townsendia was reported by botanists and identified in the Recovery Plan (USFWS 1993), yet we do not have data to document the extent and the frequency with which seed limitation occurs. Possible factors in limiting seed production include low pollinator numbers, inclement weather affecting pollinator flight activity, or small population size (Tepedino et al. 2004, USFWS 1993).

Threats and Stressors

Stressor:

Exposure:

Response:

Consequence:

Narrative: The Service listed Last Chance townsendia as a threatened species under the ESA on August 21, 1985 (50 FR 33734). The 1993 Recovery Plan for the species identified mineral and energy development, road building, livestock grazing and trailing, and OHV use as threats to the

species (USFWS 1993). Critical habitat for the species has not been designated. In 2013, the Service completed a Five-Year Review for the species with the purpose of evaluating whether or not the species' status had changed since the time it was listed (USFWS 2013). The Five-Year Review concluded that the 5C Recovery Priority Number for the species should remain unchanged from that assigned in the Recovery Plan. The 5C designation is assigned to species that face a high degree of threat and a low recovery potential that may be in conflict with economic activity.

Recovery

Recovery Actions:

- Since 1993 when the Recovery Plan was approved, many surveys have been conducted which have greatly expanded the known distribution of Last Chance townsendia (Clark 2007, USFWS 2013). The species is now known to be distributed across more than 9,000 acres of habitat compared to the 15 acres of occupied habitat documented in the Recovery Plan (USFWS 1993, 2013). Most of the known occupied habitat is on BLM land (4,830 acres) followed by the U.S. Forest Service (USFS) (2,620 acres) and CRNP (2,390 acres) (USFWS 2013). Although the known distribution of this species has increased, the current number of known individuals is 6,848 plants, which is only slightly larger than the 1993 population estimate of 6,000 plants (USFWS 2013).

References

USFWS 2016. Status of the Species and Critical Habitat: *Townsendia aprica* (Last chance townsendia). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016.

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

SPECIES ACCOUNT: *Trematolobelia singularis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

An unbranched shrub with a stem 0.6-1.5 m long. Flowers are violet. (NatureServe, 2015)

Taxonomy

A revision of the genus *Trematolobelia* in 2009 confirmed that *T. singularis* remains defined as a separate species from *T. macrostachys*. Profound differences in floral morphology and presentation, as well as the lack of intermediates with *T. macrostachys*, suggests a level of reproductive isolation appropriate for distinction at the species rank, despite the fact that the two species occur in the same area (Lammers 2009). (USFWS, 2013)

Historical Range

See current range/distribution.

Current Range

Trematolobelia singularis has been reported only from the southern Koolau Mountains of Oahu (USFWS, 1998).

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Trematolobelia singularis* under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Trematolobelia singularis* (77 FR 57648-57862). The critical habitat designation includes 14 critical habitat units, which encompass approximately 30,056 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Trematolobelia singularis* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Trematolobelia singularis* includes 14 critical habitat units, covering two ecosystem types, which encompass approximately 30,056 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; Oahu—Wet Cliff—Units 6, 7, 8.

Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Waialele, and Koloa gulches. Oahu—Lowland

Wet— Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Hauula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu— Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikēēē, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet— Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet— Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu— Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamo Ridge.

Oahu—Wet Cliff—Unit 6 [151 ac (61 ha)]. This area consists of 151 ac (61 ha) in the wet cliff ecosystem on State land on the windward side of the Koolau Mountains in Kaipapau Gulch, entirely within the Kaipapau Forest Reserve. Oahu—Wet Cliff—Unit 7 [144 ac (58 ha)]. This area consists of 144 ac (58 ha) in the wet cliff ecosystem in State land on the windward side of the Koolau Mountains in Hauula Gulch, entirely within the Hauula Forest Reserve. Oahu—Wet Cliff—Unit 8 [4,649 ac (1,881 ha)]. This area consists of 1,479 ac (598 ha) of State land, 1,281 ac (519 ha) of City and County of Honolulu land, 5 ac (2 ha) of Federal land, and 1,884 ac (762 ha) of privately owned land, in the wet cliff ecosystem along the summit of the Koolau Mountains, overlapping portions of Sacred Falls State Park, the Waiahole FR (Waiahole and Iolekaa sections), the Kaneohe and Honolulu Watershed FRs, and the Nuuna Pali State Wayside.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Trematolobelia singularis* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Trematolobelia singularis* occurs within the Lowland wet and Wet cliff ecosystems in the Koolau Mountain caldera complex:

Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (F) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Oahu—Wet Cliff—Units 6, 7, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: >65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. (F) Understory: Bryophytes, Ferns, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Trematolobelia singularis* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: This species has been observed in flower in October (Obata et al. 1985). (USFWS, 1998)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Shrubland/chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations from 700 to 960 meters (2,300 to 3,150 feet) (USFWS, 1998)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1998)

Habitat Narrative

Adult: This species usually grows on steep, windswept cliff faces or slopes in ohia-uluhe montane wet shrubland from 700 to 960 meters (2,300 to 3,150 feet) elevation. Associated plants include akia, alani, amau, hapuu, kanawao, and naenae pua melemele (USFWS 1996b; Lammers 1990; Obata 1988; St. John 1982). (USFWS, 1998)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Resiliency:

Low (inferred from USFWS, 2013)

Redundancy:

Low (inferred from USFWS, 2013)

Number of Populations:

4 (USFWS, 2013)

Population Size:

112 (USFWS, 2013)

Population Narrative:

Four populations of *Trematolobelia singularis* are known. At Waiawa-Waihole summit there were 16 mature and 75 immature individuals in 2010. At Konahuanui Crest and the summit over Manoa Valley two individuals were last observed in 2006. Seventeen immature individuals were seen at Moanalua in 2007, and two mature individuals were seen at Wailupe near the Hawaii Loa Summit. This species totals 20 mature and 92 immature individuals in all populations (Oahu Plant Extinction Prevention Program [OANRP] 2012), which represents a slight decline from the 133 reported in the last five year review. (USFWS, 2013)

Threats and Stressors

Stressor: Climate change (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) funded climate modeling that will help resolve these spatial limitations. High spatial resolution climate outputs are expected in 2013. (USFWS, 2013)

Stressor: Habitat degradation by feral pigs (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The main threats to *Trematolobelia singularis* include habitat degradation by feral pigs (*Sus scrofa*). (USFWS, 2009)

Stressor: Predation by rats (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The main threats to *Trematolobelia singularis* include predation of the fleshy fruit by introduced rats (*Rattus* spp.). (USFWS, 2009)

Stressor: Slugs (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The main threats to *Trematolobelia singularis* include invertebrate species such as slugs, which are a potential threat to the viability of the species. (USFWS, 2009)

Stressor: Competition with *Clidemia hirta* (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Other threats include competition by the introduced invasive plant species *Clidemia hirta* (Koster's curse). (USFWS, 2009)

Stressor: Reduced reproductive vigor (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Other threats include reduced reproductive vigor due to the small number of extant populations. (USFWS, 2009)

Stressor: Proximity to electrical towers and hiking trails (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The Moanalua population occurs close to electrical towers and hiking trails, and may be impacted by human traffic (Plant Extinction Prevention Program 2008). (USFWS, 2009)

Stressor: Few populations and demographic fluctuations (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: In addition to all of the other threats, species such as *Trematolobelia singularis* that are endemic to small portions of a single island are inherently more vulnerable to extinction than

widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding and disease outbreaks. (USFWS, 2009)

Stressor: Combination of natural processes and anthropogenic factors (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: When considered on their own, the natural processes associated with being a single island endemic do not affect *T. singularis* to such a degree that it is threatened or endangered with extinction in the foreseeable future, but these natural processes can exacerbate the threat from anthropogenic factors, such as habitat loss for human development or predation by introduced species (USFWS 1996, 1998). (USFWS, 2009)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1998)

Recovery Actions:

- Construct enclosures to protect populations against feral ungulates. (USFWS, 1998)
- Control competing alien plant species within enclosures. The remaining populations should immediately be weeded and protected, as feasible. (USFWS, 1998)
- Rat predation may threaten the 3 populations of this species. A rat control plan should be developed and implemented. This should include the use of the currently-approved Diphacinone bait blocks and ultimately a more broad-scale method such as aerial dispersal of rodenticide. (USFWS, 1998)

- Maintain adequate genetic stock. To prevent extinction of this species, ex situ propagation should be initiated. Propagation material should be collected immediately from all extant populations. (USFWS, 1998)

Conservation Measures and Best Management Practices:

- Continue to collect cuttings or seed from tagged individuals, keeping close track of the maternal source for use in ex situ propagation. (USFWS, 2013)
- Germination trials should be conducted on seeds stored at the NTBG to determine viability. (USFWS, 2013)
- While surveying for new populations or reintroduced populations, determine which sites are least invaded by invasive introduced plant species and which appear to have the highest likelihood of maintaining new reintroductions. (USFWS, 2013)
- Reintroduce the species back into its known historical range. (USFWS, 2013)
- Construct, maintain, and monitor ungulate-proof exclosures around each population. (USFWS, 2013)
- Control invasive introduced plant species around all populations. (USFWS, 2013)
- Implement effective control methods for rodents and slugs. (USFWS, 2013)
- Develop and implement fire management plans for all wild and reintroduced populations. (USFWS, 2013)
- Enhance coordination and collaboration among other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2013)
- Assess genetic variability within extant populations. (USFWS, 2013)
- Study *Trematolobelia singularis* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. (USFWS, 2013)
- Assess the modeled effects of climate change on this species, and use the results to determine future landscape needed for the recovery of the species. (USFWS, 2013)

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Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii

SPECIES ACCOUNT: *Trichilia triacantha* (Bariaco)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) 02/05/1988

Physical Description

Trichilia triacantha (bariaco) is an evergreen shrub or small tree which may reach 8 to 10 meters (26 to 33 feet) in height and 1.5 to 2 centimeters (3/4 to 7/8 inches) in diameter. The alternate leaves are pinnately or almost palmately compound with 3 to 7 oblong or wedge-shaped leaflets. The thick, leathery leaves, from 2 to 3 centimeters (3/4 to 1 1/4 inches) long, are clustered at the ends of the twigs. Each leaflet has 3 sharp spiny teeth, 2 to 3 millimeters (1/16 to 1/8 inch) in length, at the apex. The axis of each leaf is short (3 millimeters or 1/8 inch) and the leaves appear to be palmately compound. The upper surface is shiny with a sunken midvein and the lower surface is dull and paler (Little et al., 1974; Vivaldi and Woodbury 1981). The inflorescence is a panicle which may reach 4 centimeters (1 and 1/2 inches) in length. Flowers are perfect, sessile, and about 3 millimeters (1/8 inch) in diameter. The calyx is cupshaped with 4 to 5 minute teeth. The corolla of 4 petals is white and finely hairy on the outside. Fruits (undescribed until recently) are capsules with red arils (Vivaldi and Woodbury 1981) (USFWS, 1991).

Taxonomy

Trichilia triacantha, a member of the family Meliaceae, was first collected by Plee from the Pefiuelas area of southern Puerto Rico (USFWS, 1991).

Historical Range

Today, *Trichilia triacantha* is known from only two areas in southwestern Puerto Rico (Figure 1). Deforestation appears to have resulted in the elimination of the Pefiuelas population. Although little forested area remains in this part of Puerto Rico, other small populations, as yet undescribed, may survive. Approximately 37 individuals are known to occur on 5 sites within the Guanica Commonwealth Forest and an additional 3 individuals are found at the Punta Guaniquilla area, the extreme southwestern corner of the island. All historic and presently known sites occur on limestone-derived soils at elevations of less than 100 meters (USFWS, 1991).

Current Range

Specimens (Figure 1 and Appendix I) and population sites (Figure 2) located with uncertainties smaller than 300 m occur at elevations from 25 to 175 m above sea level (Ventosa, 2007), on soils of the following series: Pitahaya-Limestone outcrop-Seboruco complex, La Covana-Limestone outcrop-Seboruco complex, Seboruco gravelly clay, El Papayo gravelly clay loam, Aguilita stony clay, San Germán-Duey complex, Tuque stony clay, and Yauco silty clay loam, most of them on slopes of 20-60%. Other specimen localities, but with inaccurate locality descriptions (inaccuracies from 2,000 to 15,620 m), were collected within the municipalities of Guánica, Yauco or Peñuelas (Figure 2) (USFWS, 2012).

Critical Habitat Designated

Yes;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Unknown (USFWS, 1991)

Breeding Season

Adult: Bariaco has been observed in flower from January to March (USFWS, 1991)

Reproduction Narrative

Adult: Bariaco has been observed in flower from January to March, the dry season in the Guanica Forest. Flower production is abundant but fruit set appears to be poor. Information available indicates that the majority of the fruits did not reach maturity during the 1989 season; however, this particular year was exceptionally dry. Mature fruit was observed during the month of June in the 1989 observations as well as in past studies (Vivaldi and Woodbury 1981). Pollination mechanisms are not known; however, other members of this genus are wind and/or insect pollinated. It has been suggested that this species is pollinated by bees (G. Breckon, pers. comm.). Although 12 mature individuals have been observed flowering and producing fruit in the Guanica Forest, seedlings have been observed beneath only one tree. The importance of vegetative reproduction and the ability to resprout has not been studied. However, coppicing in this dry forest is common, and many of the large specimens of *Trichilia triacantha* have multiple stems (USFWS, 1991).

Habitat Type

Adult: Subtropical dry forest (USFWS, 1991)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1991)

Site Fidelity

Adult: High (inferred from USFWS, 1991)

Habitat Narrative

Adult: *Trichilia triacantha* is found in the deciduous and the semi-evergreen seasonal forests of the subtropical dry forest life zone (Ewel and Whitmore 1973) of southwestern Puerto Rico at elevations of less than 100 meters. The subtropical dry forest life zone is the driest life zone of Puerto Rico and covers about 14 percent of the island area. Extensive areas of this life zone overlie limestone, including the area in which *Trichilia triacantha* is found. Here the vegetation is more xerophytic than on other soil types found within the life zone. Much of the land in this zone has been deforested for urban development, agriculture, pasture, and charcoal production; however, the majority of the known individuals occur within the Guanica Forest. This Forest has been protected from such activities for approximately 40 years (Silander et al., 1986) (USFWS, 1991). High ecological integrity and site fidelity and low tolerance range are inferred based on specific habitat requirements and low number of populations (USFWS, 1991).

Dispersal/Migration

Motility/Mobility

Adult: Low (USFWS, 2007)

Dispersal

Adult: Low (USFWS, 2007)

Dispersal/Migration Narrative

Adult: The evidence of very limited dispersal of this plant may suggest that a former natural disperser like a forest bird species may be reduced in number or no longer in this area (USFWS, 2007).

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Low (inferred from USFWS, 2012)

Representation:

Low (inferred from USFWS, 2012)

Redundancy:

Low (inferred from USFWS, 2012)

Number of Populations:

~15 (USFWS, 2012)

Population Size:

~162 total plants (USFWS, 2012)

Population Narrative:

Bariaco was listed as an endangered species on February 5, 1988. In this status review we found that the known natural populations of Bariaco have expanded, and natural populations now extend east to the municipality of Ponce, Puerto Rico. The species is currently known from about 15 populations: ten populations described by Ventosa (2007) (seven within Guánica Commonwealth Forest and the other three in Cabo Rojo, Sabana Grande and Yauco); "Trichilia Creek" in the Guánica Commonwealth Forest, and about four other sites from Yauco to Ponce. The current number of individuals is estimated at 162 plants (not including seedlings). Although the species has expanded its range and the number of natural individuals, the plant is threatened by urban and tourism development. Despite the increase in the number of populations and the finding of a new population with an outstanding number of individuals and apparently natural recruitment, down listing criteria have not been met and an evaluation of all currently known populations and the threats of those populations is required in order to proceed with a change in classification (USFWS, 2012). Low resiliency, representation and redundancy are based on low number of populations and individuals and the specific habitat requirements of this species (USFWS, 2012). The Plan specifies that *T. triacantha* could be considered for reclassification to a threatened species when: 1. the known population at Punta

Guaniquilla is placed under protective status, and 2. at least three new populations capable of self-perpetuation have been established within protected units such as Puerto Rico Conservation Trust property or Commonwealth Forests. Criterion 1 has not been met. The Punta Guaniquilla population remains as a private property and the area is under current pressure for development. Criterion 2 has not been met. So far a strong propagation program for the species has not been initiated nor has any population been established within a protected area. Nonetheless, propagation of the species has proved to be successful as showed by Ventosa (2007) and new populations have been identified along the southern coast of Puerto Rico. The discovery of the *Trichilia* creek population in Guánica Commonwealth Forest is a great step toward recovery especially because it seems to be the best example of a healthy and self-sustainable population. Since the listing of the species, *Trichilia triacantha* has expanded in numbers and in documented natural populations. Currently, the majority (78%) of the only 162 known individuals are in a Commonwealth Forest. However, the majority of the new populations and the suitable habitat occur on private properties subject to urban development (USFWS, 2017).

Threats and Stressors

Stressor: Human caused habitat destruction (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Several areas in which this species occurs are under pressure for urban development including road construction and run-off control (USFWS, 2007).

Stressor: Human induced fires (USFWS, 2007)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Fire is not a natural event in subtropical dry or moist forest in Puerto Rico and the U. S. Virgin Islands. Thus, most species found in this type of forest are not fire-adapted. Human induced fires may lead to destruction of the native vegetation seed bank and may create conditions favorable for the establishment of exotic plant species (e.g., *Leucaena leucocephala* and *Megathyrsus maximus*) that may outcompete *T. triacantha*. The *T. triacantha* populations that occur between Peñuelas and Ponce may be susceptible to forest fires, particularly on private lands where fire could be accidentally or deliberately ignited. Evidence of recent fires in the habitat and adjacent to known populations have been observed recently at Ponce (Omar A. Monsegur, Service, pers. obs. 2011). However, there is no direct evidence of fires affecting these populations. Furthermore, the core of the populations and individuals lies within the Guánica Commonwealth Forest. This protected area has an active fire control program and recent evidence of fire has frequently been seen in the coastal portions of the Guánica Commonwealth Forest (Omar A. Monsegur, Service, pers. obs. 2011) (USFWS, 2007).

Stressor: Hurricanes/Climate Change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Since the population dynamics of this species are poorly known and we do not have enough information to determine what constitutes a viable population, we believe that the impacts discussed above could be detrimental to the species as a whole. However, based on current information and since the majority of the known populations' lie within a protected area, we consider fires, hurricanes and climate change as a low and non-imminent threat to the species (USFWS, 2007).

Stressor: Present or threatened destruction, modification or curtailment of its habitat or range (USFWS, 2017).

Exposure:

Response:

Consequence:

Narrative: The species' rarity and restricted distribution makes it vulnerable to habitat destruction and modification. However, most of the known populations and individuals are located on public lands within the Guánica Commonwealth Forest, which has been declared as a Biosphere Reserve by UNESCO and is managed for conservation. According to Ventosa (1997), about 60% of the known populations during his study were located within the Forest. Furthermore, these populations represent about 93% of the known individuals. In the Guánica Commonwealth Forest, *T. triacantha* is mostly found on the edge of trails, making the species more prone to be affected by management activities (e.g., widening of trails, clearing activities). Moreover, these populations consist of isolated clusters of adult individuals, and the majority of the seedlings are located adjacent to the parent shrub and there is no evidence of natural dispersion despite showy red seeds, which may have been dispersed by an unknown bird species. The evidence of very limited dispersal of this plant may suggest that a former natural disperser like a forest bird species may be reduced in number or no longer in this area. Despite the low number of natural populations on private lands reported by Ventosa (1997, 2007), recent assessments have led to the identification of new populations of *T. triacantha* outside the Guánica Commonwealth Forest. This may indicate bias on previous sampling efforts. On the other hand, the number of *T. triacantha* populations found within the Guánica Commonwealth Forest is probably due to the extensive botanical and ecological studies that have been conducted within the boundaries of the forest. It also highlights the importance of surveying further areas that harbors suitable habitat for the species from Ponce to Cabo Rojo. Searching these areas is critical as some of them are actually adjacent to recently discovered populations of *T. triacantha* and have been proposed for urban and tourism developments. It is unknown if these recently found small populations contain genotypes that are not found in Guánica or may be part of a bigger population that has not been identified. In Peñuelas, *T. triacantha* is found in an area that is currently under pressure for urban development. In 2007, Service biologist Omar Monsegur (pers. obs.) as part of a study for the status of *Cordia rupicola*, reported a new population of *T. triacantha* on a drainage area located at El Peñón de Ponce, which is adjacent to a residential development called "Urbanización El Peñón". In 2007, Monsegur and Breckon (2007) reported that one individual of *Cordia rupicola* on this area was extirpated by the construction of a staging area for the improvement of the Puerto Rico Highway Num. 2. According to the authors, the vegetation was removed and the area was bulldozed, apparently to control run-off from the ravine. It is unknown if the individuals of *T. triacantha* were affected by the vegetation clearing. Future development projects are proposed for the surrounding areas threatening this population, making it more isolated, and possibly eliminating its connectivity with adjacent populations (genetic flow). In Yauco, the species occurs within a private property (Finca Catala) that may be subject to urban or agricultural development (Carlos Pacheco, Service,

pers. comm., 2011). Urban development has encroached remnants of native dry forest areas in Yauco, resulting in the isolation or disjunction of rare plant populations, hence, reducing suitable habitat for the species. The area is also threatened by deforestation for agricultural practices such as cattle 13 and for the extraction of live fence posts (Alcides Morales, pers. comm., Sociedad Ornitológica Puertorriqueña, Inc., 2011). Based on the above discussion, the present or threatened destruction, modification, or curtailment of the species habitat or range is a current threat to the species. Since the majority of the known populations are affected by habitat destruction or modification, we consider this threat as high in magnitude and imminent (USFWS, 2017).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2017).

Exposure:

Response:

Consequence:

Narrative: The Commonwealth of Puerto Rico approved Law No. 241 in 1999, known as “Nueva Ley de Vida Silvestre de Puerto Rico” (New Wildlife Law of Puerto Rico). The purpose of this law is to protect, conserve, and enhance both native and migratory wildlife species, declare as the property of Puerto Rico all wildlife species within its jurisdiction, regulate permits, hunting activities, and exotic species, among others. This law has provisions that protect habitat of this endangered plant. In 2004, the Puerto Rico Department of Natural and Environmental Resources (PRDNER) approved the “Reglamento para Regir el Manejo de las Especies Vulnerables y en Peligro de Extinción en el Estado Libre Asociado de Puerto Rico” (Regulation 6766 to regulate the management of threatened and endangered species in Puerto Rico). Bariaco has been included in the list of protected species and designated as endangered under Regulation 6766. Under Article 2.06, this regulation prohibits collecting, cutting, removing, among other activities, listed plant individuals within the jurisdiction of Puerto Rico. Based on the presence of Commonwealth laws and regulations protecting *T. triacantha*, we believe that the inadequacy of existing regulatory mechanisms should no longer be considered a threat to this species. However, it is important to note that enforcement on private lands continues to be a challenge as accidental damage or extirpation of individuals has occurred due to lack of knowledge of the species by private land owners (USFWS, 2017).

Stressor: Human-Induced Fires (USFWS, 2017).

Exposure:

Response:

Consequence:

Narrative: Fire is not a natural event in subtropical dry or moist forest in Puerto Rico and the U. S. Virgin Islands. Thus, most species found in this type of forest are not fire-adapted. Human induced fires may lead to destruction of the native vegetation seed bank and may create conditions favorable for the establishment of exotic plant species (e.g., *Leucaena leucocephala* and *Megathyrus maximus*) that may outcompete *T. triacantha*. The *T. triacantha* populations that occur between Peñuelas and Ponce may be susceptible to forest fires, particularly on private lands where fire could be accidentally or deliberately ignited. Evidence of recent fires in the habitat and adjacent to known populations have been observed recently at Ponce (Omar A. Monsegur, Service, pers. obs. 2011). However, there is no direct evidence of fires affecting these populations. Furthermore, the core of the populations and individuals lies within the Guánica Commonwealth Forest. This protected area has an active fire control program and recent

evidence of fire has frequently been seen in the coastal portions of the Guánica Commonwealth Forest (Omar A. Monsegur, Service, pers. obs. 2011) (USFWS, 2017).

Stressor: Hurricanes and Climate Change (USFWS, 2017).

Exposure:

Response:

Consequence:

Narrative: Hurricanes and tropical storms frequently affect the islands of the Caribbean. As a species endemic to the central Caribbean, and with a wide distribution in Puerto Rico, *T. triacantha* should be well adapted to tropical storms. Hence, cumulative effects of severe tropical storms may jeopardize small relict populations. *Trichilia triacantha* may be threatened by climate change to some extent, which is predicted to increase the frequency and strength of tropical storms. In addition, the possibility of severe droughts may contribute to an increase in the quantity and frequency of fires on the southern coast of Puerto Rico. Since the population dynamics of this species are poorly known and we do not have enough information to determine what constitutes a viable population, we believe that the impacts discussed above could be detrimental to the species as a whole. However, based on current information and since the majority of the known populations' lie within a protected area, we consider fires, hurricanes and climate change as a low and non imminent threat to the species (USFWS, 2017).

Recovery

Reclassification Criteria:

Trichilia triacantha could be considered for reclassification to a threatened species when: (1) the known population at Punta Guaniquilla is placed under protective status, and (USFWS, 1991).

(2) at least three new populations capable of self-perpetuation have been established within protected units such as Conservation Trust property or Commonwealth Forests (USFWS, 1991).

Delisting Criteria:

Five (5) of the existing natural populations show a stable or increasing trend, evidenced by natural recruitment and multiple age classes, and four (4) of these populations must occur on lands protected via a conservation mechanism (addresses Factor A and E) (USFWS, 2019).

At least three (3) new populations containing genetic representation from Montes de Barinas, Guayanilla and Ponce-Penuelas are established or discovered on lands protected via a conservation mechanism, and these populations show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factors A and E) (USFWS, 2019).

Threat reduction and management activities have been implemented to a degree that the species will remain viable into the foreseeable future (addresses Factor A and E) (USFWS, 2019).

Recovery Actions:

- This action has not been met (USFWS, 2007)
- This action has not been met (USFWS, 2007)
- The recovery of the species should focus on the protection of the known populations and its suitable habitat. Conservation Agreements should be signed between the Service and private landowners to protect natural populations (USFWS, 2017).

- The populations that are actively reproducing need to be identified and monitored to collect seed material for propagation purposes. A protocol to collect seed should be created and implemented to avoid altering the natural recruitment of the species (USFWS, 2017).
- The recently discovered populations should be visited, and monitored on a regular basis; additional visits should be made after hurricanes, fires, or other major disturbances to determine their impacts on the populations (USFWS, 2017).
- The recovery plan should be revised to establish measurable criteria, including how many individuals constitute a self-sustainable population and how many populations would be needed to delist the species (USFWS, 2017).
- Studies should be conducted to determine the patterns of genetic variation within and among populations, in order to develop a plan to preserve the species germplasm (USFWS, 2017).
- A protocol for the propagation and reintroduction of bariaco should be developed in collaboration with partners. The protocol should address the feasibility of seed banking, and if deemed necessary, seed material should be storage at the Millennium Seed Bank (KEW) and USDA National Laboratory for Genetic Resources Preservation (NLGRP). Studies on the species genetics should be conducted to determine patterns of genetic diversity, and to provide baseline information for sound management of the species (USFWS, 2019).
- Due to the low number of populations and individuals, along with the little evidence of natural recruitment and limited dispersal, the reproductive biology and ecology of bariaco should be determined. In particular, the factors limiting seed dispersal and seedling recruitment should be studied. This should include the establishment of a long-term monitoring program (including permanent parcels) to document seedling recruitment and survival, and the conditions necessary for their establishment (USFWS, 2019).
- Due to the quality of the habitat, surveys of the Ponce-Penuelas, Guayanilla, and Montes de Barinas should be conducted in order to identify potential new populations of bariaco (USFWS, 2019).

Conservation Measures and Best Management Practices:

- The recovery of the species should focus on the protection of the known populations and its suitable habitat. Conservation Agreements should be signed between the Service and private landowners to protect natural populations (USFWS, 2012).
- The populations that are actively reproducing need to be identified and monitored to collect seed material for propagation purposes. A protocol to collect seed should be created and implemented to avoid altering the natural recruitment of the species (USFWS, 2012)
- The recently discovered populations should be visited, and monitored on a regular basis; additional visits should be made after hurricanes, fires, or other major disturbances to determine their impacts on the populations (USFWS, 2012).
- The recovery plan should be revised to establish measurable criteria, including how many individuals constitute a self-sustainable population and how many populations would be needed to delist the species (USFWS, 2012).
- Studies should be conducted to determine the patterns of genetic variation within and among populations, in order to develop a plan to preserve the species germplasm (USFWS, 2012).

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5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Southeast Region, Caribbean Ecological Services Field Office, Boquerón, Puerto Rico.

SPECIES ACCOUNT: *Trifolium amoenum* (Showy Indian clover)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest Region (R8)

Physical Description

An annual herb, 1-6 dm tall, hairy and often robust. Leaves are divided into 3 egg-shaped leaflets. Flowers (April-June) are purple with white tips and are borne in dense, round or oval heads, 2-3 cm long (NatureServe, 2015).

Taxonomy

A distinct species in a genus of about 300 species, most abundant in north temperate regions (NatureServe, 2015)

Historical Range

Historically in Alameda, Mendocino, Marin, Santa Clara, Solano, Sonoma, Napa counties, California (NatureServe, 2015)

Current Range

Currently believed extant only in Marin (native) and Sonoma (reintroduced) counties (NatureServe, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Self pollination and outcrossing (NatureServe, 2015)

Reproduction Narrative

Adult: Mating system appears to include both cross-and self-pollination, as extant plants were found to have a higher level of heterozygosity than would be expected in a predominantly self-pollinating species (Knapp and Connors 1999 cited in USFWS 2007).; Mixed selfing and outcrossing (NatureServe, 2015).

Habitat Type

Adult: Grasslands (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Serpentine soil (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species is typically in low, wet swales in grasslands. Also on grassy hillsides at up to about 400 m elevation. Per the California Dept. of Fish and Game (2000): Open, sunny sites, sometimes on serpentine soil in coastal bluff scrub and valley and foothill grassland; most recently seen on a roadside that had been graded and on an eroding cliff face. Possibly requires disturbance-created openings for germination (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species and the low number of populations and individuals.

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Decreasing (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Historically known from 25 sites but probably extirpated at all but 1 of these (although some viable seed may remain in seedbanks and may germinate if conditions are right). Loss of habitat to urbanization and agriculture was probably the primary reason for the extirpation of so many populations. Even since 1997 when this species was listed as Endangered, much habitat potentially suitable for restoration has been altered and is now unsuitable due to urbanization, agricultural operations, and changes in the biological community and hydrological conditions (USFWS 2007). Decline of >90% The one native occurrence had about 225 plants when it was

discovered in 1996 (California Dept. of Fish and Game 2000). Had been thought extinct until the early 1990s. A single plant was found in 1993 at a site in Sonoma County, but that site has now been developed and the species is considered extirpated there. However, seeds were collected from the plant prior to its extirpation and were subsequently multiplied. In 2006, some of those seeds were used to establish experimental populations at two sites in Sonoma County and at several sites at Point Reyes National Seashore (Marin County). It is as yet unknown whether any of the experimental sowings will persist (USFWS 2007). Another population, the only native population currently extant, was discovered in 1996 in Marin County. In 1997, seed from those plants was used to establish a small experimental population (approximately 20 seedlings) at Bodega Marine Laboratory (Sonoma County) (USFWS 2007). The Bodega experimental population had persisted as of 2007, but its long term fate is unknown (USFWS 2007) (NatureServe, 2015). NatureServe (2015) also notes that the short-term trend for this species is a decline of 10% and the long-term trend is a decline of 90%. Low resiliency, representation and redundancy are inferred based on the low number of known populations and individuals.

Threats and Stressors

Stressor: Urbanization (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Urbanization is listed as a threat to this species (USFWS, 2012).

Stressor: Agriculture (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Conversion of land to agriculture is listed as a threat to this species (USFWS, 2012).

Stressor: Erosion (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: In addition to the threat from erosion of the hillside, in a 2010 annual report, Dr. Connors states the possibility of an earthquake that could result in a significant portion of the Dillon Beach population being lost in a landslide since it is very close to the eroding cliff (Connors 2010) (USFWS, 2012).

Stressor: Trampling (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: A small trail providing local homeowners with access along the bluffs runs directly through the population. Although current use of the trail does not appear to threaten the population, any increase in use or expansion of the trail could adversely affect the population (Connors 2006) (USFWS, 2012).

Stressor: Herbivory (USFWS, 2012)

Exposure:**Response:****Consequence:**

Narrative: Herbivory by gophers and voles is listed as a threat to this species (USFWS, 2012).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2012)

Exposure:**Response:****Consequence:**

Narrative: The State's authority to conserve plants is comprised of four pieces of legislation: The California Endangered Species Act (CESA), the Native Plant Protection Act (NPPA), the California Environmental Quality Act (CEQA), and the Natural Community Conservation Planning Act (NCCPA). *Trifolium amoenum* is not listed under CESA, therefore neither that Act nor the NPPA apply to this review. The California Environmental Quality Act (CEQA) (chapter 2, section 21050 et seq. of the California Public Resources Code) requires government agencies to consider and disclose environmental impacts of projects to not only federally listed species, but also to those considered "rare" by other agencies or professional associations. *Trifolium amoenum*, although not state listed, is considered a List 1B plant by the California Native Plant Society. Any impacts to *T. amoenum* would be subject to evaluation through CEQA. The CEQA also requires the avoidance or mitigation of those impacts, where possible. Under CEQA, public agencies must prepare environmental documents to disclose environmental impacts of a project and to identify conservation measures and project alternatives. Through this process, the public can review proposed project plans and influence the process through public comment. However, CEQA does not guarantee that such conservation measures will be implemented. Currently there are no completed regional or county-wide Habitat Conservation Plans per the Federal Endangered Species Act (HCPs) or Natural Community Conservation Plans (NCCPs) per the Natural Community Conservation Planning Act at any of the known occurrences (USFWS, 2012).

Stressor: Non-native exotic plants (USFWS, 2012)

Exposure:**Response:****Consequence:**

Narrative: The most significant long-term threat to the Dillon Beach 10 population is invasion by the non-native *Carpobrotus edulis* (iceplant or sea fig). This plant, which competes for habitat with *Trifolium amoenum*, was planted for fire and erosion control in the adjacent yard and reached the *T. amoenum* population for the first time in 1999. Dr. Connors has developed an agreement with that landowner on an iceplant control program involving both hand-pulling and herbicide (Roundup) application (Connors 2006). Though the landowners do not follow any practices that would be harmful to the population, the status of iceplant removal is unknown. Other invasive competitors already present at the site, including *Lolium multiflorum* (Italian ryegrass) and *Plantago lanceolata* (English plantain), may gain in population size or density at the expense of *T. amoenum* (Connors 2006, in litt.). In addition, the non-native grass *Holcus lanatus* (velvet grass) is not currently at the site but has invaded many coastal bluff plant communities in the area. It could be a strong invader of the *T. amoenum* population if it became established at the Dillon Beach site (Connors 2006) (USFWS, 2012).

Stressor: Small population size and few populations (USFWS, 2012)

Exposure:

Response:**Consequence:**

Narrative: As discussed in the listing rule (Service 1997) and the 2007 5-year review, the conservation biology literature commonly notes the vulnerability of taxa known from one or very few locations and/or from small populations (e.g., Shaffer 1981, 1987; Primack 1998; Groom et al. 2006). In these situations, genetic diversity can become dangerously low. Also, as Dr. Connors reports, annual plants like clovers naturally fluctuate annually, likely due to regional patterns in amounts and timing of rainfall (Connors 2010). Yearly fluctuations in the Dillon Beach population have been large, with occasional 15 to 20-fold changes between subsequent years. Seedling density was high and quite similar in 2007, 2009 and 2010, but much lower in 2008 (Connors 2010). Seed production has been even more variable. *Trifolium* seeds are typically long-lived in suitable soils, and the importance of a seedbank in sustaining this *T. amoenum* population has been demonstrated by the strong rebounds of the population in 2007 and 2009 (Connors 2010). However, if several years of low germination in a small population are followed by a disruption to or removal of the seedbank, genetic diversity may be further diminished. That *Trifolium amoenum* occurs in small numbers and at few locations has not changed since the time of listing or the last 5-year review. Therefore, threats associated with these factors remain. The combination of a single native population, small range, and restricted habitat makes this species highly susceptible to extinction or extirpation due to random events, such as flood, drought, disease, or other occurrences (USFWS, 2012).

Recovery**Recovery Actions:**

- No approved final or draft recovery plan for *Trifolium amoenum* has been completed or is in preparation. (USFWS, 2012).

Conservation Measures and Best Management Practices:

- 1) Complete and implement a recovery plan for *T. amoenum* which outlines specific recovery criteria and recovery tasks (USFWS, 2012).
- 2) Continue to monitor known populations of *T. amoenum* so as to discern population sizes and the differences between natural and unnatural population fluctuations (USFWS, 2012).
- 3) Conduct range-wide surveys to identify additional populations for protection and outcrossing purposes (USFWS, 2012).
- 4) Expand the genetic base of the Occidental population, currently used for reintroduction experiments, to prevent further loss of evolutionary potential and the possibility of deleterious effects associated with inbreeding. Any additional plants found as a result of (3) above should be used to expand the genetic variability. If no additional individuals are identified, the Dillon Beach population should be used. Much care must be used during this process, however, as phenotypic difference between the two populations are likely adaptive. Through “controlled introgression”, a small proportion of the non-local Dillon Beach source seed could be mixed into the Occidental population over time, such that local adaptive variation is maintained while promoting adequate levels of within population genetic variation (Knapp and Connors 1999) (USFWS, 2012).
- 5) Reintroduce both growth forms into suitable habitat. The two forms of *T. amoenum* should be treated separately in any reintroduction efforts, however, because these forms have morphological differences which may be adaptive. The establishment of a self-sustaining population in a preserved

area would greatly increase the likelihood of recovery of this species. Suitable habitats might be found at the Bodega Marine Laboratory or on State or Federal lands in the area (USFWS, 2012).

- 6) Conduct research into (a) the role of herbivory, (b) whether the presence of gophers is beneficial or detrimental, (c) reasons for interannual variability in population numbers and seed productivity, (d) the tolerance of *T. amoenum* to different soil types, and (e) the effect of disturbance regimes on *T. amoenum*, among other topics (USFWS, 2012).

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SPECIES ACCOUNT: *Trifolium trichocalyx* (Monterey clover)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest Region (R8)

Physical Description

A prostrate, spreading annual herb. The prostrate branches are sometimes only 3-4 cm long, but can reach 30 cm under favorable conditions. Flowers are borne in heads, 4-14 mm wide, the pale purple petals barely extending beyond the bristly calyces. Blooms April-June. (NatureServe, 2015)

Taxonomy

Trifolium trichocalyx (Figure 7) was first collected by Amos A. Heller in 1903 following a fire 2 years earlier "in sandy pine woods about Pacific Grove" (Heller 1904). The species was described by Heller the following year (Heller 1904). Laura F. McDermott considered the taxon a variety of *T. oliganthum* in her treatment of the genus (McDermott 1910), although this classification was not recognized in subsequent floras. Axelrod (1982) reported at least one researcher who suggested that Monterey clover was a sporadic hybrid between *T. microcephalum* and *T. variegatum* and recommended removing it from the list of Monterey endemic taxa. This view was challenged by V. Yadon (in litt. 1983) who had grown *T. trichocalyx* and observed it consistently producing up to seven seeds per pod, while both putative parent plants were two-seeded taxa. *Trifolium trichocalyx* has continued to be recognized as a distinct species by Abrams (1944), Munz and Keck (1959), Howitt and Howell (1964), and Isely (1993), and we accept it as such (USFWS, 2004).

Current Range

Monterey clover) is known from only one area (Huckleberry Hill) covering approximately 16 hectares (40 acres) on property owned by the Pebble Beach Company on the Monterey Peninsula. During 1996, two locations in the Huckleberry Hill area with a total of 22 plants were located (USFWS, 2004). In 2011, *Trifolium trichocalyx* was identified along logging roads in Mendocino County. Additional populations have since been found in Mendocino but the population sizes and area remain restricted. (USFWS, 2019).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Breeding Season

Adult: *Trifolium trichocalyx* flowers between April and June (USFWS, 2004).

Reproduction Narrative

Adult: *Trifolium trichocalyx* appears to regenerate in large numbers during spring following a fire that removes the dense vegetative cover that shelters its seed bank. *Trifolium trichocalyx* populations will decline as shrubs and seedlings overshadow the plants as the forest begins to

recover following a fire. *Trifolium trichocalyx* appeared after the 1901 fire and again after the 1987 fire, thus possibly harboring a seed bank capable of surviving more than 90 years. Recent studies indicate light as the only germination requirement (Doak et al. 2000). However, seeds buried in the soil at Huckleberry Hill may require different germination cues than those seeds used in germination experiments because experimental seeds were never buried (Doak et al. 2000). *Trifolium trichocalyx* flowers between April and June. Small bees are likely pollinators as they are with other *Trifolium* clover species, although no pollinators were observed in previous studies (Jones and Stokes Associates 1996). Additionally, scarification may stimulate some *Trifolium trichocalyx* to bloom between fires (V. Yadon in litt. 2002) (USFWS, 2004).

Habitat Type

Adult: Pine forest (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Fire dependent (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (NatureServe, 2015)

Site Fidelity

Adult: High (NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits openings in and edges of Monterey pine forest. Ephemeral: plants persist for a few years following fire or other vegetation removal, but are shaded out or outcompeted after that. Soils are poorly drained, coarse loamy sands. < 100 m elevation (NatureServe, 2015).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: *Trifolium trichocalyx* becomes scarce when the forest canopy closes, persisting primarily as a seed bank in the soil while shade and competition increase during succession of the forest community (USFWS, 2004).

Population Information and Trends**Population Trends:**

Decreasing (USFWS, 2009)

Population Size:

Between 2,000 and 5,000 individuals have been observed across all the known Mendocino County populations since 2011 during annual surveys (Heise and Hulse-Stephens 2016, pp. 9-16). (USFWS, 2019).

Population Narrative:

The species has not been observed since 1995 when 22 individuals were located (USFWS, 2009).

Threats and Stressors

Stressor: Urban and recreational (e.g., golf courses) development (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The Recovery Plan (Service 2004) identifies the most significant threat to the species has been the loss of potential habitat from urban and recreational (e.g., golf courses) development. At the time of listing, less than 20 percent of the historical Monterey pine forest on the Monterey Peninsula was estimated to remain, much of it in fragmented and increasingly isolated stands (Jones and Stokes Associates 1994 in Service 1998). Jones and Stokes Associates (1996) estimated that habitat for the species has declined approximately 69 percent, from 1,754 acres (710 ha) to 539 acres (218 ha) as of 1996. Of locations mapped for the species, the majority of occurrences appear to be within the Huckleberry Hill Natural Reserve and Morse Reserve; however, individuals have been identified adjacent to the south of the Huckleberry Hill Natural Reserve. A number of plants are presumed to have been extirpated when the Poppy Hills Golf Course was developed in 1980 (Service 2004). The Service is unaware of any potential habitat losses since the species was listed in 1998 (USFWS, 2009).

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: At the time of listing, regulatory mechanisms thought to have some potential to protect *Trifolium trichocalyx* included: (1) listing under the California Endangered Species Act (CESA); (2) the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA); (3) the California Coastal Act; and (4) local land use laws, regulations, and policies. The listing rule (63 FR 43100) provides an analysis of the level of protection that was anticipated from those regulatory mechanisms. This analysis appears to remain currently valid. *Trifolium trichocalyx* was listed as endangered by the State of California in 1979. As such, projects that would affect *Trifolium trichocalyx* are subject to CESA and CEQA requirements. The lead CEQA agency with primary authority or jurisdiction over a project is responsible for conducting a review of the project and to consult with other agencies concerned about resources affected by the project. However, required biological surveys are not always adequate to identify the presence of *Trifolium trichocalyx*, as the species is not visible above ground while it exists as seed banks. In addition to the laws and regulations discussed above, local county regulations may also benefit *Trifolium trichocalyx*. This species occurs within a portion of the Monterey Peninsula included in the California Coastal Zone. The Del Monte Forest Land Use Plan of 1984 was developed to comply with the Coastal Act's requirement that all counties prepare a plan for those portions of the Coastal Zone within their jurisdiction. Once the Del Monte Forest Land Use Plan was certified by the CCC, development permits within the Del Monte Forest coastal zone

became the responsibility of the County of Monterey. The County of Monterey also has designated certain areas, including a portion of where *Trifolium trichocalyx* is known to occur, as ESHAs. Although the County of Monterey recognizes the importance of these areas, protection of listed species through the California Coastal Act and local land use designations is dependent upon the review of the lead agency involved. Additionally, while no development projects have been implemented in the area where *Trifolium trichocalyx* occurs since the time of listing, State and local regulations may not protect the species from indirect impacts that occur from such threats as changes in hydrology in adjacent areas and the spread of nonnative species (USFWS, 2009).

Stressor: Alteration of fire frequency (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat/loss of populations

Narrative: At the time of listing, the alteration of natural fire cycles was identified as a significant threat to the species' survival. The species is only known to occur within an area bordered by residential development and Pebble Beach Company facilities (e.g., golf courses, structures). This fact combined with the limited remaining habitat makes this species extremely susceptible to stochastic events. *Trifolium trichocalyx* seed banks within the Huckleberry Hill area are apparently viable after an extended period of time; however, due to fire suppression, the normal fire cycle in Monterey pines has been lengthened. Due to the lack of knowledge on the species, it is unknown what effect the lack of a natural fire regime will have on seed viability. In the absence of fire, or a reasonable habitat disturbance alternative, this species could become extirpated at certain locations or potentially be rendered extinct (CDFG 2005) (USFWS, 2009).

Stressor: Small numbers of individuals and populations (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of genetic diversity

Narrative: Conservation biology literature discusses that small populations are threatened by inbreeding depression (Ellstrand and Elam 1993). Small populations can have significantly lower germination rates than larger populations of the same species due to high levels of homozygosity (Menges 1991). Based on historical records, we believe that urban and recreational development on the Monterey Peninsula has already reduced the distribution of this species in the area where it occurs. Indirect effects from urbanization in the Huckleberry Hill area could include changes in hydrology, vegetation, and an increase in nonnative species. While any one of these factors may not be enough to threaten the survival of *Trifolium trichocalyx* independently, its limited range and the cumulative and synergistic effects of all of these factors combined could be a threat to the survival and recovery of the species (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). Recently, the potential impacts of climate change on the flora of California were discussed by Loarie et al. (2008). Based

on modeling, they predicted that species' distributions will shift in response to climate change, specifically that the species will "move" or disperse to higher elevations and northward, depending on the ability of each species to do so. Species diversity will also shift in response to these changes with a general trend of diversity increases shifting towards the coast and northwards with these areas becoming de facto future refugia. However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to *Trifolium trichocalyx* at this time (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative:

Recovery

Reclassification Criteria:

1. At least five viable populations (i.e., populations that are stable or increasing based on a minimum of 12 years of monitoring) occur in suitable habitat. One of these populations is the Huckleberry Hill population (USFWS, 2009).
2. All five of the sites are on land that is protected from human-induced disturbance (i.e., development, recreation) that would negatively affect growth or reproduction of the plants. Funds must be available for appropriate long-term management. As determined by research, protected habitat must be of adequate size (large enough to support a functioning ecosystem [e.g., species present to support seed dispersal and pollination, areas that support fluctuating distributions, areas that harbor suitable unoccupied habitat for population expansion]) and configuration to ensure that ecosystem and community processes and associated species (e.g., hydrologic regime, fire, food webs, pollinator fauna, Monterey pine forest communities) are maintained, and that an adequate diversity of sites exist for population expansion and for colonization of new areas as microhabitat conditions change (USFWS, 2009).
3. The Huckleberry Hill population and four additional viable populations (as described in 1 above) have been managed so as to allow regeneration of plants and replenishment of the seed bank found in the soil within protected habitat (USFWS, 2009).
4. A seed bank has been established at a recognized institution certified by the Center for Plant Conservation (USFWS, 2009).

Delisting Criteria:

Delisting Criterion 1) threats are reduced or eliminated so that protected populations are capable of persisting without significant human intervention or perpetual endowments are secured for management necessary to maintain the continued existence of the species. We currently do not know what the specific habitat needs are for this species. To the best we know

now, the most outstanding management need currently is: a) integrate, or find a replacement for, a fire regime as a means of revitalizing declining or senescing colonies; and b) research on soil seed bank dynamics and conditions for germination. (USFWS, 2019).

Delisting Criterion 2) unoccupied habitat in the area has been assessed for its suitability for reintroduction efforts; the area in Mendocino County where colonies were discovered in 2011 should be assessed, as well as the Monterey Peninsula area. Also, two additional, new populations are established and protected where appropriate. (USFWS, 2019).

Delisting Criterion 3) all protected populations remain viable for at least 10 years to demonstrate long-term viability under a range of environmental conditions. Assuming that habitat was being managed to incorporate a fire regime to increase openness and to release fire-adapted seed, we would then expect above-ground population size to fluctuate annually, based on response to amount and timing of rainfall (e.g. see Fox et al. 2006). Therefore, a period of 10 years should be long enough to include most of the variability in rainfall that occurs in this region (Zedler & Black 1989; NOAA 2018). (USFWS, 2019).

Recovery Actions:

- No other populations have been discovered or re-introduced within the known historic range of the species; therefore, this criterion has not been met. Ensuring that five viable populations occur in suitable habitat may be relevant; however, the complexities associated with identifying discrete populations of this ephemeral plant make it difficult for us to measure this criterion. This criterion may need to be revised in future recovery plans and could be based on preserving all or portions of the species remaining potential habitat (USFWS, 2009).
- As discussed above, we currently have no appropriate method for measuring five viable populations of the species; therefore, this criterion may need to be revised in future recovery plans. The majority of *Trifolium trichocalyx* occurrences are within areas that have been permanently protected by easements (i.e., Huckleberry Hill Natural Reserve and Morse Reserve). However, we believe that any further development in the Huckleberry Hill area of the Monterey Peninsula would directly reduce the species remaining habitat. Undeveloped areas within the vicinity of Huckleberry Hill that are not protected by easements are important for potential expansion of the species, and we believe they require protection. Additionally, funds dedicated for long-term management of the species in protected areas have not been committed. This criterion has not been met (USFWS, 2009).
- As stated in criteria (1) and (2) above, we have no suitable method to determine five distinct populations of this ephemeral species. Currently, the areas where *Trifolium trichocalyx* is known to occur is not being managed to allow regeneration of plants and replenishment of the seed bank. This criterion has not been met (USFWS, 2009).
- Currently *Trifolium trichocalyx* seed is being stored at the Plant Genetic Resources Conservation Unit located on the Griffin Campus of the University of Georgia. Additionally, *Trifolium trichocalyx* seed is being stored at the U.S. Department of Agriculture's National Center for Genetic Resource Preservation in Fort Collins, Colorado. This criterion is relevant and up-to date. This criterion has been met (USFWS, 2009).

Conservation Measures and Best Management Practices:

- 1. Work with Pebble Beach Company, Del Monte Forest Foundation, Pebble Beach Community Services District, and Pebble Beach residents to develop and implement a fire management plan

that would mimic natural fire regimes within the Huckleberry Hill area. If a burn management plan is not implemented, burn box experiments should be conducted to determine where the species occurs within the Huckleberry Hill area (USFWS, 2009).

- 2. Surveys for *Trifolium trichocalyx* should be conducted following fires and/or following substantial scarification of potential habitat on the Monterey Peninsula (USFWS, 2009).
- 3. Experiment with establishment of new populations in similar habitat on the Monterey Peninsula or at Point Lobos State Reserve. If these efforts are successful, attempts to establish other populations could be undertaken on the Monterey Peninsula (USFWS, 2009).
- 4. Germination trials should be conducted that mimic natural soil conditions and germination cues to establish more clearly the conditions needed to facilitate germination (USFWS, 2009).

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USFWS. 2019. Recovery Plan for Five Plants from Monterey County, California, Amendment 1. USFWS, Pacific Southwest Region, Ventura, CA. 18 pp.

SPECIES ACCOUNT: *Urera kaalae* (Opuhe)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/29/1991; Pacific Region (R1) (USFWS, 2016)

Physical Description

A tree or shrub, 3-7 m tall. Tiny flowers are borne in open inflorescences. (NatureServe, 2015)

Historical Range

Historically, *Urera kaalae* was known from the central to southern windward Waianae Mountains, from Waianae Ukato Kupehau Gulch (USFWS 1995, Wagner et al. 1990). (USFWS, 1998)

Current Range

Current range: Waianae Mountains of Oahu. (NatureServe, 2015)

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Urera kaalae* (Opuhe) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Urera kaalae* (77 FR 57648-57862). The critical habitat designation includes 8 critical habitat units, which encompass approximately 6,573 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Urera kaalae* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Urera kaalae* includes 8 critical habitat units, covering two ecosystem types, which encompass approximately 6,573 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3; Oahu—Lowland Wet—Units 1, 2, 3, 4, 5.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Oahu—Lowland Wet—Unit 1 [541 ac (219 ha)]. This area consists of 428 ac (173 ha) of State land and 112 ac (46 ha) of City and County of Honolulu land in the lowland wet ecosystem on the windward side of the Waianae Mountains, and partially within the Mokuleia and Waianae Kai Forest Reserves. Oahu—Lowland Wet—Unit 2 [20 ac (8 ha)]. This area consists of 19 ac (8 ha) of State land in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puuhapapa. Oahu—Lowland Wet—Unit 3 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puukanehoa. Oahu—Lowland Wet—Unit 4 [27 ac (11 ha)]. This area consists of 27 ac (11 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains on State land at Puukaua. Oahu—Lowland Wet—Unit 5 [74 ac (30 ha)]. This area consists of 74 ac (30 ha) of State land in the lowland wet ecosystem, on the windward side of the Waianae Mountains at Palikea.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Urera kaalae* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Urera kaalae* occurs within the Lowland mesic and Lowland wet ecosystems in the Waianae Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Oahu—Lowland Wet—Units 1, 2, 3, 4, 5. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (F) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepidia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Urera kaalae* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Breeding Season

Adult: Spring (USFWS, 1998)

Reproduction Narrative

Adult: Urera kaalae has been observed flowering in the spring. It is difficult to predict when seeds will be produced, and, when they are produced, they are often sterile. This may be an indication of pollinator limitation. (USFWS, 1998)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevation of 300 to 820 meters (980 to 2,700 feet) (USFWS, 1998)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1998)

Habitat Narrative

Adult: Urera kaalae typically grows on slopes and in gulches in diverse mesic forest dominated by papala kepau at an elevation of 300 to 820 meters (980 to 2,700 feet) (USFWS 1995; Wagner et al. 1990). Associated species include alan, poola, ieie, mamaki, Urera glabra, kopiko, lama, papala kepau, and olopua (HHP 1997; USFWS 1995). (USFWS, 1998)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2011)

Redundancy:

Very low (inferred from USFWS, 2011)

Number of Populations:

<10 (USFWS, 2011)

Population Size:

15-16 individuals (USFWS, 2011)

Population Narrative:

When the recovery plan was published in 1998, only ten populations were known with a total of 44 individuals. In 2009, Bakutis reported that only about 15 or 16 individuals remain in the wild on Oahu, between Palikea and Kaluaa at Ekahanui and Palawai (A. Bakutis, pers. comm. 2009; USFWS 2009, 2010). (USFWS, 2011)

Threats and Stressors

Stressor: Invasive introduced species (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species have altered the habitat and compete for resources with *Urera kaalae*. These include *Ageratina riparia* (spreading mist flower), *Aleurites moluccana* (kukui), *Bryophyllum pinnatum* (airplant), *Buddleia asiatica* (dog tail), *Clidemia hirta* (Koster's curse), *Deparia petersonii* (NCN), *Grevillea robusta* (silk oak), *Heliocarpus popayaensis* (white moho), *Lantana camara* (lantana), *Oplismenus* sp. (basketgrass), *Passiflora suberosa* (corksystem passion flower), *Physalis peruviana* (Cape gooseberry), *Pimenta dioica* (allspice tree), *Psidium guajava* (common guava), *Rubus argutus* (blackberry), *Rubus rosifolius* (thimbleberry), *Setaria parviflora* (yellow foxtail), and *Schinus terebinthifolius* (Christmas berry). The introduced invasive plant species compete with the species for water, light, and nutrients. (USFWS, 2011)

Stressor: Habitat degradation by pigs and goats (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Feral ungulates, including pigs (*Sus scrofa*) and goats (*Capra hircus*), have caused degradation of the habitat where this species occurs. (USFWS, 2011)

Stressor: Damage by landslides and rolling rocks (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Many reports also include observations of damage and mortality of these trees from landslides and rolling rocks, which can be precipitated by these animals (Hawaii Biodiversity and Mapping Program 2009; Perlman 2010; Plant Extinction Prevention Program 2009; Wood 2010). (USFWS, 2011)

Stressor: Predation by rats and slugs (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Rats (*Rattus* spp.) and slugs (unidentified species) have been noted to consume vegetative or floral parts of *Urera kaalae* (Perlman 2010; Wood 2010). (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2011)

Stressor: Few populations and demographic fluctuations (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: In addition to all of the other threats, species like *Urera kaalae* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding, and disease outbreaks. The extent of these natural processes on this single island endemic are exacerbated by anthropogenic threats, such as habitat loss for human development or predation by introduced species (USFWS 2010). (USFWS, 2011)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1998)

Recovery Actions:

- Construct enclosures or strategic barrier fence to protect populations against feral ungulates. (USFWS, 1998)

- Control competing alien plant species within enclosures. Populations that have only a few remaining individuals (Kuma Kakii and Waianae Kai Forest Reserve) should immediately be weeded and protected where accessible. (USFWS, 1998)
- A coordinated fire protection plan for endangered plant species on State forest reserves (Waianae Kai), Federal (Schofield Barracks—West Range), and private lands (Honouliuli Preserve) should be developed and implemented. (USFWS, 1998)

Conservation Measures and Best Management Practices:

- Continue to collect seed from all remaining wild individuals as well as reintroduced individuals for genetic storage and reintroduction. (USFWS, 2011)
- Construct large-scale fences around all naturally occurring and reintroduced individuals to control feral ungulates. (USFWS, 2011)
- Control invasive introduced plant species around all known populations. (USFWS, 2011)
- Continue reintroducing individuals into protected suitable habitat within historical range. (USFWS, 2011)
- Control rats in the vicinity of these populations. (USFWS, 2011)
- Develop and implement methods to control slugs. (USFWS, 2011)
- Work with Hawaii Division of Forestry and Wildlife and U.S. Army to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2011)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2011)

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SPECIES ACCOUNT: *Varronia rupicola* (No common name)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/09/2014; Southeast Region (R4) (USFWS, 2016)

Physical Description

Varronia rupicola is a large shrub reaching up to 16 ft (5 m) in height. The alternate leaves are ovate to elliptic, 0.8 to 3.5 inches (in) (2 to 9 centimeters (cm)) long with an acute apex, rounded to obtuse at the base, and chartaceous (papery) (USFWS, 2014-2).

Taxonomy

Varronia was traditionally lumped into the genus *Cordia*, a group of about 250 or more species of trees and shrubs of tropical and subtropical regions. *Varronia* was recently recognized as a monophyletic genera based on vegetative, floral, and pollen morphology (Miller and Gottschling 2007, p. 163). *Varronia* comprises multistemmed shrubs with condensed inflorescence and evenly serrate leaves (Sa´nchez de Stapf 2010, p. 133). *Varronia* is currently represented in the West Indies by about 66 valid species (Acevedo-Rodri´guez and Strong 2012, p. 170). Axelrod (2011, p. 427) recognized seven species found in Puerto Rico, with *V. bellonis* and *V. wagnerorum* being endemic to the island, and *V. rupicola* extending to the island of Anegada, British Virgin Islands (USFWS, 2014-2).

Historical Range

The species has been historically recorded from the geographical area comprising the Gua´nica Commonwealth Forest in southwestern Puerto Rico, and the area of the Vieques National Wildlife Refuge (NWR) in the island of Vieques, eastern Puerto Rico (USFWS, 2014). However, it is important to notice that *Varronia rupicola* also occurs within privately owned lands outside the Guanica Commonwealth Forest, which makes it vulnerable to habitat destruction (USFWS, 2014).

Current Range

Varronia rupicola is currently known from at least seven main localities in Puerto Rico (Table 2) and several localities from the island of Anegada. Monsegur and Breckon (2007, p. 1) visited the historical localities in Puerto Rico and provided updated information about the status and distribution of the species. The distribution of *V. rupicola* in the Gua´nica Commonwealth Forest extends to at least six small populations or subpopulations within the east section of the forest. Another population was located on the west unit of the Gua´nica Commonwealth Forest by Alcides Morales (Sociedad Ornitologica Puertoriquena, Inc., pers. comm., 2012). This is the westernmost recorded distribution for the species. From the municipality of Penuelas, Monsegur and Breckon (2007, p. 6) found a single individual in a ravine area on the west side of El Peno´n site. This seems to be part of the same population identified by Breckon and Kolterman in 1995. In addition, the Service confirmed the presence of about eight clusters of the species in an area just north of the Ponce Holiday Inn in the municipality of Ponce (O. Monsegur, Service, and J. Sustache, DNER, unpubl. Data, 2013) (USFWS, 2014).

Critical Habitat Designated

Yes; 9/9/2014.

Legal Description

On September 9, 2014, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Varronia rupicola* under the Endangered Species Act of 1973, as amended. The critical habitat designation includes seven critical habitat units (CHUs) in Puerto Rico (79 FR 53315-53344).

Critical Habitat Designation

The critical habitat designation for *Varronia rupicola* includes seven CHUs in St. Croix, Virgin Islands. This species critical habitat encompasses approximately 6,547 acres (ac) (2,648 hectares (ha)) (79 FR 53315-53344).

Montalva: Unit 1 consists of 992 ac (401 ha) of Commonwealth-owned lands located at Montalva Ward in the Municipality of Guá'nica, Puerto Rico. This unit is located just south of State Highway PR 324 and the Town of Guá'nica, and includes Cerro Montalva. It is within the geographical area occupied by the species at the time of listing. Due to the marginal agricultural value, these forests were minimally impacted by other land use practices (e.g., charcoal production and ranching). Therefore, the prime and essential habitat for the species has maintained its unique features, such as the dry coastal shrubland habitat PCEs and PBFs, including suitable climate, substrates, and associated native plants and forest structure. Despite its conservation status the habitat has been affected by human-induced fires and maintenance of access roads and rightsof-way. The PCEs in this unit may require special considerations to address threats of nonnative plant species, human-induced fires, hurricanes, and habitat modification (e.g., urban development).

Unit 2: Guá'nica Commonwealth Forest: Unit 2 consists of 584 ac (236 ha) of Commonwealth-owned lands located within Carenero and Barina Wards in the municipalities of Guá'nica and Yauco, Puerto Rico. This unit is located within the core of the east section of the Guá'nica Commonwealth Forest. The forested habitat in this unit was minimally impacted by other land use practices like charcoal production and ranching due to its marginal agricultural value; hence, it has maintained its unique features. It is within the geographical area occupied by the species at the time of listing and contains the dry coastal shrubland habitat PCEs and PBFs, including suitable climate, substrates, and associated native plants and forest structure. Despite its conservation status, the habitat has been affected by human-induced fires and maintenance of access roads and rights-of-way. The PCEs in this unit may require special considerations to address threats of nonnative plant species, humaninduced fires, hurricanes, and habitat modification (e.g., urban development and right-of-way maintenance).

Unit 3: Montes de Barina: Unit 3 consists of 2,002 ac (810 ha) of privately owned lands primarily located along Indios Ward in the municipality of Guayanilla. A small section of this unit falls within the Barinas Ward in Yauco, Puerto Rico. This unit is located just south of State Highway PR 2. The forested habitat in this unit was minimally impacted by other land use practices like charcoal production and ranching due to its marginal agricultural value; hence, it has maintained its unique features. The unit is within the geographical area occupied by the species at the time of listing and contains the dry coastal shrubland habitat PCEs and PBFs, including suitable climate, substrates, and associated native plants and forest structure. The PCEs in this unit may require special considerations to address threats of nonnative plant species, human-induced fires, hurricanes, and habitat modification (e.g., urban development).

Unit 4: Peñ ón de Ponce: Unit 4 consists of 2,174 ac (880 ha) of privately owned lands located along Encarnación and Canas Wards in the municipalities of Peñuelas and Ponce, Puerto Rico. This unit is located just north of State Highway PR 2 in the area known as Punta Cucharas. The forested habitat in this unit was minimally impacted by other land use practices like charcoal production and ranching due to its marginal agricultural value; hence, it has maintained its unique features. It is within the geographical area occupied by the species at the time of listing and contains the dry coastal shrubland habitat PCEs and PBFs, including suitable climate, substrates, and associated native plants and forest structure. The PCEs in this unit may require special considerations to address threats of nonnative plant species, human-induced fires, hurricanes, and habitat modification (e.g., urban development).

Unit 5: Punta Negra: Unit 5 is a small peninsula that consists of 291 ac (117 ha) of Commonwealth-owned lands located within Puerto Real Ward on the island of Vieques, Puerto Rico. This unit is located about 1.5 mi (2.5 km) east of the town of Esperanza and west of Puerto Ferro, Vieques National Wildlife Refuge (NWR). This natural area is managed by the Puerto Rico DNER as part of the Puerto Mosquito Natural Reserve. The forested habitat in this unit was minimally impacted by other land use practices like charcoal production and ranching due to its marginal agricultural value; hence, it has maintained its unique features. It is adjacent to an area currently occupied by the species (Unit 6), forming a continuous habitat and contains the dry coastal shrubland habitat PCEs and PBFs, including suitable climate, substrates, and associated native plants and forest structure. However, there is no specific record of the species within this unit. This unit is essential for the conservation of the species because it contains the PCEs and because its designation will safeguard other established populations in case of any stochastic event that occurs within habitats currently occupied by the species. Further, we consider Units 5, 6, and 7 to be a single ecological unit. The species is expected to occur within this area, and ecological interactions and genetic flow between this area and Units 6 and 7 may be essential for the recovery of the species. It was not included as a single unit with Units 6 and 7 because these peninsulas are united by a narrow mangrove forest that does not provide habitat for the species. The PCEs in this unit may require special considerations to address threats of nonnative plant species, human-induced fires, and hurricanes.

Unit 6: Puerto Ferro: Unit 6 is a small peninsula that consists of 381 ac (154 ha) of federally owned lands managed by the Service as the Vieques NWR, and is located within the Puerto Ferro Ward on the island of Vieques, Puerto Rico. This unit is located about 4 km (2.5 mi) east of the town of Esperanza. It is located just between Unit 5 and Unit 7, forming a continuous habitat and contains the dry coastal shrubland habitat PCEs and PBFs, and therefore we consider Units 5, 6, and 7 to be a single ecological unit. The forested habitat in this unit was minimally impacted by other land use practices like charcoal production and ranching due to its marginal agricultural value; hence, it has maintained its unique features. It is within the geographical area occupied by the species at the time of listing and contains the dry coastal shrubland habitat PCEs and PBFs, including suitable climate, substrates, and associated native plants and forest structure. It was not included as a single unit with Units 5 and 7 because these peninsulas are united by a narrow mangrove forest that does not provide habitat for the species. The PCEs in this unit may require special considerations to address threats of nonnative plant species, human-induced fires, and hurricanes.

Unit 7: Cerro Playuela: Unit 7 is a small peninsula that consists of 123 ac (50 ha) of federally owned lands managed by the Service as the Vieques NWR, and is located within Puerto Ferro

Ward on the island of Vieques, Puerto Rico. This unit is located about 0.5 km (0.31 mi) south of the former airport of Campamento Garcí'a (Vieques NWR). The forested habitat in this unit was minimally impacted by other land use practices like charcoal production and ranching due to its marginal agricultural value; hence, it has maintained its unique features. It is adjacent to an area currently occupied by the species (Unit 6), forming a continuous habitat. However, there is no specific record of the species within this unit. This unit is essential for the conservation of the species because it contains the PCEs and because its designation would safeguard other established populations in case of any stochastic event that occurs within habitats currently occupied by the species. Further, we consider Units 5, 6, and 7 to be a single ecological unit. The species is expected to occur within this area, and ecological interactions and genetic flow between this area and Unit 6 may be essential for the recovery of the species. It was not included as a single unit with Units 5 and 6 because these peninsulas are united by a narrow mangrove forest that does not provide habitat for the species. The PCEs in this unit may require special considerations to address threats of nonnative plant species, human-induced fires, and hurricanes.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Varronia rupicola* critical habitat consists of three components (79 FR 53315-53344):

- (1) Remnants of native shrubland and scrubland forest on limestone substrate within the subtropical dry forest life zone. Dry shrubland and scrubland forest includes: (a) Shrubland vegetation with canopy from 6.5 to 9.8 ft (2 to 3 m) high; (b) Limestone pavement; (c) Associated native vegetation; and (d) A shrub layer dominated by *Croton humilis*, *Eupatorium sinuatum*, *Lantana reticulata*, and *Turnera diffusa*.
- (2) Semi-deciduous dry forest on limestone substrate within the subtropical dry forest life zone. Dry limestone semi-deciduous forest includes: (a) Low forest with canopy from 8 to 15 ft (3 to 5 m) high; (b) Limestone pavement; (c) Associated dry forest native vegetation; and (d) A shrub layer dominated by *Croton humilis*, *Eupatorium sinuatum*, *Lantana reticulata*, and *Turnera diffusa*.
- (3) The type locations described in PCEs (1) and (2), above, for this species should have shallow and alkaline soils derived from limestone rock and an average rainfall of 34 in (86 cm).

Special Management Considerations or Protections

Special Management Considerations or Protections: When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. *Agave eggersiana* and *Varronia rupicola*: The primary threats to the physical or biological features (PBFs) that *Agave eggersiana* and *Varronia rupicola* depend on include: (1) Habitat destruction and modification by development; (2) competition with nonnative plant species; (3) human-induced fire; and (4) hurricanes and storm surge. The majority of these threats can be addressed by special management considerations or protection, while others (e.g., hurricanes and storm surges) are beyond the control of land owners and managers. Management activities that could ameliorate these threats include, but are not limited to, establishment of permanent conservation

easements or land acquisition to protect the species and its habitat on private lands; establishment of conservation agreements on private, nongovernment, and government lands to protect the habitat; implementation of control of invasive, nonnative plant species to reduce competition and prevent habitat degradation; implementation of management practices to control fires; and creation or revision of management plans for the identification of the areas where current developments exist and to better guide the implementation of conservation measures for the species. For *A. eggersiana*, precautions are needed to avoid inadvertent mowing and cutting of the species in the course of landscaping activities. In addition, for both *A. eggersiana* and *V. rupicola*, development of residential and tourism projects should avoid impacting these habitats directly or indirectly, and habitat fragmentation should be limited as much as possible to maintain connectivity between populations and to avoid habitat degradation due to the colonization by nonnative, invasive plants.

Critical habitat does not include manmade structures (such as buildings, bridges, docks, aqueducts, roads, and other paved areas) and the land on which they are located existing within the legal boundaries on October 9, 2014

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (USFWS, 2014-2)

Dependency on Other Individuals or Species

Adult: Insect pollinators and Animal disperser (unknown) (USFWS, 2014)

Breeding Season

Adult: Flowering and fruiting December through January, and June through July (USFWS, 2014-2)

Key Resources Needed for Breeding

Adult: Insect pollinators

Reproduction Narrative

Adult: Studies on the distribution, abundance, and reproductive biology of *Varronia rupicola* have been conducted by scientists from the University of Puerto Rico, Mayaguez Campus (Breckon and Kolterman 1996, p. 6; Monsegur and Breckon 2007, p. 13). These authors reported the species flowering and fruiting in December through January (Breckon and Kolterman 1996, p. 4), and in June through July (Monsegur and Breckon 2007, p. 1). From February to April, all plants observed were sterile. Fruit production in the populations from the Guánica Commonwealth Forest and the municipality of Ponce seem to be high, and there is evidence of recruitment associated to the majority of the clusters of individuals (O. Monsegur, Service, pers. obs., 2013). Under greenhouse conditions, seed germination has been reported as not less than 67 percent (Wenger et al. 2010). Germination in the wild has also been observed to be high (O. Monsegur, Service, pers. obs., 2013). However, apparently there is also a high mortality of seedlings, and only few individuals make the transition (natural thinning) to sapling stages (O. Monsegur, Service, pers. obs., 2013). Monsegur and Breckon (2007, p. 2) reported numerous

seedlings (>140) and various saplings in the Guánica Commonwealth Forest. However, seedling recruitment on Vieques Island seems to be low, as it has not been recorded during recent assessments (Monsegur and Breckon 2007, p. 7; Hamilton, KEW, pers. comm., 2013). Despite the showy red fruits of *Varronia rupicola*, its dispersion seems to be almost limited by gravity, as the majority of the seedlings lie under the parent tree or downslope (O. Monsegur, Service, pers. obs. 2013). The wide range of the species suggests a former animal disperser (probably a bird). Patterns of plant-animal interactions were probably altered due to the previous extensive deforestation of the island of Puerto Rico. Some observations of seed dispersal by an undetermined vector have been reported from Anegada (Hamilton, KEW, pers. comm., 2013). If not extinct, possible dispersers may have altered their foraging behavior and now do not feed on the fruits of *V. rupicola*. Recent observations in Puerto Rico indicate that flowers of *V. rupicola* are visited by several insect species, including *Apis mellifera* (honey bee) and *Electrostrymon angelia* (fulvous hairstreak, a butterfly) (O. Monsegur, Service, pers. obs. 2013). *Varronia rupicola* material germinated in the greenhouse at Cabo Rojo National Wildlife Refuge in Cabo Rojo were flowering and producing fruits in about 1 year after germination (O. Monsegur, Service, pers. obs., 2013). The rapid reproductive development of the species and the finding of individuals along recently disturbed sites (new dirt roads) and natural forest gaps (openings) may indicate that *V. rupicola* is an early colonizer or pioneer species (USFWS, 2014-2).

Habitat Type

Adult: Subtropical dry forest (USFWS, 2014-2)

Dependencies on Specific Environmental Elements

Adult: Limestone substrate

Environmental Specificity

Adult: High (Inferred from USFWS, 2014-2)

Tolerance Ranges/Thresholds

Adult: Low (Inferred from USFWS, 2014-2)

Site Fidelity

Adult: High (Inferred from USFWS, 2014-2)

Habitat Narrative

Adult: *Varronia rupicola* has been described from southwestern Puerto Rico, Vieques Island, and Anegada Island. All these sites lie within the subtropical dry forest life zone overlying a limestone substrate (Ewel and Whitmore 1973, p. 72). Subtropical dry forest life zones receive a mean annual rainfall ranging from 24 to 40 in (61 to 101 cm). The vegetation in this life zone is deciduous on most soils, with tree species dropping leaves during the dry season. The vegetation usually consists of a nearly continuous, single-layered canopy, with little ground cover. The leaves of dry forest species are succulent or coriaceous, and species with spines and thorns are common. Tree heights usually do not exceed 49 ft (15 m), and crowns are typically broad, spreading, and flattened (Ewel and Whitmore 1973, p. 72) (USFWS, 2014-2). High ecological integrity of the community, site fidelity and environmental specificity are inferred based on specific habitat needs and low number of populations, as is low tolerance range (USFWS, 2014-2).

Dispersal/Migration**Motility/Mobility**

Adult: Low (USFWS, 2014-2)

Dispersal

Adult: Low (USFWS, 2014-2)

Dependency on Other Individuals or Species for Dispersal

Adult: Yes/unknown seed disperser (possibly extinct) (USFWS, 2014-2)

Dispersal/Migration Narrative

Adult: Species is/was dispersed via an unknown animal that may now be extinct (USFWS, 2014-2)

Population Information and Trends**Population Trends:**

Not available

Population Narrative:

Varronia rupicola has a somewhat extended distribution in southern Puerto Rico. However, the species is represented by small and fragmented populations, and about half of them occur within private lands subject to urban development, making the species prone to destruction, modification, or curtailment of its habitat (Factor A). Moreover, other natural or manmade factors such as invasive species, human induced fires, hurricanes, and climate change (Factor E) also pose threats to V. rupicola. Implementation and enforcement of regulatory mechanisms to protect the species have not been effective, particularly because enforcement on private lands continues to be a challenge (Factor D). Therefore, it is very likely that cumulative effects of these threats (e.g., poorly implemented regulatory mechanisms and habitat destruction) result in limitation, or even local extirpation, of V. rupicola populations. (USFWS, 2014-2).

Threats and Stressors

Stressor: Habitat destruction (USFWS, 2014-2)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Degradation of habitat represents a threat to Varronia rupicola. About half of the known populations of V. rupicola and its suitable habitat are within privately owned land, which is being modified or is proposed to be modified for urban development. In addition, habitat fragmentation by clearing of vegetation, road constructions, and right-of-way maintenance (cutting plants and used of herbicides) can limit the species' survivability where these activities create the conditions for nonnative plants to outcompete V. rupicola. We expect that this threat would continue into the future (USFWS, 2014-2).

Stressor: Invasive species (USFWS, 2014)

Exposure:**Response:****Consequence:**

Narrative: Although invasive plant species have not been documented as a current threat to *Varronia rupicola*, they may become so in the future. Studies conducted within the Guanica Commonwealth Forest indicate that some nonnative tree species (e.g., *Leucaena leucocephala*) can persist as a dominant canopy species for at least 80 years (Wolfe 2009, p. 2). The same is expected to occur with nonnative grass species (e.g., *Megathyrsus maximus*) (USFWS, 2014).

Stressor: Human Induced Fires (USFWS, 2014)

Exposure:**Response:**

Consequence: Loss of habitat

Narrative: Human-induced fires may lead to destruction of the native vegetation seed bank and may create conditions favorable for the establishment of nonnative plant species adapted to fires (e.g., *Leucaena leucocephala* and *Megathyrsus maximus*) that may outcompete *Varronia rupicola* and *Agave eggersiana*. Furthermore, the presence of *M. maximus* and other grass species increases the amount of fuel and the intensity of fires that may affect endemic populations. Seedling mortality after fires is related to the differences on fuel loads and the different fire intensities (Santiago-García et al. 2008, p. 607). The *V. rupicola* populations that occur along the municipalities of Yauco, Pensuelas, and Ponce are susceptible to forest fires, particularly on private lands where fires are accidentally or deliberately ignited (USFWS, 2014).

Stressor: Hurricanes and Climate Change (USFWS, 2014)

Exposure:**Response:**

Consequence: Loss of habitat/Loss of individuals

Narrative: The reduced number and small size of *Varronia rupicola* and *Agave eggersiana* populations in Puerto Rico and St. Croix, respectively, make these species susceptible to hurricanes impacts (e.g., extirpation). In the case of *A. eggersiana*, the impacts may be exacerbated by the reproductive biology of the species (i.e., the species depends on asexual reproduction, plants dying after flowering, and limited dispersal of bulbils). Therefore, impacts to a population may compromise its natural recruitment. In addition, for *V. rupicola*, a severe hurricane could result in extensive defoliation and could cause stem damage. Populations of *Varronia rupicola* may be threatened by climate change, which is predicted to increase the frequency and strength of tropical storms and can cause severe droughts (Hopkinson et al. 2008, p. 260) (USFWS, 2014).

Recovery**Recovery Actions:**

- A Recovery Plan has not been developed for this species

References

U.S. Fish and Wildlife Service. 2014-2. Endangered and Threatened Wildlife and Plants

Endangered Status for *Agave eggersiana* and *Gonocalyx concolor*, and Threatened Status for *Varronia rupicola*. Final Rule. FR Vol. 79, No. 174 Pages 53303-53315

U.S. Fish and Wildlife Service. 2014. Endangered and Threatened Wildlife and Plants

Designation of Critical Habitat for *Agave eggersiana*, *Gonocalyx concolor*, and *Varronia rupicola*. FR Vol. 79, No. 174 pages 53315-53344.

U.S. Fish and Wildlife Service. 2014. Endangered and Threatened Wildlife and Plants

Designation of Critical Habitat for *Agave eggersiana*, *Gonocalyx concolor*, and *Varronia rupicola*. Final Rule. 79 FR 53315-53344 (September 9, 2014).

SPECIES ACCOUNT: *Verbena californica* (Red Hills vervain)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/14/1998; California/Nevada Region (R8) (USFWS, 2016)

Physical Description

A perennial herb, 3-7.5 dm tall, that produces spikes of blue to purple flowers. Blooms May-September. (NatureServe, 2015)

Taxonomy

Verbena californica is a narrowly distributed biennial or perennial herb belonging to the vervain family (Verbenaceae). *Verbena californica* was first discovered in 1938 in Tuolumne County, California (Moldenke 1942) (USFWS, 2008).

Current Range

Currently, the entire range of *Verbena californica* is presumed to be an area of about 77 square kilometers (30 square miles) or 12 kilometers (7.5 miles) by 6.4 kilometers (4 miles). Within this narrow range, the total area occupied by the populations is estimated to be 50 hectares (124 acres) (CNDDB 2011). *Verbena californica* grows at elevations between 255 and 400 meters (837 to 1,310 feet) (CNDDB 2011). Most of the sites are within the expanded Red Hills Area of Critical Environmental Concern (ACEC) that now consists of about 4,042 hectares (9,988 acres, about 15.6 square miles) of public land south of the historic town of Chinese Camp in Tuolumne County (BLM 2011) (USFWS, 2012).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Formerly, the species was thought to also reproduce vegetatively through rhizomes, but Knox (1998) found no evidence of rhizomes when she dug up plants. In nature, seed germination has been observed as early as mid-October and probably continues throughout the winter (Knox 1998). The progress of seedling maturation has not been reported. Plants mature and can begin flowering by late May, with flowering continuing through September (Stone 1992; Tibor 2001) (USFWS, 2012).

Reproduction Narrative

Adult: Knox (1998) determined that soil moisture was the primary factor influencing the distribution and reproduction of this species. Underground springs were responsible for maintaining summer water flow in the stream reaches she studied. Nine of the total 11 *V. californica* occurrences are along streams in *Pinus sabiniana* (foothill pine) woodlands (USFWS, 2008). Seeds apparently are the primary means of reproduction for *Verbena californica*. Formerly, the species was thought to also reproduce vegetatively through rhizomes, but Knox (1998) found no evidence of rhizomes when she dug up plants. In nature, seed germination has

been observed as early as mid-October and probably continues throughout the winter (Knox 1998). The progress of seedling maturation has not been reported. Plants mature and can begin flowering by late May, with flowering continuing through September (Stone 1992; Tibor 2001). Flowering begins at the bottom of the flower cluster and progresses upward through the season (Stone 1992). Dates of seed formation in nature have not been reported, although transplants grown in an outdoor garden had mature seeds present in July (Knox 1998). Considering that each flower can produce as many as four seeds, Knox (1998) estimated that potential seed production at her three study sites ranged from 282 to 1,245 seeds per plant. The lowest estimate was at an atypical site in a meadow with compacted soils and severe competition (Knox 1998). Seed dispersal mechanisms are not known for *V. californica* (USFWS, 2012). Availability of pollinating insects is important for reproduction. Pollination of *Verbena californica* has not been studied in great detail, but insects visiting the flowers, and possibly transferring pollen, include butterflies, flies, beetles (Stone 1992), and bees (Moldenke 1972). The most frequent visitors according to Stone (1992) were butterflies in the genus *Ochlodes* (woodland skippers; family Hesperidae). However, Moldenke (1972) reported only bees visiting the flowers of *V. californica* in 1970 and 1971, including two species of leafcutting bees (family Megachilidae), *Anthidium edwardsii* and *Chalcidoma angelarum*, and two cuckoo bees (family Anthophoridae), *Anthophora urbana* and *Melissodes lupina* (USFWS, 2012).

Habitat Type

Adult: Woodland/grassland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Serpentine substrates (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species occurs along intermittent and perennial streams with serpentine substrates. 260-400 m elevation. Cismontane woodland, valley and foothill grassland / mesic, usually serpentine seeps or creeks; elevation 260-400m (California Native Plant Society 2001) (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the species limited number of populations and the species specific habitat requirements.

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Seed dispersal mechanisms are not known for *V. californica* (USFWS, 2012).

Population Information and Trends

Population Trends:

Decreasing (USFWS, 2012)

Resiliency:

Low (inferred from USFWS, 2012)

Representation:

Low (inferred from USFWS, 2012)

Redundancy:

Low (inferred from USFWS, 2012)

Number of Populations:

6 - 20 (NatureServe, 2015)

Population Size:

2500 - 10,000 individuals (NatureServe, 2015)

Population Narrative:

The abundance of *Verbena californica* is much the same today as it was when it was listed and 15 sites are presumed extant (A. Franklin in litt. 2007; CNDDDB 2011). However, other sites may have been extirpated in the past without having been documented. We believe that current populations likely have been fragmented and reduced in size from those that existed historically (USFWS, 2012). Low resiliency, redundancy and representation are inferred based on this species specific habitat needs and low number of populations.

Threats and Stressors

Stressor: Recreational gold mining (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Placer gold mining, which includes panning and dredging along streams, is a potential threat to occurrences of *Verbena californica* on lands administered by the BLM (J. Willoughby, BLM, in litt. 1990; California Department of Fish and Game 1993; A. Franklin, in litt. 2007). In the course of gold panning, the plants themselves can be trampled or dislodged and soil can be compacted. Currently, the California Department of Fish and Game is prohibited by court order from issuing suction dredge permits. Panning of gold along streams is still allowed (USFWS, 2012).

Stressor: Adjacent development (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Hydrological changes remain a threat to the Andrew Creek occurrence. Although the *Verbena californica* population is no longer threatened directly by residential development, runoff from the proposed houses and golf course on the table land above the drainage may affect the riparian area. Lowering of the water table that feeds springs in the riparian area is also a concern (California Department of Fish and Game 2005). The direct threat from housing development has decreased since listing. The *Verbena californica* habitat that was formerly on private land within the Andrew Creek drainage became public land in 2000. The acquisition was a cooperative effort among the BLM, the Tuolumne County Land Trust, the Trust for Public Lands, the California Wildlife Conservation Board, the Packard Foundation, and the California Department of Transportation (A. Franklin, in litt. 2002). In 2004, the Tuolumne County Land Trust acquired part of the Big Creek population with funding from the California Department of Transportation (E. Cypher, California Department of Fish and Game, pers. comm. 2006, 2007) (USFWS, 2012).

Stressor: Grazing (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of individuals/degradation of habitat

Narrative: Currently, grazing on the BLM lands in the Red Hills occurs within two leases, one of which has *Verbena californica*. This lease is for 72 animal unit months over 1,178 acres within the Red Hills ACEC. Monitoring of *V. californica*, which began in 1998, uses a comparison of 2 grazed and 2 ungrazed (fenced) plots to evaluate grazing effects (BLM 2007b). No clear pattern of grazing effects has emerged from monitoring, i.e., it is not clear that the grazed or ungrazed plots are resulting in greater viability (BLM 2007b). However, grazing clearly does impact plants of *V. californica*. Clipped stems of *V. californica* have been observed both in the experimental plots and in other areas subjected to grazing. Trampling damage has been observed especially for the wet ground where *V. californica* occurs. Because the phenology of *V. californica* is relatively late, the grazing period was moved forward and now ends on April 15. We determined that the grazing program may adversely affect *V. californica*. No new grazing leases will be authorized in the Red Hills (BLM 2007b; Service 2007); however, the existing leases still remain (Peggy Cranston, Wildlife Biologist, Mother Lode Field Office, BLM, pers. comm. 2012) (USFWS, 2012).

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat/Loss of individuals

Narrative: The Endangered Species Act is the primary Federal law that provides protection for this species since its listing as threatened in 1998. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act. Therefore, we continue to believe other laws and regulations have limited ability to protect the species in absence of listing under the Endangered Species Act (USFWS, 2012).

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: The global average temperature has risen by approximately 0.6 degrees Celsius (1 degree Fahrenheit) during the 20th Century (IPCC 2001, 2007; Adger et al. 2007). There is an international scientific consensus that most of the warming observed has been caused by human activities (IPCC 2001, 2007; Adger et al. 2007), and that it is “very likely” that it is largely due to manmade emissions of carbon dioxide and other greenhouse gases (Adger et al. 2007). Ongoing climate change (Inkley et al. 2004; Kerr 2007; Adger et al. 2007; Kanter 2007) likely imperils *Verbena californica* and the resources necessary for its survival. Since climate change threatens to disrupt annual weather patterns, it may result in a loss of its habitat and/or increased numbers of its predators, parasites, and diseases. Where populations are isolated, a changing climate may result in local extinction, with range shifts precluded by lack of habitat, or in the case of plants the inability to disperse to newly suitable habitat at a rate equal to advance of newly unsuitable habitat caused by the change in environmental conditions (USFWS, 2012).

Stressor: Non-native plants (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat

Narrative:

Stressor: Small populations (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Small populations may also be subject to increased genetic drift and inbreeding (Menges 1991; Ellstrand and Elam 1993). Populations that are continually small in size are particularly susceptible to genetic changes due to drift. However, drift may also cause genetic changes with populations that occasionally fluctuate to small sizes (e.g., undergo population bottlenecks). Increased homozygosity (reduced genetic variation) resulting from genetic drift and inbreeding may lead to a loss of fitness (ability of individuals to survive and reproduce) in small populations. In addition, reduced genetic variation in small populations may make any species less able to successfully adapt to future environmental changes (Ellstrand and Elam 1993) (USFWS, 2012).

Stressor: Recreational activities (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: The Red Hills have mostly been used for recreation. Until 1991, the main recreational uses were target-shooting, off-road vehicle driving, camping, hunting, hiking, horseback riding, nature study, wildflower viewing, and hobby prospecting. In 1991, to protect the fragile biological resources of the area, target shooting and off-road vehicle use were prohibited on public land in the Red Hills (BLM 2009). Presently the main recreational activity in the Red Hills is equestrian use. Hiking, mountain biking and spring wildflower viewing are other popular activities (BLM 2007b). Overnight camping is no longer allowed within the Red Hills ACEC (BLM 2008) (USFWS, 2012).

Recovery

Recovery Actions:

- No recovery plan or outline has been completed for this species (USFWS, 2012).

Conservation Measures and Best Management Practices:

- Work with the BLM to revise the Red Hills ACEC management plan to include new data, new listings of species under the Endangered Species Act, newly acquired lands, and other lands added to the ACEC because of newly developed resource information (USFWS, 2012).
- Encourage the BLM to withdraw habitat from mining patents (USFWS, 2012).
- Establish reliable baseline data for monitoring plant occurrences. Monitor the status and trend of *Verbena californica* in order to track any threats, and to estimate current population sizes, the number and distribution of populations, and whether the species is stable, increasing, or declining (USFWS, 2012).

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SPECIES ACCOUNT: *Verbesina dissita* (Big-leaved crownbeard)

Species Taxonomic and Listing Information

Listing Status: Threatened; Pacific Southwest Region (R8)

Physical Description

A subshrub, generally 0.5-1 m tall, with distinctive bright green, rough-textured leaves. Yellow to yellow-orange flower heads bloom April-July (March-July in the Mexican populations). (NatureServe, 2015)

Taxonomy

Verbesina dissita is a member of the sunflower family (Asteraceae) (USFWS, 1996).

Historical Range

See current range/distribution.

Current Range

Verbesina dissita is found on rugged hillsides in dense maritime chaparral from Laguna Beach in Orange County south to the San Telmo area east of Cabo Colonet in Baja California, Mexico. In California it is known from two population centers less than 3.2 km (2 mi) apart (USFWS, 1996).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Knowledge of *Verbesina dissita* reproductive biology is limited to observations of rhizomatous spreading, whereby multiple shoots are sent up from underground stems that represent a single genetic individual (genet) but have the appearance of multiple plants. The individual aerial stems are termed ramets. This growth mechanism makes it difficult to determine the abundance of *V. dissita* as it is challenging to observe where a genet begins and ends spatially (USFWS, 2010).

Habitat Type

Adult: Coastal hillsides/Maritime chaparral (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (inferred from NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits rugged coastal hillsides and canyons in dense southern maritime chaparral communities. Also known from coastal sage scrub and mixed chaparral communities. < 100 m elevation (NatureServe, 2015). Clumped spatial arrangement and narrow environmental specificity as well as High ecological integrity of the community and site fidelity (and low tolerance range) are all inferred based on the species specific habitat requirements, low number of known populations and low number of known individual plants.

Dispersal/Migration**Dispersal**

Adult: Moderate (USFWS, 2010)

Dependency on Other Individuals or Species for Dispersal

Adult: Animals/Birds?

Dispersal/Migration Narrative

Adult: Since listing, additional research was conducted on *Verbesina dissita* to investigate seed viability, germination, and propagation of seeds and vegetative matter. In 2003, Michael Wall (Seed Program Coordinator, Rancho Santa Ana Botanical Garden (RSABG)) performed laboratory tests of seed viability following storage in uncontrolled conditions (room temperature) that resulted in moldy seeds with very low germination rates. Fruits collected in 2003 were stored frozen and tested for their ability to germinate in 2005, 2007, and 2008. Germination success was high with vigorous root and cotyledon (seed leaves) development. More recent analysis of the winged fruits has revealed a strong dispersal potential; fruits are now thought to be dispersed up to 200 m (656 ft) from the plant (Wall, pers. comm. 2010). The fruits have two distinct prongs, known as awns, which may aid in dispersal through attachment to animals. Dispersal by water is unclear, although it appears seeds may be buoyant for an extended amount of time before they become saturated with water (Wall, pers. comm. 2010). Plants found on the Todos Santos Islands off Baja California, Mexico (Junak and Philbrick 1994, p. 417) may have traveled to the islands by long-distance dispersal by birds. Sexual reproduction, pollination requirements, longevity of adults, and genetics continue to be poorly understood (USFWS, 2010).

Population Information and Trends**Population Trends:**

Decreasing (USFWS, 2010)

Resiliency:

Low (inferred from USFWS, 2010)

Representation:

Low (inferred from USFWS, 2010)

Redundancy:

Low (inferred from USFWS, 2010)

Number of Populations:

Two (USFWS, 2010)

Population Narrative:

In the United States, it is restricted to the Laguna Beach area of Orange County, California, though the greater portion of its historical range is in Baja California, Mexico. In Laguna Beach, it is known from two occurrences less than 0.8 kilometers (km) (0.5 mile (mi)) apart. The decline of *V. dissita* may have slowed after becoming federally listed; however, local policies guiding fire prevention and development on private land continue to reflect inadequate protection for this plant species (USFWS, 2010). Low resiliency, redundancy and representation are inferred based on the low number of populations and the restricted habitat of this species.

Threats and Stressors

Stressor: Residential development and urbanization (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Residential development and urbanization were considered the most immediate threats to plants and habitat of *Verbesina dissita* in the United States when the species was listed in 1996. Prior to Federal listing, but following state listing in 1990, at least four residences were built directly on habitat occupied by *V. dissita* in the vicinity of Nyes Place on Temple Hill (USFWS 1996, p. 52378). The location of most development appears to have been along the perimeter of the *V. dissita* range, but development has fragmented and interrupted the continuity of habitat. Such fragmentation has primarily occurred through the development of small scattered (0.2 ha (0.5 ac)) undeveloped lots within neighborhoods (Roberts 1989, p. 1). Much of this habitat loss and fragmentation has occurred in areas that were previously believed to be protected from development due to steepness of terrain. Since listing, development does not appear to be an imminent threat to either *Verbesina dissita* occurrence (EO 1 or EO 3) and we do not anticipate additional large scale habitat loss from this potential threat because it appears that the steep slopes where *V. dissita* occurs have been developed to their full potential. However, *V. dissita* occurs almost entirely on private land, so we cannot be certain that development will not continue to curtail habitat, even due to the steepness of the terrain where it occurs. Future habitat loss from development is less of a threat to EO 3 since most of this area occurs within the Reserve. Although *V. dissita* is not a covered species under the Central/Coastal NCCP/HCP, it has potential to benefit from the conservation mandate under this plan that requires that impacts to sensitive and covered species be minimized from infrastructure and recreation facilities that are permitted within the Reserve area (USFWS, 2010).

Stressor: Fuel modification (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Fuel modification prescribes various levels of removal of vegetation from a site to reduce the likelihood of the area supporting a fire. At the time of listing, creation of fuel modification zones required by local ordinances was identified as a threat to *Verbesina dissita* plants and habitat (USFWS 1996, p. 52378). The City of Laguna Beach required the creation of a fuel modification zone up to 46 m (150 ft) from residences (R. Drewberry, Laguna Beach Fire Department, pers. comm. 1991). At that time, over 20 percent of known *V. dissita* plants were within the fuel modification zone. Compliance with these ordinances caused a significant loss of *V. dissita* and its habitat. Loss of habitat due to fuel modification primarily affected EO 1. Methods for fuel modification included thinning vegetation with goats or hand tools, fire breaks, disking, and mowing (USFWS, 2010).

Stressor: Altered fire regimes (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Habitat for *Verbesina dissita* is also threatened by altered fire regimes. A large fire has the potential to cause a type-conversion from the shrub habitat of chaparral and coastal scrub to grassland (Zouhar et al. 2008, p. 185). In the southwest bioregion, increased invasion rates by nonnative species and alteration of fire regimes by humans have occurred concurrently in such a way that has resulted in the type-conversion of native-dominated chaparral and coastal scrub into grasslands dominated by nonnative species (Keeley 2001; Zouhar et al. 2008, p. 185). The particular process for type-conversion of shrublands into grasslands is known as the grass/fire cycle and has been documented in many ecosystems worldwide (Zouhar et al. 2008, p. 185). As described under Habitat or Ecosystem, *V. dissita* is not known to occur in grassland habitats. In contrast, control of fire through modification of habitat in an urban interface area may inhibit a fire-adapted species over time. The last large fire event in the relatively contiguous habitat of Laguna Beach occurred in 1993; however, there is no evidence that *Verbesina dissita* plants were burned. Should a large catastrophic wildfire occur in this region again, it has the potential to burn through all remaining populations of *V. dissita* simply due to this species' narrow distribution. If that were to occur, it is unlikely that this species would become extirpated as a result of fire alone. This is due to its evolved association with this natural event, which has possibly resulted in its ability to reproduce from rhizomes that persist underground for extended lengths of time. The fuel modification zone around the urban interface area of the City of Laguna Beach has allowed for settlement of invasive, nonnative grasses, providing a source for these species to establish themselves across a newly burned landscape. However, some invasive grasses will invade burned or unburned areas (Zouhar et al. 2008, p. 185). Impacts associated with nonnative plants will be discussed further under Factor E (USFWS, 2010).

Stressor: Agriculture (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Impacts from agriculture were cited as a threat to Mexican populations in the listing rule, and while this likely continues to be true, we have no quantified information on the extent of its severity. Agricultural practices are not a threat to *Verbesina dissita* in the United States (USFWS, 2010).

Stressor: Predation (USFWS, 2010)

Exposure:**Response:****Consequence:** Loss of individuals

Narrative: Predation of *V. dissita* plants is a current threat associated with fuel modification activities because goat grazing is utilized to thin or remove vegetation along the steep urban wildland interface in Laguna Beach. Goats have potential to kill *V. dissita* by directly consuming plants and their reproductive structures, and from goats stripping bark from stems once more palatable vegetation has been consumed. The City of Laguna Beach's goat grazing program is implemented on an annual basis by the LBFD which hires goat herders to manage herds on a rotating basis throughout various areas along the urban-wildland interface. This program involves goat herders confining their goats to targeted areas where goats browse until a desired level of vegetation thinning is achieved, then moving the goats to another fuel modification zone (USFWS, 2010).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2010)

Exposure:**Response:****Consequence:** Loss of habitat

Narrative: At the time of listing, regulatory mechanisms considered to potentially provide some protection for *Verbesina dissita* included: (1) the Native Plant Protection Act (NPPA); (2) the California Endangered Species Act (CESA); (3) the California Environmental Quality Act (CEQA); (4) implementation of conservation plans pursuant to the Natural Community Conservation Planning (NCCP) Act; (5) the Act in cases where *V. dissita* occurs in habitat occupied by a listed species; and (6) land acquisition and management by Federal, State, local agencies, or by private groups and organizations (USFWS 1996, p. 52379–52381). The following discussion describes State and Federal regulatory mechanisms that currently may offer some level of protection to *Verbesina dissita* and its habitat. These mechanisms have remained largely unchanged since listing (USFWS, 2010). Federal Protections National Environmental Policy Act (NEPA) NEPA (42 U.S.C. 4371 et seq.) provides some protection for listed species that may be affected by activities undertaken, authorized, or funded by Federal agencies. Prior to implementation of such projects with a Federal nexus, NEPA requires the agency to analyze the project for potential impacts to the human environment, including natural resources. In cases where that analysis reveals significant environmental effects, the Federal agency must propose mitigations that could offset those effects (40 C.F.R. 1502.16). These mitigations usually provide some protection for listed species. However, NEPA does not require that adverse impacts be fully mitigated, only that impacts be assessed and the analysis disclosed to the public. Therefore, this regulatory mechanism may not be adequate to fully protect species (USFWS, 2010).

Stressor: Drought and climate change (USFWS, 2010)

Exposure:**Response:****Consequence:** Loss of habitat

Narrative: Although drought was not identified as a threat in the listing rule, it is likely that cyclical drought reduces local populations over the long term. Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, p. 1; Cayan et al. 2005, pp. 1, 7–8; IPCC 2007, pp. 8–9). However, predictions of climatic conditions for smaller subregions such as California remain uncertain. It is unknown at this time if climate change in

California will result in a warmer trend with localized drying, higher precipitation events, or other effects. One study has predicted that 5 to 10 percent of California's native plant species would no longer find suitable habitat within the state, and thus be vulnerable to extinction, if average temperatures warmed 3° Celsius (5 to 6° Fahrenheit) (Morse et al. 1995, p. 393). Whether or not this would include *Verbesina dissita* is unknown (USFWS, 2010).

Stressor: Small population size (USFWS, 2010)

Exposure:

Response:

Consequence: Lack of genetic diversity

Narrative: The conservation biology literature commonly notes the vulnerability of species known from one or very few locations, or from small populations (e.g., Shaffer 1981, 1987; Primack 2006; Dunning et al. 2006). In particular, small population size and the likely low levels of genetic interchange among them make small populations potentially vulnerable to inbreeding depression and loss of genetic variability due to random fixation (e.g., genetic drift). Low genetic variation may influence the ability of populations to adjust to novel or fluctuating environments, survive stochastic events, or to maintain high levels of reproductive performance (Huenneke 1991). Small, fragmented populations may be visited by fewer pollinators and thus have reduced pollination and seed set, merely because the small number of available flowers attracts fewer pollinators (i.e., "Allee effect"; Groom 1998, pp. 487–496; Lennartsson 2002, p. 3068). In the United States, *Verbesina dissita* is known from only two occurrences within 0.8 km (0.5 mi) of each other, occupying an area of approximately 12 ha (30 ac). The western occurrence (EO 1) is divided by major barriers to distribution between the north and south, making genetic interchange across this boundary unlikely to occur in the future. Risks posed by a small population size may be more significant for *V. dissita* than currently understood due to the misleading appearance of the species, which has aerial stems that can appear to be multiple genets aboveground while actually representing several genetically identical stems supported by connected underground rhizomes. This may provide an inflated representation of the number of genetic individuals representing the population size. Additionally, interconnected groups of aerial stems may become separated if intervening rhizomes deteriorate. Therefore, the threats from small population size may be more significant if occurrences are actually composed of only a few genetically distinct types. Research on clonal diversity and breeding system for *V. dissita* should address this concern (USFWS, 2010).

Stressor: Transplantation (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of individuals/Loss of populations

Narrative: Small populations can be especially vulnerable to negative effects from transplantation efforts that are otherwise meant to benefit the species. Seeds and vegetative material of *Verbesina dissita* have been collected and propagated for mitigation measures when *V. dissita* plants were removed from EO 1 (Osborne, pers. comm. 2010; L. Robb, pers. comm. 2010). Preserving plants and genotypes is a positive step for the conservation of *V. dissita*; however, there may be a number of potentially negative impacts. These impacts include mixing genotypes, risking long term survivability of genotypes, damaging plants during the translocation process, and increasing the frequency of outcrossing if *V. dissita* is normally an inbreeder. Alternately, if *V. dissita* is an outbreeder, mixing genotypes could be beneficial. "Weedy" individuals of a species may be more generalist in their habitat requirements and thus may

survive the translocation process. These individuals may have higher survivability but lower genetic diversity, which means that translocation may effectively decrease the gene pool for the species. Lowered optimization of transplantation can result from a number of factors including lack of knowledge about habitat requirements, lack of appropriate preparation or funding, poorly timed or hasty transplanting, poor choice of transplantation site, lack of maintenance throughout the establishment period, and lack of monitoring (Hall 1987, p. 418). Data from a review of 15 transplantation projects for other rare plant species in Southern California indicate that maintenance and monitoring are the most frequently neglected variables contributing to the failure of transplantation projects (Hall 1987, p. 418). Mitigation sites that are not adequately monitored or maintained may put the displaced genetic source at risk of die-off in the long term. Conversely, mitigation sites that are over-maintained may misrepresent the success of transplantation, while also putting the genetic source at risk of die-off when the maintenance period is complete. Multiple genets of *Verbesina dissita* may be replaced by successfully transplanted genets with a smaller representative gene pool. This threat highlights the need for genetic research on *V. dissita* including identification of the extent and location of genetic variability and clonality within the small populations in the United States and between the United States and Mexico (USFWS, 2010).

Stressor: Stochastic events (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of populations/Extirpation

Narrative: The limited number of populations in a restricted geographic range, in addition to the small size of some of the remaining populations, makes *Verbesina dissita* susceptible to random catastrophic events, the most likely of which is fire. Fire has important evolutionary and ecological influences on chaparral and coastal scrub vegetation (Axelrod 1989; Rundel and Vankat 1989). Woody chaparral species often exhibit adaptations that enhance their ability to both survive fire and reproduce in postfire landscapes (Schwilk 2003; Zedler and Zammit 1989). These include resprouting from persisting root crowns, seeds that germinate after fire or have a fire-resistant seed coat, and heavy postfire seed production (Keeley 1987; Keeley and Fotheringham 1998; Keeley and Keeley 1981; Keeley and Zedler 1978). Herbaceous species that occur in chaparral communities may also have dormant, fire resistant seeds in a persistent seed bank that germinate after burning (Keeley and Fotheringham 1998). The only adaptation to fire evidenced by *V. dissita* is the presence of rhizomes noted above. We are not aware of any fruit/seed adaptations to fire or the presence of a seed bank for the species. The latter seems unlikely in light of the observations by Michael Wall as discussed above under the "Species Biology and Life History" section of this review, because plants require regeneration periods between fires. In summary, the primary threat associated with a catastrophic fire is unlikely to be extirpation due to incineration. Rather, the foreseeable threat appears to be type-conversion and displacement of *Verbesina dissita* and other native plants by nonnative plants (USFWS, 2010).

Stressor: Competition with nonnative plants (USFWS, 2010)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: At the time of listing, the establishment of nonnative plants used in landscaping (such as *Atriplex semibaccata* (Australian saltbush)) was noted as a current and future threat to the species *Verbesina dissita* directly competes for space and shade with landscaping materials such

as *A. semibaccata*, *Nicotiana glauca* (Tree tobacco), various *Acacia* spp., and other nonnative plants. This threat is best documented along the northernmost portion of EO 1 at urban interface areas where development and fuel modification have aided in the spread of nonnative plants since *V. dissita* was listed. The expansion of landscape plantings (such as *Acacia* spp.) from nearby residential areas is also a threat to EO 3. The LBFD Landscape/Fuel Modification Guidelines and Maintenance Program (Fuel Modification Guidelines) (LBFD 2010) require that any new plantings within the designated fuel modification zones be “replanted” using appropriate plants not listed on the Undesirable Plant Species List of the City of Laguna Beach (Schwartz 2010, p. 2), which includes all of the nonnative species listed above in addition to 57 other taxa (USFWS, 2010).

Recovery

Delisting Criteria:

While threats to *Verbesina dissita* have increased since listing, so too has the recognition that much suitable habitat remains unsurveyed and is potentially occupied in the United States. Additionally, more data is needed to assess impacts from new threats. Therefore, we recommend that this species remain listed as threatened and that comprehensive survey efforts be undertaken in the next 5 years to better understand the population size and distribution of *V. dissita* (USFWS, 2010).

Conservation Measures and Best Management Practices:

- 1) Work with partners and programs (such as the Partners for Fish and Wildlife Program) to organize surveys of the historical occurrences, extant occurrences, and likely suitable habitat, especially in isolated steep canyon areas during the flowering season, to detect presence and distribution of plants (USFWS, 2010).
- 2) Work with the LBFD to identify the distribution of *Verbesina dissita* in fuel hazard reduction zones and identify ways to minimize fuel modification impacts by identifying alternatives to thinning or clearing of habitat and introduction of nonnatives (USFWS, 2010).
- 3) Perform a clonal structure analysis from multiple sources across the range of the species, including Mexico. If large clumps are found to be single genetic individuals, conservation measures may need to be more aggressive to address the threats of a smaller population size. Patterns in genetic variability should be studied to understand the breeding system of *Verbesina dissita* and to address potential threats compounded by a small population size (USFWS, 2010).
- 4) Prepare site specific and species monitoring protocols to determine fine-scale habitat requirements and species fidelity to those requirements. This will allow us to discriminate between lack of seed dispersal and unsuitable habitat as explanations for discontinuities in plant distributions (USFWS, 2010).
- 5) Write a recovery plan with action items for *Verbesina dissita* and other rare associates that includes a restoration program to restore habitat required for healthy stands of *V. dissita* (USFWS, 2010).

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SPECIES ACCOUNT: *Vernonia proctorii* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 04/27/1993; Southeast Region (R4)

Physical Description

Vernonia proctorii is a small, erect shrub which may reach a height of 1.5 meters. The stems and trunk are densely pubescent with silvery uniseriate hairs and with a knobby appearance due to the persistent petiole bases. Leaves are alternate, ovate to orbicular, subsessile or with the petioles appressed to the stem, and from 1.5 to 3.5 centimeters long and 1.0 to 2.6 centimeters wide. The upper blade surface is green to olive-green and moderately strigose with scattered glistening globular trichomes. The lower surface is grayish-green, sometimes becoming rusty with age, and densely sericeous. The leaf margins are densely ciliate with silvery hairs. Flowers are borne in terminal clusters of 2 to 5 heads, each approximately 3 millimeters in length, and bright purple in color. Achenes are from 2 to 3 millimeters long and sericeous with silvery hairs (USFWS, 1994).

Taxonomy

Vernonia proctorii, of the family Asteraceae, was discovered in September of 1987 by Dr. George Proctor, Dr. Horst Haneke, and Paul McKenzie and later described by Urbatsch (1989). The family Asteraceae is the largest dicot family, consisting of more than 1,100 genera and more than 25,000 species. The family consists of the some thirteen tribes, of which the tribe Vernoniaeae includes about 1,456 species in 70 genera. More than half of the genera are monotypic, and two-thirds of the species belong to the genus *Vernonia*. *V. proctorii* is described as being closely related to *V. albicaulis* (ranging from Puerto Rico into the Lesser Antilles), *V. arbuscula* (of the Bahamas) and *V. orbicularis* (of Cuba) (Breckon and Kolterman 1994b). *V. proctorii* is currently known to occur only on the summit area of Cerro Mariquita in the range of hills known as the Sierra Bermeja (USFWS, 1994). Dr Harold Robinson, from the Department of Botany of National Museum of Natural History, Smithsonian Institute, conducted a comprehensive study about the American Vernoniaeae and concluded that none of the elements called *Vernonia* in the Eastern Hemisphere belong to the genera *Vernonia*, and they must all be transferred to other genera (Robinson 1999). The author used the pollen, style bases, raphids, inflorescence from involucre, anther appendage, and chemistry as some characters for the reclassification. Robinson changed 114 species from the genus *Vernonia* to the genus *Lepidaploa*, including *Vernonia proctorii* which the author called *Lepidaploa proctorii* (Robinson 1999). However, the Integrated Taxonomic Information System (ITIS) and the Germplasm Resources Information Network (GRIN) of USDA continue using *Vernonia proctorii* as the taxon and *Lepidaploa proctorii* as the synonymy. (USFWS, 2019).

Historical Range

Both *Vernonia proctorii* and *Lyonia truncata* var. *proctorii* are known only from the summit area of Cerro Mariquita in the Sierra Bermeja, municipality of Cabo Rojo. Elevations range from 270 to 300 meters. Proctor (1991) estimated the population of *Vernonia proctorii* at about 950 individuals in an area of several acres. The population of *Lyonia truncata* var. *proctorii* was estimated at 63 plants (Proctor 1991); however, because the species is found on extremely steep slopes this may be underestimated by as much as 50 percent (Breckon and Kolterman 1994a) (USFWS, 1994).

Current Range

At the time of listing, *A. portoricensis* was known from only two localities: at Cerro Mariquita in Sierra Bermeja and at Cerro Las Mesas in Mayagüez, both localities are in Puerto Rico. According to DNER herbarium voucher SJ014582, the plant was found and collected by E. L. Ekman in Pinar del Rio in Cuba Island (Ekman 1920, unpublished data). We were not aware of this locality at the time of listing and the information is considered as new information for the purpose of this review. Based on this information, *A. portoricensis* is not endemic to Puerto Rico and its current range of the species includes to Puerto Rico and Cuba (USFWS, 2007).

Critical Habitat Designated

Yes;

Life History**Food/Nutrient Resources****Breeding Season**

Adult: *Vernonia proctorii* has been observed in flower and fruit during the months of April and May of 1994 (Breckon and Kolterman 1994b), although a previous author (Urbatsch 1989) stated that the species flowered and produced fruit during the rainy period, from August through December (USFWS, 1994).

Reproduction Narrative

Adult: During field studies, *Vernonia proctorii* has been observed in flower and fruit during the months of April and May of 1994 (Breckon and Kolterman 1994b), although a previous author (Urbatsch 1989) stated that the species flowered and produced fruit during the rainy period, from August through December. Plants found on the steeper slopes ranged in height from 89 to 152 centimeters and in crown area from 0.29 to 1.27 square meters. Plants on the steep slopes were domed or vase-shaped and they were larger, healthier and more robust than those on the summit (Breckon and Kolterman 1994b) (USFWS, 1994).

Habitat Type

Adult: Subtropical dry forest (USFWS, 1994)

Habitat Vegetation or Surface Water Classification

Adult: The vegetation in this zone forms a complete ground cover and is deciduous on most soils (USFWS, 1994).

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1994)

Site Fidelity

Adult: High (inferred from USFWS, 1994; USFWS, 2007)

Habitat Narrative

Adult: Both areas where these three species are located are found within the subtropical dry forest life zone (Ewel and Whitmore 1973), the driest life zone in Puerto Rico. The vegetation in

this zone forms a complete ground cover and is deciduous on most soils. Leaves are succulent or coriaceous, and species with spines and thorns are common. Tree heights usually do not exceed 15 meters and the crowns are typically broad, spreading, and flattened. Fire is common on many soils, and occurs frequently on lands where the plants are located. Successional, vegetation includes grasses and the accumulated organic debris serves as fuel for the frequent dry season fires (USFWS, 1994). In the Sierra Bermeja all three species grow in exposed rock crevices and are found associated with *Aristida portoricensis* (pelos de diablo, another endangered grass species), *Digitaria eggersii*, *Comocladia dodonea* (carrasco), *Plumeria alba* (alheli), *Bursera simaruba* (almcigo), *Bucida buceras* (iicar), *Randia aculeata* (tintillo), *Croton* sp., and *Jacquinia berterii* (G. Proctor, pers. comm.). The endangered bird the Puerto Rican nightjar (*Caprimulgus noctitherus*) has recently been reported from the slopes of the Sierra Bermeja (USFWS, 1994). High ecological integrity and site fidelity and low tolerance range is inferred based on species restricted habitat and two populations (USFWS, 1994; USFWS, 2007)

Dispersal/Migration**Motility/Mobility**

Adult: Low (USFWS, 2007)

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Low (inferred from USFWS, 2007)

Representation:

Low (inferred from USFWS, 2007)

Redundancy:

Low (inferred from USFWS, 2007)

Number of Populations:

Two (USFWS, 2007)

Population Size:

~80 (USFWS, 2007). Proctor (1991c) estimated the *Vernonia proctorii* abundance in Cerro Mariquita at around 950 individuals. On January 26, 2008, a Service biologist estimated its population at 150 individuals on an area of 10 acres. The population of *Vernonia proctorii* is currently estimated at 986 individuals. During this review (2019 5-Year Review), we found no consistency and accuracy on any of these species' population estimates. (USFWS, 2019).

Population Narrative:

This species is known from two populations of approximately 75 and 7 individuals (USFWS, 2007). Low resiliency, representation and redundancy are inferred based on low number of populations and individuals.

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2007)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: When the plants *A. chaseae*, *Lyonia truncata* var *proctorii* and *Vernonia proctorii* were listed in 1993, the Service identified habitat destruction and modification as one of the factors affecting the continued existence of the species. At that time, these three species were found in Sierra Bermeja, a privately owned site subjected to agricultural, rural and tourist development. In addition, the final rule for pelos del diablo also identified proposed copper and gold mining as a threat to the species in Cerro Las Mesas. In 1996, DOI acquired La Tinaja Farm (LTF) in the Sierra Bermeja mountain range. The Service incorporated this land to the Cartagena Lagoon National Wildlife Refuge, protecting 50% of the known populations of *Lyonia truncata* var *proctorii*, approximately 80% of the known individuals of *Vernonia proctorii*, and its suitable habitat, and about 50% of the populations of *A. chaseae* and pelos del diablo. However, the remaining individuals of these species in Sierra Bermeja are located in the adjacent Cerro Mariquita area, which remains under private ownership. Although the Cerro Mariquita area was classified by the Puerto Rico Planning Board as a District of Conservation Resource 1 (CR1) (the most restrictive for development, precluding tourist and residential development and mining activities), this classification allows agricultural (e.g. cattle grazing) and rural developments (one house in 25 acres of land). In 2006 and 2007, private landowners cut new roads to gain access through their properties to the peak of Cerro Mariquita affecting indeterminate amount of habitat for these species (Pacheco, USFWS 2009, field observations). Therefore, the threat of habitat destruction and modification still exist for *A. chaseae*, pelos del Diablo, *Lyonia truncata* var *proctorii* and *Vernonia proctorii*. Based on the above discussion, we believe that these four species are currently threatened by Factor A and the imminence or degree of the threat should be considered as moderate (USFWS, 2007).

Stressor: Competition (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: The rapid growth of exotic grasses on areas where these species occur is a threat because of competition and represent an increase in fuel that may increase the impact of fire (USFWS, 2007).

Stressor: Natural catastrophic events (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: One of the most important factors affecting the continue survival of the species *Lyonia truncata* var *proctorii* and *Vernonia proctorii*, is their limited distribution. *Lyonia truncata* var *proctorii* is only found in a limited area on the edge of a precipice of the upper Jurassic chert in Cerro Mariquita. *Vernonia proctorii* is found on the steeper slopes of Cerro Mariquita. Any seismic event in this area and heavy rain that result in a landslide may affect a significant portion of the population. In September 2009, the Service observed three landslides at the Cerro

Mariquita due to the heavy rain. Fortunately, no individuals of these species were affected (USFWS, 2007).

Recovery

Reclassification Criteria:

These three species could be considered for downlisting when (1) the known populations on privately owned land in the Sierra Bermeja are placed under protective status, and (USFWS, 1994) Criterion 1 for *A. chaseae*, *Lyonia truncata* var *proctorii* and *Vernonia proctorii*, and the first criterion for *pelos del diablo* has been partially met. At the time the plans were approved, LTF and Cerro Mariquita were privately-owned and under grazing activities. *A. chaseae*, *pelos del diablo*, *Lyonia truncata* var *proctorii* and *Vernonia proctorii* were known to occur at these hills in Sierra Bermeja. The U.S. Department of Interior acquired LTF in 1996 and it is managed by the USFWS as part of the LCNWR for conservation of fish and wildlife resources. Currently, the known population of *Lyonia truncata* var *proctorii*, approximately 80% of the known individuals of *Vernonia proctorii*, and approximately half of the individuals of *A. chaseae* and *pelos del diablo* are located within LTF and thus protected. However, remaining individuals of *A. chaseae*, *pelos del diablo* and *Vernonia proctorii* in Sierra Bermeja occur in Cerro Mariquita which continue to be in privately-owned land under cattle grazing activities. For these reasons, we consider this criterion partially met (USFWS, 2007). Criterion 2 for *A. chaseae*, *Lyonia truncata* var *proctorii* and *Vernonia proctorii*, and has not been met. No studies have been conducted about number of self-sustained populations needed to establish a self-perpetuation of any of these species. Although several experiments to propagate the species were conducted, a propagation program for these species has not been established (USFWS, 2007).

(2) new populations (the number of which should be determined following the appropriate studies) capable of self perpetuation have been established within protected areas such as the Cabo Rojo National Wildlife Refuge (USFWS, 1994).

Delisting Criteria:

None listed

Recovery Actions:

- Protection of currently known natural populations occurring on privately owned lands by establishing long-term conservation mechanisms such as Habitat Conservation Plans (HCP), conservation easements and conservation agreements with the landowners. (USFWS, 2019).
- Develop conservation and management plans with landowners that includes education on species description and needs and fire management. (USFWS, 2019)
- Establishment of new populations on protected lands within the Sierra Bermeja or other suitable habitats in southwestern Puerto Rico. (USFWS, 2019).

Conservation Measures and Best Management Practices:

- Revise the recovery plans to include new information on the species and the development of measurable criteria for delisting the species (USFWS, 2007).
- Conduct comprehensive surveys of these four species at Sierra Bermeja to determine relative abundance and distribution (USFWS, 2007).

- Conduct surveys at Cerro Las Mesas to determine if pelos del diablo is still present at this area (USFWS, 2007).
- Conduct surveys at Punta Melones and Peñones de Melones to determine the status of *A. chaseae* at these areas (USFWS, 2007).
- Promote Conservation agreements with private landowners to protect and enhance existing populations (USFWS, 2007).
- Initiate propagation programs for these species to enhance existing populations in the Sierra Bermeja mountain range and establish new populations of *A. chaseae* and pelos del diablo in protected areas in southwestern Puerto Rico (USFWS, 2007).
- Work closely with private landowners in the Sierra Bermeja mountain range and Peñones de Melones to protect individuals on private lands from existing agricultural practices and control exotic grasses (USFWS, 2007).
- Implement fire prevention practices in Sierra Bermeja, CNRWR and Peñones de Melones during dry season (USFWS, 2007).
- Continue to provide technical assistance to Service's Refuge Division for the development of the CCPs for CRNWR and LCNWR and to address current threats within the refuge (USFWS, 2007).
- Conduct comprehensive studies on habitat requirements, phenology, and recruitment success of the species in the wild (USFWS, 2007).
- Determine the number of self-sustainable populations needed to delist the species (USFWS, 2007).
- Additional surveys should be conducted for the four species in Puerto Rico (USFWS, 2007).
- Continue protecting existing populations and their habitat (USFWS, 2007).
- Work closely with International Affairs to obtain information from pelos del diablo on the Island of Cuba (USFWS, 2007).

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5-Year Review: Summary and Evaluation U.S. Fish and Wildlife Service Southeast Region Caribbean Ecological Services Field Office Boquerón, Puerto Rico.

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5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Southeast Region, Caribbean Ecological Services Field Office, Boquerón, Puerto Rico.

SPECIES ACCOUNT: *Vicia menziesii* (Hawaiian vetch)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/27/1978; Pacific Region (R1) (USFWS, 2016)

Physical Description

A perennial vine with 1.5 - 20 m-long stems. Flowers are yellowish-white when young, turning rose-purple with age (NatureServe, 2015).

Taxonomy

The genus *Vicia* is in the legume family (Fabaceae or Leguminosae) and comprises some 160 species, occurring mostly in the north temperate zones (Mabberley 2008) (USFWS, 2012). The genus is worldwide, this species is endemic to Hawaii island. This species is believed to be closely related to a n. American & s. American species. This species was Hawaii's first federally listed endangered plant (1978) (NatureServe, 2015)

Historical Range

Recorded from the island of Hawaii on the volcanoes of Mauna Kea, Mauna Loa, and Hualala (NatureServe, 2015).

Current Range

During the past 150 years it had been known only from the northeastern slope of Mauna Kea (Warshauer and Jacobi 1982) (USFWS, 2012).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: self-pollination, cross-pollination (USFWS, 2012)

Lifespan

Adult: < 10 years (inferred from USFWS, 2012)

Breeding Season

Adult: April - August (USFWS, 2012)

Key Resources Needed for Breeding

Adult: Honeycreepers (USFWS, 2012)

Reproduction Narrative

Adult: It is a short-lived perennial. At the Puu Waawaa site, this species has been observed to flower from April to August (Ralph et al. 1980; Giffin 2009). Mature pods have formed by July and may last into October or beyond (Ralph et al. 1980). Of the individuals studied by Ralph et

al. (1980), 23 percent of the flowers set fruit. The species can flower prolifically but does not flower until 2 or 3 years old (Ralph et al. 1980). The honeycreepers iiwi (*Vestiaria coccinea*) and amakihi (*Loxops virens*) have been observed feeding at *Vicia menziesii*, and given their downcurved bills, may pollinate the species (Lassetter and Gunn 1979; Ralph et al. 1980). Hopper reported that most (approximately 60 percent) papilionaceous legumes that were studied are self-compatible to some degree (USFWS, 2012).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Mesic ohia-koa forest, montane koa-Myrsine forest (USFWS, 2012)

Geographic or Habitat Restraints or Barriers

Adult: 5,150 - 5,640 ft. elevation (USFWS, 2012)

Habitat Narrative

Adult: Inhabits moist montane forests on old volcanic substrates (NatureServe, 2015). The species occurs in wet to mesic forests of *Metrosideros polymorpha* (ohia)-*Acacia koa* (koa) in the Keauhou-Kilauea area, and in the upper montane zone in decadent (i.e., declining naturally) *Acacia koa*-Myrsine forests with a prominent fern understory at Puu Waawaa (Wagner et al. 1999; Giffin 2009). The elevation range for this species is 1,570 to 1,720 meters (5,150 to 5,640 feet) (USFWS, 2012).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Presumed extinct until rediscovery in 1974 (USFWS, 2012)

Species Trends:

Declining (USFWS, 2012)

Resiliency:

Very low (inferred from USFWs, 2012; see current range/distribution)

Redundancy:

Low (inferred from USFWs, 2012)

Number of Populations:

6 (USFWS, 2012)

Population Size:

37 (USFWS, 2012)

Population Narrative:

When the recovery plan was issued in 1984, there were an estimated 1,500 to 2,000 individuals within upper Keauhou Ranch (USFWS 1984). In 2010, the population census remained the same as recorded in 2009 with a total of 37 individuals located within 6 populations (Plant Extinction Prevention Program 2010). Until its rediscovery in 1974, the species had been considered extinct, having not been seen since 1915 (Lassetter and Gunn 1979; Warshauer and Jacobi 1982) (USFWS, 2012).

Threats and Stressors

Stressor: Feral ungulates (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Ungulate degradation of habitat (Warshauer and Jacobi 1982; Hawaii Department of Land and Natural Resources 2005): cattle (*Bos taurus*), goats (*Capra hircus*), feral pigs (*Sus scrofa*) were noted as a threat to the native forest outside of a fenced enclosure at the Hualalai site, which at the time contained three to five individuals of *V. menziesii* (D. Hopper, pers. comm. 2001); sheep (*Ovis aries*) (USFWS, 2012).

Stressor: Invasive plants (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Established ecosystem-altering invasive plant species degradation of habitat (Warshauer and Jacobi 1982; Hawaii Department of Land and Natural Resources 2005); *Passiflora tarminiana* (banana poka), *Rubus argutus* (Florida prickly blackberry) (USFWS, 2012).

Stressor: Logging (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Logging was listed as an earlier threat to the survival of *Vicia menziesii*, but this activity has decreased (Warshauer and Jacobi 1982) (USFWS, 2012).

Stressor: Predation/herbivory (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Rodent predation or herbivory – Rats (*Rattus* spp.) (Warshauer and Jacobi 1982; Hawaii Department of Land and Natural Resources 2005). Invertebrate predation or herbivory – Caterpillars (Anonymous 2004; Rubenstein 2007) (USFWS, 2012).

Stressor: Small population size (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Low numbers (Warshauer and Jacobi 1982; Hawaii Department of Land and Natural Resources 2005; Plant Extinction Prevention Program 2007b, 2008, 2009, 2010) (USFWS, 2012).

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species (USFWS, 2012).

Recovery

Reclassification Criteria:

Vicia menziesii may be considered for downlisting when: 1) There are 5 to 10 populations in suitable, protected habitat with 1,000 mature individuals per population; 2) All major threats are controlled around the target populations; 3) Populations are represented in an ex situ collection as defined in the Center for Plant Conservation guidelines (Guerrant et al. 2004) that is secure and well managed; and 4) All target populations have been stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions may continue to be necessary (USFWS, 2019).

Delisting Criteria:

Vicia menziesii may be considered for delisting when: 1) All of the downlisting criteria have been met; and 2) All target populations have been stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but an ongoing need for ecosystem-wide management actions may remain if long-term agreements are in place to continue management (USFWS, 2019).

Recovery Actions:

- Protect existing *Vicia* habitat from further degradation (USFWS, 1984).
- Conduct investigative and research studies for determination of recovery alternatives (USFWS, 1984).
- Instigate management to maintain and improve population status of *V. menziesii* (USFWS, 1984).
- Monitor the effects of management actions (USFWS, 1984).
- Develop and implement a public relations strategy to increase awareness and support of the recovery effort (USFWS, 1984).

Conservation Measures and Best Management Practices:

- Captive propagation for genetic storage and reintroduction: Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation and genetic storage. Collect cuttings or seed from tagged individuals, keeping close track of the maternal source for use in ex situ propagation (USFWS, 2012).
- Reintroduction / translocation site identification – Reintroduction attempts should be made at Kilauea Forest, Keauhou Ranch, and Puu Waawaa within sites that are free from ungulates (fenced) and introduced invasive plant species (USFWS, 2012).

- Reintroduction / translocation implementation – Continue to reintroduce the species back into its known historical range (USFWS, 2012).
- Ungulate exclosures: Continue to construct fenced exclosure around existing and reintroduced populations to provide protection from feral ungulates. Monitor fenced exclosures for evidence of breaching by feral ungulates (USFWS, 2012).
- Ungulate control – Protect all populations against disturbances from feral ungulates (USFWS, 2012).
- Ecosystem-altering invasive plant species control – Control invasive introduced plant species around all populations (USFWS, 2012).
- Surveys / inventories – Survey the historical range of the species for additional individuals or populations, and to determine the current status of the species (USFWS, 2012).
- Genetic research – Carry out molecular studies to assess overall genetic variation among existing populations and individuals (USFWS, 2012).
- Site / area / habitat protection – Develop and implement effective measures to reduce the impact of timber management (logging) (USFWS, 2012).
- Predator / herbivore control – Control rodents around existing populations (USFWS, 2012).
- Invertebrate control research – Research the effects of invertebrates and caterpillars around existing and reintroduced populations. If research demonstrates there is an immediate threat, determine and implement effective control measures (USFWS, 2012).
- Alliance and partnership development – Work with Hawaii Division of Forestry and Wildlife, Three Mountain Alliance Partnership, and other landowners to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2012).
- Revise recovery criteria – Update and define recovery objectives in a revised recovery plan for *Vicia menziesii* based on current, available scientific information (USFWS, 2012).
- Threat monitoring and control – Monitor populations for evidence of disease or other pests (USFWS, 2012).
- Threats research – Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2012).

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SPECIES ACCOUNT: *Vigna o-wahuensis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/10/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

Vigna o-wahuensis is a member of the Fabaceae, or pea family. It is a slender, short-lived, twining perennial herb with fuzzy stems that grow to 0.4 meter (1.3 feet). Leaves are compound, with three leaflets that are 1.2 to 8 centimeters (0.5 to 3.0 inches) long and 0.1 to 2.5 centimeter (0.04 to 1.0 inch) wide. Leaflets are sparsely to moderately covered with coarse hairs. Flowers occur in clusters of one to four, and have thin, translucent, pale yellow or greenish-yellow petals approximately 2.0 to 2.5 centimeters (0.8 to 1.0 inch) long. The calyx is sparsely hairy and 4.0 to 8.0 millimeters (0.2 to 0.3 inch) long with asymmetrical lobes. Fruits are slender pods of 4 to 9 centimeters (1.6 to 3.5 inches) in length and 5 millimeters (0.2 inch) in width. Pods may be slightly inflated and contain between 7 and 15 gray to black seeds that are less than 6.0 millimeters (0.2 inch) long (U.S. Army 2003a).

Historical Range

Historically, *Vigna o-wahuensis* was known from the islands of Hawaii, Maui, Molokai, Lanai, Kahoolawe, Nihoa, and Niihau (U.S. Army 2003a).

Current Range

Currently, it is known from Maui, Molokai, Lanai, Kahoolawe, and Hawaii (68 FR 25934; 68 FR 1220; 68 FR 39624). At least 86 individuals are believed to occur in 10 locations (U.S. Army 2003a). Thirty plants were located on the lower south and southwestern slope of Puu Nohonaohae during botanical surveys in the early 1980s, but only a single plant was observed in 2002 (Arnett 2002b).

Critical Habitat Designated

Yes; 5/14/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Vigna o-wahuensis* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 14 detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Vigna o-wahuensis* under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Vigna o-wahuensis* (77 FR 57648-57862). The critical habitat designation includes 7 critical habitat units, which encompass approximately 7,823 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Vigna o-wahuensis* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Vigna o-wahuensis* on the island of Hawaii (68 FR 39623 - 39722).

Critical Habitat Designation

The critical habitat designation for *Vigna o-wahuensis* includes 14 CHUs in Maui County, Hawaii with detailed unit information. There are also an unknown number of units on Lanai that contain this species (number of units is unknown because detailed unit descriptions for Lanai are not available) (81 FR 17790-18110).

Maui—Coastal—Unit 1 consists of 2 ac (1 ha) on Keopuka Rock on the northern coast of east Maui. This unit is State-owned, and is classified as a State Seabird Sanctuary. It is occupied by the plant *Peucedanum sandwicense* and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui-Coastal—Unit 1 is not known to be occupied by *Brighamia rockii*, *Cyperus pennatifolius*, *Ischaemum byrsoniae*, or *Vigna o-wahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Kahoolawe—Coastal—Unit 1 consists of 1,516 ac (613 ha) of State land from Kaneloa to Lae o Kaule, including Aleale, along the southern and eastern coast of Kahoolawe. It is occupied by the plant *Kanaloa kahoolawensis* and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Kahoolawe—Coastal—Unit 1 is not known to be occupied by the plants *Sesbania tomentosa* or *Vigna owahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the physical or biological features necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 2 consists of 16 ac (6 ha) of State land, and 9 ac (4 ha) of privately owned land, from Wahinepee Stream to Moiki Point on the northern coast of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). Although Maui—Coastal—Unit 2 is not currently occupied by *Brighamia rockii*, *Cyperus pennatifolius*, *Ischaemum byrsoniae*, *Peucedanum sandwicense*, or *Vigna o-wahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the physical or biological features necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small

numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Kahoolawe—Coastal—Unit 2 consists of 12 ac (5 ha) of State land on Puukoa, an islet off the southern coast of Kahoolawe. It is occupied by the plant *Sesbania tomentosa* and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Kahoolawe—Coastal—Unit 2 is not known to be occupied by *Kanaloa kahoolawensis* or *Vigna o-wahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 3 consists of 10 ac (4 ha) of privately owned land at Pauwala Point on the northern coast of east Maui. This unit is occupied by the plant *Ischaemum byrnei* and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Coastal—Unit 3 is not known to be occupied by *Brighamia rockii*, *Cyperus pennatiformis*, *Peucedanum sandwicense*, or *Vigna o-wahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Kahoolawe—Coastal—Unit 3 consists of 189 ac (76 ha) of State land from Laepaki to Honokanaia along the western coast of Kahoolawe. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). Although Kahoolawe—Coastal—Unit 3 is not known to be occupied by *Kanaloa kahoolawensis*, *Sesbania tomentosa*, or *Vigna o-wahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 4 consists of 40 ac (16 ha) of State land, and 35 ac (14 ha) of privately owned land, from Papiha Point to Honolulu Nui Bay on the northeastern coast of east Maui. This unit is occupied by the plant *Cyperus pennatiformis* and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Coastal—Unit 4 is not known to be occupied by *Brighamia rockii*, *Ischaemum byrnei*, *Peucedanum*

sandwicense, or *Vigna owahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Kahoolawe—Lowland Dry—Unit 1 consists of 1,220 ac (494 ha) of State land, north of Waihonu Gulch on west Kahoolawe. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Kahoolawe—Lowland Dry—Unit 1 is not known to be occupied by *Gouania hillebrandii*, *Hibiscus brackenridgei*, *Kanaloa kahoolawensis*, *Neraudia sericea*, *Sesbania tomentosa*, or *Vigna owahuensis*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 5 consists of 26 ac (11 ha) of State land from Keakulikuli Point to Pailoa Bay on the northeastern coast of east Maui. This unit is occupied by the plant *Ischaemum byrone* and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Coastal—Unit 5 is not known to be occupied by *Brighamia rockii*, *Cyperus pennatiformis*, *Peucedanum sandwicense*, or *Vigna o-wahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Kahoolawe—Lowland Dry—Unit 2 consists of 3,205 ac (1,297 ha) of State land from Lua o Kealialuna to Puu o Moaulaiki and Luamakika on the eastern side of Kahoolawe. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Kahoolawe—Lowland Dry—Unit 2 is not known to be occupied by *Gouania hillebrandii*, *Hibiscus brackenridgei*, *Kanaloa kahoolawensis*, *Neraudia sericea*, *Sesbania tomentosa*, or *Vigna o-wahuensis*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 6 consists of 356 ac (144 ha) of State land at Kamanamana on the southern coast of East Maui. This unit is occupied by the plant *Vigna owahuensis* and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5).

This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Coastal—Unit 6 is not known to be occupied by *Brighamia rockii*, *Cyperus pennatifolius*, *Ischaemum byrnei*, or *Peucedanum sandwicense*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 7 consists of 30 ac (12 ha) of State land, and 15 ac (6 ha) of privately owned land, from Kailio Point to Waiuha Bay, on the southern coast of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). Although Maui—Coastal—Unit 7 is not currently occupied by *Brighamia rockii*, *Cyperus pennatifolius*, *Ischaemum byrnei*, *Peucedanum sandwicense*, or *Vigna owahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 8 consists of 493 ac (199 ha) of State land from Kiakaeana Point to Manawainui on the southern coast of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). Although Maui—Coastal—Unit 8 is not currently occupied by *Brighamia rockii*, *Cyperus pennatifolius*, *Ischaemum byrnei*, *Peucedanum sandwicense*, or *Vigna owahuensis*, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Mesic—Unit 1 (and) *Palmeria dolei*—Unit 37—Lowland Mesic (and) *Pseudonestor xanthophrys*—Unit 37—Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Ctenitis squamigera*, *Cyanea dunbariae*, *C. mannii*, *C. profuga*, *Cyperus fauriei*, *Cyrtandra filipes*, *Gouania hillebrandii*, *Labordia triflora*, *Neraudia sericea*, *Santalum haleakalae* var. *lanaiense*, *Schiedea lydgatei*, *S. sarmentosa*, *Silene alexandri*, *S. lanceolata*, *Spermolepis hawaiiensis*, and *Zanthoxylum hawaiiense*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Lowland Mesic—Unit 1 is not known to be occupied by *Asplenium dielerectum*, *Bonamia menziesii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea procera*, *C. solanacea*, *Diplazium molokaiense*, *Festuca molokaiensis*, *Flueggea neowawraea*, *Isodendron pyriforme*, *Kadua laxiflora*, *Melicope*

mucronulata, *M. munroi*, *M. reflexa*, *Phyllostegia haliakalae*, *P. mannii*, *P. pilosa*, *Sesbania tomentosa*, *Stenogyne bifida*, or *Vigna o-wahuensis*, or the forest birds, the akohekohe (*Palmeria dolei*) and kiwiku (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat designation for *Vigna o-wahuensis* includes 15 critical habitat units, covering one ecosystem type, which encompasses approximately 1,332 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Coastal—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15.

Oahu—Coastal—Unit 1 [958 ac (388 ha)]. This area consists of 946 ac (383 ha) of State land, 11 ac (4 ha) of Federal land, and 2 ac (1 ha) of privately owned land in the coastal ecosystem along the northwestern coast of Oahu from Kaena Point east to Kauhao Pali and southeast to Keawaula. This unit is partially within Kaena Point State Park. Oahu—Coastal—Unit 2 [12 ac (5 ha)]. This area consists of 12 ac (5 ha) in the coastal ecosystem on Mokuauia, an islet east of Kalanai Point on the northeastern coast of Oahu. This unit is State-owned and is classified as a State Seabird Sanctuary. Oahu—Coastal—Unit 3 [15 ac (6 ha)]. consists of 15 ac (6 ha) in the coastal ecosystem, on the larger of two islets (Moku Manu) off the windward coast of Oahu near Mokapu Peninsula. This unit is Stateowned, classified as a State Seabird Sanctuary. Oahu—Coastal—Unit 4 [3 ac (1 ha)]. This area consists of 3 ac (1 ha) in the coastal ecosystem, the smaller of two islets (Moku Manu) off the windward coast of Oahu near Mokapu Peninsula. This unit is Stateowned, classified as a State Seabird Sanctuary. Oahu—Coastal—Unit 5 [12 ac (5 ha)]. This area consists of 12 ac (5 ha) in the coastal ecosystem, the larger of two islands (Mokulua Islands) off the windward coast of Oahu near Wailea Point. This unit is State-owned, classified as a State Seabird Sanctuary. Oahu—Coastal—Unit 6 [9 ac (4 ha)]. This area consists of 9 ac (4 ha) in the coastal ecosystem, on the smaller of two islands (Mokulua Islands) off the windward coast of Oahu near Wailea Point. This unit is Stateowned, classified as a State Seabird Sanctuary. Oahu—Coastal—Unit 7 [67 ac (27 ha)]. This area consists of 67 ac (27 ha) in the coastal ecosystem, on the larger of two islands (Manana Island) off the windward coast of Oahu near Makapuu Point. This unit is Stateowned, classified as a State Seabird Sanctuary. Oahu—Coastal—Unit 8 [10 ac (4 ha)]. This area consists of 10 ac (4 ha) in the coastal ecosystem, on the smaller of two islands (Kaohikaipu Island) off the windward coast of Oahu near Makapuu Point. This unit is Stateowned, classified as a State Seabird Sanctuary. Oahu—Coastal—Unit 9 [80 ac (33 ha)]. This area consists of 80 ac (33 ha) of State land in the coastal ecosystem on the leeward side of Makapuu Point (Puuokipahulu). Oahu—Coastal—Unit 10 [74 ac (30 ha)]. This area consists of 74 ac (30 ha) in the coastal ecosystem, owned by the City and County of Honolulu at Halona Point on the leeward side of Koko Crater, extending from Sandy Beach to Kahauloa. Oahu—Coastal—Unit 11 [20 ac (8 ha)]. Thi area consists of 20 ac (8 ha) of privately owned land in the coastal ecosystem, at Ihihilauea on Koko Head (Kaihuokapuaa). Oahu—Coastal—Unit 12 [11 ac (5 ha)]. This area consists of 11 ac (5 ha) of City and County land in the coastal ecosystem, at Nonoula on Koko Head (Kaihuokapuaa). Oahu—Coastal—Unit 13 [23 ac (10 ha)]. This area consists of 19 ac (8 ha) of City and County land, 1 ac (0.5 ha) of State land, and 3 ac (1 ha) of privately owned land in the coastal ecosystem at Kalaeloa. Oahu—Coastal—Unit 14 [4 ac (2 ha)]. This area consists of 2 ac (1 ha) of City and County of Honolulu land, and 2 ac (1 ha) of Federal land (U.S. Coast Guard) in the coastal ecosystem at Kalaeloa. Oahu—Coastal—Unit 15 [33 ac (13 ha)]. This area consists of 9 ac (4 ha) of

State land, 2 ac (1 ha) of privately owned land, and 21 ac (9 ha) of Federal (Pearl Harbor NWR) land at Kalaeloa.

The critical habitat designation for *Vigna o-wahuensis* includes three units totaling 335 acres in Hawaii County, Hawaii. The units are Hawaii 4—*Vigna o-wahuensis*—a, b, c. Each unit provides habitat for 1 population of 300 mature, reproducing individuals of *V. o-wahuensis*. Each unit is essential to the conservation of the species because it supports habitat that is necessary for the establishment of additional populations in order to reach recovery goals. Each unit is geographically separated from other critical habitat for this multi-island species in order to reduce the likelihood of all recovery populations being destroyed by one naturally occurring catastrophic event.

Hawaii 4—*Vigna o-wahuensis*—a [(49 ha, 121 ac): This unit contains most of Puu Pa cinder cone and lies in the Pohakuloa watershed in the southwest and in the Waikoloa/Wailaula watershed in the northeast.

Hawaii 4—*Vigna o-wahuensis*—b [35 ha, 87 ac): This unit contains most of the Holoholoku cinder cone and lies completely within the Pohakuloa watershed. This unit provides the easternmost critical habitat within the species' historical range.

Hawaii 4—*Vigna o-wahuensis*—c [51 ha, 127 ac): This unit contains the upper portions of an unnamed cinder cone in the Pohakuloa watershed. This unit provides the southernmost critical habitat within the species' historical range.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Vigna o-wahuensis* critical habitat consists of three components. Coastal (east Maui and Kahoolawe), Lowland dry (Lanai and Kahoolawe) and Lowland mesic (Lanai and Molokai) (81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*. Subcanopy: *Chamaesyce*, *Dodonaea*, *Leptecophylla*, *Osteomeles*, *Psydrax*, *Scaevola*, *Wikstroemia*. Understory: *Alyxia*, *Artemisia*, *Bidens*, *Chenopodium*, *Nephrolepis*, *Peperomia*, *Sicyos*.

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Ecosystem: Coastal. Elevation: <980 ft (<300 m). Annual precipitation: <20 in (<50 cm). Substrate: Well-drained, calcareous, talus slopes; dunes; weathered clay soils; ephemeral pools; mudflats. Canopy: *Hibiscus*, *Myoporum*, *Santalum*, *Scaevola*. Subcanopy: *Gossypium*, *Sida*, *Vitex*. Understory: *Eragrostis*, *Jacquemontia*, *Lyceum*, *Nama*, *Sesuvium*, *Sporobolus*, *Vigna*.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Vigna o-wahuensis* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Vigna o-wahuensis* was known historically (last observed > 20 yrs ago) from the indicated ecosystem in both the Koolau Mountain caldera complex and the Waianae Mountain caldera complex:

Oahu—Coastal—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15. (A) Elevation: <980 ft (<300 m). (B) Annual Precipitation: <20 in (<50 cm). (C) Substrate: Well-drained, calcareous, talus slopes; dunes; weathered clay soils; ephemeral pools; mudflats. (D) Canopy: Hibiscus, *Myoporum*, *Santalum*, *Scaevola*. (E) Subcanopy: *Gossypium*, *Sida*, *Vitex*. (F) Understory: *Eragrostis*, *Jacquemontia*, *Lyceum*, *Nama*, *Sesuvium*, *Sporobolus*, *Vigna*.

Habitat features that are essential for this species include, but are not limited to, *Dodonaea viscosa* lowland dry shrubland.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative

ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Vigna o-wahuensis* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat

destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for this species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Life history information is unknown. The taxon has been observed flowering in March, April and July. Fruits were present in July. All individuals were classified as mature (U.S. Army 2003a).

Habitat Type

Adult: lowland dry to mesic grassland and shrubland

Habitat Narrative

Adult: *Vigna o-wahuensis* occurs in lowland dry to mesic grassland and shrubland at elevations from 10 to 1,370 meters (33 to 4,495 feet). Associated plant species include *Sida fallax*, *Chenopodium* sp., *Dubautia menziesii*, and *Osteomeles anthyllidifolia* (U.S. Army 2003a).

Dispersal/Migration

Population Information and Trends

Number of Populations:

5

Population Size:

26

Population Narrative:

At least 86 individuals are believed to occur in 10 locations (U.S. Army 2003a). Thirty plants were located on the lower south and southwestern slope of Puu Nohonaohae during botanical surveys in the early 1980s, but only a single plant was observed in 2002 (Arnett 2002b). New status information: ☐ Currently, there are 26 individuals of *Vigna o-wahuensis* in 5 populations on Molokai, Maui, and Kahoolawe (USFWS 2012a). On Molokai, 2 populations totaling 12 individuals are known from Makakupaia and Makolelau. On East Maui, there are approximately 10 individuals at Kanaio Beach. In 2014, a survey discovered approximately three individuals of *V. o-wahuensis* in a new location on Maui (Plant Extinction Prevention Program [PEPP] 2014). On Kahoolawe, there is a single individual. ☐ On Hawaii Island, in 2009 and 2010 there were 3 known populations containing 71 individuals (PEPP 2009, 2010). ☐ During 2011 to 2013, approximately 200 to 300 individuals of *Vigna o-wahuensis* were known from Pohakuloa Training Area (PTA) (U.S. Army Garrison Pohakuloa [U.S. Army] 2014). ☐ Overall, the numbers of individuals have increased from the approximately 72 wild individuals reported in the previous 5-year review to approximately 226 to 326 wild individuals in 2015 (USFWS 2012a; PEPP 2014; U.S. Army 2014) (USFWS, 2015).

Threats and Stressors**Stressor:****Exposure:****Response:****Consequence:**

Narrative: Threats to *Vigna o-wahuensis* include habitat degradation by feral ungulates, competition from non-native plant species, fire, effects of military activities, reduced reproductive vigor due to the small number of existing populations and individuals, and extirpation or extinction as the result of naturally-occurring events (U.S. Army 2003a).

Stressor: Nonnative bird predation or herbivory

Exposure:**Response:****Consequence:**

Narrative: This species is often browsed by game birds at reintroduction sites thus leading to shorter stature plants and limited reproduction (U.S. Army 2010).

Stressor: Stochastic events

Exposure:**Response:****Consequence:**

Narrative: Drought mortality or reduced viability – Drought may exacerbate the effects of ungulates and has direct adverse impacts on *V. o-wahuensis* (PEPP 2013).

Recovery**Recovery Actions:**

- Recommendations for Future Actions: ☐ Surveys / inventories – Survey geographical and historical range for a current assessment of the species' status. ☐ Captive propagation for genetic storage and reintroduction – Continue collection of genetic resources for storage,

propagation, and reintroduction into protected suitable habitat within historical range. ☐ Ungulate monitoring and control – Maintain existing exclosures and monitor for potential incursions. ☐ Invasive plant monitoring and control – Eradicate invasive introduced plants within ungulate exclosures and maintain exclosures free of invasive plants. ☐ Population viability monitoring and analysis – Continue monitoring wild and outplanted individuals. ☐ Fire monitoring and control – Develop and implement a fire management plan at the existing exclosures. ☐ Alliance and partnership development – Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2015).

Conservation Measures and Best Management Practices:

- Important conservation actions needed for *Vigna o-wahuensis* include the following: control of non-native plant species and feral ungulates; elimination of fire; and research on habitat requirements, population structure, reproductive biology, and seed biology. Management actions to protect existing *V. o-wahuensis* populations and habitat from fire should be developed. Ex situ propagation should be initiated and research on seed storage methodology continued to maintain adequate genetic stock and buffer against extinction of this species. Outplanting to enhance the remaining wild populations should begin when adequate propagated material is available, and fencing and weed control are underway. New populations should be established within the historic range of *V. o-wahuensis* in areas free from the impacts of feral ungulates and non-native plants (Service 1999). In addition, a Statewide management plan that identifies areas and landscapes for the long-term conservation of all known occurrences of *V. o-wahuensis* is needed. As part of this management plan, landowners and managers should delineate management units to conserve this species and other native species through threat control and habitat restoration. Ongoing Conservation Actions: Aside from specific actions occurring at the Pohakuloa Training Area on the island of Hawaii (and discussed in a subsequent section), the Service is unaware of species-specific conservation actions being conducted for *Vigna o-wahuensis*.
- New management actions: ☐ Surveys / inventories o A survey discovered approximately three individuals of *V. o-wahuensis* in a new location on Maui (PEPP 2014). o During 2011 to 2012, approximately 18.25 square kilometers (7.05 square miles) were surveyed at PTA (U.S. Army 2013). Surveys were completed within the following fence units: *Haplostachys haplostachya* (165 acres), *Kadua coriacea* (392 hectares [969 acres]), Kipuka Alala North (407 hectares [1,066 acres]), Puu Nohona O Hae (79 hectares [195 acres]), Puu Papapa (28 hectares [68 acres]), and *Silene hawaiiensis* (18 hectares [44 acres]). During that survey, only a single location was recorded for *V. o-wahuensis* (U.S. Army 2013). o In 2014, surveys conducted in previously un-surveyed areas and previously surveyed areas discovered approximately nine locations of *V. o-wahuensis* (U.S. Army 2015). ☐ Ungulate monitoring and control o All known locations of *V. o-wahuensis* that contain live plants are protected by the Puu Papapa and Nohona o Hae fence units at PTA (U.S. Army 2010). These fence units are ungulate free (U.S. Army 2014). The location in western 3 Keamuku Maneuver Area that formerly contained individuals of *V. o-wahuensis* is not fenced (U.S. Army 2010). ☐ Invasive plant monitoring and control – Weed control for this species is problematic due to the loose and steep terrain associated with plants located on Puu Papapa (U.S. Army 2010). The Army Natural Resources Office at PTA is investigating alternative weed control methods for this species. ☐ Captive propagation for genetic storage and reintroduction o The Volcano Rare Plant Facility (2013, 2014) had five individuals growing in their nursery and eight individuals were propagated for reintroduction activities to occur next year. o The Lyon Arboretum's Seed Conservation Laboratory (2014) has more than 4,300 seeds in storage from Maui, Kahoolawe, and Hawaii Island. o Waimea Valley (2014) has two plants in cultivation from Maui. o The National Tropical Botanical Garden

(2014) has more than 300 seeds in storage from Maui and Hawaii Island. o Maui Nui Botanical Garden (2014) has thousands of seeds in genetic storage representing eight cultivated individuals from Kanaio. o During 2011 to 2013, more than 14,000 seeds from 35 accessions representing 1 group and 35 founders of *V. o-wahuensis* were collected and placed in long-term storage at PTA (U.S. Army 2014). There are now more than 33,000 seeds in storage from 55 accessions representing 1 group and 47 founders in long-term storage at PTA (U.S. Army 2014). □ Captive propagation protocol development – Propagation trials were conducted to determine appropriate storage and propagation techniques for *V. o-wahuensis*. The trials indicated that seeds from *V. o-wahuensis* germinated readily at a rate of more than 50 percent (U.S. Army 2015). Seed longevity for *V. o-wahuensis* is unknown (U.S. Army 2015). □ Population viability monitoring and analysis o The Plant Extinction Prevention Program (2013) monitored the wild population on Maui. o In 2010, annual monitoring recorded several new plant locations on Puu Papapa at PTA (U.S. Army 2010). In addition to annual monitoring, supplemental monitoring was conducted in 2010 but no additional management actions were required implementation (U.S. Army 2010). o In 2010, no individuals were observed in an area in western Keamuku Maneuver Area which formerly contained individuals of *V. o-wahuensis* (U.S. Army 2010). This location will continue to be monitored for regeneration of new individuals. o A new quarterly monitoring methodology was implemented for this species in 2010 at PTA (U.S. Army 2010). Elements of the protocol were started in October of 2009, with refinements made based on feedback and data collected. The new methodology was fully implemented in April 2010. Data collection objectives are to quantify plant abundance and plant cluster density at different times of the year so that seasonal variation and variation because of spatial and temporal gradients in resource availability can be accounted for in this ephemeral species. Plant stems are used to estimate abundance and vigor, since it is difficult to distinguish between individual plants of this species (U.S. Army 2010). Cluster counts were 4 not made until the last quarterly monitoring for this species where 27 plant clusters were found in the survey area. o Monitoring conducted in the first quarter of 2010 recorded 110 out of the 183 previously known plant stems in previously recorded plant clusters known from PTA (U.S. Army 2010). The prolonged drought from 2009 to 2010 seemed to have had a considerable impact on this and other species' abundance and vigor at PTA (U.S. Army 2010). During the second quarter monitoring only 25 out of the 183 previously known *V. o-wahuensis* stems remained alive. The number of remaining stems declined to just 3 stems in the fourth quarter. Preliminary results from monitoring in 2011 indicated that there are no living stems in the survey area (U.S. Army 2010). □ Reintroduction / translocation o During 2002 to 2012, a single individual of *V. o-wahuensis* was outplanted at Kipuka Alala South fence unit, another individual was outplanted in 2014, and one plant remained in 2014 (U.S. Army 2015). o Near Saddle Road on State-owned lands, 7 individuals were reintroduced during 2002 to 2012, no individuals were added in 2014, and no plants remained in 2014 (U.S. Army 2015). o In North Kona on State-owned lands, 100 seeds were broadcasted during 2004 to 2009 (U.S. Army 2015). o At Puu Waawaa Cone Unit on State-owned lands, 42 individuals were reintroduced during 2005 to 2012 (U.S. Army 2015). In 2014, an additional five individuals were reintroduced and monitoring conducted during the same year, recorded only three reintroduced individuals remained (U.S. Army 2015). o On County-owned lands in North Kona, 11 individuals were reintroduced during 2008 to 2012 and no reintroduced individuals remained in 2014 (U.S. Army 2015). o The Waikoloa Dry Forest Initiative has 74 reintroduced individuals with many of those individuals reaching maturity and producing seeds (J. Lawson, Waikoloa Dry Forest Initiative, pers. comm. 2015). o In 2014, two individuals were reintroduced on private land in North Kona (Wagner 2014). □ Reintroduced / translocated population management and monitoring o In North Kona on State-owned lands, natural recruitment of a single immature individual was observed in 2014 (U.S. Army 2015). o At Puu Waawaa Cone Unit on State-owned lands monitoring conducted in 2014 recorded

natural recruitment of a single immature individual of *V. o-wahuensis* (U.S. Army 2015). o On County-owned lands in North Kona, 11 individuals were outplanted during 2008 to 2012 and no outplants remained in 2014 (U.S. Army 2015). 5 Climate change adaptation strategy – Fortini et al. (2013) conducted a landscapebased assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *V. o-wahuensis* is minimally vulnerable to the impacts of climate change. 5 Listing and critical habitat designation o Fifteen units of critical habitat were designated for *V. o-wahuensis* on Oahu in the coastal ecosystem (USFWS 2012b). o Eight units of critical habitat for *V. o-wahuensis* were proposed in the coastal ecosystem on Maui and five units of critical habitat were proposed in the coastal and lowland dry ecosystems on Kahoolawe (USFWS 2012a). On Molokai, a single unit of critical habitat was proposed in the lowland mesic ecosystem (USFWS 2012a). On Lanai, critical habitat for *V. o-wahuensis* was proposed in three units in the lowland dry and lowland mesic ecosystems. The final rule for these critical habitat designations has not been published at the time of this review.

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SPECIES ACCOUNT: *Viola chamissoniana* ssp. *chamissoniana* (Pamakani)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

Viola chamissoniana ssp. *chamissoniana* is a short-lived perennial of the Violaceae (violet) family. It is a basal-branching woody shrub with branches 20 to 60 cm (8 to 23 in) long. Some occurrences, especially on steep cliffs, have plants with reclining or drooping branches; plants in other occurrences have erect branches forming upright shrubs. The triangular leaves are 2 to 4 cm (0.8 to 1.6 in) long and clustered at the ends of the stems. The flowers are large, white, and held above the leaves. The tiny, dark, egg-shaped seeds are borne in capsules that open as they dry (Wagner et al 1999; Makua Implementation Team 2003) (USFWS, 2016).

Current Range

Viola chamissoniana ssp. *chamissoniana* is endemic to the island of Oahu and is known only from the Waianae Mountains. It has been recorded throughout the mountain range on both the windward and leeward sides (USFWS, 2016).

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Viola chamissoniana* ssp. *chamissoniana* (Pamakani) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Viola chamissoniana* ssp. *chamissoniana* (77 FR 57648-57862). The critical habitat designation includes 11 critical habitat units, which encompass approximately 7,332 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Viola chamissoniana* ssp. *chamissoniana* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Viola chamissoniana* ssp. *chamissoniana* includes 11 critical habitat units, covering two ecosystem types, which encompass approximately 7,332 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3; Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole

NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac (105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Viola chamissoniana* ssp. *chamissoniana* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Viola chamissoniana* ssp. *chamissoniana* occurs within the Lowland mesic and Dry cliff ecosystems in the Waianae Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (F) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. (F) Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Viola chamissoniana* ssp. *chamissoniana* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History**Food/Nutrient Resources****Lifespan**

Adult: <10 years (USFWS, 2016)

Reproduction Narrative

Adult: Little is known about the breeding system of *V. chamissoniana* ssp. *chamissoniana*. The large, white, fragrant flowers held above the leaves suggest pollination by moths. Plant longevity probably is similar to that of other small shrubs that live less than 10 years (i.e., short-lived perennials) (Makua Implementation Team 2003). Other demographic information for *V. chamissoniana* ssp. *chamissoniana* in the wild is uncertain, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, timing of reproductive output, pollination and seed dispersal, vegetative reproduction and specific environmental requirements (USFWS, 2016).

Habitat Type

Adult: Cliffs/cliff ledges (USFWS, 2016)

Habitat Narrative

Adult: *Viola chamissoniana* ssp. *chamissoniana* occurs in mesic habitats at elevations of 700 to 1,000 m (2,297 to 3,281 ft). It is usually found on north-facing cliffs and cliff ledges that are sparsely to moderately vegetated with native shrubs, grasses, and sedges. Such sites are among the most native and undisturbed mesic habitats of the Waianae Mountains. This taxon also is found on gentle slopes in native shrubland (Makua Implementation Team 2003) (USFWS, 2016).

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Increasing (USFWS, 2016)

Number of Populations:

8 (USFWS, 2016)

Population Size:

618 (USFWS, 2016)

Population Narrative:

Currently, *Viola chamissoniana* ssp. *chamissoniana* occurs in eight population units totaling approximately 618 individuals (Table SB 40). These population units are found on Federal and State lands (68 FR 35950). One of these population units has exceeded minimum numerical criteria for a stabilization (defined as at least 50 mature, reproducing individuals for short-lived perennials). Data on numbers of individuals has only been consistent with monitoring since 2003 and indicate an increase from 374 to 618 total known individuals. This increase includes some additional individuals recently discovered in the Puu Kamakalii population unit. The Keaau and Ohikilolo population units are located in the Makua action area, and the Puu Kamakalii population is located in the action area of Schofield Barracks Military Reservation. These occurrences are located in zones at risk from training-related wildfire. Thus, *V. chamissoniana* ssp. *chamissoniana* is characterized by eight population units with low numbers, except for one population unit that exceeds minimum criteria for stabilization (USFWS, 2016).

Threats and Stressors

Stressor: Fire (USFWS, 2016)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Fire is listed as a threat to this species. Because of its overall relative abundance and population units in fire risk zones, *V. chamissoniana* ssp. *chamissoniana* has a high background risk of species extinction, and protection from existing and additional threats is needed to ensure its long-term persistence (USFWS, 2016).

Recovery**Delisting Criteria:**

Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve utilizing stabilization populations to aid in recovery (Service 1995a, 1998a) (USFWS, 2016).

Conservation Measures and Best Management Practices:

- The Makua Implementation Team (2003) has developed stabilization criteria for *Viola chamissoniana* ssp. *chamissoniana*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). In addition, this species occurs in four management units where it will benefit from population unit and/or ecosystem-level protection. The management units include Makaha, Palikea, and Puu Kumakalii, which are not fenced, and Ohikilolo, which is fenced. *Viola chamissoniana* ssp. *chamissoniana* is easy to propagate from seeds and cuttings. Seeds can be stored at appropriate conditions for several years with 60 percent germination success, and cuttings are also about 60 percent successful. Seed is difficult to collect because wild plants produce very few flowers and seeds at a time. Flowering of some greenhouse plants is more prolific, but most of the fruits are aborted. The Army is conducting nursery pollination experiments to determine limiting factors to seed production (U.S. Army Garrison

2005b). Current ex situ collections for this species include 31,000 seeds in seed storage (Lyon Arboretum Seed Storage Facility) (Service 2005b) (USFWS, 2016).

References

USFWS 2016. Status of the Species and Critical Habitat: *Viola chamissoniana* ssp. *chamissoniana* (Pamakani). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016

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SPECIES ACCOUNT: *Viola helenae* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/20/1991; Pacific Region (R1) (USFWS, 2016)

Physical Description

An erect, unbranched subshrub, 3-8 m tall. Leaves are long and narrow. Flowers are pale lavender or white. (NatureServe, 2015)

Taxonomy

Viola helenae was first collected in the Wahiawa Mountains by J. M. Lydgate in 1908 and described the following year by Lydgate and C. N. Forbes based on this same specimen (Forbes 1909). They named it for Lydgate's wife, Helen. J. F. Rock (1911) described a similar species from Lanai as a variety of *Viola helenae*, but the Lanai plant is generally regarded by botanists as a distinct species *V. lanaiensis* (Rock) W. Becker (Becker 1916, St. John 1979, Wagner et al. 1990). *Viola*, a genus of 300 to 500 species widespread in mainly temperate regions of the world, is represented in Hawai'i by 7 endemic species, 6 of which are the only woody members of this genus (Wagner et al. 1990). No vernacular names are known for this species (USFWS, 1994).

Historical Range

See current range/distribution

Current Range

Current range: Wahiawa Mountains of Kauai; historically no additional range.

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Viola helenae* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Viola helenae* includes one unit totaling 1,510 acres in Kauai County, Hawaii. The unit is Kauai 10—*Viola helenae*—a.

Kauai 10—*Viola helenae*—a: This unit is critical habitat for *Viola helenae* and is 610 ha (1,510 ac) on State (Lihue-Koloa Forest Reserve) and private land. This unit contains portions of Kanaele Swamp and Kahili Summit. This unit provides habitat for five populations of 250 mature, reproducing individuals of the short-lived perennial *Viola helenae* and is currently occupied with 137 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, stream drainage banks or adjacent valley bottoms in light to moderate shade in *Metrosideros polymorpha*-*Dicranopteris linearis* lowland wet forest or *Metrosideros polymorpha*-*Cheirodendron* wet forest. This unit is at

an appropriate size to avoid the destruction of all recovery populations by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Within this unit, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

- (i) Stream drainage banks or adjacent valley bottoms in light to moderate shade in *Metrosideros polymorpha* *Dicranopteris linearis* lowland wet forest or *Metrosideros polymorpha* *Cheirodendron* wet forest and containing one or more of the following native plant species: *Antidesma platyphyllum* var. *hillebrandii*, *Broussaisia arguta*, *Dicranopteris linearis*, *Diplazium sandwichianum*, *Dubautia* spp., *Freycinetia arborea*, *Hesperomannia lydgatei*, *Melicope* spp., or *Pritchardia* spp.; and
- (ii) Elevations between 522 and 1,006 m (1,712 and 3,301 ft).

Special Management Considerations or Protections

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species in paragraph (b) of this section and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Likely insect pollinated (USSFWS, 1994)

Reproduction Narrative

Adult: Little is known about the life history and ecology of *Viola helenae*. Wagner et al. (1990) stated that the flowers are all chasmogamous (open at maturity for access by pollinators), none being cleistogamous (remain closed and self-fertilize in the bud) as in certain other violets. It is likely that its flowers require pollination by insects for seed set. Mature flowering plants do produce seed (D. Lorence, pers. obser. 1992), however, seed viability may be low and microhabitat requirements for germination and growth may be very specific. Seeds planted at the HPCC nursery failed to germinate (K. Leeling-Rosenberger, pers. comm. 1992), although they may not have been sufficiently mature when collected and violet seeds are often very slow to germinate (Derral Herbst, USFWS, pers. comm. 1993). The seeds are jettisoned when the capsule splits open, as in most species of the genus (D. Lorence and Flynn, T. pers. obser. 1991). *Viola helenae* was first collected in the Wahiawa Mountains by J. M. Lydgate in 1908 and described the following year by Lydgate and C. N. Forbes based on this same specimen (Forbes 1909). They named it for Lydgate's wife, Helen. J. F. Rock (1911) described a similar species from Lanai as a variety of *Viola helenae*, but the Lanai plant is generally regarded by botanists as a distinct species *V. lanaiensis* (Rock) W. Becker (Becker 1916, St. John 1979, Wagner et al. 1990). *Viola*, a genus of 300 to 500 species widespread in mainly temperate regions of the world, is represented in Hawai'i by 7 endemic species, 6 of which are the only woody members of this genus (Wagner et al. 1990). No vernacular names are known for this species (USFWS, 1994).

Habitat Type

Adult: Wet forest/shrubland (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (NatureServe, 2015)

Site Fidelity

Adult: High (NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits wet forests and shrublands in gulch bottoms, gulch slopes, and on exposed ridgetops. (NatureServe, 2015). Clumped spatial arrangement of the population, high ecological integrity of the community and site fidelity and low tolerance ranges are based on there being one population, with low species numbers.

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Dispersal vectors are not indicated for this species.

Population Information and Trends**Population Trends:**

Unknown

Resiliency:

Low (NatureServe, 2015)

Representation:

Low (NatureServe, 2015)

Redundancy:

Low (NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Fragility unknown. CURRENTLY 13 PLANTS KNOWN. 1 HISTORICAL OCCURRENCE. (NatureServe, 2015). Low resiliency, representation and redundancy are inferred based on there being only one known occurrence of this species with a low number of individuals and the species apparent restricted habitat requirements (restricted to the Wahiawa Drainage Basin) (NatureServe, 2015) New Status Information: In addition to those populations cited in the previous 5-year review, new observations include the following: • At the time of the last 5-year review in 2008 there were two populations totaling fewer than 20 individuals in the Wahiawa drainage on the island of Kauai. In 2016, the IUCN Red List of Threatened Species estimated there to be one population totaling six individuals (Clark 2016). Currently, there are two populations in the same area totaling approximately 30 individuals (one location with seven plants) (PEPP 2017). It may be possible that the IUCN Red List accidentally omitted the larger population (USFWS, 2017).

Threats and Stressors

Stressor: Feral pigs (USFWS, 2008)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Habitat degradation and browsing by feral pigs is a major threat to this species (USFWS, 2008).

Stressor: Invasive plants (USFWS, 2008)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Habitat degradation by and competition with introduced invasive plant species is a major threat to this species (USFWS, 2008).

Stressor: Stochastic events (USFWS, 2008)

Exposure:

Response:

Consequence: Extinction

Narrative: Risk of extinction from stochastic events such as landslides and other erosion, and hurricanes is a major threat to this species (USFWS< 2008).

Stressor: Reduced reproductive vigor (USFWS, 2008)

Exposure:

Response:

Consequence: Extinction

Narrative: Reduced reproductive vigor due to the small number of wild individuals is listed as a threat to this species (USFWS, 2008).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Viola helenae* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.744 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this species has no overlap between current and future climate envelopes, and is unlikely to tolerate expected changes in climate at its current location. This means that this species must persist within suitable microrefugia, or move to newly available climate-compatible areas to avoid extinction. Therefore, additional management actions are needed to conserve this taxon into the future.

Recovery

Reclassification Criteria:

The five listed Wahiawa species can be considered for down-listing to threatened status once: (1) the population of each species has been stabilized by removal of threats; (2) each species occurs in at least three populations, each with at least 250 reproductive individuals; and (3) the full genetic diversity of each population is backed up as living and stored material at one or more nurseries or botanical gardens. These populations should be as genetically diverse as possible, and if artificially established, they must be within the historical range of the species. Each species should be able to reproduce naturally, i.e. , complete its life cycle within the population areas, with percentages of adults, juveniles and seedlings necessary for long-term maintenance of population numbers and genetic diversity. This objective is considered to be biologically reasonable and attainable, but it should be reevaluated as new information becomes available (USFWS, 1994).

Delisting Criteria:

The target for delisting includes locating, or establishing if necessary, at least 2 additional wild populations, for a total of at least 5 reproductively stable populations, each with at least 250 reproductive individuals, per species. These populations should be stable over an estimated ten year period. Further field exploration on Kaua'i is likely to yield additional populations of at least some of these species. If more populations are discovered, they should be augmented to reach the target size. If new populations are established, they should have optimum genetic

composition and be within the historical range of the species. All five populations should be unmanipulated and able to sustain themselves indefinitely without such human intervention as fencing and alien plant control. The numbers of individuals and populations given in the above objectives were chosen, based on our current understanding of these species, they should provide for the maintenance of the majority of the genetic diversity of each species, and provide some assurance that a single catastrophic event will not destroy all members of a species. Much basic research on the life history and reproductive biology of all five species needs to be conducted in order to ascertain whether these objectives are indeed valid. This recovery plan should, therefore, be modified to incorporate any new information as it becomes available (USFWS, 1994).

Recovery Actions:

- Recommendations for Future Actions: No new threats and no other significant new information regarding the species' biological status have been reported since the last 5-year review in 2008. Therefore, the following recommendations for future actions are reiterated for the 5-year review for 2017.
- Surveys and inventories—Search for new populations of *Viola helenae*, and regularly visit the sites where the species formerly grew to search for any seedlings that might germinate at the sites from a seedbank.
- Ungulate monitoring and control—Continue to construct and maintain small-scale fenced exclosures around all populations to prevent imminent extinction. Continue to protect all occurrences against disturbances from feral ungulates.
- Invasive plant monitoring and control—
 - o Control established ecosystem-altering nonnative invasive plant species around all populations.
 - o Control invasive nonnative plant species around all populations that compete with the species.
- Captive propagation protocol—Determine best method for seed germination to produce more individuals for reintroduction.
- Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock.
- Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historical range that is being managed for known threats to this species.
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered throughout historic range to reduce impacts from landslides and erosion.
- Population biology research—Study *Viola helenae* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Search for new populations of *Viola helenae*, and regularly visit the sites where the species formerly grew to search for any seedlings that might germinate at the sites from a seedbank (USFWS, 2008).
- Control introduced invasive plant species around the remaining population (USFWS, 2008).
- Fence the remaining population to control ungulates (USFWS, 2008).
- Find the most effective propagation method, and best horticultural techniques for growing this species (USFWS, 2008).
- Study new or reintroduced *Viola helenae* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2008).
- Develop a plan for conserving the species' genetic diversity in ex situ collections and in reintroduced populations (USFWS, 2008).

- New Management Actions: • NTBG and PEPP have been collecting seeds from both populations for storage and propagation at Lyon Arboretum and the Kokee Rare Plant Facility (NTBG 2017; PEPP 2010, 2011, 2012, 2013, 2014, 2015, 2016). There is one founder from the larger population represented at the Kokee Rare Plant Facility (DOFAW 2016). There is one founder at the NTBG nursery (NTBG 2017). • PEPP has outplanted four individuals in a fenced enclosure at Kanaele Bog (PEPP 2011, 2014). In 2014, two outplanted individuals remained. Currently, all plants have died (PEPP 2017). • Lyon Arboretum has one founder represented in tissue culture. There are two founders from the small population and eight founders from the larger population represented in the seed bank (Lyon Arboretum 2017).

References

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SPECIES ACCOUNT: *Viola kauaiensis* var. *wahiawaensis* (Nani wai`ale`ale)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

A perennial herb with subterranean rhizomes. Flowers are solitary. Petals are white on the upper surface; the lower surface is purple or blue to white. (NatureServe, 2015)

Taxonomy

Charles Noyes Forbes collected a specimen of *Viola kauaiensis* var. *wahiawaensis* on Kauai in 1909. In 1920, he described the variety, naming it for Wahiawa Bog where it was first collected (USFWS 1996) (USFWS, 1998).

Historical Range

See current range/distribution

Current Range

Current range: Wahiawa area of Kauai; historically no additional range. Genus widespread in temperate regions of world. Species endemic to Kauai and Oahu, variety endemic to Kauai.

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designate critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Viola kauaiensis* var. *wahiawaensis* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Viola kauaiensis* var. *wahiawaensis* includes one unit totaling 1,623 acres in Kauai county, Hawaii. The unit is Kauai 10—*Viola kauaiensis* var. *wahiawaensis*—a.

Unit description not available.

Primary Constituent Elements/Physical or Biological Features

Within this unit, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) *Machaerina angustifolia* *Rhynchospora rugosa* lowland bog or mixed wet shrubland and adjacent *Metrosideros polymorpha* wet forest and containing one or more of the following native plant species: *Antidesma platyphyllum* var. *hillebrandii*, *Bidens forbesii*, *Chamaesyce remyi*, *Chamaesyce sparsiflora*, *Coprosma* spp., *Cyanea fissa*, *Dicranopteris linearis*, *Diplopterygium pinnatum*, *Dubautia imbricata*, *Dubautia raillardii*, *Gahnia vitiensis*, *Leptochophylla tameiameia*, *Lobelia kauaensis*, *Machaerina angustifolia*, *Machaerina*

mariscoides, Melicope spp., Psychotria wawrae, Sadleria pallida, Scaevola gaudichaudii, Sphenomeris chinensis, Syzygium sandwicensis, Tetraplasandra oahuensis, or Vaccinium dentatum; and

(ii) Elevations between 394 and 1,006 (1,291 and 3,301 ft).

Special Management Considerations or Protections

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Two types of flowers are present. One is self-pollinating and does not open, while the other opens and requires cross-pollination. Five plants were seen flowering by botanists from the National Tropical Botanical Garden while conducting a bog survey in December 1994 (Steve Perlman, personal communication 1997). No additional life history information for this species is currently available (USFWS, 1998).

Habitat Type

Adult: Montane bogs (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 1998)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1998)

Site Fidelity

Adult: High (inferred from USFWS, 1998)

Habitat Narrative

Adult: Wet habitats. Montane bogs, and on ridges. (NatureServe, 2015). *Viola kauaiensis* var. *wahiawaensis* is found in open bog surrounded by low scrub of ohia, uluhe *Diplopterygium pinnatum* and ohia ha at about 640 meters (2,100 feet) elevation and in wet shrubland dominated by uluhe ground cover, with scattered ohia and *Syzygium* sp., at about 865 meters (2,840 feet) elevation (USFWS 1996) (USFWS, 1998). High ecological integrity of the population and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of the species and the fact that there is only one known population.

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: No information found

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Fragility unknown. No counts or estimates. 1 current and no historical occurrences. (NatureServe, 2015). Low resiliency, redundancy and representation are inferred based on the fact that there are only two known populations with few individuals (NatureServe, 2015). New Status Information: In addition to those populations cited in the previous 5-year review, new observations include the following: • At the time of the last 5-year review in 2009 there were two populations totaling fewer than 50 individuals in the Wahiawa bog and on the ridge between the summits of Kapalaoa and Kahili on the island of Kauai. Currently, there is one population in the same area totaling between one and two individuals (PEPP 2017; Walsh 2017, in litt.). Another population of more than 100 individuals was discovered at Kawaikini; however, the identity of these plants has not been confirmed (PEPP 2015) (USFWS, 2017).

Threats and Stressors

Stressor: Reduced vegetative vigor (USFWS, 2009)

Exposure:

Response:

Consequence: Extinction

Narrative: Reduced reproductive vigor due to the small number of existing populations and individuals is considered one of the main threats to this species (USFWS, 2009).

Stressor: Feral pigs (USFWS, 2009)

Exposure:**Response:**

Consequence: Loss of habitat/habitat degradation

Narrative: Habitat degradation from the rooting activities of feral pigs (*Sus scrofa*) is a major threat to this species (USFWS, 2009).

Stressor: Invasive plants (USFWS, 2009)

Exposure:**Response:**

Consequence: Loss of habitat

Narrative: Competition with introduced invasive plants such as *Juncus planifolius* (broadleaf rush) and *Pterolepis glomerata* (False meadowbeauty) (Factor E) (Lorence and Flynn 1991; Wood 1994; USFWS 1996, 1998, 2003) is listed as a threat to this species (USFWS, 2009).

Stressor: Over collection (USFWS, 2009)

Exposure:**Response:**

Consequence: Loss of individuals

Narrative: Collection other than for conservation purposes is considered a threat to this species due to the detrimental effect that collection may pose to the small population (Factor B) (USFWS 1998, 2003) (USFWS, 2009).

Stressor: Climate change loss or degradation of habitat

Exposure:**Response:****Consequence:**

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Viola kauaensis* var. *wahiawaensis* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.622 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future.

Recovery**Reclassification Criteria:**

For downlisting, a total of five to seven populations of each taxon should be documented on Kauai where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1998).

Delisting Criteria:

For delisting, a total of 8 to 10 populations of each taxon should be documented on Kauai where they now occur or occurred historically. Each of these populations must be naturally

reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1998).

Recovery Actions:

- Recommendations for Future Actions: Since the last 5-year review in 2009, a new population of *Viola* was observed, but it is uncertain at this time if it is *Viola kauaensis* var. *wahiawaensis*. Therefore, the following recommendations for future actions reflect this potentially new population and are reiterated for the 5-year review for 2017. • Surveys and inventories—Survey geographical and historic range for a thorough current assessment of the species. • Ungulate monitoring and control—Continue to construct and maintain small-scale fenced exclosures around all populations to prevent imminent extinction. Continue to protect all occurrences against disturbances from feral ungulates. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative plant species around all populations that compete with the species. • Captive propagation for genetic storage and reintroduction—Implement propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Population biology research—Study *Viola kauaensis* var. *wahiawaensis* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. • Species identification and taxonomy – Determine the species of the *Viola* population discovered at Kawaikini (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Collect genetic resources for storage, future propagation and reintroducing into protected suitable habitat within historical range (USFWS, 2009).
- Enhance current natural population to increase numbers of individuals and establish new populations as material becomes available from propagation (USFWS, 2009).
- Expand existing exclosure fences to protect all individuals from the negative impacts of feral pigs and construct new fences within suitable habitat, and eradicate introduced invasive plant species within the exclosures (USFWS, 2009).
- Work with the Kauai Watershed Alliance to continue and expand ecosystem-level management of the Wahiawa Bog area (USFWS, 2009).
- Survey geographical and historical range for a thorough current assessment of the species (USFWS, 2009).
- Assess genetic variability of extant populations (USFWS, 2009).
- Study *Viola kauaensis* var. *wahiawaensis* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2009).
- New Management Actions: • PEPP has outplanted four individuals in a fenced exclosure at Kanaele Bog and monitors this area (PEPP 2015). • We are unaware of any ex situ collections of this species.

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SPECIES ACCOUNT: *Viola lanaiensis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/20/1991; Pacific Region (R1) (USFWS, 2016)

Physical Description

A small, erect, unbranched or few-branched subshrub 10-40 cm tall. Leaves long and narrow, and are clustered toward the upper part of the stem. Flowers are white tinged purple or with purple veins. (NatureServe, 2015)

Taxonomy

Viola lanaiensis was first formally described by Rock as a variety of *Viola helenae* (*Viola helenae* var. *lanaiensis*) from his own collection of the plants from 1910 (Rock 1911). Before *Viola helenae* had been described (Forbes 1909), Hillebrand (1888) had noted that a plant collected by Remy on Lana'i was probably *Viola robusta*. This plant must have been *Viola lanaiensis*, since it is the only taxon of *Viola* that occurs on Lana'i (Becker 1916, MacCaughey 1918, St. John 1989, Skottsberg 1940, Wagner et al. 1990). Wilhelm Becker described the taxon as *Viola lanaiensis* (Becker 1916) independently and without knowledge of Rock's 1911 publication (USFWS 1991). Skottsberg accepted Rock's taxonomy (Skottsberg 1940), but St. John reinstated Becker's designation of the plant as a separate species (St. John 1979) (USFWS, 1994).

Historical Range

See current range/distribution

Current Range

Current range: Lanai. Historically no additional range.

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Viola lanaiensis* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes an unknown number of critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Viola lanaiensis* includes an unknown number of CHUs in Maui County, Hawaii. The number of CHUs is unknown because detailed CHU information is not available for the island of Lanai (81 FR 17790-18110).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Viola lanaiensis* critical habitat consists of three components. Montane wet (Lanai), Dry cliff (Lanai) and Wet cliff (Lanai) (81 FR 17790-18110):

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Ecosystem: Dry Cliff. Elevation: unrestricted. Annual precipitation: <75 in (<190 cm). Substrate: >65 degree slope, rocky talus. Canopy: None. Subcanopy: *Antidesma*, *Chamaesyce*, *Diospyros*, *Dodonaea*. Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Schiedea*.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. Understory: Bryophytes, Ferns, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire,

drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Unknown (USFWS, 1994)

Reproduction Narrative

Adult: When approximately 21 plants were observed in October 1992 (R. Hobdy, L. Loope, A. Medeiros, and P. Thomas, personal observation 1992), one small fruit was noted; however, October may not have been the optimum time to observe flowering or fruiting. One sighting of this plant was on a relatively new landslide CHHP 1991); the rapid establishment of this taxon under these circumstances may reflect a high sensitivity to competition. Flowering time, pollination vectors, seed dispersal agents, longevity of plants and seeds, specific environmental requirements, and other limiting factors are unknown (USFWS, 1994).

Habitat Type

Adult: Moist forests and wet cloud forests (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (Inferred from USFWS, 2012)

Environmental Specificity

Adult: Narrow/specialist (Inferred from USFWS, 2012)

Tolerance Ranges/Thresholds

Adult: Low (Inferred from USFWS, 2012)

Site Fidelity

Adult: Low (Inferred from USFWS, 2012)

Habitat Narrative

Adult: Species inhabits moist forests and wet cloud forests on gulch slopes and gulch bottoms (NatureServe, 2015). The habitat of the Awehi population of *Viola lanaiensis* is stratified, with the middle to upper slopes consisting of *Metrosideros polymorpha* (ohia)- *Dicranopteris linearis* (uluhe) lowland mesic forest. A distinct change occurs along the lower slopes, where the community is composed of *Nestegis sandwicensis* (olopua), *Myrsine lanaiensis* (kolea), *Scaevola chamissoniana* (naupaka), *Kadua affinis* (manono), *Antidesma platyphyllum* (hame), *Pouteria sandwicensis* (alaa), and *Freycinetia arborea* (ieie) (Hawaii Biodiversity and Mapping Program 2010; H. Oppenheimer, pers. comm. 2010). At Kunoa Gulch, *Viola lanaiensis* is found in a *Metrosideros polymorpha**Dicranopteris linearis* lowland wet to riparian forest associated with *Pittosporum confertiflorum* (hoawa), *Pipturus albidus* (mamaki), *Perrottetia sandwicensis* (olomea), *Scaevola chamissoniana*, *Broussaisia arguta* (kanawao), *Cyrtandra grayana* (haiwale), *Freycinetia arborea*, *Sadleria pallida* (amau), and *Diplopterygium pinnatum* (uluhe lau nui) (Wood 2005). The discovery of a colony of 27 individuals (all size classes) of *Viola lanaiensis* in Kunoa Gulch in 1991 on a relatively new landslide suggests that it is a pioneer species that does not respond well to competition (USFWS 1995; Hawaii Biodiversity and Mapping Program 2010; H. Oppenheimer, pers. comm. 2010). Havran (2008) characterized known populations as typically being distributed on steep banks dominated by *Metrosideros polymorpha* (ohia), but was unable to conclude whether extant populations represent the optimal range of this species, or whether the species has been displaced from its preferred native range by invasive introduced plants and ungulates (USFWS, 2012). Clumped spatial arrangement of the population, narrow environmental specificity, low tolerance ranges and high site fidelity and

ecological integrity of the population are inferred based on the specific habitat requirements of this species and the apparent need for a lack of competition in order to truly thrive in its habitat.

Dispersal/Migration**Dispersal**

Adult: Unknown (USFWS, 1994)

Dispersal/Migration Narrative

Adult: Seed dispersal agents are unknown (USFWS, 1994)

Population Information and Trends**Population Trends:**

Decreasing (USFWS, 2012)

Resiliency:

Low (inferred from USFWS, 2012)

Representation:

Low (inferred from USFWS, 2012)

Redundancy:

Low (inferred from USFWS, 2012)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Fragility unknown. Fewer than 90 plants known. 3 current (between 1982 and 1997) and 7 historical occurrences. (NatureServe, 2015). In 1991, there were 38 to 40 individuals in the vicinity of Kunoa Gulch (Hawaii Biodiversity and Mapping Program 2010). These populations have not since been reported as extant, but Wood (2005) reported a new sighting of a single individual in 1997 in Kunoa Gulch (Hawaii Biodiversity and Mapping Program 2010). Subsequently, no individuals were observed in Kunoa until nine individuals were found scattered in the main gulch and a tributary in 2007 (Plant Extinction Prevention Program 2007). In 2008, an additional four individuals were found in another subgulch (Plant Extinction Prevention Program 2008). The latest census totals are: two populations (Kunoa Gulch and Awehi) with 20 mature individuals (Plant Extinction Prevention Program 2009, 2010; USFWS 2010) and 6 seedlings (H. Oppenheimer, pers. comm. 2010) (USFWS, 2012). Low resiliency, representation and redundancy are inferred based on the low number of individuals and populations as well as the specific habitat requirements for the species (USFWS, 2012). New Status Information: • A new population of 140 individuals of *Viola* sp. was discovered on west Maui in 2010. The genetic and morphological analysis by Havran et al. (2012) showed that the west Maui population is indistinguishable from (conspecific with) *Viola lanaiensis*. It is not known whether the

populations on Lānaʻi and west Maui represent vestiges of a much larger population that was continuous throughout Maui Nui, or if the presence of the species on either island represents the result of interisland dispersal (Havran et al. 2012). • Currently, there are three populations on Lanai totaling approximately 300 individuals and two subpopulations on west Maui totaling about the same number of individuals (Oppenheimer 2018, in litt.; PEPP 2012, 2015, 2017a, b, 2018). The population at Kunoa Gulch on Lānaʻi is gone (Oppenheimer 2018, in litt.). • In 2012, the Service revised critical habitat for *Viola lanaiensis*, and the proposed rule identified six critical habitat units in three ecosystems (montane wet, dry cliff, and wet cliff) on Lānaʻi (2,044 ac, 828 ha) (77 FR 34464, July 11, 2012). In the final rule, the Service excluded critical habitat for this species on the island of Lānaʻi because, as demonstrated by the ongoing conservation activities by the private landowner, their commitment to develop the Lānaʻi Natural Resources Plan, and a memorandum of understanding with the Service, exclusion from critical habitat would provide greater long-term benefits to the species than designation of critical habitat (USFWS 2015; 81 FR 17790, March 30, 2016). • In 2016, no critical habitat units were designated on west Maui for *V. lanaiensis* because the identity of the west Maui occurrence was not assured at the time of document preparation (USFWS, 2018).

Threats and Stressors

Stressor: Ungulate degradation (USFWS, 2012)

Exposure:

Response:

Consequence: Habitat loss/habitat degradation

Narrative: Ungulate degradation of habitat – Axis deer (*Axis axis*) (Plant Extinction Prevention Program 2008, 2009, 2010; Hawaii Biodiversity and Mapping Program 2010; H. Oppenheimer, pers. comm. 2010) (USFWS, 2012).

Stressor: Invasive plants (USFWS, 2012)

Exposure:

Response:

Consequence: Habitat loss/habitat degradation

Narrative: Established ecosystem-altering invasive plant species degradation of habitat (Plant Extinction Prevention Program 2008, 2009, 2010; Hawaii Biodiversity and Mapping Program 2010; H. Oppenheimer, pers. comm. 2010) o *Melinis minutiflora* (molasses grass) o *Morella faya* (firetree) o *Psidium cattleianum* (strawberry guava) o *Rubus rosifolius* (thimbleberry). Established invasive plant species competition (Plant Extinction Prevention Program 2008, 2009, 2010; Hawaii Biodiversity and Mapping Program 2010; Wood 2005; H. Oppenheimer, pers. comm. 2010) o *Adiantum hispidulum* (rough maiden-hair) o *Blechnum appendiculatum* (palm fern) o *Christella parasitica* (no common name) o *Cinnamomum burmanii* (Padang cassia) o *Deparia petersenii* (no common name) o *Leptospermum scoparium* (New Zealand tea) o *Pluchea carolinensis* (sourbush) (USFWS, 2012).

Stressor: Landslides and flooding (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Landslides and flooding (Plant Extinction Prevention Program 2008, 2009, 2010; Hawaii Biodiversity and Mapping Program 2010; H. Oppenheimer, pers. comm. 2010) (USFWS, 2012).

Stressor: Ungulate predation or herbivory (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Ungulate predation or herbivory – Axis deer (Plant Extinction Prevention Program 2008, 2009, 2010; Hawaii Biodiversity and Mapping Program 2010; H. Oppenheimer, pers. comm. 2010) (USFWS, 2012).

Stressor: Rodent predation or herbivory (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Rodent predation or herbivory – Rats (*Rattus* spp.) (Plant Extinction Prevention Program 2008, 2009, 2010; Hawaii Biodiversity and Mapping Program 2010; H. Oppenheimer, pers. comm. 2010) (USFWS, 2012).

Stressor: Nonnative bird predation (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Nonnative bird predation (Plant Extinction Prevention Program 2008, 2009, 2010; Hawaii Biodiversity and Mapping Program 2010; H. Oppenheimer, pers. comm. 2010) o Feral turkeys (*Meleagris gallopavo*) o Chickens (*Gallus gallus domesticus*) o Black francolin (*Francolinus francolinus*) (USFWS, 2012).

Stressor: Fire (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Fire is listed as a threat to this species (USFWS, 2012).

Stressor: Drought (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Drought is listed as a threat to this species (USFWS, 2012).

Stressor: Ungulate trampling (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Ungulate trampling is listed as a threat to this species (USFWS, 2012).

Stressor: Low numbers (USFWS, 2012)

Exposure:**Response:****Consequence:** Extinction**Narrative:** Low numbers is listed as a threat to this species (USFWS, 2012).**Stressor:** Climate change (USFWS, 2012)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. We anticipate high spatial resolution climate outputs by 2013 (USFWS, 2012).**Stressor:** Predation and herbivory by slugs**Exposure:****Response:****Consequence:****Narrative:** Predation and herbivory by slugs is noted to be a threat to *Viola lanaiensis* on west Maui (Oppenheimer 2018, in litt.; PEPP 2017a).**Stressor:** Climate change loss or degradation of habitat**Exposure:****Response:****Consequence:****Narrative:** We previously reported that climate change may pose a threat to this species, anticipating an analysis by 2013. The assessment conducted by Fortini et al. (2013) concluded that *Viola lanaiensis* is extremely vulnerable to the impacts of climate change, with a vulnerability score of 0.922 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, the assessment classified *V. lanaiensis* as a “wink-out” species. “Wink-out” species are those species with no future climate envelope. No projected suitable climate areas exist for the species to persist in the future. Therefore, additional management actions are needed to conserve this taxon into the future, such as identifying suitable microsites where climate change is anticipated to occur more slowly and considering suitable habitat on islands outside of its known range.**Recovery****Reclassification Criteria:**

For downlisting, a total of five to seven populations of each taxon should be documented on Lanai and at least one other island where they now occur or occurred historically. In certain cases, however, a particular taxon may be eligible for downlisting even if all five to seven of the populations are on only one island, provided all of the other recovery criteria have been met and the populations in question are widely distributed and secure enough that one might reasonably conclude that the taxon is not in danger of extinction throughout all or a significant part of its range. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population

for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1994).

Delisting Criteria:

For delisting, a total of 8 to 10 populations of each taxon should be documented on Lanai and at least 1 other island where they now occur or occurred historically. As with downlisting, there may be cases in which a particular taxon may be eligible for delisting even if all 8 to 10 of the populations are on only 1 island, provided all of the other recovery criteria have been met and the populations in question are widely distributed and secure enough that one might reasonably conclude that the taxon is not likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1994).

Recovery Actions:

- Current conservation efforts: ? Ungulate enclosure: o Castle and Cooke have begun the construction of approximately 35 kilometers (22 miles) of fencing around Lanai Hale to control the depredations of feral axis deer. The fence will be completed in three increments. The first increment is completed and the second increment is well under construction (H. Oppenheimer, pers. comm. 2010). o The Awehi population is in a fenced enclosure of about 2 hectares (5 acres). Besides *Viola lanaiensis*, the Awehi enclosure also protects the only two known individuals of *Cyanea munroi*, several individuals *Labordia tinifolia* var. *lanaiensis*, and *Pleomele fernaldii*. o Staff of the Maui Nui Plant Extinction Prevention Program inspect the fenced enclosure at Awehi on a regular basis and makes repairs as necessary. Currently, erosion is undermining the fence, which was not constructed with a complete ground secured apron around the perimeter (H. Oppenheimer, pers. comm. 2010) (USFWS, 2012).
- Current conservation efforts: ? Captive propagation for genetic storage and reintroduction: o In 2011, the National Tropical Botanical Garden (2011) reported 31 seeds in genetic storage. o The Plant Extinction Prevention Program (2009) reported a single immature fruit was collected from the Awehi population for tissue culture by Lyon Arboretum; seeds have been collected several times but have not been successfully germinated (H. Oppenheimer, pers. comm. 2010). o The Lyon Arboretum Micropropagation Laboratory reported a single individual in genetic storage (Harold L. Lyon Micropropagation Laboratory 2010). ? Population viability monitoring – Individuals located within the Awehi enclosure and at Kunoa Gulch have all been numbered, tagged, and mapped with a Global Positioning System to ensure traceable seed parentage, and are being closely monitored for seed production (Plant Extinction Prevention Program 2007; H. Oppenheimer, pers. comm. 2010) (USFWS, 2012).
- Recommendations for Future Actions: Herbivory by slugs is noted as a new threat to the species; however, we are not aware of significant new information regarding the species' biological status since the last 5-year review in 2012. Thus, the following recommendations for future actions are added or reiterated for the 5-year review for 2018. • Surveys and inventories—Continue to conduct thorough surveys of suitable habitat where *Viola lanaiensis* was last observed. • Ungulate monitoring and control— o Protect all populations from disturbances by feral ungulates. o Complete the Lānaʻihale fencing project and repair

fence apron to prevent ungulate ingress. o Monitor all fences, including those at 'Āwehi and Puhielelu on Lāna'i. o Assess the need for fencing at the west Maui occurrences. • Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around populations of *V. lanaiensis*. • Habitat and natural process management and restoration—Develop and implement effective measures to reduce the impacts of tree fall, drought, landslides, and erosion. • Captive propagation for genetic storage and reintroduction— o Continue to collect seeds and track individuals carefully for use in ex situ propagation to maximize genetic variation. o Continue to collect soil from areas of previously known individuals for germination trials. • Reintroduction and translocation— o Continue to reintroduce individuals at protected sites within historical range. o Determine new sites for reintroduction that have the highest likelihood of success. • Predator and herbivore control— o Implement effective control methods for rats. o Determine and implement effective control methods for slugs. o Study the impact of predation by nonnative birds and if necessary, determine and implement effective control methods. o Monitor wild and reintroduced populations of *V. lanaiensis* for evidence of insects and diseases, and implement effective control methods if necessary. • Climate change adaptation strategy—Assess the effects of climate change on this species and use to determine future landscape needed for the recovery of the species. • Alliance and partnership development—Work with the Hawai'i Division of Forestry and Wildlife, the PEPP, Pūlama Lāna'i, and other land managers to initiate planning and contribute to ecosystem-level restoration and management to benefit this species (USFWS, 2018).

Conservation Measures and Best Management Practices:

- ? Captive propagation for genetic storage and reintroduction o Continue to collect seeds from tagged individuals, keeping close track of the maternal source for use in ex situ propagation. o Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation (USFWS, 2012).
- Reintroduction / translocation protocol development – Maximize the genetic variation among individuals at each reintroduction site, based on microsatellite data and detailed information from crossing records (USFWS, 2012).
- Reintroduction / translocation site identification – While surveying for new populations or reintroduced populations, determine which sites are least invaded by invasive introduced plant species and which appear to have the highest likelihood of maintaining new reintroductions (USFWS, 2012).
- Reintroduction / translocation implementation – Once sites are identified and protected from feral ungulates, reintroduce the species back into its known historical range (USFWS, 2012).
- Ungulate exclosure: o Complete repairs of fenced exclosure at Awehi by securing an apron around the perimeter of the fence to prevent erosion. o Complete the Lanaihale fencing project. o Continue to monitor all fences for any signs of breaching (USFWS, 2012).
- Ungulate control – Protect all populations against disturbances from feral ungulates (USFWS, 2012).
- Ecosystem-altering invasive plant species control – Control invasive introduced plant species around all populations (USFWS, 2012).
- Predator / herbivore control – Implement effective control methods for rodents (USFWS, 2012).
- Threats research – Study the impact of nonnative bird predation on populations of *Viola lanaiensis*. If necessary determine and implement effective control methods (USFWS, 2012).

- Threat monitoring and control – Monitor newly established reintroduced and wild populations for evidence of plant disease and insect predation. If threats are found implement effective control methods (USFWS, 2012).
- Site / area / habitat protection – Develop and implement effective measures to reduce the impact of tree fall, drought, and landslides and erosion (USFWS, 2012).
- Surveys / inventories – Continue to conduct thorough surveys of all suitable habitats where *Viola lanaiensis* was historically seen (USFWS, 2012).
- Alliance and partnership development – Work with Castle and Cooke and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2012).
- Threats research – Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2012).
- New Management Actions:
 - Surveys and inventories—The Plant Extinction Prevention Program (PEPP) surveys for new populations and monitors the known population of *Viola lanaiensis* on Lanai and west Maui (PEPP 2012, 2013, 2014, 2015, 2016, 2017a, 2018). Soil samples at Kunoa Gulch and Puhielelu on Lanai are tested for possible seed banks.
 - Ungulate monitoring and control—Fences are checked and repaired as necessary (PEPP 2015, 2016).
 - Invasive plant monitoring and control—PEPP monitors and controls nonnative plants at all occurrences of *V. lanaiensis* (PEPP 2012, 2013, 2014, 2015, 2016, 2017a, 2018).
 - Captive propagation for genetic storage and reintroduction—
 - o PEPP collects seeds for storage at Lyon Arboretum and for propagation at the Olinda Rare Plant Facility (ORPF) (PEPP 2012, 2016, 2017a).
 - o The Lyon Arboretum micropropagation facility reported 142 containers of propagules of *Viola lanaiensis* in storage. The Lyon Arboretum Seed Conservation Laboratory reported 130 seeds in storage from the Awehi population in 2013; 2,166 seeds in storage in from 'Āwehi and 22 seeds from Launiupoko in 2014; 87 seeds in storage from 'Āwehi in 2015, and 2 seeds in storage from Launiupoko in 2016, for a total of over 2,400 seeds (Lyon Arboretum 2017).
 - o The Olinda Rare Plant Facility (ORPF) reported seven plants in propagation representing four individuals from Puhielelu (ORPF 2013, 2014, 2015, 2017).
 - Reintroduction and translocation—In 2013, four individuals were outplanted at Lihau on west Maui. In 2014, 14 individuals were outplanted at Launiupoko on west Maui. In 2015, four individuals were outplanted at Awehi on Lanai. In 2018, 56 were outplanted at Awehi, with 35 currently remaining at that site (PEPP 2013, 2014, 2015, 2018).

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SPECIES ACCOUNT: *Viola oahuensis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

Viola oahuensis is a woody shrub and member of the Violaceae (violet family). Similar to *V. chamissoniana*, this growth habit is unusual in the genus as most non Hawaiian species of *Viola* are small herbs. *Viola oahuensis* is an erect, usually unbranched sub-shrub which ranges in height from 6 to 40 cm (2.4 to 15.7 in). The elliptic leaves are somewhat clustered at the ends of the branches. The pale yellow flowers occur on stalks of one to two flowers with petals that range from 8 to 16 mm (0.3 to 0.6 in). Fruits are 9 to 16 mm (0.4 to 0.6 in) long and contain ovoid pale brown seeds (Wagner et al. 1999).

Historical Range

Historically, *Viola oahuensis* was known from 17 occurrences scattered over approximately 37 km (23 mi) from Puu Kainapuaa to Palolo in the Koolau Mountains of Oahu.

Current Range

Only eight occurrences, with 329 individuals, are now extant. These are found between Kawainui-Koloa summit divide and Waimalu-Koolaupoko divide, specifically in the following locations: north and south Kaukonahua (22 individuals), Kamananui Gulch (1), Kawainui-Koloa Ridge (29), north Kaukonahua (5), Kawai Iki to Halemano (greater than 100), Konahuanui (22), Koolau summit between Kipapa and Manana (100), and Wailau-Kahaluu summit ridge (50) (HINHP Database 2001; J. Lau, HINHP, pers. comm. 2003; K. Kawelo, U.S. Army, pers. comm. 2003).

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Viola oahuensis* under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Viola oahuensis* (77 FR 57648-57862). The critical habitat designation includes 14 critical habitat units, which encompass approximately 30,056 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Viola oahuensis* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Viola oahuensis* includes 14 critical habitat units, covering two ecosystem types, which encompass approximately 30,056 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; Oahu—Wet Cliff—Units 6, 7, 8.

Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Hauula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikēkee, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet—Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet—Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu—Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamo Ridge.

Oahu—Wet Cliff—Unit 6 [151 ac (61 ha)]. This area consists of 151 ac (61 ha) in the wet cliff ecosystem on State land on the windward side of the Koolau Mountains in Kaipapau Gulch, entirely within the Kaipapau Forest Reserve. Oahu—Wet Cliff—Unit 7 [144 ac (58 ha)]. This area consists of 144 ac (58 ha) in the wet cliff ecosystem in State land on the windward side of the Koolau Mountains in Hauula Gulch, entirely within the Hauula Forest Reserve. Oahu—Wet Cliff—Unit 8 [4,649 ac (1,881 ha)]. This area consists of 1,479 ac (598 ha) of State land, 1,281 ac (519 ha) of City and County of Honolulu land, 5 ac (2 ha) of Federal land, and 1,884 ac (762 ha) of

privately owned land, in the wet cliff ecosystem along the summit of the Koolau Mountains, overlapping portions of Sacred Falls State Park, the Waiahole FR (Waiahole and Iolekaa sections), the Kaneohe and Honolulu Watershed FRs, and the Nuuanu Pali State Wayside.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Viola oahuensis* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Viola oahuensis* occurs within the Lowland wet and Wet cliff ecosystems in the Koolau Mountain caldera complex:

Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (F) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Oahu—Wet Cliff—Units 6, 7, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: >65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: *Broussaisia*, *Cheirodendron*, *Leptecophylla*, *Metrosideros*. (F) Understory: Bryophytes, Ferns, *Coprosma*, *Dubautia*, *Kadua*, *Peperomia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Viola oahuensis* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: The species has been observed flowering in August and September but little else is known about its flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors. *V. oahuensis* is considered to be a short-lived perennial species (Service 1998a).

Habitat Type

Adult: wet shrublands and mixed montane bogs

Habitat Narrative

Adult: *Viola oahuensis* is generally found on exposed, windswept ridges at elevations that range from 415 to 959 m (1,361 to 3,146 ft). It occurs on moderate to steep slopes in wet

Metrosideros polymorpha-Dicranopteris linearis shrublands and M. polymorpha-mixed montane bogs of the cloud zone. V. oahuensis typically grows among wind-stunted Antidesma spp., Bidens macrocarpa, Broussaisia arguta, Cibotium spp., Dubautia laxa, Hedyotis terminalis, Labordia spp., Machaerina spp., Melicope spp., Sadleria spp., Syzygium sandwicensis, Vaccinium spp., and Wikstroemia spp. (HINHP Database 2001; Service 1998a; 61 FR 53089).

Dispersal/Migration

Population Information and Trends

Number of Populations:

8

Population Size:

329

Population Narrative:

Only eight occurrences, with 329 individuals, are now extant.

Threats and Stressors

Stressor:

Exposure:

Response:

Consequence:

Narrative: The primary threats to Viola oahuensis include predation and habitat destruction by feral pigs; competition for light, space, and nutrients from non-native plant species (e.g., Axonopus fissifolius, Clidemia hirta, Paspalum conjugatum, Psidium cattleianum, and Pterolepis spp.); reduced reproductive vigor due to the small number of occurrences; and risk of extinction from stochastic events (HINHP Database 2001; Service 1998 ; 61 FR 53089).

Recovery

Conservation Measures and Best Management Practices:

- A State-wide management plan should be developed and implemented for the long-term conservation of all known occurrences of Viola oahuensis. This plan should also include broader landscape actions that are needed for the recovery of this plant throughout its range. The recovery plan for this species identifies the following important conservation actions: construction of exclosures around all known occurrences of V. oahuensis to reduce and, ultimately, eliminate impacts from feral pigs. In areas where fencing is not possible due to severe topography or potential damage to plant communities, other means of pig control should be implemented. Immediate fencing and protection is needed for those which have only a few remaining individuals (e.g., scattered locations along the Kawanui-Koloa summit divide, Kaukonahua Ridge). The occurrences should also be monitored for the presence of competitive non-native plant species, and when detected these invasive plants should be removed (Service 1998a). Ongoing Conservation Actions: The Lyon Arboretum has Viola oahuensis seed in genetic storage (Service 2002). The Service is currently not aware of any other conservation efforts for this species.

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SPECIES ACCOUNT: *Warea amplexifolia* (Wide-leaf warea)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/29/1987; Southeast Region (R4)

Physical Description

Warea amplexifolia is an annual herb in the mustard family (Brassicaceae). Plants may be 30 to 100 cm tall and the stalk may be unbranched or, more often, branching midway up the stem. Leaves are alternate, from 2 to 5 cm long, and 1 to 3 cm wide, smaller as they ascend the stalk, with a rounded apex and entire margin. On young plants, the leaves are slightly folded along the midrib, tipped upward, and the lobes at the base of leaves reach around the stem. This characteristic has led to one of the common names for the species, clasping warea. The heart-shaped clasping leaf bases and its pale green, slightly glaucous leaves readily distinguish *W. amplexifolia* from the three other species in its genus in Florida. The characteristic leaves can be used in field identification even if the plants are not flowering. The pale lavender flowers of *W. amplexifolia* vary in individuals from almost white to almost purple. Flowers appear at the ends of the branches in spherical clusters about 5 to 6 cm across. Superficially, the flowers look like small versions of the garden cleome (*Cleome hasslerana*), a member of the family Capparaceae. The inflorescences are dainty, and in the field the flowering plants look almost fluffy. Individual flowers are about 1.5 cm across, with four petals and six long stamens. *Warea amplexifolia* is also readily identifiable in seed, even as the stalk turns brown and the leaves wither, by the clusters of narrow down-curving seed pods, from 5 to 7 cm long. The pods split longitudinally, with small black seeds on either side of the center membrane. (USFWS, 1999)

Taxonomy

Warea amplexifolia was originally described by Thomas Nuttall in 1822 from a specimen collected in central peninsular Florida by N.A. Ware. Nuttall at first placed this plant in the genus *Stanleya*, but in 1834 transferred it to the genus *Warea* and provided an amplified description that accommodated specimens from the Florida panhandle. The panhandle specimens were later recognized as a distinct species, *Warea sessilifolia*, by Nash. Shinnars (1962) proposed a new name for the peninsular species, *Warea auriculata*, but most authors consider *W. amplexifolia* the correct name (Payson 1922, Channell and James 1964, Judd 1980). (USFWS, 1999)

Historical Range

Judd (1980) believed the former range of *W. amplexifolia* included Lake County, western Orange County, extreme northwestern Osceola County, and northern Polk County, Florida. (USFWS, 1999)

Current Range

Endemic to the Lake Wales Ridge of central Florida in Lake, Orange, and Polk counties (USFWS, 2017)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources**Reproductive Strategy**

Adult: Sexual (Produces seeds) Abiotic (wind), Biotic (Hymenoptera; Lepidoptera) (USFWS, 1999)

Lifespan

Adult: Annual (USFWS, 1999)

Breeding Season

Adult: Flowering occurs from mid-August to early October, and fruiting occurs from late September to mid-November (USFWS, 1999)

Reproduction Narrative

Adult: *Warea amplexifolia* flowers from mid-August to early October, and fruiting occurs from late September to mid-November. Senescence occurs just before the fruit matures, and the population overwinters as seeds. The showy flowers are pollinated by various Hymenoptera (bees) and Lepidoptera (butterflies). Reproduction is exclusively sexual, with seeds probably released from the pods by wind action. The small seeds generally fall near the parent plant (FWS 1986). Experimental propagation to field plots at Bok Tower Gardens suggests that the number of flowering plants is related to the amount of rainfall during the December prior to the growing season. They also found that plants grew from seeds that had been sown into the experimental plots 2 to 4 years earlier, which indicates that seed banking in the soil is important in this species (Bok Tower Gardens 1994). (USFWS, 1999)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Oak sandhills and sand pine-scrub oak scrub (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Sunny openings with exposed sand in longleaf pine/turkey oak sandhills and sand pine-scrub oak scrub. (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (inferred from NatureServe, 2015)

Environmental Specificity

Adult: Narrow/Specialist (NatureServe, 2015)

Habitat Narrative

Adult: *Warea amplexifolia* is endemic to high pine ecosystems of Florida. The high pine refers to the hilly portions of the ecosystem rather than the stature of the pines themselves. The undulating xeric sand ridges supporting the high pine are known as sandhills and the entire community is referred to by the same term. Sandhills are maintained under natural conditions by frequent patchy summer fires sparked by lightning. The resulting habitat condition is an open, often sparse over-story plant assemblage of longleaf pine (*Pinus palustris*), longleaf

pine/turkey oak (*Quercus laevis*), or live oak/bluejack oak (*Q. geminata*/*Q. incana*) with an open, park-like understory. The ground cover consists of perennial grasses and forbs interspersed with deciduous clonal oaks (Myers 1990). *Warea amplexifolia* occurs on well-drained, sterile, yellow sands and is typically widely scattered in the sunny openings of the sandhills. (USFWS, 2017)

Dispersal/Migration**Motility/Mobility**

Adult: Moderate (NatureServe, 2015)

Dispersal

Adult: Abiotic (wind) (NatureServe, 2015)

Dispersal/Migration Narrative

Adult: Seed is dispersed by wind (NatureServe, 2015)

Population Information and Trends**Number of Populations:**

12 (9 naturally occurring; 3 introduced) (USFWS, 2017)

Population Size:

over 10,000 individual plants (USFWS, 2017)

Population Narrative:

The most recent data suggest there are over 10,000 plants in the 9 extant natural populations (Peterson 2016); however, the Warea Tract in Lake County and the Ocklawaha property (Ocklawaha North EOR #28 and Ocklawaha South EOR #30) in Marion County typically account for greater than 95% of the plants range-wide. Lake Griffin State Recreation Area historically had a larger population, but the recent surveys suggest the population appears to be declining. The remaining six populations generally have low population numbers. (USFWS, 2017)

Threats and Stressors

Stressor: Habitat destruction or modification

Exposure:

Response:

Consequence:

Narrative: Habitat destruction, modification, and degradation on private lands remain the primary threat to the species range-wide. Populations occurring on private lands remain subject to habitat destruction or fragmentation due to development. In addition, the absence of habitat management on private lands results in unsuitable conditions for the species to successfully flourish and reproduce. Publicly owned conservation lands typically are afforded controlled access and may even have enforcement personnel on-site to prevent destructive activities. These lands also have management plans to create, restore, or maintain desirable habitat conditions; however, budget shortfalls and staffing constraints may preclude beneficial activities in some years. Also, depending on the management plan for various public lands, not all public conservation lands where the species occurs are specifically managed to benefit *W. amplexifolia*.

The management is often a balance of the multiuse activities occurring on the sites and prioritized accordingly to available budget and respective mission (e.g. state park, state forest, county or city utility property, etcetera). Currently, four of the extant populations (Lake Griffin State Recreation Area, Warea Tract, Sugarloaf Mountain, and Schofield Sandhill) occur on public lands, four populations (Ferndale Ridge, Bissett Property, Mountain Lake Estates, and Ocklawaha North and South) are under private ownership, and one population (Twin Lakes) occurs on private property and in a road/utility easement. (USFWS, 2017)

Stressor: Inadequacy of existing regulatory mechanisms

Exposure:

Response:

Consequence:

Narrative: The Florida Administrative Code 5B-40 (Preservation of Native Flora of Florida) provides the Florida Department of Agriculture and Consumer Services (FDACS) with limited authority to protect plants on State and private lands (primarily from the standpoint of illegal harvest). *Warea amplexifolia* is listed as an Endangered Plant under this statute, which requires anyone wishing to “willfully harvest, collect, pick, remove, injure, or destroy any plant listed as endangered growing on the private land of another or on any public land or water” to “obtain the written permission of the owner of the land or water or his legal representative” (FAC 5B-40.003(1)(a)). A permit is also required to transport “for the purpose of sale, selling, or offering for sale any plant contained on the endangered plant list which is harvested from such person’s own property” (FAC 5B-40.003(1)(c)). (USFWS, 1999)

Stressor: Other natural or manmade factors

Exposure:

Response:

Consequence:

Narrative: Drought, fire suppression, and invasive plant species encroachment continue to negatively affect *W. amplexifolia* populations. The Intergovernmental Panel on Climate Change (IPCC) concluded that warming of the climate system is unequivocal (Pachauri et al. 2014). Effects associated with changes in climate have been observed including changes in arctic temperatures and ice, widespread changes in precipitation amounts, ocean salinity, and wind patterns and aspects of extreme weather including droughts, heavy precipitation, heat waves, and the intensity of tropical cyclones (Pachauri et al. 2014). Species that are dependent on specialized habitat types, limited in distribution, or at the extreme periphery of their range may be most susceptible to the impacts of climate change (Byers and Norris 2011; Anacker et al. 2012). However, while continued change is certain, the magnitude and rate of change is unknown in many cases. The magnitude and rate of change could be affected by many factors (e.g., circulation patterns), but we have no additional information or data regarding these factors with respect to *W. amplexifolia*. There is evidence that some terrestrial plant populations have been able to adapt and respond to changing climatic conditions (Franks et al. 2013). Both plastic (phenotypic change such as leaf size or phenology) and evolutionary (shift in allelic frequencies) responses to changes in climate have been detected. Both can occur rapidly and often simultaneously (Franks et al. 2013). Relatively few studies are available, however, that (1) directly examine plant responses over time, (2) clearly demonstrate adaptation or the causal climatic driver of the responses, or (3) use quantitative methods to distinguish plastic versus evolutionary responses (Franks et al. 2013). (USFWS, 2017)

Recovery**Reclassification Criteria:**

1. When 10 geographically distinct, self-sustaining populations are protected and managed (USFWS, 1993).

Delisting Criteria:

1. When 20 such populations are protected and managed, and each has been monitored for at least 8 years. Recovery will require a minimum of 10 years (until 2003), if establishment of new populations is prompt and obviously successful (USFWS, 1993).

Recovery Actions:

- Determine current distribution of *W. amplexifolia*. Conduct surveys of *W. amplexifolia*. Maintain distribution of known populations and suitable habitat in GIS database. Use GIS to map existing populations and to assess the species' status and trends over time. The database should contain information on locations, population sizes, and status. This information should also be used for project review, in land acquisition activities, and to coordinate updates with the FNAI database. Currently, the Lake Wales Ridge Ecosystem Working Group and Archbold Biological Station are proposing to map the entire central ridge. This information would show potential habitat for scrub and high pine endemics based on their habitat needs. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding areas has been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases is isolated. (USFWS, 1999)
- Continue research on life history characteristics of *W. amplexifolia*. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species more specific biological information is needed. (USFWS, 1999)
- Continue monitoring the existing populations of *W. amplexifolia*. Evaluate the effectiveness of the monitoring protocol used to assess population trends for *W. amplexifolia*. Monitor and detect changes in demographic characteristics, such as growth, survival, and mortality. Monitor the effects of various land management actions on *W. amplexifolia*. Continue to work with private landowners. Monitor introduced plants. (USFWS, 1999)
- Provide public information about *W. amplexifolia*. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of *W. amplexifolia* and other rare species require a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- Habitat-Level Recovery Actions: Prevent degradation of existing habitat. Secure habitat through acquisition, landowner agreements, and conservation easements. Manage and enhance habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and high pine and their unique biota. (USFWS, 1999)

Conservation Measures and Best Management Practices:

- Revise the current recovery plan to include objective and measurable recovery criteria that are related to reducing and/or eliminating threats to *W. amplexifolia* as well as updated on the species distribution and ecology (USFWS, 2007).
- Provide funding and technical support for further research on: The effects of prescribed burning and other management tools on *W. amplexifolia*. Continue working with public managers to increase the management on their sites. Additional life history needs. Information is needed on how *W. amplexifolia* plants and seeds are affected by years of drought. Genetic inbreeding depression. This information will help us determine what constitutes a stable population. The most appropriate methodology to germinate seeds, grow seedlings, and successfully out-plant seedlings to native habitats. The various pollinators (e.g. Hymenoptera and Lepidoptera), as well as how different species assist with seed dispersal (USFWS, 2007).
- Encourage non-Federal agencies to protect and manage habitat under the Partners for Fish and Wildlife Program (USFWS, 2007).
- Update the range-wide survey, that was completed by Dr. Jack Stout in 200, on all known and potential sites occupied by *W. amplexifolia* and determine population size. Current distribution information is needed to determine where plants currently exist and to prioritize recovery actions (USFWS, 2007).
- Consider reintroduction and monitoring of *W. amplexifolia* on additional publicly owned lands with suitable habitat. Prior to reintroduction, research on the microhabitat needs of *W. amplexifolia* should be considered. Reintroduction of *W. amplexifolia* could help to increase the number of populations on protected sites and augment populations where needed (USFWS, 2007).
- Acquisition and management of the remaining known populations on private lands. Areas within the Ocklawaha and Ferndale Ridge developments where native sandhill habitat still exists would be the primary areas to target near-term. (USFWS, 2017)
- Active management of the four natural populations on public lands to maintain or create openness of the habitat and to control the invasive plant species encroachment. (USFWS, 2017)
- Yearly monitoring of the natural populations and the introduced populations on public lands will be necessary to accurately determine future population viability. (USFWS, 2017)
- Continued research on life history, biology, and ecology (population genetics, seed germination, spatial seedling recruitment patterns, demography, pollination biology, microhabitat factors, etcetera). (USFWS, 2017)
- Update range-wide survey to determine number of extant populations and individual plant abundance at each location. (USFWS, 2017)
- . Continue population introductions and population augmentations. (USFWS, 2017)
- Compare sites with long-term data sets from different locations within close proximity to one another and their associated management to increase the understanding of the ecological conditions that influence population abundance. (USFWS, 2017)

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SPECIES ACCOUNT: *Warea carteri* (Carter's mustard)

Species Taxonomic and Listing Information

Listing Status: Endangered; 2/20/1987; Southeast Region (R4)

Physical Description

Warea carteri is an annual herb, 0.2 to 1.5 m tall with erect green stems. The plants usually have many slender, ascending branches forming an open, rounded crown. The leaves lack stipules and are arranged alternately on the stem. Lower leaves are lost by the time the plant flowers. Leaf size and shape varies with age and position on the plant. At the time of flowering, leaf petioles range from 0.8 to 3.9 mm with blades 1 to 3 cm long. Towards the tips of stems, the leaves are smaller and narrowly elliptical to almost linear, while closer to the bases of stems and branches, the leaves are larger and oblanceolate or spatulate. All leaves are rounded at the tip, their margins entire, and their bases attenuate to cuneate. The lower leaves can also be undulate, margined or lobed. The many inflorescences of *W. carteri* are dense, rounded racemes with many flowers (60 or more). The flowers are radially symmetric, with four white linear-oblanceolate sepals, about 4.5 mm long, and curved toward the center of the flower at the tip. The four petals are white, about 6.0 mm long, with more than half their length in the form of a slender claw. The petal's blade is nearly round with irregular margins. The six spreading stamens are irregularly subequal in length and arise from a nectar-producing floral disc. The ovary is superior, cylindric, about 2.3 mm long, and raised on a slender stalk (gynophore) about 2 mm long. The sessile stigma has two lobes. *W. carteri* is protandrous: the anthers begin to dehesce within an hour or two after the flower has opened. The stigmas are receptive until 2 to 4 days afterwards, by which time the stamens on that flower have dropped. *Warea carteri*'s fruit is a silique, long, slender pod divided lengthwise by a partition (septum). The pod is flattened, cylindrical in cross-section and gently curved along its length, which is 4 to 6 cm long and 1.5 mm wide. The pod is borne on a gynophore, which is a stalk-bearing pistil 5 to 6 mm long, above a spreading pedicel, which is around 8.5 mm long. The pod carries numerous oblong seeds, each 1.5 mm long (Kral 1983). Fruits split apart passively to shed the seeds. (USFWS, 1999)

Taxonomy

Warea carteri was named by Small in 1909. A review of the genus by Channell and James in 1964 retained Small's treatment of the species. There are no scientific synonyms (Nauman 1980). Common names for the species include Carter's mustard, Carter's warea, and Carter-warea. (USFWS, 1999)

Historical Range

Carter's mustard was once found in Miami-Dade County, Florida, as well as Lake, Polk, and Highland Counties, Florida. Extirpated from extirpated from Miami-Dade County.

Current Range

On the Lake Wales Ridge in Lake, Polk, and Highlands counties, Florida (USFWS, 2019).

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Self-pollinating

Breeding Season

Adult: Flowering occurs in September and October. Fruiting occurs in October and November (USFWS, 1999)

Other Reproductive Information

Adult: Large fluctuations observed in above ground population size suggest the possibility that seed banking plays a significant role in *W. carteri*'s biology. Environmental cues necessary for germination were explored experimentally at Archbold Biological Station. Moisture and light were found to be necessary for germination. The use of an oak leachate did not significantly affect germination. Some seeds stored in dry, dark conditions for 2 years germinated, demonstrating the potential of *W. carteri*'s seeds to remain dormant at least that long. Fire-related cues such as heat do not stimulate germination, but germination does require light and seeds may remain dormant for more than 2 years. (USFWS, 1999)

Reproduction Narrative

Adult: Experiments have demonstrated that *Warea carteri* is self-pollinating, autogamous, and self-compatible (Evans et al., in press). Autogamy and self-compatibility allow isolated or sparsely distributed individuals to reproduce. Natural levels of fruit- and seed-set are quite high, with a fruit-set of 62 percent, and seed-set of 50 percent (Evans et al. in press). Self-pollinated flowers showed significantly lower fruit- and seed-set, 41 percent fruit-set and 28 percent seed-set. This indicates that insect-mediated pollination is important in keeping fruit- and seed-set high, and individual fecundity high. Pollinators appear to be the limiting factor in fruit and seed production. Because aboveground populations fluctuate wildly, autogamy helps ensure fecundity and may be a key life history trait. Germination in *W. carteri* occurs in late winter through early spring (January-March). Flowering occurs in September and October. Fruiting occurs in October and November, and dispersal follows in November and early December (Kral 1983). Preliminary observations of insect activity on *W. carteri* indicate it is a generalist with respect to pollination. A great diversity of insects visit the flowers, including native solitary bees, bumblebees, syrphids (known as hoverflies or bee-flies), wasps, flies, beetles, etc. Within-plant movements by insects appear to predominate over among-plant movements. Because of this, and in combination with the close proximity of male and female flowers in an inflorescence, self-pollination probably is a regular method of reproduction in this species. (USFWS, 1999)

Habitat Type

Adult: Upland sandy areas; xeric, shrub-dominated habitats

Habitat Narrative

Adult: Carter's mustard is found almost exclusively in upland areas and is a soil generalist, being found on yellow, gray, or white sands (Menges et al. 2007). It is found primarily in sandhills and scrubby flatwoods, and often at the ecotone between these two vegetation types. In the northern part of its range, most sites are on sandhill. This is also true for sites at Tiger Creek

Preserve, a site in the central part of its range, which supports the greatest number of plants. At this site, the species is found in both high-quality, frequently burned sandhill, as well as in overgrown sandhill that could also be termed xeric hammock (Menges in litt. 2008d). Near the south end of its range (e.g., ABS), Carter's mustard is found primarily in scrubby flatwoods, often just downhill from a ridge of yellow sand (Menges in litt. 2008e). These habitats have a range of fire return intervals from 2 to 15 years (Menges 2007). Although Carter's mustard has a large populations after fire, it can also recover from a persistent soil seed bank after many years or even decades without fire (Menges in litt. 2008f). Although preferring post-fire or disturbed sites, Carter's mustard is not a gap specialist. Plants often grow among dense shrubs in scrubby flatwoods or shrubby sandhill sites.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: There are no obvious specialized forms of seed dispersal in *W. carteri*. The siliques do not open explosively; rather, the external walls of the fruit peel away from the central septum as the fruit slowly dries, exposing the mature seeds inside. The seeds drop passively to the ground or they may be flung a bit further if the plant is brushed. It's not likely that seeds are moved by wind once they reach the ground. Collection or movement of seeds of *W. carteri* by ants or other animals has not been studied, but there are no obvious specialized structures on the seed that would encourage such movement. (USFWS, 1999)

Population Information and Trends

Number of Populations:

50 known occurrences (USFWS, 2019)

Population Narrative:

The most recent FNAI Element Tracking Summary (FNAI 2015) reported 50 known occurrences for Carter's mustard, of which 41 were found on 12 managed areas. Historical populations in Brevard and Miami-Dade Counties are believed extirpated. Although Carter's mustard has large populations after fire, it can also recover from a persistent soil seed bank after many years or even decades without fire. Carter's mustard populations fluctuate widely from year to year. For burned populations especially, these fluctuations are biennial (peak every two years) and dampen over time. Fires usually initiate cycles, with the largest population sizes occurring the year following fire. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat destruction or modification

Exposure:

Response:

Consequence:

Narrative: This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further

loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 million persons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

Stressor: Lack of adequate fire management

Exposure:

Response:

Consequence:

Narrative: Fire is necessary to maintain the scrub habitats upon which this species depends. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time (Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species. (USFWS, 2019)

Stressor: Limited geographic range.

Exposure:

Response:

Consequence:

Narrative: This species occurs within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

Recovery

Reclassification Criteria:

1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations required to assure 95 percent probability of persistence for 100 years (USFWS, 1999)
2. When these populations, within the historic range of *W. carteri* are adequately protected from further habitat loss, degradation, and fire suppression (USFWS, 1999)
3. When these sites are managed to maintain the scrubby flatwoods and turkey oak dominated high pine to support *W. carteri* (USFWS, 1999)
4. When monitoring programs demonstrate these sites support sufficient population sizes, are distributed throughout the historic range, and are sexually reproducing at sufficient rates to maintain the population (USFWS, 1999)

Delisting Criteria:

1. At least 40 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)
2. Populations (as defined in criterion 1) in yellow sand scrub or scrubby flatwoods habitats are distributed across the known range of the species. (USFWS, 2019)
3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

Recovery Actions:

- Determine current distribution of *W. carteri*. Some portions of *W. carteri*'s range have been well surveyed, yet a total distribution has not been ascertained for this species. A thorough survey is needed to determine the distribution for this species. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties has been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Conduct research on life history characteristics of *W. carteri*. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species' more specific biological information is needed. (USFWS, 1999)
- Monitor existing populations of *W. carteri*. (USFWS, 1999)
- Provide public information about *W. carteri*. It is important for the recovery of this species that governmental agencies, conservation organizations, and private landowners be appropriately informed about this species. (USFWS, 1999)
- Habitat-level Recovery Actions: Prevent degradation of existing habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat and ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

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SPECIES ACCOUNT: *Wikstroemia skottsbergiana* (akia)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2016a)

Physical Description

A shrub or small tree. Leaf blades are ovate to ovate-elliptic, usually 8 - 9 cm long, usually 3.8 - 5.4 cm wide. Peduncles are usually 10 - 15 mm long. Rachis are 2 - 6 mm long. Flowers are green; calyx tube is 6 - 10 mm long. Fruit is red, ellipsoid, ca. 15 mm long, ca. 8 mm in diameter (NatureServe, 2015).

Taxonomy

A member of the akia family (Thymelaceae) (USFWS, 203). Genus found in southeastern Asia, Australia, Fiji and Hawaiian Islands. Species endemic to Kauai. (NatureServe, 2015). *Wikstroemia skottsbergiana* (Sparre) is recognized as a distinct taxon in the 1999 update to the Manual of Flowering Plants of Hawaii (Wagner et al. 1999, p. 1290) (USFWS, 2014).

Historical Range

Endemic to the island of Kauai in the state of Hawaii (NatureServe, 2015). Historically, it was known from the Wahiawa Mountains, Hanalei Valley, and Kauhao Valley on the island of Kauai (Peterson 1999, p. 1290) (USFWS, 2015).

Current Range

Currently, there is one occurrence on an undisclosed private site on the island of Kauai (Hawaii Plant Extinction Prevention Program 2012, p. 26) (USFWS, 2014).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available

Habitat Type

Adult: Terrestrial (USFWS, 2014)

Habitat Vegetation or Surface Water Classification

Adult: Wet and diverse mesic forest (USFWS, 2014)

Dependencies on Specific Environmental Elements

Adult: Lowland wet ecosystem (USFWS, 2016b).

Geographic or Habitat Restraints or Barriers

Adult: Occurs < 3,300 ft. elevation (USFWS, 2015)

Habitat Narrative

Adult: Wikstroemia skottsbergiana occurs in wet and diverse mesic forest (USFWS, 2014). It occurs in the lowland wet ecosystem, which is generally found below 3,300 ft. (1,000 m) elevation (USFWS, 2015). Wikstroemia skottsbergiana occurs in wet forest on the island of Kauai, in the lowland wet ecosystem (Peterson 1999, p. 1290; TNCH 2007) (USFWS, 2016b).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Very low (inferred from USFWS, 2015)

Redundancy:

Very low (inferred from USFWS, 2015)

Number of Populations:

1 (USFWS, 2015)

Population Size:

30 (USFWS, 2015)

Population Narrative:

Currently, this species is limited to 30 individuals at one site (PEPP 2012, p. 26) (USFWS, 2015).

Threats and Stressors

Stressor: Feral pigs and goats (USFWS, 2016b)

Exposure:

Response:

Consequence:

Narrative: Feral pigs and goats destroy and modify the habitat of Wikstroemia skottsbergiana on Kauai, with evidence of the activities of these animals reported in the areas where this species occurs (DLNR 2005, in litt.; Wood 2015, in litt.) (USFWS, 2016b).

Stressor: Nonnative plants (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Nonnative plants destroy and modify the native habitat of W. skottsbergiana, and displace this and other native Hawaiian plants by competing for water, nutrients, light, and

space, or they may produce chemicals that inhibit the growth of other plants (Smith 1985, pp. 180–250; Vitousek et al. 1987 in Cuddihy and Stone 1990, p. 74; HBMP 2010) (USFWS, 2015).

Stressor: Rat predation (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Predation of seeds by rats may pose a threat to this species (DLNR 2005, in litt.) (USFWS, 2015).

Stressor: Small population size (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: This species may experience reduced reproductive vigor due to low levels of genetic variability, leading to diminished capacity to adapt to environmental changes, thereby lessening the probability of its long-term persistence (DLNR 2005, in litt.; Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361). The small number of remaining individuals may limit this species' ability to adapt to environmental changes (USFWS, 2015).

Stressor: Climate change (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to the ecosystem that supports this species. Fortini et al. (2013, pp. 1-134) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013, p. 91) concluded that *Wikstroemia skottsbergiana* is vulnerable to the impacts of climate change (USFWS, 2014).

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- The Service is unaware of any conservation measures being implemented for *Wikstroemia skottsbergiana* at this time. However, *W. skottsbergiana* is a Plant Extinction Prevention Program (PEPP) species, which aims to monitor, survey, collect and store seeds, propagate, and outplant all designated PEPP plant species (USFWS, 2014).

- Survey for populations of *Wikstroemia skottsbergiana* in areas of potentially suitable habitat (USFWS, 2014).
- Begin propagation efforts for maintenance of genetic stock (USFWS, 2014).
- Reintroduce individuals into suitable habitat within historic range that is being managed for additional known threats (e.g., nonnative animals and plants) to this species (USFWS, 2014).

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SPECIES ACCOUNT: *Wikstroemia villosa* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (R1) (USFWS, 2016)

Physical Description

Shrubs or trees 3-4.5 m tall. Leaf blades broadly elliptic to elliptic-ovate, usually 8-13 cm long, usually 3-4 cm wide, tomentose to villous, sometimes becoming glabrate. Peduncles 2-4 mm long. Rachis 5-25 mm long. Flowers yellow. Fruit elliptic, 10-13 mm long, ca. 7 mm in diameter. (NatureServe, 2015)

Historical Range

See current range/distribution

Current Range

Wikstroemia villosa is endemic to the island of Maui in the state of Hawaii. It was historically recorded from East and West Maui. Currently it is known only from a single location on East Maui (USFWS 2012).

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Wikstroemia villosa* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 14 critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Wikstroemia villosa* includes 14 CHUs in Maui County, Hawaii (81 FR 17790-18110).

Maui—Lowland Wet—Unit 1 (and) *Palmeria dolei*—Unit 2—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 2— Lowland Wet This area consists of 6,616 ac (2,677 ha) of State land, 7,425 ac (3,005 ha) of privately owned land, and 2,038 ac (825 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Kipahulu Valley on the northern and eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia samuelii*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *M. ovalis*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 1 is not known to be occupied by the plants *Clermontia oblongifolia* ssp. *mauiensis*, *C. peleana*, *Mucuna sloanei* var. *persericea*, *Phyllostegia haliakalae*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwiku* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet

species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 2 (and) *Palmeria dolei*—Unit 3—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 3—Lowland Wet (and) *Newcombia cumingi*—Unit 1—Lowland Wet This area consists of 65 ac (26 ha) of State land at Moomoku, on the northwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. Although Maui—Lowland Wet—Unit 2 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendrion pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), or by the Newcomb's tree snail (*Newcombia cumingi*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 3 (and) *Palmeria dolei*—Unit 4—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 4—Lowland Wet This area consists of 1,247 ac (505 ha) of State land at Honanana Gulch on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta*, *Cyanea asplenifolia*, and *Pteris lidgatei*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 3 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendrion pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 4 (and) *Palmeria dolei*—Unit 5—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 5—Lowland Wet This area consists of 864 ac (350 ha) of State land at

Kahakuloa Valley on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta* and *Cyanea asplenifolia*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 4 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriforme*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 5 (and) *Palmeria dolei*—Unit 6—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 6— Lowland Wet This area consists of 30 ac (12 ha) of State land at Iao Valley on the eastern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 5 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriforme*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 6 (and) *Palmeria dolei*—Unit 7—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 7— Lowland Wet This area consists of 136 ac (55 ha) of State land at Honokowai and Wahikuli valleys on the western slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 6 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C.*

magnicalyx, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 7 (and) *Palmeria dolei*—Unit 8—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 8— Lowland Wet This area consists of 898 ac (364 ha) of State land at Olowalu Valley, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Alectryon macrococcus*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 7 is not currently occupied by the plants *Asplenium dielarectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 8 (and) *Palmeria dolei*—Unit 9—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 9— Lowland Wet This area consists of 230 ac (93 ha) of State land at upper Ukumehame Gulch, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 8 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielarectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 1 (and) *Palmeria dolei*—Unit 10—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 10— Montane Wet This area consists of 1,313 ac (531 ha) of State land and 798 ac (323 ha) of privately owned land, at Haiku Uka on the northern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Cyanea duvalliorum*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *Phyllostegia pilosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 1 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 11—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 11— Montane Wet This area consists of 4,075 ac (1,649 ha) of State land, 9,633 ac (3,898 ha) of privately owned land, and 875 ac (354 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Puukaukanu and upper Waihoi Valley, on the northern and northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Geranium hanaense*, *G. multiflorum*, and *Wikstroemia villosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 2 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea glabra*, *C. maritae*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, and *Schiedea jacobii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 3 (and) *Palmeria dolei*—Unit 12—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 12— Montane Wet This area consists of 2,228 ac (902 ha) of federally owned land (Haleakala National Park) in Kipahulu Valley, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. maritae*, and *Melicope ovalis*, and by the forest bird, *kiwiku* (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 3 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea duvalliorum*, *C. glabra*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest bird, the *akohekohe* (*Palmeria dolei*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 4 (and) *Palmeria dolei*—Unit 13—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 13— Montane Wet This area consists of 180 ac (73 ha) of State land and 1,653 ac (669 ha) of federally owned land (Haleakala National Park), in Kaapahu Valley on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *Cyrtandra ferripilosa*, and *Huperzia mannii*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 4 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea duvalliorum*, *C. glabra*, *C. mceldowneyi*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwiku* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 5 (and) *Palmeria dolei*—Unit 14—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 14— Montane Wet This area consists of 222 ac (90 ha) of State land, and 165 ac (67 ha) of federally owned land (Haleakala National Park), near Kaumakani on the eastern

slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units area occupied by the plant *Bidens campylotheca* ssp. *pentamera*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 5 is not currently occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 1 (and) *Palmeria dolei*—Unit 18—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 18— Montane Mesic This area consists of 6,593 ac (2,668 ha) of State land, 707 ac (286 ha) of privately owned land, and 3,672 ac (1,486 ha) of federally owned land (Haleakala National Park), from Kealahou to Puualae, nearly circumscribing the summit of Haleakala on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Asplenium dielerectum*, *A. peruvianum* var. *insulare*, *Clermontia lindseyana*, *Cyanea horrida*, *C. obtusa*, *Cyrtandra ferripilosa*, *C. oxybapha*, *Diplazium molokaiense*, *Geranium arboreum*, *G. multiflorum*, *Huperzia mannii*, *Melicope adscendens*, and *Neraudia sericea*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 1 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Cyanea glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. mceldowneyi*, *Phyllostegia bracteata*, *P. mannii*, *Santalum haleakalae* var. *lanaiense*, *Wikstroemia villosa*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Wikstroemia villosa* critical habitat consists of three components. Lowland wet (east Maui and west Maui), Montane wet (east Maui) and Montane mesic (east Maui) (81 FR 17790-18110):

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: *Acacia*, *Ilex*, *Metrosideros*, *Myrsine*, *Nestegis*, *Nothocestrum*, *Pisonia*, *Pittosporum*, *Psychotria*, *Sophora*, *Zanthoxylum*. Subcanopy: *Alyxia*, *Charpentiera*, *Coprosma*, *Dodonaea*, *Kadua*, *Labordia*, *Leptecophylla*, *Phyllostegia*, *Vaccinium*. Understory: Ferns, *Carex*, *Peperomia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the

conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: No information found.

Habitat Type

Adult: Wet/moist forest (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 2016)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 2016)

Site Fidelity

Adult: High (inferred from USFWS, 2016)

Habitat Narrative

Adult: Wet and/or moist forests. (NatureServe, 2015). Historically known from the lowland wet, montane wet, and montane mesic ecosystems on east and west Maui, this species is currently known from a recent discovery (2007) of one individual on the windward side of Haleakala (on east Maui), in the montane wet ecosystem (Peterson 1999, p. 1,291; TNC 2007; HBMP 2010). As of 2010, there was one individual and one seedling at the same location (Oppenheimer 2010m, in litt.). In addition, three individuals have been outplanted in Waikamoi Preserve (Oppenheimer 2010m, in litt.) (USFWS, 2016). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the fact the species is only known from one site (two individuals) which also infers that the species prefers a very specific habitat.

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: No information found.

Population Information and Trends**Population Trends:**

Unknown

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1 - 50 individuals (NatureServe, 2015)

Population Narrative:

As of 2010, there was one individual and one seedling at the same location on East Maui (Oppenheimer 2010 cited by USFWS 2012). In addition, three individuals have been outplanted (Oppenheimer 2010 cited by USFWS 2012). (NatureServe, 2015)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs), nonnative plants, landslides, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Landslides destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, rats, and slugs) is considered an ongoing threat to *Wikstroemia villosa* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor: Small populations (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: *Wikstroemia villosa* faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). *Wikstroemia villosa* is known only from a single occurrence, with two individuals (USFWS, 2013).

Recovery**Recovery Actions:**

- There is no recovery plan for this species.

References

USFWS. 2016. Environmental Conservation Online System (ECOS) – Species Profile. <http://ecos.fws.gov/ecp0/>. Accessed July 2016

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

Final Rule . 81 FR 17790-18110 (March 30, 2016).

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USFWS. 2013. Determination of Endangered Status for 38 Species on Molokai, Lanai, and Maui

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SPECIES ACCOUNT: *Wilkesia hobdyi* (Dwarf iliau)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/22/1992; Pacific Region (R1) (USFWS, 2016)

Physical Description

An erect to sprawling shrub up to 0.7 m tall, freely branching near the base. Each stem bears a head of narrow leaves. Terminal inflorescences 2-4.5 dm long. (NatureServe, 2015)

Taxonomy

Wilkesia hobdyi was discovered by Robert W. Hobdy on Polihale Ridge, Kauai, in 1968. He sent a specimen of the plant to the late Dr. Harold St. John, a botanist who was affiliated with the Bishop Museum herbarium. St. John described the plant as a new species and named it in Hobdy's honor (St. John 1971) (USFWS, 1995).

Current Range

Endemic to west coast of Kauai.

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Wilkesia hobdyi* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Wilkesia hobdyi* includes one unit totaling 1,914 acres in Kauai County, Hawaii. The unit is Kauai 11—*Wilkesia hobdyi*—a.

Primary Constituent Elements/Physical or Biological Features

Within this unit, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Coastal dry cliffs or very dry ridges containing one or more of the following associated native plant species: *Artemisia australis*, *Dodonaea viscosa*, *Eragrostis variabilis*, *Hibiscus kokio* ssp. *saint johnianus*, *Lipochaeta connata*, *Lobelia niihauensis*, *Myoporum sandwicense*, *Peperomia blanda*, *Peperomia* spp., *Peperomia tetraphylla*, *Peucedanum sandwicense*, *Psydrax odorata*, *Sida fallax*, *Waltheria indica*, or *Wilkesia gymnoxiphium*; and

(ii) Elevations between 12 and 685 m (40 and 2,246 ft).

Special Management Considerations or Protections

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the

species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: likely insect pollinated (USFWS, 1995)

Breeding Season

Adult: Flowering has been observed most often in the winter months, but also during June (USFWS, 1995).

Reproduction Narrative

Adult: This species is probably pollinated through outcrossing and is probably self-incompatible. Insects are the most likely pollinators. Reproduction and seedling establishment are occurring and appear sufficient to sustain the populations. Flowering has been observed most often in the winter months, but also during June. Fruits may be dispersed when they stick to the feathers of birds. Densities reach one plant per square meter (approximately one square yard) in localized areas and hybridization with *Wilkesia gymnoxiphium* may be occurring (Carr 1982a) (USFWS, 1995).

Habitat Type

Adult: Steep slopes and cliffs (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (inferred from NatureServe, 2015 and USFWS, 1995))

Environmental Specificity

Adult: Narrow/specialist (inferred from NatureServe, 2015 and USFWS, 1995))

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015 and USFWS, 1995))

Site Fidelity

Adult: High (inferred from NatureServe, 2015 and USFWS, 1995))

Habitat Narrative

Adult: Species inhabits dry to moist steep slopes and cliffs with native shrubs and grasses. Component of lowland dry shrubland and lowland mesic shrubland communities (Wagner et al. 1999). (NatureServe, 2015). *Wilkesia hobbdyi* grows in degraded cliff sites and very dry ridges 275 to 400 meters (90 to 1,312 feet) in elevation (Wagner et al. 1990) (USFWS, 1995). Clumped spatial arrangement of the population, narrow environmental specificity, high ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on

the specific habitat and elevational requirements of this species and the low number of known populations.

Dispersal/Migration

Dispersal

Adult: Fruits may be dispersed when they stick to the feathers of birds (USFWS, 1995).

Dispersal/Migration Narrative

Adult: Fruits may be dispersed when they stick to the feathers of birds (USFWS, 1995).

Population Information and Trends

Population Trends:

Unknown (USFWS, 2010)

Resiliency:

Unknown (NatureServe, 2015)

Representation:

Unknown (NatureServe, 2015)

Redundancy:

Unknown (NatureServe, 2015)

Number of Populations:

6 - 20 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Adaptability:

Fragility unknown. (NatureServe, 2015)

Population Narrative:

Fragility unknown. Ca. 460-560 individuals currently observed. 7 current (between 1982 and 1997) and 1 historical occurrence. (NatureServe, 2015). While *Wilkesia hobbdi* may appear to be increasing in the number of populations and individuals, it is unlikely that this is actually the case, and is most likely the result of increased surveys in *W. hobbdi* habitats (USFWS, 2010).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2003)

Exposure:

Response:

Consequence:

Narrative: The greatest immediate threats to the survival of this species are habitat disturbance and browsing by feral goats. Although the low number of individuals and their restricted habitat

could be considered a potential threat to the survival to the species, the plant appears to have vigorous reproduction and may survive indefinitely if goats were eliminated from its habitat. Fire and extinction through naturally occurring events, such as landslides or hurricanes, could also be threats to the survival of the species (USFWS, 2003).

Stressor: Climate change loss or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Wilkesia hobbdi* is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.75 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future.

Stressor: Hurricanes—Loss and degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Hurricanes were omitted in the last five year review. In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event, and 70 percent of all listed plant species on Kauai are only found on Kauai. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013).

Recovery

Reclassification Criteria:

For downlisting, a total of five to seven populations of each taxon should be documented on Kauai and at least one other island where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 1995).

Delisting Criteria:

For delisting, a total of 8 to 10 populations of each taxon should be documented on Kauai and at least one other island where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of five consecutive years (USFWS, 1995).

Recovery Actions:

- Protect current populations, control threats and monitor (USFWS, 1995).
- Expand current populations (USFWS, 1995).
- Conduct research essential to conservation of the species (USFWS, 1995).
- Establish new populations as needed to reach recovery objectives (USFWS, 1995).
- Validate and revise recovery objectives (USFWS, 1995).
- Devise and implement a public education program (USFWS, 1995).
- Recommendations for Future Actions: No new threats and no other significant new information regarding the species' biological status have been reported since the last 5-year review in 2010. Therefore, the following recommendations for future actions are reiterated for 5-year review for 2017. • Surveys and inventories—Survey potentially suitable habitat and historic range for a thorough current assessment of the species. • Ungulate monitoring and control—Protect all occurrences against disturbances from feral ungulates. Construct and maintain fenced exclosures around all populations. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative plant species around all populations that compete with the species. • Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides. • Population biology research—Study *Wilkesia hobbayi* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2017)

Conservation Measures and Best Management Practices:

- Continue collecting seed from all known populations (USFWS, 2010).
- Place a portion of genetically representative seed accessions into long-term seed storage (USFWS, 2010).
- Continue reintroducing individuals into protected suitable habitat within historical range (USFWS, 2010).
- Fence wild populations to exclude goats, when possible, given cliff habitat (USFWS, 2010).
- Control invasive introduced plants within and around exclosures, when possible (USFWS, 2010).
- Resurvey known locations at regular intervals of five years or less, to obtain indications of status and trend of the populations of this species (USFWS, 2010).

- Work with Hawaii Division of Forestry and Wildlife, Hawaii State Parks, and the U.S. Navy to initiate planning and contribute to implementation of ecosystem level restoration and management to benefit this species (USFWS, 2010).
- New Management Actions: • The NTBG seed bank has nine founders represented from the Makaha population. There are a few dozen plants on the garden's grounds from collections from Makaha, and one plant from Polihale Ridge. There are also plants in the nursery from one collection from Makaha (NTBG 2017). One thousand seeds were sent to the National Center for Genetic Resources Preservation in 2008 for research (NTBG 2017). • This species is currently being monitored by the State of Hawaii's Division of Land and Natural Resources Department of Forestry and Wildlife.

References

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U. S. Fish and Wildlife Service. 2010. 5-YEAR REVIEW. Short Form Summary. Species Reviewed: *Wilkesia hobbii* (dwarf iliau). Current Classification: Endangered

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A."

USFWS. 2003. Final Designation or Nondesignation of Critical Habitat for 95 Plant Species From the Islands of Kauai and Niihau, HI

Final Rule. 68 Federal Register 39, February 27, 2003. Pages 9116 – 9479.

U.S. FISH AND WILDLIFE SERVICE. 2017. 5-YEAR REVIEW Short Form Summary Species Reviewed: *Wilkesia hobbii* (Dwarf iliau).

U.S. Fish and Wildlife Service. 1995. Recovery Plan for the Kauai Plant Cluster. U.S. Fish and Wildlife Service, Portland, OR. 270 pp.

SPECIES ACCOUNT: *Xylosma crenatum* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/1992; Pacific Region (R1) (USFWS, 2016)

Physical Description

A tree, up to 14 m tall. Flowers are borne in short inflorescences along the stem. (NatureServe, 2015)

Taxonomy

Xylosma crenatum was first collected in 1917 by Charles Forbes on the west side of the Waimea drainage basin. However, the collection was misidentified as *Hibiscus wairneae* (HHP 1990s). Over 50 years later (in 1968), Robert Hobdy made the second collection of this plant, along the banks of Mohihi Stream at the edge of the Alakai Swamp. In 1972, Harold St. John recognized the plant as a distinct species, and named it *Antidesma crenatum*, after the rounded teeth along the leaf edges (St. John 1972). In 1976, St. John transferred the name to the genus *Xylosma* (USFWS, 1995).

Current Range

Endemic to northwest Kauai.

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designate critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Xylosma crenatum* on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Xylosma crenatum* includes two units totaling 2,204 acres in Kauai County, Hawaii. The units are Kauai 11—*Xylosma crenatum*—a, and Kauai 12—*Xylosma crenatum*—b.

Kauai 11—*Xylosma crenatum*—a: This unit is critical habitat for *Xylosma crenatum* and is 840 ha (2,077 ac) on State land (Kokee and Na Pali Coast State Parks). This unit contains portions of the Awaawapuhi, Honopu, and Nualolo Trails, and Kainamanu and Kalahu Summits. This unit provides habitat for four populations of 100 mature, reproducing individuals of the long-lived perennial *Xylosma crenatum* and is currently occupied with 14 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, diverse *Acacia koa*, *Metrosideros polymorpha* montane mesic or wet forest, or *Metrosideros polymorpha*-*Dicranopteris linearis* montane wet forest. This unit is geographically separated from the other unit designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Although we do not feel that there is enough habitat that

currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is at an appropriate size and distance from the other unit to avoid their destruction by one naturally occurring catastrophic event.

Kauai 12—*Xylosma crenatum*—b: This unit is critical habitat for *Xylosma crenatum* and is 52 ha (128 ac) on State land (Kuia NAR and Waimea Canyon State Park) near Lapa Picnic Area and Lua Reservoir. This unit provides habitat for one population of 100 mature, reproducing individuals of the long-lived perennial *Xylosma crenatum* and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is important to the establishment of additional populations on Kauai in order to reach recovery goals. The habitat features contained in this unit that are essential for this species include, but are not limited to, diverse *Acacia koa*-*Metrosideros polymorpha* montane mesic or wet forest, or *Metrosideros polymorpha*-*Dicranopteris linearis* montane wet forest. This unit is geographically separated from the other unit designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Although we do not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is at an appropriate distance from the other unit to avoid their destruction by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Diverse *Acacia koa*-*Metrosideros polymorpha* montane mesic or wet forest, or *Metrosideros polymorpha*-*Dicranopteris linearis* montane wet forest, and containing one or more of the following associated native plant species: *Athyrium sandwicense*, *Cheirodendron* spp., *Claoxylon sandwicense*, *Coprosma* spp., *Cyanea* spp., *Diplazium sandwichianum*, *Dubautia knudsenii*, *Hedyotis* spp., *Ilex anomala*, *Lobelia yuccoides*, *Myrsine* spp., *Nestegis sandwicensis*, *Perrottetia sandwicensis*, *Pleomele aurea*, *Poa sandwicensis*, *Pouteria sandwicensis*, *Psychotria* spp., *Scaevola procera*, *Streblus pendulinus*, *Tetraplasandra* spp., *Touchardia latifolia*, or *Zanthoxylum dipetalum*; and

(ii) Elevations between 941 and 1,284 m (3,086 and 4,212 ft).

Special Management Considerations or Protections

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species in paragraph (b) of this section and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Little is known about the life history of *Xylosrna crenaturn*. Flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown (USFWS, 1995).

Habitat Type

Adult: Moist forest (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (Inferred from NatureServe, 2015 and USFWS, 1995)

Tolerance Ranges/Thresholds

Adult: Low (Inferred from NatureServe, 2015 and USFWS, 1995)

Site Fidelity

Adult: High (Inferred from NatureServe, 2015 and USFWS, 1995)

Habitat Narrative

Adult: Moist forests on gulch slopes and gulch bottoms. (NatureServe, 2015). *Xylosrna crenaturn* is known from diverse koa - ohia montane mesic forest at an elevation of about 975 to 1,065 meters (3,200 to 3,500 feet), sometimes along stream banks or within a planted conifer grove. Associated species include the native manono and *Athyrium sandwicensis* and alien strawberry guava (USFWS 1992a) (USFWS, 1995). Clumped spatial arrangement of the population, high ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat needs of this species and the the number of known individuals and populations (one).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Little is known about the life history of *Xylosrna crenaturn*. Flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown (USFWS, 1995).

Population Information and Trends**Population Trends:**

Not found

Resiliency:

Fragility unknown. (NatureServe, 2015)

Representation:

Fragility unknown. (NatureServe, 2015)

Redundancy:

Fragility unknown. (NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Adaptability:

Fragility unknown. (NatureServe, 2015)

Population Narrative:

Fragility unknown. Fewer than 20 plants known. 1 CURRENT POPULATION, 2 HISTORICAL RECORDS. (NatureServe, 2015)

Threats and Stressors

Stressor: Non-native Vegetation (USFWS, 1995)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Major threat invasion by alien vegetation (USFWS, 1995)

Stressor: Small numbers/scattered distribution

Exposure:

Response:

Consequence: Extinction

Narrative: The small number of individuals and scattered distribution make this species vulnerable to human or natural environmental disturbance (USFWS, 1995).

Stressor: Climate Change or degradation of habitat

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Xylosma crenatum* is extremely vulnerable to the impacts of climate change, with a vulnerability score of 0.99 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this assessment classified *X. crenatum* as a “wink-out” species. “Wink-out” species are those species with no future climate envelope. No projected suitable climate areas exist for the species to persist in the future, and the species is unlikely to tolerate expected changes in climate at its current location. Therefore, additional management actions are needed to conserve this taxon into the future.

Recovery

Reclassification Criteria:

For downlisting, a total of five to seven populations of each taxon should be documented on Kauai and at least one other island where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 1995).

Delisting Criteria:

For delisting, a total of 8 to 10 populations of each taxon should be documented on Kauai and at least one other island where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of five consecutive years (USFWS, 1995).

Recovery Actions:

- Protect current populations, control threats and monitor (USFWS, 1995).
- Expand current populations (USFWS, 1995).
- Conduct research essential to conservation of the species (USFWS, 1995).
- Establish new populations as needed to reach recovery objectives (USFWS, 1995).
- Validate and revise recovery objectives (USFWS, 1995).
- Devise and implement a public education program (USFWS, 1995).
- Recommendations for Future Actions: No new threats and no other significant new information regarding the species' biological status have been reported since the last 5-year review in 2009. Therefore, the following recommendations for future actions are reiterated for the 5-year review for 2017.
 - Surveys and inventories—Continue surveys of potentially suitable habitat and historic range for a thorough current assessment of the species.
 - Ungulate monitoring and control—Protect all occurrences against disturbances from feral ungulates. Construct and maintain fenced exclosures around all populations.
 - Invasive plant monitoring and control—o Control established ecosystem-altering nonnative invasive

plant species around all populations. o Control invasive nonnative plant species around all populations that compete with the species. • Fire monitoring and control—Develop and implement fire management plans for all wild and reintroduced populations. • Predator and herbivore control research—Study *Xylosma crenatum* populations to determine level of threat from invertebrate herbivory and any additional needed recovery actions. • Predator and herbivore monitoring and control—Implement effective control methods for rodents. • Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides. • Human interaction monitoring and management—Develop and implement effective measures to reduce the impacts of road maintenance. • Genetic research—Assess genetic variability of extant populations and compare to *Xylosma hawaiiense* to determine validity of *X. crenatum* as a separate species. • Population biology research—Study *Xylosma crenatum* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Continue collection of genetic resources for storage, future propagation and reintroducing into protected suitable habitat within historical range (USFWS, 2009).
- Enhance current natural populations and establish new populations to increase numbers of individuals (USFWS, 2009).
- Construct enclosure fences to protect all remaining individuals from the negative impacts of feral pigs and deer, and eradicate introduced invasive plant species within the enclosures (USFWS, 2009).
- Work with Hawaii Division of Forestry and Wildlife and Hawaii State Parks to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species in the mesic forests of western Kauai (USFWS, 1995).
- Survey geographical and historical range for a thorough current assessment of the species (USFWS, 1995).
- Assess genetic variability of extant populations (USFWS, 2009).
- Study *Xylosma crenatum* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2009).
- New Management Actions: • Seeds and cuttings were collected by NTBG Kaluapuhi, Kokee, Nualolo, Awaawapuhi, Makaha, and Waiakoali. There is one airlayer at the NTBG nursery (NTBG 2017b). Lyon Arboretum had 78 explants and 3 potted plants between 2002 and 2015, but currently does not have this species in storage (Lyon Arboretum 2017). • PEPP is conducting pollination trials and is also producing propagules by air-layering (PEPP 2010, 2011, 2012, 2013, 2014, 2015). • PEPP monitors *Xylosma crenatum* at Nualolo, Kawaiiki, Kokee, Mohihi, Kaluapuhi, Milolii-Makaha, Nawaimaka, Awaawapuhi, and Waiakoali (PEPP 2010, 2011, 2012, 2013, 2014, 2015).

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U.S. Fish and Wildlife Service. 2009. 5--Year Review. Short Form Summary. Species Reviewed: *Xylosma crenatum* (No common name). Current Classification: Endangered.

SPECIES ACCOUNT: *Yermo xanthocephalus* (Desert yellowhead)

Species Taxonomic and Listing Information

Listing Status: Threatened; 03/14/2002; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

A deeply taprooted perennial herb with 1-several hollow stems that reach 3 dm in height. Leaves are leathery, alternate, lance-shaped to oval, and often folded on the midrib. Numerous flower heads, each composed of about 4-6 yellow disk flowers borne above yellow bracts, bloom in a crowded terminal cluster (the yellow involucre bracts are nearly unique in the Asteraceae). This is a highly distinctive species - a new genus was named to accommodate it, and the genus itself is easily separated from all other genera of the Asteraceae in most of the world. The closest taxonomic relatives of this desert plant occur in more moist habitats over 1000 km east. Dorn (1991) speculated that *Y. xanthocephalus* and these more mesic species were derived from a common ancestor, noting that temperate deciduous forests once existed in the now-arid part of Wyoming where *Y. xanthocephalus* is found, but that these habitats began to move eastward as regional conditions became drier during the Miocene. (NatureServe, 2015)

Taxonomy

Desert yellowhead was discovered by botanist Robert Dorn in the Beaver Rim area of central Wyoming in 1990 (Dorn 1991). Dorn estimated approximately 500 plants occurred in 1.0 hectare (ha) (2.5 acres (ac)) of sparsely vegetated, sandy hollows among sandstone outcrops. He determined this unusual plant was a member of the Aster family (Asteraceae). Upon closer examination and research, Dorn realized that the species had not been previously described and represented a new genus. Dorn (1991) described and named his discovery *Yermo xanthocephalus*, or literally "desert yellowhead." Asteraceae is one of the largest plant families in the world and is comprised of many tribes (Heidel 2002). Since the original species description, more recent taxonomic work has indicated that not only is *Yermo xanthocephalus* the only member of a monotypic genus, *Yerimo*, but it is the only Wyoming species in a new subtribe Tussilagininae (Cass.) (Dumort) (Barkley 1999). Preliminary results from a study comparing six species of subtribe Tussilagininae showed the specimens of desert yellowhead has less variation as a species than some other members of the subtribe (Van Vleet 1996, as cited in Scott and Scott 2009). Additionally, desert yellowhead did not overlap with the other species. In other words, individual desert yellowhead plants are very similar to each other, but very different from other Asteraceae species within the same subtribe (USFWS, 2012).

Current Range

State endemic restricted to the Beaver Rim area in the Sweetwater River Plateau in Fremont County, Wyoming.

Critical Habitat Designated

Yes; 3/16/2004.

Legal Description

On March 16, 2004, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Yermo xanthocephalus* (Desert yellowhead) under the Endangered Species Act of 1973, as

amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Wyoming (69 FR 12278-12290).

Critical Habitat Designation

The critical habitat designation for *Yermo xanthocephalus* includes one CHU in Fremont County, Wyoming. This species critical habitat encompasses approximately 360 acres (146 ha) (69 FR 12278-12290).

Fremont County, Wyoming. (i) From U.S. Geological Survey 7.5? quadrangle maps Dishpan Butte and Sweetwater Station, Wyoming. T. 31 N., R. 95 W., SW¼ sec. 27, NW¼ sec. 34, and W½ W½ NE¼ sec. 34.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Yermo xanthocephalus* critical habitat consists of three components (69 FR 12278-12290):

(i) Recent soils derived from sandstones and limestones of the Split Rock Formation at its junction with the White River Formation. These are shallow, loamy soils of the Entisol order that can be classified as course-loamy over sandy-skeletal, mixed, Lithic Torriorthent. The surface stratum has little organic matter, and subsurface layers show no accumulation of humus, clay, gypsum, salts, or carbonates.

(ii) Plant communities associated with *Yermo xanthocephalus* that include, but may not be limited to, sparsely vegetated cushion plant communities with scattered clumps of *Oryzopsis hymenoides* (Indian ricegrass) between 2,043 and 2,073 m (6,700 and 6,800 ft) in Fremont County, Wyoming. Species common to these communities include *Arenaria hookeri* (Hooker's sandwort), *Astragalus kentrophyta* (thistle milkvetch), *Hymenoxys acaulis* (stemless hymenoxys), and *Phlox muscoides* (squarestem phlox). These cushion-plant communities also contain natural openings.

(iii) Topographic features/relief and physical processes, particularly hydrologic processes, that maintain the shape and orientation of the hollows characteristic of *Yermo xanthocephalus* and maintain moisture below the surface of the ground.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Insect pollinated/Vegetative buds (USFWS, 2012)

Lifespan

Adult: 21+ years (USFWS, 2012)

Breeding Season

Adult: Desert yellowhead usually flowers from mid-June to August and may prolong flowering, or flower for a second time in September (Heidel 2002). The growing season has an average of 124 days (Scott and Scott 2009) (USFWS, 2012).

Reproduction Narrative

Adult: Desert yellowhead is a long-lived perennial that produces sexually by seed and asexually by vegetative buds (Scott and Scott 2009). At least some desert yellowhead plants have a lifespan of a minimum of 21 years (Scott and Scott 2009). This species is typically described as a classic 'K' selected species, characterized by a long-lived perennial growth form, adaptation to severe habitats, and low annual reproductive output (Fertig 1995). Desert yellowhead usually flowers from mid-June to August and may prolong flowering, or flower for a second time in September (Heidel 2002). The growing season has an average of 124 days (Scott and Scott 2009). This species is likely pollinated by visually-oriented insects attracted to its bright disk flowers and bracts (Dom 1991). Ants and nectar-feeding butterflies were noted as frequent visitors to desert yellowhead flowers (Heidel et al. 2011). The butterfly was identified as the small wood nymph (*Cercyonis oetus*), a common species in Wyoming that typically feeds on the nectar of yellow composite flowers. Additionally, small skipper butterflies (*Hesperiidae* family) visit desert yellowhead; however, these butterflies were not identified to species (Scott and Scott 2009). Flowering levels of desert yellowhead appear to decline in drought years; however, no specific studies have been conducted. Preliminary inferences regarding seed dispersal include the capacity for wind or water dispersal (Dom 1991; Heidel 2002). The hairy seeds mature in the latter half of summer when they are dispersed by wind (Heidel et al. 2011) (USFWS, 2012).

Habitat Type

Adult: Barren outcrops (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits barren outcrops of white silty clay of the Split Rock Formation. Topography is bowl-like, allowing for snow accumulation. (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirement of the species as well as the relatively low number of known populations.

Dispersal/Migration

Dispersal

Adult: Wind (USFWS, 2012)

Dispersal/Migration Narrative

Adult: Preliminary inferences regarding seed dispersal include the capacity for wind or water dispersal (Dom 1991; Heidel 2002). The hairy seeds mature in the latter half of summer when they are dispersed by wind (Heidel et al. 2011) (USFWS, 2012).

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Resiliency:

Moderate (inferred from NatureServe, 2015)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Population Growth Rate:

Unknown (NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

2500 - 100,000 individuals (NatureServe, 2015)

Population Narrative:

Plants are hardy, deep-rooted perennials and habitat is not visited extensively. Unknown Dorn estimated only about 500 plants in 1990. The federal register notice gives an estimate of 1,500 plants in 1998 (USFWS 1998) based on 1994 survey, lower than all ensuing counts. Annual census by Richard and Beverly Scott has documented numbers as high as 13244 plants. Known only from one locality in the Cedar Rim area of Fremont County, Wyoming. (NatureServe, 2015). Low representation and redundancy are inferred based on the low number of known populations and, the limited geography that the plant inhabits. Moderate resiliency is inferred based on the plants being 'hardy perennials'.

Threats and Stressors

Stressor: Oil and gas development (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Based on conservation actions by the BLM, oil and gas development are considered to be low in severity and magnitude and not an immediate threat to the species. If desert yellowhead is proposed to be delisted, the Wyoming BLM Standard Mitigation Guidelines for Surface Disturbing Activities would not apply as the protections of this document are for federally threatened and endangered species. Instead, it is anticipated that the Service would request the BLM continue to apply Conditions of Approval on Applications for Permit to Drill within the populations of desert yellowhead prohibiting all surface disturbing activities. Additionally, the BLM's 6840 Manual Sensitive Species designation would provide some protections to the species for five years following delisting and potentially longer (see Section 2.3.2.4. for further discussion). Therefore, in the absence of protections under the ESA, we anticipate that the threat from oil and gas development would remain low in severity and magnitude and not an immediate threat to the species (USFWS, 2012).

Stressor: Mineral extraction (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: we consider the threat from mineral extraction to be low in severity and magnitude and not an immediate threat to the species. In the absence of ESA protections, the BLM's 6840 Manual Sensitive Species designation would provide some protections to the species for five years following delisting and potentially longer (see section 2.3.2.4. for further discussion). Additionally, if desert yellowhead is proposed to be delisted, it is anticipated that the Service would enter into discussions with the BLM prior to the delisting to determine whether the withdrawal should remain in effect. Therefore, in the absence of protections under the ESA, we anticipate that the threat from mineral extraction would remain low in severity and magnitude and not an immediate threat to the species (USFWS, 2012).

Stressor: Motor Vehicles and Off-Road Vehicles (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: We consider the threat from motor vehicles and off-road vehicles to be low in severity and magnitude and not an immediate threat. In the absence of ESA protections, the BLM's 6840 Manual Sensitive Species designation would provide some protections to the species for five years following delisting and potentially longer (see Section 2.3.2.4. for further discussion). Additionally, if desert yellowhead is proposed to be delisted, it is anticipated that the Service would enter into discussions with the BLM prior to the delisting to determine whether the road closure should remain in effect. In general, motor vehicle policies on Federal lands have been moving towards more strategic transportation plans, closing excess roads and trails. We anticipate that these roads would remain closed. Therefore, in the absence of protections under the ESA, we anticipate that the threat from motor vehicles and offroad vehicles would remain low in severity and magnitude and not an immediate threat to the species (USFWS, 2012).

Stressor: Invasive species (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The level of threat from invasive species has been reduced to low in severity and magnitude and is not an immediate threat. In the absence of ESA protections, the BLM's 6840 Manual Sensitive Species designation would provide some protections to the species for five years following delisting and potentially longer (see Section 2.3.2.4. for further discussion). If desert yellowhead is proposed for delisting, it is anticipated that the Service would enter into discussions with the BLM prior to the delisting to determine appropriate conservation measures to ensure continued protection of the species. Therefore, in the absence of protections under the ESA, we anticipate that the threat from invasive species would remain low in severity and magnitude and not an immediate threat to the species (USFWS, 2012).

Stressor: Disease (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: In August 2010, botanists noticed a few desert yellowhead plants had turned chlorotic (the yellowing or whitening of normally green plant tissue because of a decrease amount of chlorophyll, often as a result of disease or nutrient deficiency) (Heidel et al. 2011). This condition appeared to cause mortality; however, it developed after flowering and did not affect reproduction. More than one subpopulation contained plants that were chlorotic (Heidel 2012a, pers. comm.). We have no other reports of disease. Therefore, the threat of disease is considered to be low in severity and magnitude and not an immediate threat. In the absence of protections under the ESA, the severity, magnitude, and immediacy of this threat are not anticipated to increase (USFWS, 2012).

Stressor: Livestock and Wild Ungulate Grazing and Trampling (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: The threat of grazing and trampling by wild ungulates and/or cattle is low in severity and magnitude and the threat is not immediate. In the absence of ESA protections, the BLM's 6840 Manual Sensitive Species designation would provide some protections to the species for five years following delisting and potentially longer (see Section 2.3.2.4. for further discussion). Additionally, if desert yellowhead is proposed to be delisted, it is anticipated that the Service would enter into discussions with the BLM prior to the delisting to determine appropriate conservation measures to ensure continued protection of the species. Therefore, in the absence of protections under the ESA, the threat of grazing and trampling by wild ungulates or cattle is likely to remain low in severity and magnitude and not an immediate threat to the species (USFWS, 2012).

Stressor: Small population size (USFWS, 2012)

Exposure:

Response:

Consequence: Extinction

Narrative: While small population size remains an issue of concern, there is no evidence that the plant has occurred outside of the area currently occupied or in substantially larger numbers any time in the recent past. More information on this issue is required to assess the degree of this vulnerability. Specifically, we need to improve our understanding of the species demographics to assess the risk associated with the species' limited distribution and small population size. An

ongoing study (mentioned above in Section 2.3.1.) conducted through the University of Wyoming aims to provide demographic information on both populations of desert yellowhead and develop a population viability assessment (USFWS, 2012).

Stressor: Genetic Vulnerability (USFWS, 2012)

Exposure:

Response:

Consequence: Extinction

Narrative: Populations of plants that remain very small for several generations or populations that have gone through a past episode of rapid population decline may lose much of their previous genetic variability (Godt et al. 1996). The loss of genetic variability may reduce a species ability to respond to changing environmental conditions. In addition, the potential for inbreeding depression increases. Inbreeding depression can decrease fertility and survival rates. Although environmental and demographic factors usually supersede genetic factors in threatening species viability, inbreeding depression and the low genetic diversity may enhance the probability of extinction of rare plant species (Levin et al. 1996). On the other hand, some plant species have shown no evidence of inbreeding depression, despite low genetic diversity. There are a lot of unknowns regarding the historical distribution and genetic viability of desert yellowhead and how these issues affect the species. However, monitoring of desert yellowhead has not indicated that any of these factors are currently causing a decline in the species. At this time, we do not have enough information regarding the small population size and genetic vulnerability of desert yellowhead. Recommendations to improve our knowledge are included in Section 4 (USFWS, 2012).

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: In general, a trend of warming in the mountains of western North America is expected to decrease snowpack, hasten spring runoff, and reduce summer flows (IPCC 2007). While this change could affect desert yellowhead and its habitat, to date, a negative impact has not been documented. A significant degree of uncertainty exists as to how projected climate changes, alone and in concert with other threats, will affect the desert yellowhead or its habitat in the future. While fewer cold days and nights could result in increased vegetative yield in colder environments, increased summer heat and areas affected by drought may increase (IPCC 2007). Desert yellowhead is adapted to a low moisture environment that is susceptible to flooding and erosion events. However, we have limited evidence of reduced reproduction in drought conditions. More research on the drought tolerance of the species is needed. Another factor to consider regarding desert yellowhead's ability to adapt to climate change is the species' origin. Several hypotheses have been proposed (Heidel 2002, Scott and Scott 2009). The hypothesis most often cited is that desert yellowhead is a relict species that has become restricted in its distribution. This hypothesis is supported by the extreme restricted distribution pattern of desert yellowhead and the absence of the species on similar adjacent surfaces. However, the fact that the Sand Draw population and the Cedar Rim population differ in several habitat conditions supports the hypothesis that desert yellowhead was once more widespread and its distribution has become restricted (Heidel et al. 2011). If this second hypothesis is correct, the species may be more adaptable as it has survived through a variety of selective pressures. Conversely, if desert yellowhead has a more recent origin and has always occupied a restricted habitat, the

species may not be able to adapt well in the face of changing climatic conditions. More studies on this species' responses to changes in climate need to be completed. Overall, it appears possible that the desert yellowhead or its habitat may be affected negatively by climate change (USFWS, 2012).

Recovery

Conservation Measures and Best Management Practices:

- The BLM has committed to conservation measures to protect desert yellowhead and its habitat. The BLM's adoption of the updated Wyoming BLM Standard Mitigation Guidelines for Surface Disturbing Activities protects all threatened or endangered species habitats from surface disturbing activities and surface occupancy (BLM 2011). All known locations of desert yellowhead benefit from these guidelines. Additionally, any leased activities with the potential to affect desert yellowhead and its habitat would be reviewed under NEPA and section 7 of the ESA (USFWS, 2012). 1. Develop and implement a monitoring plan for the species and its designated critical habitat. The plan will include regular patrol of the site for unlawful uses of the land, and the monitoring of invasive weed populations. This plan also would include, but is not limited to, the inventory and monitoring of all vehicle access to the area for the purpose of restricting access of vehicles that pose a threat to the species. 2. Prohibit biological control of weeds in the species' habitat until the impacts of the control agent has been fully evaluated and determined not to adversely affect the plant population (USFWS, 2012)
- The BLM has committed to implement several conservation measures with regard to grazing for the protection of the Sand Draw population of desert yellowhead. These measures are detailed to in the U.S. Fish and Wildlife Service's (Service) Biological Opinion on the BLM's Lander Resource Management Plan (Service 2005). The conservation measures include: (1) The BLM will not increase current permitted livestock levels; (2) The BLM will not approve location of mineral supplements or additional water sources for livestock, wild horses, or wildlife on public lands within 3.2 km (2 mi) of the site; (3) No supplemental feeding or straw placement can be done without proper authorization (43 CFR 4140 (a)(3)); and (4) Livestock will not be intentionally herded within 0.8 km (0.5 mi) of the Sand Draw population of desert yellowhead or in designated critical habitat. Additionally, the BLM will not conduct wild horse management actions (e.g., temporary gathering/holding facilities) within designated critical habitat (USFWS, 2012).

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SPECIES ACCOUNT: *Zanthoxylum dipetalum* var. *tomentosum* (A`e)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

A tree, 4-15 m tall. Leaves are compound, with 5-7 leaflets. The lowest pair of leaflets is much reduced in size. (NatureServe, 2015)

Taxonomy

Horace Mann described *Zanthoxylum dipetalum* in 1867, and Rock named a new variety *Zanthoxylum dipetalum* var. *tomentosum*, based on a specimen he collected at Puu Waawaa on Hualalai in 1909 (Rock 1913). The specific epithet refers to the dense covering of soft hairs on the undersurface of the leaflets. Some authors have placed Hawaiian taxa in the genus *Fagara*, resulting in the name *Fagara dipetala* var. *tomentosa*. However, *Zanthoxylum dipetalum* var. *tomentosum* is maintained in the current treatment of the Hawaiian species (Stone et al. 1990) (USFWS, 1998).

Historical Range

See current range/distribution

Current Range

Known historically from the island of Hawaii, Puuwaawaa region (NatureServe, 2015).

Critical Habitat Designated

Yes; 7/2/2003.

Legal Description

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Zanthoxylum dipetalum* var. *tomentosum* on the island of Hawaii (68 FR 39623 - 39722).

Critical Habitat Designation

The critical habitat designation for *Zanthoxylum dipetalum* var. *tomentosum* includes one unit totaling 4,164 acres in Hawaii County, Hawaii. The unit is Hawaii 10—*Zanthoxylum dipetalum* ssp. *tomentosum*—a.

Hawaii 10—*Zanthoxylum dipetalum* ssp. *tomentosum*—a [1,685 ha (4,164 ac)]: The unit contains Puu Ike, Puu Paha, and Puuwaawaa and is in the Kiholo watershed. This unit provides habitat for 7 populations of 100 mature, reproducing individuals of the *Z. dipetalum* ssp. *tomentosum* and is currently occupied by 8 to 10 individuals. This unit is essential to the conservation of *Z. dipetalum* ssp. *tomentosum* because it supports an extant colony of this island-endemic species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. Although we do not believe enough habitat currently exists to reach the recovery goal of 8 to 10 populations for this island-endemic species, this unit is of an appropriate size so that each of the seven potential recovery populations within the unit is geographically

separated enough to avoid their destruction by one naturally occurring catastrophic event. No other critical habitat for this species is designated on the island of Hawaii.

Primary Constituent Elements/Physical or Biological Features

Habitat features that are essential for this species include, but are not limited to, *Metrosideros polymorpha* dominated montane mesic forest, often on aa lava.

Special Management Considerations or Protections

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for this species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Flowers are usually either male or female, and usually only one sex is found on a single tree. Clusters of 5 to 15 flowers, 9 to 18 millimeters (0.4 to 0.7 inch) long, have a main flower stalk 10 to 40 millimeters (0.4 to 1.6 inches) long and individual flower stalks 3 to 8 millimeters (0.1 to 0.3 inch) long. Each flower has four broadly triangular sepals about 1 to 1.5 millimeters (0.04 to 0.06 inch) long and two or four yellowish-white petals, sometimes tinged with red, 6 to 10 millimeters (0.2 to 0.4 inch) long. The fruit is an oval follicle (dry fruit that opens along one side) 15 to 33 millimeters (0.6 to 1.3 inches) long, containing one black seed about 10 to 26 millimeters (0.4 to 1 inch) long. This variety is distinguished from *Zanthoxylum dipetalum* var. *dipetalum* by the hairs on the undersurface of the leaflets. It is distinguished from other Hawaiian species of the genus by its reduced lower leaflets, the presence of only one joint on some of the leaflet stalks, and the large seeds (Rock 1913, Stone et al. 1990) (USFWS, 1998).

Habitat Type

Adult: Moist forests on old lava flows. (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (inferred from NatureServe, 2015 and USFWS, 1998)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015 and USFWS, 1998)

Site Fidelity

Adult: High (inferred from NatureServe, 2015 and USFWS, 1998)

Habitat Narrative

Adult: Moist forests on old lava flows. (NatureServe, 2015). *Zanthoxylum dipetalum* var. *tomentosum* grows in degraded ohia-dominated Montane Mesic Forest, often on aa lava, at elevations between 915 and 1,040 meters (3,000 and 3,400 feet) (M. Brueggemann, in litt., 1994). Associated species include mamane, lama, alaa, iliahi, ohe, kolea, and kopiko (HHP 1993g; HPCC 1993d) (USFWS, 1998). Clumped spatial arrangement of the population, high ecological integrity of the population and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of the species and the fact that there is only one known population.

Dispersal/Migration***Population Information and Trends*****Resiliency:**

Unknown (NatureServe, 2015)

Representation:

Unknown (NatureServe, 2015)

Redundancy:

Unknown (NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

In 2011, there were 11 wild individuals at Puu Waawaa (Plant Extinction Prevention Program [PEPP] 2012). In 2013, the 11 wild individuals remained at Puu Waawaa (PEPP 2014). Currently, there are still 11 wild individuals at Puu Waawaa (E. Adkins, Division of Forestry and Wildlife, pers. comm. 2015). The single tree known from Amy B.H. Greenwell Ethnobotanical Garden is dead (P. Van Dyke, Amy B.H. Greenwell Ethnobotanical Garden, pers. comm. 2015) (USFWS, 2015).

Threats and Stressors

Stressor: Predation/trampling (USFWS, 1998)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: Browsing, trampling, and habitat disturbance by cattle, feral pigs, and feral sheep are a threat to this species (USFWS, 1998).

Stressor: Invasive plants (USFWS, 1998)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Competition from alien plant species, such as kikuyu grass, fountain grass, lantana, koa haole, and *Grevillea robusta* (silk oak) is listed as a threat to this species (USFWS, 1998).

Stressor: Volcanic activity/fire (USFWS, 1998)

Exposure:

Response:

Consequence: Extinction/loss of habitat

Narrative: Habitat change due to volcanic activity; and fire (HHP 1993g; HPCC 1993d; M. Brueggemann, in lift., 1994; J. Lau, in lift., 1992) is listed as a threat to this species (USFWS, 1998).

Stressor: Reduced reproductive vigor/natural events (USFWS, 1998)

Exposure:

Response:

Consequence: Extinction

Narrative: The species is also at risk of extinction from to naturally occurring events and/or reduced reproductive vigor due to the small number of existing individuals in only one population (USFWS, 1998).

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Climate change destruction or degradation of habitat – Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Zanthoxylum dipetalum* is marginally vulnerable to the impacts of climate change (USFWS, 2015).

Stressor: Stochastic events (USFWS, 2015)

Exposure:

Response:

Consequence: Extinction

Narrative: Drought mortality or reduced viability – Drought may exacerbate the effects of ungulates and has direct adverse impacts on *Z. dipetalum* var. *tomentosum* (PEPP 2011) (USFWS, 2015).

Recovery

Reclassification Criteria:

For downlisting, a total of five to seven populations of each taxon should be documented on the Big Island where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats for 5 years, with a minimum of 100 mature individuals per population for long-lived perennials, a minimum of 300 mature individuals per population for short-lived perennials, and a minimum of 500 mature individuals for the annual taxon (USFWS, 1998).

Delisting Criteria:

For delisting, a total of 8 to 10 populations of each taxon should be documented on the Big Island where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, a minimum of 300 mature individuals per population for short-lived perennials, and a minimum of 500 mature individuals for the annual taxon. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1998).

Recovery Actions:

- Recommendations for Future Actions: ☐ Surveys / inventories – Survey geographical and historical range for a current assessment of the species' status. ☐ Captive propagation for genetic storage and reintroduction – Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. ☐ Ungulate monitoring and control – Maintain existing exclosures and monitor for potential incursions. ☐ Invasive plant monitoring and control – Eradicate invasive introduced plants within ungulate exclosures and maintain exclosures free of invasive plants. ☐ Population viability monitoring and analysis – Continue monitoring outplanted individuals. ☐ Fire monitoring and control – Develop and implement a fire management plan at the existing exclosures. ☐ Climate change adaptation strategy – Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. ☐ Alliance and partnership development – Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2015).

Conservation Measures and Best Management Practices:

- Surveys / inventories – Survey geographical and historical range for a current assessment of the species' status (USFWS, 2015).
- Captive propagation for genetic storage and reintroduction – Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range (USFWS, 2015).
- Ungulate monitoring and control – Maintain existing exclosures and monitor for potential incursions (USFWS, 2015).
- Invasive plant monitoring and control – Eradicate invasive introduced plants within ungulate exclosures and maintain exclosures free of invasive plants (USFWS, 2015).
- Population viability monitoring and analysis – Continue monitoring outplanted individuals (USFWS, 2015).
- Fire monitoring and control – Develop and implement a fire management plan at the existing exclosures (USFWS, 2015).
- Climate change adaptation strategy – Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change (USFWS, 2015).

- Alliance and partnership development – Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2015).

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SPECIES ACCOUNT: *Zanthoxylum hawaiiense* (A`e, Hawaiian yellow wood)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/04/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

Zanthoxylum hawaiiense is a member of the Rutaceae, or citrus family. It is a tree which can range in height from 3 to 8 meters (10 to 26 feet) tall, with trunks that can be 25 centimeters (10 inches) in diameter. Leaves are alternate and are comprised of three, leathery triangular-oval or lance-shaped, gland-dotted, lemon-scented, toothed leaflets. These leaflets are 3.4 to 10 centimeters (1.3 to 3.9 inches) long and 1.5 to 5 centimeters (0.6 to 2.0 inches) wide. The stalk of the opposite leaflets has one joint and the central, terminal leaflet has two. Trees are dioecious, having either male or female flowers. Inflorescences contain 15 to 20 flowers, each with four triangular sepals. Fruits are sickle-shaped follicles which range in length from 8 to 10 millimeters (0.3 to 0.4 inch). The fruits contains a single black seed of approximately 7 to 8 millimeters (0.3 inch) in diameter. The species is distinguished from other Hawaiian species by its leaves, presence of only one joint on some the leaflet stalks, and length and shape of the follicle (U.S. Army 2003a).

Historical Range

Historically, *Zanthoxylum hawaiiense* occurred on Kauai (central portion), Molokai (east side), Lanai (central), Maui (eastern portion, on the southern slopes of Haleakala), and Hawaii (Kohala Mountains).

Current Range

This species has been extirpated from Lanai but still persists on Hawaii, Molokai, Maui and Kauai. On these islands, approximately 262 to 312 individuals are found in 10 to 13 occurrences (U.S. Army 2003a).

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Zanthoxylum hawaiiense* (A`e) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 21 critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Zanthoxylum hawaiiense* on the island of Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for *Zanthoxylum hawaiiense* includes 21 CHUs in Maui County, Hawaii (81 FR 17790-18110).

Molokai—Lowland Mesic—Unit 1 (and) *Palmeria dolei*—Unit 37—Lowland Mesic (and) *Pseudonestor xanthophrys*—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Ctenitis squamigera*, *Cyanea dunbariae*, *C. mannii*, *C. profuga*, *Cyperus fauriei*, *Cyrtandra filipes*, *Gouania hillebrandii*, *Labordia triflora*, *Neraudia sericea*, *Santalum haleakalae* var. *lanaiense*, *Schiedea lydgatei*, *S. sarmentosa*, *Silene alexandri*, *S. lanceolata*, *Spermolepis hawaiiensis*, and *Zanthoxylum hawaiiense*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Mesic—Unit 1 is not known to be occupied by *Asplenium dielirectum*, *Bonamia menziesii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea procera*, *C. solanacea*, *Diplazium molokaiense*, *Festuca molokaiensis*, *Flueggea neowawraea*, *Isodendrion pyriformum*, *Kadua laxiflora*, *Melicope mucronulata*, *M. munroi*, *M. reflexa*, *Phyllostegia haliakalae*, *P. mannii*, *P. pilosa*, *Sesbania tomentosa*, *Stenogyne bifida*, or *Vigna o-wahuensis*, or the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 1 (and) *Palmeria dolei*—Unit 38—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 38— Lowland Wet This area consists of 2,195 ac (888 ha) of State land, and 754 ac (305 ha) of privately owned land (partly within The Nature Conservancy's Pelekunu Preserve), from Pelekunu Valley to Wailau Valley, in north-central Molokai. These units are occupied by the plant *Cyrtandra filipes*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Wet—Unit 1 is not known to be occupied by *Asplenium dielirectum*, *Bidens wiebkei*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Lysimachia maxima*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 1 consists of 11,465 ac (4,640 ha) of State land, 2,069 ac (837 ha) of federally owned land, and 3 ac (1 ha) of privately owned land, from Kanaio to Kahualau Gulch on the southern slopes of east Maui. This unit is occupied by the plants *Bonamia menziesii*, *Cenchrus agrimonoides*, *Flueggea neowawraea*, *Melicope adscendens*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and includes the mixed herbland and shrubland, the moisture

regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 1 is not known to be occupied by *Alectryon macrococcus*, *Bidens micrantha* ssp. *kalealaha*, *Canavalia pubescens*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Sesbania tomentosa*, *Solanum incompletum*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 2 (and) *Palmeria dolei*—Unit 39—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 39— Lowland Wet This area consists of 1,356 ac (549 ha) of State land and 594 ac (241 ha) of privately owned land, from Kahanui to Pelekunu Valley, in north-central Molokai. These units are occupied by the plant *Lysimachia maxima*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Wet—Unit 2 is not known to be occupied by *Asplenium dielerectum*, *Bidens wiebkei*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Cyrtandra filipes*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 2 consists of 1,851 ac (749 ha) of State land at Keokea on the southern slopes of east Maui. This unit is occupied by the plants *Bonamia menziesii*, *Canavalia pubescens*, and *Hibiscus brackenridgei*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 2 is not known to be occupied by *Alectryon macrococcus*, *Bidens micrantha* ssp. *kalealaha*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 3 consists of 94 ac (38 ha) of State land, and 3,125 ac (1,265 ha) of privately owned land, from Waiahookalo gulch to Moaula stream and Puniuohua, on eastern Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Molokai—Lowland Wet—Unit 3 is not known to be occupied by *Asplenium dielerectum*, *Bidens wiebkei*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Cyrtandra filipes*, *Lysimachia maxima*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 3 consists of 188 ac (76 ha) of privately owned land, at Keauhou on the southern slopes of east Maui. This unit is occupied by the plant *Canavalia pubescens*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 3 is not known to be occupied by *Bidens micrantha* ssp. *kalealaha*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 1 (and) *Palmeria dolei*—Unit 40—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 40—Montane Wet This area consists of 1,545 ac (625 ha) of State land, and 1,851 ac (749 ha) of privately owned land, from the headwaters of Waialeia Stream and above Pelekunu Valley, eastward along the summit area to Mapulehu, in northcentral Molokai. These units are occupied by the plants *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. profuga*, *Phyllostegia hispida*, and *Pteris lidgatei*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Montane Wet—Unit 1 is not known to be occupied by *Adenophorus periens*, *Cyanea procera*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Melicope reflexa*, *Phyllostegia mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for

the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 4 consists of 1,266 ac (512 ha) of State land (including the Department of Land and Natural Resources) at Ahihi-Kinau Natural Area Reserve on the southern slopes of east Maui. This unit includes the mixed hermland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Maui—Lowland Dry—Unit 4 is not currently occupied by *Bidens micrantha* ssp. *kalealaha*, *Bonamia menziesii*, *Canavalia pubescens*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 41—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 41—Montane Wet This area consists of 871 ac (353 ha) of State land, and 39 ac (16 ha) of privately owned land, from Honukaupu to Olokui (between Pelekunu and Wailau valleys), in north-central Molokai. These units include the mixed hermland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). Although Molokai—Montane Wet—Unit 2 is not known to be occupied by *Adenophorus periens*, *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. procera*, *C. profuga*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Melicope reflexa*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Pteris lidgatei*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 3 consists of 77 ac (31 ha) of State land, and 726 ac (294 ha) of privately owned land, above the east rim of Wailau Valley on eastern Molokai. This unit is occupied by the plant *Melicope reflexa*, and includes the mixed hermland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Montane Wet—Unit 3 is not known to be occupied by *Adenophorus periens*, *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. procera*, *C. profuga*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Platanthera holochila*,

Pteris lidgatei, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Mesic—Unit 2 consists of 1,034 ac (419 ha) of State land, and 113 ac (46 ha) of privately owned land, from Honokohau to Launiupoko on the western slopes of west Maui. This unit is occupied by the plants *Ctenitis squamigera*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, and *Zanthoxylum hawaiiense*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Mesic—Unit 2 is not known to be occupied by *Asplenium dielirectum*, *Bidens campylotheca* ssp. *pentamera*, or *Colubrina oppositifolia*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within its historical range. Due to its small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could approach recovery.

Maui—Lowland Mesic—Unit 3 (and) *Palmeria dolei*—Unit 1—Lowland Mesic (and) *Pseudonestor xanthophrys*—Unit 1— Lowland Mesic This area consists of 477 ac (193 ha) of State land at Ukumehame on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). Although Maui—Lowland Mesic—Unit 3 is not currently occupied by the plants *Asplenium dielirectum*, *Bidens campylotheca* ssp. *pentamera*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Zanthoxylum hawaiiense*, or by the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 1 (and) *Palmeria dolei*—Unit 18—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 18— Montane Mesic This area consists of 6,593 ac (2,668 ha) of State land, 707 ac (286 ha) of privately owned land, and 3,672 ac (1,486 ha) of federally owned land (Haleakala National Park), from Kealahou to Puualae, nearly circumscribing the summit of Haleakala on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Asplenium dielirectum*, *A. peruvianum* var. *insulare*, *Clermontia lindseyana*, *Cyanea horrida*, *C. obtusa*, *Cyrtandra ferripilosa*, *C. oxybapha*, *Diplazium molokaiense*, *Geranium arboreum*, *G. multiflorum*, *Huperzia mannii*, *Melicope adscendens*, and *Neraudia sericea*. These units also contain unoccupied habitat that is

essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 1 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Cyanea glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. mceldowneyi*, *Phyllostegia bracteata*, *P. mannii*, *Santalum haleakalae* var. *lanaiense*, *Wikstroemia villosa*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 2 (and) *Palmeria dolei*—Unit 19—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 19—Montane Mesic This area consists of 124 ac (50 ha) of State land at Helu and the upper reaches of Puehuhunui on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Lysimachia lydgatei*, *Remya mauiensis*, and *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 2 is not known to be occupied by the plants *Geranium hillebrandii*, *Huperzia mannii*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 3 (and) *Palmeria dolei*—Unit 20—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 20—Montane Mesic This area consists of 174 ac (70 ha) of State land at Lihau on the southwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plant *Geranium hillebrandii*, and contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 3 is not known to be occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Huperzia mannii*, *Lysimachia lydgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 4 (and) *Palmeria dolei*—Unit 21—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 21— Montane Mesic This area consists of 72 ac (29 ha) of State land at Halepohaku on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). Although Maui—Montane Mesic—Unit 4 is not known to be occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Geranium hillebrandii*, *Huperzia mannii*, *Lysimachia lydgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 5 (and) *Palmeria dolei*—Unit 22—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 22— Montane Mesic This area consists of 170 ac (69 ha) of State land at the upper reaches of Manawainui Gulch on the southeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants *Remya mauiensis* and *Santalum haleakalae* var. *lanaiense*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 5 is not known to be occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Geranium hillebrandii*, *Huperzia mannii*, *Lysimachia lydgatei*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Dry—Unit 1 consists of 2,962 ac (1,199 ha) of State land, and 563 ac (228 ha) of federally owned land (Haleakala National Park), from Kanaio to Naholoku and Kaupo Gap along the southern slopes of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane dry ecosystem (see Table 5). Although Maui—Montane Dry—Unit 1 is not known to be occupied by the plants *Alectryon macrococcus*, *Geranium arboreum*, *Melicope knudsenii*, *M. mucronulata*, *Santalum haleakalae* var. *lanaiense*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these montane dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Subalpine—Unit 1 (and) *Palmeria dolei*—Unit 24—Subalpine (and) *Pseudonestor xanthophrys*—Unit 24— Subalpine This area consists of 10,785 ac (4,365 ha) of State land, 1,622

ac (656 ha) of privately owned land, and 3,568 ac (1,444 ha) of federally owned land (Haleakala National Park), from Kanaio north to Puu Nianiau on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the subalpine ecosystem (see Table 5). They are occupied by the plants *Bidens micrantha* ssp. *kalealaha* and *Geranium arboreum*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Subalpine—Unit 1 is not known to be occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Asplenium peruvianum* var. *insulare*, *Geranium multiflorum*, *Phyllostegia bracteata*, *Schiedea haleakalensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these subalpine species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Subalpine—Unit 2 (and) *Palmeria dolei*—Unit 25—Subalpine (and) *Pseudonestor xanthophrys*—Unit 25—Subalpine This area consists of 50 ac (20 ha) of privately owned land, and 9,836 ac (3,981 ha) of federally owned land (Haleakala National Park), from the summit north to Koolau Gap and east to Kalapawili Ridge on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the subalpine ecosystem (see Table 5). They are occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Geranium multiflorum*, and *Schiedea haleakalensis*, and by the forest bird, the *akohekohe* (*Palmeria dolei*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Subalpine—Unit 2 is not known to be occupied by the plants *Asplenium peruvianum* var. *insulare*, *Bidens micrantha* ssp. *kalealaha*, *Geranium arboreum*, *Phyllostegia bracteata*, or *Zanthoxylum hawaiiense*, or by the forest bird, the *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these subalpine species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat designation for *Zanthoxylum hawaiiense* includes one unit totaling 1,292 acres in Kauai County, Hawaii. The unit is Kauai 11—*Zanthoxylum hawaiiense*—a.

Kauai 11—*Zanthoxylum hawaiiense*—a [523 ha; 1,292 ac]: This unit is critical habitat for *Zanthoxylum hawaiiense* and is 523 ha (1,292 ac) on State land (Alakai Wilderness Preserve and Puu Ka Pele Forest Reserve), containing portions of Kawaiiki Valley. This unit provides habitat for two populations of 100 mature, reproducing individuals of the long-lived perennial *Zanthoxylum hawaiiense* and is currently occupied with three plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, lowland dry or mesic forests dominated by *Metrosideros polymorpha* or *Diospyros*

sandwicensis. This unit provides for two populations within this multi-island species' historical range on Kauai that are some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Zanthoxylum hawaiiense* critical habitat consists of seven components. Lowland dry (east Maui), Lowland mesic (west Maui and Molokai), Lowland wet (Lanai and Molokai), Montane wet (Molokai), Montane mesic (east Maui and west Maui), Montane dry (east Maui) and Sub-alpine (east Maui) (81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: Diospyros, Myoporum, Pleomele, Santalum. Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Sicyos.

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepis.

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: Acacia, Charpentiera, Cheirodendron, Metrosideros. Subcanopy: Broussaisia, Cibotium, Eurya, Ilex, Myrsine. Understory: Ferns, Carex, Coprosma, Leptecophylla, Oreobolus, Rhynchospora, Vaccinium.

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: Acacia, Ilex, Metrosideros, Myrsine, Nestegis, Nothocestrum, Pisonia, Pittosporum, Psychotria, Sophora, Zanthoxylum. Subcanopy: Alyxia, Charpentiera, Coprosma, Dodonaea, Kadua, Labordia, Leptecophylla, Phyllostegia, Vaccinium. Understory: Ferns, Carex, Peperomia.

Ecosystem: Montane Dry. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Dry cinder or ash soils, loamy volcanic sands, blocky lava, rock outcroppings. Canopy: Acacia, Metrosideros, Myoporum, Santalum, Sophora. Subcanopy: Chamaesyce, Coprosma, Dodonaea, Dubautia, Leptecophylla, Osteomeles, Wikstroemia. Understory: Bidens, Eragrostis, Melanthera, Vaccinium.

Ecosystem: Subalpine. Elevation: 6,500–9,800 ft (2,000–3,000 m). Annual precipitation: 15–40 in (38–100 cm). Substrate: Dry ash, sandy loam, rocky, undeveloped soils, weathered lava. Canopy:

Chamaesyce, Chenopodium, Metrosideros, Myoporum, Santalum, Sophora. Subcanopy: Coprosma, Dodonaea, Dubautia, Geranium, Leptecophylla, Vaccinium, Wikstroemia. Understory: Ferns, Bidens, Carex, Deschampsia, Eragrostis, Gahnia, Luzula, Panicum, Pseudognaphalium, Sicyos, Tetramolopium.

Within this unit, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

- (i) Lowland dry or mesic forests dominated by *Metrosideros polymorpha* or *Diospyros sandwicensis*, and containing one or more of the following associated plant species: *Alectryon macrococcus*, *Antidesma platyphyllum*, *Charpentiera elliptica*, *Dodonaea viscosa*, *Melicope* spp., *Myrsine lanaiensis*, *Pisonia* spp., *Pleomele aurea*, *Streblus pendulinus*, or *Zanthoxylum dipetalum*; and
- (ii) Elevations between 332 and 1,151 m (1,089 and 3,774 ft).

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the

conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and

augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Trees are dioecious, having either male or female flowers. Inflorescences contain 15 to 20 flowers, each with four triangular sepals. Fruits are sickle-shaped follicles which range in length from 8 to 10 millimeters (0.3 to 0.4 inch). The fruits contains a single black seed of approximately 7 to 8 millimeters (0.3 inch) in diameter. The species is distinguished from other Hawaiian species by its leaves, presence of only one joint on some the leaflet stalks, and length and shape of the follicle (U.S. Army 2003a).

Habitat Type

Adult: Lowland dry or mesic forests/ montane dry forests, and on lava

Habitat Narrative

Adult: *Zanthoxylum hawaiiense* typically grows in *Metrosideros*-dominated lowland dry or mesic forests, in montane dry forests, and on lava at elevations that range from 550 to 1,740 meters (1,804 to 5,709 feet). The species is associated with *Antidesma platyphyllum* and *Streblus pendulinus* on the island of Maui and with *Myrsine lanaiensis*, *Sophora chrysophylla*, and *Myoporum sandwicense* on the island of Hawaii. Individuals of this species are widely scattered and rarely will more than a few plants be found in close proximity to one another (U.S. Army 2003a). At the Pohakuloa Training Area (PTA) on the island of Hawaii, *Z. hawaiiense* is found on lava and in a variety of plant community types including sparse *Metrosideros* Treelands, Open *Metrosideros* Treelands with dense shrub understory, Intermediate *Metrosideros* Mixed Treelands, *Myoporum* Shrublands, and *Myoporum*-*Dodonaea* Shrublands.

Dispersal/Migration

Population Information and Trends

Number of Populations:

10 - 13

Population Size:

262 - 312

Population Narrative:

This species has been extirpated from Lanai but still persists on Hawaii, Molokai, Maui and Kauai. On these islands, approximately 262 to 312 individuals are found in 10 to 13 occurrences (U.S. Army 2003a).

Threats and Stressors**Stressor:****Exposure:****Response:****Consequence:**

Narrative: Threats to *Zanthoxylum hawaiiense* include habitat degradation and browsing by feral and domestic animals, competition from non-native plant species, seed predation by rodents, fire; trampling, and effects of military activities (U.S. Army 2003a).

Stressor: Invasive species degradation of habitat**Exposure:****Response:****Consequence:**

Narrative: The wild population on east Maui is threatened by *Bocconia frutescens* (tree poppy), *Melinis minutiflora* (molasses grass), *Melinis repens* (natal red top), and *Neonotonia wightii* (glycine) (PEPP 2010). o On Kauai, *Schinus terebinthifolius* (Christmasberry) is a threat to the wild population (PEPP 2012).

Stressor: Ungulate herbivory**Exposure:****Response:****Consequence:**

Narrative: Feral axis deer (*Axis axis*) are a threat to the population on Maui (PEPP 2012).

Stressor: Stochastic events**Exposure:****Response:****Consequence:**

Narrative: Drought mortality or reduced viability – Drought may exacerbate the effects of ungulates and has direct adverse impacts on *Z. hawaiiense* (U.S. Army 2012; PEPP 2012, 2014).

Stressor: Slug predation or herbivory**Exposure:****Response:****Consequence:**

Narrative: On Molokai, herbivory by slugs were reported as a threat (PEPP 2013).

Stressor: Landslides and flooding degradation of habitat**Exposure:****Response:****Consequence:**

Narrative: Erosion is a threat to this species on West Maui (PEPP 2012) and on Kauai (PEPP 2014).

Recovery

Recovery Actions:

- Recommendations for Future Actions: • Surveys / inventories – Survey geographical and historical range for a current assessment of the species' status. • Captive propagation for genetic storage and reintroduction – Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. • Reintroduction / translocation – Additional populations should be established across the species' range to increase the number and occurrences of individuals to account for the dioecious behavior of this species. • Ungulate monitoring and control – Maintain existing exclosures and monitor for potential incursions. • Invasive plant monitoring and control – Eradicate invasive introduced plants within ungulate exclosures and maintain exclosures free of invasive plants. • Population viability monitoring and analysis – Continue monitoring wild and outplanted individuals. • Fire monitoring and control – Develop and implement a fire management plan at the existing exclosures. • Climate change adaptation strategy – Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. • Alliance and partnership development – Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2015).

Conservation Measures and Best Management Practices:

- The following important conservation actions are needed for *Zanthoxylum hawaiiense*: control of non-native plant species, feral ungulates, and rodents; elimination of fire; and research on habitat requirements, population structure, reproductive biology, and seed biology. Steps should be taken to ensure that populations remain viable on each of the four islands on which *Z. hawaiiense* presently occurs. Additional populations should be established across the species' range to increase the number of individuals. The widely scattered distribution and dioecious behavior of this species may suggest that larger areas are required to maintain viable populations for the survival and recovery of *Z. hawaiiense*. Rodent control in existing and reintroduced populations is necessary to allow for successful recruitment (Service 1996a). In addition, a State-wide management plan that identifies areas and landscapes for the long-term conservation of all known occurrences of *Z. hawaiiense* is needed. As part of this management plan, landowners and managers should delineate management units to conserve this species and other native species through threat control and habitat restoration. Ongoing Conservation Actions: Aside from any actions occurring at the PTA (and discussed the section below), the Service is unaware of species-specific conservation actions being conducted for *Zanthoxylum hawaiiense*.
- New management actions: 3 • Surveys / inventories o A survey discovered approximately 85 new locations of *Z. hawaiiense* at PTA (U.S. Army 2015). o In 2012, a survey conducted on West Maui found 20 additional plants (PEPP 2012). In 2013, another survey was conducted below the known population and discovered three new individuals (PEPP 2014). • Ungulate monitoring and control – In May 2014, a damaged 10-acre fenced exclosure in Upper Puu Anahulu/Puu Waawaa was repaired and will provide protected habitat for reintroducing individuals of *Z. hawaiiense* and other dry to mesic plants (DLNR 2014a). • Captive propagation for genetic storage and reintroduction o The Volcano Rare Plant Facility (2013) has a single individual in their nursery. The Facility propagated two plants for reintroduction next year. Meanwhile, two individuals were reintroduced at Puu Waawaa. In 2014, the Volcano Rare Plant Facility had a single individual in their nursery and a single individual was reintroduced at Puu Waawaa (Volcano Rare Plant Facility 2014). o The Olinda Rare Plant Facility (2013) has one potted plant in their nursery. o The Lyon Arboretum's Seed Conservation Laboratory (2014) had 54 seeds from Molokai in storage; however, only four seeds remain in storage after conducting viability trials. o The Natural Resources Office PTA (U.S. Army

2015) has 45 seeds from two founders in genetic storage. • Captive propagation protocol development – Propagation trials were conducted to determine appropriate storage and propagation techniques for *Z. hawaiiense*. The trials indicated that seeds from *Z. hawaiiense* had a low germination rate over an extended yearly time span (exact amount of years not specified) and seeds remained viable for more than 10 years (U.S. Army 2015). • Population viability monitoring and analysis o The wild individual on East Maui was monitored for seeds, none was collected (PEPP 2009, 2010, 2012). o The population on West Maui was monitored for seeds, none was collected (PEPP 2010). In 2011, the population was monitored again and all known plants were numbered and tagged (PEPP 2012). More than 200 seeds were collected from the ground under three wild individuals. The seeds were sent to Olinda Rare Plant Facility (PEPP 2012). o In April of 2012, the wild individual on Kauai was monitored and two air layers were created (PEPP 2012). In August of 2012, the individual was monitored again and one of the air layers died but the other air layer is surviving (PEPP 2013). In September of 2013, the plant was monitored (PEPP 2014). Another single wild individual on Kauai was monitored in March of 2014 (PEPP 2014). o In 2013, a single wild individual on Molokai was monitored (PEPP 2013, 2014). o The wild population at Kauaula on Maui was monitored and only one of the four trees known from the area was observed (PEPP 2014). That plant was in poor condition and heavily damaged by black twig borers(USFWS, 2015).

References

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

Final Rule . 81 FR 17790-18110 (March 30, 2016).

U.S. Fish and Wildlife Service. 2003. Endangered and Threatened Wildlife and Plants

Final Designation or Nondesignation of Critical Habitat for 95 Plant Species From the Islands of Kauai and Niihau, HI. Final rule. 68 FR 9116 - 9479 (February 27, 2003).

Threats to *Zanthoxylum hawaiiense* include habitat degradation and browsing by feral and domestic animals, competition from non-native plant species, seed predation by rodents, fire

trampling, and effects of military activities (U.S. Army 2003a).

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SPECIES ACCOUNT: *Zanthoxylum oahuense* (A`e)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/18/2012; Pacific Region (R1) (USFWS, 2016)

Physical Description

A small tree, 3-6 m tall. Leaflets 3, coriaceous, broadly deltate. Flowers usually 15-40 (or sometimes more?) in axillary, open, cymose inflorescences usually 8-12 cm long. (NatureServe, 2015)

Taxonomy

Zanthoxylum oahuense (ae) is a small tree in the rue family (Rutaceae) (USFWS, 2012).

Current Range

Endemic to the Koolau Mountains of the island of Oahu, state of Hawaii. Scattered along the northern Koolau mountains.

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On September 18, 2012, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Zanthoxylum oahuense* (A`e) under the Endangered Species Act of 1973, as amended (Act) (77 FR 57648-57862). The critical habitat designation includes 11 critical habitat units, which encompass approximately 25,112 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Zanthoxylum oahuense* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for *Zanthoxylum oahuense* includes 11 critical habitat units, covering one ecosystem type, which encompasses approximately 25,112 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16.

Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Haula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu—Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikeekee, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac

(6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet— Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet— Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu— Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamo Ridge.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Zanthoxylum oahuense* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Zanthoxylum oahuense* occurs within the indicated ecosystem in the Koolau Mountain caldera complex:

Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (F) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Zanthoxylum oahuense* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes,

landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 2,060 and 2,720 feet (USFWS, 2012)

Habitat Narrative

Adult: *Zanthoxylum oahuense* (ae), a small tree in the rue family (Rutaceae), occurs in wet forest in the lowland wet ecosystem at elevations generally between 2,060 and 2,720 ft (628 and 829 m) (Wagner et al. 1999, p. 1,216; TNC 2007; HBMP 2008). (USFWS, 2012)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Long-term trends indicate declines of >10%, whereas short-term trends suggest declines of 10-30% (NatureServe, 2015)

Resiliency:

Low (inferred from USFWS, 2012)

Redundancy:

Low (inferred from USFWS, 2012)

Population Growth Rate:

Slowly declining (NatureServe, 2015)

Number of Populations:

5 (USFWS, 2012)

Population Size:

21 to 25 (USFWS, 2012)

Population Narrative:

Long-term population trends indicate declines of >10%, whereas short-term trends suggest declines of 10-30%. Currently, *Z. oahuense* is found in the Koolau Mountains from Halawa-Kalauao ridge to ridges in Moanalua-Kamananui- Manaiki, and further east at Hawaiiiloa Ridge, in 5 occurrences totaling 21 to 25 individuals (U.S Army 2006; HBMP 2008; Lau 2011, in litt.). Low resiliency and redundancy are inferred based on the low number of known individuals, specific habitat requirements and low number of populations. (NatureServe, 2015; USFWS, 2012)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Adverse impacts on habitat of this species have been identified from nonnative plants, animals (pigs), and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The projected effects of climate change will likely exacerbate the effects of the other threats to the species (USFWS, 2012).

Stressor: Predation and herbivory (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Predation and herbivory by nonnative animal species (pigs, goats, and two-spotted leafhopper) is considered an ongoing threat to *Zanthoxylum oahuense* throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2012).

Stressor: Small populations (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: *Zanthoxylum oahuense* faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). Botanists have observed a steady decline in the numbers of individuals of *Z. oahuense* over the last 9 years. This species is also susceptible to infestation by the two-spotted leafhopper (USFWS, 2012).

Stressor:

Exposure:

Response:
Consequence:
Narrative:

Recovery

Reclassification Criteria:
Not available.

Delisting Criteria:
Not available.

Recovery Actions:

- Not available.

Conservation Measures and Best Management Practices:

- Not available.

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SPECIES ACCOUNT: *Zanthoxylum thomasianum* (St. Thomas prickly-ash)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/20/1985; Southeast Region (R4)

Physical Description

Zanthoxylum thomasianum is an evergreen tall shrub or small tree reaching 20 feet (6 meters) in height with a stem diameter of 4 inches (10 centimeters). The alternate leaves are primarily compound, up to 5 inches (12 centimeters) long with 5 to 13 ovate to obovate leaflets. The leaflets are usually pointed at the apex, rounded at the base, leathery, and shiny green on the upper surface. The stems, twigs, and leaves are armed with prominent, ¼ inch (6 millimeter) spines, of which 1 to 3 may project from the midvein on the lower surface of each leaflet. The species is dioecious – tiny male and female flowers are borne in axillary clusters on different plants. The fruits are small, egg shaped capsules containing a shiny black seed approximately 3/16 inch (5 millimeters) in diameter (USFWS, 1988).

Taxonomy

Zanthoxylum thomasianum, a member of the citrus family (Rutaceae), was first described in 1896 as *Fagara thomasiana* by Krug and Urban. They based their determination on specimens collected in 1880 by H.F. Eggars at Flag Hill on St. Thomas, where the largest known population of this species survives today. In 1911, Percy Wilson transferred the species to genus *Zanthoxylum*, an alternative generic treatment that is usually preferred to *Fagara* (Brizicky 1962). In 1913, Britton and Shafer found the species on St. John, while R.O. Woodbury first collected it on Puerto Rico in the early 1960's at two localities near Coamo (USFWS, 1988).

Historical Range

See Current Range

Current Range

The available information on the distribution of St. Thomas prickly-ash indicates that its distribution includes the islands of St. Thomas and St. John in U.S. Virgin Islands, the municipalities of Coamo, Salinas, and Isabela in Puerto Rico (USFWS 1988), and later reported in the British Virgin Islands in Gorda Peak National Park on Virgin Gorda (Clubbe et al. 2003), and at Hawk's Nest on Tortola (Pascoe 2014) (USFWS, 2015).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Dioecious (USFWS, 2015)

Breeding Season

Adult: Observations of the St. Thomas population, where the species reaches its greatest density, indicate that while flowering occurs regularly at the onset of the wet season (May), seed production is very low (1988).

Reproduction Narrative

Adult: *Zanthoxylum thomasi* is dioecious, producing tiny male and female flowers on separate plants. Pollination is probably effected by insects or wind, although the pollination biology of this species has not been studied. Observations of the St. Thomas population, where the species reaches its greatest density, indicate that while flowering occurs regularly at the onset of the wet season (May), seed production is very low. This suggests that the present population density is so low or the sex ratio skewed to the point that pollination is inhibited. The numbers of seedlings observed reflects the level of seed production: within one group approximately 100 plants covering nearly 3 acres, only 9 seedlings were found, and nearly all of the mature plants fell into a single size class. If recruitment remains this low, population decline can be expected. Elsewhere in the species range, populations are sufficiently small that pollination and seed set are probably even less likely to occur. In addition, recent germination tests (Popenoe, pers. Comm) indicate that viable seed is not always produced. The importance of vegetative regeneration to population growth appears to be minimal. The species does not root-sucker, although resprouting (coppicing) has been observed where plants have been cut near ground level. The multistemmed growth form exhibited by most of the plants of this and other species on St. Thomas and St. John seems to have developed in response to cutting during earlier land clearing (USFWS, 1988).

Habitat Type

Adult: Subtropical Dry Forest (USFWS, 1988)

Habitat Vegetation or Surface Water Classification

Adult: Single canopy forest with virtually no undergrowth (USFWS, 1988)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1988)

Site Fidelity

Adult: High (inferred from USFWS, 1988)

Habitat Narrative

Adult: *Zanthoxylum thomasi* is typical of the plant species comprising the evergreen component of the semideciduous forests of Puerto Rico and the Virgin Islands, which have been classified by Ewel and Whitmore (1973) as subtropical dry forests. The species has also been found in one seemingly anomalous location in the moist forest zone of northern Puerto Rico, although the summits of the limestone hills of this region are edaphically dry, and often support tree species typical of dry forests to the south (USFWS, 1988). The dry forests within which *Zanthoxylum thomasi* occurs can be termed semideciduous, with more than half the species dropping leaves during the dry season. Where *Zanthoxylum thomasi* occurs in the limestone karst region of northern Puerto Rico, soil development and available moisture, topographic position, and resulting physiognomy of the vegetation are analogous to conditions found in the otherwise distinct climatic and geologic regions elsewhere within the species range.

Many of the associated species, particularly the dominants, are the same as those found in the dry forest communities where the species is found (USFWS, 1988). High ecological integrity of the community, low tolerance range and high site fidelity are inferred from USFWS (1988) due to low number of populations and specific habitat requirements.

Dispersal/Migration**Motility/Mobility**

Adult: Low (USFWS, 1988)

Dispersal

Adult: Low (USFWS, 1988)

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Low (inferred from USFWS, 2015)

Representation:

Low (inferred from USFWS, 2015)

Redundancy:

Low (inferred from USFWS, 2015)

Population Growth Rate:

Low (USFWS, 2015)

Number of Populations:

5 (USFWS, 2015)

Population Size:

6 to 116 per population (USFWS, 2015)

Minimum Viable Population Size:

Unknown (USFWS, 2015)

Population Narrative:

Ray and Stanford (2005) found that recruitment of new seedlings was very low in four of five populations, despite relatively large seed crops present at all sites. For example, they found that 84% of the individual plants tagged in the four populations had produced a total of 8 (4.8%) seedlings. Ray and Stanford (2005) also found that the size class distribution of the five populations was biased towards moderate and older age classes and indicated the finding was indicative of an aging population lacking recruitment of young individuals (USFWS, 2015). Ray and Stanford (2005) documented a mean abundance of 37.8 individuals across the five surveyed populations. The populations ranged in size from 6 individuals at Johnson Bay Ridge, to 112 at

Point Rendezvous on Giffit Hill (Table 1), which contrasts with the 50 individuals reported in the Recovery Plan for that area (USFWS 1988). Mean density for all sites was 35.3 individuals per hectare with population areas averaging one hectare (Table 1). According to Ray and Stanford (2005), the Point Rendezvous population was probably larger because the privately-owned land east of the surveyed area has not been searched systematically. In fact, three of the five populations studied by Ray and Stanford (2005) grow on private land, and a total of 138 (74%) of individuals tagged during the survey derived from private property (USFWS, 2015). There is no information to determine what constitutes a viable population (USFWS, 2015).

Threats and Stressors

Stressor: Habitat modification/road construction (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat/Loss of individuals

Narrative: Information from St. Thomas and St. John suggests that habitat modification or destruction is probably the main threat to the species outside the Virgin Islands National Park. For example, an aerial photo from 2009 shows that Flag Hill in St. Thomas was impacted by the construction of a road, which resulted in areas of deforestation (Google Earth, St. Thomas, USVI, 2009). On the island of St. John, land surveying and road construction caused significant damage to a St. Thomas prickly-ash population by cutting 12% of its individuals, and at least 15 shrubs were subsequently eliminated by bulldozing for a road construction (Ray and Stanford 2005). Human-induced threats are expected to increase as road construction already has permanently converted forest habitat, and excavation for home sites and driveways is likely to triple the area of lost habitat, further reducing the St. Thomas prickly-ash population according to Ray and Stanford (2005). Excavation for subdivision roads, driveways and home sites are expected to continue, posing a threat to the species. Moreover, Ray and Stanford (2005) indicated that edge effect and increase in light penetration from perimeter areas of small wood lots will encourage weed infestation, which can reduce the habitat quality for the species (see factor E). Within the Virgin Islands National Park boundaries, however, the native forest habitat described for the species by Ray and Stanford (2005) is well represented. This park covers over half of the island of St. John, and probably harbors undetected populations of St. Thomas prickly-ash. (USFWS, 2015).

Stressor: Predation (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat/Loss of individuals

Narrative: Predation by feral ungulates may be a threat to St. Thomas prickly-ash in the U.S. Virgin Islands. Feral goats, key deer, and donkeys roam freely in areas where St. Thomas prickly-ash is found in St. John, posing a threat to the species (Ray and Stanford 2005). However, grazing by these herbivores may be considered a secondary, low-level threat, as clearing for residential development is probably the main threat to St. Thomas prickly-ash on St. John and St. Thomas (Ray and Stanford 2005). The main impacts from feral ungulates may be more related to the modification of microhabitat conditions necessary for natural recruitment and trampling of small individuals (see Factor E) (USFWS, 2015).

Stressor: Hurricanes and Landslides (USFWS, 2015)

Exposure:

Response:**Consequence:** Loss of populations and individuals

Narrative: Hurricanes frequently affect the islands of the Caribbean. As a species endemic to the Puerto Rican Bank, St. Thomas prickly-ash should be adapted to tropical storms. However, despite adaptation, the loss of any population or individuals poses a threat to the species by making them more susceptible to stochastic events such as hurricanes. Furthermore, the heavy rains associated with tropical storms and hurricanes in the Caribbean, sometimes up to two to three feet of rain in a single storm event, often lead to landslides. In fact, a landslide actually occurred on the lower portion of El Costillar haystack where St. Thomas prickly-ash is found on the very edge of a cliff. A landslide in that area would not only take out the plants, but will also affect their seed bank and substrate as well. In addition, landslides create openings in the vegetation that allow other plants (native or non-native, herbaceous or woody) to become established. At present, there is no information regarding the competitive abilities of St. Thomas prickly-ash in such a situation (USFWS, 2015).

Stressor: Genetic variation (USFWS, 2015)**Exposure:****Response:****Consequence:** Decrease genetic variability

Narrative: Along with decreasing population size, negative impacts of habitat fragmentation may result in erosion of genetic variation through the loss of alleles by random genetic drift (Honnay and Jacquemyn 2007). Given the scattered distribution of St. Thomas prickly-ash and the small size of the majority of the populations, its genetic variability is likely to be an important factor. In fact, information from the island of St. John on the genetics of this species indicates a low genetic variability among sampled populations (Ray and Stanford 2005). Therefore, although the phenology and pollination biology of the species are unknown, we can confidently say that, within in Puerto Rico, and between the U.S. and British Virgin Islands, the distances are big enough to exclude any genetic exchange (D. Kolterman and J. D. China, UPRM, pers. comm., 2012. (USFWS, 2015).

Recovery**Reclassification Criteria:**

The recovery plan specifies that St. Thomas prickly-ash could be considered for reclassification to a threatened species when: 1. With the help of material supplied through ex-situ propagation, at least two separate populations capable of self-perpetuation are established within appropriate units of the Commonwealth Forest System of Puerto Rico (Guánica or Guajataca) or on lands designated to protect the species, and (USFWS, 2015). Criterion 1: Has not been met. No propagation or reintroduction project has been implemented within the Puerto Rico's Commonwealth Forest System. So far all the naturally occurring populations in Puerto Rico lie within private lands and are relatively small (USFWS, 2015).

2. a) at least one large, self-perpetuating population has either been identified or established within the Virgin Islands National Park, and b) a significant portion of the St. Thomas population has been protected through redesignation of lands in Flag Hill area. Criterion 2: Has been partially met. Natural populations of St. Thomas prickly-ash have been identified within the Virgin Islands National Park in St. John. Nonetheless, the Flag Hill area in St. Thomas remains privately owned and unprotected. This is the type location of the species and supported the

largest known population of St. Thomas pricklyash at the time of listing (USFWS 1988) (USFWS, 2015).

Delisting Criteria:

No criteria listed (USFWS, 2015)

The two (2) natural populations within the Virgin Islands National Park boundaries in the U.S. Virgin Islands, and the one (1) natural population within the boundaries of Gorda Peak National Park in the British Virgin Islands show a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (USFWS, 2019).

The natural populations within private lands on St. John (3), St. Thomas (1), and Puerto Rico (1) are protected through a conservation mechanism, and populations show a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (addresses Factors A and E) (USFWS, 2019).

At least two (2) new populations (genetically representing the Puerto Rico population) are established on lands protected by a conservation mechanism in Puerto Rico (e.g., Guanica or Guajataca Commonwealth Forests, or lands designated for conservation). New populations show stable or increasing population trends, evidenced by natural recruitment, and multiple age classes (addresses Factor A and E) (USFWS, 2019).

At least one (1) new population (genetically representing the St. Thomas population) is established on lands protected by a conservation mechanism (e.g., Vieques National Wildlife Refuge). The new populations show a stable or increasing population trend, evidenced by natural recruitment, and multiple age classes (addresses Factor A and E) (USFWS, 2019).

Threat reduction and management activities have been implemented to a degree that the species is viable into the foreseeable future (addresses Factor A and E) (USFWS, 2019).

Recovery Actions:

- A protocol for the propagation and reintroduction of St. Thomas prickly-ash should be developed in collaboration with partners (e.g., UPR, KEW, Fairchild Tropical Botanic Garden, PRDNER, Para La Naturaleza and Natural Resources Conservation Service). The protocol should address the feasibility of seed banking this species, and if deemed necessary, seed material should be stored at the Millennium Seed Bank (KEW) and USDA National Laboratory for Genetic Resources Preservation (NLGRP) in Fort Collins. Studies on the species' population genetics should be conducted to determine patterns of genetic diversity across the species natural distribution (including BVI), and to provide baseline information for sound management of the species. Recovery task: 33 (USFWS, 2019).
- Due to the low number of populations and individuals, along with the little evidence of natural recruitment and limited dispersal, the reproductive biology and ecology of St. Thomas prickly-ash should be determined. In particular, the factors limiting seed dispersal and seedling recruitment should be studied. This should include the establishment of a long-term monitoring program (including permanent parcels) to determine seedling recruitment and survival, and the conditions necessary for their establishment. Recovery task: 31 and 32 (USFWS, 2019).

- Since the core populations of St. Thomas prickly-ash extend to the BVI, the Service foresees collaboration with overseas partners (KEW and National Park Trust) in order to maximize the species recovery (e.g., exchange of species information and prioritization of research needs). Recovery task: 21, 31, 32 and 33 (USFWS, 2019).
- Invasive feral mammals (i.e., white-tail deer, goats and wild hogs) pose a serious threat to the native vegetation of St. John (particularly natural recruitment). Thus, a management plan for the control of feral mammals within the Virgin Islands National Park (St. John) should be developed and implemented. Recovery task: 11 and 12 (USFWS, 2019).

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SPECIES ACCOUNT: *Ziziphus celata* (Florida ziziphus)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/28/1989; Southeast Region (R4) (USFWS, 2015)

Physical Description

Ziziphus celata is a spiny shrub that averages between 0.5 to 1.5 m in height, but can grow to over 2 m. Plants occur in groups of stems, arising from what are assumed to be connected root systems. The primary branches are jointed and bent, and give rise to short, straight, spiny, branchlets. The oblong-elliptic to obovate leaves are alternate and deciduous. The leaves are characterized by rounded tips, cuneate bases, and entire margins. The upper leaf surface is dark glossy green, while the underside is a dull light green. Leaves vary from 4.5 to 21 mm in length, and from 3 to 13 mm in width. Fragrant *Z. celata* flowers are small, axillary, and solitary, but are tightly bundled on short shoots. Flowers are perfect, with five greenish-yellow sepals, and five white petals clasping five stamens; however, three- and four-merous flowers have been observed (Race and Weekley 1996). The bright yellow drupes range from 10 mm to 20 mm long, and 3 mm to 10 mm wide (Judd and Hall 1984, DeLaney et al. 1989, Race and Weekley 1996). (USFWS, 1999)

Taxonomy

Ziziphus celata was originally collected near Sebring in 1948. A second specimen was collected in 1954, perhaps from the same site as the original specimen, but the location of the latter collection is unknown. The plant remained unidentified and unnamed until 1984, when Judd and Hall (1984) named the original herbarium specimen *Ziziphus celata*. When it was named, the Florida ziziphus was thought to be extinct. However, it was rediscovered in 1987 at a site in Polk County (DeLaney et al. 1989). (USFWS, 1999)

Historical Range

See Current Range.

Current Range

Florida ziziphus is known only from a few sites on the Lake Wales Ridge in southern Polk and northern Highlands counties, in Florida. (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated; Asexual (USFWS, 1999)

Breeding Season

Adult: Begins to flower in late December or early January and flowering continues through late February (varying by site and year), while the branches are still bare.

Other Reproductive Information

Adult: Research on the genetics, reproductive biology, and demography of Florida ziziphus for over a decade has quantified limited genetic variation in the wild populations. Breeding system experiments have demonstrated that Florida ziziphus is self-incompatible and that most genotypes are also cross-incompatible. The combination of limited genetic variation and a limited range of mating types explains why most populations are self-sterile. Demographic research has shown that populations are stable with high survival but variable levels of clonal recruitment. Without augmentation, most populations are predicted to undergo slow decline in numbers (Menges 2012). (USFWS, 2019)

Reproduction Narrative

Adult: Ziziphus celata is deciduous, losing its leaves in late fall. It begins blooming in late December or early January and blooming continues through late February (varying by site and year), while the branches are still bare (Burkhart et al. 1997). Fruits begin to develop in March, with new leaves forming at the same time or soon after. The fruits ripen in May or early June. No seedlings have been found in the wild, so it is not known whether the seeds germinate in the summer or later in the year. Common pollinators (bees and flies) have been observed visiting the flowers, although it is not known if these are pollinators of Ziziphus. No viable seeds have been observed in the wild. Natural fruit set has been observed twice in the wild, but few fruit were produced, and of those all aborted before maturity. Lack of sexual reproduction may be due to the absence of compatible genotypes at a given site and/or the age of the above ground stems (Burkhart et al. 1997). Ziziphus celata spreads asexually by sending shoots up from its roots. These additional stems give Z. celata a clump-like appearance, where individual plants in the clump are not distinguishable. Like other members of its genus, Z. celata is capable of parthenocarpic production of fruit, but it differs from others in its genus by not being dichogamous, having pistils and stamens that mature at different times to prevent self-fertilization (Burkhart et al. 1997). (USFWS, 1999)

Habitat Type

Adult: Oak-hickory scrub

Habitat Narrative

Adult: Florida ziziphus is a thorny clonal shrub found only on yellow sand xeric habitats that historically supported longleaf pine/wiregrass sandhills and similar vegetative communities. Most Florida ziziphus habitat has been converted to citrus groves and cattle ranches. (USFWS, 2019)

Dispersal/Migration***Population Information and Trends*****Number of Populations:**

14

Population Narrative:

Florida ziziphus is known only from a few sites on the Lake Wales Ridge in southern Polk and northern Highlands counties. Only four of the 14 known populations occur in publicly protected

sites. Most populations are self-sterile due to limited genetic diversity and the isolation of population. The most recent FNAI Element Tracking Summary (FNAI 2015) reported 10 known occurrences for Florida ziziphus, of which 5 are protected at 4 different managed areas. In addition, four new populations have been established since 2008. Florida ziziphus has been reintroduced using transplants and seeds to four sites, including The Nature Conservancy's Tiger Creek Preserve, the Lake Wales Ridge State Forest, and the Lake Wales Ridge NWR. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat destruction or modification

Exposure:

Response:

Consequence:

Narrative: This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggest that Florida's 2070 population will be early 15 million persons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

Stressor: Lack of adequate fire management

Exposure:

Response:

Consequence:

Narrative: This species occurs within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation

seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

Stressor: Limited geographic range

Exposure:

Response:

Consequence:

Narrative: This species occurs within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

Recovery

Reclassification Criteria:

Not defined. (USFS, 1999)

Delisting Criteria:

1. At least 40 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)
2. Populations (as defined in criterion 1) in sand hill habitat are distributed across the known range of the species. (USFWS, 2019)
3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

Recovery Actions:

- Determine current distribution of *Z. celata*. It is possible that populations of this species have yet to be discovered. Currently, three of the sites for *Z. celata* are in pastures and the other two are in restricted remnant areas. A complete survey has not been made of the Lake Wales Ridge for this species, making defining a distribution difficult. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties has been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases is isolated. Within the islands of xeric habitat, this species is found in only two remnant natural

- sites and three pastures sites, indicating how little habitat is left for *Z. celata*. For this reason, existing populations are in need of protection. (USFWS, 1999)
- Continue research on life history characteristics of *Z. celata*. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species more specific biological information is needed. (USFWS, 1999)
 - Continue monitoring existing populations of *Z. celata*. (USFWS, 1999)
 - Provide public information about *Z. celata*. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Care is needed, though, to avoid revealing specific locality information about *Z. celata*. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of *Z. celata* and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)
 - Habitat-level Recovery Actions: Prevent degradation of existing habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

References

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SPECIES ACCOUNT: *Chamaesyce deltoidea* ssp. *deltoidea* (Deltoid spurge)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/19/1985; Southeast Region (R4)

Physical Description

Chamaesyce deltoidea ssp. *deltoidea* is a small, monoecious, prostrate to decumbent herb occurring in mats over exposed limestone. The stems are terete (circular although slightly oblong) in cross section, brown, and 0.3 to 0.6 mm in diameter. The leaves are smooth above to slightly hairy below, with an obtuse apex, cordate base, margins entire; stipules laciniate, brown to reddish brown with light tips, and smooth. The inflorescence is found singly, in leaf axils, with a short peduncle (1 mm long). The cyathium is 1.2 mm long, 1.0 mm wide and smooth (glabrous). It is green and ovate in shape with four glands and minute appendages. The fruit is a capsule, 1.0 mm long and 1.0 mm wide, and completely glabrous. The pedicel is also glabrous. It is fully exerted at maturity. There are three seeds, 1.0 mm long and 0.5 mm wide, ovate in shape and glabrous. The seeds are laterally four-ridged and yellowish-white (Remus 1979). The leaves and stems of the subspecies *Chamaesyce deltoidea* ssp. *adhaerens* are appressed to the ground surface and the plants form mats. In some cases the stems will ascend and form tufts (Herndon 1993). The inflorescence is solitary, terminal, pedunculate (1.5 mm long), and glabrous proximally to pilose distally. The main distinction between the two subspecies is their pubescence. The pubescence of the subspecies *C. deltoidea* ssp. *adhaerens* is appressed on the leaves and on the stems it is spreading or appressed (Herndon 1993). The pubescence for *C. deltoidea* ssp. *deltoidea* is sparse, appressed on the leaves and the stems are glabrous or thinly pubescent (Herndon 1993). (USFWS, 1999)

Taxonomy

Deltoid spurge was first described as *Euphorbia deltoidea* by Engelman (Chapman 1883). In 1903, Small transferred the species to the genus *Chamaesyce*, a natural genus distinguished from *Euphorbia* by having the main stem abortive just above the cotyledons, making the aerial portion of *Chamaesyce* homologous to the inflorescence of *Euphorbia* subgenus *Esula* (Webster 1967). Burch (1966) treated *C. deltoidea* as a complex of three taxa endemic to South Florida: *C. deltoidea*, *C. adhaerens* Small, and *C. serphyllum* Small, treating deltoid spurge as *C. deltoidea* (Engelman ex Chapman) Small subsp. *deltoidea* var. *deltoidea* without comment. In Herndon's (1993) revision of the *C. deltoidea* complex, he recognized four subspecies endemic to South Florida: ssp. *deltoidea*, ssp. *adhaerens*, ssp. *pinetorum*, and ssp. *serphyllum*. The taxonomy of this complex is difficult and some follow Burch's 1966 treatment and others follow Herndon's 1993 treatment. The final rule as listed in the Federal Register applies to the taxa *deltoidea* and *adhaerens*, which are restricted to Miami-Dade County, Florida. According to this, all members of the *C. deltoidea* complex that are restricted to Miami-Dade County are considered endangered species by the FWS. For purposes of clarity, Herndon's treatment will be used for this recovery plan. Synonyms: *Euphorbia deltoidea* Engelman ex Chapman; *Chamaesyce deltoidea* (Engelman ex Chapman) Small ssp. *deltoidea* var. *deltoidea*; *Chamaesyce adhaerens* Small; *Chamaesyce deltoidea* (Engelm. ex Chapman) ssp. *deltoidea* var. *adhaerens* (Small) Burch. (USFWS, 1999)

Historical Range

In Florida, endemic that was historically known to occur in pine rocklands from the Goulds area north to the center of the city of Miami (USFWS, 1999)

Current Range

In Florida, from south Miami to the Homstead area (USFWS, 2019)

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Breeding Season**

Adult: Flowers from April through November, peaking in July. (USFWS, 1999)

Reproduction Narrative

Adult: Studies into the life history of the deltoid spurge have only recently begun and little is known about its reproduction. It is a perennial that flowers from April through November, peaking in July. Its extensive root system gives evidence that it is a long-lived plant (DERM 1994). The reproductive ecology in *Chamaesyce* has been poorly studied but it is known to be highly variable (Ehrenfeld 1976, 1979; Webster 1967). Some species are completely reliant on insects for pollination and seed production, while others are self-pollinating. Pollinators may include bees, flies, ants, and wasps (Ehrenfeld 1979). Seed capsules of many Euphorbiaceae are explosively dehiscent, ejecting seeds a short distance from the parent plant. The seeds of some species are dispersed by ants (Pemberton 1988). (USFWS, 1999)

Habitat Type

Adult: Pine rocklands (USFWS, 1999)

Habitat Narrative

Adult: The deltoid spurge tends to occur in areas with an open shrub canopy, exposed limestone (oolite), and minimal litter (pine needles, leaves, and other organic materials). It is most often found growing at the edges of sand pockets with plants growing both in sand (sometimes in association with the endangered *Polygala smallii*) and on oolitic limestone. The soils in which it grows are classified as Opalocka-Rock Outcrop soils. The subspecies *C. deltoidea* ssp. *adhaerens* occurs in fine, reddish sandy loam over limestone. Dense colonies are sometimes found in pinelands that have undergone a slight mechanical disturbance, where little or no topsoil is formed and where productivity is low. The shrub canopy in this disturbed habitat is often poorly developed providing high light levels and low organic litter accumulation rates. The pine rocklands are often considered a fire subclimax, and are maintained with periodic fires (3 to 7 years). These periodic fires keep the shrub canopy down and eliminate the litter accumulations. (USFWS, 1999)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Seed capsules of many Euphorbiaceae are explosively dehiscent, ejecting seeds a short distance from the parent plant. The seeds of some species are dispersed by ants (Pemberton 1988).

Population Information and Trends

Population Trends:

Unknown

Number of Populations:

17 sites (USFWS, 2019)

Population Size:

~16,000 to 20,000 individuals (USFWS, 2019)

Population Narrative:

Chamaesyce deltoidea ssp. *deltoidea* is only known from the pine rocklands of Miami-Dade County. The remaining *C. d.* ssp. *deltoidea* populations occur entirely within a narrow region of pine rockland fragments that includes 17 sites – 16 public and 1 private (Institute for Regional Conservation [IRC] 2006; Bradley, IRC, pers. comm. 2010a; Lange, pers. comm. 2017; Possley, pers. comm. 2017a, 2017b). Three of the largest extant populations (Larry and Penny Thompson Park, Martinez Pineland, and Zoo Miami), which consist of approximately 16,000 plants (Lange, pers. comm. 2017; Possley, pers. comm. 2017a) occur within the Richmond Pine Rocklands, portions of which are being developed or are being considered for future projects. Ongoing or additional development within this area will reduce habitat for these species and may complicate land managers' ability to conduct conservation activities (e.g., prescribed fire) based on the proximity of or adjacency to residential and commercial properties. Four populations on County-managed conservation lands (Deering Estate at Cutler, Ludlum Pineland, Pine Shore Preserve, and Ned Glenn Nature Preserve) retain moderately-sized populations ranging from 200 to 800 individuals. The ten additional sites have fewer than 100 individual plants per population. Five of the recently extirpated populations occurred on County-owned conservation lands and were lost due to inadequate land management. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat loss and fragmentation

Exposure:

Response:

Consequence:

Narrative: The pine rockland community of south Florida is critically imperiled globally (FNAI 2010b). In Miami-Dade County, development and agriculture have reduced pine rockland habitat by 90 percent. Continued habitat loss (Factor A) and fragmentation threaten the existence of this species, and less than 1 percent of the original acreage of pine rockland habitat remains outside of ENP (Herndon 1998). Populations on private sites remain threatened with destruction or habitat modification due to improper or lack of management (Factors A and E). (USFWS, 2019)

Stressor: Nonnative invasive plants

Exposure:

Response:**Consequence:**

Narrative: Invasion by exotic plant species continue to affect this species (Factor E) Nonnative invasive plants compete with native plants for space, light, water, and nutrients, and make habitat conditions unsuitable for this species, which prefers open conditions (Factor E). Bradley and Gann (1999) indicated that the control of nonnative plants is one of the most important conservation actions for the pine rockland species and a critical part of habitat maintenance. Nonnative plants have significantly affected pine rocklands and negatively impacted all occurrences of this species to some degree. (USFWS, 2019).

Stressor: Inadequate fire management

Exposure:**Response:****Consequence:**

Narrative: Fire suppression continues to affect this species (Factor E). Historically, frequent (approximately twice per decade), lightning-induced fires were a vital component in maintaining native vegetation and ecosystem functioning within south Florida pine rocklands. A period of just 10 years without fire may result in a marked decrease in the number of herbaceous species due to the effects of shading and litter accumulation (FNAI 2010b). The majority of extant populations of these species are affected by some degree of inadequate fire management, with the primary threat being shading by hardwoods (Bradley and Gann 1999; Bradley and Gann 2005). (USFWS, 2019)

Stressor: Inadequacy of existing regulatory mechanisms

Exposure:**Response:****Consequence:**

Narrative: Regulatory mechanisms (Factor D) provide limited protections for this species. The Florida Department of Agriculture and Consumer Services designated this species as endangered under Chapter 5B-40, Florida Administrative Code. This law regulates the taking, transport, and sale of listed plants. This law does not prohibit private property owners from destroying listed plants nor does it require them to manage habitats to maintain populations. The Natural Forest Communities (NFC) program was established by Miami-Dade County to encourage but not require private landowners to protect forested lands by making it necessary to apply for a permit with the County prior to working in designated NFCs (i.e., pinelands, hammocks). (USFWS, 2019)

Recovery**Reclassification Criteria:**

1. Enough demographic data are available to determine the appropriate numbers of self sustaining populations required to ensure 20 to 90 percent probability of persistence for 100 years (USFWS, 2010)
2. When these populations, within the historic range of deltoid spurge are adequately protected from further habitat loss, degradation, exotic plant invasion, and fire suppression (USFWS, 2010)
3. When these sites are managed to maintain the pine rocklands to support deltoid spurge (USFWS, 2010)

4. When monitoring programs demonstrate that populations of deltoid spurge on these sites support sufficient populations sizes, are distributed throughout the historic range, and are sexually or vegetatively reproducing at sufficient rates to maintain the population. (USFWS, 2010)

Delisting Criteria:

1. Existing natural populations achieve and maintain a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (addresses Factors A and E) (USFWS, 2019)
2. A network of 6 new populations are either discovered or reintroduced that exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (addresses Factors A and E) (USFWS, 2019)
3. All populations (criteria 1 and 2) are protected by a conservation mechanism. (addresses Factors A, D, and E) (USFWS, 2019)
4. Threats have been reduced or eliminated to the degree that this species will remain viable for the foreseeable future. (addresses Factors A, D, and E) (USFWS, 2019)

Recovery Actions:

- Conduct surveys to determine distribution of pine rockland plants. Pine rockland plants were thoroughly surveyed in Miami-Dade County; however, the status of *C. deltoidea* is not known over its entire range. (USFWS, 1999)
- Protect and enhance existing populations. It is imperative for the recovery of pine rockland plants that additional populations not be lost. (USFWS, 1999)
- Collect biological information important to species recovery. Additional information on the ecology and life history of pine rockland plants needs to be collected. The size and viability of known populations of *C. deltoidea* needs to be evaluated. (USFWS, 1999)
- Monitor *C. deltoidea* populations. Use existing standardized monitoring protocols developed by the Florida Natural Areas Inventory to record baseline data regarding the biology and ecology of *C. deltoidea*. Determine the effects of management actions on *C. deltoidea*. Initiate quarterly monitoring programs. (USFWS, 1999)
- Continue implementation of the fire education program and modify as necessary any fire management education program that has been developed. Future modifications to this program may include tri-lingual distribution (Spanish, English, and Haitian Creole). (USFWS, 1999)
- Habitat-Level Recovery Actions: Continue to protect pine rockland plant habitat in order to prevent degradation. Restore areas to suitable habitat. Conduct habitat-related research. (USFWS, 1999)

Conservation Measures and Best Management Practices:

- Habitat degradation continues to be a moderate threat because vegetation restoration and management programs are costly and depend upon availability of funding (Service 2006).

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SPECIES ACCOUNT: *Chamaesyce garberi* (Garber's spurge)

Species Taxonomic and Listing Information

Listing Status: Threatened; 7/18/1985; Southeast Region (R4) (USFWS, 2015)

Physical Description

A prostrate herb with pubescent stems. Leaves are ovate and 4-9 mm long. Flowers are conspicuous. (NatureServe, 2015)

Taxonomy

Garber?'s spurge was first described by Engelman as *Euphorbia garberi* Engelman in 1883 (Engelman in Chapman 1883). In 1903, Small transferred it to the genus *Chamaesyce* (Small 1903), a natural genus distinguished from *Euphorbia* by having the main stem abortive just above the cotyledons, making the aerial portion of *Chamaesyce* homologous to the inflorescence of *Euphorbia* subgenus *Esula* (Webster 1967) (USFWS, 1999).

Historical Range

Garber?'s spurge is endemic to South Florida (USFWS, 1999). It formerly occurred in Dade and Monroe counties, Florida, from Miami to the lower Florida Keys. Has disappeared from much of its historical range. (NatureServe, 2015)

Current Range

It is currently known from Miami-Dade county and 14 islands in the Keys in Monroe county (USFWS, 2007).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Key Resources Needed for Breeding

Adult: Insect pollinators (EPA, 2016)

Reproduction Narrative

Adult: Pollinators may include bees, flies, ants, and wasps (EPA, 2016).

Habitat Type

Adult: Terrestrial, palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Herbaceous wetland, barrens, forest, grassland, dune, shrubland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Periodic fires (NatureServe, 2015)

Habitat Narrative

Adult: Dry, sandy soil in ecotones between hammocks and pinelands or coastal hammocks and sea-oats dunes. Requires periodic burning or is shaded out as succession occurs (NatureServe, 2015). Garber's spurge occurs at low elevations either on thin sandy soils composed largely of Pamlico sands or directly on limestone. It is found in a variety of open to moderately shaded habitat types. In pine rocklands, it grows out of crevices in oolitic limestone. On Cape Sable, Everglades NP, it has been reported from hammock edges, open grassy prairies, and backdune swales. In the Florida Keys, it grows on semi-exposed limestone shores, open calcareous salt flats, pine rocklands, calcareous sands of beach ridges, and along disturbed roadsides. Soils are composed largely of Pamlico sands or directly on limestone (EPA, 2016).

Dispersal/Migration**Dependency on Other Individuals or Species for Dispersal**

Adult: Unknown (EPA, 2016)

Dispersal/Migration Narrative

Adult: Seed dispersal occurs via wind and potentially insects. The capsules of many Euphorbiaceae are explosively dehiscent, ejecting seeds a short distance from the parent plant. The seeds of some species are dispersed by ants (EPA, 2016).

Population Information and Trends**Population Trends:**

Declining (inferred from USFWS, 2007)

Species Trends:

Unknown (USFWS, 2007)

Resiliency:

Low (inferred from

Redundancy:

Moderate (inferred from USFWS, 2007)

Number of Populations:

17 (USFWS, 2007)

Population Size:

Unknown (NatureServe, 2015)

Population Narrative:

Abundance data is not available (NatureServe, 2015). The species status is unknown due to the lack of information on population trends and threats in 2006. It is currently known from about 17 populations. It only occurs on at most half of the islands in the Keys where it once occurred (USFWS, 2007).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Development is a concern for this species mainly in the Keys. Without intervention, areas on private land that may contain Garber's spurge will most likely be altered. Some sites are threatened by fire suppression and/or exotic plants that have been managed insufficiently (USFWS, 2007).

Stressor: Key deer (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Dooley (1975) reported Garber's spurge as a food plant of Key deer. The Key deer population increased 240% between 1971 and 2001 (Lopez et al. 2004), and this increase has probably had a significant impact on the vegetation in the deer's range (USFWS, 2007).

Stressor: Recreation (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Populations on dunes have the potential to be threatened by trampling from beach goers (USFWS, 2007).

Stressor: Small population size (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Because populations are very small, they are subject to extirpation as a result of human or natural stochastic events. Sea level rise may become a significant threat in coming decades. Populations typically occur at elevations less than 0.50 meters; recent estimates for sea level rise through 2100 range from 0.28 - 0.34 meters (Church and White 2006) (USFWS, 2007).

Recovery

Reclassification Criteria:

1. Enough demographic data are available to determine the appropriate numbers of self-sustaining populations required to ensure 95% probability of persistence for 100 years (USFWS, 2007).
2. When these populations within the historic range of Garber's spurge are adequately protected from further habitat loss, degradation, exotic plant invasion, and fire suppression (USFWS, 2007).
3. When these sites are managed to maintain the pine rocklands to support Garber's spurge (USFWS, 2007).

4. When monitoring programs demonstrate that populations of Garber's spurge on these sites support sufficient population sizes, are distributed throughout the historic range, and are sexually or vegetatively reproducing at sufficient rates to maintain the population (USFWS, 2007).

Delisting Criteria:

Not available

Recovery Actions:

- Determine the distribution of the species in South Florida (USFWS, 1999).
- Protect and enhance populations (USFWS, 1999).
- Conduct research on biology/ecology (USFWS, 1999).
- Monitor populations (USFWS, 1999).
- Inform and involve stakeholders and the general public in the recovery process (USFWS, 1999).

Conservation Measures and Best Management Practices:

- Acquire privately owned properties where the species occurs, including coastal rock barrens on Long Key and Crawl Key (USFWS, 2007).
- Where present on roadsides, maintain an infrequent mowing regime to allow plants sufficient time to flower and disperse seeds. Do not plant turf grasses in or next to roadside populations. Trim hardwoods from edges of population to prevent shading. Communicate these road maintenance guidelines with road maintenance crews (USFWS, 2007).
- Implement a prescribed fire program at the Deering Estate at Cutler with a fire return interval of 3 - 7 years (USFWS, 2007).
- Ensure that Monroe county regulators can identify Garber's spurge to ensure that developers pay proper mitigation fees when applying for building permits (USFWS, 2007).
- Continue or initiate exotic plant control at all sites where populations occur (USFWS, 2007).
- Initiate long-term monitoring of presence or population sizes of all populations, or at a minimum, at a subset which includes the geographic range of the species and a variety of habitat types (USFWS, 2007).
- Initiate long-term, detailed demographic studies in a subset of populations which includes the geographic range of the species and a variety of habitat types, including pine rockland, coastal habitats, and disturbed areas (USFWS, 2007).
- Reintroduce populations to stations where formerly present (USFWS, 2007).
- Conduct studies of coastal rock barren habitat to determine successional processes and management needs of the ecosystem (USFWS, 2007).
- Remove hardwoods from disturbed area where Garber's spurge occurs at Crocodile Lake National Wildlife Refuge, and use this population as a source of germplasm for reintroductions into natural habitats in the Key Largo area (USFWS, 2007).
- Conduct genetic studies to clarify relationships with *C. porteri*, determine if patterns of morphological variation reported by Herndon (1993) are genetically based, and determine if inbreeding depression is occurring within any populations (USFWS, 2007).
- Develop population viability and risk assessments for all populations, based on monitoring and demographic studies (USFWS, 2007).
- Conduct seed bank studies to determine longevity of seed bank and viability under different conditions (USFWS, 2007).

- Study relationship of fire to population demography of Garber's spurge to determine potential impacts of sea level rise (USFWS, 2007).
- Search recently burned pine rocklands in the lower Florida Keys for Garber's spurge (USFWS, 2007).
- Study impacts of hurricanes on Garber's spurge populations in coastal habitats (USFWS, 2007).
- One recovery criteria that should be modified states that sites must be managed to maintain pine rocklands to support Garber's spurge. Because pine rockland is not the primary habitat for the species in much of its range, this criterion should be updated to additionally require that dunes, coastal grasslands, and coastal rock barrens be managed to support the species (USFWS, 2007).
- Determine if Key deer forage significantly on Garber's spurge (USFWS, 2007).

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SPECIES ACCOUNT: *Chamaesyce hooveri* (Hoover's spurge)

Species Taxonomic and Listing Information

Listing Status: Threatened; 03/26/2016; California/Nevada Region (R8) (USFWS, 2015)

Physical Description

Chamaesyce hooveri forms gray-green mats from a few inches to a few feet across. The flowering structure is a small, highly simplified cup-like "cyathium," as in all other spurges (*Chamaesyce* and *Euphorbia*). The flowering structure in *C. hooveri* has petallike glands that are red to olive in color. Flowers bloom in July. (USFWS, 2009)

Taxonomy

This plant was originally named *Euphorbia hooveri*, based on a specimen collected by Hoover in Yettem, Tulare County (Wheeler 1940). At that time, the genus *Euphorbia* was viewed as comprising several subgenera, including *Chamaesyce* and *Euphorbia*. Webster (1975) subsequently elevated the subgenus *Chamaesyce* to the rank of genus based on growth patterns and physiology. The currently accepted scientific name, *Chamaesyce hooveri*, was validated when Koutnik (1985) published the new combination. (USFWS, 2009)

Historical Range

For decades, *Chamaesyce hooveri* was known from only three localities: near Yettem and Visalia in Tulare County, and near Vina in Tehama County. Collections were made from these three areas in the late 1930s and early 1940s (Wheeler 1941, Munz and Keck 1959, Stone et al. 1988). From 1974 through 1987, 21 additional occurrences of *C. hooveri* were reported. The majority of these (15) were in Tehama County. One to three occurrences were discovered during this period in each of Butte, Merced, Stanislaus, and Tulare Counties (Stone et al. 1988). The historical localities for this species were in the Northeastern Sacramento Valley, San Joaquin Valley, Solano-Colusa, and Southern Sierra Foothills Vernal Pool Regions (Keeler-Wolf et al. 1998). (USFWS, 2005)

Current Range

Of the 26 occurrences presumed to be extant, only 3 have been observed within the past decade (California Natural Diversity Data Base 2003). The main remaining area of concentration for *Chamaesyce hooveri* is within the Northeastern Sacramento Valley Vernal Pool Region. The Vina Plains of Tehama and Butte Counties contain 14 (53.8 percent) of the 26 known extant occurrences for *C. hooveri* (California Natural Diversity Data Base 2003) in an area of about 91 square kilometers (35 square miles; Stone et al. 1988). One other site in the same region is near Chico in Butte County. Seven of the extant occurrences are in the Southern Sierra Foothills Vernal Pool Region, including five in the Visalia-Yettem area of Tulare County and two in the Hickman-La Grange area of Stanislaus County. Three other occurrences are on the Sacramento National Wildlife Refuge in Glenn County, which is in the Solano-Colusa Vernal Pool Region. The one other extant occurrence is on the Bert Crane Ranch in Merced County, which is within the San Joaquin Valley Vernal Pool Region (Keeler-Wolf et al. 1998, California Natural Diversity Data Base 2003). (USFWS, 2005)

Critical Habitat Designated

Yes; 2/10/2006.

Legal Description

On August 11, 2005, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Chamaesyce hooveri* (Hoover's spurge) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes seven critical habitat units (CHUs), in California (71 FR 7118-7316).

Critical Habitat Designation

The critical habitat designation for *Chamaesyce hooveri* includes seven CHUs in Merced, Stanislaus, Tehama, Tulare, and Tuolumne Counties, California. This species critical habitat encompasses approximately 114,713 acres (71 FR 7118-7316).

Unit 1: Tehama County, California. From USGS 24,000 topographic quad Acorn Hollow, Richardson Springs NW

Unit 2: Butte County, California. From USGS 24,000 topographic quad Hamlin Canyon

Unit 4: Stanislaus and Tuolumne Counties.

Unit 5: Stanislaus and Merced Counties. (i) Unit 5A: Stanislaus and Merced Counties. From USGS 24,000 topographic quads Paulsell, Cooperstown, Le Grange, Montpelier, Turlock Lake, Snelling, Merced Fall. (ii) Unit 5B: Merced County. From USGS 24,000 topographic quad Turlock Lake. USGS 24,000 topographic quads Paulsell, Montpelier.

Unit 6: Merced County. (i) Unit 6A: Merced County. USGS 24,000 topographic quads Stevinson, San Luis Ranch. Unit 6B: Merced County. From USGS 24,000 topographic quad Stevinson, Arena, San Luis Ranch, Turner Ranch. Unit 6C: Merced County. From USGS 24,000 topographic quad Arena, Turner Ranch. Unit 6D: Merced County. USGS 24,000 topographic quad Turner Ranch, Sandy Mush. Unit 6E: Merced County. USGS 24,000 topographic quad Turner Ranch, Sandy Mush.

Unit 7: Tulare County. (i) Unit 7A: Tulare County. From USGS 24,000 topographic quads Stokes Mtn., Ivanhoe. Unit 7B: Tulare County. From USGS 24,000 topographic quads Ivanhoe. (iii) Unit 7C: Tulare County. From USGS 24,000 topographic quads Stokes Mtn., Auckland, Ivanhoe, Woodlake. Unit 7D: Tulare County. From USGS 24,000 topographic quad Woodlake. Unit 7E: Tulare County. From USGS 24,000 topographic quad Monson. Unit 7F: Tulare County. USGS 24,000 topographic quad Monson. Unit 7G: Tulare County. USGS 24,000 topographic quad Monson.

Unit 3: Glenn and Colusa Counties, California. This unit was excluded from the designation pursuant to Section 4(b)(2) of the Act (see Exclusions under 4(b)(2) in the final critical habitat rule (70 FR 46924).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Chamaesyce hooveri* critical habitat consists of two components (70 FR 46924-46999):

(i) Topographic features characterized by isolated mound and intermound complex within a matrix of surrounding uplands that result in continuously, or intermittently, flowing surface water in the depressional features including swales connecting the pools described below in paragraph (2)(ii), providing for dispersal and promoting hydroperiods of adequate length in the pools;

(ii) Depressional features including isolated vernal pools with underlying restrictive soil layers that become inundated during winter rains and that continuously hold water or whose soils are saturated for a period long enough to promote germination, flowering, and seed production of predominantly annual native wetland species and typically exclude both native and nonnative upland plant species in all but the driest years. As these features are inundated on a seasonal basis, they do not promote the development of obligate wetland vegetation habitats typical of permanently flooded emergent wetlands;

Special Management Considerations or Protections

When designating critical habitat, we assess whether the areas determined to be essential for conservation may require special management considerations or protections. As we undertake the process of designating critical habitat for a species, we first evaluate lands defined by those physical and biological features essential to the conservation of the species for inclusion in the designation pursuant to section 3(5)(A) of the Act. Secondly, we then evaluate lands defined by those features to assess whether they may require special management considerations or protection. In designating critical habitat, we also have considered how this designation highlights habitat that needs special management considerations or protection. For example, we have many regional HCPs under development, and this designation will be useful in helping applicants determine what vernal pool habitat areas should be highest priority for special management or protection, and where there may be more flexibility in conservation options. This designation will guide them and us in ensuring that all local habitat conservation planning efforts are consistent with conservation objectives for these species. Once a vernal pool habitat has been protected from direct filling, it is still necessary to ensure that the habitat is not rendered unsuitable for vernal pool species because of factors such as altered hydrology, contamination, nonnative species invasions, or other incompatible land uses. Many of the factors that cause the decline and localized extirpation of vernal pool species can be avoided. Actions that should be avoided include the following: (1) Actions that increase competition from invasive species as many of the species addressed in this rule are threatened by invasion of nonnative species (CNDDDB 2001). (2) Alteration of natural hydrology such as construction of dams or other structures that artificially increase the length of vernal pool inundation or construction of ditches that artificially drain vernal pools. (3) Human degradation of vernal pools such as off-road vehicle use, dumping, and vandalism that threatens many of the species addressed in this rule.

Life History

Food/Nutrient Resources

Lifespan

Adult: 1 year (annual) (USFWS, 2005)

Dependency on Other Individuals or Species

Adult: Beetles (order Coleoptera), flies (order Diptera), bees and wasps (order Hymenoptera), and butterflies and moths (order Lepidoptera) have been observed visiting the flowers of *Chamaesyce hooveri* and may potentially serve as pollinators (Stone et al. 1988, Alexander and Schlising 1997). (USFWS, 2005)

Breeding Season

Adult: Late May to October (USFWS, 2005)

Reproduction Narrative

Adult: *Chamaesyce hooveri* is a summer annual, but few details of its life history are known. Populations in Merced and Tulare Counties typically flower from late May through July, whereas those farther north in Stanislaus County and the Sacramento Valley flower from mid-June into October (Alexander and Schlising 1997, J. Silveira in litt. 2000, California Natural Diversity Data Base 2003). Beetles (order Coleoptera), flies (order Diptera), bees and wasps (order Hymenoptera), and butterflies and moths (order Lepidoptera) have been observed visiting the flowers of *Chamaesyce hooveri* and may potentially serve as pollinators (Stone et al. 1988, Alexander and Schlising 1997). (USFWS, 2005)

Habitat Type

Adult: Temporary pool (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Vernal pools (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (USFWS, 2005)

Site Fidelity

Adult: High (inferred from USFWS, 2005)

Habitat Narrative

Adult: *Chamaesyce hooveri* is restricted to vernal pools (Stone et al. 1988, Koutnik 1993, Skinner and Pavlik 1994). Deeper pools apparently provide better habitat for this species because the duration of inundation is longer and the deeper portions are nearly devoid of other vegetation, thus limiting competition from other plants (J. Stebbins in litt. 2000a, Stone et al. 1988). However, the plant appears to adapted to a wide variety of soils, which range in texture from clay to sandy loam. (USFWS, 2005)

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Not available

Resiliency:

Low (inferred from USFWS, 2009)

Representation:

Low (inferred from USFWS, 2009)

Redundancy:

Low (inferred from USFWS, 2009)

Number of Populations:

27 (USFWS, 2009)

Population Size:

100-2,500 (USFWS, 2009)

Population Narrative:

Population numbers have ranged from less than 100 plants seen in 2001 to over 2,500 plants seen in 1993 (J. Silveira, in litt. 2009). Of the 31 known occurrences and sites, 27 are presumed to be extant (LSA 2003; CNDDDB 2007). (USFWS, 2009)

Threats and Stressors

Stressor: Habitat loss

Exposure:

Response:

Consequence:

Narrative: Habitat loss occurs from direct destruction and modification of pools due to filling, grading, discing, leveling, paving, and other activities, as well as modification of surrounding uplands, which alters vernal pool watersheds and the supporting upland ecosystem. Fifty-five percent of presumed extant sites of *C. hooveri* are on private land and are not protected (CNDDDB 2007). (USFWS, 2009)

Stressor: Agriculture conversion

Exposure:

Response:

Consequence:

Narrative: During the 30 years prior to listing, agricultural land conversion was known to have caused the extirpation of one population and threatened two more populations of *Chamaesyce hooveri* in Tulare County (Stone et al. 1988). In Stanislaus County, the area east of Waterford and Hickman was being converted into grainfields, almond orchards, and irrigated pasture. Thus agricultural land conversion in this area threatened 2 more existing populations of *C. hooveri* (Stone et al. 1988). It is likely that several occurrences were eliminated by habitat losses before they became known, mainly from conversion of vernal pool habitat to agricultural uses (Stone et al. 1988). We estimated a total of nearly 5,600 acres had been converted, with the greatest acreage, approximately 5,000 acres, converted within the Merced core area. Additionally, one of the occurrences of *Chamaesyce hooveri* within the Vina Plains core area appears to have been converted to more intensive agriculture. (USFWS, 2009)

Stressor: Habitat degradation

Exposure:

Response:

Consequence:

Narrative: Vernal pool habitats in the Central Valley now represent approximately 9 percent of their former area (State of California 2003), and remaining habitats are considerably more fragmented and isolated than historically and during the recent past. California's human population is expected to increase by 60 percent between 2000 and 2025 (California Department of Finance 2004) and almost double the 1990 State population. In areas where habitat remains, increased urban conversion of vernal pool habitat continues to threaten this species and habitat loss is expected to continue as urban boundaries expand further especially through high and low terrace formations on the eastern side of the valley. Even in areas where habitat is protected, the urbanization of lands surrounding conserved areas results in the fragmentation of protected habitats, preventing dispersal between occurrences, as well as increased edge effects to pool complexes. Habitat conversion is expected to continue as the human population increases (Teitz et al. 2005). (USFWS, 2009)

Stressor: Nonnative plants

Exposure:

Response:

Consequence:

Narrative: Competition from invasive native or non-native plant species threatens nine of the extant occurrences, including eight in the Vina Plains and one on the Sacramento National Wildlife Refuge in Glenn County. Native competitors of *Chamaesyce hooveri* include *Eryngium* species (coyote-thistle), *Malvella leprosa* (alkali mallow), a noxious weed according to Hill (1993), *Phyla nodiflora* (lippia), *Scirpus acutus* var. *occidentalis* (hard-stemmed tule, alkali bulrush (*Scirpus maritimus*), and *Xanthium strumarium* (cocklebur). Non-native competitors include bindweed (a noxious weed according to Dempster 1993) and *Crypsis schoenoides* (swamp grass) (J. Silveira in litt. 2000; CNDDDB 2007). On the Vina Plains Preserve, the pools with *Chamaesyce hooveri* also had the highest frequency of bindweed, at least in 1995 (Alexander and Schlising 1997). Increasing dominance by these competitors may be associated with changes in hydrology and livestock grazing practices (Stone et al. 1988, Alexander and Schlising 1997; CNDDDB 2007). Due to late spring rains during the last few years, an invasive plant, *Crypsis vaginiflora* has become dominant in many Basin-Rim vernal pools within the Sacramento NWR Complex (Sacramento, Delevan and Colusa). (USFWS, 2009)

Stressor: Drought and climate change

Exposure:

Response:

Consequence:

Narrative: *Chamaesyce hooveri* is an obligate wetland species found only in vernal pools, typically on alluvial fans or terraces of ancient rivers or streams, with a few on the rim of the Central Valley basin. Therefore, maintenance of the natural hydrology of the pools is necessary for the survival and recovery of this species. Drought or flood conditions will place additional strains on the vernal pool ecosystem supporting *C. hooveri* occurrences, some of which are already fragmented or reduced by agricultural conversion and development. Where occurrences persist on only marginal habitat, the addition of extreme drought conditions is likely to result in higher rates of mortality in the short term with the effects of low reproductive output and survivorship persisting after the drought has ceased. (USFWS, 2009)

Stressor: Stochastic events

Exposure:**Response:****Consequence:**

Narrative: Small population size poses a serious threat for at least four of the known occurrences, which total fewer than 100 individuals even in favorable years (CNDDDB 2007). Such small populations are subject to extirpation from random events such as extended drought and genetic drift. Small population size makes it difficult for this species to persist while sustaining the impacts of habitat fragmentation. Such populations may be highly susceptible to extirpation due to chance events, inbreeding depression, or additional environmental disturbance (Gilpin and Soule 1988; Goodman 1987). (USFWS, 2009)

Recovery**Reclassification Criteria:**

Reclassification criteria are not available.

Delisting Criteria:

Delisting criteria are not available.

Recovery Actions:

- Protect vernal pool habitat in the largest blocks possible from loss, fragmentation, degradation, and incompatible uses. (USFWS, 2005)
- Manage, restore, and monitor vernal pool habitat to promote the recovery of listed species and the long-term conservation of the species of concern. (USFWS, 2005)
- Conduct range-wide status surveys and status reviews for all species addressed in this recovery plan to determine species status and progress toward achieving recovery of listed species and long-term conservation of species of concern. (USFWS, 2005)
- Conduct research and use results to refine recovery actions and criteria, and guide overall recovery and long-term conservation efforts.
- Develop and implement participation programs. (USFWS, 2005)

Conservation Measures and Best Management Practices:

- Protect vernal pool habitat from being destroyed or modified by development, agriculture, or other activities. Acquiring conservation easements or fee title to habitat lands are some ways that conservators can help guarantee protection of the species in perpetuity. (USFWS, 2009)
- Develop standardized population trend survey protocols and implement to complete updated status surveys, especially for populations on private lands where trends have not been recently updated. (USFWS, 2009)
- Manage invasive plants on preserves. Management should include research to determine effective eradication methods of nonnative competitors, and pool conditions that favor one plant over another. (USFWS, 2009)
- Create and convene regional vernal pool working groups in regions where *Chamaesyce hooveri* occurs. Regional vernal pool working groups will be important for the tracking the progress of recovery efforts, including the amount of suitable habitat protected for each of the species in the core areas. (USFWS, 2009)
- Collect seeds from each core area following the Center for Plant Conservation Guidelines (1991). Seed collections should be stored in at least two sites, including the National Center for Genetic

Resources in Fort Collins, Colorado, and a facility certified by the Center for Plant Conservation. (USFWS, 2009)

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Final Designation of Critical Habitat for Four Vernal Pool Crustaceans and Eleven Vernal Pool Plants in California and Southern Oregon

Evaluation of Economic Exclusions From August 2003 Final Designation. Final rule. 70 FR 46924-46999 (August 11, 2005). U.S. Fish and Wildlife Service. 2006. Endangered and Threatened Wildlife and Plants

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SPECIES ACCOUNT: *Charpentiera densiflora* (Papala)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Charpentiera densiflora, a member of the amaranth family (Amaranthaceae), is a tree that grows up to 12 meters (39 feet) tall, with brown tomentose (densely covered in small hairs) new growth and stems 4 to 9 millimeters (mm) (0.16 to 0.35 inch (in)) in diameter below the apex. Leaves are coriaceous (leathery), elliptic to subovate, 13 to 40 centimeters (cm) (5 to 16 in) long, 5.5 to 9.5 cm (2 to 4 in) wide, with the marginal vein somewhat developed. Flowers are borne in branched panicles 22 to 48 cm (9 to 19 in) long, with 20 to 100 flowers per branch. Seeds are 1 mm (0.04 in) or less in length. Individuals of this species possess some of the largest leaves in the genus (Wagner et al. 1999; Sohmer 1972). (USFWS, 2017)

Taxonomy

Genus found in Hawaiian, Austral & Cook Islands. Species endemic to Na Pali Coast, Kauai. This species hybridizes with *C. elliptica* where sympatric. (NatureServe, 2015) A member of the amaranth family (Amaranthaceae) (USFWS, 2010).

Historical Range

Historically, *C. densiflora* was found along the Kalalau trail in the Hoolulu Valley, with limited distribution in three valleys (including Hanakapiai and Hanakoa) along the Na Pali Coast of Kauai (Sohmer 1972, p. 294) (USFWS, 2010).

Current Range

Charpentiera densiflora occurs only on the island of Kauai in the state of Hawaii. It is narrowly endemic to the Na Pali Coast on the northwestern side of the island, in a series of valleys and gulches over a 6 km stretch (NatureServe, 2015). It occurs in Hanakapiai, Kalalau, Limahuli, Hoolulu, and Waiahuakua valleys, and in Pohakuao, a hanging valley between Kalalau and Hanakoa (HBMP 2007) (USFWS, 2010).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Charpentiera densiflora* (Papala) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 11 critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for *Charpentiera densiflora* includes 11 CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Lowland Mesic—Section 1: Lowland Mesic—Section 1 consists of 2,006 ac (812 ha) in the lowland mesic ecosystem, including mesic forest extending from Awaawapuhi Trail south to

Makaha Ridge, in the Na Pali Kona Forest Reserve and the Kuia NAR (Figure 1-A). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plants *Doryopteris angelica*, *Labordia helleri*, *Platydesma rostrata* and *Psychotria hobbdi*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these four species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic–Section 1 is not known to be occupied by the species *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Dubautia kenwoodii*, *Pittosporum napaliense*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 2: Lowland Mesic—Section 2 consists of 379 ac (154 ha) in the lowland mesic ecosystem, including mesic forest extending from Keanapuka to Kahuamaa Flat along the rim and cliffs of the Kalalau Valley, in the Na Pali Coast State Park (Figure 1-A, above). The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plants *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Pittosporum napaliense*, and *Psychotria hobbdi*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these six species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic–Section 2 is not known to be occupied by the species *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Platydesma rostrata*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 3: Lowland Mesic—Section 3 consists of 124 ac (50 ha) in the lowland mesic ecosystem, including mesic forest extending from Manono Ridge, Pohakuao Valley, to Kanakuu, within the Na Pali Coast State Park (Figure 1- A, above). The entire section is Stateowned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plants *Canavalia napaliensis*, *Chamaesyce eleanoriae*, and *Charpentiera densiflora*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these three species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic–Section 3 is not known to be occupied by the species *Chamaesyce remyi* var. *remyi*, *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Pittosporum napaliense*, *Platydesma rostrata*, *Psychotria*

hobdyi, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 4: Lowland Mesic—Section 4 consists of 81 ac (33 ha) in the lowland mesic ecosystem, including mesic forest at the head of the Hanakapiai Valley, in the Na Pali Coast State Park (Figure 1-A, above). The entire section is Stateowned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plant *Charpentiera densiflora* and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. Although Lowland Mesic—Section 4 is not known to be occupied by the species *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *Chamaesyce remyi* var. *remyi*, *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Pittosporum napaliense*, *Platydesma rostrata*, *Psychotria hobdyi*, and *Tetraplasandra bisattenuata*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Mesic—Section 5: Lowland Mesic—Section 5 consists of 37 ac (15 ha) in the lowland mesic ecosystem, including mesic forest on the slopes of Mt. Haupu, on privately owned land (Figure 1-B). The entire section is within previously designated critical habitat, and falls within Critical Habitat Unit 7 of 50 CFR 17.99(a)(1), Map 23a. This section is occupied by the plants *Chamaesyce remyi* var. *remyi* and *Tetraplasandra bisattenuata*, and includes mesic forest and shrubland, the moisture regime, and subcanopy and understory native plant species identified as PCEs in the lowland mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of these two species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic—Section 5 is not known to be occupied by the species *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *Charpentiera densiflora*, *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Pittosporum napaliense*, *Platydesma rostrata*, and *Psychotria hobdyi*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 1: Lowland Wet—Section 1 consists of 1,164 ac (471 ha) in the lowland wet ecosystem (117 ac (47.4 ha) on State land; 1,047 ac (424 ha) on private land), including wet forest extending from Kulanalilia into Limahuli Valley to Honoanapali, in the Halelea Forest Reserve (Figure 2-A). The section includes 1,099 ac (445 ha) of State and privately owned land within previously designated critical habitat and 65 ac (26 ha) of newly designated critical habitat on private land. The area that falls within designated critical habitat lies within

Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and newly designated Critical Habitat Unit 20, Map 217c. This section is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Labordia helleri*, and *Phyllostegia renovans*. This section also contains unoccupied habitat that is essential to the conservation of these four species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 1 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Melicope paniculata*, *M. puberula*, *Platydesma rostrata*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 2: Lowland Wet—Section 2 consists of 172 ac (70 ha) in the lowland wet ecosystem, including wet forest extending from Alealau to Pohakea, within the Hono o Na Pali NAR and the Na Pali Coast State Park (Figure 2-A, above). The entire section is Stateowned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plant *Melicope puberula*. This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 2 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope paniculata*, *Phyllostegia renovans*, *Platydesma rostrata*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 3: Lowland Wet—Section 3 consists of 756 ac (306 ha) in the lowland wet ecosystem, including wet forest in upper Wainiha Valley, on privately owned land in the Halelea Forest Reserve (Figure 2-B). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plants *Chamaesyce remyi* var. *kauaiensis*, *Cyrtandra oenobarba*, *Melicope puberula*, *Phyllostegia renovans*, and *Stenogyne kealiae*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 3 is not known to be occupied by the species *Chamaesyce remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope paniculata*, *Platydesma rostrata*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we

have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 4: Lowland Wet—Section 4 consists of 591 ac (239 ha) in the lowland wet ecosystem, including wet forest at the head of Lumahai Valley, on State (10 ac, 4.1 ha) and privately owned (581 ac, 235 ha) land in the Halelea Forest Reserve (Figure 2-B, above). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyrtandra oenobarba*, *Melicope paniculata*, *Phyllostegia renovans*, and *Platydesma rostrata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 4 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Dubautia imbricata* ssp. *imbricata*, *Labordia helleri*, *Melicope puberula*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population numbers of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 5: Lowland Wet—Section 5 consists of 1,541 ac (624 ha) in the lowland wet ecosystem, including wet forest extending from the headwaters of the Wailua River at “Blue Hole” south to Iole, on State (442 ac, 179 ha) and privately owned (1,099 ac, 445 ha) land in the Lihue-Koloa Forest Reserve (Figure 2-C). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36a, and is occupied by the plants *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Melicope paniculata*, *Phyllostegia renovans*, and *Platydesma rostrata*. This section also contains unoccupied habitat that is essential to the conservation of these five5 species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet—Section 5 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhliewa*, *Labordia helleri*, *Melicope puberula*, *Stenogyne kealiae*, *Tetraplasandra bisattenuata*, and *T. flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 6: Lowland Wet—Section 6 consists of 789 ac (319 ha) in the lowland wet ecosystem, including wet forest extending from Kapalaoa to Kanaele Bog and

Lauahihaihai in the Wahiawa Mountains, on State (134 ac, 54 ha) and privately owned (655 ac, 265 ha) land in the Lihue-Koloa Forest Reserve (Figure 2-D). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36a, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Cyrtandra oenobarba*, *Dubautia imbricata* ssp. *imbricata*, *Platydesma rostrata*, and *Tetraplasandra bisattenuata*. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet–Section 6 is not known to be occupied by the species *Chamaesyce remyi* var. *kauaiensis*, *Charpentiera densiflora*, *Cyanea eleeleensis*, *C. kolekoleensis*, *C. kuhihewa*, *Labordia helleri*, *Melicope paniculata*, *M. puberula*, *Phyllostegia renovans*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Charpentiera densiflora* critical habitat consists of two components (Lowland mesic and Lowland wet) (75 FR 18960-19165):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<914 m). Annual precipitation: 50–75 in (127–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Ecosystem: Lowland Wet. Elevation: <3,000 ft (<914 m). Annual precipitation: >75 in (>190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have

also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: The genus *Charpentiera* is described as having a gynodioecious breeding system (Wagner et al. 1999). (USFWS, 2017)

Breeding Season

Adult: Flowering has been observed in May, July, August, and September (NTBG 1982, 1983, 2010, 2012a-d). (USFWS, 2017)

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: *Diospyros*-*Metrosideros* (lama-ohia) mixed mesic forest (USFWS, 2010)

Dependencies on Specific Environmental Elements

Adult: Moist environments (NatureServe, 2015); lowland mesic and lowland wet ecosystems (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: 400 - 2,200 ft. elevation (USFWS, 2010)

Environmental Specificity

Adult: Very narrow to moderate. (NatureServe, 2015)

Habitat Narrative

Adult: *Charpentiera densiflora* occurs primarily in the lowland mesic ecosystem, with one record from the lowland wet ecosystem (Wagner et al. 1999; HBMP 2010; TNCH 2007). This species is found in moist, closed canopy, and grows along drainages and in gulches in valleys, primarily in *Diospyros* spp. (lama)–*Metrosideros polymorpha* (ohia) mixed mesic forest, at elevations between 122 and 671 meters (400 and 2,200 feet) (HBMP 2010). It is found with the following associated native plant species: *Alectryon macrococcus* (mahoe), *Antidesma platyphyllum* (hame), *Bobea elatior* (ahakea lau nui), *Carex meyenii* (no common name (NCN)), *C. wahuensis* (NCN), *Charpentiera elliptica* (papala), *Diplazium sandwicianum* (hoio), *Diospyros hillebrandii* (lama), *D. sandwicensis*, *Doodia kunthiana* (okupukupu), *Elaeocarpus bifidus* (kalia), *Freycinetia arborea* (ie ie), *Metrosideros* spp. (ohia), *Nestegis sandwicensis* (olopua), *Ochrosia kauaiensis* (holei), *Pisonia umbellifera* (papapla kepau), *Pittosporum napaliense* (hoawa), *Planchonella sandwicensis* (alaa), *Pleomele aurea* (hala pepe), *Polyscias* spp. (oheohe), *Pritchardia napaliensis* (loulu), *Psychotria mariniana* (kopiko), *Psydrax odorata* (alahee), *Pteralyxia sandwicensis* (kaulu), *Rauvolfia sandwicensis* (hao), *Scaevola taccada* (naupaka), *Syzygium sandwicensis* (ohia ha), and *Wikstroemia oahuensis* (akia) (HBMP 2010; NTBG 2010, 2012a, 2014a). (USFWS, 2017)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Low (see current range/distribution)

Redundancy:

Low (inferred from USFWS, 2010)

Number of Populations:

6 (USFWS, 2017)

Population Size:

<150 wild individuals; 458 outplanted individuals (USFWS, 2017)

Population Narrative:

At the time of listing in 2010, there were seven populations totaling approximately 400 individuals at Hanakapiai, Kalalau, Limahuli, Hoolulu, Waiahuakua, and Pohakuao (USFWS 2010a). Currently, six populations are known, totaling 135 individuals (Bruegmann et al. 2016). Only one of these populations contains 50 mature individuals (Bruegmann et al. 2016). (USFWS, 2017)

Threats and Stressors

Stressor: Ungulate predation and herbivory (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Herbivory by pigs and goats has been noted as a threat to this species (HBMP 2010; NTBG 2011). (USFWS, 2017)

Stressor: Ungulate degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Feral pigs (*Sus scrofa*) and goats (*Capra hircus*) (Perlman 2007; HBMP 2010; NTBG 2011) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil. (USFWS, 2017)

Stressor: Established ecosystem-altering invasive plant modification and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community. Invasive introduced plants impacting *Charpentiera densiflora* are *Adiantum hispidulum* (rough maidenhair fern), *Aleurites moluccana* (kukui), *Andropogon glomeratus* (bushy beardgrass), *Blechnum appendiculatum* (no common name (NCN)), *Clidemia hirta* (Koster's curse), *Cordyline fruticosa* (ti), *Cyclosorus dentatus* (paiiha), *C. parasiticus* (NCN), *Elephantopus mollis* (elephant's foot), *Erigeron karvinskianus* (daisy fleabane), *Hedychium gardnerianum* (kahili ginger), *Kalanchoe pinnata* (air plant), *Lantana camara* (lantana), *Melia azedarach* (chinaberry), *Melinis minutiflora* (molasses grass), *Oplismenus hirtellus* (basketgrass), *Pluchea carolinensis* (sourbush), *Psidium cattleianum* (strawberry guava), *P. guajava* (common guava), *Rubus rosifolius* (thimbleberry), *Syzygium cumini* (java plum), and *S. malaccense* (mountain apple) (HBMP 2010; NTBG 2010, 2012a, 2014a). (USFWS, 2017)

Stressor: Landslides and flooding destruction or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Landslides, including tree falls and erosion associated with them, can have a significant effect on small populations of *Charpentiera densiflora* (HBMP 2010). Landslides and erosion due to natural weathering destabilize substrates, damage and destroy individual plants, and alter hydrological patterns (Stearns 1985). (USFWS, 2017)

Stressor: Fire destruction or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: *Charpentiera densiflora* occurs in mesic and mesophytic forest areas that are more susceptible to fires (HBMP 2010). Fire kills most native trees and shrubs, and alters the native ecosystem, leading to invasion by nonnative grasses that contribute to the grass/fire cycle (D'Antonio and Vitousek 1992). (USFWS, 2017)

Stressor: Hurricanes—Loss and degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a

localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013). (USFWS, 2017)

Stressor: Climate change loss or degradation of habitat (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. *Charpentiera densiflora* is highly vulnerable to the impacts of climate change with a vulnerability score of 0.778 (on a scale of 0 to 1). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2017)

Stressor: Rodent predation or herbivory (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Herbivory by rats (*Rattus* spp.) has been noted as a threat to *Charpentiera densiflora* (Perlman 2007; HBMP 2010; NTBG 2011). Rats eat virtually every part of plants and at every stage: fleshy fruits, seeds, flowers, stems, leaves, shoots, seedlings, and roots (Russell 1980; Cuddihy and Stone 1990). The effects on plants range from reduced vigor and decreased reproduction to mortality of individuals and complete lack of recruitment. (USFWS, 2017)

Stressor: Black twig borer herbivory (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Infestation by and damage or death caused by the black twig borer (*Xylosandrus compactus*) is a threat to *Charpentiera densiflora* (NTBG 2001). This insect pest burrows into branches, introduces a pathogenic fungus as food for its larvae, and lays its eggs. Twigs, branches, and even entire plants can be killed from an infestation (Davis 1970; Extension Entomology and UH-CTAHR Integrated Pest Management Program 2006; NTBG 2001). (USFWS, 2017)

Stressor: Lack of adequate hunting regulations (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Nonnative feral ungulates pose a major ongoing threat to native species through destruction and modification of habitat, and by direct herbivory or predation. Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (i.e., sustained yield) in some areas, with one animal allowed per day; to other areas

with as few as one animal allowed per year (DLNR 2010). Game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations are at risk (DLNR 2010). Six of the seven known populations of *Charpentiera densiflora* occur in State hunting areas: four populations are in Na Pali Coast State Wilderness Park (mammal and bird hunting area) and two populations occur in Hono o Na Pali NAR (mammal hunting area). None of these populations are fenced. (USFWS, 2017)

Stressor: Lack of adequate biosecurity legislation (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Invasion of the State of Hawaii by invasive nonnative plant species, and destruction of habitat and competition by nonnative plants are threats to *Charpentiera densiflora*. The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, is authorized to prevent the introduction or dissemination of animal and plant pests on all ships, aircraft, and their cargo and baggage arriving in the U.S. and its territories; however, pest species continue to enter the State. In addition, Federal import regulations do not address many species that could be pests in Hawaii (CGAPS 2009; Ikuma et al. 2002). (USFWS, 2017)

Stressor: Invasive Species (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Established invasive plant species competition—Plant species including *Aleurites moluccana* (candlenut, kukui), *Kalanchoe pinnata* (air plant), *Cyclosorus dentatus* (downy wood fern), *Cordyline fruticosa* (ti), *Elephantopus mollis* (elephant's foot), *Pluchea carolinensis* (sourbush), and *Syzygium cumini* (Java plum) compete with *Charpentiera densiflora* for water, light, and nutrients (HBMP 2010; NTBG 2010, 2012a, 2014a). (USFWS, 2017)

Stressor: Stochastic events—Reduced viability due to low numbers (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Small, isolated populations often exhibit reduced levels of genetic variability, which diminishes the species' capacity to adapt and respond to environmental changes, thereby lessening the probability of long-term persistence (Barrett and Kohn 1991; Newman and Pilson 1997; HBMP 2010). The problems associated with small population size and vulnerability to random demographic fluctuations or natural catastrophes are further magnified by synergistic interactions with other threats, such as anthropogenic impacts like habitat loss from human development or predation by nonnative species. Very small plant populations may experience reduced reproductive vigor due to ineffective pollination or inbreeding depression. (USFWS, 2017)

Recovery

Reclassification Criteria:

To meet the interim stage of recovery of *Charpentiera densiflora*, 200 mature individuals are needed in each of three populations and all major threats must be controlled around each

population designated for recovery at this stage. There should also be demonstrated regeneration of seedlings and growth to at least sapling stage for woody species and documented replacement regeneration within each of the target populations. Each population must be adequately represented in an ex situ collection as defined in the Center for Plant Conservation's guidelines (Guerrant et al. 2004). Adequate monitoring must be in place and conducted to assess individual plant survival, population trends, trends of major limiting factors, and response of major limiting factors to management. (USFWS, 2017)

In addition to achieving 5 to 10 populations with 400 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats. (USFWS, 2017)

Delisting Criteria:

In addition to achieving 5 to 10 populations with 400 mature individuals per populations and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis. (USFWS, 2017)

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys. (USFWS, 2010)
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units. (USFWS, 2010)
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys. (USFWS, 2010)

- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range. (USFWS, 2010)
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction. (USFWS, 2010)
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security. (USFWS, 2010)
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems. (USFWS, 2010)
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations. (USFWS, 2010)
- Surveys and inventories—Survey for populations of *Charpentiera densiflora* in areas of potentially suitable habitat. (USFWS, 2017)
- Ungulate monitoring and control—Fence all wild and reintroduced populations to prevent disturbances from feral ungulates. Protect all occurrences against browsing and disturbances from feral ungulates. (USFWS, 2017)
- Invasive plant monitoring and control - Control established ecosystem-altering nonnative invasive plant species around all populations. Control invasive nonnative plant species around all populations that compete with the species. (USFWS, 2017)
- Fire monitoring and control—Develop and implement a fire management plan for existing populations (USFWS, 2017).
- Predator and herbivore control—Implement rat control at current populations. (USFWS, 2017)
- Herbivore control research—Study *Charpentiera densiflora* populations to assess the threat from black twig borer (*Xylosandrus compactus*) and the need for additional recovery actions. (USFWS, 2017)
- Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. (USFWS, 2017)
- Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2017)
- Predator and herbivore monitoring and control—Implement effective measures to control rodents around all populations. (USFWS, 2017)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms. (USFWS, 2017)
- Based on the recovery criteria above, consider development of a recovery plan. (USFWS, 2017)

Conservation Measures and Best Management Practices:

- Conservation measures are not available.

References

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

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SPECIES ACCOUNT: *Chionanthus pygmaeus* (Pygmy fringe-tree)

Species Taxonomic and Listing Information

Listing Status: Endangered; 2/20/1987; Southeast Region (R4)

Physical Description

Pygmy fringe tree is a shrub or small tree that is often less than 1 m (3 feet tall), but can reach 4 m (feet). The twigs are opposite or sub-opposite and stiff, while the leaf scars and leaves are mostly opposite but sometimes alternate. The leaves are simple, mostly 3 to 10 cm (about 1 to 4 inches) long, and lacking stipules. They have short petioles, and the somewhat leathery blades are ovate to elliptic or obovate in shape, and acute to rounded at the tip. The base of the blade is attenuated to the petiole. The upper surface of the blade is dark yellow-green and smooth, but the lower surface is paler and reticulate. The inflorescence is a leafy-bracted panicle that appears with the new shoots from the axils of most leaf scars from the previous season. The axis (main stem) of the inflorescence is rather short with numerous opposite branches that are spreading, slender and dropping, terminating in clusters of three to six flowers. Bracts toward the base of the inflorescence are similar to, but smaller than, the leaves. The flowers are regular, perfect, and pleasingly fragrant. The four sepals are green, united at the base, and 1.5 to 2.0 millimeters (mm) long. The four petals are white, united at the base to a short, campanulate throat, with narrowly linear lobes, 1.0 to 1.5 cm long and somewhat spreading. The two stamens are fused (adnate) to the corolla base. The ovary is superior with a single style. The fruit is a drupe 2.0 to 2.5 cm long, oval, and green, becoming purplish-brown when ripe. (USFWS, 1999)

Taxonomy

Small (1933) named this species *Chionanthus pygmaea*. Since then there have been no other taxonomic treatments. There are no scientific synonyms, but the common name used in literature is pygmy fringetree and the spelling variation pygmy fringe-tree (Wood 1985, Ward and Godfrey 1979). The gender of the name has been unclear. When he named the species, Small (1933) used the Greek suffix -aea which indicates the species' status as a tree. The use of this ending has been questioned and every author since, including Hardin (1974), has used the suffix -aeus indicating its status as a shrub. (USFWS, 1999)

Historical Range

Lake, Osceola, Polk, and Highland Counties, Florida. No longer found on the Mount Dora Range (USFWS, 1999).

Current Range

Chionanthus pygmaeus is known from west of Lake Apopka in Lake County, northwestern Osceola County, and the Lake Wales Ridge in Polk and Highlands counties, Florida. (USFWS, 1999)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Although the reproductive biology of this species has not been thoroughly investigated, it is known to spread by root sprouts and occasionally by seed (Stout in press). The plants appear to be functionally dioecious (Gill and Pogge 1974), and the female flowers have stunted anthers that usually do not open (Goodrum and Halls 1961). The four plants in the endangered species display garden at the Historic Bok Sanctuary (2 males, 2 females) flowered and set seed in 1997 (Center for Plant Conservation 2003). After spring flowering, fruiting probably occurs in June, with seed dispersal in September (Gill and Pogge 1974, Ward and Godfrey 1979). Seeds (drupes) may remain on the plants well into winter (Stout 2001, in press). Little is known about seed dissemination of pygmy fringe tree, and seed production is variable from year to year, with mixed reports for success of germination. In nursery conditions the best results are obtained with cleaned, air-dried seed, but whole fruits have also germinated. Bok Tower Gardens has achieved 60 to 70 percent germination rates under greenhouse conditions (T. Race, Bok Tower Gardens, personal communication 1996). Germination dates for pygmy fringe tree are unknown. Leafing occurs mid-March, budding occurs in March, and anthesis is from late March to early April. Recruitment is exceedingly slow in this species. At The Nature Conservancy's Tiger Creek Preserve (Possum Creek Trail Scrub), over 100 individuals of pygmy fringe trees have been tagged and monitored (I.J. Stout, University of Central Florida, personal communication 1997). In more than 10 years of monitoring, hundreds of root sprouts were found, but only one seedling was located. Despite this extremely low seedling recruitment, the number of individuals at the site appears to be stable. Due to population stability and this species' reliable resprouting after fires, The Nature Conservancy no longer conducts detailed monitoring on this species (B. Pace-Aldana, The Nature Conservancy, in litt. 2005). This species is long-lived and persists in scrub that is burned on a frequency between 20 and 70 years. However, it is a fire-dependent species that resprouts after fire events. This species has above-ground stems growing from rootstocks or buried stems that have survived the infrequent fires that are characteristic of the habitat (Kral 1983, Ward and Godfrey 1979). It has been observed to resprout from rootstocks following a spring burn (Stout in press). Fires may have an important indirect effect on pygmy fringe tree by regulating the numbers and sizes of plants that might shade or otherwise compete with it (Kral 1983). In the spring and summer of 1997, The Nature Conservancy burned sandhill vegetation at Tiger Creek Preserve that contains pygmy fringe tree. The effects of fire on these individuals were monitored (I.J. Stout, personal communication 1997). Burning to restore the sandhill vegetation's original grassy appearance continues, and Bea Pace has monitored the results (Center for Plant Conservation 2003). Pygmy fringe tree is also present at the Carter Creek tract of Lake Wales Ridge National Wildlife Refuge, where restoration of sandhill is being studied by Archbold Biological Station (Menges et al. 2005). Their results to date "suggest that burning is beneficial for sandhill community structure and the populations of several key species. Chainsawing as a pre-treatment has mixed results depending on the species. . . . The saw & burn treatment promotes more complete and intense fires (Menges et al. unpubl. data) and more open post-treatment subcanopies, which may have a number of benefits for restoration of the sandhill ecosystem and its species. Subsequent fires may be more effective in areas impacted once with this mechanical pre-treatment to fire."

Habitat Type

Adult: Dry/Xeric Hammocks

Habitat Narrative

Adult: Pygmy fringe tree inhabits excessively drained sandy soils on central Florida's LWR (and historically on the Mount Dora Ridge, Orange County). This species is found on low- nutrient St. Lucie fine sand soil which is subject to rapid drying (Wunderlin et al. 1981), as well as other dry sand soils. Pygmy fringe tree occurs primarily in scrub as well as high pine, dry hammocks, xeric hammocks, and transitional habitats. It is abundant at a few sites, where it may form thickets along with evergreen oaks and other shrubs such as tallow wood, silk bay, and scrub hickory. In some locations, it may be the dominant plant while in others it may be codominant or subdominant (Wunderlin et al. 1981). At Carter Creek, where it is relatively abundant, it is scattered among turkey oaks.

Dispersal/Migration***Population Information and Trends*****Population Narrative:**

This species is protected on a substantial number of conservation lands, most of them purchased after it was listed. It has been monitored at LWR State Forest (Weekley 1996, 1999), and it is clearly a long-lived resprouting species. The Service does not have current information on threats because this shrub is considered relatively abundant and secure by managers of the conservation lands of the Lake Wales Ridge, so limited funds for monitoring have been devoted to other species. After this plant was listed, an extensive network of state conservation lands and the Lake Wales Ridge National Wildlife Refuge came into existence, providing habitat and habitat management supported by extensive ecological research and monitoring programs.

Threats and Stressors**Stressor:****Exposure:****Response:****Consequence:**

Narrative: The rapid loss of suitable scrub habitat in Central Florida to residential, recreational and related commercial development is of the utmost concern. Some of these well drained upland soils are also being converted to citrus production. The long term exclusion of fire from the scrub can lead to a dense canopy layer unfavorable to the growth of the short pygmy fringetree. (NatureServe, 2015)

Recovery**Reclassification Criteria:**

1. When existing populations, within the historic range of *C. pygmaeus*, are adequately protected from further habitat loss, degradation, and fire suppression. Large areas of land are needed to support populations of this tree/shrub species. These sites must also be managed to maintain xeric oak scrub to support *C. pygmaeus*. Habitat destruction is occurring at an alarming rate. To ensure the survival of this species, actions must be taken to protect its remaining habitat. Difficulty in conserving this species may be compounded by the low seed germination rates that could affect this plant's ability to rebound from a reduction of adult individuals. (USFWS, 1999)

Delisting Criteria:

1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations required to ensure 95 percent probability of persistence for 100 years (USFWS, 1999)
2. When these populations, within the historic range of *C. pygmaeus*, are adequately protected from further habitat loss, degradation, and fire suppression (USFWS, 1999)
3. When these sites are managed to maintain the serial stage of xeric oak scrub to support *C. pygmaeus* (USFWS, 1999)
4. When monitoring programs demonstrate that these sites support sufficient population sizes, are distributed throughout the historic range, and are sexually or vegetatively reproducing at sufficient rates to maintain the population. (USFWS, 1999)

Recovery Actions:

- Determine current distribution of *C. pygmaeus*. This species' distribution is somewhat questionable for taxonomic reasons and ease of overlooking individuals. A thorough survey is needed to determine the distribution for this species. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties has been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Conduct research on life history characteristics. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species, more specific biological information is needed. (USFWS, 1999)
- Monitor existing populations of *C. pygmaeus*. Develop monitoring protocol to assess population trends for *C. pygmaeus*. Develop a quantitative description of the population structure of *C. pygmaeus*. (USFWS, 1999)
- Provide public information about *C. pygmaeus*. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. However, caution should be taken to avoid revealing specific locality information of *C. pygmaeus*. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of *C. pygmaeus* and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- Habitat-level Recovery Actions: Prevent degradation of existing habitat. Prevent degradation of existing habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

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SPECIES ACCOUNT: *Chlorogalum purpureum* var. *reductum* (Camatta Canyon amole)

Species Taxonomic and Listing Information

Listing Status: Threatened; 03/20/2000; California/Nevada Region (R8) (USFWS, 2015)

Physical Description

A perennial lily with a basal cluster of bright green leaves, which are elongate, with a wavy margin, and with a thickened midrib (Service 2002, Holland 2004, Guretzky et al. 2005). The basal leaves typically range from 1 to 8 in number (Woodbury 2005b), but as many as 14 have been recorded (Guretzky et al. 2005), with a width of 2 to 5 mm. The bulb is ovoid, 2.5 to 3.0 cm long, white to brown in color, and occurs in the upper few inches of soil (Service 2002, Holland 2004). The flower cluster is borne on a single stem with multiple branches. The flowers are deep blue or purple with bright yellow anthers. The fruits are capsules, each with three chambers containing one or two black, ovoid seeds (Jernstedt 1993). (USFWS 2008)

Taxonomy

Chlorogalum purpureum is the only member of the genus with flowers that are blue or purple in color; the other members of the genus have flowers that are white or pink (Hoover 1940, Jernstedt 2007). Two varieties of *Chlorogalum purpureum* are recognized (Hoover 1940, Jernstedt 2007): *Chlorogalum purpureum* var. *purpureum* and *Chlorogalum purpureum* var. *reductum*. However, the International Plant Names Index (2005) places the genus *Chlorogalum* in the hyacinth family (Hyacinthaceae), while recent comparative molecular studies support the inclusion of the genus in the agave family (Agavaceae; Bolger et al. 2006). (USFWS, 2008)

Historical Range

See current range/distribution.

Current Range

The Camatta Canyon amole *Chlorogalum purpureum* var. *reductum* is endemic to the La Panza Range in central San Luis Obispo County. The type locality for the Camatta Canyon amole is 18 miles east of Creston on La Panza road, San Luis Obispo County, California. The taxon is known only from a small geographic area. The main population is approximately 0.8 km (0.5 mi) east of the southern end of Camatta Canyon. (USFWS 2008)

Critical Habitat Designated

Yes; 10/24/2002.

Legal Description

On October 24, 2002, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), *Chlorogalum purpureum* var. *reductum* (Camatta Canyon amole).

Critical Habitat Designation

The critical habitat designation for *Chlorogalum purpureum* var. *reductum* includes two units totaling approximately 1,772 ha (4,378 ac) of land. Approximately 25 percent of this total area

consists of Federal lands, private lands comprise approximately 75 percent, and State lands comprise less than 0.1 percent.

Jolon Unit: This unit consists of 620 ha (1,532 ac) of private property near Jolon Road. This population is probably a remnant of a much larger population that historically extended beyond the immediate Fort Hunter Liggett area. The land within this unit provides those characteristics essential for the species.

Camatta Canyon Unit: This unit consists of one area that encompasses the similar topographic features and vegetative communities that surround the only two known occurrences of this species. The Camatta Canyon Unit (1,772 ha (4,378 ac)) encompasses the plateau on both the north and south sides of Highway 58 near Camatta Canyon, extending south approximately 5 km (3 mi) to include two private inholding areas within the LPNF boundaries. The land within this unit provides those characteristics essential for the species discussed above. More specifically, the area surrounding the known distribution of *Chlorogalum purpureum* var. *reductum* and the plateau adjacent to the known distribution (i.e., finger-like extensions in northern portion of the unit) are essential because: (1) *Chlorogalum purpureum* var. *reductum* is found at only two sites in the La Panza Range in central San Luis Obispo County. The two sites likely make up one “population” of plants due to the close proximity of the sites and the characteristic “patchiness” of plants that has been observed with both varieties of *C. purpureum*. The limited geographic distribution of *C. p. var. reductum* increases the likelihood of its extinction. The risk of extinction elevates the need for protecting all existing plants, habitat, and soil conditions for the taxon’s expansion. Additionally, ecological attributes upon which the species relies (e.g., pollinators, seed dispersal agents) should be protected. Activities that may adversely affect or destroy the plant and the habitat that is critical for its survival and expansion should be limited. These activities include, but are not limited to, off-road vehicle use, livestock grazing, herbivory, and ground disturbance by gophers. (2) Thorough surveys of the distribution of *Chlorogalum purpureum* var. *reductum* have not been conducted in the area. Surveys are needed across multiple years to determine the presence or absence of the species. Monitoring of *C. p. var. purpureum* at Fort Hunter Liggett has found known individual mature plants to be dormant for at least three years. During dormancy, both varieties of *Chlorogalum* are not detectable on the surface. Because discoveries of new *C. p. var. purpureum* sites are being found within the range of the taxon at Fort Hunter Liggett, one may expect “new patches” of *C. p. var. reductum* to occur in the Camatta Canyon Unit if surveys were conducted within the critical habitat boundary in those areas where the primary constituent elements occur. (3) An extension of the plateau/flattop area where *Chlorogalum purpureum* var. *reductum* is currently known to occur exists between the northern site and the southern site. This area harbors the soils and vegetation appropriate for *C. p. var. reductum* growth and expansion. The Service believes it is important to provide connectivity between the two sites. Additionally, the area encompasses what appear to be flat-top/ mesa-like extensions (which likely contain suitable habitat) that occur between the two known distributions (D. Chipping, California Polytechnic State University, in litt., 1997). A. Koch (CDFG, pers. comm., 2001) also notes that *C. p. var. reductum* occurs on private property which falls between the two known sites and within the critical habitat boundary line. (4) The vegetation community that *Chlorogalum purpureum* var. *reductum* depends on extends beyond the boundary of the known distribution. By encompassing plateau areas, the known distribution, and a portion of the adjacent vegetation community that the species depends on, ecological functions (e.g., cryptogamic crust formation, predator-prey relationships, pollinator activity) within the habitat are maintained such that “edge effects” from encroaching activities not

conductive to *C. p. var. reductum* persistence (e.g., off-road vehicle use, livestock grazing, etc.) do not inhibit the taxon's expansion or survival. Additionally, adjacent grassland and oak woodland habitat that is adversely affected could result in greater rates of herbivory or regeneration/expansion of nonnative plants that can outcompete smaller, herbaceous species such as *C. p. var. reductum*. Lands proposed are under private, State, and Federal jurisdiction. State lands are managed by CalTrans, and Federal lands are managed by the the Forest Service (i.e., LPNF).

Primary Constituent Elements/Physical or Biological Features

The primary constituent elements of critical habitat for *Chlorogalum purpureum* var. *reductum* consist of, but are not limited to:

- (i) Well-drained, red clay soils with a large component of gravel and pebbles on the upper soil surface; and,
- (ii) Plant communities in functioning ecosystems that support associated plant and animal species (e.g., pollinators, predator-prey species, etc.), including grassland, blue oak woodland (*Quercus douglasii*) or oak savannahs, and open areas within shrubland communities. Within these vegetation communities *C. p. var. reductum* appears where there is little cover of other species which compete for resources available for growth and reproduction.

Special Management Considerations or Protections

Critical habitat does not include existing features and structures, such as buildings, hard-packed roads (e.g., asphalt, pavement), aqueducts, railroads, airport runways and buildings, other paved areas, lawns, and other urban landscaped areas not containing any of the primary constituent elements.

Special management and protection that *C. purpureum* critical habitat may require are: (1) The soils on which *Chlorogalum purpureum* is found should be maintained. Physical properties of the soil, such as its chemical composition, structure, and drainage capabilities, would best be maintained by limiting or restricting the use of herbicides, fertilizers, or other soil amendments; and by minimizing or avoiding activities that result in soil compaction (e.g., offroad wheeled and tracked vehicle use, trampling by people and livestock) and those that would alter the hydrology of areas immediately adjacent to or upslope of the species and its critical habitat. (2) The soil surface should be maintained to enhance cryptogamic crust formation by minimizing the intensity, frequency, duration, and acreage of soil surface disturbance. The soil surface should be protected at relict sites (i.e., sites with well-developed crusts) to provide reference areas and baseline comparisons for research. Because cryptogamic crusts are highly susceptible to hot fires (Belnap et al. 2001) and the presence of nonnative annual grasses in *Chlorogalum purpureum* habitat may promote fires. Annual, intense fires should be avoided. The effects of activities that can damage biotic soil crusts (e.g., excavations, offroad vehicle use, trampling) should be reduced by moving them to areas where crusts are less vulnerable, limiting the area affected, and conducting such activities in dryer seasons. (3) The associated plant and animal communities should be maintained to ensure the habitat needs of pollinators and seed dispersal agents are maintained, and predator-prey relationships are functioning. The use of pesticides should be restricted so that viable populations of pollinators are present to facilitate reproduction of *Chlorogalum purpureum*. Fragmentation of habitat through road construction, development, and certain types of fencing should be limited. Additionally, predator-prey relationships should be

managed and protected. For example, installation of fencing could exclude predator species (e.g., coyotes, bobcats, San Joaquin kit fox), thus causing an increase in prey species (e.g., ground squirrels, gophers, rabbits) abundance. A change such as this could result in increased herbivory, bulb predation, or burrowing that could affect *C. purpureum* growth and survival. (4) In all plant communities where *Chlorogalum purpureum* occurs, invasive, nonnative species such as *Centuarea solstitialis* (yellow starthistle), *Avena* spp. (wild oats), *Bromus* spp. (*B. hordeaceus*, *B. diandrus*, *B. madritensis*, *B. rubens* (brome)), *Erodium* spp. (storksbill or fillaree), and other species need to be actively managed and controlled to maintain the open habitat that *Chlorogalum purpureum* needs. Nonnative annual grasses may promote fires by providing recurring annual fuel sources. Thus, proactive management should be implemented to prevent annual fires, unless future research demonstrates that a series of annual fires can benefit *Chlorogalum purpureum* by reducing competition from nonnative species. (5) Certain critical habitat areas (i.e., suitable, unoccupied habitat between or adjacent to known patches of *Chlorogalum purpureum*) may need to be temporarily fenced or demarcated to identify exclusion areas for protection from accidental or intentional trampling by humans, livestock, or off-road vehicle use. Heavy disturbance to these critical areas may be detrimental to this species' persistence. Seasonal exclusions may work in certain areas to protect the critical habitat and *C. purpureum* plants during the critical season of growth and reproduction. (6) In areas where *Chlorogalum purpureum* and its habitat occur in conjunction with off-road vehicle traffic (e.g., military wheeled and tracked vehicles, OHVs), the Service recommend managing to minimize the severity of those effects. Management should include: limiting or avoiding new structures and permanent roads and trails; managing excavations, scrapings, or other ground surface disturbance; managing tracked and wheeled vehicle use during *C. purpureum* growing and dormant seasons; and managing foot traffic, bivouacking, and congregations of high numbers of people during *C. purpureum* growing and dormant seasons. These types of activities should be managed to limit loss of adults, bulbs, and seeds, loss of habitat, increased soil compaction, and increased nonnative species encroachment. (7) Monitoring programs should be developed or enhanced so that areas occupied by purple amole are studied, allowing for a full range of life-history data and a thorough analysis of the compatibility and impacts of those activities that may adversely affect the species. Representative areas should be chosen throughout the distribution of the species, including large, highdensity populations that have a higher potential for persistence. Monitoring studies should be designed to aid in the determination of population stability as well as provide basic life-history information and data on the ecological needs of the species (e.g., identification and status of pollinator species, disturbance factors, etc.).

Life History

Food/Nutrient Resources

Dependency on Other Individuals or Species

Adult: Small bees are common pollinators of the Camatta Canyon amole, including sweat bees (Halictidae; Center for Plant Conservation 2007b). (USFWS, 2008)

Breeding Season

Adult: April to June (USFWS, 2008)

Reproduction Narrative

Adult: Small bees are common pollinators of the Camatta Canyon amole, including sweat bees (Halictidae; Center for Plant Conservation 2007b). Flowering and fruit development occurs during May and June for the purple amole and from April to June for the Camatta Canyon amole. As the fruits mature, the leaves wither and the inflorescence dries and turns brown. The plant is then dormant as a bulb during the summer and fall. (USFWS, 2008)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Barrens, Forest/Woodland, Grassland/herbaceous, Shrubland/chaparral, Woodland - Hardwood, Woodland - Mixed (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Mediterranean climate with summers that are hot and dry, and winters that are cool and wet (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 305 to 630 m (1,000 to 2,050 ft) (NatureServe, 2015)

Habitat Narrative

Adult: All locations for *C. purpureum* var. *purpureum* and *C. purpureum* var. *reductum* are in semiarid environments and have a Mediterranean climate with summers that are hot and dry, and winters that are cool and wet (USFWS 2008). *C. purpureum* var. *reductum* in the Los Padres National Forest grows in open areas on a ridgetop in blue oak savanna and annual grassland, and in open areas in grassland and woodland. The Service (2001, 2002) reported the Camatta Canyon amole to occur at 305 to 625 m (1,000 to 2,050 ft) elevation. However, others (e.g., Jernstedt 1993, 2007; California Department of Fish and Game 2007; California Native Plant Society 2007) reported elevations from 579 to 630 m. (USFWS, 2008; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Stable (USFWS, 2008)

Resiliency:

Low (inferred from USFWS, 2008)

Redundancy:

Low (inferred from USFWS, 2008)

Population Growth Rate:

Slow (USFWS, 2008)

Population Size:

100,000 to 500,000 (USFWS, 2008)

Population Narrative:

One record in the California Natural Diversity Data Base (California Department of Fish and Game 2007) reports approximately 500,000 Camatta Canyon amole at the site in 1991. The Center for Plant Conservation (2007) states that as many as 100,000 Camatta Canyon amole may exist, with most of these plants on approximately 2 ha to 3 ha (5 ac to 7 ac) of land. Based upon general observations, the California Department of Fish Game has not observed the Camatta Canyon amole to be decreasing over the past ten years (Koch pers. com. 2007). The Camatta Canyon amole grows extremely slowly and requires years to mature and produce seeds (California Department of Fish and Game 2005). (USFWS, 2008)

Threats and Stressors

Stressor: Road maintenance (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: The intended use of the highway right-of-way along State Highway 58 is for transportation purposes. A two-lane highway right-of-way is typically comprised of a 40-ft wide strip of land: a paved road, 24 ft wide; then a shoulder on each side, each 4 ft wide; and then another 4 ft of ground on each side. In the location with the Camatta Canyon amole, the plants are usually growing "sporadically" along the fenceline boundary with the adjacent private properties (Edell pers. com. 2007). The California Department of Transportation has designated the right-of-way with the Camatta Canyon amole as a botanical management area. Because of this designation, the California Department of Transportation conducts occasional monitoring and gives greater scrutiny when construction or maintenance occurs in the area (Edell in litt. 2007a, 2007b). (USFWS, 2008)

Stressor: Displacement by non-native annual grasses (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Non-native annual grasses and other invasive plant species continue to be a threat to the purple amole at Fort Hunter Liggett and Camp Roberts and to the Camatta Canyon amole on the Los Padres National Forest. The invasive plant species may have the ability to displace the *Chlorogalum purpureum* by outcompeting and monopolizing limited resources (growing space, sunlight, soil nutrients, water; Stephenson and Calcarone 1999), with the potential effects of preventing growth and recruitment (U.S. Army 2004b). The invasive plant species may also have the ability to alter characteristics of the fire regime, such as frequency, intensity, and seasonality of fires (Brooks et al. 2004). (USFWS, 2008)

Stressor: Illegal vehicle trespass in the National Forest (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: The taxon is at risk of destruction, modification, and curtailment of its habitat and known range due to illegal vehicle trespass and cattle grazing in the Camatta Canyon amole area on the Los Padres National Forest. Off-highway vehicles and cattle grazing can cause physical damage to the Camatta Canyon amole, compact the soil, stimulate soil erosion, damage cryptogamic crusts, reduce the presence of native plants, and increase the presence of invasive plants (e.g. Fleischner 1994, Service 2000, Belnap and Eldridge 2001). (USFWS, 2008)

Stressor: Livestock grazing (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: The area occupied by the Camatta Canyon amole on the Los Padres National Forest is in the Navajo Allotment where the permittee is authorized to graze cattle between February and May. Because the Camatta Canyon amole flowers and develops fruit from April to June, we believe that cattle grazing is likely adversely affecting the taxon by trampling, soil compaction, and possibly herbivory. (USFWS, 2008)

Stressor: Recreation (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: The Camatta Canyon amole area is in the Pozo-La Panza unit of the Los Padres National Forest. The unit "is best known for its variety of OHV [off-highway vehicle] opportunities that require advanced skill levels." The OHV routes, which include an unofficial staging area near the Camatta Canyon amole area, are heavily used (U.S. Forest Service 2005). (USFWS, 2008)

Stressor: Fires (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: The frequency of fires in California is increasing (Syphard et al. 2007), and fires at certain times of the year have the ability to prevent annual reproductive success of the purple amole (Niceswanger 2002) and also of the Camatta Canyon amole. The *Chlorogalum purpureum* are susceptible to damage by fire when the living structures, including the seeds, are above ground or near the soil surface. However, fires at certain times of the year may potentially benefit the *Chlorogalum purpureum* by removing other competitive plants, both native and invasive species. The *Chlorogalum purpureum* may also respond favorably to fire in other ways. (USFWS, 2008)

Recovery

Reclassification Criteria:

Reclassification criteria are not available.

Delisting Criteria:

Delisting criteria are not available.

Recovery Actions:

- Recovery actions are not available.

Conservation Measures and Best Management Practices:

- We recommend that the U.S. Forest Service prepare and implement a management plan for the Camatta Canyon amole on the Los Padres National Forest, including surveys and a monitoring program. (USFWS, 2008)
- We recommend that the U.S. Forest Service implement measures to prevent trespass by vehicles, in particular motorcycles, into the Camatta Canyon amole area and designated critical habitat on the Los Padres National Forest. We recommend that the effectiveness of any implemented measures be monitored and then adaptive management actions taken. (USFWS, 2008)
- We recommend that the U.S. Forest Service consult with the Service regarding its activities that may affect the Camatta Canyon amole and its designated critical habitat on the Los Padres National Forest, in particular cattle grazing. (USFWS, 2008)
- We recommend that the U.S. Forest Service conduct research to determine the effects of gophers and feral pigs on the Camatta Canyon amole, and the relationship between the Camatta Canyon amole and cryptogamic crusts. (USFWS, 2008)
- We recommend that the California Department of Transportation conduct surveys to determine the distribution of the Camatta Canyon amole along State Highway 58 (and adjacent private properties if possible) and submit a report of the survey results to the Service. (USFWS, 2008)

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SPECIES ACCOUNT: *Chlorogalum purpureum* (Purple amole)

Species Taxonomic and Listing Information

Listing Status: Threatened; 03/20/2000; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial herb with a basal rosette of long, linear leaves and a widely branching stem, 1-2 dm tall, arising from an underground bulb. The flower cluster is borne on a single stem with multiple branches. The flowers are deep blue or purple with bright yellow anthers. The fruits are capsules, each with three chambers containing one or two black, ovoid seeds (Jernstedt 1993). (NatureServe, 2015)

Taxonomy

The genus *Chlorogalum* comprises five plant species in the lily family (Liliaceae; Jernstedt 2007) which inhabit western North America from southern Oregon to Baja California, Mexico. *Chlorogalum purpureum* is the only member of the genus with flowers that are blue or purple in color; the other members of the genus have flowers that are white or pink (Hoover 1940, Jernstedt 2007). Two varieties of *Chlorogalum purpureum* are recognized (Hoover 1940, Jernstedt 2007): *Chlorogalum purpureum* var. *purpureum* and *Chlorogalum purpureum* var. *reductum*. There have been no changes or proposed changes in nomenclature since the species was listed in 2000 (Jernstedt 2007). However, the International Plant Names Index (2005) places the genus *Chlorogalum* in the hyacinth family (Hyacinthaceae), while recent comparative molecular studies support the inclusion of the genus in the agave family (Agavaceae; Bolger et al. 2006). (USFWS, 2008)

Historical Range

When *Chlorogalum purpureum* was listed as threatened in 2000, the *Chlorogalum purpureum* var. *purpureum* taxon was known only from three localities on Fort Hunter Liggett. (USFWS, 2008)

Current Range

The purple amole *Chlorogalum purpureum* var. *purpureum* is endemic to the Santa Lucia Range of Monterey and San Luis Obispo counties, California. The taxon is known from two properties: several localities on Fort Hunter Liggett, southern Monterey County; and one locality on Camp Roberts in northern San Luis Obispo County (USFWS, 2008)

Critical Habitat Designated

Yes; 10/24/2002.

Legal Description

On October 24, 2002, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Chlorogalum purpureum* (Purple amole) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in California (67 FR 65414-65445).

Critical Habitat Designation

The critical habitat designation for *Chlorogalum purpureum* includes two CHUs in San Luis Obispo and Monterey counties, California. This species critical habitat encompasses approximately 5,910 acres (ac) (2,443 hectares (ha)) (67 FR 65414-65445).

Jolon Unit: This unit consists of 620 ha (1,532 ac) of private property near Jolon Road. This population is probably a remnant of a much larger population that historically extended beyond the immediate Fort Hunter Liggett area. The land within this unit provides those characteristics essential for the species discussed above.

Camatta Canyon Unit This unit consists of one area that encompasses the similar topographic features and vegetative communities that surround the only two known occurrences of this species. The Camatta Canyon Unit (1,772 ha (4,378 ac)) encompasses the plateau on both the north and south sides of Highway 58 near Camatta Canyon, extending south approximately 5 km (3 mi) to include two private inholding areas within the LPNF boundaries. The land within this unit provides those characteristics essential for the species discussed above. More specifically, the area surrounding the known distribution of *Chlorogalum purpureum* var. *reductum* and the plateau adjacent to the known distribution (i.e., finger-like extensions in northern portion of the unit) are essential because: (1) *Chlorogalum purpureum* var. *reductum* is found at only two sites in the La Panza Range in central San Luis Obispo County. The two sites likely make up one “population” of plants due to the close proximity of the sites and the characteristic “patchiness” of plants that has been observed with both varieties of *C. purpureum*. The limited geographic distribution of *C. p.* var. *reductum* increases the likelihood of its extinction. The risk of extinction elevates the need for protecting all existing plants, habitat, and soil conditions for the taxon’s expansion. Additionally, ecological attributes upon which the species relies (e.g., pollinators, seed dispersal agents) should be protected. Activities that may adversely affect or destroy the plant and the habitat that is critical for its survival and expansion should be limited. These activities include, but are not limited to, off-road vehicle use, livestock grazing, herbivory, and ground disturbance by gophers. (2) Thorough surveys of the distribution of *Chlorogalum purpureum* var. *reductum* have not been conducted in the area. Surveys are needed across multiple years to determine the presence or absence of the species. Monitoring of *C. p.* var. *purpureum* at Fort Hunter Liggett has found known individual mature plants to be dormant for at least three years. During dormancy, both varieties of *Chlorogalum* are not detectable on the surface. Because discoveries of new *C. p.* var. *purpureum* sites are being found within the range of the taxon at Fort Hunter Liggett, one may expect “new patches” of *C. p.* var. *reductum* to occur in the Camatta Canyon Unit if surveys were conducted within the critical habitat boundary in those areas where the primary constituent elements occur. (3) An extension of the plateau/flattop area where *Chlorogalum purpureum* var. *reductum* is currently known to occur exists between the northern site and the southern site. This area harbors the soils and vegetation appropriate for *C. p.* var. *reductum* growth and expansion. We believe it is important to provide connectivity between the two sites. Additionally, the area encompasses what appear to be flat-top/ mesa-like extensions (which likely contain suitable habitat) that occur between the two known distributions (D. Chipping, California Polytechnic State University, in litt., 1997). A. Koch (CDFG, pers. comm., 2001) also notes that *C. p.* var. *reductum* occurs on private property which falls between the two known sites and within the critical habitat boundary line. (4) The vegetation community that *Chlorogalum purpureum* var. *reductum* depends on extends beyond the boundary of the known distribution. By encompassing plateau areas, the known distribution, and a portion of the adjacent vegetation community that the species depends on, ecological functions (e.g., cryptogamic crust formation, predator-prey relationships, pollinator activity)

within the habitat are maintained such that “edge effects” from encroaching activities not conducive to *C. p. var. reductum* persistence (e.g., off-road vehicle use, livestock grazing, etc.) do not inhibit the taxon’s expansion or survival. Additionally, adjacent grassland and oak woodland habitat that is adversely affected could result in greater rates of herbivory or regeneration/expansion of nonnative plants that can outcompete smaller, herbaceous species such as *C. p. var. reductum*. Lands proposed are under private, State, and Federal jurisdiction. State lands are managed by CalTrans, and Federal lands are managed by the the Forest Service (i.e., LPNF). The approximate areas of proposed critical habitat by land ownership are shown in Table 1.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Chlorogalum purpureum* critical habitat consists of two components (67 FR 65414-65445):

The primary constituent elements of critical habitat for *Chlorogalum purpureum* var. *reductum* consist of, but are not limited to: (i) Well-drained, red clay soils with a large component of gravel and pebbles on the upper soil surface; and,

(ii) Plant communities in functioning ecosystems that support associated plant and animal species (e.g., pollinators, predator-prey species, etc.), including grassland, blue oak woodland (*Quercus douglasii*) or oak savannahs, and open areas within shrubland communities. Within these vegetation communities *C. p. var. reductum* appears where there is little cover of other species which compete for resources available for growth and reproduction.

Special Management Considerations or Protections

Special management considerations or protections may be needed to maintain the primary constituent elements for *Chlorogalum purpureum* within the units being proposed as critical habitat. In some cases, protection of existing habitat and current ecological processes may be sufficient to ensure that populations of *C. purpureum* are maintained at those sites, and have the ability to reproduce and disperse into surrounding habitat. In other cases, however, active management may be needed to maintain the primary constituent elements for *C. purpureum*. We have outlined below the most likely kinds of special management and protection that *C. purpureum* critical habitat may require. (1) The soils on which *Chlorogalum purpureum* is found should be maintained. Physical properties of the soil, such as its chemical composition, structure, and drainage capabilities, would best be maintained by limiting or restricting the use of herbicides, fertilizers, or other soil amendments; and by minimizing or avoiding activities that result in soil compaction (e.g., offroad wheeled and tracked vehicle use, trampling by people and livestock) and those that would alter the hydrology of areas immediately adjacent to or upslope of the species and its critical habitat. (2) The soil surface should be maintained to enhance cryptogamic crust formation by minimizing the intensity, frequency, duration, and acreage of soil surface disturbance. The soil surface should be protected at relict sites (i.e., sites with well-developed crusts) to provide reference areas and baseline comparisons for research. Because cryptogamic crusts are highly susceptible to hot fires (Belnap et al. 2001) and the presence of nonnative annual grasses in *Chlorogalum purpureum* habitat may promote fires. Annual, intense fires should be avoided. The effects of activities that can damage biotic soil crusts (e.g., excavations, offroad vehicle use, trampling) should be reduced by moving them to areas where crusts are less vulnerable, limiting the area affected, and conducting such activities in dryer

seasons. (3) The associated plant and animal communities should be maintained to ensure the habitat needs of pollinators and seed dispersal agents are maintained, and predator-prey relationships are functioning. The use of pesticides should be restricted so that viable populations of pollinators are present to facilitate reproduction of *Chlorogalum purpureum*. Fragmentation of habitat through road construction, development, and certain types of fencing should be limited. Additionally, predator-prey relationships should be managed and protected. For example, installation of fencing could exclude predator species (e.g., coyotes, bobcats, San Joaquin kit fox), thus causing an increase in prey species (e.g., ground squirrels, gophers, rabbits) abundance. A change such as this could result in increased herbivory, bulb predation, or burrowing that could affect *C. purpureum* growth and survival. (4) In all plant communities where *Chlorogalum purpureum* occurs, invasive, nonnative species such as *Centuarea solstitialis* (yellow starthistle), *Avena* spp. (wild oats), *Bromus* spp. (*B. hordeaceus*, *B. diandrus*, *B. madritensis*, *B. rubens* (brome)), *Erodium* spp. (storksbill or fillaree), and other species need to be actively managed and controlled to maintain the open habitat that *Chlorogalum purpureum* needs. Nonnative annual grasses may promote fires by providing recurring annual fuel sources. Thus, proactive management should be implemented to prevent annual fires, unless future research demonstrates that a series of annual fires can benefit *Chlorogalum purpureum* by reducing competition from nonnative species. (5) Certain critical habitat areas (i.e., suitable, unoccupied habitat between or adjacent to known patches of *Chlorogalum purpureum*) may need to be temporarily fenced or demarcated to identify exclusion areas for protection from accidental or intentional trampling by humans, livestock, or off-road vehicle use. Heavy disturbance to these critical areas may be detrimental to this species' persistence. Seasonal exclusions may work in certain areas to protect the critical habitat and *C. purpureum* plants during the critical season of growth and reproduction. (6) In areas where *Chlorogalum purpureum* and its habitat occur in conjunction with off-road vehicle traffic (e.g., military wheeled and tracked vehicles, OHVs), we recommend managing to minimize the severity of those effects. Management should include: limiting or avoiding new structures and permanent roads and trails; managing excavations, scrapings, or other ground surface disturbance; managing tracked and wheeled vehicle use during *C. purpureum* growing and dormant seasons; and managing foot traffic, bivouacking, and congregations of high numbers of people during *C. purpureum* growing and dormant seasons. These types of activities should be managed to limit loss of adults, bulbs, and seeds, loss of habitat, increased soil compaction, and increased nonnative species encroachment. (7) Monitoring programs should be developed or enhanced so that areas occupied by purple amole are studied, allowing for a full range of life-history data and a thorough analysis of the compatibility and impacts of those activities that may adversely affect the species. Representative areas should be chosen throughout the distribution of the species, including large, highdensity populations that have a higher potential for persistence. Monitoring studies should be designed to aid in the determination of population stability as well as provide basic life-history information and data on the ecological needs of the species (e.g., identification and status of pollinator species, disturbance factors, etc.).

Life History

Food/Nutrient Resources

Lifespan

Adult: 5 to 7 years (USFWS, 2008)

Breeding Season

Adult: April to May (NatureServe, 2015)

Reproduction Narrative

Adult: In one study, *Chlorogalum purpureum* flowered at three years following germination, and all plants had flowered at four years following germination. *C. purpureum* typically flower between April and May (NatureServe, 2015). Most plants died between the fifth and seventh year following germination. For seed-producing plants at Fort Hunter Liggett, the number of seeds produced per plant was highly variable, with a recorded range of 1 to 386 seeds per plant and a recorded mean of 28 seeds per plant (Niceswanger 2002). (USFWS, 2008; NatureServe, 2015))

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Barrens, Forest/Woodland, Grassland/herbaceous, Shrubland/chaparral, Woodland - Hardwood, Woodland - Mixed (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 213 to 407 m (700 to 1,336 feet)

Spatial Arrangements of the Population

Adult: Discontinuous patches (USFWS, 2008)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Dependency on Other Individuals or Species for Habitat

Adult: The purple amole (e.g., Guretzky et al. 2005; Woodbury 2006) and the Camatta Canyon amole (E.L. Painter in litt. 1998) have been reported to grow in association with cryptogamic crusts. (USFWS, 2008)

Habitat Narrative

Adult: The taxon is known from the lower elevations on the eastern side of the range, at approximately 213 to 407 meters (m) (700 to 1,336 feet (ft)) elevation. On Fort Hunter Liggett, there are hundreds of discontinuous patches of purple amole in grassland, oak savanna, and oak woodland communities where they occur in association with gravelly, clay soils. The purple amole (e.g., Guretzky et al. 2005; Woodbury 2006) and the Camatta Canyon amole (E.L. Painter in litt. 1998) have been reported to grow in association with cryptogamic crusts. The purple amole occurs in patches that range from a few plants to more than 10,000 individuals per ha (4,047 individuals per ac) at the densest locations. (USFWS, 2008)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Stable to increasing (USFWS, 2008)

Resiliency:

Low (inferred from USFWS, 2008)

Redundancy:

Low (inferred from USFWS, 2008)

Number of Populations:

14 (NatureServe, 2015)

Population Size:

~260,000 (inferred from USFWS, 2008)

Population Narrative:

C. purpureum var. *purpureum* is known from 13 occurrences in Monterey County (Fort Hunter Liggett Military Reservation) and 1 occurrence San Luis Obispo County (Camp Roberts Military Reservation). One locality contained scattered patches of the plant, with estimates suggesting several thousand individuals. The second locality contained at least 400 to 500 plants and possibly several thousand. The third locality contained an estimated 10,000 plants. In 2000, the population at Camp Roberts was estimated to comprise 10,000 individuals. However, in 2001, this population was intensively censused and mapped, which resulted in the documentation of over 250,000 plants on approximately 87 ha (215 ac). In 2007, the U.S. Army considered the status of the purple amole on Fort Hunter Liggett to be "stable to increasing" (Clark in litt. 2007b). Niceswanger (2002) believed that the population of purple amole on Fort Hunter Liggett is highly vulnerable to stochastic events, especially catastrophes affecting mature plants such as fire. (USFWS, 2008; NatureServe, 2015)

Threats and Stressors

Stressor: Habitat alteration (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: The property comprising Fort Hunter Liggett has a long history of settlement and use by "Europeans," dating back to 1771, which has affected the current distribution of the purple amole. On Fort Hunter Liggett, the purple amole is nearly absent from areas that were previously cultivated by disking. The taxon is most abundant in areas that were not previously disked, including areas where intensive military training has been common since 1941 (U.S. Army 2004a, 2004b). (USFWS, 2008)

Stressor: Military activities (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: The California Army National Guard ceased conducting military activities in the purple amole area in 2000, with exception of road use for four weeks in 2001 and 2003 and occasional use of the tank trail where the taxon does not occur. (USFWS, 2008)

Stressor: Gophers (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Niceswanger (2002) reported that "gophers (or possibly other rodents) tunneled through the sites and ate the leaves and flowering stems." Woodbury's (2005a, 2005b, 2006) data suggested that gophers may forage on the leaves of purple amole, with little or no interest in the bulbs. Woodbury (2006) stated that gophers displace the soil and the bulbs. From 2003 to 2006, the amounts of quadrats with gopher activity within 1 m were 41 percent, 32 percent, 26 percent, and 23 percent, respectively. (USFWS, 2008)

Stressor: Fungus (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Niceswanger (2002) observed a fungus affecting the purple amole at two transects during 2000, causing the plants to wither and rot. This is the only report of any disease affecting the purple amole. (USFWS, 2008)

Stressor: Feral pigs (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Holland (2007) observed pervasive soil disturbance by feral pigs in the purple amole habitat. Although Holland (2007) reported the effects to the purple amole to be unknown, Olson (pers. com. 2007) informed us that feral pigs eat the bulbs. (USFWS, 2008)

Stressor: Non-native annual grasses and invasive species (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Non-native annual grasses and other invasive plant species continue to be a threat to the purple amole at Fort Hunter Liggett and Camp Roberts and to the Camatta Canyon amole on the Los Padres National Forest. The invasive plant species may have the ability to displace the *Chlorogalum purpureum* by outcompeting and monopolizing limited resources (growing space, sunlight, soil nutrients, water; Stephenson and Calcarone 1999), with the potential effects of preventing growth and recruitment (U.S. Army 2004b). The invasive plant species may also have the ability to alter characteristics of the fire regime, such as frequency, intensity, and seasonality of fires (Brooks et al. 2004). We have no information on the site-specific presence of non-native plants in purple amole occurrences on Fort Hunter Liggett and Camp Roberts, or the effects that non-native competitors have on the frequency and seasonality of fire. (USFWS, 2008)

Stressor: Fire (USFWS, 2008)

Exposure:

Response:**Consequence:**

Narrative: The frequency of fires in California is increasing (Syphard et al. 2007), and fires at certain times of the year have the ability to prevent annual reproductive success of the purple amole (Niceswanger 2002) and also of the Camatta Canyon amole. The *Chlorogalum purpureum* are susceptible to damage by fire when the living structures, including the seeds, are above ground or near the soil surface. However, fires at certain times of the year may potentially benefit the *Chlorogalum purpureum* by removing other competitive plants, both native and invasive species. The *Chlorogalum purpureum* may also respond favorably to fire in other ways. (USFWS, 2008)

Stressor: Stochastic events (USFWS, 2008)

Exposure:**Response:****Consequence:**

Narrative: Niceswanger (2002) believed that the population of purple amole on Fort Hunter Liggett is highly vulnerable to stochastic events, especially catastrophes affecting mature plants such as fire. She therefore recommended protection and management of the habitat by administrative regulations, including prohibitions against physical disturbances during the reproductive stage. (USFWS, 2008)

Recovery**Reclassification Criteria:**

Reclassification criteria are not available.

Delisting Criteria:

Delisting criteria are not available.

Recovery Actions:

- Recovery actions are not available.

Conservation Measures and Best Management Practices:

- We recommend that the U.S. Army search for the purple amole in potentially-suitable habitat on nearby private properties and at additional localities on Fort Hunter Liggett. (USFWS, 2008)
- We recommend that the U.S. Army complete its endangered species management plan for the purple amole on Fort Hunter Liggett as soon as possible. (USFWS, 2008)
- In light of the known error by first-year surveyors in 2002 (Clark in litt. 2007a), we recommend that the U.S. Army re-analyze its data regarding fire and the purple amole on Fort Hunter Liggett. Further, we recommend that the U.S. Army conduct research regarding the effects of fire (frequency, seasonality) and invasive plants to the purple amole. (USFWS, 2008)
- We recommend that the U.S. Army actively manage the known occupied localities for the benefit of the purple amole. In particular, we recommend that the U.S. Army evaluate and consider conducting activities that may potentially benefit the purple amole on Fort Hunter Liggett, including controlled burns to remove invasive plants, the removal of feral pigs, and the use of the ball-and-chain method to remove competing plants in potential habitat. (USFWS, 2008)

- We recommend that the U.S. Army conduct research to determine the effects of gophers and feral pigs on the purple amole, and the relationship between the purple amole and cryptogamic crusts. (USFWS, 2008)
- We recommend that the California Army National Guard search for the purple amole in potentially-suitable habitat on nearby private properties and at additional localities on Camp Roberts. (USFWS, 2008)
- We recommend that the California Army National Guard complete the process of updating its draft Integrated Natural Resources Management Plan for Camp Roberts and consulting with the Service regarding it and the ongoing activities that may affect the purple amole. (USFWS, 2008)
- We recommend that the California Army National Guard statistically analyze its data regarding the effects of fire on the purple amole at Camp Roberts. Further, we recommend that the California Army National Guard conduct research regarding the effects of fire (frequency, seasonality) and invasive plants to the purple amole. (USFWS, 2008)
- We recommend that the California Army National Guard actively manage the known occupied localities for the benefit of the purple amole. In particular, we recommend that the California Army National Guard evaluate and consider conducting activities that may potentially benefit the purple amole on Camp Roberts, including controlled burns to remove invasive plants, controlled grazing by goats or sheep to remove invasive plants, and the removal of feral pigs. (USFWS, 2008)
- We recommend that the California Army National Guard conduct research to determine the effects of gophers and feral pigs on the purple amole, and the relationship between the purple amole and cryptogamic crusts. (USFWS, 2008)

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SPECIES ACCOUNT: *Chorizanthe howellii* (Howell's spineflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/22/1992; Pacific Southwest (R8)

Physical Description

An herbaceous annual; the plants are 0.3—1 decimeter (1.2—3.9 inches) tall and 1—5 decimeters (3.9—20 inches) across. The basal leaves are 1—3 centimeters (0.39—1.2 inches) long and 5—15 millimeters (0.2—0.6 inch) wide. What appears to be a spiny flower is in fact mostly the involucre that surrounds the flower, tipped with 6 brown, straight spines (awns). The distinguishing morphological feature of *C. howellii* is its straight (not hooked) awns. The only other coastal spineflowers with this trait are *C. valida* (distinguished by an erect growth habit and whitish to straw-colored awns), and some northern populations of *C. cuspidata* (formerly distinguished as *C. villosa*), which has a very prominent central tooth (not minute as in *C. howellii*) on each perianth lobe (petal or sepal). The involucre, including its spines, is 3—4 millimeters (0.1—0.2 inch) long. Flowers are 3.5—4.5 millimeters (0.1-0.2 inch) long. Figure 1 (page 79) shows the appearance of *C. howellii*. (USFWS, 1998)

Taxonomy

Chorizanthe is a genus of herbs in the buckwheat family (Polygonaceae) with many species in California. *Chorizanthe howellii* (Howell's spineflower) was described in 1934 by George Goodman. Its name commemorates John Thomas Howell, who had collected specimens in 1929. Chromosome counts of this species ($n = 40$) indicate that it is a stabilized polyploid hybrid (Reveal and Hardham 1989), most likely between *C. cuspidata* var. *villosa* ($n = 20$) and *C. valida*. This is a typical means by which new plant species arise. (USFWS, 1998)

Historical Range

Endemic to 7 miles of coastal dunes extending from the City of Fort Bragg north to the Ten Mile River, Mendocino County, California. (USFWS, 2019a)

Current Range

Endemic to 7 miles of coastal dunes extending from the City of Fort Bragg north to the Ten Mile River, Mendocino County, California. (USFWS, 2019a)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: 1 year (USFWS, 2011)

Breeding Season

Adult: May to July (USFWS, 2011)

Reproduction Narrative

Adult: As an annual species, *C. howellii* completes its entire life cycle within a year, and therefore responds almost immediately to changes in its environment. *C. howellii* blooms between May and July. (USFWS, 2011)

Habitat Type

Adult: Terrestrial (USFWS, 2011)

Habitat Vegetation or Surface Water Classification

Adult: Coastal dunes (USFWS, 2011)

Geographic or Habitat Restraints or Barriers

Adult: Sea-level to 37 m, sparsely-vegetated areas, sandy substrate (USFWS, 2011; NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist

Dependency on Other Individuals or Species for Habitat

Adult: In coastal dunes, it is associated with sand verbena, *Abronia latifolia*, and Menzies' wallflower, *Erysimum menziesii*. In coastal prairie habitat, it is associated with two alien grasses, sweet vernalgrass, *Anthoxanthum odoratum*, and velvetgrass, *Holcus lanatus*, and two species of special concern, Mendocino coast paintbrush, *Castilleja mendocinensis*, and Northcoast phacelia, *Phacelia insularis* var. *continentis* (FWS, 1997). (NatureServe, 2015)

Habitat Narrative

Adult: *Chorizanthe howellii* prefers coastal dunes and adjacent sandy soils of coastal prairies from sea level to 37 m. The preference of this species for vegetation gaps or sparsely-vegetated areas on sandy substrate allows seedlings to establish in areas that are relatively free from other competing native species. In coastal dunes, it is associated with sand verbena, *Abronia latifolia*, and Menzies' wallflower, *Erysimum menziesii*. In coastal prairie habitat, it is associated with two alien grasses, sweet vernalgrass, *Anthoxanthum odoratum*, and velvetgrass, *Holcus lanatus*, and two species of special concern, Mendocino coast paintbrush, *Castilleja mendocinensis*, and Northcoast phacelia, *Phacelia insularis* var. *continentis* (FWS, 1997). (USFWS, 2011; NatureServe, 2015)

Dispersal/Migration**Motility/Mobility**

Adult: High (USFWS, 2011)

Dependency on Other Individuals or Species for Dispersal

Adult: Animals (USFWS, 2011)

Dispersal/Migration Narrative

Adult: Seed dispersal by *C. howellii* is facilitated by the floral spines, which attach to passing animals. (USFWS, 2011)

Population Information and Trends**Population Trends:**

Not available

Number of Populations:

8 occurrences (USFWS, 1998)

Population Size:

~2,000,000 plants (USFWS, 2019b)

Additional Population-level Information:

In 2019, AFWO conducted a population estimate for *Chorizanthe howellii*. We collected density data in random 1-meter 2 plots within occupied habitat (as mapped in 2018). Density data were collected in 237 plots, among four different strata. Strata were identified for sampling based on land management in each strata. The four strata were sampled proportionate to their area. Results from the 2019 sampling yielded an estimated abundance of 2,025,768 plants, with a 95% confidence interval of 1,581,020- 2,525,575 plants. (USFWS, 2019b)

Population Narrative:

The mapping was updated for the current distribution of *Chorizanthe howellii* on MacKerricher State Park in April 2018. This updated mapping showed that the distribution had increased by 1.5 acres since the last status review. Occupied habitat as mapped in 2011 was approximately 14 acres. In 2018, occupied habitat had increased to approximately 15.5 acres. Some habitat was lost during the MacKerricher State Park Dune Rehabilitation Project (AFWO-13BO104- 13F0189; Dune Rehabilitation Project) in 2013, due to removal of stabilized dunes when the Haul Road was removed. That loss, however, was mitigated by habitat restoration, through iceplant (*Carpobrotus* sp.) removal and dispersal of seeds. Monitoring data from MacKerricher State Park, collected as part of the mitigation and monitoring plan for the Dune Rehabilitation Project, showed an increase in cover of *Chorizanthe howellii* in the mitigation plots from 2013 to 2016. (USFWS, 2019b)

Threats and Stressors

Stressor: Pedestrian, equestrian, and off-road vehicle use (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Equestrian and pedestrian trails within MSP continue to affect a significant portion of the occupied habitat, mostly in the area south of the IF-TD Natural Preserve. Residential development around the park combined with completion of a pedestrian bridge between Fort Bragg and MSP likely will increase recreational pressure on the park. However, completion of a proposed coastal trail within Fort Bragg may counter some of that potential increase (R. Pasquinnelli, pers. comm. 2006, 2011a). Both equestrian and recreational trails facilitate public access to the dunes, and increase the risk of trampling in the more remote populations of *C. howellii*. Moderate to heavy pedestrian and horse traffic preclude establishment of *C. howellii* within the well-used center of pathways. (USFWS, 2011)

Stressor: Invasive plant species (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: *C. howellii* was listed, in part, due to the past introduction and invasion of its habitat by a variety of invasive, non-native plant species. These species threaten virtually the entire distribution of *C. howellii*, through direct competition for space, stabilization of the dunes, and in some cases, enrichment of the soils, which then stimulates invasion by other aggressive species. Within *C. howellii* habitat, European beachgrass, iceplant, burclover, ripgut brome and other annual grasses are principle threats (R. Pasquinelli, pers. comm. 2006). The majority of these species have not been, nor are they currently, mapped within MSP on a routine basis, so there is little documentation of encroachment rates; however, evidence suggests these taxa will continue to invade *C. howellii* habitat, necessitating routine and permanent management action. MSP has implemented several projects aimed at controlling European beachgrass and iceplant. Efforts to remove European beachgrass began in 1997 (CDPR 1997), and was supported by private donations, and funding under ESA section 6 grants to the states (CDPR 2002). As of 2011, European beachgrass has been treated on over 150 acres in the north portion of MSP (B. Maslach, pers. comm. 2011a). Once removed, treated habitat requires periodic retreatment to eliminate sprouting and new recruits. In summary, MSP has made substantial efforts to implement research and management aimed at controlling invasive species and restoring *C. howellii* habitat, and learning more about the ecology and habitat requirements of *C. howellii*. These efforts, particularly the monitoring, should be continued and expanded. While the threat posed by invasive species has been addressed to some extent, at least temporarily, no mechanism has been implemented which ensures continued funding and implementation of an invasive species control program, or the monitoring necessary to effectively implement such a program.

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: A new recognized threat to *C. howellii* is climate change and associated ocean-rise. The most recent literature on climate change includes predictions of hydrological changes, higher temperatures, and expansion of drought areas, resulting in a northward and/or upward elevation shift in range for many species (IPCC 2007). It is unknown if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. There is also little or no data indicating the sensitivity of *C. howellii* to changes in environmental factors such as air temperature and soil moisture. Ocean rise, coupled with the fact that in portions of MSP the waveslope is eroding inland, indicate that overwash occurrences may be more frequent and extend further inland (Wollenberg and Maslach 2004). The result will be increased potential for erosion and blowouts, resulting in loss or degradation of an unknown amount of *C. howellii* habitat. (USFWS, 2011)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The California Environmental Quality Act (CEQA) (chapter 2, section 21050 et seq. of the California Public Resources Code) and the California Coastal Act are perhaps the two most important laws protecting the species. Many activities on both public and private property, such as building construction, sand mining, or road construction are subject to review under CEQA. In addition, because virtually all of the distribution of *C. howellii* falls within the Coastal Zone, most projects in *C. howellii* habitat are subject to the California Coastal Act, which is administered locally by the Mendocino Local Coastal Program (LCP). Both acts require an assessment of impacts on sensitive resources. While CEQA may allow significant impacts, subject to mitigation, the Coastal Act generally prohibits significant impacts to sensitive resources. However, a number of activities on private property that could affect *C. howellii* are not subject to a permit at the local, state, or federal level, or are difficult to enforce, such as small-scale vegetation removal or creation of trails through sensitive habitat. *C. howellii* was listed as Threatened by the State of California in January 1987. As such, it also receives limited protections under the California Native Plant Protection Act and California Endangered Species Act (Service 1992; CDFG 2011b). The primary protections under federal law are afforded by the Endangered Species Act of 1973 (Act), as amended. Overall, the most significant current threats to *C. howellii* are either unregulated, or of a kind not affected by land use regulations (e.g., invasive species encroachment, pedestrian impacts, climate change). Thus regulatory restrictions, even when applicable, are currently inadequate to conserve this species. (USFWS, 2011)

Recovery

Reclassification Criteria:

1. Habitat occupied by the species that is needed to allow delisting has been secured, with longterm commitments and, if possible, endowments to fund conservation of the native vegetation. (USFWS, 2019a)
2. Management measures are being implemented to address the threats of invasive species, pedestrians, and off-road vehicles at some sites. (USFWS, 2019a)
3. Monitoring reveals that management actions are successful in reducing threats of invasive nonnative species. (USFWS, 2019a)
4. Additional restored habitat has been secured, with evidence of either natural or artificial longterm establishment of additional populations, and long-term commitments (and endowments where possible) to fund conservation of the native vegetation. (USFWS, 2019a)

Delisting Criteria:

1. General Delisting Criterion: Full recovery of these taxa will be achieved when the dune systems they inhabit are secure, with experience to demonstrate that exotic plants and other threats (recreational use, off-road vehicles, etc.) are controlled and managers have demonstrated their ability to keep the threats under control. The taxa need to be secure in their presently-occupied ranges, and opportunities should be taken to introduce these plants to restored habitat in or near historic ranges. To be counted toward recovery, (re)introduced populations should be naturally reproducing in vegetation that also appears to be persisting without excessive maintenance or "gardening." The area occupied by the plants should increase commensurate with improving habitat conditions. The determination that delisting is possible must be based on at least 15 years of monitoring for the endangered taxa, to include wet and

drought years. For some of the species, aspects of demography and population biology must be understood to be assured that populations are likely to persist. The species can be considered for delisting when sites are secure from habitat modification (development), occupied habitat is stable or improving and free of weed invasion. (USFWS, 2019a)

2. Specific Delisting Criterion: *Chorizanthe howellii* may be considered for delisting when restoration of habitat at McKerricher State Park has resulted in a minimum of 42 acres of habitat occupied by *C. howellii*. Monitoring and mapping should demonstrate that the area occupied by *C. howellii* has met that minimum threshold consistently for at least 15 years and that populations are not being lost to non-native, invasive species or recreational activity. (USFWS, 2019a)

Recovery Actions:

- 1. Protect habitat of the listed species and their occurrences on private lands. The listed species addressed in this plan should be secured where they occur on private lands through conservation easements, conservation agreements, or purchase where there are willing sellers. This is necessary to prevent further declines in distribution and abundance of the listed species from loss and degradation of habitat. The development of cooperative weed control programs will greatly facilitate recovery of these species, so it is a high priority to develop landowner incentives and providing funds for control of invasive exotic vegetation is a high priority. This task regularly refers to “occurrences” as defined by the NDDB. Readers are reminded that “occurrences” are convenient units for storing data, and do not necessarily coincide with biological populations nor with geographic units of vegetation or geological features such as the dune fields upon which these plants depend. (USFWS, 1998)
- 2. Minimize threats to the plants and butterfly. Invasive non-native plant species are immediate biological threats to all of the listed plant species. Invasive plants are also a problem for Myrtle’s silverspot (i.e., competition with native larval and adult food plants). Infestations of invasive plant species need to be controlled. (USFWS, 1998)
- 3. Develop management strategies through a research program to document the listed species’ life histories and their responses to vegetation management. Habitat management for the species in this recovery plan is needed to control the threats to their existence. Data must be obtained to determine how to conduct the management. (USFWS, 1998)
- 4. Manage occurrences and habitats: Management of the listed plant species and their habitat will depend upon information gained from monitoring, threat analysis and the evaluation of protection alternatives. It will be important to involve the expertise of local landowners, land managers, and species experts to develop conservation programs. There may be different management programs for each species. The management program selected will require periodic review to ensure that it is effective in protecting the species. (USFWS, 1998)
- 5. Monitor occurrences and threats to determine effectiveness of management and to establish delisting criteria. (USFWS, 1998)
- 6. Coordinate recovery actions to protect other listed species and species of special concern. Other rare and endangered wildlife species occur within the ranges of the seven listed plant species. Management actions, such as the removal of invasive non-native plant species through herbicide application, may affect these species. Management actions should avoid adverse impacts to these species and their habitats, and actively include them in recovery

actions to facilitate their reoccupation of historic ranges and prevent range collapse or declines in their abundance. (USFWS, 1998)

- 7. Develop ecosystem restoration and multi-species reintroduction projects at degraded dune systems. Numerous dune systems within the historic range of listed species and species of concern have either reduced value or none for them because of past or ongoing degradation of habitat quality. Benefits for multiple species can be efficiently regained by establishing habitat and population restoration programs for these undermanaged or degraded dune systems. By returning independent dune systems within historic range of rare species to current ecological function, the risk of species extinction can be substantially decreased.
- 8. Develop and implement an outreach program. Increasing public awareness of the seven endangered plant species and the Myrtle's silverspot butterfly will facilitate efforts to preserve these species, associated rare species, and the coastal dune ecosystem. Prepare and distribute regionally specific informational brochures and audio-visual and sign programs on preservation and recovery. Through the cooperative interagency working groups, prepare brochures and audio-visual materials that describe the plight of the listed species and the regional efforts being undertaken for their recovery. Disseminate the brochures to affected landowners and other community facilities. Provide the audio-visual materials to public facilities, such as park interpretive programs and school programs. Prepare interpretive educational signs for PRNS and other locations. (USFWS, 1998)

Conservation Measures and Best Management Practices:

- 1. Using GPS, remap the distribution of *C. howellii*-occupied polygons within MSP in 2008, and again in 2012. Using that map, derive a statistically valid estimate of population during both years. In particular, the inventory should emphasize habitat restored over the past decade. (USFWS, 2011)
- 2. Continue the monitoring begun as part of the section 6 iceplant/spineflower study implemented in 2003, to better characterize the relationship between iceplant removal and recolonization by *C. howellii*. Plots should be monitored at no less than two year intervals, beginning spring 2008. (USFWS, 2011)
- 3. Fully implement the disturbance-related *C. howellii* population monitoring initiated in 2003, and monitor those plots at not less than 2 year intervals. (USFWS, 2011)
- 4. Incorporate language in the forthcoming management plan developed for the Inglenook Fen-Ten Mile Dunes Natural Preserve, which specifically commits to future conservation of *C. howellii* within that area. (USFWS, 2011)
- Partnerships: Successful partnership with C DPR, the agency that owns the majority of the land where *C. howellii* and its habitat occur, is crucial to successful implementation of the recovery plan and conserving the species. Therefore, continued collaboration between the Service and C DPR is important. (USFWS, 2011)
- Monitoring Program to Measure the Impacts of Ocean-rise and Targeted Restoration: The California Shoreline Mapping Project, implemented in 2010, will provide high resolution LIDAR photography enabling development of an accurate digital elevation model (California Ocean Protection Council 2011). Those data should become available in 2012. At that time an analysis of *C. howellii* occupied habitat should be conducted to help evaluate future trends in population and habitat based on habitat elevation. Because *C. howellii* may be vulnerable to significant impacts from ocean-rise, future habitat restoration efforts should begin to focus on areas that are at elevations sufficient to avoid the majority of impacts. (USFWS, 2011)

- Invasive Species Removal: Efforts should continue with respect to removal of iceplant and European beachgrass, and exploring ways to implement a permanent invasive species monitoring and response program. Such a program could potentially be included within the Weed Inventory Monitoring System (WIMS) program initiated by CDPR. (USFWS, 2011)
- Acquisition and/or Protection of Habitat: The CDPR and the Service should continue to pursue opportunities for acquisition or protection of important habitat adjacent to the park, which either supports *C. howellii*, or contributes to the integrity of the Ten Mile Dunes ecosystem. In decreasing order of priority, these important lands include: inland dune habitat immediately south of Ten Mile River; inland dune and prairie habitat northeast of Cleone Grange; dune habitat surrounding Virgin Creek and dunes habitat located east of highway 101 south of Virgin Creek; dune habitat near the inland extent of the dune sheet north of Ward Avenue; dune habitat near the inland extent of the dune sheet north of Cleone Lake. (USFWS, 2011)
- Permanent Funding: The CDPR and/or the Service should determine the amount of needed funds, and then pursue opportunities to secure permanent funding in the form of an endowment or trust fund, which ensures that periodic monitoring and habitat restoration are conducted in perpetuity. Such funding would not then be subject to future CDPR staffing and budgetary limitations. (USFWS, 2011)

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SPECIES ACCOUNT: *Chorizanthe orcuttiana* (Orcutt's spineflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/07/1996; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An annual herb with prostrate, yellowish stems, 1-15 cm long. Yellow, densely hairy flowers (2.5-4 mm) bloom March-April and produce a single seed. (NatureServe, 2015)

Taxonomy

Not available

Historical Range

See current range/distribution.

Current Range

Known only from San Diego County, California. All of the known occurrences of this species are within 5 km of the Pacific Ocean at elevations below 100 m above mean sea level (Bauder 2000). (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: 1 year (USFWS, 2007)

Breeding Season

Adult: March to April (NatureServe, 2015)

Reproduction Narrative

Adult: *Chorizanthe orcuttiana* (Orcutt's spineflower) is a small (1-15 cm), annual plant species known only from San Diego County, California. *C. orcuttiana* flowers bloom from March to April (NatureServe, 2015). (USFWS, 2007; NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Maritime shrubland/chaparral (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Small patches (USFWS, 2007)

Environmental Specificity

Adult: Narrow/specialist (inferred from USFWS, 2007)

Habitat Narrative

Adult: Chorizanthe orcuttiana prefers open areas with sandy soils within low, fairly open southern maritime chaparral communities. (NatureServe, 2015). Soil samples examined were dominated by the sand fraction with moderate acidity, low organic content and nitrate nitrogen (Bauder 2000). The four extant occurrences are small patches often with constricted connectivity to adjacent patches. The habitat of C. orcuttiana is described as loose sandy soils in openings in coastal or maritime chaparral by Bauder (2000, p. 31). (USFWS, 2007; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Number of Populations:

4 (USFWS, 2007)

Population Size:

470 to 3,000 (USFWS, 2007)

Population Narrative:

Currently we consider there to be four extant occurrences of Chorizanthe orcuttiana, one at Oak Crest Park in Encinitas and three on Point Loma. For the four occurrences considered to be currently extant, the highest recorded number of plants for any single occurrence was 2,520 plants in 1998 at Point Loma (EO 12) (Bauder 1998). Recent plant counts for all of the extant occurrences combined range from a high of about 3,000 to a low of about 470 plants. (USFWS, 2007)

Threats and Stressors

Stressor: Habitat loss (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Maritime chaparral as the habitat type with which Chorizanthe orcuttiana is associated and it is estimated that there were 1,500 to 3,700 acres of southern maritime chaparral habitat remaining in San Diego County and 150 acres in Orange County. The Service stated that this represented an estimated loss of between 82 and 93 percent of southern maritime chaparral in San Diego County. (USFWS, 2007)

Stressor: Random events (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: In the final listing rule (USFWS 1996 p. 52381) *Chorizanthe orcuttiana* was considered threatened by naturally occurring random events exacerbated by drought or fire because of the species' restricted distribution and the small size of the known population. (USFWS, 2007)

Stressor: Invasive plant species (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Invasive exotic grass and weed species as well as interruption of the natural fire cycle were also considered threats to this species. *Muhlenbergia rigens* (deergrass), a native grass species, was removed from some of the habitat at Oak Crest Park because of its potential to crowd out and shade the *Chorizanthe orcuttiana* (Bauder 2000 p. 21). The lack of a natural fire regime or managed alternative for the associated southern maritime chaparral may pose a threat to *Chorizanthe orcuttiana* by allowing the shrub canopy to cover over the sandy openings favored by the Orcutt's spineflower. (USFWS, 2007)

Stressor: Fire (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: The natural fire cycles in the area have likely been altered. A single natural random event, such as a fire, could jeopardize the continued existence of the species at one or more of the occurrences by killing standing plants, reducing input to the seed bank, or by being intense enough to kill some of the seeds in the seed bank. Such an event could also reduce vegetation cover and result in erosion and loss of habitat. (USFWS, 2007)

Stressor: Invasive non-native plant species (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Invasive non-native plants are the greatest known threat to the occurrences of Orcutt's spineflower on Point Loma. The invasive non-native *Carpobrotus edulis* (Hottentot fig; iceplant) covers many of the open sandy areas on Point Loma (Bauder 2000). Iceplant produces thick layers of prostrate, succulent stems and leaves over the soil surface, deposits organic material, and grows back readily after removal (Bauder 2000). *Rhynchelytrum repens* (Natal grass) is another nonnative plant that threatens Orcutt's spineflower (Rusev and Zink 2005). A potentially invasive *Acacia* spp. has also been identified at Point Loma (Bauder 2000). These species can prevent expression of the above ground population of Orcutt's spineflower. If this is a long-term condition, presumably the seed bank would eventually be depleted thereby diminishing the range of the species. (USFWS, 2007)

Stressor: Small populations (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: *Chorizanthe orcuttiana* (Orcutt's spineflower) has never been known to be abundant or widespread. Local populations are still relatively to extremely small. (USFWS, 2007)

Stressor: Recreation (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: The occurrence at Oak Crest Park was fenced in 2000 with money from a section 6 grant through the State to the City of Encinitas. The open rail fence affords the occurrence protection from casual walkers and other recreational activities, noted as threats in the listing rule. (USFWS, 2007)

Recovery**Reclassification Criteria:**

Reclassification criteria are not available.

Delisting Criteria:

Delisting criteria are not available.

Recovery Actions:

- Recovery actions are not available.

Conservation Measures and Best Management Practices:

- Continue to work with the City of Encinitas and the U.S. Navy to protect and enhance habitat for *Chorizanthe orcuttiana*. (USFWS, 2007)
- Eliminate negative impacts from non-native and native vegetation on the known occurrence of the species in Oak Crest Park, Encinitas. (USFWS, 2007)
- Determine the presence and location of similar sites in Oak Crest Park, Encinitas and create clearings among the vegetation on suitable soils. (USFWS, 2007)
- Field-check the historical occurrence sites and suitable habitat identified by Bauder (2000) to verify the presence of suitable habitat and the presence or absence of the species. (USFWS, 2007)
- Determine the reproductive cycle of the species to include pollen and seed dispersal agents, fecundity of the species in relation to rainfall patterns, and any identifiable bottlenecks to the species survival other than those already known. (USFWS, 2007)
- Determine the most effective manner to consistently limit the impact of invasive non- native plants on this species. These may have to be site and/or species specific. (USFWS, 2007)
- Determine and implement an appropriate seed banking strategy for the species. (USFWS, 2007)

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SPECIES ACCOUNT: *Chorizanthe parryi* var. *fernandina* (San Fernando spineflower)

Species Taxonomic and Listing Information

Listing Status: Proposed Threatened; California/Nevada Region (R8) (USFWS, 2016)

Physical Description

An annual flowering plant (NatureServe, 2015)

Historical Range

California endemic, extirpated in San Bernardino and Orange Counties (California Dept. of Fish and Game Natural Diversity Data Base, Sept. 1999) (NatureServe, 2015).

Current Range

Currently known from two disjunct localities: one site in southeastern Ventura County and a second in southwestern Los Angeles County (Farris 2002) (NatureServe, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Coastal scrub (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits sandy coastal scrub (NatureServe, 2015).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Decline of 70 - 90% (NatureServe, 2015)

Resiliency:

Very low (inferred from NatureServe, 2015)

Redundancy:

Very low (inferred from NatureServe, 2015)

Number of Populations:

2 (NatureServe, 2015)

Population Size:

> 1,000,000 individuals (NatureServe, 2015)

Population Narrative:

Of the 12 historical occurrences, the sites in San Bernardino and Orange counties, and all but one of the Los Angeles county sites, have likely been extirpated over the years by urbanization (Farris 2002). Large blocks of suitable habitat no longer exist in those areas (Farris 2002). This species has experienced a long term decline of 70 - 90%. The numbers vary greatly from one year to another. In a peak year (2003), about six million plants were present (USFWS, 2004). However, in a more typical year, 5,000 - 10,000 individuals were seen in one 1.3 acre site (California Dept. of Fish and Game Natural Diversity Data Base, Sept. 1999). One occurrence found in May, 1999, in Ventura County, and another found in 2000 in Los Angeles county; all other occurrences are historic (California Department of Fish and Game Natural Diversity Data Base, Sept. 1999). About a dozen historical localities, in Los Angeles, Orange, and San Bernardino counties, all in Los Angeles area (USFWS, 2004). Attempts to locate additional localities have not been successful. The two known populations total about 25 acres in area (USFWS, 2004) (NatureServe, 2015).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Threats to *C. parryi* var. *fernandina* from habitat destruction or modification include development, cattle grazing on Newhall Ranch. Cattle grazing may harm the species by trampling and soil compaction, and could also alter the nutrient content of the soils where the species grows through fecal inputs, which in turn may favor the growth of other plant species that would otherwise not grow so readily on the mineral-based soils. Over time, changes in species composition may render the sites less favorable for the persistence of *C. parryi* var. *fernandina*. Soil compaction by cattle could render the soil impenetrable, thus disrupting seed germination. Lastly, hoof-prints may break apart the soil crust, which is characteristic habitat, leaving it vulnerable to erosion processes (USFWS, 2013).

Stressor: Nonnative plants (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: This species may be threatened by invasive nonnative plants, including grasses, which could potentially displace it from available habitat; compete for light, water, and nutrients; and reduce survival and establishment. A study of the species implicated shade as the primary factor affecting the survival, reproduction, and biomass. If not managed, such species could degrade the quality of the habitat for *C. parryi* var. *fernandina* over time (USFWS, 2013).

Stressor: Predation (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Predation by livestock or wildlife is a current threat to this species. The Upper Las Virgenes Creek Open Space Preserve site had been heavily grazed by sheep in the past, and the Newhall Ranch sites are currently grazed by cattle (see discussion in Factor A above concerning impacts to habitat due to cattle grazing) (USFWS, 2013).

Stressor: Stochastic events (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: This species is particularly vulnerable to extinction due to its concentration in two isolated areas. The existence of only two areas of occurrence, and a relatively small range, makes the variety highly susceptible to extinction or extirpation from a significant portion of its range due to random events such as fire, drought, erosion, or other occurrences. Once the number of populations or the plant population size is reduced, the remnant populations, or portions of populations, have a higher probability of extinction from random, chance events (USFWS, 2013).

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- Not available - this species does not have a recovery plan.

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SPECIES ACCOUNT: *Chorizanthe pungens* var. *hartwegiana* (Ben Lomond spineflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/07/1994; Pacific Southwest (R8)

Physical Description

a small annual herb in the buckwheat family (Polygonaceae). The plants grow up to 2.5 decimeters (10 inches) high. Whorls of bracts (involucres) below the flowers are 1.5—2.5 millimeters (0.6—1.0 inch) long and have pink scarious (thin and dry) margins. The tepals (undifferentiated petals and sepals) are irregularly toothed at the tips. Compared to other species in the *pungens-robusta* complex, Ben Lomond spineflower is more erect and the flower clusters and associated structures (inflorescences) are pink with small distinct heads (Ertter 1996). (USFWS, 1998)

Taxonomy

Chorizanthe pungens was first described by George Bentham in 1836 based on a specimen collected in Monterey. This taxon was recognized by George Goodman in 1934 as the type species in describing the *Pungentes* section of the genus. *Chorizanthe pungens* var. *hartwegiana* was distinguished from *C. pungens* var. *pungens* by James Reveal and Clare Hardham (1989) based on a distinction between the coastal form and an inland form “in the Ben Lomond sandhills area.” (USFWS, 1998)

Historical Range

See current range/distribution.

Current Range

Monterey and San Luis Obispo counties, CA. (USFWS, 2912)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (USFWS, 2007)

Breeding Season

Adult: *Chorizanthe pungens* var. *hartwegiana* seeds germinate in the late fall after the first substantial winter rains. The plants remain small through the winter, then grow quickly and begin producing flowers in April. The length of the flowering season may persist for several months if the climatic conditions during the spring and early summer are favorable (USFWS, 2007).

Reproduction Narrative

Adult: *Chorizanthe pungens* var. *hartwegiana* seeds germinate in the late fall after the first substantial winter rains. The plants remain small through the winter, then grow quickly and begin producing flowers in April. The length of the flowering season may persist for several months if the climatic conditions during the spring and early summer are favorable. Flowers are pollinated by a variety of insects, including wasps, bees, flies, and butterflies (Morgan 1997 in Service 1998). Seed set varies with site conditions; in controlled experiments with plants transplanted into grass, manzanita, and pine sites, seed set varied from none to about 60 seeds per plant. Higher seed set was closely tied to the lack of shading (Kluse 1994) (USFWS, 2007). This taxon is a short-lived annual species which undergoes large variations in population numbers from year to year depending on climatic conditions and other factors (USFWS, 2007). First-year and, frequently, second-year plants consist of a basal rosette. In subsequent years, the basal rosette withers as the main flowering stem develops. In *Erysimum* species, flowering may be postponed due to unproductive habitat; therefore, some adults may be older than two years old. Successful reproduction most likely depends on habitat characteristics and climatic conditions (Berg 1986) (USFWS, 1998).

Habitat Type

Adult: Ponderosa pine woodland (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Restricted to pockets of sandstone-derived coarse sandy soils - uplifted ancient marine terraces persisting in a mountain range of volcanic origin. These coarse sands create drier soil conditions than those in the surrounding substrates and support an unusual, open, park-like ponderosa pine woodland community. (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the species specific habitat requirements and low number of known populations.

Dispersal/Migration**Dispersal**

Adult: Seeds dispersed by large mammals (mule deer, coyotes, rabbits) and small mammals (on their fur). Insects also disperse seed (USFWS, 2012).

Dispersal/Migration Narrative

Adult: Seeds are dispersed by mule deer (*Odocoileus hemionus*), coyotes (*Canis latrans*), rabbits (*Sylvilagus* spp.), and small mammals that come into contact with the plants in late June and July (McGraw 2004b). At that time, the seeds, which are contained in spiny involucre, are easily separated from the flower stems and adhere to the coats of mammals (McGraw 2004b). Insects, including ants, carry out secondary dispersal of those seeds that fall to the soil in late summer (McGraw 2004b). Dense patches of seedlings below the parent plant, however, suggest that many seeds are not widely dispersed (McGraw 2004b). With seeds viable only up to 1 year after production, and with germination less than 0.01 percent, there is little evidence to suggest that *Chorizanthe pungens* var. *hartwegiana* has an extensive seed bank (McGraw 2004b). New information concerning the soil seed bank of the closely related *Chorizanthe pungens* var. *pungens* was published in 2006 (Fox et al. 2006). This 5-year study found that the density of *Chorizanthe pungens* var. *pungens* in a population was directly related to the previous year's seed set, and that the species germinates well under most winter conditions and does not develop an extensive persistent soil seed bank (USFWS, 2012).

Population Information and Trends

Population Trends:

Unknown (USFWS, 2012)

Resiliency:

Low (inferred from NatureServe, 2015)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Narrative:

1-5 current EOs. (NatureServe, 2015). Population trends are unknown and will be difficult to monitor due to natural yearly fluctuations in populations (USFWS, 2012). Low resiliency, representation and redundancy are inferred based on the low number of known populations, specific habitat requirements and relatively small geographic area in which the species is known to occur.

Threats and Stressors

Stressor: Private development (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Private development was occurring on a limited scale within the habitat of the species at the time of listing, and is still occurring at low levels. Between 1993 and 1998, urban development has resulted in the loss of over 480 hectares (194 ha) of sandhills habitat (Service

1998). Construction of private homes, roads, and businesses has removed vegetation and modified soils through excavation, compaction, and disruption of soil horizons (Service 1998). Recent private development has had only a limited effect on the overall habitat and range of the species. One of the secondary effects of destruction and fragmentation of habitat by urban development is the introduction, either intentionally or inadvertently, of non-native plants to adjacent remaining habitat (USFWS, 2012).

Stressor: Recreational threats (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat/loss of individuals

Narrative: Recreational threats identified in the Recovery Plan, including hiking, equestrian use, off-road vehicles, mountain biking, and camping, have resulted in habitat degradation and fragmentation (Service 1998; McGraw 2004b). Mountain bikes and off-highway vehicles continue to pose the greatest recreational threats to sensitive habitat, and have caused extensive damage to suitable habitat - specifically at Henry Cowell Redwoods State Park (McGraw, in litt. 2011). These activities crush and remove vegetation, compact soils, promote soil erosion, and can occasionally result in oil and gasoline spills. Equestrian use, mountain biking, motorcycles and social gatherings that can include bonfires remain ongoing impediments to recovery of the species at Olympia Wellfield and Quail Hollow Quarry (C. Mitcham, in litt. 2011; McGraw 2009b). There is also evidence of people accessing Quail Hollow Quarry for games of paintball (McGraw 2009b). These factors continue to threaten the existence of this species and remain relatively unaddressed at this time (McGraw 2004b; McGraw, in litt. 2011) (USFWS, 2012).

Stressor: Increased vegetation cover (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Increased vegetation cover resulting from fire exclusion was not identified as a major threat at the time of listing, but is one of the most serious ongoing threats to the persistence of *Chorizanthe pungens* var. *hartwegiana* (McGraw 2004b; McGraw, in litt. 2011; T. Hyland, pers. comm. 2011). Encroachment by woody species and litter buildup, in large part stemming from the disruption of natural fire cycles, encourages habitat type conversion (McGraw 2004b). The exclusion of wildfires from sandhill communities results in longer intervals between fire events, and in the sand parkland and northern maritime chaparral communities, this has resulted in increased vegetation cover and heightened competition for space with other species over time. Increased shading due to abundant vegetation cover also may reduce the quality of the habitat for this species. *Chorizanthe pungens* var. *hartwegiana* has the potential to benefit from fire, but little is known about the fire regime to which it is adapted. Ongoing modifications to the sandhills habitat, including widespread invasive species and non-native annual grasses, may impact how *Chorizanthe pungens* var. *hartwegiana* interacts and responds to fire (McGraw 2009b). Furthermore, fire suppression methods, including application of fire retardant, foam, and large amounts of water, can influence how *Chorizanthe pungens* var. *hartwegiana* will recover after a fire, and they may affect the surrounding community assemblage by fertilizing the sandy soil and perhaps providing a competitive advantage to non-native annual grasses and other invasive species (McGraw 2009b) (USFWS, 2012).

Stressor: Disease or Predation (USFWS, 2012)

Exposure:**Response:**

Consequence: Loss of individuals (USFWS, 2012)

Narrative: Disease and predation were not identified as factors at the time of listing, and are not known to currently be factors. Limited herbivory by lepidopteran larvae (caterpillars) on *Chorizanthe pungens* var. *hartwegiana* rosettes and mammalian herbivory on seedlings were personally observed by Jodi McGraw, but do not seem to have a detrimental effect on overall seedling survivorship (McGraw 2004b) (USFWS, 2012).

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2012)

Exposure:**Response:**

Consequence: Loss of habitat

Narrative: Given the existing regulations, we have seen some benefit from the Federal and County regulations to *Chorizanthe pungens* var. *hartwegiana*. Several HCPs have been implemented by private landowners, who are required to mitigate the effects that their actions have on *Chorizanthe pungens* var. *hartwegiana*. The existing regulations can only prevent habitat loss if the HCP requires that landowners avoid habitat or restore degraded habitat (USFWS, 2012).

Stressor: Fire Exclusion (USFWS, 2012)

Exposure:**Response:**

Consequence: Loss of habitat

Narrative: Although not indicated at the time of listing, fire exclusion in Santa Cruz County was leading to encroachment by native woody species and non-native annual grasses threatening habitat type conversion and loss of suitable habitat for *Chorizanthe pungens* var. *hartwegiana*. Fire exclusion allows for the accumulation of understory litter and the establishment of plants with which *Chorizanthe pungens* var. *hartwegiana* cannot compete for light. The result from fire exclusion is a reduction in sand parkland habitat for the *Chorizanthe pungens* var. *hartwegiana* (McGraw 2004b). *Chorizanthe pungens* var. *hartwegiana* experiences reductions in population size as a result of competition with exotic species for open habitat (McGraw 2004b). Research was completed by McGraw (2004b) on various habitat management strategies, including the use of prescribed fire and manual clearing. Management efforts aimed at restoring *Chorizanthe pungens* var. *hartwegiana* habitat should apply these research findings (USFWS, 2012).

Stressor: Stochastic Extinction (USFWS, 2012)

Exposure:**Response:**

Consequence: Extinction

Narrative: Due to its small population and restricted habitat within a narrow geographic range, *Chorizanthe pungens* var. *hartwegiana* is vulnerable to stochastic extinction (Service 1994; McGraw and Levine 1998). Typically, annuals and other monocarpic plants (individuals that die after flowering and fruiting), such as *Chorizanthe pungens* var. *hartwegiana*, are vulnerable to random fluctuations or variation (stochasticity) in annual weather patterns and other environmental factors (Huenneke et al. 1986). A small population size may make it difficult for a species to persist while sustaining other impacts such as habitat alteration that favors non-native species (USFWS, 2012).

Stressor: Climate Change (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, Intergovernmental Panel on Climate Change (IPCC) 2007). *Chorizanthe pungens* var. *hartwegiana*'s small and isolated range increases its vulnerability to random fluctuations in annual weather patterns and environmental disturbances such as can be brought about by climate change. Recently, the potential impacts of climate change on the flora of California were discussed by Loarie et al. (2008). Based on climate modeling, they predicted that species' distributions will shift in response to climate change and that the species will "move" to higher elevations and northward, depending on the ability of each species to do so. In the case of the sandhills ecosystem, which is limited to specific soil types in Santa Cruz County, the opportunities to move to higher elevations or further north are limited. *Chorizanthe pungens* var. *hartwegiana*'s presence at relatively high elevations (90-610 meters (295-2000 feet)) does not make it immediately vulnerable to sea level rise; however, it is susceptible to an altered hydrological regime if changes in the annual precipitation schedule or fog patterns occur. The species requires full access to the sun to survive and reproduce, and an increase in fog cover or too much precipitation can reduce the reproductive capacity of the plant to unsustainably low levels. In general, the scientific community lacks adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors such as limited geographical distribution, will affect species like *Chorizanthe pungens* var. *hartwegiana*. Small-ranged species, such as *Chorizanthe pungens* var. *hartwegiana*, however, are more vulnerable to extinction due to these changing conditions (Loarie et al. 2008) (USFWS, 2012).

Stressor: Nitrogen Deposition (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The coarse nature of Zayante soils contributes to this sandy substrate generally having low moisture and nutrient availability. Traditionally, nitrogen can be one of the limiting nutrients in the sandhills, and increased nitrogen deposition from air pollution and urbanization can threaten the biodiversity of the ecosystem (Weiss 1999). *Chorizanthe pungens* var. *hartwegiana* could be impacted by increased nitrogen deposition, resulting primarily from the combustion of fossil fuels. Nitrogen can fertilize non-native annual grasses, such as rattlesnake grass (*Briza maxima*), rip-gut brome (*Bromus diandrus*), and rattail fescue (*Vulpia myuros*), which exert strong competitive effects on *Chorizanthe pungens* var. *hartwegiana* (McGraw 2004a). Competition with nonnative plants poses the greatest threat to *Chorizanthe pungens* var. *hartwegiana* (Service 1998). At the Bonny Doon Ecological Reserve, the presence of the non-native annual grass *Vulpia myuros* was shown to significantly inhibit the growth and reproductive success of *Chorizanthe pungens* var. *hartwegiana* where they occur together (Pollock 1995) (USFWS, 2012).

Recovery

Reclassification Criteria:

1. The 21 currently known populations have been secured through fee-title acquisition, conservation easements, or Habitat Conservation Plans. (USFWS, 1998)
2. Conservation measures for this species are included in Habitat Conservation Plans (Graniterock Quarry, Kaiser Sand and Gravel Felton Plant, and the County of Santa Cruz) that have been developed and implemented for the listed insect species. (USFWS, 1998)
3. Management plans for populations on Quail Hollow Ranch County Park and the adjacent State-owned parcel, Bonny Doon Ecological Reserve, Henry Cowell Redwoods State Park, Big Basin State Park, and Gray Whale Ranch State Park are developed and being implemented. (USFWS, 1998)
4. Population numbers are stable or increasing. (USFWS, 1998)

Delisting Criteria:

When the downlisting criteria have been met for a species the species can be considered for delisting if: 1. Threats are reduced or eliminated so that populations are capable of persisting without significant human intervention or perpetual endowments are secured for management necessary to maintain the continued existence of the species. (USFWS, 1998)

Recovery Actions:

- 1. Protect habitat for Santa Cruz Mountains species on private land through Habitat Conservation Plans and landowner agreements. Because of the extremely limited amount of habitat that exists, recovery cannot be achieved by the management of State and County lands alone (see task 2). Habitat Conservation Planning with local governments, quarry owners, and developers will provide additional protection. The long-term survival of these species will depend to a large extent on the protection that can be achieved on private lands (USFWS, 1998)
- 2. Manage habitat for Santa Cruz Mountains species. Management of the seven species included in this recovery plan and the habitats that support them will depend on data gathered from monitoring, threat analyses, and available conservation measures. Development and implementation of management programs should be specific to the species complex, ecological process, landowner, and particular threats to be managed. (USFWS, 1998)
- 3. Conduct research on the life history, ecology, and population dynamics of these species that will contribute to appropriate management strategies. Research is needed to ensure that management actions that are undertaken are appropriate and will contribute to the long-term survival of these species and the habitats on which they depend. (USFWS, 1998)
- 4. Locate additional habitat/populations within the historic range of the species. The status of any new populations of these species that are discovered in the future should be evaluated and an assessment made of appropriate management actions. The value to the recovery strategy for these species of any additional habitat that is located should be assessed. (USFWS, 1998)
- 5. Develop and implement a public outreach program. An educational program should be established for the public, including private landowners whose property supports these taxa or suitable habitat, to encourage conservation and proper management of the taxa. Nongovernmental organizations such as the California Native Plant Society and the Santa

Cruz Mountains Biodiversity Task Force should be approached about participating in this effort. (USFWS, 1998)

- 6. Evaluate progress of recovery effectiveness of management and recovery actions and revise management plans. (USFWS, 1998)
- Recommended Action from 2012 5-Year Review: Coordination of recovery partners and consolidation of occurrence data is critical to get a better overview of the current status of *Chorizanthe pungens* var. *hartwegiana* (USFWS, 2012).
- Recommended Action from 2012 5-Year Review: Increased Service oversight as time allows, may accelerate completion of the HCP with the County of Santa Cruz and other management plans under development at Big Basin State Park, Henry Cowell Redwoods State Park, Gray Whale Ranch State Park, Quail Hollow Ranch County Park, and Bonny Doon Ecological Reserve. These plans need to be completed before implementation and effective recovery efforts may begin (USFWS, 2012).
- Recommended Action from 2012 5-Year Review: Surveys and ongoing monitoring should be undertaken to ensure that potential populations are identified and reliable demographic information is collected. These efforts should focus on sandhills habitats identified as population occurrences to clarify whether and where management actions are necessary. In addition, the CNDDDB records should be updated with the most current information available. Specifically, the areas listed in McGraw (2004) as West Lompico, Weston Road, Hilton Drive, Sunset Ridge, Marion, and Landfill Heights; Gray Whale Ranch State Park; and Henry Cowell State Park (USFWS, 2012).
- Recommended Action from 2012 5-Year Review: More detailed knowledge of population occurrences and completion of management plans should allow active management to prevent encroachment of both native and nonnative species in fire-suppressed areas which may lead to type conversion of the habitat and potential extirpation of individual populations. Prescribed burns are the most natural way to restore the vegetation thinning needed to restore open habitat, but in many areas proximity of human habitation precludes this as an option. Mechanical means of vegetation and leaf litter removal (i.e., raking) have proven effective in reducing the chances of habitat type conversion and increased germination rates in *Chorizanthe pungens* var. *hartwegiana* seeds (McGraw, 2004). This method may be used in places where fire would create unacceptable risk to local communities (USFWS, 2012).
- Recommended Action from 2012 5-Year Review: Outreach to owners of private holdings with potentially conservable habitat and populations should be attempted. These parties should be provided with information necessary to facilitate management of habitats on these holdings. These private efforts could prevent habitat type conversion due to encroachment by other species in fire suppressed areas, minimize unnecessary impacts, and could aid in maximizing the conservation potential of all suitable habitat and populations (USFWS, 2012).
- Recommended Action from 2012 5-Year Review: The second criterion for downlisting in the recovery plan should be reworded. The criterion as currently worded lists specific HCPs by name. Many HCP projects are abandoned for various reasons. Additionally, entities listed on HCPs may change name and ownership over time and even requirements may change. These changes may in turn lead to alterations of the HCP title or content. For these reasons, including specific HCPs in draft form as downlisting or delisting criterion should be avoided. A blanket statement reflecting the need of the species to be included in any HCP that covers its geographic area would be more appropriate (USFWS, 2012).

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5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Ventura, California.

SPECIES ACCOUNT: *Chorizanthe pungens* var. *pungens* (Monterey spineflower)

Species Taxonomic and Listing Information

Listing Status: Threatened; 02/04/1994; California/Nevada (R8) (USFWS, 2015)

Physical Description

An annual herb, 5-50 cm tall, somewhat prostrate or slightly ascending. The white to pink flowers (April-July) are subtended by awned bracts and distinctly or indistinctly aggregated into heads, each about 1 cm in diameter. (NatureServe, 2015)

Taxonomy

Accepted by Kartesz (1994 checklist and 1999 floristic synthesis) and Flora of North America (2005); however, not listed specifically as distinct at the varietal level by Hickman (1993). Results from a molecular study indicate that *Chorizanthe pungens* var. *pungens* and *C. robusta* var. *robusta* are more closely related to each another than to the other subspecific taxa in the *C. pungens* and *C. robusta* complex; however, more analysis is needed to determine how this would their taxonomic treatment (Brinegar 2006, Baron and Brinegar 2007, Brinegar and Baron 2008 cited by USFWS 2009). (NatureServe, 2015)

Historical Range

Based on a single collection from 1842, it may have also occurred historically in extreme northern San Luis Obispo County near San Simeon (Flora of North America Editorial Committee 2005; CNPS 2009). (NatureServe, 2015)

Current Range

California, Monterey County, Monterey Peninsula northward to extreme southern Santa Cruz County, and inland into the Salinas Valley. (NatureServe, 2015)

Critical Habitat Designated

Yes; 1/9/2008.

Legal Description

On January 9, 2008, the U.S. Fish and Wildlife Service (Service) designated revised critical habitat for *Chorizanthe pungens* var. *pungens* (Monterey spineflower) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes nine critical habitat units (CHUs), in California (73 FR 1525-1554). The 2008 Rule replaced critical habitat designated on May 28, 2002 (67 FR 37498-37546).

Critical Habitat Designation

The critical habitat designation for *Chorizanthe pungens* var. *pungens* includes nine CHUs in Santa Cruz and Monterey Counties, California. In total, approximately 11,055 acres (ac) (4,475 hectares (ha)) fall within the boundaries of this revised critical habitat designation (73 FR 1525-1554).

Unit 1: Sunset (85 ac (35 ha)): This unit consists of coastal beaches, dunes, and bluffs located west of Watsonville in southern Santa Cruz County. Unit 1 contains space for individual and population growth, including sites for seed dispersal and germination; provides the basic requirements for growth; and includes soils primarily in the coastal beach, dune land, and Baywood sand series (Soil Conservation Service 1978, pp. 13–25; 1980 (maps)) (PCE 1). This unit was occupied at the time of listing (59 FR 5499) and is currently occupied (CNDDDB 2006, California Department of Parks and Recreation (CDPR) 2006a). This unit consists exclusively of State land (85 ac (35 ha)) and is entirely within the boundaries of Sunset State Beach. The unit includes land from Sunset Beach Road south to the gate on Shell Road, just north of the mouth of the Pajaro River, and west of Shell Road, which extends the length of Sunset State Beach. Unit 1 is essential because it supports a large population of *Chorizanthe pungens* var. *pungens* that in some years numbers in the tens of thousands (CNDDDB 2006; CDPR 2006a). The features essential to the conservation of the species may require special management considerations or protection in this unit due threats from invasive, nonnative plants, particularly European beachgrass, which forms dense stands on coastal beaches and crowds out *C. p.* var. *pungens*, and from recreational activities, including camping and foot traffic, which could trample plants.

Unit 2: Moss Landing (250 ac (101 ha)): This unit consists of coastal beaches, dunes, and bluffs to the north and south of the community of Moss Landing in northern Monterey County. Unit 2 contains space for individual and population growth, including sites for seed dispersal and germination; provides the basic requirements for growth; and includes soils in the coastal beach and dune land series (Soil Conservation Service 1978, pp. 13–25) (PCE 1). The northern portion of this unit includes lands owned and managed by the State (which includes portions of Zmudowski State Beach and Moss Landing State Beach between the mouths of the Pajaro River and Elkhorn Slough), 20 ac (8 ha) of private lands, and 6 ac (2 ha) of county lands. The southern portion of this unit includes State lands within Salinas River State Beach. This unit was occupied at the time of listing (59 FR 5499) and was included in the previous critical habitat designation. Herbarium records indicate that this site was occupied as early as 1933, and has remained occupied through time (Consortium of California Herbaria 2006 cites collections by H.S. Bates 1936; T. Craig 1933; and J. Thomas 1950). *Chorizanthe pungens* var. *pungens* was also recently observed in this unit (CDPR 2006b, unpaginated). This unit contains one of only five populations found along the coast, and it may provide connectivity between the Sunset Unit to the north and the Marina Unit to the south. The features essential to the conservation of the species may require special management considerations or protection in this unit due threats from invasive, nonnative plants, particularly ice-plant, which forms dense ground cover on coastal beaches and crowds out *C. p.* var. *pungens*, and from recreational activities including foot traffic, which could trample plants.

Unit 3: Marina (881 ac (357 ha)): This unit consists of coastal beaches, dunes, and bluffs ranging from just south of the mouth of the Salinas River, south to the city of Monterey in northern Monterey County; these lands are entirely west of Highway 1. Unit 3 contains space for individual and population growth, including sites for seed dispersal and germination; provides the basic requirements for growth; and includes soils in the coastal beach, dune land, and Oceano loamy sand soil series (Soil Conservation Service 1978, pp. 13–25, 54–55) (PCE 1). This unit was occupied at the time of listing (59 FR 5499) and it is currently occupied (CNDDDB 2006; CDPR 2006; Service 2002, p. 54). Unit 3 is comprised of State lands, including Marina State Beach and Monterey State Beach. This unit is essential because it supports a population of *Chorizanthe pungens* var. *pungens* that numbers in the thousands in some years (CNDDDB 2006; Service 1998,

p. 67); it is the southernmost of the Monterey Bay area coastal populations; and it may provide connectivity between the populations along the coast and the more interior populations found at former Fort Ord. The features essential to the conservation of the species may require special management considerations or protection in this unit due to threats from invasive, nonnative plants, particularly ice-plant, which forms dense ground cover on coastal beaches and crowds out *C. p. var. pungens*; recreational activities such as foot traffic, which could result in the trampling of plants; and edge effects of urban development.

Unit 4: Asilomar (48 ac (19 ha)): This unit consists of coastal dunes and bluffs near the communities of Pacific Grove and Pebble Beach on the Monterey Peninsula in northern Monterey County. This unit includes a portion of Asilomar State Beach, and extends just beyond Lighthouse Avenue to the north and terminates at the boundary of the Asilomar Conference Grounds. This unit's eastern boundary extends from Highway 68 north along Asilomar Avenue, and then turns west on Arena Avenue where the boundary connects to Sunset Drive. Unit 4 contains space for individual and population growth, including sites for seed dispersal and germination; provides the basic requirements for growth; and includes soils in the coastal beach, dune land, and Baywood sand soil series (Soil Conservation Service 1978, pp. 13–25) (PCE 1). This unit is comprised of 4 ac (1 ha) of Federal lands, 40 ac (16 ha) of State lands at Asilomar State Beach, and 4 ac (2 ha) of local government ownership. This unit was occupied at the time of listing (59 FR 5499) and is currently occupied. Herbarium records that contain specimens from this area include the following (collector and year): Lemmon 1881, L.C. Wheeler 1936, R. Hoover 1941 and 1963, and L.S. Rose 1963 (Consortium of California Herbaria 2006)). This unit currently supports a population of *Chorizanthe pungens* var. *pungens* that numbers in the hundreds (Moss 2000, unpaginated). This unit is essential because it is the southernmost of only five populations of *C. p. var. pungens* along the coast. Preserving the genetic characteristics that have allowed individuals at this site to survive at the southern end of the species' range along the coast is essential to the long-term survival and conservation of *C. p. var. pungens*. Protecting peripheral or isolated populations is necessary because they may contain genetic variation not found in core populations. The genetic variation results from the effects of population isolation and adaptation to locally distinct environments (Lesica and Allendorf 1995, pp. 754–757; Fraser 2000, pp. 49– 51; Hamrick and Godt 1996, pp. 291– 295). The features essential to the conservation of the species may require special management considerations or protection in this unit due to threats from invasive, nonnative plants, particularly ice-plant, which forms dense ground cover on coastal beaches and crowds out *C. p. var. pungens*; recreational activities such as foot traffic which could trample plants; and edge effects of urban development. An additional threat in this unit is the expansion of unregulated vehicle parking in the dunes associated with the high numbers of visitors this area receives each year.

Unit 5: Freedom Boulevard (24 ac (10 ha)): This unit consists of grassland, maritime chaparral, and oak woodland habitat near the western terminus of Freedom Boulevard and northeast of Highway 1 in Santa Cruz County. This unit consists entirely of private lands (24 ac (10 ha)). Unit 5 contains space for individual and population growth, including sites for seed dispersal and germination; provides for the basic requirements for growth; and includes soils in the Baywood sand and Ben Lomond sandy loam series (Soil Conservation Service 1980, pp. 64–65; maps) (PCE 1). This unit was occupied at the time of listing (59 FR 5499) and is currently occupied (CNDDB 2006, element occurrences (EOs) 32 and 34; Morgan 2006, unpaginated). This unit currently supports a population of *Chorizanthe pungens* var. *pungens* that numbers in the thousands in favorable years, but many fewer in unfavorable years (CNDDB 2006, EOs 32, 34). This unit is

essential because it is the northernmost known occurrence. In the absence of genetic data, protecting populations at the boundaries of a taxon's range is necessary because they may contain genetic variation not found in core populations. The genetic variation results from the effects of population isolation and adaptation to locally distinct environments (Lesica and Allendorf 1995, pp. 754–757; Fraser 2000, pp. 49–51; Hamrick and Godt 1996, pp. 291–295). The features essential to the conservation of the species may require special management considerations or protection in this unit due to threats from invasive, nonnative plants, particularly annual grasses that crowd out *C. p. var. pungens*, and from edge effects of urban development.

Unit 6: Manresa (94 ac (38 ha)): This unit consists of coastal bluffs along the immediate coast, south of Seacliff State Beach and north of Sunset State Beach in Santa Cruz County. Unit 6 contains space for individual and population growth, including sites for seed dispersal and germination; provides the basic requirements for growth; and includes soils in the coastal beach, Baywood sand, and Elder sandy loam series (Soil Conservation Service 1980, pp. 11–70, maps) (PCE 1). This unit is comprised entirely of lands owned and managed by the State at Manresa State Beach. This unit was occupied at the time of listing (59 FR 5499) and is currently occupied. This unit is essential because it is the most northerly population that is known from the immediate coast and provides connectivity to populations in the Sunset Unit to the south. The features essential to the conservation of the species may require special management considerations or protection in this unit due to threats from invasive, nonnative plants and from recreational activities such as foot traffic, which could trample plants.

Unit 7: Prunedale (190 ac (77 ha)): This unit consists of grassland, maritime chaparral, and oak woodland in the area around Prunedale in northern Monterey County. On the west side of Highway 101, the unit includes the Manzanita County Park subunit located between Castroville Boulevard and San Miguel Canyon Road. On the east side of Highway 101, the unit consists of four additional subunits. The five subunits support similar plant communities and need similar types of special management; therefore, we discuss them as a unit. Unit 7 contains space for individual and population growth, including sites for seed dispersal and germination; provides the basic requirements for growth; and includes soils in the Arnold loamy sand, Santa Ynez fine sandy loam, and Arnold-Santa Ynez complex series (Soil Conservation Service 1978, pp. 9–11, 72–73) (PCE 1). This unit consists of 155 ac (63 ha) of State lands, 18 ac (7 ac) of local agency lands (Manzanita County Park), and 17 ac (7 ha) of Pacific Gas and Electric easement lands. This unit was occupied at the time of listing, was included in our listing rule in reference to the Prunedale area (59 FR 5499), and is currently occupied (Caltrans 2001; Consortium of California Herbaria 2006). This unit is essential because it is one of only four units that are known to support populations in maritime chaparral and oak woodland habitats more representative of hotter, interior sites and is the easternmost of the units in the interior hills. The features essential to the conservation of the species may require special management considerations or protections in this unit due to threats from invasive, nonnative plants, which crowd out *Chorizanthe pungens* var. *pungens*; edge effects from urban development; and recreational activities such as off road vehicles, which can crush plants and destroy seeds.

Unit 8: Fort Ord (9,432 ac (3,817 ha)): This unit consists of grassland, maritime chaparral, coastal scrub, and oak woodland on the former Department of Defense base at Fort Ord, east of the city of Seaside in northern Monterey County. This unit is entirely within the area formerly known as Fort Ord, bounded by Highway 1 on the northwest, the Salinas River to the east, and Monterey-

Salinas Road (Highway 68) on the south. Approximately 87 percent of this critical habitat unit is Federal land (8,172 ac (3,307 ha)) managed by BLM and the Army, 6 percent is State land (606 ac (245 ha)), and 7 percent is under local jurisdictions (654 ac (265 ha)). Portions of Fort Ord have been transferred to BLM; University of California, California State University at Monterey Bay; and local (city and county) jurisdictions. All of the lands included in this unit are designated as current or future habitat reserves under the Army's habitat management plan (Corps 1997, Attachment A map; Zander Associates 2002, Figures 4–6). About one-half of Unit 8 still must be cleaned of environmental contaminants by the Army before it can be transferred to BLM. Unit 8 contains space for individual and population growth, including sites for seed dispersal and germination; provides the basic requirements for growth; and includes soils in the Arnold-Santa Ynez complex, Baywood sand, and Oceano loamy sand series (Soil Conservation Service 1978, pp. 9–73). Lands in this unit are intended to be managed at a landscape scale, using prescribed fire, as needed, to maintain a range of different-aged maritime chaparral stands (Corps 1997, pp. 4.24–4.25), and by doing so preserve substantial populations of rare maritime chaparral species in the Monterey Bay area. This unit was occupied at the time of listing (59 FR 5499) and is currently occupied. This unit is essential because it currently supports multiple large populations of *Chorizanthe pungens* var. *pungens* that number in the tens of thousands in some years (CNDDDB 2006, EO 2; Jones and Stokes 1992, Figure F–3; BLM 2006), and it is one of only five units that include maritime chaparral and oak woodland habitats more representative of hotter, interior sites. The features essential to the conservation of the species may require special management considerations or protection in this unit due to threats from invasive species that crowd out *C. p.* var. *pungens*, munitions clean-up methods on former ranges that remove and chip all standing vegetation, and recreational activities and road and trail maintenance that could trample plants.

Unit 9: Soledad (51 ac (21 ha)): This unit consists of an interior dune in the floodplain of the Salinas River channel just south of the city of Soledad in central Monterey County on privately owned lands. Unit 9 contains space for individual and population growth, including sites for seed dispersal and germination; provides the basic requirements for growth; and includes soils in the dune land and Metz complex soil series (Soil Conservation Service 1978, pp. 24, 48–49) (PCE 1). This unit was occupied at the time of listing (59 FR 5499) and is currently occupied. Approximately 5,000 plants were observed in this unit in 1994 (CNDDDB 2006, EO 28; Wesco 1994, pp. 5–8). This unit is essential because it is the southernmost interior location that supports a population and the only unit where *Chorizanthe pungens* var. *pungens* grows in interior floodplain dune habitat. This population is geographically remote from all others in this revised critical habitat designation. Protecting peripheral or isolated populations of rare species is highly desirable because they may contain genetic variation not found in core populations (Lesica and Allendorf 1995, pp. 755–757). The features essential to the conservation of the species may require special management considerations or protection in this unit due to threats from invasive, nonnative plants, which crowd out *C. p.* var. *pungens*; overspray of herbicides and pesticides from agricultural operations; and vegetation clearing activities associated with road maintenance.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The primary constituent element of critical habitat for *Chorizanthe pungens* var. *pungens* (73 FR 1525-1554) is a vegetation structure arranged in a mosaic with openings between the dominant elements (e.g., scrub, shrub, oak trees, or clumps of

herbaceous vegetation) that changes in spatial position as a result of physical processes such as windblown sands and fire and that allows sunlight to reach the surface of the following sandy soils: coastal beaches, dune land, Baywood sand, Ben Lomond sandy loam, Elder sandy loam, Oceano loamy sand, Arnold loamy sand, Santa Ynez fine sandy loam, Arnold—Santa Ynez complex, Metz complex, and Metz loamy sand.

Special Management Considerations or Protections

Critical habitat does not include manmade structures (such as buildings, aqueducts, airports, and roads) and the land on which such structures are located, existing within the legal boundaries on the effective date of this rule.

Life History**Food/Nutrient Resources****Breeding Season**

Adult: March to June (USFWS, 2009)

Reproduction Narrative

Adult: *Chorizanthe pungens* var. *pungens* is a prostrate annual species in the buckwheat family (Polygonaceae). Flowering occurs from late March to June, depending on weather patterns, and seed is dispersed in mid-summer. *Chorizanthe pungens* var. *pungens* plants produce a maximum of one seed per flower and, depending on the vigor of the plant, produce dozens of seeds per plant (Fox et al. 2006). (USFWS, 2009)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest Edge, Forest/Woodland, Grassland/herbaceous, Old field, Sand/dune, Savanna, Shrubland/chaparral, Woodland - Hardwood (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Mild maritime climate, characterized by fog and winter rains (USFWS, 1998)

Geographic or Habitat Restraints or Barriers

Adult: Found in open areas: openings between shrubs, roadsides, firebreaks, and a heavily disturbed firing range. (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Scattered (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (inferred from USFWS, 2009)

Habitat Narrative

Adult: *Chorizanthe pungens* var. *pungens* is found scattered on sandy soils within coastal and near-coastal dune, coastal scrub, grassland, maritime chaparral, and oak woodland

communities. Found in open areas: openings between shrubs, roadsides, firebreaks, and a heavily disturbed firing range. This plant occurs in areas of relatively mild maritime climate, characterized by fog and winter rains. The fog helps keep summer temperatures cool and winter temperatures relatively warm, and provides moisture in addition to the normal winter rains. Other plants associated with this species include beach-bur (*Ambrosia chamissonis*), coastal sagewort (*Artemisia pycnocephala*), and mock heather (*Ericameria ericoides*). (USFWS, 1998; NatureServe, 2015)

Dispersal/Migration**Motility/Mobility**

Adult: High (inferred from USFWS, 2009)

Dispersal

Adult: High (inferred from USFWS, 2009)

Dependency on Other Individuals or Species for Dispersal

Adult: Animals (USFWS, 2009)

Dispersal/Migration Narrative

Adult: Seed dispersal in *C. p. var. pungens* is likely facilitated by hooked spines on the structure surrounding the seed. In the *Chorizanthe* genus, these are believed to attach to passing animals and disperse seeds between plant colonies and populations (Reveal 2001). Wind also likely disperses seeds within colonies and populations. (USFWS, 2009)

Population Information and Trends**Population Trends:**

Declining

Resiliency:

Moderate (inferred from USFWS, 2009)

Redundancy:

Moderate (inferred from USFWS, 2009)

Number of Populations:

~18 (NatureServe, 2015)

Population Size:

200,000 to 2,000,000 (USFWS, 1998)

Adaptability:

Moderate (USFWS, 2009)

Population Narrative:

Approximately 18 occurrences observed since 1989 (CNDDDB 2008). Populations in the hills between Watsonville and Aptos are small, declining, and have been impacted by developments

throughout the 1990s (Hayes and Taylor 2006). *C. pugnens* var. *pugnens* has the ability to recolonize sites when invasive plants are removed if there is a seed source (USFWS 2009). The original survey used large blocks of habitat and the calculations included closed canopy blocks of woody vegetation. The reduction in estimated occupied habitat yields a population between 200,000 and 2,000,000 individuals. (USFWS, 1998; USFWS, 2009; NatureServe, 2015)

Threats and Stressors

Stressor: Development for residential, commercial and industrial uses (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Conversion of lands for urban development continues in the Monterey Bay area. Development projects have been proposed or approved in the last 5 years that would remove or fragment habitat of *Chorizanthe pugnens* var. *pugnens* in the Prunedale Hills (e.g., the Prunedale Improvement Project, Pesante Canyon developments), coastal region (e.g., at Armstrong Ranch, Monterey Airport), and on the Monterey Peninsula (e.g., at Pebble Beach) (Lowe 2001, Monterey County 2005, California Department of Transportation (Caltrans) 2005, City of Marina 2007, Rana Creek Habitat Restoration 2007). Development is also planned within the boundaries of the 28,000-acre former Fort Ord military base in Monterey County. On former Fort Ord, *Chorizanthe pugnens* var. *pugnens* is found in maritime chaparral, coastal sage scrub, and in openings in oak woodland. It occurs on parcels designated for development and habitat reserve, as well as in the margins of areas to be redeveloped. (USFWS, 2009)

Stressor: Recreation (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: *Chorizanthe pugnens* var. *pugnens* requires open sandy habitat in which to grow, so it consequently colonizes openings along roads and trails and may colonize trail beds, if use is infrequent. In at least one State Park site, at Sunset State Beach where recreational use was previously heavy, new barriers have been introduced to funnel recreational traffic and allow *C. p. var. pugnens* to expand into the area from nearby occurrences (State Parks 2006a). Grading of trails (e.g., at former Fort Ord) may also diminish populations. However, on Fort Ord Public Lands, BLM hopes to maintain adequate open space along the margins of trails and thereby retain trail use by people and continued occupancy by *C. p. var. pugnens* along trail margins (BLM 2003). It appears that light recreational use, such as foot traffic, maintains more open habitat suitable for *C. p. var. pugnens*, but excludes the taxon where traffic is frequent during the growing season. (USFWS, 2009)

Stressor: Dune stabilization (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Non-native species were introduced for dune stabilization and subsequently, compete for habitat with *C. pugnens* var. *pugnens*. (USFWS, 2009)

Stressor: Land ownership (USFWS, 2009)

Exposure:**Response:****Consequence:**

Narrative: The dune scrub habitat of *Chorizanthe pungens* var. *pungens* is protected from development at numerous coastal locations. In Santa Cruz County, populations occur at Sunset State Beach and Manresa State Beach. In Monterey County, coastal populations occur along the Monterey Bay on preserved lands at Zmudowski, Moss Landing, Salinas River, Marina, Monterey, and Asilomar State Beaches, the latter of which is on the Monterey Peninsula near the southern end of this taxon's extant range (Moss 2000, State Parks 2006b, CNDDDB 2007). The interior occurrences in Santa Cruz County (e.g., Freedom Boulevard and Bel Mar areas (Service 2002: 67 FR 37498)), which are not discussed in the specific recovery criteria above, are not secure from development. In northern Monterey County in the Prunedale Hills, populations occur on easements owned by Pacific Gas and Electric, on private lands, on lands owned or managed by conservation-oriented organizations such as the Elkhorn Slough Foundation, at a County Park, and on State lands managed by the California Department of Transportation (Caltrans). The eventual use of the Caltrans land has not been determined (Siepel pers. comm. 2004; Robison 2006). *Chorizanthe pungens* var. *pungens* also occurs at numerous places on former Fort Ord, a closed military base and Superfund site that is being cleaned and planned for reuse. The population in a river dune near Soledad is privately owned and represents the southernmost interior population known to be extant. (USFWS, 2009)

Stressor: Invasive non-native species (USFWS, 2009)

Exposure:**Response:****Consequence:**

Narrative: The final rule identifies competition from invasive nonnative species, such as the iceplants (sea-fig) (*Carpobrotus edulis*, *Mesembryanthemum crystallinum*), and European beach grass (*Ammophila arenaria*), as a threat to this taxon (59 FR 5499). These species are particularly adept at colonizing dune sands and several of them have been used in California to promote dune stabilizations (Albert 2000). Invasive nonnative species remain a threat to *Chorizanthe pungens* var. *pungens*. In addition to the species noted in the final rule, others that have invaded maritime chaparral and coastal sage scrub where *C. p.* var. *pungens* occurs include jubata grass (*Cortaderia jubata*), French broom (*Genista monspessulana*), and invasive annual grasses of European origin, such as wild oats (*Avena* sp.), soft chess (*Bromus hordeaceus*), and riggut brome (*Bromus diandrus*) (BLM 2003, Parsons 2004, Fusari and McStay 2007). These latter species are typically able to colonize disturbed sites with more well-developed soils than occur on dunes. In addition to the direct effects that invasive, non-native plant species may have on *Chorizanthe pungens* var. *pungens*, *Chorizanthe* species may be indirectly affected by these species via diminished pollinator visitation. Many of the hymenopteran pollinators important to *Chorizanthe* pollination (e.g., sphecids wasps, bumblebees, and bees from the families Halictidae and Anthophoridae), require bare ground for nesting (Murphy 2003). (USFWS, 2009)

Stressor: Climate change (USFWS, 2009)

Exposure:**Response:****Consequence:**

Narrative: Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer

continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). Beaches along the coast will be subject to greater and more frequent wave attack, resulting in erosion and shoreline retreat (CCC 2001). The extent to which such events are caused by climate change and the extent to which it could affect *Chorizanthe pungens* var. *pungens* are unknown at this time. (USFWS, 2009)

Recovery

Reclassification Criteria:

Reclassification criteria are not available.

Delisting Criteria:

1. The Fort Ord disposal and reuse process has led the management agencies to develop, fund, and implement permanent protection plans for the species' habitat including permanent iceplant suppression programs. (USFWS, 2009)

2. Beach-dune occurrences on State Park and private lands throughout its current range from Santa Cruz to the Monterey Peninsula are covered under a permanent protection plan. Plans at the time of writing to conserve roughly 60 percent of Fort Ord appear sufficient for recovery of the interior occurrence. A reassessment would be made should plans call for conservation of less habitat. Existing management along the coast at the State Parks units needs to be supplemented with protection and management on private lands to be determined after a thorough analysis of the beach populations. (USFWS, 2009)

Recovery Actions:

- Protect habitat of the listed species and their occurrences on private lands by informing landowners and consulting with local lead agencies (USFWS, 1998)
- Minimize threats to the plants by minimizing the threats from invasive non-native plants and threats on private and public lands. (USFWS, 1998)
- Develop management strategies through a research program to document the listed species' life histories and their responses to vegetation management. (USFWS, 1998)
- Develop and implement management practices for the occurrences and habitat of *Chorizanthe pungens* var. *pungens* by establishing a working group to collaborate with private and public landowners and appropriate agencies to develop specific management guidelines. (USFWS, 1998)
- Monitor occurrences and threats to determine effectiveness of management and to establish delisting criteria including trends, effectiveness of reduce threats, and survey likely habitat for additional occurrences.
- Coordinate recovery actions to protect other listed species and species of special concern.
- Develop and implement an outreach program

Conservation Measures and Best Management Practices:

- The criteria should be revised to identify the importance of having protected populations in the interior north (Santa Cruz) and central (Prunedale Hills) portions of this taxon's range.
- Encourage the State to establish a permanent protection and management mechanism for the Caltrans managed lands in the Prunedale Hills.
- Continue to support and partner with organizations, agencies, and individuals to preserve, restore, and enhance lands on which this taxon occurs.

- Develop a Memorandum of Understanding or coordinate with land managers on other mechanisms (e.g., a set of management actions within a management plan) that would meet the recovery criterion of ensuring adequate management (primarily control of nonnative species and maintaining openings in native vegetation) on lands that support *Chorizanthe pungens* var. *pungens*.
- The current recovery criteria call for 15 years of monitoring. Coordinate with land managers to determine the most efficient means to implement and document adequate monitoring to ensure that the general trend or persistence of the populations is being tracked. Focus surveys and monitoring in years of high rainfall when the extent of its distribution is most likely to be apparent.

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SPECIES ACCOUNT: *Chorizanthe robusta* var. *hartwegii* (Scotts Valley spineflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/07/1994; California/Nevada Region (Region 8)

Physical Description

An annual species in the buckwheat family. The plant grows to 3 decimeters (12 inches) high and has an erect rather than prostrate habit. The rose-pink color on the margins of the bracts below the flowers is confined to the basal portion of the teeth. The medium-sized heads (1.0—1.5 centimeters in diameter) are distinctly clustered. (USFWS, 1998)

Taxonomy

Previously known as Hartweg's spineflower. The systematics of the species comprising *Chorizanthe* are difficult and confusing (Reveal and Hardham 1989; Hickman 1993). The Service funded research on the phylogenetic relationships of the *Chorizanthe robusta*/*Chorizanthe pungens* complex. Using molecular techniques, Brinegar and Baron (2008) determined the following: (1) *Chorizanthe robusta* var. *robusta* is more closely related to *Chorizanthe pungens* var. *pungens* (Monterey spineflower, threatened) than to *Chorizanthe robusta* var. *hartwegii*; (2) *Chorizanthe robusta* var. *hartwegii* is more closely related to *Chorizanthe pungens* var. *hartwegiana* (Ben Lomond spineflower, endangered) than to *Chorizanthe robusta* var. *robusta*; and (3) these four taxa comprise a number of geographically-close populations in ecologically-different habitats, and although they are generally morphologically distinct (except in some cases at the extremes of their ranges), the genetic differences are small. In brief, Brinegar and Baron (2008) suggested that systematists consider recognizing *Chorizanthe robusta* (inclusive of *Chorizanthe robusta* var. *robusta* and *Chorizanthe robusta* var. *hartwegii*) and *Chorizanthe pungens* (inclusive of *Chorizanthe pungens* var. *pungens* and *Chorizanthe pungens* var. *hartwegiana*) as a single species while retaining variety designations. (USFWS, 2009)

Historical Range

See current range/distribution.

Current Range

Scotts Valley, Santa Cruz County, California. (USFWS, 2019b)

Critical Habitat Designated

Yes; 6/28/2002.

Legal Description

On May 29, 2002, the U.S. Fish and Wildlife Service (Service), designated critical habitat (effective 6/28/2002) pursuant to the Endangered Species Act of 1973, as amended (67 FR 37336 - 37353), for *Chorizanthe robusta* var. *hartwegii* (Scotts Valley spineflower). Approximately 116 hectares (287 acres) of land fall within the boundaries of the critical habitat designation located in Santa Cruz County, California.

Critical Habitat Designation

The critical habitat designation for *Chorizanthe robusta* var. *hartwegii* includes two units totaling 297 acres in Santa Cruz County, California. The units are 1. Glenwood Unit and 2. Polo Ranch Unit. Brief descriptions are presented below. Detailed coordinates and maps depicting the CH units are available in the Final Rule (67 FR 37336 - 37353).

Unit 1: Glenwood Site. Unit 1 consists of approximately 87 ha (214 acres) to the west of Glenwood Drive and north and northwest of Casa Way, in the City of Scotts Valley, including land owned and managed by the Salvation Army, land owned and managed by the Scotts Valley High School District as a preserve, but excluding the rest of the High School, and to the east of Glenwood Drive, encompassing the parcel known as the Glenwood Development. (USFWS, 2002)

Unit 2: Polo Ranch Site. The Polo Ranch site consists of approximately 30 ha (73 ac) to the east of Carbonera Creek on the east side of Highway 17 and north and northeast of Navarra Drive, in the City of Scotts Valley, known as the Polo Ranch, in the County of Santa Cruz, California. (USFWS, 2002)

Primary Constituent Elements/Physical or Biological Features

The primary constituent elements of critical habitat for *Chorizanthe robusta* var. *hartwegii* are the habitat components that provide:

- (i) Thin soils in the Bonnydoon series that have developed over outcrops of Santa Cruz mudstone and Purisima sandstone;
- (ii) “Wildflower field” habitat that has developed on these thin-soiled sites;
- (iii) A grassland plant community that supports the “wildflower field” habitat, that is stable over time and in which nonnative species are absent or are at a density that has little or no adverse effect on resources available for growth and reproduction of *Chorizanthe robusta* var. *hartwegii*;
- (iv) Sufficient areas around each population to allow for recolonization to adjacent suitable microhabitat sites in the event of catastrophic events;
- (v) Pollinator activity between existing colonies of *Chorizanthe robusta* var. *hartwegii*;
- (vi) Seed dispersal mechanisms between existing colonies and other potentially suitable sites; and
- (vii) Sufficient integrity of the watershed above habitat for *Chorizanthe robusta* var. *hartwegii* to maintain soil and hydrologic conditions that provide the seasonally wet substrate for growth and reproduction.

Special Management Considerations or Protections

Existing features and structures, such as buildings, roads, railroads, airports, other paved areas, lawns, and other urban landscaped areas, do not contain one or more of the primary constituent elements. Federal actions limited to those areas, therefore, would not trigger a consultation under section 7 of the Act unless they may affect the species and/or primary constituent elements in adjacent critical habitat.

The most likely kinds of special management and protection that *C. r. var. hartwegii* may require are: (1) The soils on which *Chorizanthe robusta* var. *hartwegii* is found should be maintained to optimize conditions for its persistence. Physical properties of the soil, such as its chemical composition, surface crust, and drainage capabilities would best be maintained by limiting or restricting the use or application of herbicides, fertilizers, or other soil amendments. (2) Overspray from irrigation or saturation of soils beyond the normal season should also be avoided, as this may alter the structure and composition of the grassland community, or render the native species more vulnerable to pathogens found in wetter soil regimes. (3) The associated plant communities must be maintained to ensure that the habitat needs of pollinators and seed dispersal agents are maintained. For pollinators, the use of pesticides should be limited or restricted so that healthy populations of pollinators are present to effect seed set in *Chorizanthe robusta* var. *hartwegii*. For dispersal agents, the fragmentation of habitat through construction of roads and certain types of fencing should be limited so that these agents may disperse seed of *C. r. var. hartwegii* throughout the unit. (4) Within the grassland community where *Chorizanthe robusta* var. *hartwegii* occurs, invasive, non-native species such as bromes and other species may need to be actively managed to maintain the patches of open habitat that *C. r. var. hartwegii* needs. (5) Certain areas where *Chorizanthe robusta* var. *hartwegii* occurs may need to be fenced to protect it from accidental or intentional trampling by humans and livestock. While *C. r. var. hartwegii* appears to withstand light to moderate disturbance, heavy disturbance may be detrimental to its persistence. Seasonal exclusions may work in certain areas to protect *C. r. var. hartwegii* during its critical season of growth and reproduction.

Life History**Food/Nutrient Resources****Lifespan**

Adult: 1 year (USFWS, 2009)

Breeding Season

Adult: April to June (USFWS, 2009)

Reproduction Narrative

Adult: In general, the plants germinate during the winter, flower from April to June, dry and turn a rusty hue during the summer, and eventually break apart during the fall. Depending on vigor of individual plants, dozens to possibly hundreds of seeds are produced per plant, with seed maturation by August. The plants occur in full sun (Reveal and Morgan 1989). (USFWS, 2009)

Habitat Type

Adult: Terrestrial (USFWS, 2009)

Habitat Vegetation or Surface Water Classification

Adult: Exposed bedrock (USFWS, 2009)

Dependencies on Specific Environmental Elements

Adult: Full sun (USFWS, 2009)

Geographic or Habitat Restraints or Barriers

Adult: 213 to 244 m elevation (700 to 800 ft) (Hinds and Morgan 1995), and approximately 11 km (7 mi inland from the coast (USFWS, 2009)

Spatial Arrangements of the Population

Adult: Colonies (USFWS, 2009)

Environmental Specificity

Adult: Narrow/specialist (inferred from USFWS, 2009)

Dependency on Other Individuals or Species for Habitat

Adult: Wildflower fields (USFWS, 2009)

Habitat Narrative

Adult: The plants occur only on patches of exposed bedrock (Santa Cruz mudstone, Purisima sandstone) overlain with a thin layer of soil in fragmented islands of annual grasslands (Reveal and Morgan 1989, Service 1994) at Scotts Valley in the Santa Cruz Mountains. In the Scotts Valley area, the grasslands are generally on the middle to lower slopes within the sub-watersheds, while the higher slopes support redwood (*Sequoia sempervirens*) and mixed forest (Service 2003). The species occurs at 213 to 244 m elevation (700 to 800 ft) (Hinds and Morgan 1995), and approximately 11 kilometers (7 miles) inland from the coast. The plants occur in full sun (Reveal and Morgan 1989). The taxon grows in colonies in wildflower fields associated with the following native species: *Arenaria californica* (California sandwort), *Arenaria douglasii* (Douglas' stitchwort), *Calochortus luteus* (yellow mariposa lily), *Clarkia purpurea* (winecup clarkia), *Corethrogyne filaginifolia* (common sandaster), *Gilia clivorum* (purplespot gilia), *Hemizonia corymbosa* (coastal tarweed), *Lasthenia californica* (California goldfields), *Lepidium nitidum* (shining pepperweed), *Lomatium caruifolium* (alkali desertparsley), *Lotus purshianus* (American bird'sfoot trefoil), *Lupinus nanus* (sky lupine), *Navarretia atractyloides* (hollyleaf pincushionplant), *Castilleja densiflora* (denseflower Indian paintbrush), *Polygonum hickmanii* (Scotts Valley polygonum), *Trifolium albopurpureum* (rancheria clover), *Trifolium barbigerum* (Andrews' clover), *Trifolium depauperatum* (cowbag clover), and *Trichostema lanceolatum* (vinegarweed) (Reveal and Morgan 1989, Service 2002). (USFWS, 2009)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Decreasing to stable (USFWS, 2019b)

Number of Populations:

3 (USFWS, 2019b)

Population Size:

Total estimated at approximately 35,000 individuals (USFWS, 2019b)

Population Narrative:

The geographic range comprises approximately 1.6 square kilometers (0.6 square mile), with three occurrences (mapped colonies within 0.25 mi of each other) on five properties: Salvation Army land, Scotts Valley High School Ecological Preserve, the Glenwood Open Space Preserve, Polo Ranch, and a private parcel. The total occupied area is less than 0.4 hectare (1 acre) (Service 2002). In our 2009 5-Year Review, we determined that, in light of the observed decline in numbers of individuals and the extirpation of some colonies since 1992, the abundance of *Chorizanthe robusta* var. *hartwegii* is decreasing. In 2018, the best available information indicates that three of the five sites known for the species are declining, one appears stable to increasing, and the status of one site is unknown. (USFWS, 2019b)

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: The threat of development has been removed at the Scotts Valley High School Ecological Preserve and the Glenwood Open Space Preserve. At the Scotts Valley High School Ecological Preserve there is an agreement to manage the land in perpetuity for the Scotts Valley spineflower and other biological resources. The Glenwood Open Space Preserve is held in a conservation easement by the Land Trust of Santa Cruz County and is managed to preserve the Scotts Valley spineflower and other biological resources and an endowment has been established that funds management actions. Development of the areas where Scotts Valley spineflower occurs at Polo Ranch is prohibited by the City of Scotts Valley's permit for the adjacent housing development, but the species cannot be considered protected from developmental disturbance and other threats until a conservation easement is finalized and a funded management plan is established. The colonies on Salvation Army land and private land are not protected and remain threatened by the possibility of development, though habitat management at the Salvation Army colonies was recently initiated through an informal agreement. All known occurrences remain threatened by stochastic extinction, invasive species, and climate change. (USFWS, 2019b)

Stressor: Stochastic extinction (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Stochastic extinction is a threat because *Chorizanthe robusta* var. *hartwegii* is an annual plant that is restricted to a habitat of limited distribution within a small geographic area and its populations are small and isolated. In this situation, naturally occurring events can cause extinction through mechanisms operating at the genetic level (e.g., decrease in genetic variability), the population level (e.g., lack of ability to attract pollinators because of few individuals), or the landscape level (e.g., storms, drought, fire) (Service 2003). (USFWS, 2009)

Stressor: Invasive species and competitive native species (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Much of the previously native grassland is now occupied by invasive grasses, which are now a threat to *Chorizanthe robusta* var. *hartwegii* on all four properties. In particular, much of the habitat on the Scotts Valley High School Preserve is now occupied by non-native grasses, which must be mowed to reduce adverse effects to this species and *Polygonum hickmanii*. At Polo Ranch, competitive native species are also threatening *Chorizanthe robusta* var. *hartwegii* and its habitat. (USFWS, 2009)

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, Intergovernmental Panel on Climate Change 2007). While we lack adequate information to make specific and accurate predictions regarding how climate change in combination with other factors such as small population size will affect *Chorizanthe robusta* var. *hartwegii*, small-ranged species are more vulnerable to extinction due to these changing conditions (Loarie et al. 2008). (USFWS, 2009)

Recovery

Reclassification Criteria:

1. All four parcels of private land that support the Scotts Valley spineflower have permanent conservation easements or have been acquired. (USFWS, 1998)
2. Conservation measures for the Scotts Valley spineflower are included in a Habitat Conservation Plan with the City of Scotts Valley. (USFWS, 1998)
3. Population numbers are stable or increasing. (USFWS, 1998)

Delisting Criteria:

When the downlisting criteria have been met for a species, the species can be considered for delisting if: (USFWS, 2019a) 1. Threats are reduced or eliminated so that populations are capable of persisting without significant human intervention or perpetual endowments are secured for management necessary to maintain the continued existence of the species; (USFWS, 2019a)

2. An ex situ seedbank is maintained in a Center for Plant Conservation-affiliated botanic garden. While sufficient seedbank in the soil would typically provide a strategy for the taxon to persist through several years of short- or medium-term drought, it may not be sufficient to persist through long-term drought. Therefore, an ex situ seedbank would provide assurance that a population could be reseeded, should long-term drought – or other stochastic events – make it necessary; (USFWS, 2019a)

3. All existing populations are stable or increasing in the wild for at least 10 years. We expect above-ground population size to fluctuate annually in response to amount and timing of rainfall (e.g. see Fox et al. 2006). Therefore, a period of 10 years should be long enough to include most

of the variability in rainfall that occurs in this region (Zedler & Black 1989; NOAA 2018). (USFWS, 2019a)

Recovery Actions:

- 1. Protect habitat for Santa Cruz Mountains species on private land through Habitat Conservation Plans and landowner agreements. Because of the extremely limited amount of habitat that exists, recovery cannot be achieved by the management of State and County lands alone (see task 2). Habitat Conservation Planning with local governments, quarry owners, and developers will provide additional protection. The long-term survival of these species will depend to a large extent on the protection that can be achieved on private lands (USFWS, 1998)
- 2. Manage habitat for Santa Cruz Mountains species. Management of the seven species included in this recovery plan and the habitats that support them will depend on data gathered from monitoring, threat analyses, and available conservation measures. Development and implementation of management programs should be specific to the species complex, ecological process, landowner, and particular threats to be managed. (USFWS, 1998)
- 3. Conduct research on the life history, ecology, and population dynamics of these species that will contribute to appropriate management strategies. Research is needed to ensure that management actions that are undertaken are appropriate and will contribute to the long-term survival of these species and the habitats on which they depend. (USFWS, 1998)
- 4. Locate additional habitat/populations within the historic range of the species. The status of any new populations of these species that are discovered in the future should be evaluated and an assessment made of appropriate management actions. The value to the recovery strategy for these species of any additional habitat that is located should be assessed. (USFWS, 1998)
- 5. Develop and implement a public outreach program. An educational program should be established for the public, including private landowners whose property supports these taxa or suitable habitat, to encourage conservation and proper management of the taxa. Nongovernmental organizations such as the California Native Plant Society and the Santa Cruz Mountains Biodiversity Task Force should be approached about participating in this effort. (USFWS, 1998)
- 6. Evaluate progress of recovery effectiveness of management and recovery actions and revise management plans. (USFWS, 1998)
- Recommendations for Future Actions from 2019 5-Year Review: There is no opportunity to expand the range of Scotts Valley spineflower due to naturally restrictive habitat requirements and a lack of existing suitable habitat due to surrounding development. The persistence of the remaining occurrences is therefore necessary for the recovery of the species. Any additional loss of colonies will limit the ability of the species to recover. The following actions are needed to promote the recovery of the species: • Manage and monitor all occurrences by formal management plans; • Survey all occurrences annually in order to evaluate species stability and guide management; • Collect seed and place it into a conservation seed bank; • Conduct seed viability and germination tests so that experimental outplanting can be conducted; • Attempt reintroductions at colonies where Scotts Valley spineflower had occurred but has not been recently observed; • Seek conservation easements and/or agreements with landowners for all occurrences; • Periodically survey

potentially suitable habitat in the vicinity of the existing occurrences for the existence of previously unrecorded populations. (USFWS, 2019b)

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SPECIES ACCOUNT: *Chorizanthe robusta* var. *robusta* (Robust spineflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/04/1994; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

Chorizanthe robusta var. *robusta* is an annual spineflower in the Pungentes section of the genus *Chorizanthe* in the buckwheat family (Polygonaceae) (Figure 1). Like other spineflowers, it is branched from the base and subtended by a rosette of basal leaves. The plant has an erect to spreading or prostrate habit, usually standing not more than 20 cm (8 in high). The whorl of bracts subtending the flowers (involucre) has thin white to pinkish scarious (thin and translucent) margins along the basal portions of the teeth. Relative to other spineflower taxa in the Pungentes section, the flower heads are large (1.5 to 2.0 cm in diameter and distinctly aggregate. (USFWS, 2004)

Taxonomy

Accepted by Kartesz (1994 checklist and 1999 floristic synthesis) and Flora of North America (2005). However, Hickman (1993) does not list this taxon as distinct. Results from a molecular study indicate that *Chorizanthe pungens* var. *pungens* and *C. robusta* var. *robusta* are more closely related to each another than to the other subspecific taxa in the *C. pungens* and *C. robusta* complex; however, more analysis is needed to determine how this would their taxonomic treatment (Brinegar 2006, Baron and Brinegar 2007, Brinegar and Baron 2008 cited by USFWS 2009). (NatureServe, 2015)

Historical Range

Occurrences of *Chorizanthe robusta* var. *robusta* populations have been recorded since the late 1800s, occurring as far north as San Francisco and Alameda Counties, and south into Monterey County. Inland occurrences were documented in and around San Jose and Los Gatos in Santa Clara County. Coastal and near coastal occurrences have been documented in San Mateo County and Santa Cruz County where it is found today (CNDDB). (USFWS, 2010)

Current Range

Currently, there are 11 populations in Santa Cruz County over a range of approximately 21 miles (33.8 km). (USFWS, 2010)

Critical Habitat Designated

Yes; 5/28/2002.

Legal Description

On May 28, 2002, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Chorizanthe robusta* var. *robusta* (Robust spineflower) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six critical habitat units (CHUs), in California (67 FR 36822-36845).

Critical Habitat Designation

The critical habitat designation for *Chorizanthe robusta* var. *robusta* includes six CHUs in Santa Cruz County, California. This species critical habitat encompasses approximately 469 acres (ac) (190 hectares (ha)) (67 FR 36822-36845).

Unit A: Pogonip Unit: Unit A consists of sandy openings within mixed forest habitat within Pogonip Park in the City of Santa Cruz. Of the 64 ha (159 acre) unit, 62 ha (152 ac) are owned and managed by the City; and the remainder are privately owned. As of the year 2000, two colonies comprising approximately 800 individuals occupied this site. This unit is important to the conservation of the taxon because it supports extant colonies of *Chorizanthe robusta* var. *robusta*. This unit also includes habitat that is important for the expansion of existing colonies and connectivity between the two colonies. In addition, it is also important because, aside from the Wilder Creek location which we were not aware of at the time of the proposed rule, Pogonip Park is the most northerly and westerly location known for the species. It is also one of only three known locations where *C. r. var. robusta* is found more than 5 km (3 mi) away from the beach. Preserving the genetic characteristics that have allowed individuals at this site to survive under these slightly different environmental conditions may be important for the long-term survival and conservation of *C. r. var. robusta*.

Unit B: Branciforte Unit: Unit B consists of an old field/ grassland unit within the city limits of Santa Cruz. The 4-ha (9-ac) unit is privately owned. As of the year 2001, this unit supported a *Chorizanthe robusta* var. *robusta* population of approximately 500 individuals. This unit also includes habitat that is important for the expansion of the existing population. This unit is important to the conservation of the species because it contains one of the only eight known locations of *C. r. var. robusta*. It is the only other unit in close proximity to Unit A

Unit C: Aptos Unit: Unit C consists of sandy openings within maritime chaparral. The 28 ha (70 ac) unit is comprised entirely of private lands. As of the year 2000, this unit supported a *Chorizanthe robusta* var. *robusta* population of approximately 3,000 individuals. This unit also includes habitat that is important for the expansion of the existing population. It is also one of only three locations that supports *C. r. var. robusta* more than 5 km (3 mi) away from the beach. Preserving the genetic characteristics that have allowed individuals at this site to survive under these slightly different environmental conditions (i.e., more inland conditions) may be important for the long-term survival and conservation of *C. r. var. robusta*.

Unit D: Freedom Unit: Unit D consists of grasslands and sandy areas in openings within maritime chaparral and oak woodland. This 4 ha (9 ac) unit is comprised of private and Pajaro Unified School District lands. As of the year 2001, this unit supports a *Chorizanthe robusta* var. *robusta* colony of several hundred individuals. Additionally, other colonies of *C. r. var. robusta* occur within a few hundred yards of the first colony; these additional colonies are outside the critical habitat boundary. This unit is important to the conservation of the taxon because it supports one of only eight known extant locations of *C. r. var. robusta*. This unit also includes habitat that is important for the expansion of the existing colony and connectivity between the two colonies.

Unit E: Buena Vista Unit: Unit E consists of grasslands within maritime chaparral and oak woodland on the Buena Vista parcel. The 55 ha (135 ac) unit is comprised entirely of private lands. As of 1999, this unit supports multiple colonies of *Chorizanthe robusta* var. *robusta* comprising approximately 1,500 individuals. This unit is important to the conservation of the species because it is one of only two units that supports multiple extant colonies of *C. r. var.*

robusta. This unit also includes habitat that is important for the expansion of the existing colonies, and connectivity between the multiple colonies.

Unit F: Sunset Unit: Unit F consists of coastal dune habitat, and is identical to critical habitat that is being designated for the *Chorizanthe pungens* var. *pungens*. All of this 35 ha (86 ac) unit is within Sunset State Beach. As of 2001, this unit supports the largest concentration of *C. r.* var. *robusta*, including dozens of colonies of comprising tens of thousands of individuals. This unit is important to the conservation of the species because it is only one of two units that supports multiple extant colonies of *C. r.* var. *robusta*. This unit also includes habitat that is important for the expansion of these existing colonies into areas that were historically occupied, and for maintaining connectivity between the multiple colonies. The unit is also important because it is the most southerly location known for the species and the only location, aside from Manresa State Beach which was not proposed for critical habitat, where *C. r.* var. *robusta* is found so close to the beach. Preserving the genetic characteristics that have allowed individuals at this site to survive under these slightly different environmental conditions (i.e., more coastal conditions) may be important for the long-term survival and conservation of *C. r.* var. *robusta*. Lands designated as critical habitat are under private, city, and State jurisdiction. The approximate areas of designated critical habitat by land ownership are shown in Table 1.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Chorizanthe robusta* var. *robusta* critical habitat consists of four components (67 FR 36822-36845):

- (i) Sandy soils associated with active coastal dunes, coastal bluffs with a deposition of windblown sand, inland sites with sandy soils, and interior floodplain dunes;
- (ii) Plant communities that support associated species, including coastal dune, coastal scrub, grassland, maritime chaparral, oak woodland, and interior floodplain dune communities, and have a structure such that there are openings between the dominant elements (e.g, scrub, shrub, oak trees, clumps of herbaceous vegetation);
- (iii) Plant communities that contain no or little cover by nonnative species which would compete for resources available for growth and reproduction of *Chorizanthe robusta* var. *robusta*; and
- (iv) Physical processes, such as occasional soil disturbance, that support natural dune dynamics along coastal areas.

Special Management Considerations or Protections

Special management considerations or protections may be needed to maintain the primary constituent elements for *Chorizanthe robusta* var. *robusta* within the units being designated as critical habitat. In some cases, protection of existing habitat and current ecological processes may be sufficient to ensure that populations of *C. r.* var. *robusta* are maintained, and have the ability to reproduce and disperse into surrounding habitat at those sites. In other cases, however, active management may be needed to maintain the primary constituent elements for *C. r.* var. *robusta*. We have outlined below the most likely kinds of special management and protection that *C. r.* var. *robusta* may require. (1) In near-coastal areas, the supply and movement of sand along the coast must be maintained to create the dynamic dune habitats that are needed for

Chorizanthe robusta var. *robusta*. (2) In more interior locations, the sandy soils on which *Chorizanthe robusta* var. *robusta* is found should be maintained to optimize conditions for the species. Physical properties of the soil, such as its chemical composition, salinity, and drainage capabilities would best be maintained by limiting or restricting the use of herbicides, fertilizers, or other soil amendments. (3) The associated plant communities must be maintained to ensure that the habitat needs of pollinators and dispersal agents are maintained. The use of pesticides should be limited or restricted so that viable populations of pollinators are present to facilitate reproduction of *Chorizanthe robusta* var. *robusta*. Fragmentation of habitat through construction of roads and certain types of fencing should be limited so that seed dispersal agents may move seed of *C. r.* var. *robusta* throughout the unit. (4) In some plant communities, it may be important to maintain a mosaic of different-aged stands of coastal scrub or maritime chaparral patches so that openings that support *Chorizanthe robusta* var. *robusta* will be maintained. Depending on location, the use of prescribed fire, thinning, or other forms of vegetation management may be useful in creating and maintaining this type of mosaic. (5) In all plant communities where *Chorizanthe robusta* var. *robusta* occurs, invasive, non-native species such as harding grass (*Phalaris aquaticus*), veldt grass (*Ehrharta* spp.), European beachgrass, iceplant, and other species need to be actively managed to maintain the open habitat that *C. r.* var. *robusta* needs. (6) Certain areas where *Chorizanthe robusta* var. *robusta* occurs may need to be fenced to protect them from accidental or intentional trampling by humans and livestock. While *C. r.* var. *robusta* appears to withstand light to moderate disturbance, heavy disturbance may be detrimental to its persistence. Seasonal exclusions may work in certain areas to protect *C. r.* var. *robusta* during its critical season of growth and reproduction.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Asexual (self-fertilization) (USFWS, 2010)

Lifespan

Adult: 1 year (annual) (USFWS, 2010)

Breeding Season

Adult: April to June (USFWS, 2010)

Key Resources Needed for Breeding

Adult: Murphy (2003) revealed that insect pollination significantly increased seed set for *C. robusta* var. *robusta*, suggesting that pollinators may enhance its overall fitness. (USFWS, 2010)

Reproduction Narrative

Adult: *Chorizanthe robusta* var. *robusta* is a short-lived annual spineflower in the Pungentes section of the genus *Chorizanthe*, in the buckwheat family (Polygonaceae). *Chorizanthe robusta* var. *robusta* is self-compatible and capable of self-fertilization, seed set was demonstrated to be higher in individuals that were insect pollinated. Germination of *Chorizanthe robusta* var. *robusta* occurs during winter months; flowering occurs from April through June, and in some cases throughout the summer. (USFWS, 2010)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Sand/dunes (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Requires open canopy; shade intolerant (USFWS, 2010)

Environmental Specificity

Adult: Narrow/specialist

Site Fidelity

Adult: Moderate (inferred from USFWS, 2010)

Habitat Narrative

Adult: Specific biological and physical habitat components that are essential to the conservation of *Chorizanthe robusta* var. *robusta* include sandy soils associated with active coastal dunes and inland sites with sandy soils; plant communities that support associated species, including coastal dune, coastal scrub, grassland maritime chaparral, and oak woodland communities, and have a structure such that there are openings between the dominant elements; plant communities that contain little or no cover by nonnative species that would compete for resources available for growth and reproduction of *C. robusta* var. *robusta*; and physical processes, such as occasional soil disturbance, that support natural dune dynamics along coastal areas (Service 2004). (USFWS, 2010)

Dispersal/Migration**Motility/Mobility**

Adult: High (inferred from USFWS, 2010)

Dispersal

Adult: High (inferred from USFWS, 2010)

Dispersal/Migration Narrative

Adult: Seeds disperse when the involucre spines attach to passing animals. Small mammals and birds are the most likely seed dispersers of *Chorizanthe robusta* var. *robusta*; though wind also plays a part in the dispersal of seeds (Service 2004). (USFWS, 2010)

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Moderate (inferred from USFWS, 2010)

Representation:

Moderate (inferred from USFWS, 2010)

Redundancy:

Low (inferred from USFWS, 2010)

Number of Populations:

11 (USFWS, 2010)

Population Narrative:

Currently, there are 11 populations in Santa Cruz County over a range of approximately 21 miles (33.8 km). Three sites are on park lands that support large populations on the order of 10,000 individuals or more; the other seven sites support significantly smaller populations (USFWS 2004). Population size value left blank for this seed-banking annual because the large number of individuals suggests a sense of security that is not warranted. Approximately 12 occurrences observed since 1989 (CNDDDB 2008). Known from 10 sites that support a total of 12 populations (USFWS 2004). Recent management actions performed by Baron and Eidam at the Pogonip sites may prove that slight disturbance can be beneficial for populations of *C. robusta* var. *robusta*. The disturbance can create necessary open areas that increase light, heat, and water, and may improve conditions for ground nesting pollinators (Murphy 2003). While we believe stochastic extinction is less of a threat now for *C. robusta* var. *robusta* than at the time of listing, it is still a concern for several of the smaller-sized populations. (USFWS, 2010)

Threats and Stressors

Stressor: Recreation (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: In the various park units at Pogonip and Sunset and Manresa State Beaches, recreational activities can have an impact on *Chorizanthe robusta* var. *robusta*, although low to moderate levels of impacts may be beneficial. Recent management actions performed by Baron and Eidam at the Pogonip sites may prove that slight disturbance (in this case, scraping with a McLeod) can be beneficial for populations of *C. robusta* var. *robusta*. The disturbance can create necessary open areas that increase light, heat, and water, and may improve conditions for ground nesting pollinators (at Pogonip, *Steniolia elegans* (digger wasp) and an undescribed wasp species of the genus *Tachysphex* (Murphy 2003)). These populations at Pogonip showed a large increase in numbers after management actions were implemented (Baron and Eidam 2008). Conversely, without proper management, high levels of recreational impact at these park sites (i.e., horseback riding and mountain biking) may eliminate the taxon altogether (Service 2004). (USFWS, 2010)

Stressor: Invasive plants (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: An observation in 2009 reported that the Branciforte population appears healthy; however, the presence of a chain link fence for excluding off-highway vehicles is barring fire safety mowing that had previously helped control invasive trees from encroaching into the

population. As a result, the population is now also being threatened by invasives, particularly *Ailanthus altissima* (tree of heaven) (Cheap, in litt. 2009a). Upon further observation at the Branciforte site, it is clear that *Chorizanthe robusta* var. *robusta* is well established there and has the potential to flourish. However, *Ailanthus altissima* is prolific and abundant within the *C. robusta* var. *robusta* population and is an even more imminent threat than originally considered (Chang and Glenn, Service biologists, pers. obs. 2009b). The shade created by this non-native tree will inevitably eliminate *C. robusta* var. *robusta* from the site. In addition to *Ailanthus altissima*, other species that have been identified as threats to the Branciforte population are *Rubis ursinus* (Pacific blackberry), *Rubis discolor* (Himalayan blackberry), *Carpobrotus edulis* (iceplant), *Lathyrus latifolius* (sweet pea), *Genista monspessulana* (French broom), *Lobularia maritima* (sweet alyssum), and *Lotus scoparius* var. *scoparius* (deerweed) (Boursier and Hardwicke 2007). (USFWS, 2010)

Stressor: Residential development (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Populations of *Chorizanthe robusta* var. *robusta* on private lands are subject to additional and sometimes more serious threats. The Branciforte site has been approved by the City of Santa Cruz for a housing development project, though it is unknown when construction activities will begin. The Service and the California Native Plant Society (CNPS) submitted comments recommending larger buffer areas for *C. robusta* var. *robusta* populations. In the early 1990s, the Freedom population at Aptos High School suffered losses of *Chorizanthe robusta* var. *robusta* individuals when land was modified in preparation for lot divisions. Additionally, in the late 1990s, the school widened a foot path running through the population in order to accommodate vehicles (Service 2004). An observation made in 2004 recorded in the CNDDDB reported that a large colony east of the school baseball field remained intact, but that plants below the parking lot were eliminated by construction. Upon subsequent observation at this site, *C. robusta* var. *robusta* was visible along a foot trail southeast of the baseball field, growing on the edges of the trail, where the sandy soil is loose and there is less growth of other plants (Chang and Glenn, pers. obs. 2009a). (USFWS, 2010)

Stressor: Herbivory (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Baron and Bros (2005) investigation of insect herbivory on *Chorizanthe robusta* var. *robusta* concluded that insect herbivores reduced plant size, significantly decreasing both size and lifetime seed production of *C. robusta* var. *robusta*, subsequently compromising the plant's ability to obtain resources. In addition, rabbits browsing on *C. robusta* var. *robusta* removed mature seed heads from 11 percent of the study plants. The results of this study suggest that effects of herbivory can potentially be a threat to *C. robusta* var. *robusta*, or exacerbate other threats to *C. robusta* var. *robusta* populations (Baron and Bros 2005). (USFWS, 2010)

Stressor: Variation in annual weather patterns (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Annuals and other monocarpic plants (individuals that die after flowering and fruiting), such as *Chorizanthe robusta* var. *robusta*, are typically vulnerable to random fluctuations or variation in annual weather patterns and other environmental factors (Service 1994). (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999; Cayan et al. 2005; IPCC 2007). However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to particular species at this time. (USFWS, 2010)

Stressor: Stochastic extinction (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: A small population size may make it difficult for a species to persist while sustaining other impacts such as habitat alteration that favors non-native species. Although *Chorizanthe robusta* var. *robusta* is self-compatible and capable of self-fertilization, seed set was demonstrated to be higher in individuals that were insect pollinated. Small populations may also have a more difficult time attracting pollinators and therefore may experience lower seed viability rates. Many of the populations appear to be stable or support a larger number of individuals than we knew of at the time of listing. While we believe stochastic extinction is less of a threat now for *C. robusta* var. *robusta* than at the time of listing, it is still a concern for several of the smaller-sized populations. (USFWS, 2010)

Recovery

Reclassification Criteria:

1. Within each recovery unit, the number of populations and acreage of occupied habitat for each population has been protected. (USFWS, 2004)
2. Habitat in each protected population has been appropriately managed and restored. (USFWS, 2004)
3. Population monitoring shows a stable or increasing trend in population size or density during favorable precipitation years over at least 10 years. (USFWS, 2004)

Delisting Criteria:

1. Within each recovery unit, the number of populations and acreage of occupied habitat for each population has been protected. (USFWS, 2004)

2. Habitat in each protected population has been appropriately managed and restored. (USFWS, 2004)
3. Population monitoring shows a stable or increasing trend in population size or density during favorable precipitation years over at least 10 years. (USFWS, 2004)
4. The total number of populations has increased to at least 18, at least 15 of which have an average population of 1,000 individuals in favorable (nondrought) rainfall years over at least 10 years (beyond the downlisting monitoring period). (USFWS, 2004)

Recovery Actions:

- Protect habitat for *Chorizanthe robusta* var. *robusta* at all existing sites. (USFWS, 2004)
- Manage habitat for *Chorizanthe robusta* var. *robusta* at existing sites. (USFWS, 2004)
- Conduct management-oriented research. (USFWS, 2004)
- Establish populations in appropriate habitat within the historical range of the species. (USFWS, 2004)
- Review and revise recovery criteria as new information becomes available. (USFWS, 2004)
- Develop and implement an outreach program. (USFWS, 2004)

Conservation Measures and Best Management Practices:

- 1. Establish and/or continue long-term management and monitoring programs for *Chorizanthe robusta* var. *robusta* populations, particularly those on park and refuge lands. (USFWS, 2010)
- 2. Continue genetic research to clarify uncertainties within the *Chorizanthe robusta*/*Chorizanthe pungens* complex. (USFWS, 2010)
- 3. Investigate opportunities for conservation of the Branciforte population, and remove *Ailanthus altissima* (tree of heaven) and other invasive species at the site, in accordance with the “Branciforte Creek Residential Development Robust Spineflower (*Chorizanthe robusta* var. *robusta*) Management and Monitoring Plan,” whether or not planned development goes forth. (USFWS, 2010)
- 4. Conduct surveys on suitable habitat and within the historical range to locate new populations, in conjunction with examination of genetic information to ensure the plant’s identity. Discovery of additional new populations such as the population at Merk Road will broaden our understanding of *Chorizanthe robusta* var. *robusta*’s status, its habitat, and range. (USFWS, 2010)
- 5. Initiate an outplanting program to establish new *Chorizanthe robusta* var. *robusta* populations in appropriate habitat within its historical range by: a. locating appropriate habitat for outplanting; b. conducting experimental habitat enhancement; c. applying appropriate habitat enhancement techniques; d. conducting propagation experiments to determine the best techniques for developing material to use in introductions; e. conducting experimental introductions; f. developing a protocol to guide introductions; g. conducting large-scale introductions on appropriate sites; and h. monitoring newly established populations (Service 2004). (USFWS, 2010)
- 6. Establish an outreach program to increase public awareness for populations on both public and private lands, particularly on park lands, refuges, and at Aptos High School. (USFWS, 2010)
- 7. Revise the recovery plan and recovery criteria as appropriate based on new information and/or research. (USFWS, 2010)

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SPECIES ACCOUNT: *Chorizanthe valida* (Sonoma spineflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/22/1992; California/Nevada (Region 8)

Physical Description

A herbaceous annual, very similar in appearance to *Chorizanthe howellii* (Howell's spineflower), the primary distinguishing characteristic of *C. valida* being its ascending to erect growth habit and the brightly colored red and white involucres. The bright red base of the involucre's straight spines contrasts with their bright ivory tips, and the red spine bases contrast sharply with the dull-colored involucre tube. The basal leaves of *C. valida* are 1 to 2.5 centimeters (0.4 to 0.9 inch) long, 4 to 8 millimeters (0.2 to 0.3 inch) wide, and often less hairy on the top surface than underneath. The flowers are 5 to 6 millimeters (0.2 to 0.3 inch) long. (USFWS, 1998)

Taxonomy

Closely related to *C. pungens* (Bittman 1998). (NatureServe, 2015) The Sonoma spineflower, *Chorizanthe valida*, was described by Sereno Watson in 1877 from specimens collected in 1840-41 by Ilya G. Vosnesensky, an entomologist and curator of the Zoological Museum in St. Petersburg, Russia, who traveled and collected in northern California. (USFWS, 1998)

Historical Range

The Point Reyes area in Marin County, California. Possible historical occurrences from the interior portion of Sonoma County. (USFWS, 2010)

Current Range

Near the eastern end of Abbott's Lagoon on the Lunny "G" Ranch, at Point Reyes National Seashore (PRNS) in Marin County, California. (USFWS, 2019)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Lifespan

Adult: 1 year (USFWS, 1998)

Breeding Season

Adult: June to August (USFWS, 1998)

Reproduction Narrative

Adult: *Chorizanthe valida* is an herbaceous annual in the buckwheat family (Polygonaceae). Flowers, which appear June through August, are white to lavender to rose in color, are 5 to 6 mm (0.20 to 0.24 in) long (Reveal and Hardham 1989) and occur in dense, ball-shaped, pinkish clusters with green bracts below. (USFWS, 1998; USFWS, 2010)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Grassland/herbaceous (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Mild maritime climate, characterized by fog and winter rains (USFWS, 1998)

Habitat Narrative

Adult: The Abbott's Lagoon colony is located in coastal prairie grassland and occurs on the Sidrak sand soil type, consisting of well-drained, Pleistocene dune sands with a 2-4 percent slope, bearing to the north-northwest (towards Abbott's Lagoon). This soil type has low to moderate available water capacity, and can support only a limited plant community that is drought tolerant (Davis and Sherman 1992). The species occurs in areas of relatively mild maritime climate, characterized by fog and winter rains. The fog helps keep summer temperatures cool and winter temperatures relatively warm, and provides moisture in addition to the normal winter rains. (USFWS, 1998; USFWS, 2010)

Dispersal/Migration**Motility/Mobility**

Adult: Low (USFWS, 1998)

Dispersal

Adult: Low (USFWS, 1998)

Dispersal/Migration Narrative

Adult: After about a month, the dull brown flowerhead begins to disintegrate and the spiny seeds are dispersed on the ground nearby. (USFWS, 1998)

Population Information and Trends**Population Trends:**

Variable (USFWS, 2010)

Number of Populations:

1 (USFWS, 2010)

Population Size:

Variable; estimates from 62,580 individuals in 2006 to 710,460 individuals in 2009 (USFWS, 2010)

Population Narrative:

A single extant endemic population of *Chorizanthe valida* exists near the eastern end of Abbott's Lagoon on the Lunny "G" Ranch, at Point Reyes National Seashore (PRNS) in Marin County, California at an elevation of approximately 15 meters (49 feet) above sea level. The population of *Chorizanthe valida* at Abbott's Lagoon exists as two disjunct subpopulations that are spatially

separated from each other by approximately 80 meters (262 feet). The larger of the two subpopulations is referred to as the "main population" and is approximately 4 times as large as the smaller of the two subpopulations. The smaller of the two subpopulations is referred to as the "sub-population". Based on the results of mapping the spacial distribution of the population in 1999, 2000, 2005, 2006 and 2008, the area occupied by *Chorizanthe valida* at Abbott's Lagoon fluctuates seasonally, but does not appear to be contracting (Williams 2008). According to the recovery plan (Service 1998), the entire Abbott's Lagoon population of *C. valida* was estimated to cover 358 square meters (1,076 square feet) in 1983. In 1984, more than 2,000 plants covered an area of 5,130 square meters (16,829 square feet) (Fowler and Fellers 1984). According to Davis and Sherman (1992), the entire population exists within 17,000 square meters (55,773 square feet). Between 1983 and 1998, the California Native Plant Society (CNPS) conducted a census of the population and the number of individuals varied widely from 100 to 30,000 plants (Rogers 2005). In 1999, PRNS staff began developing a long-term, quantitative monitoring program for the Abbott's Lagoon population. Over the next 6 years, several monitoring methods were tested. In 1999, the number of *Chorizanthe valida* plants in the main population was estimated to be 18,000. In 2001, the number was calculated to be 184,311 individuals. The main population was not counted in 2000 or after 2002. From 2002 to 2004 permanent monitoring plots were used as indicators of the overall population trend in the main population. However, data collected using these permanent plots have now been rejected due to statistical invalidity. The number of plants in the sub-population has increased dramatically each year it has been censused, from 4,707 individuals in 1999 to 16,836 in 2001. Beginning in 2005, PRNS staff began sampling the main population of *Chorizanthe valida* using a macroplot. The macroplot is 100 x 40 meters (328 x 131 feet), encompassing 35 temporary quadrats each measuring 40 x 0.05 meters (131 x 0.16 feet). Sample results estimated there were 560,171 plants in the macroplot in 2005, with 95% confidence that the true number of plants in the macroplot is between 470,000 and 650,275. Data extrapolation to the entire population is beyond reasonable statistical inference. Since 2005, the population within the macroplot has fluctuated from an estimated 62,580 individuals in 2006 to 710,460 individuals in 2009. (USFWS, 2010)

Threats and Stressors

Stressor: Recreation (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Trampling by hikers and accidental incursion still pose a minor threat to *C. valida*. (USFWS, 2010)

Stressor: Off-road vehicles (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Due to the presence of a road that bisects the Abbott's Lagoon population, which is used for ranching activities, off-road vehicle use still poses a threat. However, off-road vehicle use within PRNS is not permitted for recreational purposes and the road bisecting the Abbott's Lagoon population is scheduled for realignment in 2010; thus, this threat will be drastically reduced as a result. (USFWS, 2010)

Stressor: Cattle grazing (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The unknown effects of cattle grazing also remain a threat. However, since *Chorizanthe valida* is unpalatable to cattle and cattle consume many of the nonnative invasive plants that threaten the species, the removal of cattle from the system could in itself threaten the species. Due to the results of Davis and Sherman (1992), it is now believed the damage caused by livestock trampling is outweighed by the benefits of grazing livestock in reducing competition with other plant species. (USFWS, 2010)

Stressor: Stochasticity (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Because *Chorizanthe valida* exists as a single endemic population and a single reintroduced population, with plant densities that fluctuate annually, it is highly susceptible to stochastic events such as prolonged drought, fire, disease, or other unforeseen causes of extinction. Stochasticity remains a major threat to the species. (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Impacts to this species as a result of climate change are unclear. A trend of warming in the mountains of western North America is expected to decrease snowpack, hasten spring runoff, and reduce summer stream flows, and increased summer heat may increase the frequency and intensity of wildfires (IPCC 2007). While it appears reasonable to assume that the species may be affected, we lack sufficient certainty on knowing how and when climate change will affect the species, the extent of average temperature increases in California/Nevada, or potential changes to the level of threat posed by drought, fire, etc. (USFWS, 2010)

Stressor: Nonnative invasive species (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The population of *Chorizanthe valida* at Abbott's Lagoon is surrounded by the invasive perennial grass species *Holcus lanatus* (common velvetgrass) on all sides. This nonnative invasive grass is of concern to the long term management of this population. As part of the Preventing Extinction Grant awarded to PRNS, *H. lanatus* and *Lupinus arboreus* will be removed from the area. Regardless, nonnative invasive species remain an ongoing threat to *C. valida*. (USFWS, 2010)

Stressor: Fire suppression (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The effects of fire suppression on *Chorizanthe valida* are not known. The natural fire return interval at PRNS is likely relatively long due to persistently moist and cool conditions coupled with relatively low incidence of lightning strikes (Keeley 2002). However, the use of fire by Native Americans in the area is not known. (USFWS, 2010)

Recovery

Reclassification Criteria:

A/1: At least six successful populations have been established. These populations will be considered self-sustaining populations after 15 years, which includes a normal precipitation cycle. (USFWS, 2019)

A/2: The area of each Sonoma spineflower population is maintained at or above approximately 2 acres in size. (USFWS, 2019)

A/3: The cover of invasive native and non-native plants, such as bush lupine, at all sites is controlled at <1% within areas containing Sonoma spineflower. (USFWS, 2019)

A/4: There are management measures implemented to address the threats of invasive species and other problems, including pedestrians and off-road vehicles at some sites. (USFWS, 2019)

A/5: Monitoring reveals that management actions are successful in reducing threats of invasive non-native species. (USFWS, 2019)

E/1: The number of individuals within each Sonoma spineflower population remains at or above 90,000 for 15 years, which includes cycles of normal precipitation. (USFWS, 2019)

E/2: Seeds are stored in at least two Center for Plant Conservation certified facilities; seed germination, propagation, and out-planting propagation techniques are understood. (USFWS, 2019)

Delisting Criteria:

A/1: At least eight successful populations have been established on appropriate habitat [that] has been secured within the historic range. Populations will be self-sustaining after 15 years, which includes a normal precipitation cycle. (USFWS, 2019)

A/2: Further invasion or increase in non-native or native invasive plant species has been prevented, including perennial species such as bush lupine and coyotebrush, within all Sonoma spineflower populations. (USFWS, 2019)

A/3: Habitat occupied by the species that is needed to allow delisting has been voluntarily secured, with long-term commitments and, if possible, endowments to fund [the] conservation of the native vegetation. (USFWS, 2019)

E/1: Ensure that seed banking practices, including seed germination, propagation, and outplanting propagation techniques, are understood and implemented as needed. (USFWS, 2019)

E/2: Seeds at banking facilities are renewed at a rate to ensure that seed stores remain viable in perpetuity. (USFWS, 2019)

Recovery Actions:

- Protect habitat of the listed species and their occurrences on private lands. The listed species should be secured where they occur on private lands through conservation easements, conservation agreements, or purchase where there are willing sellers. This is necessary to prevent further declines in distribution and abundance of the listed species from loss and degradation of habitat. The development of cooperative weed control programs will greatly facilitate recovery of these species, so it is a high priority to develop landowner incentives and providing funds for control of invasive exotic vegetation is a high priority. This task regularly refers to “occurrences” as defined by the NDDB. Readers are reminded that “occurrences” are convenient units for storing data, and do not necessarily coincide with biological populations nor with geographic units of vegetation or geological features such as the dune fields upon which these plants depend. (USFWS, 1998)
- Minimize threats to the plants from invasive non-native species, and minimize threats on private and public lands. Invasive non-native plant species are immediate biological threats to the listed plant species. Infestations of invasive plant species need to be controlled. (USFWS, 1998)
- Develop management strategies through a research program to document the listed species’ life histories and their responses to vegetation management. Habitat management for the species in this recovery plan is needed to control the threats to their existence. Data must be obtained to determine how to conduct the management. (USFWS, 1998)
- Manage occurrences and habitats. Management of the listed plant species and its habitat will depend upon information gained from monitoring, threat analysis and the evaluation of protection alternatives. It will be important to involve the expertise of local landowners, land managers, and species experts to develop conservation programs. There may be different management programs for each species. The management program selected will require periodic review to ensure that it is effective in protecting the species. (USFWS, 1998)
- Monitor occurrences and threats to determine effectiveness of management and to establish delisting criteria. (USFWS, 1998)
- Coordinate recovery actions to protect other listed species and species of special concern. Other rare and endangered wildlife species occur within the ranges of the listed plant species. Management actions, such as the removal of invasive non-native plant species through herbicide application, may affect these species. Management actions should avoid adverse impacts to these species and their habitats, and actively include them in recovery actions to facilitate their reoccupation of historic ranges and prevent range collapse or declines in their abundance. (USFWS, 1998)
- Develop ecosystem restoration and multi-species reintroduction projects at degraded dune systems. Numerous dune systems within the historic range of listed species and species of concern have either reduced value or none for them because of past or ongoing degradation of habitat quality. Benefits for multiple species can be efficiently regained by establishing habitat and population restoration programs for these undermanaged or degraded dune systems. By returning independent dune systems within historic range of rare species to current ecological function, the risk of species extinction can be substantially decreased. (USFWS, 1998)

- Develop and implement an outreach program. Increasing public awareness of the listed plant species will facilitate efforts to preserve the species,, associated rare species, and the coastal dune ecosystem. Prepare and distribute regionally specific informational brochures and audio-visual and sign programs on preservation and recovery. Through the cooperative interagency working groups, prepare brochures and audio-visual materials that describe the plight of the listed species and the regional efforts being undertaken for their recovery. Disseminate the brochures to affected landowners and other community facilities. Provide the audio-visual materials to public facilities, such as park interpretive programs and school programs. Prepare interpretive educational signs for PRNS and other locations. (USFWS, 1998)
- Additional Site-specific Recovery Actions from 2019 Amended Recovery Plan: 1. Establish or protect additional populations of Sonoma spineflower. 1.1 Introduce at least three new self-sustaining populations (Priority 1) 1.2 Research possible insect pollinator species to determine appropriate management strategies for reintroduction sites. 1.3 Continue work on seedbank dynamics with the goal of using the information to run a population viability analysis on the species (Priority 2). 1.4 Research to determine what might cause population declines within the wild population, focusing on grazing intensity and pollinators (Priority 1) (USFWS, 2019)
- Additional Site-specific Recovery Actions from 2019 Amended Recovery Plan: 2. Conduct research to better understand life history and annual establishment. 2.1 Determining the extent of Sirdrak Sand outside of the park to help inform the location of potential introduction sites (Priority 3). 2.2 Conduct an analysis of soil type and nutrients/water balance, vegetation cover, disturbance dynamics (grazing, rodents, rabbits) to identify new introduction sites outside of the PRNS to determine if appropriate habitat exists for possible reintroductions (Priority 3). 2.3 Research the potential to augment nesting habitat for main pollinators near some of the current and future introduction sites (Priority 3). (USFWS, 2019)
- Additional Site-specific Recovery Actions from 2019 Amended Recovery Plan: 3. Monitor and manage existing populations on protected lands. 3.1 Maintain shrub cover within existing sites at acceptable levels through removal, as necessary (Priority 3). 3.2 Determine where some of the main pollinators identified in the two years of study on Sonoma spineflower nest near these populations (Priority 3). 3.3 Research the potential to augment nesting habitat for main pollinators near some of the current and future introduction sites (Priority 3). (USFWS, 2019)

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SPECIES ACCOUNT: *Chromolaena frustrata* (Cape Sable Thoroughwort)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/25/2013; Southeast Region (R4) (USFWS, 2015)

Physical Description

Chromolaena frustrata is a perennial herbaceous plant. Mature plants are 5.9 to 9.8 inches (in) (15 to 25 centimeters (cm)) tall with erect stems. The blue to lavender flowers are borne in heads, usually in clusters of two to six. Flowers are produced mostly in the fall, though sometimes year round. (USFWS, 2014)

Taxonomy

Chromolaena frustrata (Family: Asteraceae) was first reported by Chapman, from the Florida Keys in 1886, naming it *Eupatorium heteroclinium* (Chapman 1889). Synonyms include *Eupatorium frustratum* B.L. Robinson and *Osmia frustrata* (B.L. Robinson) Small. (USFWS, 2014)

Historical Range

Chromolaena frustrata was historically known from Monroe County, both on the Florida mainland and the Florida Keys, and in Miami-Dade County along Florida Bay. The species was observed historically on Big Pine Key, Boca Grande Key, Fiesta Key, Key Largo, Key West, Knight's Key, Lignumvitae Key, Long Key, Upper Matecumbe Key, and Lower Matecumbe Key. (USFWS, 2013)

Current Range

In Everglades National Park, 11 *Chromolaena frustrata* populations supporting approximately 1,600 to 2,600 plants occur in buttonwood forests and coastal hardwood hammocks from the Coastal Prairie Trail near the southern tip of Cape Sable to Madeira Bay. In the Florida Keys, *Chromolaena frustrata* is now only known from Upper Matecumbe Key, Lower Matecumbe Key, Lignumvitae Key, Long Key, Big Munson Island, and Boca Grande Key (USFWS, 2013)

Critical Habitat Designated

Yes; 2/7/2014.

Legal Description

On January 8, 2014, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective February 7, 2014) for *Chromolaena frustrata* (Cape Sable Thoroughwort) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes nine critical habitat units (CHUs), in Florida (79 FR 1552-1590).

Critical Habitat Designation

The critical habitat designation for *Chromolaena frustrata* includes nine CHUs in Sabine and San Augustine Counties, Texas. This species critical habitat encompasses approximately 10,968 acres (ac) (4,439 hectares (ha)). General descriptions are presented below. Maps depicting the CH units are available in the Final Rule. (79 FR 1552-1590).

Unit 1: Everglades National Park, Monroe County and Miami-Dade County: Unit 1 consists of a total of 6,166 acres (2,495 hectares) in Monroe and Miami-Dade Counties. This unit is composed

entirely of lands in Federal ownership, 100 percent of which are located within the Everglades National Park.

Unit 2: Key Largo, Monroe County: Unit 2 consists of a total of 3,431 acres (1,388 hectares) in Monroe County. This unit is composed of Federal lands within Crocodile Lake National Wildlife Refuge (NWR) (804 acres (325 hectares)); State lands within Dagny Johnson Botanical State Park, John Pennekamp Coral Reef State Park, and the Florida Keys Wildlife and Environmental Area (2,170 acres (878 hectares)); and parcels in private ownership (457 acres (185 hectares)).

Unit 3: Upper Matecumbe Key, Monroe County, Florida: Unit 3 consists of 69 acres (28 hectares) in Monroe County. This unit is comprised of State lands within Lignumvitae Key State Botanical Park, Indian Key Historical State Park (24 acres (10 hectares)); City of Islamorada lands within the Key Tree Cactus Preserve and Green Turtle Hammock Park and parcels in private ownership (45 acres (18 hectares)).

Unit 4: Lignumvitae Key, Monroe County: Unit 4 consists of a total of 180 acres (73 hectares) in Monroe County. This unit is composed entirely of lands in State ownership, 100 percent of which are located within the Lignumvitae Key Botanical State Park on Lignumvitae Key in the Florida Keys. This unit includes the entire upland area of Lignumvitae Key.

Unit 5: Lower Matecumbe Key, Monroe County: Unit 5 consists of a total of 44 acres (18 hectares) in Monroe County. The unit is composed of State lands within Lignumvitae Key Botanical State Park and parcels owned by the Florida Department of Transportation (22 acres (9 hectares)), and parcels in private ownership (22 acres (9 hectares)).

Unit 6: Long Key, Monroe County: Unit 6 consists of a total of 208 acres (84 hectares) in Monroe County. This unit is composed of State lands within Long Key State Park (151 acres (61 hectares)) and parcels in private ownership (57 acres (23 hectares)).

Unit 7: Big Pine Key, Monroe County: Unit 7 consists of a total of 780 acres (316 hectares) in Monroe County. This unit is composed of Federal land within the National Key Deer Refuge (686 acres (278 hectares)) and parcels in private ownership (94 acres (38 hectares)).

Unit 8: Big Munson Island, Monroe County Unit 8 consists of a total of 28 acres (11 hectares) in Monroe County. This unit is composed entirely of lands in private ownership.

Unit 9: Boca Grande Key, Monroe County: Unit 9 consists of a total of 62 acres (25 hectares) in Monroe County. This unit is composed entirely of lands in Federal ownership, 100 percent of which is located within the Key West National Wildlife Refuge.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Chromolaena frustrata* critical habitat consists of four components (79 FR 1552-1590):

- (i) Areas of upland habitats consisting of coastal berm, coastal rock barren, coastal hardwood hammock, rockland hammocks, and buttonwood forest. (A) Coastal berm habitat that contains: (1) Open to semi-open canopy, subcanopy, and understory; and (2) Substrate of coarse,

calcareous, storm-deposited sediment. (B) Coastal rock barren (Keys cactus barren, Keys tidal rock barren) habitat that contains: (1) Open to semi-open canopy and understory; and (2) Limestone rock substrate. (C) Coastal hardwood hammock habitat occurring in Everglades National Park that contains: (1) Canopy gaps and edges with an open to semi-open canopy, subcanopy, and understory; and (2) Substrate of marl covered with a thin layer of highly organic soil. (D) Rockland hammock habitat that contains: (1) Canopy gaps and edges with an open to semi-open canopy, subcanopy, and understory; and (2) Substrate with a thin layer of highly organic soil, marl, humus, or leaf litter on top of the underlying limestone. (E) Buttonwood forest habitat that contains: (1) Open to semi-open canopy and understory; and (2) Substrate with calcareous marl muds, calcareous sands, or limestone rock.

(ii) Plant communities of predominately native vegetation with either no invasive, nonnative species or with low enough quantities of nonnative, invasive plant species to have minimal effect on the survival of *Chromolaena frustrata*.

(iii) A disturbance regime, due to the effects of strong winds or saltwater inundation from storm surge or infrequent tidal inundation, that creates canopy openings in coastal berm, coastal rock barren, coastal hardwood hammock, rockland hammocks, and buttonwood forest.

(iv) Habitats that are connected and of sufficient area to sustain viable populations in coastal berm, coastal rock barren, coastal hardwood hammock, rockland hammocks, and buttonwood forest.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. Special management considerations or protection are necessary throughout the critical habitat areas to avoid further degradation or destruction of the habitat that contains those features essential for the conservation of the species. The primary threats to the physical or biological features that *Chromolaena frustrata* depends on include: (1) Habitat destruction and modification by development; (2) competition with nonnative, invasive plant species that changes the habitat composition and structure; (3) wildfire that destroys habitat; (4) hurricanes and storm surge, if too frequent or severe destroy or modify habitat making it unsuitable; and (5) sea-level rise that changes the habitat to a more saline environment. Some of these threats can be addressed by special management considerations or protection while others (e.g., sea-level rise, hurricanes) are beyond the control of landowners and managers. However, while landowners or land managers may not be able to control all the threats, they may be able to address the results of the threats to the habitats. Management activities that could ameliorate these threats include the monitoring and minimizing recreational activities impacts, nonnative species control, and protection from development. Precautions are needed to avoid the inadvertent trampling of *Chromolaena frustrata* in the course of management activities and public use. Development of recreation facilities or programs should avoid impacting these habitats directly or indirectly. Ditching and filling should be avoided because they alter the hydrology and species composition of these habitats. Sites that have shown increasing encroachment of woody species over time may require efforts to maintain the open nature of the habitat, which favors these species. Nonnative species control programs are needed to reduce competition and prevent habitat degradation. The reduction of these threats will require

the implementation of special management actions within each of the critical habitat areas identified in this rule. All critical habitat requires active management to address the ongoing threats listed. In summary, we find that each of the areas we are designating as critical habitat contain features essential to the conservation of *Chromolaena frustrata* that may require special management considerations or protection to ensure conservation of the species. These special management considerations and protections are required to preserve and maintain the essential features provided to *C. frustrata* by the ecosystems upon which it depends. A more detailed discussion of these threats is presented in the proposed rule under “Summary of Factors Affecting the Species” (77 FR 61836; October 11, 2012).

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (USFWS, 2014)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 2014)

Reproduction Narrative

Adult: Produces flowers in fall. Pollination occurs via insects and abiotic factors (EPA, 2016). The reproductive biology and genetics of *Chromolaena frustrata* have received little study. Fresh *C. frustrata* seeds show a germination rate of 65 percent, but germination rates decrease to 27 percent after the seeds are subjected to freezing, suggesting that long-term seed storage may present difficulties (Kennedy et al. 2012, pp. 40, 50–51). While there have been no studies on the reproductive biology of *C. frustrata*, the Service can draw some generalizations from other species of *Chromolaena*, which reproduce sexually. New plants originate from seeds. Pollinators are likely to be generalists, such as butterflies, bees, flies, and beetles (USFWS, 2014).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Barrens, forest, dune (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Moderate to full sun exposure (USFWS, 2013)

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits coastal rock barrens and berms, and sunny edges of rockland hammocks. The environmental specificity is narrow, as the plants occur only along the shore zone of limestone outcrops in southern Florida (NatureServe, 2015). Grows in open canopy habitats in coastal berms and coastal rock barrens and in semi-open to closed canopy habitats, including

buttonwood forests, coastal hardwood hammocks and rockland hammocks (EPA, 2016). It prefers moderate to full sun exposure (USFWS, 2013).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seed dispersal is largely by wind (Lakshmi et al. 2011, p. 1) (USFWS, 2014).

Population Information and Trends

Population Trends:

Decline of 70-90% (NatureServe, 2015)

Species Trends:

30 - 50% decline (NatureServe, 2015)

Resiliency:

Low (inferred from USFWS, 2013)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

8 (USFWS, 2013)

Population Size:

~5,000 (NatureServe, 2015)

Adaptability:

Moderate (inferred from USFWS, 2014)

Population Narrative:

Eupatorium frustratum's restricted ecological range, and its drastic loss of habitat suggest that the number of individuals is declining (Halupa 2002). It once ranged widely in the Florida Keys, and is now known there only from a few small sites; on the mainland, it had several historical localities, and is now known from just one site. This species has experienced a long-term decline of 70-90% and short-term decline of 30 - 50%. Thousands of plants occur densely in one area on Big Munson Island, making counting difficult; a few hundred plants altogether occur at the other sites. In total, fewer than 5,000 plants were estimated in 2003 (Bradley and Gann 2004) and the only population discovered since is not large (USFWS 2005). Only one population has good viability/integrity (NatureServe, 2015). The species appears to be able to rebound at affected sites within a few years (Bradley 2009, pers. comm.) (USFWS, 2014). The current range of *Chromolaena frustrata* includes eight populations spread across 209 km (130 mi) (USFWS, 2013).

Threats and Stressors

Stressor: Habitat modification and destruction (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Habitat destruction and modification resulting from development are considered a major threat to *Chromolaena frustrata* throughout the species' range. The populations on Fiesta Key, Knights Key, Key Largo, and Key West were lost due to development. Fiesta Key is completely developed as a Kampgrounds of America (KOA) campground and is devoid of native plant communities. Knights Key is almost completely developed and has no remaining suitable habitat. Key Largo has undergone extensive disturbance and development. Two *Chromolaena frustrata* populations, including the largest population (Big Munson Island), are located on private lands (the population at Long Key Layton Hammock only partially so), which are vulnerable to further development. (USFWS, 2013)

Stressor: Herbivory (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: On Big Munson Island, much of the *Chromolaena frustrata* population was observed to suffer from severe herbivory in 2004. No insects were observed on any plants, and the endangered Key deer (*Odocoileus virginianus clavium*) was the suspected culprit. The significance of herbivory on *C. frustrata* population dynamics is unknown. (USFWS, 2013)

Stressor: Nonnative plant species (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: *Schinus terebinthifolius* (Brazilian pepper), a nonnative, invasive tree, occurs in the habitat of this species. *Schinus terebinthifolius* forms dense thickets of tangled, woody stems that completely shade out and displace native vegetation. *Schinus terebinthifolius* can dramatically change the structure of rockland hammocks, coastal berms, and shell mounds, making habitat conditions unsuitable for *Chromolaena frustrata*, which prefers moderate to full sun exposure. *Colubrina asiatica* (lather leaf), a nonnative shrub, has invaded large areas of coastal berm and coastal berm edges. *Colubrina asiatica* also forms dense thickets and mats, and is of particular concern in coastal hammocks. *Casuarina equisetifolia* (Australian pine) invades coastal berm and is a threat to suitable habitat at most sites that could support this species. *Casuarina equisetifolia* forms dense stands that exclude all other species through dense shade and a thick layer of needles that contain substances that leach out and suppress the growth of other plants. (USFWS, 2013)

Stressor: Small, isolated populations (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: The current range of *Chromolaena frustrata* includes eight populations spread across 209 km (130 mi) between ENP and Boca Grande Key; four of eight *C. frustrata* populations consist of fewer than 100 individuals. These populations may not be viable in the long term due to their

small number of individuals. Threats exacerbated by small population size include hurricanes, storm surges, climate change, freezing temperatures, and recreation impacts. (USFWS, 2013)

Stressor: Climate change (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Projections suggest that sea level rise is the largest climate-driven challenge to low-lying coastal areas and refuges in the subtropical ecoregion of southern Florida (U.S. Climate Change Science Program (CCSP) 2008). This species occurs in habitats near sea level in areas of south Florida where considerable habitat is projected to be lost to sea level rise by the year 2100. Most populations are located less than 2 m (6.6 ft.) above mean sea level, and the effects of sea level rise are expected to be a continual problem for these species and their habitats. Using Rahmstorf et al. (2007), sea level rise projections of 100 to 140 cm, 80.5 to 92.2 percent of the Florida Keys land area would be inundated by 2100. A 1.8-m (5.9-ft) rise would inundate all existing mainland *Chromolaena frustrata* occurrences in ENP (USFWS, 2013).

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- Fairchild Tropical Botanic Garden (FTBG) has 44 seed collections of *Chromolaena frustrata* from ENP, which were provided to the National Center for Genetic Resources Preservation (NCGRP) for testing and storage, and one collection from Lignumvitae Key. Key West Botanical Garden (KWBG) has one collection of *Chromolaena frustrata* from Big Munson Island. Numerous *C. frustrata* are planted on the KWBG grounds (USFWS, 2013).
- The Service; NPS; State of Florida; Sarasota, Charlotte, Lee, Miami-Dade, and Monroe Counties; and several local governments conduct nonnative species control efforts on sites that support *Chromolaena frustrata* (USFWS, 2013).

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USFWS 2013. Endangered and Threatened Wildlife and Plants

Determination of Endangered Status for *Chromolaena frustrata* (Cape Sable Thoroughwort), *Consolea corallicola* (Florida Semaphore Cactus), and *Harrisia aboriginum* (Aboriginal Prickly-Apple)

Final Rule. 78 Federal Register 206. October 24, 2013. Pages 63795 - 63821

USFWS 2014. Endangered and Threatened Wildlife and Plants

Designation of Critical Habitat for *Chromolaena frustrata* (Cape Sable Thoroughwort)

Final Rule. 79 Federal Register 5. January 8, 2014. Pages 1551 - 1590.

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Final Rule. 78 FR 63795 - 63821 (October 24, 2013).

SPECIES ACCOUNT: *Chrysopsis floridana* (Florida golden aster)

Species Taxonomic and Listing Information

Listing Status: Endangered; Proposed for Delisting

Physical Description

A biennial or perennial herb, growing 2.5-4.0 dm tall. Stems may be erect or ascending. Stems and upper leaves are woolly-haired. Lower leaves are 4-9 cm long; upper leaves are 1-3 cm long. Ray flowers are golden yellow. (Based on Ward 1979.) (NatureServe, 2015)

Taxonomy

Distinct, one of many species in this genus. (NatureServe, 2015)

Historical Range

Historically, *C. floridana* was considered an endemic to the Tampa Bay region of central Florida, which includes Hillsborough, Hardee, Manatee, and Pinellas Counties. The historic distribution of this species could not be determined accurately since most of the suitable habitat in this region had been lost to development by the late 1980s (USFWS 1988, 1999) (USFWS, 2009).

Current Range

C. floridana is known to occur on land in Hillsborough, Manatee, Hardee, and Pinellas Counties (USFWS, 2009).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual and asexual (USFWS, 1988)

Breeding Season

Adult: November (EPA, 2016)

Key Resources Needed for Breeding

Adult: Insect pollinators (EPA, 2016)

Reproduction Narrative

Adult: Produces flowers in November and fruit in late January. Pollination occurs via insects and abiotic factors (EPA, 2016). The plants can spread by forming new basal rosettes at the ends of rhizomes, but reproduction is primarily by seed. The entire genus has an out-crossing breeding system (USFWS, 1988).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Sand pine scrub (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Periodic fire (USFWS, 2009)

Spatial Arrangements of the Population

Adult: Colonial (inferred from USFWS, 1988)

Habitat Narrative

Adult: Inhabits sand pine scrub with exposed sunny openings or occurs on the ecotonal edges of scrub. (NatureServe, 2015). It prefers open, sandy areas within the sand pine scrub community (USFWS 1999). They have been found growing in the ecotone between scrub and other communities. Historically, *C. floridana* was known to occur in scrub habitat on coastal dunes, and was reintroduced to this habitat type at Fort Desoto County Park. Soils are excessively drained and characteristic of sand pine scrub, such as Archbold fine sands, St. Lucie fine sands, Lakewood fine sands, Duette fine sands, and Pomello fine sands (Wunderlin et al. 1981). All of these soils are extremely nutrient-poor and well-drained and are composed primarily of siliceous sand (EPA, 2016). Plants that occupy open sandy areas in scrub habitat rely on periodic fire to prevent canopy closure (USFWS, 2009). It behaves as a colonizing species by invading areas of sunny, bare sand (USFWS, 1988).

Dispersal/Migration**Dependency on Other Individuals or Species for Dispersal**

Adult: Unknown (EPA, 2016)

Dispersal/Migration Narrative

Adult: Dispersal mechanisms are unknown (EPA, 2016).

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Increasing (USFWS, 2009)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

A very restricted Florida endemic with few individuals at each occurrence. There are 1 to 5 occurrences (NatureServe, 2015). The species status is improving; additional surveys conducted

in 2004, 2006, and 2008 found additional *C. floridana* on conservation lands in Hillsborough, Manatee, and Pinellas Counties and on private lands in Hardee County. Markham (1998) found that there were little genetic differences between sites (USFWS, 2009).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Although habitat loss has been reduced, there are still private lands and conservation lands throughout the species' range that could be lost due to habitat destruction or lack of management. Lack of management (i.e., prescribed fire) has led to habitat degradation of *C. floridana* throughout its range. *C. floridana* occurs mainly in open sandy patches that have been controlled under natural conditions with fire. Without natural-caused or prescribed fires, the habitat can become overgrown and may lead to the establishment of exotic grasses, thus making the habitat unsuitable for *C. floridana* (USFWS, 2009).

Recovery

Reclassification Criteria:

1. When ten (10) geographically distinct self-sustaining populations of the plant are protected in Hardee, Hillsborough, Manatee, and Pinellas Counties, Florida (USFWS, 1988).

Delisting Criteria:

1. When twenty (20) geographically distinct self-sustaining populations of the plant are protected in one or more of the following counties: Hardee, Hillsborough, Manatee, and Pinellas Counties, Florida. (USFWS, 1988)

Recovery Actions:

- Protect habitat of the Florida golden aster. Because most of the habitat presently occupied by this plant can be protected through Federal government actions. Because the golden aster's habitat requirements are reasonably well understood, it should be feasible to protect unoccupied suitable habitat. (USFWS, 1988)
- Augment existing populations of Florida golden aster. Expand protected populations and attempt to establish populations on protected sites with sand pine scrub or coastal dune habitat. (USFWS, 1988)
- Enforce available protective legislation. Employ local, State, and Federal regulations to protect sand pine scrub vegetation containing Florida golden aster. (USFWS, 1988)
- Provide public information about Florida golden aster. The support of governmental agencies, conservation organizations such as the Florida Native Plant Society, and garden clubs may be crucial to the recovery of this species. The local press should also be kept informed of conservation activities. (USFWS, 1988)
- Conserve germ plasm. The Center for Plant Conservation sponsors the establishment of garden populations of endangered plants at member botanical gardens. Bok Tower Gardens in Lake Wales, Florida is working with this species. The center can also arrange long-term seed storage in cooperation with the U.S. Department of Agriculture. (USFWS, 1988)

Conservation Measures and Best Management Practices:

- Revise the current recovery plan to include updated objective and measurable recovery criteria for delisting that are related to reducing the threats identified in the recovery plan, as well as updated information on the species distribution and biology (USFWS, 2009).
- Support further research on: a. The effects of prescribed burning and other management tools on *C. floridana*. b. Life history needs. c. Microhabitat requirements of this species (USFWS, 2009).
- Continue working with public land managers to increase management efforts to benefit *C. floridana* on their sites (USFWS, 2009).
- Encourage non-Federal agencies and private landowners to protect and manage habitat under the Service's Partners for Fish and Wildlife Program (USFWS, 2009).
- Continue conducting rangewide surveys to provide distribution information needed to determine where plants currently exist and to prioritize recovery actions (USFWS, 2009).
- Continue reintroduction and monitoring of *C. floridana* on additional publicly owned lands with suitable habitat. Reintroduction of *C. floridana* could help to increase the number of populations on protected sites and augment existing populations where needed (USFWS, 2009).

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SPECIES ACCOUNT: *Cirsium fontinale* var. *fontinale* (Fountain thistle)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/06/1995; California/Nevada (Region 8)

Physical Description

An herbaceous perennial of the aster family (Asteraceae) with several stout, erect reddish stems 30 to 60 centimeters (1 to 2 feet) high. The basal leaves are 10 to 20 centimeters (4 to 8 inches) long with spine-tipped lobes; the leaves on the stems are smaller. The flowers are dull white to pinkish, becoming brown with age (Munz and Keck 1959, Hickman 1993). The egg-shaped, recurved bracts beneath the flower head of *Cirsium fontinale* var. *fontinale* distinguish it from the most similar thistle in the area, brownie thistle (*Cirsium quercetorum*) (Niehaus 1977a). (USFWS, 1998)

Taxonomy

Cirsium fontinale var. *fontinale* (fountain thistle) was first described as *Cnicus fontinalis* (Greene 1886a). In 1892, Greene reassigned the plant to the genus *Carduus* (Greene 1892). Willis Jepson, in his *Flora of Western Middle California* (1901), put the taxon in the genus *Cirsium*. In 1938, John Thomas Howell described a close relative of the fountain thistle, *Cirsium fontinale* var. *obispoense* (Chorro Creek bog thistle) (Howell 1938). (USFWS, 1998)

Historical Range

May have occurred in both San Mateo and Santa Clara Counties (Niehaus 1977a) although the Santa Clara County location may be erroneous (California Natural Diversity Data Base 1996. D. Kelch, pers. comm., 1996) (USFWS, 1998)

Current Range

San Mateo County, California. (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (hybridization) (USFWS, 1998)

Breeding Season

Adult: June to October (USFWS, 2010)

Key Resources Needed for Breeding

Adult: The primary pollinators for *C. fontinale* var. *fontinale* in this study were Vosnesenski's bumblebee (*Bombus vosnesenskii*), common honeybee (*Apis mellifera*), and sweat bees (*Halictidae*). A study showed that *C. fontinale* var. *fontinale* experienced a 90 percent reduction in seed production when pollinators were excluded. (USFWS, 2010)

Reproduction Narrative

Adult: Generally, the flower heads are grouped into clusters and are nodding when in bloom. Flowers are white to pink or lavender and appear from June to October (Keil and Turner 1993). The species may hybridize with *Cirsium quercatorum* (McClintock and Danielson 1975, California Native Plant Society 1988b, California Natural Diversity Data Base 1996). The primary pollinators for *C. fontinale* var. *fontinale* in this study were Vosnesenski's bumblebee (*Bombus vosnesenskii*), common honeybee (*Apis mellifera*), and sweat bees (Halictidae). A study showed that *C. fontinale* var. *fontinale* experienced a 90 percent reduction in seed production when pollinators were excluded. (USFWS, 1998; USFWS, 2010)

Habitat Type

Adult: Serpentine seeps (USFWS, 2019)

Habitat Vegetation or Surface Water Classification

Adult: Grasslands or chaparral (USFWS, 2019)

Dependencies on Specific Environmental Elements

Adult: Found at elevations between 90 and 190 m (300 to 600 feet) (USFWS, 1998)

Habitat Narrative

Adult: *Cirsium fontinale* var. *fontinale* is found in serpentine seeps in grasslands or chaparral. The largest occurrence of the species, which is a group of approximately 10 subpopulations, is located on the east side of Crystal Springs Reservoir and is approximately 400 feet in elevation. Other plant species which occur there are tufted hairgrass (*Deschampsia caespitosa* ssp. 8 *holciformis*), bugle hedgenettle (*Stachys ajugoides*), seep monkeyflower (*Mimulus guttatus*), creeping wild rye (*Leymus triticoides*), coyote brush (*Baccharis pillularis*) and the invasive species, pampas grass (*Cortaderia selloana*). The Stulsaft Park occurrence is found in a serpentine seep in an opening in a coast live oak-bay (*Quercus agrifolia* – *Umbellularia californica*) woodland. The elevation of this site is 150 feet and the associated plants are spike bentgrass (*Agrostis exarata*), twotooth sedge (*Carex serratodens*), blue wildrye (*Elymus glaucus*) and iris-leaf rush (*Juncus xiphioides*) (CNDDDB 2010). The occurrence east of Woodside Glens is located on a serpentine seep in an open area associated with sedges (*Carex* sp.), willows (*Salix* sp.), and monkeyflower (*Mimulus* sp.) (CNDDDB 2010). The elevation of this site is not known. (USFWS, 2010)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Number of Populations:

3 (USFWS, 2019)

Population Size:

~25,000 (USFWS, 2019)

Population Narrative:

At the time of listing in 1995, three *Cirsium fontinale* var. *fontinale* occurrences were known to exist: 1) the occurrence located east of Crystal Springs Reservoir which contained between 1,000 and 2,800 plants, 2) the occurrence located 10 km (6 mi) to the south in the Triangle area which contained between 100 and 200 plants, and 3) the third occurrence in Edgewood Park which consisted of a single plant in 1987. The most recent data show that a newly discovered portion (Boat Ramp) of the Crystal Springs Reservoir occurrence, Element Occurrence 1, had 19,342 plants in December 2009 (S. Foree, in litt., January 12, 2010). Survey data collected from 2007 to 2009 estimate that the entire Crystal Springs occurrence consists of approximately 7 25,000 plants (Environmental Science Associates 2010). The Triangle area occurrence declined to 7 plants by 2000 (CNDDDB 2010) and is no longer considered extant as of 2009 (S. Foree, San Francisco Water District, pers. comm., August 5, 2009). The single plant in Edgewood Park disappeared in 1996 (CNDDDB 2010). Two small occurrences have been found since the time of listing. An occurrence of 50 plants (Element Occurrence 7) was discovered at Stulsaft Park, in Redwood City, in 2007. Another occurrence of about 20 plants (Element Occurrence 8) was found east of Woodside Glens in 2003 (CNDDDB 2010). Currently, three occurrences of *Cirsium fontinale* var. *fontinale* are known to exist. (USFWS, 2019)

Threats and Stressors

Stressor: Hydrologic changes (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: A small project to widen Highway 92 east of Crystal Springs Reservoir was under review and removal of water from the increased road surface had the potential to adversely affect some of the plants. Proposed construction of multi-use trails on San Francisco Water Department land in the Triangle area west of I-280 was considered a threat to a small occurrence through modification of hydrologic regimes and direct loss of plants. *C. fontinale* var. *fontinale* is dependent on seeps and springs, therefore, any reduction in water flow would have threatened the plants. A single plant in Edgewood Park occurred in a drainage ditch beside a trail. Clearing of this ditch to improve drainage could have damaged or destroyed the plant and any seedlings it may have produced. (USFWS, 2010)

Stressor: Habitat alteration (USFWS, 1998)

Exposure:

Response:

Consequence:

Narrative: Decline of populations in the Crystal Springs region of San Mateo County has been attributed to destruction of habitat from urbanization, alteration of local hydrology (California Native Plant Society 1988b), dam construction in the 19th century (D. Kelch, in litt., 1996) and highway construction (Niehaus 1977a, K. Berg, in litt., 1991). The type locality suffered negative impacts from construction of the Interstate 280 and the Highway 92 interchange. Some seeps were incidentally created in the process of construction and may provide habitat for *Cirsium*

fontinale var. fontinale (D. Kelch, in litt., 1996). The available information is insufficient to evaluate whether the seeps and drainages in question supported *Cirsium fontinale* var. *fontinale* before construction or were colonized as a result of the project (B. Olson, in litt., 1998). (USFWS, 1998)

Stressor: Predation by beetle larvae (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Seed predation by unspecified insect larvae continued to be observed in seed collected from the Crystal Springs Reservoir occurrence in 2009 and 2010 (M. Wall in litt., 2009, 2010); however the effects of insect predation on *C. fontinale* var. *fontinale* have not been studied. . (USFWS, 2010)

Stressor: Non-native plants (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Several subpopulations were known to be threatened by nonnative plant species including pampas grass (*Cortaderia selloana*). Dumping of garden debris from households on the ridge above the plants covered the plants and rendered the habitat unsuitable for plant establishment and growth. Seed predation had been observed and was thought to increase the vulnerability of the species to elimination by chance events. A portion of Element Occurrence 1 near the intersection of Highway 92 and Interstate 280 is impacted by jubata grass (*Cortaderia jubata*) (S. Foree, pers. comm., August 5, 2009). (USFWS, 2010)

Stressor: Pollinators population decline (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: A threat that has become evident since the time of listing, is the species' dependence on a limited number of pollinators, one of which (the common honeybee) is in decline. The Powell et al. (2009) study on *Cirsium fontinale* var. *fontinale* found that seed production was reduced by 90 percent when pollinators were excluded. The primary pollinators were the yellow-face bumblebee (*Bombus vosnesenskii*) and the honeybee (*Apis mellifera*). Native bumblebees and honeybees are in serious decline. A decline in the abundance and distribution in North America of several native bumblebees has been noted since the mid 1990's (Evans et al. 2008). Although it is not known whether *B. vosnesenskii* is experiencing losses, the severe decline of several previously common bumblebees, including the recent disappearance of the western bumblebee (*Bombus occidentalis*) from northern and central California, is cause for concern. A similar loss of the primary pollinators for *C. fontinale* var. *fontinale* would result in greatly reduced seed production and fewer numbers of plants. (USFWS, 2010)

Stressor: Habitat fragmentation (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Habitat fragmentation and loss from Highway 92 widening. Construction of trails on San Francisco Public Utilities Commission land in the Triangle could result in loss of plants or modification of hydrology. (USFWS, 2010)

Stressor: Nonnative insects (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: This species is threatened by the invasion of nonnative Argentine ants (*Linepithema humile*) and their impact on seed dispersal. Fountain thistle seeds contain a fat- and protein-rich protrusion known as an elaiosome, which native ants are known to eat. Dispersal occurs when a native ant either drops the seed while carrying it to their nest for later consumption or by eating the elaiosome and leaving the rest of the seed buried, which can then germinate when conditions are appropriate (Pemberton and Irving 1990; Christian 2001). Conversely, Argentine ants are known to consume the elaiosomes and leave the rest of the seed exposed under the parent plant, leaving it vulnerable to predation, disease, fire, and increased competition due to being in close proximity to its parent plant (Christian 2001). Since Argentine ants are known to displace native ants in areas they have invaded (Holway et al. 2002), and Argentine ants have been documented throughout the range of the fountain thistle (Niederer and Elliott 2011), it is likely the dispersal of fountain thistle at each known location has declined. (USFWS, 2019)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The Endangered Species Act is the primary Federal law that has provided protection for these species since the dates of their listing as endangered in 1985 and 1995. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent their status under the Act. Therefore, we continue to believe other laws and regulations have limited ability to protect the species in absence of the Endangered Species Act. (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Climate is predicted to change in California during the 21st century (Field et al. 1999; Cayan et al. 2005). Even modest changes in warming could result in a reduction of the spring snowpack, earlier snowmelt, and more runoff in winter with less runoff in spring and summer, more winter flooding, and drier summer soils (Field et al. 1999; Cayan et al. 2005). The predicted impacts on California's ecosystems projected with a high certainty include higher sea level; decreased suitable habitat for many terrestrial species as climate change intensifies human impacts; and increased competition among urban, agricultural, and natural ecosystem uses (Field et al. 1999). Although the specific effects of climate change on *Cirsium fontinale* var. *fontinale* are unknown, the effects of increased winter flooding and drought conditions in the spring have the potential to adversely affect these species. (USFWS, 2010)

Recovery

Reclassification Criteria:

A/1: Occupied habitats at Crystal Springs Reservoir, Stulsaft Park, and Woodside Glens, and former known habitat at the Triangle and Edgewood Park sites, are fully protected and managed with the primary intention of preserving them in perpetuity. Each protected area includes occupied habitat with adjacent unoccupied habitat and a 150-meter (500-foot) buffer, where possible.¹³ Alternatively, currently unoccupied sites may be protected as a substitute for currently occupied sites (or sites containing former known habitat) if they are of equivalent habitat quality, are managed through a Service-approved management plan (see A/2 below), and meet the occupancy criterion (see E/1 below). Populations should be secured through voluntary land acquisitions, conservation easements, or other means. (USFWS, 2019)

A/2: Management plan(s), approved by the Service, are implemented for the populations located at Crystal Springs Reservoir, Stulsaft Park, and Woodside Glens and any adjacent occupied or unoccupied habitat identified as essential to continued survival. Management plans include survival of the species as an objective; provisions for standardized monitoring of populations every 3 years to determine demographic trends; and strategies to control nonnative, invasive plant species¹⁴ and Argentine ants.¹⁵ Adequate funding is secured to implement the management plan(s) in perpetuity. (USFWS, 2019)

E/1: Unless research shows otherwise, populations under A/1 contain a minimum of 2,000 reproductive, self-regenerating adults to produce a mixture of reproductive stages (seedlings, juveniles, adults) sufficient to ensure self-perpetuation. The Crystal Springs Reservoir population contains a minimum of 20,000 reproductive, self-regenerating adults that are well distributed throughout each subpopulation.¹⁶ Each population and subpopulation contains reproductive, self-regenerating adults to produce a mixture of reproductive stages sufficient to ensure self-perpetuation. (USFWS, 2019)

E/2: As described in A/2, standardized population monitoring at Crystal Springs Reservoir, Stulsaft Park, Woodside Glens or any alternative site (see A/1) shows stable or increasing populations with evidence of natural recruitment over a period of 20 years that includes two normal precipitation cycles¹⁷ (or longer if suggested by the results of demographic monitoring). Because the species is a biennial to short-lived monocarpic perennial, generally flowering and dying no later than its 3rd year from seed, monitoring should include both flowering and vegetative individuals. (USFWS, 2019)

E/3 Seeds are stored in at least two Center for Plant Conservation certified facilities and reliable seed germination and propagation techniques are understood. (USFWS, 2019)

Delisting Criteria:

Delisting criteria have not been developed. (USFWS, 1998; USFWS, 2019)

Recovery Actions:

- Recovery actions are not available.
- Protect and manage the remaining populations by working with San Francisco Water Department, Caltrans, and San Mateo County to ensure the long-term survival of the species on their lands. In general, the largest possible block of serpentine habitat should be protected at each site. Protection should, at least, involve securing the populations

- themselves as well as a 150-meter (500-foot) buffer around each population, where possible, to reduce external influences and allow expansion of populations. In some cases, it may be necessary to enlarge the buffer to include the entire local watershed; sites and their watersheds should be evaluated individually (R. Bittman, in litt., 1998). (USFWS, 1998)
- Other unoccupied habitat at the sites that might provide space for expansion of the populations and habitat for pollinators and seed dispersers must be protected. Management plans emphasizing *Cirsium fontinale* var. *fontinale* and other special status species in these locations must be developed and implemented. The plans should include provisions for standardized monitoring of *Cirsium fontinale* var. *fontinale* populations every 3 years to determine demographic trends. The plans should also include strategies to minimize known threats at the sites as well as to identify new threats as they may appear. In particular, threats from invasive non-natives and from recreational activities must be eliminated; the former is an especially high priority for recovery. Where pampas grass (*Cortaderia* spp.) removal is required, cautions must be taken to avoid adverse impacts to federally listed animal species that may occur in the area (e.g. San Francisco garter snake [*Thamnophis sirtalis tetrataenia*]). (USFWS, 1998)
 - If new threats are identified or other new information becomes available, management plans need to be reevaluated and revised. (USFWS, 1998)
 - Collection and banking of seed in Center for Plant Conservation certified botanic gardens is also a high priority in recovery efforts for *Cirsium fontinale* var. *fontinale*. Collections are prudent to guard against extinction of the species from chance catastrophic events and to provide potential material for enhancement efforts in existing populations, repatriation, and/or introductions to new sites. All known populations should be represented in seed collections. Care should be taken to ensure that seed collection does not adversely affect the donor populations. (USFWS, 1998)
 - Activities of lower priority include surveys of potential habitat and research. Surveys of other serpentine habitat within the species' range should be conducted to determine whether undiscovered populations may exist. If new populations are discovered, they should be protected and managed as discussed above. During these surveys, potential introduction sites might also be identified. At least some of these surveys would require the cooperation of the San Francisco Water Department because suitable habitat occurs on their land. (USFWS, 1998)
 - Research topics that need to be addressed include seed predation by the seedhead weevil (*Rhinocyllus conicus*), frequency of and potential threat from hybridization with brownie thistle (*Cirsium quercetorum*), seed germination and propagation techniques, the role of disturbance in colonization, reproduction (mating system and pollination), and demography (e.g. to identify limiting life history stages). (USFWS, 1998)

Conservation Measures and Best Management Practices:

- Conduct surveys at occurrences of all three species which have not been visited for five years to determine if habitat remains and whether these areas would be suitable reintroduction sites if the species is no longer present. (USFWS, 2010)
- Collect information on habitat preferences for all species in order to facilitate the search for suitable habitat for outplanting. Data to be collected should include associated plant communities, soil types, soil nutrients, pollinators, and hydrology of the currently occupied habitat as well as the historically occupied sites. Conditions at currently occupied sites may not represent the habitat that supported

the species at historic locations, particularly for *Pentachaeta bellidiflora* which had a far greater range historically and likely more variability between sites. (USFWS, 2010)

- Conduct research on propagation methods for the *Cirsium fontinale* var. *fontinale* and *Pentachaeta bellidiflora* for future outplantings and habitat restoration. (USFWS, 2010)
- Conduct research on the relationship between *Cirsium fontinale* var. *fontinale* and *Deschampsia caespitosa* ssp. *holciformis* (tufted hairgrass). Determine if *D. caespitosa* ssp. *holciformis* is critical to outplantings and restoration of *C. fontinale* var. *fontinale* occurrences. (USFWS, 2010)
- Determine identity and importance of pollinators for *Acanthomintha obovata* ssp. *duttonii* and *Pentachaeta bellidiflora*. (This information has already been collected for *Cirsium fontinale* var. *fontinale*). Determine habitat needs of the pollinators and ways to incorporate this information into management and restoration/outplanting plans for the species. (USFWS, 2010)

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SPECIES ACCOUNT: *Cirsium fontinale* var. *obispoense* (Chorro Creek bog thistle)

Species Taxonomic and Listing Information

Listing Status: Endangered; 1/17/1995; California/Nevada (Region 8)

Physical Description

A biennial or short-lived perennial plant up to 2 meters (m) (6.6 feet (ft)) tall in the aster and sunflower family (Asteraceae). The leaves are spiny with glandular hairs on the upper and lower surfaces. The flowers are white, pink, or lavender with a drooping posture (Figure 1). Each flower head produces an average of 73 seeds up that are up to 4 millimeters (mm) (0.2 inches (in)) long (Turner and Herr 1996). Seeds are topped with a pappus (set of bristles) that aids in dispersal. (USFWS, 2014)

Taxonomy

Chorro Creek bog thistle (*Cirsium fontinale* var. *obispoense*) is in the composite family (Asteraceae) and is one of three varieties of *C. fontinale* and is distinguished from the other two by a combination of morphological characteristics involving the stem, leaf, inflorescence, flower, and fruit. *Cirsium fontinale* var. *obispoense* is geographically separated from the other two varieties. The species first was described by Edward L. Greene in 1886 as *Cnicus fontinalis*. Six years later, he transferred the plant to the genus *Carduus*, and in 1901 Jepson transferred the plant to the genus *Cirsium*. In 1938, J. (USFWS, 2014)

Historical Range

Local endemic on serpentine in San Luis Obispo County, California. (NatureServe, 2015)

Current Range

In San Luis Obispo County, California. The known geographic range comprises 462 square km (178 square mi), extending from San Simeon Creek (35.630897°N, 121.060711°W) to the vicinity of the city of San Luis Obispo (a distance of 56 km (35 mi)). All known occurrences of *Cirsium fontinale* var. *obispoense* are west of the outer coast ranges of the Central Coast Region in San Luis Obispo County, California. (USFWS, 2014)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: 2-3 years (USFWS, 2014)

Breeding Season

Adult: May to July and occasionally extends into September or October (Magney 2006). (USFWS, 2014)

Reproduction Narrative

Adult: *Cirsium fontinale* var. *obispoense* typically live 2 or 3 years. The plants usually flower during the second spring and then die after flowering. However, some plants may persist into a third year if sufficient energy reserves remain (Chipping 1994). Flowering occurs generally during May to July and occasionally extends into September or October (Magney 2006). Each flower head produces an average of 73 seeds up that are up to 4 mm (0.2 in) long (Turner and Herr 1996). (USFWS, 2014)

Habitat Type

Adult: Palustrine wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Bog/fen, herbaceous wetland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations of 37 to 381 m (120 to 1,250 ft) (USFWS, 2014)

Spatial Arrangements of the Population

Adult: Colonies (USFWS, 2014)

Habitat Narrative

Adult: *Cirsium fontinale* var. *obispoense* occupies perennial seeps and springs in serpentine soil and rock in western San Luis Obispo County, California (Figure 3). The plants usually occur on slopes, with existing records at 37 to 381 m (120 to 1,250 ft) elevation (CDFW 2013a). The plants often grow in colonies (spatial groups of presumably separate individuals). (USFWS, 2014)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Seeds are topped with a pappus (set of bristles) that aids in dispersal. (USFWS, 2014)

Population Information and Trends**Population Trends:**

Not available

Number of Populations:

19 (USFWS, 2014)

Population Size:

~10,000 (inferred from USFWS, 2014)

Adaptability:

Low (inferred from USFWS, 2014)

Population Narrative:

The taxon is currently known from 19 occurrences, and multiple colonies comprise most occurrences. The Service considers stochastic events, in particular drought, an ongoing threat. Because *Cirsium fontinale* var. *obispoense* is associated with seeps and springs, a severe or prolonged drought could reduce or eliminate its specialized habitat and result in the extirpation of some occurrences. Six occurrences have been reported to comprise more than 1,000 plants at particular points in time: occurrence 1 at San Simeon Creek (1,076 plants in 1993; CDFW 2013a), occurrence 2 at Laguna Lake Park (approximately 2,075 plants in 2006; M. Elvin, Service, pers. obs. 2006), occurrence 3 at Camp San Luis Obispo (1,872 plants in 2008; Holland 2009), occurrence 6 in the El Chorro Biological Reserve (2,200 plants in 1993; Chipping 1994), occurrence 10 at Miossi Creek (more than 1,000 plants in 1997; CDFW 2013a), and near Serpentine Lane (more than 4,000 plants in 2001; CDFW 2013a). The other 13 occurrences are each likely comprised of fewer than 1,000 plants in 2014, with the most recent estimates ranging from 0 to 800 plants per occurrence. (USFWS, 2014)

Threats and Stressors

Stressor: Road maintenance (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Road maintenance (including grading, road expansion, mowing, herbicide application) and water diversions were identified as potential threats at that time (Wikler and Morey 1992). (USFWS, 2014)

Stressor: Invasive plants (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Although the serpentine substrate is not conducive for most invasive plant species (Harrison et al. 2006.), *Cortaderia* (pampas grass) became established in the habitat and which the City of San Luis Obispo removed in 2010. Magney (2006) reported that the invasive *Sonchus asper* (prickly sow thistle) was invading the habitat and that it was being eradicated. Some occurrences are threatened by dense vegetation in and near the habitat, including native (*E. macrostachya*, *Distichlis spicata* (salt grass)) and invasive species (*Helminthotheca echioides* (bristly oxtongue), *Centaurea calcitrapa* (purple star-thistle), *S. asper*) (J. Olson, Colorado State University, pers. comm. 2012). (USFWS, 2014)

Stressor: Cattle grazing (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Several properties where *Cirsium fontinale* var. *obispoense* is found is zone for grazing. Light, controlled cattle grazing is conducted in some habitats, which appears to benefit *Cirsium fontinale* var. *obispoense* by reducing invasive plants (Siepel, pers. comm. 2012). (USFWS, 2014)

Stressor: Agriculture (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: A small area (approximately 2 ha (5 ac)) of the property on the northern side of Chorro Creek is planted with row-crops, and likewise the adjacent property. This agriculture is in close proximity to *Cirsium fontinale* var. *obispoense* in Chorro Creek and is not compatible with its survival. (USFWS, 2014)

Stressor: Predation by insects (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: The Eurasian flower-head weevil has been reported preying on *Cirsium fontinale* var. *obispoense* at several sites (Service 1994), including San Simeon Creek (Chipping 1994; Herr 2004), Laguna Lake Park (Herr 2004), and Camp San Luis Obispo (California Army National Guard 2012). In a study on one property at San Simeon Creek, 28 percent of the flower heads of *Cirsium fontinale* var. *obispoense* were infested throughout the plant's growing season, with 27 percent of the seeds destroyed on average in the preyed flower heads. (USFWS, 2014)

Stressor: Herbivory by cattle (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: There are two issues to consider regarding cattle grazing in and near the habitat of *Cirsium fontinale* var. *obispoense*: herbivory and trampling. Trampling by cattle while grazing in the habitat could severely damage established plants, especially when water becomes limited to the cattle and they congregate at the seep or spring. (USFWS, 2014)

Stressor: Stochastic events (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Species with small populations are vulnerable to extinction by stochastic events (Ricklefs 2008). This means that chance or random events can cause the population size of the species to decrease, possibly below the level of sustainability and down to extinction. We consider stochastic events, in particular drought, an ongoing threat. Because *Cirsium fontinale* var. *obispoense* is associated with seeps and springs, a severe or prolonged drought could reduce or eliminate its specialized habitat and result in the extirpation of some occurrences. (USFWS, 2014)

Stressor: Climate change (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: We identify climate change as a new threat. Current climate change projections for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999; Cayan et al. 2005; IPCC 2007). We lack adequate information to make specific and accurate predictions regarding how climate change in combination with other factors such as isolation at perennial seeps and springs will affect *Cirsium fontinale* var. *obispoense*. However, limited-range taxa are

likely to be more vulnerable to extinction due to these changing conditions. Our major concern is the effects of extreme weather events (e.g., severe drought, severe storm, harsh winter) due to climate change on the 19 occurrences of *Cirsium fontinale* var. *obispoense*. (USFWS, 2014)

Recovery

Reclassification Criteria:

1. Populations from throughout the range, each made up of multiple colonies, and their habitat at six sites are secure from human-induced threats, including water diversions or drawdowns. (USFWS, 1998)
2. At least three of these sites are in protected areas larger than 100 acres and populations are deemed viable and stable or increasing as determined by monitoring over a precipitation cycle that includes multiple years of below average rainfall. (USFWS, 1998)
3. Protected sites are being managed in a way that will support the continued existence of *Cirsium fontinale* var. *obispoense* and its wetland habitat. (USFWS, 1998)
4. Management is effective, as shown by at least 10 years of monitoring. (USFWS, 1998)

Delisting Criteria:

When the downlisting criteria have been met for a species, the species can be considered for delisting if:

1. Threats are reduced or eliminated so that occurrences are capable of persisting without significant human intervention or perpetual endowments are secured for management necessary to maintain the continued existence of the species (USFWS, 2019)
2. An ex situ seedbank is established in a Center for Plant Conservation-affiliated botanic garden. While sufficient seedbank in the soil would typically provide a strategy for the taxon to persist through several years of short- or medium-term drought, it may not be sufficient to persist through long-term drought. Therefore, an ex situ seedbank would provide assurance that a occurrences could be reseeded, should long-term drought – or other stochastic events – make it necessary; (USFWS, 2019)
3. All existing occurrences are stable or increasing in the wild for at least 10 years. We expect above-ground occurrences size to fluctuate annually, based on response to amount and timing of rainfall (e.g. see Fox et al. 2006). Therefore, a period of 10 years should be long enough to include most of the variability in rainfall that occurs in this region (Zedler & Black 1989; NOAA 2018). Ten occurrences were surveyed during the 5-year period from 2012 to 2016, which will provide a baseline for the status of these occurrences; these data should provide a basis for monitoring occurrence attributes to determine trajectory over time. (USFWS, 2019)

Recovery Actions:

- Secure populations and habitat on unprotected lands. Methods for securing lands include in-fee purchase, gifts of easement or fee interest by the property owner, deed restrictions (provided restrictions cannot be changed privately without the knowledge of Federal, State

and County agencies), acquisition of property rights (e.g., development rights) or permanent conservation easements. (USFWS, 1998)

- Manage secured lands to control or eliminate other known threats. Although habitat alteration through development is currently the most substantial and irreversible threat facing all of the species in this plan, the management of lands secured from development will remain a formidable task, made more so in those cases where the secured habitats are adjacent to high density residential and urban development. (USFWS, 1998)
- Evaluate potential threats and conduct management-oriented research. Conduct habitat-oriented research for Morro Bay species. Conduct species-specific research. Evaluate research results and use in future management. (USFWS, 1998)
- Determine population dynamics and effects of recovery efforts. Studies should be conducted to learn the number and size of successful self sustaining populations for the species to establish criteria for its reclassification. (USFWS, 1998)
- Develop and implement an education/information program. The benefits of protecting native species and their habitats and maintaining native biological communities should be explained clearly to all concerned parties. (USFWS, 1998)
- Reevaluate recovery criteria and revise recovery plan based on expanded knowledge from research, monitoring, and management. The scientific validity of the recovery criteria and recovery plan should be reviewed and revised as more information becomes available. The criterion of maintaining sufficient numbers of populations or conservation areas should be assessed, and the success or failure of management actions should be evaluated. (USFWS, 1998)
- Recommendation from 2014 5-Year Review: Additional occurrences of *Cirsium fontinale* var. *obispoense* likely exist in San Luis Obispo County, and also possibly in Monterey and Santa Barbara Counties. We recommend that searches be conducted in potentially suitable habitat with serpentine soil and rock in San Luis Obispo, Monterey and Santa Barbara Counties. (USFWS, 2014)
- Recommendation from 2014 5-Year Review: We recommend that the Service seek partnerships with the private landowners for assisting them to manage *Cirsium fontinale* var. *obispoense* on their properties. (USFWS, 2014)
- Recommendation from 2014 5-Year Review: We recommend that a range-wide census of the 19 occurrences be conducted in 2015 as a team effort including the California Army National Guard, the California Native Plant Society (San Luis Obispo Chapter), California Polytechnic State University, the City of San Luis Obispo, the private landowners, and the Service. The methods should be standardized in advance. (USFWS, 2014)
- Recommendation from 2014 5-Year Review: We recommend that the relevant biologists, landowners, and land managers monitor for invasive plant species in and near the habitat of *Cirsium fontinale* var. *obispoense* and take the necessary actions to eliminate this threat. (USFWS, 2014)
- Recommendation from 2014 5-Year Review: We recommend that any cattle grazing in the habitat of *Cirsium fontinale* var. *obispoense* be controlled and monitored. A controlled grazing regime may benefit *Cirsium fontinale* var. *obispoense* by reducing other vegetation (invasive and native) in and near the habitat and by providing favorable sites for the germination of seeds. Herbivory of *Cirsium fontinale* var. *obispoense* would be minor because their spiny characteristics make them generally unpalatable. However, trampling could severely damage the established plants, especially when water becomes limited to the cattle and they congregate in the seep or spring. (USFWS, 2014)

- Recommendation from 2014 5-Year Review: The relevant biologists, landowners, and land managers should be aware of the introduced Eurasian flower-head weevil and the threat it poses to *Cirsium fontinale* var. *obispoense*. We recommend that they monitor for and report the presence of this introduced insect to the U.S. Fish and Wildlife Service, Ventura, California, and to the Department of Agriculture for San Luis Obispo County, California. (USFWS, 2014)

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SPECIES ACCOUNT: *Cirsium hydrophilum* var. *hydrophilum* (Suisun thistle)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/20/1997; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

A perennial herb with erect stems, usually 1-1.5 m tall, and with spiny, deeply lobed leaves. Pale lavender or pink flower heads, 2-2.5 cm long, are borne singly or in loose groups. In the pre-flowering phase, it grows as a short, broad, vegetative rosette with large leaves, approximately 0.3 to 0.9 m long. Stems are typically branched above the middle of the main stem, but up to 15 stems may occasionally branch from the base of single large plants (P. Baye unpubl. data 2000). Leaves on stems are much smaller, more deeply lobed, and spiner than juvenile leaves of the rosette. The egg-shaped flowerheads (2.5 cm) are composed of small individual florets united into a single unit. Flowerheads occur either as solitary units or in clusters. The bracts of the flowerheads have a distinct green, glutinous ridge on the back that distinguishes *C. hydrophilum* var. *hydrophilum* from other *Cirsium* species in the area. (USFWS, 2013)

Taxonomy

Cirsium hydrophilum var. *hydrophilum* was originally described as *Cnicus breweri* Gray var. *vaseyi* Gray (Gray 1888). *Cnicus breweri* is a taxon now placed in *Cirsium douglasii* DC var. *breweri* (A. Gray) (Keil and Turner 1993). Subsequent synonyms, now invalid, include *Carduus hydrophilus* Greene (Greene 1892) and *Cirsium vaseyi* (Gray) Jepson var. *hydrophilum* (Greene) Jepson (Jepson 1925). Jepson (1901) was the first to apply the combination *Cirsium hydrophilum*. The species *Cirsium hydrophilum*, as now interpreted, (Howell 1969, Keil and Turner 1993) comprises two morphologically similar varieties: *C. hydrophilum* var. *vaseyi*, (synonym: *Cirsium vaseyi* [A. Gray] Jepson), a related rare thistle endemic to seeps in serpentine soils on Mount Tamalpais, Marin County, and *C. hydrophilum* var. *hydrophilum*, endemic to brackish tidal marshes in Suisun Marsh, Solano County. (USFWS, 2013)

Historical Range

Not available

Current Range

Cirsium hydrophilum var. *hydrophilum* is only known from locations in Suisun Marsh.

Critical Habitat Designated

Yes; 4/12/2007.

Legal Description

On April 12, 2007, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cirsium hydrophilum* var. *hydrophilum* (Suisun thistle) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes five critical habitat units (CHUs), in California (72 FR 18518-18553).

Critical Habitat Designation

The critical habitat designation for *Cirsium hydrophilum* var. *hydrophilum* includes three CHUs in Solano County, California. This species critical habitat encompasses approximately 2,052 acres (ac) (830 hectares (ha)) (72 FR 18518-18553).

Unit 1: Hill Slough Marsh: Unit 1 consists of approximately 525 ac (213 ha) located north of Potrero Hills between Grizzly Island Road and Highway 12. As discussed in “Criteria Used to Identify Critical Habitat for *Cirsium hydrophilum* var. *hydrophilum*” above, this unit is currently unoccupied and was unoccupied at the time of listing, but it is essential to the conservation of the subspecies because it is the single best area for establishment of an additional population (see response to Comment 2). It contains all the necessary PCEs and is the subject of ongoing planning and restoration efforts within the Suisun Marsh. The unit consists of approximately 440 ac (178 ha) of State-owned land (Hill Slough Wildlife Area), which is managed by the CDFG, and 85 ac (35 ha) of privately owned land. The unit receives tidal inundations irregularly (not daily) (NWI 2005) from Hill Slough and a flood control channel along the western unit boundary.

Unit 2: Peytonia Slough Marsh: Unit 2 consists of approximately 346 ac (140 ha) of tidal marsh (PCE 1) located adjacent to Cordelia Road to the west, Suisun Slough to the east, Peytonia Slough to the south, and Suisun City to the north. The unit consists of approximately 192 ac (78 ha) of State-owned land (Peytonia Slough Ecological Reserve), which is managed by the CDFG, and 154 ac (62 ha) of privately owned high tidal marsh. Although the unit is bisected, north to south, by an elevated railroad line, much of the track is on trestle rather than berm, allowing tidal waters to reach both sides of the unit through Peytonia Slough and several smaller unnamed sloughs (NWI 2005; Vollmar 2005a, pp. 2, 3, 5; Huffman 2006, p. 1). Because of this hydrological connection, we are treating designated habitat on both sides of the track as a single unit, rather than splitting it into two subunits as we did in the proposed designation. *Cirsium hydrophilum* var. *hydrophilum* occupied the unit at the time of listing as identified in the final listing rule (62 FR 61916; November 20, 1997) and contains the features essential to the conservation of *C. hydrophilum* var. *hydrophilum*.

Unit 3: Rush Ranch/Grizzly Island Wildlife Area: Unit 3 consists of approximately 1,181 ac (477 ha) of tidal marsh located adjacent to Suisun Slough to the west, Cutoff and Montezuma Sloughs to the south, and Potrero Hills to the North. This unit consists of 231 ac (93 ha) of State-owned land (the Joice Island portion of Grizzly Island Wildlife Area), which is managed by the CDFG, and 950 ac (384 ha) of land owned by the Solano Land Trust (local nonprofit public land trust). *Cirsium hydrophilum* var. *hydrophilum* occupied the unit at the time of listing as identified in the final listing rule (62 FR 61916; November 20, 1997) and contains the features essential to the conservation of *C. hydrophilum* var. *hydrophilum*. The unit receives regular tidal inundations at least once daily (NWI 2005) from the abovementioned tidal sloughs. Additional special management considerations or protection beyond the special management required for common threats, as discussed above, may be required to control the presence of *Rhinocyllus conicus* (a nonnative biological control weevil) or other plant-eating insects that could reduce the reproductive potential of *C. hydrophilum* var. *hydrophilum*.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cirsium hydrophilum* var. *hydrophilum* critical habitat consists of three components (72 FR 18518-18553):

- (i) Persistent emergent, intertidal, estuarine wetland at or above the mean high-water line (as extended directly across any intersecting channels);
- (ii) Open channels that periodically contain moving water with ocean-derived salts in excess of 0.5 percent; and
- (iii) Gaps in surrounding vegetation to allow for seed germination and growth.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the areas determined to be occupied at the time of listing and that contain the PCEs may require special management considerations or protection. Most of the PCEs and the known occurrences of *Cirsium hydrophilum* var. *hydrophilum* and *Cordylanthus mollis* ssp. *mollis* are threatened by: (1) tidal wetland conversions to diked, managed, or muted tidal marshes; (2) changes to channel water salinity and tidal regimes; (3) mosquito abatement activities; (4) marsh invasions by nonnative plants; (5) plant-eating insects; (6) urban, industrial, and agricultural encroachment; (7) impacts from livestock overgrazing; (8) feral pigs (*Sus scrofa*); and (9) impacts from unauthorized foot and off-road vehicle traffic. These combined threats result in the loss and fragmentation of suitable habitat for *C. hydrophilum* var. *hydrophilum* and *C. mollis* ssp. *mollis*, which could significantly affect their long-term survival. Individually, these threats may require special management considerations or protection as addressed under the critical habitat unit descriptions below.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual (vegetative) (USFWS, 2013)

Lifespan

Adult: 1 year (USFWS, 2013)

Dependency on Other Individuals or Species

Adult: Bees and insects (USFWS, 2009)

Breeding Season

Adult: July to September (USFWS, 2009)

Reproduction Narrative

Adult: *Cirsium hydrophilum* var. *hydrophilum* is an annual plant, dying after one year of seed reproduction. Its vegetative period is usually one year (biennial), but if small vegetative plant size or unfavorable environmental conditions delay flowering, it may regenerate from the central root crown for more than one year. Pale lavender-rose flower heads appear between July and September. Flowering plants may produce hundreds of seed heads. Seed heads observed in July 2000 had three to five ripe seeds per head, but many of them contained aborted seeds or were found with insect larvae in active seed predation (Baye 2000). Specific flower pollinators of *Cirsium hydrophilum* var. *hydrophilum* have not been directly studied; however, field observations indicate that several bee species may be important in pollinating

the species (LCLA 2003). The most common insect species observed gathering pollen at Rush Ranch was the yellow-faced bumble bee (*Bombus vosnesenskii*) (LCLA 2003). (USFWS, 2009; USFWS, 2013)

Habitat Type

Adult: Tidal marsh (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Restricted to regularly flooded and permanently saturated habitats within 50 to 100 feet of the high water mark of tidal channels (USFWS, 2009)

Spatial Arrangements of the Population

Adult: Discrete colonies or clusters of small patches (USFWS, 2013)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Habitat Narrative

Adult: The dispersion pattern of *C. hydrophilum* var. *hydrophilum* (California Department of Water Resources in litt. 1996) in discrete colonies or clusters of small patches suggests there may be limited seed dispersal. Most known *Cirsium hydrophilum* var. *hydrophilum* occurrences are found in regularly flooded and permanently saturated habitats, along the banks of canals or ditches, within 50 to 100 feet of the high water mark of natural tidal channels; and on tidal floodplains within tidal marshes (U.S. Fish and Wildlife Service 2007). (USFWS, 2009; USFWS, 2013)

Dispersal/Migration**Motility/Mobility**

Adult: Low (USFWS, 2013)

Dispersal

Adult: Low (USFWS, 2013)

Dispersal/Migration Narrative

Adult: The dispersion pattern of *C. hydrophilum* var. *hydrophilum* (California Department of Water Resources in litt. 1996) in discrete colonies or clusters of small patches suggests there may be limited seed dispersal. (USFWS, 2013)

Population Information and Trends**Population Trends:**

Long-term decline of 50 - 70% (NatureServe, 2015)

Resiliency:

Low (USFWS, 2009)

Representation:

Low (inferred from USFWS, 2009)

Redundancy:

Low (inferred from USFWS, 2009)

Number of Populations:

4 (USFWS, 2009)

Population Size:

22,300 to 873,200 individuals, with a best estimate of 137,500 individuals (LCLA 2003). (USFWS, 2013)

Adaptability:

Low (USFWS, 2009)

Population Narrative:

It was once widespread in Suisun Marsh, but, due to habitat loss, in the last two decades has been found in only four localities: Grizzly Island, Peytonia Slough, Rush Ranch, and Hill Slough. These populations have been in decline in the 1990s and 2000s. The species was considered to belong to a large, single population of approximately 22,300 to 873,200 individuals, with a best estimate of 137,500 individuals (LCLA 2003) in a recent comprehensive survey in 2003. The resulting small populations are still highly susceptible to extinction due to random natural and human-made events, such as pest outbreaks, extended drought, oil spills, genetic or demographic problems or a combination of these events. Long-term trends suggest a decline of 50-70% due to massive changes in the Suisun Marsh due to water projects and utilization. (USFWS, 2009; USFWS, 2013; NatureServe, 2015)

Threats and Stressors

Stressor: Alteration of tidal regime (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Diking and filling involved in agricultural land conversion and urbanization, ditching for mosquito abatement, changes to freshwater inflow, and habitat fragmentation are threats to *Cirsium hydrophilum* var. *hydrophilum*. Private lands continue to experience development (Grewell, pers. comm. 2007). Derelict and actively maintained levees from historic diking practices continue to result in muted (damped) tidal flows, which in turn, reduce available habitat for *C. hydrophilum* var. *hydrophilum*. Alteration of natural tidal cycles still exists in much of the potential habitat and represents both the most significant historic and current threat to *Cirsium hydrophilum* var. *hydrophilum* and its habitat. With respect to effects to *C. hydrophilum* var. *hydrophilum*, alteration of tidal cycles includes muting of tidal flows, increases in freshwater runoff and diversion of freshwater for agricultural and municipal uses. A large portion of historic tidal marshes in Suisun Bay were diked and managed for waterfowl. These historic reductions of habitat have affected the extent and composition of tidal marsh communities. The brackish tidal wetlands in Rush Ranch have been ditched extensively to drain standing water, in an effort to reduce mosquito breeding habitat. Ditching has greatly altered the hydrology of the marsh, primarily because the ditches cut across natural drainage patterns. As a result, mosquito ditches

have led to the reduction of tidal inundation and the consequent infilling of first order channels, creating new mosquito breeding habitat (Collins et al. 1986, WRA et al. 1989). Originally, ditching may have reduced *Cirsium hydrophilum* var. *hydrophilum* habitat by reducing tidal influence in first order channels. However, the mosquito ditching currently provides new, artificial habitat for *C. hydrophilum* var. *hydrophilum* similar enough to first order channels to promote colonization of these ditches. (USFWS, 2009)

Stressor: Feral pigs (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The threat from feral hogs (*Sus scrofa*) to *Cirsium hydrophilum* var. *hydrophilum* was not described in the listing rule, however, it is a present threat at both known locations of the species. Thirty-four percent of the *C. hydrophilum* var. *hydrophilum* subpopulations at Rush Ranch showed signs of damage due to rooting and trampling of feral pigs when surveyed in 2003 (LCLA 2003). Further, disturbances on the landscape created by feral pigs may enhance colonization opportunities for a non-native plant *Lepidium latifolium* (perennial pepperweed), to threaten the tidal marsh ecosystem, discussed further under Factor E (LCLA 2003). (USFWS, 2009)

Stressor: Sea-level rise (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Sea level rise, such as that potentially associated with global climate change, and anticipated associated flood control responses, though not discussed in the listing rule, may impose significant long-term threats to conservation of *Cirsium hydrophilum* var. *hydrophilum*. Conservation of high marsh zones in the face of sea level rise requires landward transgression (displacement) of the marsh profile on broad, sloping plains (Field et al. 1999, Baye 2006). If the sea level rises, conflicting needs for flood protection, agriculture, and marsh transgression could effectively compress tidal marsh zones to a point at which they could not support *C. hydrophilum* var. *hydrophilum* habitat (Grewell 2006). (USFWS, 2009)

Stressor: Thistle weevil (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The presence of a thistle weevil (*Rhinocyllus conicus*) in a portion of the *Cirsium hydrophilum* var. *hydrophilum* population was stated to be a possible threat to the species. This threat was discovered by California Department of Water Resources in June 1996 when the weevil was collected inside *C. hydrophilum* var. *hydrophilum* flower heads, many of which had no seeds (U.S. Fish and Wildlife Service 1997). The larval stage of this weevil is known to feed on seeds. Plant-eating insects can significantly limit seed production and plant demography as seen in several other *Cirsium* species (Louda and Potvin 1995; Palmisano and Fox 1997; Rose et al. 2005). (USFWS, 2009)

Stressor: Caterpillars (USFWS, 2009)

Exposure:

Response:**Consequence:**

Narrative: Phyciodes mylitta caterpillars were collected on a population of *C. hydrophilum* var. *hydrophilum* in September 1996. These caterpillars have caused significant damage to the rosettes of plants that will flower the following year (U.S. Fish and Wildlife Service 1997). Though documented in the listing rule to have occurred previously at Rush Ranch, *Phyciodes mylitta* caterpillars were not located there during LCLA's 2003 study. (USFWS, 2009)

Stressor: Non-native plants (USFWS, 2009)

Exposure:**Response:****Consequence:**

Narrative: All known populations of *Cirsium hydrophilum* var. *hydrophilum* are negatively affected by nonnative plants. The most problematic and widespread invasive plant in Suisun Marsh is the perennial herb, *Lepidium latifolium* (Grewell 2005). It occurs along the high marsh edge of San Francisco Bay, especially in disturbed areas, deposits of sand or tidal litter, or levee slopes. In brackish marshes with lower salinity, it invades the middle marsh plain and channel edges. *Lepidium latifolium* forms large monotypic patches that displace native marsh vegetation (Renz 2000). As much as 40 percent of *L. latifolium* biomass is below-ground, with most of it concentrated in the upper 24 inches (Renz 2000). This concentration of biomass in surface roots enhances the weed's competitiveness for water and nutrients. Further, as well as being a prolific seed producer, its roots fragment easily and can sprout even after exposure on the soil over the winter. Root fragments also can be carried by water and establish new populations where they are deposited (Renz 2000). (USFWS, 2009)

Stressor: Hybridization (USFWS, 2009)

Exposure:**Response:****Consequence:**

Narrative: Hybridization with *Cirsium vulgare*, a non-native, also is a potential threat to *Cirsium hydrophilum* var. *hydrophilum*. Hybridization with *C. vulgare* was suggested as a possible explanation for the previously presumed extinction of *C. hydrophilum* var. *hydrophilum* (Smith and Berg 1988). Though recent studies have indicated that the two species coexist at Rush Ranch, no genetic studies have been conducted since the time of listing to determine if hybridization has indeed occurred. L.C. Lee and Associates (2003) found that 45 percent of *C. hydrophilum* var. *hydrophilum* subpopulations at Rush Ranch contained *C. vulgare*. It is known that *C. vulgare* hybridizes readily with other *Cirsium* species. (USFWS, 2009)

Stressor: Chronic pollution (USFWS, 2009)

Exposure:**Response:****Consequence:**

Narrative: Oil spills and chronic pollution from point and non-point sources (heavy metal contamination from point and non-point sources) continue to occur in or near habitat for *Cirsium hydrophilum* var. *hydrophilum* (U.S. Fish and Wildlife Service 2007). On April 27, 2004, Kinder Morgan Energy Partners, L.P. spilled 123,774 gallons of diesel fuel through a ruptured pipeline in western Suisun Marsh near Roos Cut. The spill occurred within known habitat for *C. hydrophilum* var. *hydrophilum* and contaminated 225 acres of the marsh to varying degrees (Solano County

2005). It is not known whether populations of *C. hydrophilum* var. *hydrophilum* were directly affected. (USFWS, 2009)

Stressor: Fire (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: It is not known how fire affects the viability of *Cirsium hydrophilum* var. *hydrophilum* or its seed, but it is considered a minor threat nonetheless. Human-caused fires present a continual threat of at least temporary habitat loss in Suisun Marsh. Three fires have occurred recently within existing and potential *C. hydrophilum* var. *hydrophilum* habitat in Suisun Marsh (Grewell pers comm. 2007). Arsonists set fire in 2001 to a large portion of Peytonia Slough Ecological Reserve, burning all vegetation from Suisun Slough to the Southern Pacific Railroad tracks, including the only remaining previously known population at Peytonia Slough Ecological Reserve. (USFWS, 2009)

Stressor: Random events (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Since the time of listing, the distribution of the species within its range has not increased and the habitat of the species remains restricted due to fragmentation and historic conversion to other uses. The resulting small populations are still highly susceptible to extinction due to random natural and human-made events, such as pest outbreaks, extended drought, oil spills, genetic or demographic problems or a combination of these events. (USFWS, 2009)

Recovery

Reclassification Criteria:

1. The minimum area inhabited annually by the species must be 2,000 acres over a period of five years. (USFWS, 2013)
2. A minimum of 4,000 acres must be permanently preserved and under protective management. This must include existing or successfully restored tidal marsh areas with suitable habitat for the species and encompass a minimum of 80 percent of the extant occurrences of the species. (USFWS, 2013)
3. Reduction in extant *Lepidium latifolium* populations in tidal areas of Suisun Marsh (in and down-gradient of the high marsh-upland ecotone) to less than ten percent cover for five years. (USFWS, 2013)
4. Natural tidal range must be restored at Hill Slough and the ponded area at Rush Ranch to return periodic tidal flooding. (USFWS, 2013)
5. At least three separate populations or one large population must occur within Suisun Marsh. Required target number of individuals is dependent on whether separate populations are easily identifiable, as described below. A population shall be any concentration of plants with closest

individuals to other populations greater than 1 kilometer (0.6 mile) apart over a period of five years. (USFWS, 2013)

6. Over five years of monitoring, a mean of at least 3,000 individuals must occur annually over the entire range of the species. The third-largest separate population over the same period must have a mean of at least 300 individuals. If there are fewer than three separate populations, a mean of at least 5,000 individuals must occur annually throughout the entire range of the species over a period of five years. The entire species must not fall below 800 individuals for two consecutive years over a period of five years. (USFWS, 2013)

Delisting Criteria:

1. The minimum area inhabited annually by the species must be 3,000 acres over a period of eight years. (USFWS, 2013)

2. A minimum of 6,000 acres of suitable habitat must be permanently preserved and under protective management. This must include existing or successfully restored tidal marsh areas with suitable habitat for the species and encompass a minimum of 80 percent of the species, as well as habitat supporting adequate self-sustaining populations of pollinators. (USFWS, 2013)

3. All conditions under downlisting criterion number 3 have been met. In addition, a plan must be developed and implemented for early detection and control of *Lepidium latifolium* following any future increase beyond ten percent cover in tidal areas of Suisun Marsh (in and down-gradient of the high marsh-upland ecotone). Also, a funding source must be secured to fund such actions in perpetuity. (USFWS, 2013)

4. All conditions under downlisting criterion number 4 have been met. (USFWS, 2013)

5. Reliable propagation and reintroduction methods must be developed and available. (USFWS, 2013)

6. Trampling and rooting damage to *Cirsium hydrophilum* var. *hydrophilum* by feral pigs must have been eliminated at all populations for five years. (USFWS, 2013)

7. Unnaturally high seed predator pressures on *C. hydrophilum* var. *hydrophilum* from thistle weevil (*Rhinocyllus conicus*) must fall below a level at which it negatively affects long-term population persistence. (USFWS, 2013)

8. At least four separate populations must occur within Suisun Marsh. Over eight years of monitoring, a mean of at least 4,000 individuals must occur annually, spread across at least four populations and the fourth-largest population over the same period must have a mean of at least 500 individuals. If not divisible into separate populations, a mean of at least 7,000 individuals must occur annually throughout the entire range of the species over a period of eight years. The entire species must not fall below 1,000 individuals for two consecutive years over a period of eight years. (USFWS, 2013)

9. Seed banking of all extant populations and representative genetic diversity (per commonly accepted seed banking protocols) must be complete. (USFWS, 2013)

10. Research must be conducted to determine if hybridization is occurring between *Cirsium hydrophilum* var. *hydrophilum* and *Cirsium vulgare*. If research shows that hybridization is occurring, extant *C. vulgare* populations must be eliminated in Suisun Marsh and a monitoring plan must be in place to detect and eliminate future infestations of *C. vulgare*. (USFWS, 2013)

11. To minimize impacts sustained after oil spills occurring at or near populations, the San Francisco Bay and Delta Area section of the Sector San Francisco-Area Contingency Plan must be revised to place high priority on the emergency protection of *Cirsium hydrophilum* var. *hydrophilum*. (USFWS, 2013)

12. High marsh/upland transition lands must be preserved or created as part of new marsh restoration efforts and managed to provide opportunity for landward migration of species in response to sea level rise. (USFWS, 2013)

Recovery Actions:

- Short-term recovery actions should be implemented concurrently with long-term habitat restoration and should focus on protecting and managing existing populations and habitats. Recovery strategies include: suppression of invasive non-native plant species, protection and management of nearby native bee and wasp habitats, control of *Cirsium vulgare*, if research indicates necessity, restoration of normal tidal range and salinity, seed banking of *Cirsium hydrophilum* var. *hydrophilum*, monitoring of populations and habitat, and research aspects of life history, population ecology, and seed predation of *C. hydrophilum* var. *hydrophilum*. (USFWS, 2013)

Conservation Measures and Best Management Practices:

- A recovery plan for *Cirsium hydrophilum* var. *hydrophilum* should be developed which describes recovery strategies and specific tasks necessary for recovery of the species. A draft recovery plan for this species and five other listed tidal marsh species is currently in development by the Service. (USFWS, 2009)
- Natural tidal cycles should be maintained (and restored at Hill Slough and the ponded area of Rush Ranch) because the middle to high marsh area, with periodic tidal flooding, is vital to *Cirsium hydrophilum* var. *hydrophilum*. (USFWS, 2009)
- Control of *Lepidium latifolium* should be conducted at Peytonia Slough Ecological Reserve, Rush Ranch, Hill Slough, Grizzly Island Wildlife Area, as appropriate, to reduce competition with *Cirsium hydrophilum* var. *hydrophilum*. (USFWS, 2009)
- Research should be conducted to determine whether hybridization is occurring between *Cirsium hydrophilum* var. *hydrophilum* and *Cirsium vulgare* at Rush Ranch. (USFWS, 2009)
- Research should be conducted to determine the extent to which seed predation by *Rhinocyllus conicus* is negatively affecting populations of *Cirsium hydrophilum* var. *hydrophilum*. If a substantial threat exists, research into effective means of *Rhinocyllus conicus* control should be researched and implemented at appropriate sites. (USFWS, 2009)
- Surveys should be conducted within potential *Cirsium hydrophilum* var. *hydrophilum* habitat as well as at known population centers to identify potential new occurrences as well as to provide an updated species status with which to make management decisions. Specifically, Peytonia Slough Ecological Reserve should be surveyed to determine if that population is extant and the Hill Slough area should be more extensively surveyed to determine the abundance of *C. hydrophilum* var. *hydrophilum* there. (USFWS, 2009)

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SPECIES ACCOUNT: *Cirsium loncholepis* (La Graciosa thistle)

Species Taxonomic and Listing Information

Listing Status: Endangered; 04/19/2000; California/Nevada (Region 8)

Physical Description

a biennial or short-lived perennial plant that flowers once and then dies (Lea 2002, p. 67; Teed 2003, p. iv; Baldwin et al. 2012, p. 289), with a probable life span of 2 to 6 years (Lea 2002, p. 68). It is an erect or spreading mound-like plant with spines on the leaves and flower heads. The plants have one or more stems that range usually from 10 to 100 cm/4 to 39 in tall but occasionally up to 150 cm/59 in. The lower leaves are 10 to 30 cm/4 to 12 in long with spiny petioles (leaf stalks) and usually deeply lobed with secondary lobes or teeth. The leaves have a wavy edge, with the bases of the middle and upper leaves forming short, spiny wings along the petiole. Flower heads are 2 to 4 cm/0.8 to 1.6 in wide in tight clusters and at the tips of stems. The flowers are 25 to 30 mm/1.0 to 1.2 in long, and nearly white with a purplish tube containing purple anthers (Figure 2). The fruits are achenes (dry fruit containing one seed only; Lea 2002, p. 7), 3 to 4 mm/0.1 to 0.2 in long, and topped with a pappus (umbrella of small hairs) 15 to 25 mm/0.6 to 1.0 in long (Keil and Turner 1993, p. 236) that facilitates wind dispersal. La Graciosa thistle can be confused with the clustered thistle (*Cirsium brevistylum*; Table 3) and cobwebby thistle (*Cirsium occidentale*). (USFWS, 2018)

Taxonomy

Cirsium loncholepis was described and named by Petrak (1917, p. 375) from a specimen collected “near La Graciosa” by Alice Eastwood in 1906. It is in the aster and sunflower family (Asteraceae; Baldwin et al. 2012, p. 289). The common name La Graciosa thistle is in reference to the collection site of the holotype, which apparently was near Graciosa railway station or La Graciosa village (now south Orcutt; Figure 1) in Santa Barbara County (Wilken 2009, p. 3). (USFWS, 2018)

Historical Range

See Current Range. An occurrence previously reported in Monterey County has since been determined to be the Alameda County thistle (*Cirsium quercetorum*). (USFWS, 2018)

Current Range

In San Luis Obispo and Santa Barbara Counties, California. (USFWS, 2018)

Critical Habitat Designated

Yes; 12/3/2009.

Legal Description

On November 3, 2009, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective December 3, 2009) for *Cirsium loncholepis* (La Graciosa thistle) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six critical habitat units (CHUs), in California (74 FR 56978-57046).

Critical Habitat Designation

The critical habitat designation for *Cirsium loncholepis* includes six CHUs in San Luis Obispo and Santa Barbara Counties, California. This species critical habitat encompasses approximately 24,103 acres (ac) (9,754 hectares (ha)). Brief descriptions are provided below; detailed coordinates and maps are included in the Final Rule (74 FR 56978-57046; USFWS, 2009).

Unit 1: Callender-Guadalupe Dunes (9,690 ac (3,921 ha)) Unit 1 is located in the southwestern corner of San Luis Obispo County, California. It stretches along 8.5 mi (13.5 km) of coast from Arroyo Grande Creek to the Santa Maria River. This unit is south of Pismo Beach, west of Nipomo and north of Guadalupe.

Unit 2: Santa Maria River-Orcutt Creek (13,227 ac (5,353 ha)) Unit 2 is located along the lower 5 mi (8 km) of the Santa Maria River and along the length of Orcutt Creek (approximately 13 mi (21 km)) in San Luis Obispo and Santa Barbara Counties, California.

Unit 3: Canada de las Flores (740 ac (299 ha)) Unit 3 is located approximately 5 mi (8 km) northwest of the town of Los Alamos and southwest of the Solomon Hills in Santa Barbara County, California.

Unit 4: San Antonio Creek (185 ac (75 ha)) Unit 4 is located in the northwestern portion of Santa Barbara County, California. The majority of Unit 4 lands occur on VAFB.

Unit 5: San Antonio Terrace (52 ac (21 ha)) Unit 5 is located in western Santa Barbara County, California. We determined that all lands in Unit 5 (7,334 ac (2,968 ha)) on San Antonio Terrace are essential to the conservation of *Cirsium loncholepis*. Unit 5 stretches along 4 mi (6.5 km) of the coast north from San Antonio Creek.

Unit 6: Santa Ynez River (210 ac (85 ha)) Unit 6 is located in the western portion of Santa Barbara County, California. Unit 6 is west of Lompoc and east of Surf.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cirsium loncholepis* critical habitat consists of four components (74 FR 56978-57046):

(i) Mesic areas associated with: (A) Margins of dune swales, dune lakes, marshes, and estuaries that are associated with dynamic (changing) dune systems including the Santa Maria Valley Dune Complex and Santa Ynez Valley Dune Complex; (B) Margins of dynamic riparian systems including the Santa Maria and Santa Ynez Rivers and Orcutt and San Antonio Creeks; and (C) Freshwater seeps and intermittent streams found in other habitats, including grassland, meadow, coastal scrub, and oak woodland. These areas provide space needed for individual and population growth including sites for germination, reproduction, seed dispersal, seed bank, and pollination;

(ii) Associated plant communities including: Central dune scrub, coastal dune, coastal scrub, freshwater seep, coastal and valley freshwater marsh and fen, riparian scrub (e.g., mule fat scrub, willow scrub), oak woodland, intermittent streams, and other wetland communities, generally in association with the following species: *Juncus* spp. (rush), *Scirpus* spp. (tule), *Salix* spp. (willow), *Toxicodendron diversilobum* (poison oak), *Distichlis spicata* (salt grass), *Baccharis pilularis* (coyote brush), and *B. douglasii* (Douglas' baccharis);

(iii) Soils with a sandy component including but not limited to dune sands, Oceano sands, Camarillo sandy loams, riverwash, and sandy alluvial soils; and

(iv) Features that allow dispersal and connectivity between populations, particularly: (A) Natural riparian drainages in Santa Maria River, Orcutt Creek, San Antonio Creek, and Santa Ynez River that are not channelized or confined by barriers or dams, such that they have soft bottoms and sides and a natural flood plain (allowing uninterrupted water flows); and (B) Natural aeolian geomorphology in the Santa Maria Dune Complex and Santa Ynez Dune Complex, and along the Santa Maria River, Orcutt Creek, San Antonio Creek, and Santa Ynez River drainages that is not confined by barriers or wind-blocks such as large manmade structures, tree rows, or windbreaks (allowing uninterrupted winds across these areas).

Special Management Considerations or Protections

Many of the known occurrences of *Cirsium loncholepis* are threatened by direct and indirect effects from energy-related operations (i.e., maintenance activities, hazardous waste cleanup); development that results in additional habitat modification or land use changes (i.e., conversion of agricultural and urban development); county zoning changes; issuance of development permits; non point source pollution such as from urban and agricultural runoff (e.g., herbicides, fertilizers); facility accidents by oil companies or VAFB; groundwater extraction throughout the range of the species; hydrological alterations; direct and indirect effects from off highway vehicle (OHV) activity (i.e., habitat disturbance, hazardous materials spills); small population size; and habitat fragmentation and loss through the invasion of aggressive nonnative weeds such as *Ammophila arenaria* (European beach grass), *Carpobrotus* spp. (iceplant), *Ehrharta calycina* (veldt grass), and *Mesembryanthemum crystallinum* (crystalline iceplant). These threats may require special management to ensure the long-term conservation of *C. loncholepis*.

The essential features found in Unit 1 may require special management considerations or protection resulting from: (1) direct and indirect effects from energy-related operations (i.e., maintenance activities, hazardous waste cleanup, facility accidents); (2) ground water extraction which lowers the water table, dries the wetlands, and can destroy surface and subsurface hydrologies; (3) stochastic (i.e., random) extirpation/extinction events that occur because the population size is small or isolated; (4) trampling and grazing from trespass of cattle; (5) competition from invasive, aggressive, nonnative weeds (e.g., *Ammophila arenaria*, *Carpobrotus* spp., *Ehrharta calycina*, *Mesembryanthemum crystallinum*); (6) direct and indirect effects from OHV activity (i.e., habitat disturbance, hazardous materials spills); (7) habitat fragmentation; and (8) nutrient inputs in the water systems that are above concentrations known to adversely affect freshwater ecosystems and cause adverse ecological effects including altering the composition of the plant community and inducing biostimulation.

The essential features found in Unit 1 may require special management considerations or protection resulting from: (1) direct and indirect effects from energy-related operations (i.e., maintenance activities, hazardous waste cleanup, facility accidents); (2) ground water extraction which lowers the water table, dries the wetlands, and can destroy surface and subsurface hydrologies; (3) stochastic (i.e., random) extirpation/extinction events that occur because the population size is small or isolated; (4) trampling and grazing from trespass of cattle; (5) competition from invasive, aggressive, nonnative weeds (e.g., *Ammophila arenaria*, *Carpobrotus* spp., *Ehrharta calycina*, *Mesembryanthemum crystallinum*); (6) direct and indirect effects from OHV activity (i.e., habitat disturbance, hazardous materials spills); (7) habitat fragmentation; and

(8) nutrient inputs in the water systems that are above concentrations known to adversely affect freshwater ecosystems and cause adverse ecological effects including altering the composition of the plant community and inducing biostimulation.

Life History

Food/Nutrient Resources

Lifespan

Adult: 2-3 years (inferred from USFWS, 2011)

Dependency on Other Individuals or Species

Adult: Pollinators

Breeding Season

Adult: Blooms from April to September (USFWS, 2018)

Other Reproductive Information

Adult: La Graciosa thistle blooms from April to September (Baldwin et al. 2012, p. 289). Potential pollinators include ants, beetles, bees, butterflies and flies (Keil 2001, p. 1; Lea 2002, p. 80). Seed dispersal is by wind (Keil and Turner 1993, p. 236; Lea 2002, p. 7; USFWS 2016a, p. 68) and also likely by water because it is a wetland plant. The seed bank of La Graciosa thistle may be similar to that of the wetland jewelweed (*Impatiens capensis*) for which no persistent seed bank exists (Simpson et al. 1985, p. 307). This is supported by the data in our Table 2. Of the 13 occurrences for which zero plants were recorded and then a subsequent census conducted, 11 also had zero plants recorded in the subsequent census. In other words, only two of 13 occurrence were found to be extant after a previous census record of zero plants. This combined with the observations of Hendrickson (1990b, p. 23), Lea (2002, p. 45) and Teed (2003, p. 29) indicate that La Graciosa thistle has only a minimally persistent seed bank. (USFWS, 2018)

Reproduction Narrative

Adult: *Cirsium scariosum* var. *loncholepis* (La Graciosa thistle) is a short-lived monocarpic perennial (a plant that blooms once, then dies) (Hendrickson 1990, Keil and Turner 1993, Teed 2003). *C. loncholepis* flowers bloom between June to August (NatureServe, 2015). Large individuals produce more flowering heads and more seeds per head (average = 473 seeds per plant) than smaller individuals (average = 168 seeds per plant), and therefore contribute disproportionately to the future seedbank of the population (M. Lea, California Polytechnic State University, San Luis Obispo, pers. comm. 2001).

Habitat Type

Adult: Wetlands (USFWS, 2011)

Habitat Vegetation or Surface Water Classification

Adult: Mesic wetlands, coastal dunes, brackish marshes and swamps (USFWS, 2011; NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Intermediate moisture (USFWS, 2011)

Geographic or Habitat Restraints or Barriers

Adult: Requires medium moisture conditions that are neither very wet nor very dry (USFWS, 2011)

Environmental Specificity

Adult: Narrow/specialist

Habitat Narrative

Adult: La Graciosa thistle exists as groups of individuals in wetland habitats in an arid and semi-arid landscape. The plants inhabit the margins of wetlands (swales, lakes, ponds, freshwater marshes, streams, rivers, seeps) in southwestern San Luis Obispo County and western Santa Barbara County in central coastal California. The majority of occurrences are associated with wetlands in the backdunes of two coastal sand dune complexes, the Callender Dunes and the Guadalupe Dunes (Figure 1). Many of the wetlands in the sand dune complexes occur where the groundwater table is at or near the surface (Lea 2002, p. 66; California Department of Fish and Game 2005, p. 328), and the water levels rise and fall naturally with rainfall. Low water levels can be exacerbated by drought (Holland et al. 1995, p. 23). (USFWS, 2018)

Dispersal/Migration**Motility/Mobility**

Adult: High (USFWS, 2011)

Dispersal

Adult: High (USFWS, 2011)

Dispersal/Migration Narrative

Adult: The achenes (fruit) are 0.01 to 0.02 inches (3 to 4 mm) long and topped by an umbrella of long awns (0.6 to 1.0 in) that are ideal for wind dispersal (Keil and Turner 1993). Research has shown that *Cirsium scariosum* var. *loncholepis* are long-distance dispersers. (USFWS, 2011)

Population Information and Trends**Population Trends:**

Declining (USFWS, 2018)

Species Trends:

Declining (USFWS, 2018)

Resiliency:

Resiliency analysis determined that three of the four extant occurrences have medium resiliency (score of 2 out of possible 3), suggesting a moderate ability of these occurrences to withstand stochastic and catastrophic events and natural environmental variation. One extant occurrence has low resiliency (score of 1), suggesting little ability for it to withstand stochastic and catastrophic events and natural environmental variation. (USFWS, 2018)

Representation:

Genetic diversity and spatial extent of La Graciosa thistle has declined (USFWS, 2018)

Redundancy:

Severely reduced (USFWS, 2018)

Number of Populations:

4 or 5 extant occurrences; 16 extirpated occurrences (USFWS, 2018)

Population Narrative:

Currently, 21 extirpated and extant occurrences range coastally from Pismo State Beach (occurrence 14; 35.107367, -120.625009), San Luis Obispo County, southward to the floodplain of the Santa Ynez River near the south entrance of Vandenberg Air Force Base (occurrence 1; 34.662962, -120.556957), Santa Barbara County (32.7 km/20.3 mi distance), and from the Pacific Ocean eastward to a freshwater marsh 1.6 km/1.0 mi northeast of Los Alamos (occurrence 33; 34.748658, -120.259412), Santa Barbara County (31.7 km/19.7 mi distance). The occurrence previously reported in Monterey County has since been determined to be the Alameda County thistle (*Cirsium quercetorum*) (Lea 2002, p. 3). The majority (n = 17) of occurrences are within 6.3 km/3.9 mi of the coast, while four occurrences are at substantially greater distances. Most of the occurrences (n = 16) are in or proximal to two coastal sand dune complexes in San Luis Obispo County: the Callender Dunes just south of Arroyo Grande, and the contiguous Guadalupe Dunes just north of the Santa Maria River. Of the 21 known occurrences, 16 are likely extirpated, four are currently extant (occurrences 6, 11, 18, 31), and one has unknown status. The four extant occurrences are on lands of various ownership: one occurrence on private property of Chevron Corporation (18), one occurrence on private properties of Chevron Corporation and another landowner (6), one occurrence on private property with a conservation easement to the Land Conservancy of San Luis Obispo County (11), and one occurrence on Guadalupe-Nipomo Dunes National Wildlife Refuge (31). (USFWS, 2018)

Threats and Stressors

Stressor: Habitat loss (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: The primary threat to La Graciosa thistle in 2018 is lack of water, with groundwater decline as the likely major source. The groundwater decline appears to be a result of extraction for urban, agricultural and industrial uses, and it is exacerbated by drought and climate change. Groundwater decline causes habitat loss and degradation for La Graciosa thistle. Past development and agriculture have also caused substantial habitat loss and fragmentation by conversion of land for other uses (Hendrickson 1990b, p. 22). From the 1850's to 1987, 90% of California's coastal wetlands disappeared (Caughman and Ginsberg 1987, p. 24). In the 21st century, the remaining wetlands in central coastal California continue to decrease in quantity and quality (USFWS 2011, p. 11). Due to its minimally persistent seed bank, any occurrence of the species that has not had flowering plants over several consecutive years is at risk of extirpation. (USFWS, 2018)

Stressor: Urbanization (USFWS, 2011)

Exposure:**Response:****Consequence:**

Narrative: Most of the historical occurrences and their surrounding areas are urbanized and/or indirectly impacted by urbanization (Service 2009a, CNDDDB 2010). As mentioned above in the Abundance and Population Trends section, *Cirsium scariosum* var. *loncholepis* has experienced considerable declines throughout its range in the number of populations, occurrences, and individuals. It is only known to be extant at 8 of the 21 known occurrences (see Table 1). This decline in range, populations, occurrences, and individuals has further limited this species' ability to colonize or recolonize adjacent and intermediate locations of suitable habitat. (USFWS, 2011)

Stressor: Development of habitat for petroleum extraction (USFWS, 2011)

Exposure:**Response:****Consequence:**

Narrative: Habitat loss has been implicated from petroleum related activities. (USFWS, 2011)

Stressor: Cattle grazing and herbivory (USFWS, 2011)

Exposure:**Response:****Consequence:**

Narrative: Cattle have been documented crushing and breaking *C. scariosum* var. *loncholepis* plants on the Guadalupe-Nipomo National Wildlife Refuge (Elvin 2007d). Trampling and crushing impacts from cattle have been documented in and among plants at the Chevron project site in the Guadalupe Dunes (Elvin 2006). *Cirsium scariosum* var. *loncholepis* was last reported at the Cañada de Las Flores population in 1989 (Service 2009a). This population has been overgrazed according one local rancher (Elvin 2007c). This overgrazing has reduced plant cover, compacted the soil, and may have crushed plants at this population. Trampling and crushing of plants and compaction of soil may have been an exacerbating circumstance that led to the possible extirpation of this species at this population. While this plant may be able to withstand some herbivory, it may cause a reduction in its reproductive success due to the loss of flowers and the corresponding reduction in the production of seeds. (USFWS, 2011)

Stressor: Loss of connectivity between populations (Long-Distance Dispersal) (USFWS, 2011)

Exposure:**Response:****Consequence:**

Narrative: Recent research on species that are long-distance dispersers (such as *Cirsium scariosum* var. *loncholepis*) determined that when the distances between suitable habitat sites for a species become greater than its dispersal distance (such as due to habitat fragmentation), its long-term survival will be threatened unless the long-distance dispersal between the sites can be re-established (Trakhtenbrot et al. 2005). Alterations of hydrological regimes (e.g., flood control) have increased the lack of connectivity between populations (Service 2009a). Wilken (2009a) stated that the current hydrological regulatory process in the Santa Ynez River may not be conducive to conditions favoring establishment of *C. scariosum* var. *loncholepis*. Connectivity between populations, particularly natural riparian drainages in Santa Maria River, Orcutt Creek, San Antonio Creek, and Santa Ynez River that are not channelized or confined by barriers or dams, such that they have soft bottoms and sides and a natural flood plain (allowing

uninterrupted water flows) is one of the primary constituent elements for *C. scariosum* var. *loncholepis* in the final critical habitat rule (Service 2009a) and is important to maintain connectivity between populations for seed dispersal and the establishment of intermediate linkage populations that may be transitory in nature. Habitat that would provide connectivity between occurrences and populations is essential to recover *C. scariosum* var. *loncholepis* (Service 2009a). (USFWS, 2011)

Stressor: Water quality (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Threats identified since the time of listing discussed above under Factor A include excessive amounts of nitrogen and other nutrients in watersheds that either currently support or historically supported *Cirsium scariosum* var. *loncholepis*. These nutrient levels have a direct effect on the vegetation in these watersheds, which causes excessive growth that is consistent with biostimulation and eutrophication. Excessive nutrient inputs can lead to vegetation community composition changes due to biostimulatory effects (California State Water Resources Control Board 2006b, Central Coast Ambient Monitoring Program 2002, Dodds et al. 1998). (USFWS, 2011)

Stressor: Genetics as affected by small population size (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The limited gene pool of this species may depress its reproductive vigor. Human-caused or natural environmental disturbances (e.g., flood, drought, disease) could increase the risk of extinction of *Cirsium scariosum* var. *loncholepis*. Small populations are threatened by inbreeding depression (Ellstrand and Elam 1993). Small plant populations can have significantly lower germination rates than larger populations of the same species due to high levels of homozygosity (Menges 1991); this has already been observed in *C. scariosum* var. *loncholepis* (Hendrickson 1990). Genetic stochasticity results from changes in gene frequencies due to founder effect, random fixation, or inbreeding (Shaffer 1981). Low levels of genetic variation among and within populations could impair a species' ability to adapt to changes in the environment or contribute to inbreeding depression (i.e., loss of reproductive fitness or vigor) (Arias et al. no date). The existence of less than 10 populations and the small number of individuals in these populations places *Cirsium scariosum* var. *loncholepis* at extreme risk of extinction due to low levels of genetic diversity. (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, a rise in sea level, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). The extent to which climate change could affect *C. scariosum* var. *loncholepis* is unknown at this time due to the general nature of these predictions. Despite the uncertainty regarding the specific effects of climate change on this species, an increase in the rate of sea level rise has been predicted for the

coast of California (CCC 2001, California Climate Change Center 2006, Heberger et al. 2009). In particular, dunes along the coast will be subject to greater and more frequent wave attack, resulting in erosion and shoreline retreat estimated to be between 459 and 1,083 feet (140 and 330 m), corresponding to an estimated loss of approximately 1.4 square miles (896 acres) of dunes in San Luis Obispo County by the year 2100 (CCC 2001, Heberger et al. 2009). Because *Cirsium scariosum* var. *loncholepis* occurs in coastal dune habitats, erosion of these areas and corresponding loss or decreased quality of habitat could potentially adversely affect the species. (USFWS, 2011)

Recovery

Reclassification Criteria:

A Recovery Plan has not been developed for this species.

Delisting Criteria:

A Recovery Plan has not been developed for this species.

Recovery Actions:

- Recommendation for Future Actions from the 2019 5-Year Review: The results of our 2018 SSA indicate that La Graciosa thistle viability has declined sharply from historic conditions and has continued to decline since the 2011 5-year review. Both near-term and long-term efforts are required to achieve recovery. Several recommendations designed to halt this downward trajectory and ultimately reverse it, so that La Graciosa thistle can recover and persist into the future, are provided below. (USFWS, 2018)
- Near-term Recovery Actions: • Annual monitoring at the five extant occurrences; • Collect seed for banking and bulking, test seed viability; 10 • Conduct outplanting of La Graciosa thistle at historical occurrences and in other potentially suitable habitats; • Conduct habitat restoration and management at five extant occurrences and any newly established sites (including but not limited to- invasive species management, manual disturbance such as removal of thatch and vegetation clearing, supplemental watering, removal of overgrown hydrophytic species, re-introduction of controlled grazing regimes as a potential invasive species management tool, and installation of cages around individual plants during particular phenological stages); • Conduct education and outreach; and • Utilize the La Graciosa thistle Recovery Team and other potential recovery partners and stakeholders to facilitate ongoing collaborations. (USFWS, 2018)
- Longer-term Recovery Actions: • Establish living La Graciosa thistle collections at botanic gardens; • Pursue site access to occurrences (both historic and unknown) and potentially suitable habitats on private properties for surveys; and • Establish easements to support La Graciosa thistle recovery endeavors. (USFWS, 2018)
- Research Needs: • Habitat suitability modeling to identify potential outplanting sites throughout the species range; • Evaluation of the role of disturbance and management techniques for species recovery; • Seed viability and germination testing; • Hydrology and groundwater analyses; • Genetics work; • Pollination studies; and • Regional climate change simulations and projections. (USFWS, 2019)

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SPECIES ACCOUNT: *Cirsium pitcheri* (Pitcher's thistle)

Species Taxonomic and Listing Information

Listing Status: Threatened; 8/17/1988; Great Lakes-Big Rivers Region (R3)

Physical Description

Pitcher's thistle is a monocarpic (flowers and sets seed only once), perennial, herbaceous plant, generally flowering after a 5-8 year juvenile stage (Loveless 1984). The stems and leaves of juveniles and adults are woolly-white, and the leaves are deeply pinnatifid with the lobes less than 1 centimeter (cm) wide and up to 4 cm long. Minute spines are concentrated along the edge of the leaf at its base, with a few spines between the lobes of the distal leaf margins. The flowering stems are up to 1 meter (m) tall and have several to a dozen widely scattered leaves. Individuals typically have a single branching flowering stem with terminal and axillary flowering heads of a cream or pinkish color. Juveniles and adults have a taproot that may reach 2 m in length (McEachern and Pavlovic pers. obs.). (USFWS, 2002)

Taxonomy

This distinctive dune plant, often referred to as the dune thistle, was first noted by Dr. Zina Pitcher about 1827 at the Grand Sable Dunes of the Upper Peninsula of Michigan. The species was first described by Eaton (1829) as *Cnicus pitcheri* from the type specimen which was apparently collected in 1827 on or near Mackinac Island by Dr. Edwin James (Voss 1996). (USFWS, 2002)

Historical Range

Pitcher's thistle (*Cirsium pitcheri*) is endemic to the beaches and grassland dunes of Lakes Michigan, Superior, and Huron. Distribution of the species extends along the Lake Michigan shoreline in Wisconsin. In the east it ranges through northern Lake Huron to the Manitoulin Island archipelago and southern Georgian Bay in Ontario. Pitcher's thistle extends as far south as Lambton County, Ontario, Canada on Lake Huron, (USFWS, 2002)

Current Range

Current distribution is Illinois (Lake County), Indiana (Porter County), and Michigan (Alcona, Alger, Allegan, Alpena, Antrim, Arenac, Benzie, Berrien, Charlevoix, Cheboygan, Chippewa, Delta, Emmet, Grand Traverse, Huron, Iosco, Leelanau, Mackinac, Manistee, Mason, Muskegon, Oceana, Ottawa, Presque Isle, Schoolcraft, Van Buren Counties), and Wisconsin (Door, Manitowoc, and Sheboygan Counties). (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual

Other Reproductive Information

Adult: Pitcher's thistle reproduces only sexually. Pollination occurs through a variety of insects but primarily through bees (Hymenoptera). Pitcher's thistle blooms from June to September and is protandrous (pollen maturing before stigmas are receptive on individual flowers), and partially self-compatible (Higman and Penskar 1999). Seed dispersal occurs from June to August (McEachern 1992), depending on latitude, and does so through individual seeds blowing from the inflorescence head or by the whole plant and heads falling to the ground at the end of the growing season. A secondary means of dispersal is by wind blowing seed and seed heads across the sand, snow or water surface (Loveless 1984). The seeds are subject to herbivory by artichoke plume moth larvae (*Platyptilia carduidactyla*), ground squirrels, birds, especially goldfinches (*Spinus tristis*), and deer. Seed dormancy is broken by cold, moist stratification (Hamzé and Jolls 2000), with seed germination occurring in May and June (Loveless 1984). After germination, seedlings emerge producing one to six leaves in the first season (Loveless 1984). Seedling densities are greater where bare ground is abundant (McEachern et al. 1989) than in stabilized sites with greater vegetation cover. Juvenile plants typically consist of one rosette and may remain dormant for one or two years as a result of drought (McEachern 1992). The chances of juvenile mortality decrease as the plants increase in size. Causes of mortality include trampling (Keddy and Keddy 1984; Gibson 1988), sand deposition and erosion, drought, and herbivory. Juveniles grow or maintain a constant size throughout the growing season, but may diminish in size over the winter (Loveless 1984; McEachern 1992). Observations indicate juvenile plants in foredunes grow by increasing leaf number, whereas in inland stabilized habitats they grow by increasing leaf size (Loveless 1984). These growth differences may be significant in determining the age when juveniles reach a critical flowering size. The probability of insect herbivory increased with juvenile size, large juvenile density, and population successional stage (Stanforth et al. 1997). However, Rowland and Maun (2001) found that plants negatively affected by herbivory were able to recover and compensate for lost tissue by the following growing season. Conversely, plants subjected to herbivory, required a longer juvenile period to reach reproductive stage, thus increasing the period of vulnerability to herbivory and environmental stresses. Pitcher's thistle typically reaches reproductive age after 5 to 8 years. Reproduction appears to be correlated with habitat as Loveless (1984) found that adults bloom sooner in more stabilized habitats than in foredunes. Specific reproductive triggers are unknown, but the length of the longest leaf (Loveless 1984) and the root crown diameter (McEachern 1992) were found to be significant predictors of timing of reproduction. However, flowering probably involves an interaction between plant size (growth rate) and age, as small plants have also been observed to flower (USFWS 2002). Pitcher's thistle plants exhibit overcompensation as a response to damage (i.e., herbivory) by producing multi-stemmed plants. Multi-stemmed plants produce more seeds per plant and exhibit higher pollination activity than single-stemmed plants (Dao 2013). (USFWS, 2018)

Reproduction Narrative

Adult: *Cirsium pitcheri* is closely related to *C. canescens*, a thistle of the sand hills of the Great Plains (Ownbey and Hsi 1963). Recent electrophoretic evidence has shown that the thistles share the same genetic loci, but differ greatly in the level of genetic diversity (Loveless and Hamrick 1988). *Cirsium pitcheri* possesses a much reduced level of genetic variability than does *C. canescens*, suggesting derivative-progenitor relationship, respectively. It is believed that Pitcher's thistle migrated to the Great Lakes region soon after the close of the Wisconsin glaciation and that its reduced genetic diversity is a result of repeated and prolonged population bottlenecks (Loveless and Hamrick 1988). Seed germination in *C. pitcheri* has been observed

during June in Ontario (Keddy and Keddy 1984, Keddy 1981), Michigan and Indiana (McEachern et al. 1989). Keddy and Keddy (1984) found that the highest seedling mortality typically occurred in sand substrates, with the lowest in substrate of debris. In a season of drought, Zierner (pers. comm.) still found seedling survivorship in the species to be fairly high (roughly 40%). Seedling survivorship in her study was found to be highest of the lakeward side of the foredune where active sand deposition and associated grasses (*Ammophila* and *Calamovilfa*) were common. Although Keddy and Keddy (1984) found that mortality did not significantly differ between seedlings growing in clusters or individually, Zierner (pers. comm.) arrived at different conclusions. In her study, seedling survivorship was found to be highest in areas where other seedlings occurred. Once established in the rosette form, mortality is low (Keddy and Keddy 1984). This is, in part, due to the fact that immature plants can withstand burial by up to 15 cm of sand (Weller in litt.) and possess taproots that often reach down 5 to 7 feet, to where available moisture lies (Pepoon 1927). Of 193 rosettes studied in Ontario by Keddy and Keddy (1984), only seven died (due in part to caribou trampling and human intervention). Plume moth (*Platyptilia carduidactyla*) larvae occur within the centers of rosettes but do not appear to cause mortality (Keddy and Keddy 1984). They can, however, cause injury to the apical meristem of the plant, resulting in a multi-branched parental plant. *Cirsium pitcheri* is a monocarpic species which exists in a rosette for 5-8 years, flowers the following year, then dies (Crispin and Penskar 1990, McEachern et al. 1989, Dobberpuhl and Gibson 1987). Plants can remain in the rosette form until enough resources have been obtained in the root system to fuel the bolting plant and subsequent seed production (Keddy and Keddy 1984). The proportion of juvenile to adult plants is not unexpectedly skewed in favor of juvenile plants, 71.8% : 28.2% in Door County and 69.8% : 31.2% in Manitowoc County, Wisconsin (Dobberpuhl and Gibson 1987). According to Keddy and Keddy (1984) in Ontario, plants in grassland habitat dominated by beach grass and horsetail produced over twice as many branches and flower heads than plants in the debris habitat or on a crescent beach. Those on the crescent beach were nearly all vertical. This branched growth form may be attributed to the abundance of plume moth (*Platyptilia carduidactyla*) larvae in the grass habitat (Keddy and Keddy 1984). Attacks, by these larvae typically result in multi-branched individuals, as discussed above. Growth of *C. pitcheri* plants is also hindered at times by spittlebugs which lay eggs in the meristems of the plants, damaging newly-forming leaves (Crispin and Penskar 1990). This apparently causes mortality in some plants. Flowering begins in late June, peaks in late July, then declines rapidly (McEachern et al. 1989, Loveless 1983). According to Loveless (1983), many plants are dead and dying by early August, but some continue flowering until mid-September. After four to seven days of blooming, flowers begin to wither and die (Keddy 1981). As flowers brown, the involucre bracts gradually close in around them, protecting developing seeds. Flower heads per stalk vary from two to as many as 125 (Keddy 1981). Flower tubes of *C. pitcheri* contain several micro-liters of sweet-scented nectar secreted by a ridge at the base of the style (Keddy 1981, Knuth 1908). Apparently, a wide array of potential pollinators are attracted to this nectar. Of the 10 species of insects listed as flower visitors in Ontario (Keddy and Keddy 1984) and 23 insect visitors observed by Loveless (1983) in Michigan, only one species was the same, a bumblebee (*Bombus perplexus*). Insect pollen vectors include species within the genus *Bombus* (bumble-bees), *Megachile* (megachilid bees), *Melissodes* (anthophorid bees), *Lasioglossum* (small halictid bees), *Agapostemon* (large halictid bees), and butterflies and skippers of several genera (Loveless 1983). Other visitors to the flowers include flies, wasps, honeybees and sedentary beetles and bugs (Loveless 1983). Keddy and Keddy (1984) listed lepidopterans, dipterans and hymenopterans as flower visitors in Ontario, the most abundant of which was *Bombus vagans*. Prominent butterfly pollinators included *Vanessa cardui* and *Daneus peleyippus* (Crispin and Penskar 1990). Nocturnal visitors

have not been studied, but moths are believed to visit the flowers (Loveless 1983). For a species list of known pollen vectors and flower visitors, see Loveless (1983) and Keddy and Keddy (1984). Seed set is known to decline between late July and August in *C. pitcheri*. This decline in seed set has been attributed, in part, to pollinator availability which parallels this decline (Loveless 1983). Loveless (1983) observed that many plants died prior to maturing a single flower head, suggesting that the species allocates its resources early in the season when the likelihood of maturing fruits is highest. The artichoke plume moth (*Platyptilia carduidactyla*) larvae feed on the immature seeds of *C. pitcheri*, sometimes causing flower mortality (McEachern et al. 1989, Keddy and Keddy 1984). This insect has been observed by Loveless (1983) in Michigan, Keddy and Keddy (1984) in Ontario, and Dobberpuhl and Gibson (1987) in Wisconsin. In Ontario, Keddy and Keddy (1984) found that most plants were affected by the moth only in July, with predation highest in a grass habitat. Fewer plants were infected in a habitat of debris, while predation was non-existent in a crescent beach population. Loveless (1983), however, found that levels of seed damage in various habitats were nearly equal, suggesting that seed predation was density-dependant. In addition, Loveless observed that seed predation in Michigan did not markedly change throughout the season. For a brief description of the plume moth life cycle, see Keddy (1981). McEachern (pers. comm.) stated that she had observed a larva within the flower head in Michigan but is unsure as to its identity at this time. Mosquin et al. (1986) suggested that the presence of the plume moth in *C. pitcheri* populations may be mutually beneficial. Presence of larvae in the rosettes of *C. pitcheri* causes the plant to become multi-branched (Keddy and Keddy 1984). As a consequence, more flowers and seeds are produced. At present, there is little information to substantiate this hypothesis. In addition, the moth is also known to feed on the seeds of the thistle, so there may be a simple trade off or net loss of seed production despite the multiple-branched stemming of the plant. Keddy and Keddy (1984), in fact, suggested that up to 40% of the normal seed crop was lost in a given year in Ontario as a result of the moth predation. American goldfinches were observed to devour approximately 50% of the seeds within a given flowerhead (Loveless 1984). Other birds, primarily sparrows, forage on unburied seeds. The thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*) is ; (NatureServe, 2015)

Habitat Type

Adult: Great Lakes sand dunes

Habitat Narrative

Adult: *Cirsium pitcheri* occurs most prominently in Michigan, occurring in 18 counties along the shorelines of Lakes Michigan, Huron and Superior (Nepstad 1981). In Wisconsin, the species currently exists in eight sites in four counties on the Lake Superior shoreline (Alverson 1981). The species occurs at seven extant sites along Lake Michigan in Indiana (IN NHP 1989), but has been extirpated from Illinois (Sidle 1987, White 1981). It is also known from roughly 12 extant sites in Ontario, including a population on the shoreline of Lake Superior (Keddy and Keddy 1984, Keddy 1988). Pitcher's thistle is a regional endemic restricted to the dune habitats in the western Great Lakes region (USFWS 1987, Dobberpuhl and Gibson 1987, Keddy and Keddy 1984, Loveless 1983, Guire and Voss 1963). The species is a colonizer on open dune ridges, dune blowouts, and along disturbed sites in sand dunes, but is found on stabilized grassy sand terraces, sandy gravel flats and dune valleys as well (Loveless 1983). In all habitat types, however, the species appears to establish itself only in very open, sandy soil (Loveless 1983). McEachern et al. (1989) described the habitats associated with the lakeshores as: 1) extremely exposed open communities on lake level foredunes and dune bluff edges dominated

by *Ammophila breviligulata*, 2) transitional communities dominated by three dune grasses, *A. breviligulata*, *Calamovilfa longifolia* and *Schizachyrium scoparium*, and 3) stabilized inland blowouts characterized by *S. scoparium*/*C. longifolia* codominance and moderate vegetation and litter accumulation. These three habitat types mark a successional gradient, in which *A. breviligulata*, adapted to high rates of sand deposition occurring in the shoreline habitats, is replaced by the more competitive *C. longifolia* and finally, *S. scoparium* in progressively stable inland areas (McEachern et al. 1989). Associated with this change in dominant vegetation along a shoreline to inland transect, there is an equally significant reduction in the percentage of bare ground. This amount of bare ground is apparently significant, for it is in the most stable, *S. scoparium* dominated areas that *C. pitcheri* is the least abundant (McEachern et al. 1989). In Michigan, *C. pitcheri* is most common along the northern and northeastern shore of Lake Michigan, although small populations are known from the southeastern shores of Lake Michigan and northern Lake Huron (Crispin and Penskar 1990). A few populations also occur along Lake Superior. *Cirsium pitcheri* typically grows in association with *Ammophila breviligulata*, *Schizachyrium scoparium*, *Arabis lyrata*, *Arctostaphylos uva-ursi*, *Calamovilfa longifolia* and *Agropyron dasystachyum* (Crispin and Penskar 1990, MI NFI 1990). At disturbed sites, *Asclepias syriaca* may be present (Crispin and Penskar 1990). At Sleeping Bear Dunes National Lakeshore in Michigan, the species is apparently doing well, even in the intensely utilized areas around the marina (Hazlett and van de Kopple 1983). A recent survey by McEachern et al. (1989) found that *C. pitcheri* was occupying much of its potential habitat: foredunes, blowouts, dune ridges, valleys and slopes. Although *C. pitcheri* was least common from the backslopes of inland dunes, localized populations were found there as well. On the Manitou Islands portion of Sleeping Bear Lakeshore, plants have been found on perched (260 feet above Lake Michigan, on glacial moraines) and coastal dunes. McEachern et al. (1989) found that plants growing on the dunes of South Manitou Island appeared more stunted and were more dispersed than those on the mainland, possibly reflecting the harsher environment of the island. Associates on a gravel lag behind a coastal dune complex at Dimmick's Point on North Manitou Island include *Agropyron dasystachyum*, *Schizachyrium scoparium*, *Anemone multifida*, *Artemisia caudata*, *Betula papyrifera*, *Campanula rotundifolia*, *Carex garberi*, *Thuja occidentalis* and *Zygadenus glaucus* with an overstory of *Betula papyrifera*. Associates in a dune blowout on South Manitou include *Schizachyrium scoparium*, *Anemone multifida*, *Arctostaphylos uva-ursi*, *Arenaria stricta*, *Aster* sp., *Calamovilfa longifolia*, *Coreopsis palmata*, *Equisetum hyemale*, *Ostrya virginiana*, *Polygonatum pubescens*, *Prunus virginiana*, *Trientalis borealis*, *Trillium grandiflorum*, *Viburnum acerifolium*, *Viola canadensis* and *Viola* sp. (Hazlett and van de Kopple 1983). For additional habitat information pertinent to Sleeping Bear National Lakeshore, see McEachern et al. (1989), Hazlett (1986) and Loveless (1983). At Grand Sable Dunes within the Pictured Rocks National Lakeshore of Michigan, McEachern et al. (1989) found the populations occupying dune and blowout habitats ranging from the dune bluff inland to wooded areas. In contrast to Sleeping Bear, populations were scattered and were far less abundant. For habitat information concerning populations at Pictured Rocks National Lakeshore, see McEachern et al. (1989). Within the state of Indiana, plants have been observed on dunes, foredunes, blowouts and beaches along Lake Michigan (IN NHP 1989). At the Indiana Dunes National Lakeshore, Bowles et al. (1985) found *Cirsium pitcheri* restricted to early and mid-successional blowouts on the high dunes adjacent to Lake Michigan. It appeared to be absent from the first foredune. Sites were extremely well-drained and support sparse dry sand prairie-like communities (Bowles et al. 1985). A recent survey of the site by McEachern et al. (1989) produced similar conclusions. In all, six small populations were found, all on the steep, lakeward-facing slopes or grassland blowouts of the secondary dunes. No plants were observed on the beach and foredune

complexes still rebuilding since the high-water levels of 1986 and 1987. Dobberpuhl and Gibson (1987) stated that in Wisconsin, the plant is found in three habitats: (1) dry sand of partially-stabilized dunes along Lake Michigan, (2) dry, open areas of loose sand (sand blowouts) behind the main foredune and infrequently on (3) low, moist to wet beaches. Colonies thrive best in situations where the dunes are somewhat stabilized, in various slope aspects and degrees of steepness. Two populations in Wisconsin are at the mouths of creeks, where continual sand deposition from the creeks provides new habitat and increasing site longevity (WI NHP 1990, Dobberpuhl and Gibson 1987). Associated plants species in Wisconsin include *Agropyron dasystachyum*, *Calamovilfa longifolia* var. *magna*, *Elymus canadensis*, *Ammophila breviligulata*, *Agropyron trachycaulon*, *Artemisia caudata*, *Lathyrus maritimus*, *Oenothera parviflora*, *Potentilla anserina* and *Solidago gillmani* (WI NHP 1990, Alverson 1979, Johnson and Iltis 1963). In Canada, *C. pitcheri* is found only in Ontario on sandy beaches and dunes of the shores of Lake Huron and Georgian Bay (Moore and Frankton 1974) and Lake Superior (Keddy and Keddy 1984, Keddy 1981). At Lake Superior sites in Pukaskwa National Park, plants grow approximately 1-2 meters above the lake level on gently sloping sand beaches in three distinct habitats: 1) grass (dominated by *Ammophila breviligulata* and *Equisetum variegatum*), 2) debris (dominated by *Prunus pumila* and *Festuca saximontana*) and 3) shrub (dominated by *Juniperus horizontalis* and *Arctostaphylos uva-ursi*) (Keddy and Keddy 1984, Keddy 1981). Most plants (79%) were found in the grass habitat, with 21% growing in the debris habitat. Less than 1% were found in the shrub habitat (NatureServe, 2015). The Pitcher's thistle (*Cirsium pitcheri*), also known as dune thistle, is a Great Lakes endemic that is typically found on open beaches and grassland dunes and occasionally on lag gravel associated with the shoreline dunes. The Service listed Pitcher's thistle as a threatened species under the Act on July 18, 1988 (USFWS 2002). Pitcher's thistle is one of a few plant species endemic to the post-Wisconsinan Great Lakes sand dunes. It is found most frequently in the near-shore plant communities where it colonizes patches of open, windblown areas of the landscape. The species gradually declines locally as the density of vegetation and ground litter increases through plant succession and in areas heavily used by people. Pitcher's thistle density peaks in mid-successional habitats and requires 70% open sand for successful seedling establishment and survival (McEachern 1992). Healthy populations of Pitcher's thistle are an indication of the general well-being of dune ecosystems. No species is known to depend completely on Pitcher's thistle. However, the rust, *Puccinia laschii*, that is sometimes found on adult Pitcher's thistle leaves may be host-specific, and therefore, dependent on it (Saville 1970). In addition, Pitcher's thistle is a food (pollen, nectar, and seed) source for many organisms (Keddy and Keddy 1984; Loveless 1984). Pitcher's thistle depends on the geomorphic processes that maintain dune systems to create sparsely vegetated habitats where successful population growth can occur. Populations are prone to extirpation due to successional change, erosional loss, and catastrophic events depending on their location. A shifting mosaic of dune processes on a large dune system landscape can ensure this species' persistence as long as seed is available to disperse to existing or newly created adjacent suitable habitats. For a particular occurrence of Pitcher's thistle to survive, disturbance must be frequent enough to prevent extirpation from succession and infrequent enough to allow juveniles to reach maturity; thus, the Pitcher's thistle life history is finely tuned to a specific disturbance regime (McEachern 1992). Disturbances may eliminate local occurrences, but as long as those disturbances are not synchronous throughout the landscape and occurrence creation exceeds decline, the species will persist (Pavlovic 1994).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seed dispersal occurs from June to August (McEachern 1992), depending on latitude, and does so through individual seeds blowing from the inflorescence head or by the whole plant and heads falling to the ground at the end of the growing season. A secondary means of dispersal is by wind blowing seed and seed heads across the sand, snow or water surface (Loveless 1984). The seeds are subject to herbivory by artichoke plume moth larvae (*Platyptilia carduidactyla*), ground squirrels, birds, especially goldfinches (*Spinus tristis*), and deer.

Population Information and Trends**Number of Populations:**

81 - 300 (NatureServe, 2015)

Population Size:

100,000 - 1,000,000 individuals (NatureServe, 2015)

Population Narrative:

The dune habitat is subject to high levels of natural wind and water-induced disturbance. These natural disturbances are necessary in maintaining the primary habitat in which *C. pitcheri* occurs. Over the last 200yrs this species has declined 10-30% in MI, 80-90% in IN, 50-70% in WI, and declined 100% (12 extirpated EOs) in IL. Long term trends are unknown in Canada. Estimations are mainly based on habitat loss. Decline of 70-80% ~50,000 in Canada, 10-20k in WI, ~100k in MI, and 500-1000 in IN. Occurs at about 156 extant sites in Michigan, 9 extant sites in Wisconsin, 8 sites in Indiana and 25-30 sites in Ontario, Canada. The species has apparently been extirpated from Illinois (NatureServe, 2015). Within its U.S. range, there are 211 historic and extant element occurrences (MNFI 2009; USFWS 2002). Of these, 18 are extirpated (4 in Indiana and 14 in Illinois). Pitcher's thistle probably occurred more commonly along the Great Lakes shorelines prior to European settlement, but it is unknown how many occurrences were lost due to settlement and shoreline development. Of the remaining 193 occurrences, 169 (88%) are within Michigan. Nonetheless, all occurrences are not considered priority occurrences. The recovery plan defines priority occurrences as element occurrences that have the following characteristics: (1) located on Federal or State-owned lands; (2) ranked excellent to fair; (3) located in southern Lower Michigan, Indiana, or Wisconsin; and (4) are part of complex perched dune systems. According to this definition, 139 priority occurrences are known range-wide in the U.S., with 118 in Michigan. The 21 remaining priority occurrences consist of nine in Wisconsin and 12 in Indiana. All naturally occurring Pitcher's thistle populations in Illinois are extirpated. Of all occurrences, including non-priority occurrences, the majority (77%) are located within the Lake Michigan basin. Twenty-two percent are found in the Lake Huron basin and one occurrence (<1%) in the Lake Superior basin. Of the priority occurrences, 83 (60%) are entirely in public ownership (MNFI 2009) and eight (6%) are under the ownership of land conservancies. The remaining 48 (35%) priority occurrences are on private lands. In Michigan, over two-thirds of occurrences are located in the Lower Peninsula, mostly along Lake Michigan. The Upper Peninsula supports 28 priority occurrences located along the northern shores of Lake Michigan. Most U.P. occurrences are found in Mackinac County. The one occurrence in Alger County is the only occurrence on the shore of Lake Superior.

Threats and Stressors

Stressor: Habitat destruction (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Pitcher's thistle is threatened by habitat destruction, overuse, and repeated disturbance from trampling by beach and dune visitors and off-road vehicles. Approximately ten percent of its population has been lost, modified or curtailed through these actions. Some populations have also been lost or negatively impacted through alteration of local dune geomorphic processes, which prevent the creation and maintenance of Pitcher's thistle habitat. In addition, shoreline stabilization projects, such as sea walls, rip rap, and planting of beach grass, northern white cedar, and some non-native species, also alter dune building processes and may decrease habitat available to Pitcher's thistle. (USFWS, 2016)

Stressor: Non-native and invasive species

Exposure:

Response:

Consequence:

Narrative: Encroachment by non-native and invasive species, such as spotted knapweed, baby's breath, and Lombardy poplar, also pose a threat to Pitcher's thistle. For example, spotted knapweed is known to negatively influence the soil in its vicinity to prevent the growth of native species (Louda et al. unpub. data 2007), as well as out-compete native species for resources. The introduction and spread of non-native insect species for biological control is an additional threat. Two species of non-native weevils used for biological control have been documented in Michigan, as well as some of the surrounding states, and these newly emerging threats place the range-wide existence of Pitcher's thistle at risk. These non-native weevils oviposit eggs near the base of developing seed heads (Louda et al. 1997, Louda et al. 2005, McEachern and Pavlovic 2013). Larvae develop inside the receptacle tissue at the base of the head, feeding on receptacle and eventually seeds within the ovary (Louda et al. 1997, Louda et al. 2005, McEachern and Pavlovic 2013). As the seed head matures, the weevils emerge as adults, often leaving visible exit holes at the base of the head (McEachern and Pavlovic 2013). The weevils' actions prevent seeds from forming or flowering. Flowerhead weevil (*Rhinocyllus conicus*) was introduced from Europe in 1969 to control *Carduus* species, especially musk thistles (*Carduus nutans*) and others plants (Rees 1982, Bradley 2007, Sauer and Bradley 2008). The weevil also develops on multiple native *Cirsium* species in the United States (Goeden and Ricker 1986a, 1986b, 1987a, 1987b; Turner et al. 1987; Louda et al. 1997). Laboratory and garden host specificity tests revealed that flowerhead weevils fed, oviposited, and developed completely on Pitcher's thistle, as well as its target species, and taller Pitcher's thistle plants with more flowerheads were significantly more vulnerable to the weevil (Louda et al. 2005). *Rhinocyllus conicus* has been documented in Wisconsin, where it was released in 1975, with a second release in 1978 (Sauer and Bradley 2008). It has since spread to several other counties (Sauer and Bradley 2008); however, it has not yet been documented in wild populations of Pitcher's thistle in the state. The weevil was also found on Pitcher's thistle in a common garden at Chicago Botanic Garden (CBG) in 2007 (J. Fant, CBG, pers. comm. 2007; N. Pavlovic, USGS, pers. comm., 2007) and in a Pitcher's thistle nursery at Illinois Beach State Park near a restoration site in 2011 (Bell and Hankins, unpublished, cited in McEachern and Pavlovic 2013). In 2012, *R. conicus* was collected from Pitcher's thistle at the Miller Dunes unit of the Indiana Dunes National Lakeshore (McEachern and Pavlovic 2013). Based on the 2012 surveys conducted in Michigan, the weevil was observed on musk thistles in Jackson and Lenawee counties (D. Landis, Michigan State University, pers. comm. 2012), which are not

within range of Pitcher's thistle. A greenhouse test documented the weevil in approximately 40% of Pitcher's thistle seed heads and reduced seed set by 95% in those heads during the first year of infestation (Louda et al. 2005, Havens et al. 2012a). A demographic model suggests that *R. conicus* will reduce Pitcher's thistle population growth rate by 15% per year and the time to halve the population size from 66.9 years to 4.0–4.0 years (K. McEachern, USGS, pers. comm. 2011). In addition to reducing seed numbers in Pitcher's thistle, *R. conicus* predation is also expected to reduce seed mass (M. Bowles, The Morton Arboretum, pers. comm. 2013). *Larinus planus*, a seed-eating weevil, was inadvertently introduced into the U.S. from Eurasia in the 1960s and has since been redistributed for control of Canada thistle (*Cirsium arvense* L.) (White 1972, Havens et al. 2012a, McEachern and Pavlovic 2013). In 2010, *L. planus* was first documented in Pitcher's thistle populations at Whitefish Dunes State Park, Door County, Wisconsin, in approximately one-third of examined seed heads (Havens et al. 2012). No viable seeds were found in those heads (Havens et al. 2012a). A more extensive survey of the Whitefish Dunes population in 2011 found the weevil in half the seed heads and almost no viable seeds (Havens et al. 2012a). Subsequent surveys of public and private lands throughout the Door Peninsula found *L. planus* in every Pitcher's thistle population (Havens et al. 2012a). In 2012, three Pitcher's thistle heads collected from research plots at Wilderness State Park, Emmet County, Michigan, had adult *L. planus* emerge from the flower heads in late-July 2012 (Havens et al. 2012b). Consequently, a more extensive search for the weevil was conducted at six element occurrences of Pitcher's thistle at Wilderness in mid-August 2012. Suspected weevil-damaged seed heads were collected and sent to CBG to examine for *L. planus* infestation. Although CBG found no adult weevils, most element occurrences had at least one damaged seed-head that was consistent with the weevil damage observed in Wisconsin, which consisted of one or more of the following characteristics: destruction of all or nearly all developing seeds, mass of digested ovules, seeds, frass remnants, and a pupal chamber visible in the receptacle tissue (Havens et al. 2012b). Currently, there is limited knowledge about the life-history of weevils, their relationships with Pitcher's thistle, and lack of knowledge of how to control the weevils along Great Lakes shoreline. (USFWS, 2016)

Stressor: Seed predation (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Pitcher's thistle seeds are subject to pre- and post- dispersal herbivory (USFWS 2002). American goldfinches (*Spinus tristis*) are one of the species listed in the recovery plan as being a pre-dispersal herbivore of Pitcher's thistle (USFWS 2002). The goldfinches have recently become more abundant at Indiana Dunes National Lakeshore (IDNL) and have been observed feeding on Pitcher's thistle seeds, prying open the phyllaries as seeds are developing, often consuming 90% of the seed crop of an individual thistle plant (McEachern and Pavlovic 2013). Miller High Dunes of IDNL has had up to 100% seed predation by goldfinches (Pavlovic, pers. comm. 2013). With the already small and declining populations of Pitcher's thistle at IDNL, the increase in goldfinch seed feeding has compounded the potential weevil threat (McEachern and Pavlovic 2013). (USFWS, 2016)

Stressor: Inadequate regulation (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Government units below State level generally do not provide adequate protection for rare plants. A few townships passed zoning ordinances designed to protect some natural resources, but other townships with outdated zoning ordinances remain ill-equipped to deal with current development. At the State level, MDEQ continues to permit home development in Critical Dune Areas. Although permits may include conditions to avoid immediate loss of existing plants, these permits do not address fragmentation or potential alteration of dune-sustaining processes. The State of Michigan has no authority to require protection of plants from indirect effects and does not require State-level endangered species permits if direct impacts to the species are not expected. In Wisconsin, State agencies do not have authority to protect listed species from impacts on private lands unless the activity otherwise requires a Federal permit or funding. (USFWS, 2016)

Stressor: Climate Change (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Our analyses under the Act include consideration of ongoing and projected changes in climate. The terms “climate” and “climate change” are defined by the Intergovernmental Panel on Climate Change (IPCC). “Climate” refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007). The term “climate change” thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007). Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative and they may change over time, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables (e.g., habitat fragmentation) (IPCC 2007). In our analyses, we use our expert judgment to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change. In the Great Lakes region, the climate will likely grow warmer and probably drier overall during the 21st century (Kling et al. 2003). Although average annual precipitation may increase slightly by the end of the century, seasonal precipitation cycles are predicted to become more extreme. Winter and spring rains are likely to increase, while summer rains are expected to decrease by up to 50 percent. These potential impacts of climate change are increasingly evident in the Great Lakes region. Summer lake water temperatures are increasing, with Lake Superior’s average summer surface water temperature increasing by 4.5° F since 1980 (Austin and Colman 2007). Ice forms later and melts earlier throughout the region. Earlier models had indicated that altered precipitation patterns, higher air temperatures, and reduced ice cover would increase evaporation in the Great Lakes, resulting in lake level drops of 1.5 feet to as much as 8 feet (Sousounis and Glick 2000; AMEC 2006; Kling et al. 2003). However, more recent models show a more variable response in lake levels. A majority of the model simulations run by Angel and Kunkel (2010) resulted in reductions in lake levels, yet also showed a high degree of uncertainty in possible future lake levels, depending on future emissions. Furthermore, Hayhoe et al. (2010) suggest that the competing effects of shifting precipitation and warmer temperatures will result in little change in Great Lake levels until the end of the century, when net decreases in lake levels are expected under higher emission scenarios. If Great Lakes levels recede, more dune formation may occur, potentially increasing habitat for shoreline occurrences of Pitcher’s thistle (M. Penskar, Michigan Natural Features Inventory, pers. comm. 2009). Increased water

temperatures will also result in decreased ice cover that when combined with an expected intensity of winter storms, will leave coastal areas more vulnerable to the effects of winter storms and flooding (Fang and Stefan 2000; AMEC 2006), altering Pitcher's thistle habitat. A warmer climate could also bring about a northward shift and an even greater increase in invasive species that may be more problematic in the dunes and lakeshore systems, thus increasing competition with native plant species (Malcolm et al. 2002; AMEC 2006; Penskar, pers. comm. 2009). (USFWS, 2016)

Recovery

Reclassification Criteria:

Not applicable.

Delisting Criteria:

1. The essential habitat associated with a total of 115 priority occurrences representing each biogeographic region and dune type is protected and managed under a management plan, including: a) all Federal and State owned essential habitat and occurrences, b) all publicly and privately-owned essential habitat and occurrences having a rank of A, AB, B, or BC, c) all occurrences in southern Lower Michigan, Indiana, and Wisconsin, and d) all complex perched dune systems. (USFWS, 2002)
2. Regular field surveys to verify occurrences and record new occurrences have been established. (USFWS, 2002)
3. Landowner contacts have been initiated and protection has been investigated for the remaining (rank < BC) public and private occurrences. (USFWS, 2002)
4. Monitoring of known sites shows a stable or increasing trend toward recovery and that protective plans are being implemented. (USFWS, 2002)
5. Restoration of two occurrences from among historical sites where sufficient habitat remains in Illinois, Indiana, Wisconsin, and southern Lower Michigan has been completed. (USFWS, 2002)
6. Research necessary to protect, manage and restore Pitcher's thistle has been conducted. (USFWS, 2002)

Recovery Actions:

- 1. Protect and manage known occurrences and essential habitat, giving priority to essential habitat. To ensure the long-term perpetuation of *Cirsium pitcheri*, planned protection for all 115 priority occurrences must occur and the remaining lower priority sites should receive some protection. Protection strategies will depend on cooperation between Federal and State agencies, private conservation organizations, regional planning councils, local jurisdictions, private developers and landowners. Principal cooperators include State and provincial resource agencies, The Nature Conservancy (TNC), The Nature Conservancy of Canada, the Center for the Great Lakes' Great Legacy program, the U. S. Forest Service (USFS), the National Park Service (NPS), and the U. S. Fish and Wildlife Service (Service). Working together should assure the highest level of protection for each site (USFWS, 2002)

- 2. Establish and conduct ongoing field surveys to verify known and record new occurrences. Pitcher's thistle is highly dependent upon the fluctuating environment of its lakeshore habitat. Therefore it is important to monitor the status of populations and habitats on a regular basis over periods of several decades to detect responses to fluctuating lake levels and habitat changes. Monitoring of sites is necessary for effective management. The monitoring should be designed to detect fluctuations in Pitcher's thistle population size and age class distribution and collect information on age at flowering. This will permit assessment of implemented management actions and determine if remedial action is required. (USFWS, 2002)
- 3. Inform the public, recreationists, public land managers, and private landowners. Knowledgeable individuals are an important part of the recovery process. Informing managers, recreational groups and landowners about Pitcher's thistle, its status as a protected species, and protection methods is an important step toward cooperative protection and management. Accurate and current information can foster interest and appreciation for the Pitcher's thistle. Groups such as the Michigan Nature Association, Michigan Natural Areas Council, The Nature Conservancy, The Nature Conservancy of Canada, Center for the Great Lakes, the International Joint Commission, Federal, State, provincial and local resource agencies, and local Audubon groups and garden clubs should be kept informed of recovery efforts. Federal land managers must be aware of the need to protect, and methods of protecting, Pitcher's thistle on Federal lands to facilitate decisions that will protect the species. Cooperators will develop, distribute, and update information and make recommendations for managers to protect Pitcher's thistle and its essential habitat. Information sent to individual managers will include the location of occurrences and essential habitat, as well as the specific known and suspected threats to the species under the manager's care. Public utilities, with their promotion of environmental programs, may underwrite or sponsor public awareness campaigns. Resource agencies may encourage greater conservation through liaisons with public utilities. (USFWS, 2002)
- 4. Monitor occurrences for stable and increasing trends and implementation of protective plans. Protective management of Pitcher's thistle requires knowledge of its current status and threats. Inventory must incorporate population size, quality, and threats to be useful for scientific assessment and planning. (USFWS, 2002)
- 5. Restore Pitcher's thistle to an element rank of at least BC on at least one appropriate site within its historical range. *C. pitcherii* has been extirpated from parts of its natural range, so restoration is necessary to recover Pitcher's thistle throughout the area addressed in the recovery objective. Restoration is intended to recolonize sites where the species formerly occurred and cannot be used as justification or mitigation for destruction of an existing high quality occurrence elsewhere. Restoration planning should be integrated with ongoing interagency coordination and should be complementary and reinforcing. Restoration guidelines are needed in order to meet the objective of preserving populations throughout the species range. (USFWS, 2002)
- 6. Conduct research necessary for protection, management, and restoration. Answers to questions related to seed production, viability, dispersal distances, and predation would allow managers to assess risk to the species from different management scenarios. Improved understanding about the needs of Pitcher's thistle would focus management goals for the species and lead to better protection of Pitcher's thistle habitat (USFWS, 2002)

Conservation Measures and Best Management Practices:

- Continue to plan and implement regular surveys, monitor occurrences, and document habitat conditions and population trends at all Pitcher's thistle locations. (USFWS, 2018)
- Monitor an approach of using biocontrol insects to manage non-native plant species. (USFWS, 2018)
- Seek funding opportunities to support research that addresses the following knowledge gaps: Demographic features of Pitcher's thistle populations located on Sleeping Bear Dunes National Lakeshore and other NPS properties within the Great Lakes region. Assess the threat of invasive weevils, including *Larinus planus*. . (USFWS, 2018)
- Work with partners to conduct a population viability analysis or similar for Pitcher's thistle . (USFWS, 2018)
- Complete Pitcher's Thistle Species Status Assessment (SSA) by 2024. Investigate whether possible extirpation of populations in southern Michigan is significant in terms of representation. (USFWS, 2018)

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SPECIES ACCOUNT: *Cirsium vinaceum* (Sacramento Mountains thistle)

Species Taxonomic and Listing Information

Listing Status: Threatened; 06/16/1987; Southwest Region (R2) (USFWS, 2016)

Physical Description

A robust perennial herb with a purple stem that grows up to 2 m tall. The deeply lobed, spine-tipped leaves can be as long as 5 dm. Many nodding, white to purple flower heads appear in late summer. The plant's nectar is highly attractive to hummingbirds, bees, and butterflies (NatureServe, 2015).

Taxonomy

It was originally named *Carduus vinaceus* in accordance with generic concepts at that time. Wootton and Standley (1915) later combined it with the genus *Cirsium* where it was maintained by Petrak (1917) in his revision of the North American species of *Cirsium*. Although *Cirsium* is a common genus in the New Mexico flora, *Cirsium vinaceum* is a distinctive species with no close relatives within its range of occurrence. Its closest relative is the Mexican species, *Cirsium conspicuum* (USFWS, 1993).

Historical Range

Endemic to the Sacramento Mountains of south-central New Mexico (Otero County) (USFWS, 2010).

Current Range

The range occurs approximately 6 mi northeast to 17 mi south of Cloudcroft. Greater than 95% of the known thistle habitats occur on the Lincoln National Forest (USFWS, 2010).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual: vegetative (USFWS, 2010); sexual (inferred from USFWS, 1993)

Key Resources Needed for Breeding

Adult: Insect and hummingbird pollinators (USFWS, 1993)

Reproduction Narrative

Adult: This species is a monocarpic, short-lived perennial initially forming robust rosettes of spiny leaves that live for one or more years as juvenile plants (Burks 1994). It is capable of root sprouting to produce multiple rosettes (clones) per genetic individual (USFWS, 2010). Pollen vectors include hummingbirds and numerous species of bees, beetles, flies, and moths (USFWS, 1993).

Habitat Type

Adult: Riparian (NatureServe, 2015); wetland (USFWS, 2010)

Habitat Vegetation or Surface Water Classification

Adult: Stream banks, wet meadows (NatureServe, 2015); conifer forest, valley (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: 2,460 - 3,020 m elevation (USFWS, 2010)

Spatial Arrangements of the Population

Adult: Dense patches (USFWS, 2010)

Environmental Specificity

Adult: Moderate (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits moist banks of streams, wet meadows, and other moist areas. Remaining populations are mostly in the vicinity of springs flowing out of limestone, where steep calcium carbonate deposits have formed. These receive less grazing and trampling than the surrounding flat areas and have provided a refuge for the species. The environmental specificity is moderate; it is an obligate wetland species that is dependent on streams or springs (NatureServe, 2015). It is endemic to elevations between 2,460 and 3,020 m. It is a wetland-obligate species inhabiting saturated alkaline soils in valley bottoms. Many of the travertine deposits are covered with dense patches of *C. vinaceum* to the point of being nearly a monoculture of this species (Thomson 1991). Thistle habitats occur in mixed conifer forests and open valleys (USFWS, 2010).

Dispersal/Migration**Dispersal**

Adult: Low to moderate (inferred from USFWS, 2010; 1993)

Dispersal/Migration Narrative

Adult: Craddock and Huenneke (1997) determined that stream flow dispersal and occasional thistle establishment in streamside habitats were sufficient to genetically link some discrete patches of thistles (USFWS, 2010). The seed is heavy, but fairly dispersible by wind. Therefore, gene flow from pollen vectors and seed dispersal is probably effective up to about 0.5 mile (USFWS, 1993).

Population Information and Trends**Population Trends:**

Not available

Species Trends:

10 - 30% decline (NatureServe, 2015)

Resiliency:

Low (inferred from USFWS, 2010; see current range/distribution)

Redundancy:

Moderate (inferred from NatureServe, 2015)

Number of Populations:

~20 (NatureServe, 2015)

Population Size:

100,000 - 1,000,000 individuals (NatureServe, 2015)

Population Narrative:

Thirty-seven+ occurrences (10/96), but some may be part of a continuous population resulting in about 20 populations (11/12). Five populations were extirpated between 1995 and 2007 (10 - 30% decline). The estimated population size is 100,000 - 1,000,000 individuals (NatureServe, 2015).

Threats and Stressors

Stressor: Water diversions/alterd hydrology (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Appropriation of water rights from springs for uses such as livestock water, farming, domestic use, or recreational facilities, usually uses points of diversion that curtail natural surface flows. One diversion for a residential subdivision currently is taking water from an aquifer on private property above a small thistle habitat in Fresno Canyon and has been for several years (Sivinski, unpublished observation, 2005). Several thistle habitats have been subjected to direct and indirect impacts from land uses that damage travertine substrates and hydrological characteristics. Increasing population and associated agricultural and economic activities will require additional water from this relatively dry region (USFWS, 2010).

Stressor: Exotic weeds (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Huenneke and Thomson (1995) surmised that if a dense cover of teasel, or other exotic weeds, became established in thistle habitats, thistle germination would be inhibited by access to light, and the population might decline. Huenneke (1996) also noted that during drought, the drying soils in thistle habitats provided excellent conditions for teasel and other non-native plants, possibly lending non-natives a competitive edge in drier conditions (USFWS, 2010).

Stressor: Forestry (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Historically, negative effects of timber harvest and management on Sacramento Mountains thistle habitat have been associated with roads and other surface disturbance that

directly impacted thistle habitats or made changes in hydrology and erosion. Mortality to thistles growing in moist areas along roadsides occasionally occurs from mowing, road maintenance, or herbicides (Tonne 2007; Guaderrama, pers. Comm. 2007) (USFWS, 2010).

Stressor: Recreation (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Recreational impacts to Sacramento Mountains thistles from human destruction have been noted to occur at the Bluff Springs habitat location (USFWS 1993, USFWS 2008, Barlow-Irick 2008, USFS 2008b, USFWS 2010). Recreationalists have also been observed driving ATVs through enclosures typically fenced to exclude livestock; cut fences and opened gates have been noted in the same enclosed areas (USFS 2008b) (USFWS, 2010).

Stressor: Livestock and wildlife (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Grazing and trampling of Sacramento Mountains thistle by livestock and wildlife can reduce photosynthetic tissue, damage seedlings, rosettes, and flowering stems, as well as inflict hoof damage to travertine and soft substrates in occupied and potential habitat (Thompson 1991; USFS 1994). Thistle habitats on travertine springs and the soft-bottom valley habitats provide the majority of watering locations for livestock and elk. These fragile habitats are subjected to trampling and hoof damage. At present, Sacramento Mountains thistle habitats continue to be exposed to livestock with consistently detrimental effects to the thistle, particularly on the Sacramento Grazing allotment (USFS 2007) (USFWS, 2010).

Stressor: Insect damage (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Burks (1994) determined that overall seed predation by insects consumed or damaged roughly 17% of the seeds produced by this thistle before dispersal. Sivinski (2007, 2008) documented insect seed predation from four native and one introduced species, which damaged flower heads or cause premature stem death of the thistle. In September 2007, these insect predators significantly damaged flowering stems. Seed production from insect attack was significantly reduced from 2007 to 2009 in the Silver Springs population, particularly as a result of the stem boring weevil (Sivinski 2007, 2008, 2009b) (USFWS, 2010).

Stressor: Pesticides (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: USFWS Standards and Guidelines allow for the use of pesticides to control forest pests and such use is likely to adversely affect the thistle by reducing pollinator populations (USFWS, 2010).

Stressor: Climate change (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: For mountain tops in New Mexico, weather patterns remain unpredictable, yet most likely will reflect regional trends of warming and drying, leading to the shrinking of cooler and moister habitats associated with higher elevations (Agency Technical Work Group State of New Mexico 2005, Archer and Predick 2008). Drought conditions have been detected in the Sacramento Mountains based on decreased water flows at occupied springs and the contraction of the numbers and area occupied by Sacramento Mountains thistle (USFS 2007) (USFWS, 2010).

Recovery**Reclassification Criteria:**

Not available

Delisting Criteria:

1. Acquire water rights specifically for the maintenance of travertine spring habitats at a minimum of 30 percent of the occupied spring localities, including at least 1 occupied spring locality in each of the 20 known canyons of occurrence (USFWS, 2010).

2. Develop habitat management plans to alleviate threats to the species and ensure permanent protection of at least 75 percent of the known occupied habitats according to steps outlined in the plans. Sites should include both core populations at springs as well as other occupied riparian habitats. Unoccupied steam habitat downstream of occupied springs should be protected for future colonization by the thistle (USFWS, 2010).

3. Establish a 10-year monitoring and research program to demonstrate the effectiveness of management implemented under the plans (USFWS, 2010).

Recovery Actions:

- Develop and implement a policy for spring development on LNF and acquire water rights to springs if in-stream flow legislation is ever passed in New Mexico (USFWS, 2010).
- Implement livestock management practices to protect plants and their associated spring and riparian habitats (USFWS, 2010).
- Implement logging practices that minimize indirect hydrologic and erosion effects on Sacramento Mountains thistle habitat (USFWS, 2010).
- Study impacts of exotic plant competitors and biological controls (USFWS, 2010).
- Conduct long-term monitoring to evaluate effectiveness of management (USFWS, 2010).
- Other (conduct genetic and hydrologic studies, locate new populations, manage recreation activities, engage in education and law enforcement) (USFWS, 2010).

Conservation Measures and Best Management Practices:

- The recovery plan should be revised or amended. The criterion for acquiring water rights to maintain Sacramento Mountains thistle habitats does not reflect the legal challenges in obtaining such rights through legislation in the State of New Mexico. A revised criterion that also relies upon suitable points of diversion could have an additive effect on recovery, in conjunction with the existing criterion for water rights acquisition, should be considered. The recovery plan should also

be amended to include criteria for uplisting Sacramento Mountains thistle to endangered species status (USFWS, 2010).

- The arrivals of an invasive seed-head weevil, *Rhinocyllus conicus*, and a stem boring weevil, *Lixus pervestitus*, in the immediate environment of Sacramento Mountains thistle are potential new threats to the survival of this threatened species. Additional research should be conducted to track the distribution of both weevil species in the Sacramento Mountains and the presence or absence of these weevils in Sacramento Mountains thistle seed heads and stems. Effects of *R. conicus* and native seed predators on seed production of the Sacramento Mountains thistle need to be ascertained (USFWS, 2010).
- Exclosures preventing livestock access to wetland thistle habitats should be constantly maintained. Resources to construct fencing around thistle populations exposed to livestock, especially those on the Sacramento Grazing Allotment, should be obtained and additional exclosures should be constructed to prevent thistles and promote thistle recovery (USFWS, 2010).
- Erecting signage, indicating the value and conservation status of the Sacramento Mountains thistle, should be considered at the Bluff Springs site (USFWS, 2010).
- continue to monitor invasive plants in thistle habitat. Should invasive thistle and teasel in the region continue to encroach upon Sacramento Mountains thistle habitats, hand-applied use of an EPA-approved, novel herbicide, aminopyralide, commercially known as Milestone, may be warranted (Fletcher, pers. comm. 2007) (USFWS, 2010).
- Monitoring of the Sacramento Mountains thistle populations, reproductive individuals, and rosettes should be conducted biennially by experienced biologists. Demonstrated impacts of invasive wetland plants and insect predators in particular should be studied to prevent further population declines of the thistle. Interactions among thistle population trends in response to grazing, exclosures, invasive plants, and insect herbivory, along with predictions of warmer average temperatures and potentially less average precipitation potentially associated with climate change, should be monitored to direct future management for the thistle (USFWS, 2010).

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SPECIES ACCOUNT: *Cirsium wrightii* (Wright's marsh thistle)

Species Taxonomic and Listing

Information Listing Status: Threatened

Physical Description

Wright's marsh thistle is a biennial (a plant completing development in 2 years, and producing flowers in its 2nd year) or a weak monocarpic perennial (a plant that flowers, sets seed, then dies), in the sunflower family (Asteraceae). The plant is prickly with short black spines and a 3- to 8-foot (ft) (0.9- to 2.4-meter (m)) single stalk covered with succulent leaves (Sivinski 1996, p. 1; Arizona Game and Fish Department (AGFD) 2001, p. 1). Numerous slender flowering branches emerge from the stalk, starting about one-third up the length of the plant stalk. The ends of the branches support one or a few small flowering heads, which have numerous slender phyllaries (a modified leaf associated with the flower) (Sivinski 1996, p. 1). Flowers are white to pale pink in areas of the Sacramento Mountains, but are vivid pink in all the Pecos Valley locations (Sivinski 1996, p. 1). Blooms March-August.

Taxonomy

Kingdom: Plantae; Phylum: Anthophyta; Class: Dicotyledoneae; Order: Asterales; Family: Asteraceae (Asters, sunflowers). Wright's marsh thistle is a wetland obligate that was originally collected in 1851 at San Bernardino Cienega, Cochise County, Arizona (Gray 1853, p. 101; Smithsonian 1849, p. 1).

Historical Range

Mexico - Uncertain; U.S. - Arizona, New Mexico. Wright's marsh thistle has been extirpated from all previously known locations in Arizona (e.g., San Bernardino Cienega) (Sivinski 1996, pp. 1, 4, 9, 2006a, 2009a, p. 1, 2012, p. 2; Worthington 2002a, p. 4; Baker 2011, entire), many in New Mexico (Roswell, Lake Valley), and was misidentified and likely not ever present in Texas (Poole 1992, entire; 2010, entire; Sivinski 1996, p. 2). The status of the species in Mexico is uncertain, with few verified collections of the plant (Sivinski 2012, p. 5).

Current Range

U.S. - Arizona: Cochise County; New Mexico: Chaves, Eddy, Guadalupe, Otero, and Socorro counties.

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Habitat Type

Adult: In New Mexico, the species occurs in wet, alkaline soils in spring seeps and marshy edges of streams and ponds between 3,450 and 7,850 ft (1,152 and 2,393 m) in elevation (Sivinski 1996, p. 1; 2005a, pp. 3-4; Worthington 2002a, entire). *C. wrightii* appears to be an obligate of seeps, springs, and wetlands that have saturated soils with surface or subsurface water flow

(Sivinski 1996, 2012, entire; Service 1998, pp. 1-2; Worthington 2002a, p. 2; NMRPTC 2009). Plants commonly found in areas inhabited by this species include *Scirpus* spp. (bulrush), *Salix* spp. (willow), *Baccharis glutinosa* (seepwillow), *Helianthus paradoxus* (Pecos sunflower), *Juncus* spp. (rush), and *Typha* spp. (cattail) (Sivinski 1996, pp. 2-5; Sivinski and Bleakly 2004, p. 2; Worthington 2002a, pp. 1-2).

Habitat Vegetation or Surface Water Classification

Adult: Palustrine habitat: Herbacious wetland; Terrestrial habitat: Desert; marshy wetlands (cienegas) near springs in otherwise semi-arid to arid areas. (NatureServe)

Dependencies on Specific Environmental Elements

Adult: Wright's marsh thistle appears to be an obligate of seeps, springs, and wetlands that have saturated soils with surface or subsurface water flow (Sivinski 1996, 2012, entire; Service 1998, pp. 1-2; Worthington 2002a, p. 2; NMRPTC 2009).

Habitat Narrative

Adult: Wright's marsh thistle is a wetland obligate (occurs only in water-saturated soils) that was originally collected in 1851 at San Bernardino Cienaga, Cochise County, Arizona (Gray 1853, p. 101; Smithsonian 1849, p. 1). In the New Mexico portion of the species range, *C. wrightii* appears to be an obligate of seeps, springs, and wetlands that have saturated soils with surface or subsurface water flow (Sivinski 1996, 2012, entire; Service 1998, pp. 1-2; Worthington 2002a, p. 2; NMRPTC 2009). Plants commonly found in areas inhabited by this species include *Scirpus* spp. (bulrush), *Salix* spp. (willow), *Baccharis glutinosa* (seepwillow), *Helianthus paradoxus* (Pecos sunflower), *Juncus* spp. (rush), and *Typha* spp. (cattail) (Sivinski 1996, pp. 2-5; Sivinski and Bleakly 2004, p. 2; Worthington 2002a, pp. 1-2).

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Unknown

Species Trends:

Unknown

Number of Populations:

8 populations in 5 counties (Otero, Chavez, Guadalupe, Eddy, and Socorro)

Population Size:

populations of 2 to ~18,000

Population Narrative:

There are eight general localities of Wright's marsh thistle extant within New Mexico. Additional historical populations have been extirpated, including at least two larger and two smaller populations in New Mexico, and the population at the type locality in Arizona. The population at BLNWR is likely the most robust, with between 14,000 to 18,000 individuals (Sivinski 2012, p. 30). Santa Rosa contains scattered localities throughout four sections of land, and some of these

have been extirpated recently. However, the population in 2012 was estimated between 12,000 to 14,000 individuals (Sivinski 2012, p. 52). The population along Tularosa Creek has undergone a significant reduction since 1995 and now contains only four individuals (Sivinski 2012, p. 21). The remaining populations in the Sacramento Mountains are mostly small, containing from two to perhaps several hundred individuals (Sivinski 2012, p. 9-24). The populations at Blue Spring and Alamosa Springs were recently discovered. There have been no subsequent surveys at Blue Spring to determine whether this population is stable or declining. Alternatively, in 2012, the population at Alamosa Springs was estimated at 900 flowering individuals (Sivinski 2012, p. 9), indicating a relatively stable status since its discovery in 2005). An experimental planting of 61 rosettes occurred at Burro Cienega in 2011, but was not monitored during 2012 to determine success or failure. The collections from Texas were misidentified, and we conclude *C. wrightii* never occurred in the state. Finally, there is only one verified historic collection from Mexico, and no recent information on the status of the species from this population. For these reasons, the status of this species remains tenuous.

Threats and Stressors

Stressor: Agricultural and urban development

Exposure: Water withdrawal

Response:

Consequence:

Narrative: Past and present alteration of rare desert springs, seeps, and wetland habitats that support Wright's marsh thistle is a significant threat. The four largest localities of *C. wrightii* at Blue Spring, BLNWR, Santa Rosa, and Alamosa Creek have the potential to be further modified by ongoing and future water withdrawal. Changes in water tables throughout the range of *C. wrightii* have also resulted in diminished discharge from springs or complete loss of surface water. Therefore, there has been a trend of diminishing habitat quantity and excessive degradation of habitat quality for the species throughout its range, as a result of agriculture and urban development, diversion of springs, and drought.

Stressor: Introduced plants

Exposure: Increased fire risk, competition and changes in hydrology

Response:

Consequence:

Narrative: The presence of and effects from *Phragmites australis* (common reed) threatens *C. wrightii* localities through increased fire risk, competition, and changes in hydrology.

Stressor: Inadequate regulatory protection

Exposure:

Response:

Consequence:

Narrative: Wright's marsh thistle receives inadequate protection from the Clean Water Act. Similarly, the species lacks adequate regulatory protection from its various designations a Forest Service sensitive species, or endangered status by the State of New Mexico because these designations only serve to notify the public of the species' status and do not require conservation or management actions. We are not aware of any other existing regulatory mechanisms. Wright's marsh thistle is currently threatened by the inadequacy of existing regulatory mechanisms. This will continue into the foreseeable future.

Recovery**Recovery Actions:**

- Establish additional grazing exclosures in riparian areas on Forest Service lands, on the Lincoln National Forest to support expansion of extant populations of Wright's marsh thistle.
- Investigate the possibility of reintroductions to historically occupied habitat where natural recolonization is unlikely. Transplants of rosettes within existing localities may also assist in the expansion of occupied habitat.
- Conduct additional surveys for Wright's marsh thistle particularly springs and cienegas in southeastern New Mexico and Mexico.
- Coordinate closely with BLNWR on management of the species. For example, investigate how Wright's marsh thistle responds to changing water levels on the refuge, when soils are not continuously saturated throughout the growing season.
- Develop a conservation strategy for the species, to guide coordinated conservation efforts by multiple partners. This strategy would also include an educational component to inform private and State landowners of wetland permitting requirements when they fill or drain their lands.
- Monitor and evaluate whether insect predators are a threat to Wright's marsh thistle, particularly in Sacramento Mountains.

Conservation Measures and Best Management Practices:

- Establish additional grazing exclosures in riparian areas on Forest Service lands, on the Lincoln National Forest to support expansion of extant populations of Wright's marsh thistle.
- Control populations of *Pyragmites Australis* where they threatened Wright's marsh thistle.

References

USFWS. 2014. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for *Cirsium wrightii* (Wright's Marsh Thistle)

Southwest Region

29 p.

USFWS 2014. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for *Cirsium wrightii* (Wright's Marsh Thistle)

SPECIES ACCOUNT: *Clarkia franciscana* (Presidio clarkia)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/06/1995; California/Nevada Region (R8)

Physical Description

A slender, erect, herbaceous annual of the evening-primrose family (Onagraceae), 40 centimeters (16 inches) tall with few, very small, and narrow leaves. The lavender-pink petals have a lighter basal portion and a reddish-purple basal spot. The slender capsule is 2 to 4 centimeters (1 to 2 inches) long. *Clarkia franciscana* can be distinguished from *Clarkia rubicunda* (ruby chalice clarkia), a related species that may occur in the same area, by its petals that have irregular teeth on the apical margin (the edge near the tip). *Clarkia rubicunda* has petals that are rounded at the apex (Lewis and Raven 1958a) and usually twice the length of *Clarkia franciscana* (Lewis and Raven 1958a, Lewis 1977). (USFWS, 1998)

Taxonomy

The type specimen of *Clarkia franciscana* (Presidio clarkia) was collected by Peter Raven in 1956. *Clarkia franciscana* was described by Harlan Lewis and Peter Raven (1958a). (USFWS, 1998)

Historical Range

In California, in San Francisco County, and later found in Alameda County. (USFWS 1998).

Current Range

In California, in San Francisco County and Alameda County. (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Predominantly self-pollinated with possibility cross-pollination (USFWS, 2010)

Dependency on Other Individuals or Species

Adult: Possibly small halictid bees (USFWS, 2010)

Breeding Season

Adult: May to July (USFWS, 2010)

Reproduction Narrative

Adult: Presidio clarkia flowers from May to July. Flowers develop from erect buds and set seed in late summer or early fall. It is thought to be predominantly self-pollinated; however, there is some evidence to suggest that small halictid bees (sweat bees) could potentially be pollinators for the species. Due to its mechanism of self-pollination, there is restricted genetic variability in the populations. (USFWS, 2010)

Habitat Type

Adult: Grassland and coastal scrub communities (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: restricted to serpentine soil

Spatial Arrangements of the Population

Adult: Clumped

Environmental Specificity

Adult: special habitat requirements

Site Fidelity

Adult: high

Habitat Narrative

Adult: *C. franciscana* is known from only two locations within highly urbanized areas of the San Francisco Bay Area, California (the Presidio within the City of San Francisco [SF Presidio] and the Oakland Hills within the City of Oakland, Alameda County [Oakland Hills]), where the plant is restricted to serpentine soils in grassland and coastal scrub communities (Skinner and Pavlik 1994). Serpentine soils are formed from weathered volcanic (ultramafic rocks) such as serpentinite, dunite, and peridotite. The *C. franciscana* has adapted to the harsh environments of serpentine soils that limit plant growth: low calcium : magnesium ratios; lack of essential nutrients such as nitrogen, potassium, and phosphorus; and high concentrations of heavy metals (mineral toxicity).

Dispersal/Migration**Motility/Mobility**

Adult: not mobile

Dispersal

Adult: limited

Dispersal/Migration Narrative

Adult: Not much information is available regarding the dispersal of this species (USFWS, 2010)

Population Information and Trends**Population Trends:**

Unknown (USFWS, 2019)

Species Trends:

Unknown (USFWS, 2019)

Population Growth Rate:

unknown

Number of Populations:

9 extant populations (USFWS, 2010)

Population Size:

~ 100,000 or more individuals estimated in all populations (USFWS, 2019)

Population Narrative:

This species is known to occur in only two locales, the Presidio in San Francisco County and Oakland Hills in Alameda County, California. Since the approval of the 1998 recovery plan, new locations for Presidio clarkia within these two locales have been either introduced or discovered. The 2010 5-year review for Presidio clarkia (Service 2010b) summarizes the introduction along the Pacific coast at the Presidio ("Coastal Bluffs" site) and the discovery of four additional sites in Oakland Hills (for seven total Oakland Hills sites). Since the 2010 5-year review, Presidio clarkia was also reintroduced at the historical "West Crissy Bluffs" site (also referred to as "McDowell Avenue," CNDDDB occurrence #3) at the Presidio (Chassé and Forrestel 2014). The CNDDDB (2018) reflects all known Presidio clarkia sites in Oakland Hills (CNDDDB occurrence #4), but has not been updated for the Coastal and West Crissy bluffs introductions at the Presidio. - Ongoing habitat restoration and enhancement at the Presidio and Redwood Regional Park have increased local distributions and abundances of Presidio clarkia at these managed sites. Inspiration Point (Presidio; CNDDDB occurrence #2) and Redwood Regional Park (Oakland Hills) continue to be the largest and most productive Presidio clarkia sites. The average population estimates for a 1.0-hectare (2.5-acre) plot at Inspiration Point is 58,904 individuals (2006-2018) and for a 3.0-hectare (7.4-acre) plot at Redwood Regional Park is 59,758 individuals (2008-2011, 2014-2015, and 2017). Since monitoring began, abundances at the other Presidio clarkia sites did not exceed 2,000 individuals³ until 2018. The 2018 censuses recorded 2,924 and 3,223 individuals at the Presidio's West Crissy Bluffs and WWII Memorial sites, respectively. Despite the recent increase in numbers, the likelihood that the West Crissy Bluffs site (or the Coastal Bluffs site) will continue to support Presidio clarkia is in question. - All of the seven Oakland Hills sites are likely the remaining portions of a single population that was fragmented by residential development. Six of the Oakland Hills sites contain only small patches of serpentine that are surrounded by residences, roads, and a tennis club. These sites, held by the City of Oakland or private landowners, are rarely monitored. Thus, the status of Presidio clarkia in these patches is currently unknown. Prior to 2010, these six Oakland Hills sites had abundances that ranged from 20 to over 1000 plants (summarized in Service 2010b). (USFWS, 2019)

Threats and Stressors

Stressor: Habitat disturbance (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: The six small Oakland Hills sites remain unprotected and are especially vulnerable to erosion, roadside maintenance for fire management, competing plant species, and residential development. Presidio clarkia has likely persisted in some of these habitat fragments because the steep terrain is unconducive for development and landscaping. Thus, the terrain is also erosive and Presidio clarkia plants and seeds are subject to being washed into roads and disposed of. The

habitat fragments that are not too steep and erosive are frequently mowed prior to seed set (R. Kanz, conservationist and Oakland resident, pers. comm. 2018; Service 2010b). Unlike the protected sites, the Oakland Hills fragments are not managed to reduce nonnative plant competition and trees are typically favored in residential areas. Plans for a residential development on the Crestmont Drive site are in process, though it is uncertain when the development will be constructed. The City of Oakland has not yet approved the lot divisions for the development because the requirements for a rare plant conservation easement have not all been fulfilled (M. Grefsrud, CDFW, pers. comm. 2018). At the Presidio in San Francisco County, Presidio clarkia at the West Crissy Bluffs site are threatened by the site's small size, high disturbance rate, and position just below a road. Declining numbers of Presidio clarkia at the Coastal Bluffs introduction site could be due to inadequate seed input (only one year of seeding), or because the coastal climate and habitat are not suitable for Presidio clarkia (M. Chassé, pers. comm. 2018). (USFWS, 2019)

Stressor: Erosion and altered hydrology (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: In 1978, the Ecology Trail was routed through a then unknown subpopulation of *Clarkia franciscana* at Inspiration Point. Since then, the trail has been fenced off but the Inspiration Point subpopulation of *C. franciscana* at the SF Presidio continues to be threatened by trail erosion, storm drain runoff, and other hydrologic issues. A storm drain flows directly into the Inspiration Point site. This is thought to potentially threaten the *C. franciscana* because, as observed at the War Memorial site, the species does not do well under wetter conditions. - In the Oakland Hills, most of the subpopulations of *Clarkia franciscana* occur on very steep, highly erosive serpentine roadcuts, and, therefore, are vulnerable to altered hydrology and accelerated erosion resulting from human disturbance. The *C. franciscana* has become restricted to areas with steeper slopes and thinner soils in the Oakland Hills due to the invasion of nonnative annual grasses onto the deeper serpentine soils. The lower Tennis Club site within the Tennis Club/Sunrise subpopulation is highly vulnerable to altered hydrology and erosion due to its location in a steep gully between the Sunrise Assisted Living Facility and the Oakland Hills Tennis Club. Only the Chadbourne Way subpopulation and some patches of the Redwood Regional Park subpopulation are not currently threatened by erosion and altered hydrology due to their locations on more gentle slopes. - Until recently, concerns about landslides slowed residential development on some of the steeper serpentine slopes in the Oakland Hills where *Clarkia franciscana* occurs. However, since the Federal listing of the species, many residential developments have been constructed on steep serpentine soils that may or may not have had *C. franciscana*. In some cases, these residential developments proceeded without environmental review. - The Crestmont Drive subpopulation of *Clarkia franciscana* may be threatened by altered hydrology and erosional gullying due to the construction of seven single family homes immediately upslope on Colgett Drive between 1998 – 2003. A local resident and member of Friends of Oakland's Endangered Species reports "observations of the site [Crestmont Drive] indicate the impacts of water from uphill properties [on Colgett Drive] may be causing rilling and erosion". (USFWS, 2010)

Stressor: Small populations (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The Recovery Plan (Service 1998) recommends securing populations containing a minimum of 2,000 plants each (but preferably more). The probability of population persistence over the long-term is expected to be higher for larger populations because large size decreases the likelihood of reduced viability or population extirpations due to random demographic or genetic events (Barrett and Kohn 1991, Ellstrand and Elam 1993). Currently, only two of the nine subpopulations of *Clarkia franciscana* (Inspiration Point and Redwood Regional Park) exceed the criteria for containing a minimum of 2,000 plants. Thus, the *C. franciscana* continues to be threatened by habitat fragmentation, a small number of populations, and the small size of most of the subpopulations. (USFWS, 2010)

Stressor: Loss of pollinators (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The *Clarkia franciscana* is thought to reproduce primarily through self-pollination. However, small halictid bees (sweat bees) have been observed visiting the flowers and could potentially be pollinators for the species (Lewis and Raven 1958). Thus, the use of pollinators by the *C. franciscana* could be important for increasing gene flow among populations and maintaining the genetic variability of the species. A study by Gottlieb and Edwards (1992) verified the low intrapopulation genetic variability within the SF Presidio population and the Oakland Hills population (Redwood Regional Park) as is expected for a species that is predominately self-pollinated (Stebbins 1978). Species with small populations and low genetic variability, such as the *C. franciscana*, are at greater risk of extirpation from natural catastrophic events (disease, fire, and drought) (Menges 1991). The reproduction and genetic variability of the *Clarkia franciscana* could be threatened by the recent worldwide decrease in pollinators. Pollinators are threatened by the use of both regulated (e.g., malathion) and unregulated pesticides (e.g., pyrethroids) (Department of Pesticide Regulation 2006, Keith 2006, Service 2000). More recently, the decline in pollinators observed across North America has been attributed to introduced parasites, in particular the varroa mite (*Varroa jacobsoni*), which affects the honey bee (*Apis mellifera*) (Nielsen 2006, National Research Council 2006). The potential effects of introduced parasites on *C. franciscana* pollinators are not known. Hafernik (2009), however, reported a rich diversity of bees at the SF Presidio, including 56 species representing 23 genera. The diversity and abundance of bees and other pollinators in the Oakland Hills is not known at this time. (USFWS, 2010)

Stressor: Loss of genetic diversity (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The SF Presidio and Oakland Hills populations of the *Clarkia franciscana* are separated by 17 miles and the San Francisco Bay resulting in two genetically distinct populations (Gottlieb and Edwards 1992). However, the genetic distinctiveness of the Oakland Hills population of *C. franciscana* could potentially be threatened by genetic swamping from *C. franciscana* plants of SF Presidio genetic stock (which had been cultivated for 40 years at Tilden Botanical Garden) planted by residents within the Oakland Hills. (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:**Consequence:**

Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, Intergovernmental Panel on Climate Change 2007). However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to particular species at this time. The *Clarkia franciscana* has evolved to adapt to the highly specific soil, environmental, and microclimatic conditions that are unique to the two locations where it occurs in the San Francisco Bay Area: the SF Presidio and the Oakland Hills. Observations at the War Memorial site demonstrate that the *C. franciscana* is not very tolerant of certain microclimatic conditions associated with this coastal location (cooler, wetter, and greater exposure to wind and fog) (Chassé et al. 2009). Thus, due to the highly restrictive soil, environmental, and microclimatic conditions under which the *C. franciscana* can grow, the species may be vulnerable to even small changes in climate. (USFWS, 2010)

Stressor: Competition from plant species (USFWS, 2019)

Exposure:**Response:****Consequence:**

Narrative: Presidio clarkia, throughout its limited range, is threatened with competition from nonnative invasive grasses, native shrubs, nonnative trees, and native trees planted outside of their natural range. Invasive grasses compete by depleting shallow soil moisture and creating dense thatch that smothers and suppresses seedling recruitment in native plants. Elevated atmospheric nitrogen deposition from increased air pollution exacerbates the invasive grass problem because additions of nitrogen to nutrient-deficient soils, like serpentine, facilitate the invasion of weedy species (Weiss 2006). Nitrogen deposition in nitrogen-limited ecosystems may also affect mycorrhizal communities and increase plant susceptibility to other environmental stressors (summarized in Service 2010b). Shrubs and trees compete by shading annual grassland plants. Trees also bury the nutrient-poor serpentine soil with a thick layer of organic material, which encourages further invasion of non-serpentine species. (USFWS, 2019)

Stressor: Atmospheric nitrogen deposition from air pollution (USFWS, 2010)

Exposure:**Response:****Consequence:**

Narrative: Elevated atmospheric nitrogen deposition from air pollution is particularly harmful to the nutrient-poor serpentine grasslands where the *Clarkia franciscana* occurs because nitrogen is the primary limiting nutrient for plant growth on serpentine soils (Weiss 1999). The use of catalytic converters on vehicles has increased the availability of nitrogen in a form that is directly absorbed by plants (EBRPD 2009a). The excess nitrogen deposited leads to increases in nonnative annual grasses which outcompete the native flora (Fenn et al. 2003, Weiss 1999). Other potential effects of elevated atmospheric nitrogen deposition on plants in nitrogen-limited ecosystems (Wolkowski et al. 2008), such as that in which the *Clarkia franciscana* grows, include decreased diversity of mycorrhizal communities. Increased nitrogen deposition can also

predispose plants to other environmental stresses such as elevated concentrations of ozone, drought, frost, or insect attacks. It is not known at this time if elevated atmospheric nitrogen deposition from air pollution impact *C. franciscana* mycorrhiza. (USFWS, 2010)

Recovery

Reclassification Criteria:

A/1: A minimum of five populations of *Presidio clarkia*, which shall include Inspiration Point at the Presidio and Redwood Regional Park in Oakland Hills, are fully protected and managed with the primary intention of preserving the populations in perpetuity. Each protected area includes occupied habitat and known former habitat along with adjacent unoccupied habitat and a 150-meter (500-foot) buffer. (USFWS, 2019)

A/2: Management plan(s), approved by the Service, are implemented for the populations described in A/1 and any occupied or unoccupied habitat identified as essential to survival. The plans include provisions for standardized annual monitoring of populations. (USFWS, 2019)

E/1: Each population described in A/1 contains a minimum of 2,000 (but preferably more) individuals each year for a minimum of 20 years. (USFWS, 2019)

E/2: Each population described in A/1 has numbers of individuals that exhibit a stable or increasing trend over a period of 20 years that includes two normal precipitation cycles (or longer if suggested by the results of demographic monitoring). (USFWS, 2019)

E/3: Impacts from competing plant species are managed so they do not pose a threat to the persistence of any of the *Presidio clarkia* populations described in A/1. (USFWS, 2019)

E/4: Seeds, representative of the breadth of the species' genetic diversity, are stored in at least two Center for Plant Conservation certified facilities and reliable seed germination and propagation techniques are understood. Unless storage techniques and/or research show otherwise, stored seeds are replenished every 10 years in order to ensure seed viability. (USFWS, 2019)

Delisting Criteria:

A/1: A minimum of ten self-sustaining populations of *Presidio clarkia* are established on suitable habitat within or near the plant's known historical range, and are fully protected and managed with the primary intention of preserving the populations in perpetuity. Each protected area includes occupied habitat with adjacent unoccupied habitat and a 150-meter (500-foot) buffer, where possible. Additional populations are protected if indicated by modeling or research. (USFWS, 2019)

A/2: All lands upslope from the populations described in A/1 are protected from incompatible uses. (USFWS, 2019)

A/3: Each of at least six of the populations described in A/1 are contained in a protected area comprised of at least 12 hectares (30 acres) of rehabilitated serpentine grassland. (USFWS, 2019)

E/1: For a minimum of 20 consecutive years⁷⁹ that include two normal precipitation cycles, each population described in A/1 exhibits a stable or increasing population trend with a minimum of 2,000 individuals⁸¹ each year. (USFWS, 2019)

E/2: For a minimum of 20 consecutive years⁸² that include two normal precipitation cycles, each of the six populations described in A/3 contains a minimum of 28,000 individuals⁸⁴ each year with a rolling 20-year average of at least 140,000 individuals. (USFWS, 2019)

E/3: The populations described in A/1 adequately represent the genetic diversity present in the range of the species. At least two of the six populations described in A/3 represent the genetic diversity of *Presidio clarkia* at the Presidio and another two of six populations represent the genetic diversity in Oakland Hills. (USFWS, 2019)

E/5: The populations described in A/1 occupy serpentine grasslands with negligible nonnative plant cover and with species-appropriate disturbance regimes such as grazing and/or burrowing mammal populations. Impacts from competing plant species are managed so they do not pose a threat to the persistence of *Presidio clarkia* in any of the populations described in A/1. (USFWS, 2019)

E/6: Long-term management of *Presidio clarkia* habitat is both practically and financially sustainable. Active management is not required more frequently than once every 5 years. Financial resources for long-term habitat management are secured. (USFWS, 2019)

Recovery Actions:

- 1. Protect *Presidio clarkia* sites and establish additional populations. 1.1. Identify and protect potential introduction sites. (Priority 1). 1.2. Develop and implement a seed increase or collection program that represents the breadth of genetic diversity in the species. (Priority 1). 1.3. Establish, by seeding, new populations within or near the species' known historical range. Seeding should take place in suitable habitats that also exhibit a range of natural environmental conditions. Numerous introductions may be necessary to achieve adequate success rates and determine the range of habitat conditions under which successful establishment can be achieved. (Priority 1). 1.4. Secure populations through land acquisitions, conservation easements, or other means. (Priority 1). 1.5. Work with the City of Oakland and private landowners to maintain *Presidio clarkia* sites for the long-term survival of the species on their lands. Collaboratively determine the best management practices to accomplish both landowner objectives and conservation goals. Educate local roadside maintenance crews and landscapers. (Priority 1). (USFWS, 2019)
- 2. Research *Presidio clarkia* life history and conservation strategies. 2.1. Conduct genetic research on existing populations to determine the species' genetic structure and diversity. (Priority 2). 2.2. Research optimal habitat characteristics, mechanisms of dispersal, pollination biology, seed viability of populations from both the Presidio and Oakland Hills, and potential impacts from climate change. (Priority 2). 2.3. Study the demography and reproductive biology of populations. (Priority 3). (USFWS, 2019)
- 3. Monitor and manage *Presidio clarkia* populations. 3.1. Implement site-specific management plans for *Presidio clarkia* and other native serpentine species. Manage habitat in occupied areas and in surrounding areas that affect, or could affect, conditions in occupied areas (e.g. weedy species invade from adjacent areas). . Best habitat management practices may include complete eradication of nonnative species and restoration of native

serpentine plant communities. (Priority 1). 3.2. Implement a standardized annual monitoring program with the power to detect population trends. (Priority 2). 3.3. Store seeds in at least two Center for Plant Conservation certified facilities. Unless storage techniques and/or research show otherwise, replenish seed stock every 10 years to ensure seed viability. (Priority 2). 3.4. Establish a Service-approved monitoring plan to cover a minimum of 5 years post-delisting. The plan will be ready for implementation at the time of delisting to ensure the ongoing conservation of the species and the continued effectiveness of management actions. Adequate funding must be dedicated in order to implement the delisting management plan. (Priority 3). (USFWS, 2019)

Conservation Measures and Best Management Practices:

- 1. Implement and evaluate the effectiveness of the habitat enhancement recommendations suggested by Weiss and Neiderer (2009) and EBRPD (Appendix B in EBRPD 2010) (e.g., tree removal, reseeding, scraping, fall tarping, fall flaming (post-germination), spring mowing, and installation of protective fencing), for increasing the survivorship of *Clarkia franciscana*, controlling nonnative annual grasses, and expanding *C. franciscana* populations into adjacent areas. (USFWS, 2010)
- 1a. The effectiveness of various habitat enhancement measures may vary dependent on sitespecific conditions as observed in the different results obtained in studies of the SF Presidio (Weiss and Neiderer 2009) and Oakland Hills (EBRPD 2010) populations. Monitor the results, determine the best treatment intervals, and adaptively manage. (USFWS, 2010)
- 1b. Expand *Clarkia franciscana* plants into adjacent areas of suitable habitat by collecting *clarkia* seeds from nearby plants and actively seeding in areas of bare ground and low cover of nonnative annual grasses. Collect seeds at different times in the season from *C. franciscana* plants throughout the adjacent areas, from large and small individuals, to capture a range of genetic diversity (Appendix B in EBRPD 2010). To avoid overcollecting, seed collection should be limited to less than 1 percent of the seedset in the first year while efficacy is being tested (EBRPD 2010). (USFWS, 2010)
- 1c. Persuade private landowners in the Oakland Hills (e.g., Oakland Hills Tennis Club, Sunrise Assisted Living Facility, and the proposed Crestmont development) to monitor the *Clarkia franciscana* subpopulations on their lands and control invasive species as required under their management plans that were developed during the CEQA process (e.g., Center for Biological Diversity 2007; Kanz in litt. 2009; EBRPD 2009b; City of Oakland 2006b). (USFWS, 2010)
- 1d. Persuade the City of Oakland and private landowners in the Oakland Hills (e.g., Colgett Drive, Kimberlin Heights Drive, and Crestmont Drive) to remove trees where they have been planted in suitable *Clarkia franciscana* habitat as is being done at Redwood Regional Park and the SF Presidio. (USFWS, 2010)
- 2. Reintroduce *Clarkia franciscana* to suitable habitat at the SF Presidio (restored site at the West Crissy serpentine grassland near McDowell Avenue; historic location for the species) (Chassé et al. 2009). (USFWS, 2010)
- 3. Address storm drain runoff and erosion issues at Inspiration Point in the SF Presidio and at Crestmont Drive in the Oakland Hills. (USFWS, 2010)
- 4. Increase education of City of Oakland road maintenance and vegetation and fire management teams in how to avoid and minimize impacts to the *Clarkia franciscana* including delaying their activities (e.g., mowing and weed-whacking) in areas with *C. franciscana* (Chadbourne Way, Old Redwood Road, and Redwood Regional Park subpopulations) until after the *clarkia* have set seed (late summer, early fall). (USFWS, 2010)
- 5. Analyze the genetic diversity among the seven subpopulations of *Clarkia franciscana* within the Oakland Hills. Store seeds representing the genetic diversity within the Oakland Hills population at

the University of California Botanical Garden, Berkeley, California, and the Rancho Santa Ana Botanic Gardens, Claremont, California. Also collect seeds from the SF Presidio population of *C. franciscana* for storage at the Rancho Santa Ana Botanic Gardens, Claremont, California. (USFWS, 2010)

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SPECIES ACCOUNT: *Clarkia imbricata* (Vine Hill clarkia)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/21/1997; California/Nevada (Region 8)

Physical Description

An erect annual herb in the Onagraceae (Evening primrose) family, growing up to 60 centimeters (2.5 feet) tall, with unbranched or numerous short branches in the upper parts. This plant is densely leafy, with entire (smooth leaf margins), lanceolate leaves (tapering to a point at the apex and sometimes at the base) 2.0 to 2.5 cm (0.8 to 1.0 in long and 4 to 7 mm (0.2 to 0.3 in broad that are ascending and overlapping. Showy inflorescences appear from late June through July. Flowers are grouped closely together and each flower has a conspicuous funnel shaped tube at its base and four fan-shaped, lavender petals 2.0 to 2.5 cm (0.8-1.0 in) long with a V-shaped purple spot extending from the middle to the upper margin of the petal. *Clarkia imbricata* is distinguished from other morphologically similar *Clarkia* species by the broad, overlapping, ascending leaves. (USFWS, 2015)

Taxonomy

In 1953, Frank H. Lewis and Margaret Lewis described *Clarkia imbricata* from specimens collected on July 10, 1951, along Vine Hill Road, near Pitkin Ranch in Sonoma County, California. *Clarkia imbricata* is distinguished from other morphologically similar *Clarkia* species by the broad, overlapping, ascending leaves. (USFWS, 2015)

Historical Range

Same as current range. (USFWS, 2015)

Current Range

Vine Hill Area, Sonoma County, California. in the area of Vine Hill Road between the cities of Forestville and Santa Rosa. (USFWS, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual (self-fertilization) (USFWS, 2015)

Lifespan

Adult: 1 year (USFWS, 2015)

Breeding Season

Adult: June to August (USFWS, 2015)

Reproduction Narrative

Adult: *Clarkia imbricata* is self-compatible (capable of self-fertilization). Plants begin to flower in June, and often bloom through August. Seeds generally set in early September. It is not known when seeds germinate or how flowers are pollinated. As with many annual plants, numbers can vary substantially from year to year, depending on seasonal weather variations. (USFWS, 2015)

Habitat Type

Adult: Palustrine wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Herbaceous wetland, grassland/herbaceous, shrubland/chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Restricted to open grassland near freshwater marsh at elevations between 60 to 75 m (California Native Plant Society, 2001) (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist

Habitat Narrative

Adult: All known populations of *Clarkia imbricata* have been found between 60 to 75 meters (197 to 246 feet) elevation, on what has been mapped as Goldridge acidic sandy loams, in an area sometimes referred to as the Sonoma Barrens. *Clarkia imbricata* is restricted to Vine Hill region on Goldridge acidic sandy loam soil series. Historically the vegetation growing in the Vine Hill region was “chaparral or Sonoma barren”, a mixture of chaparral and Douglas-fir/oak woodland, mixed evergreen forest in the canyons and freshwater marsh and riparian habitat along Pitkin, Green Valley and Atascadero Creeks in Sonoma County. *C. imbricata* inhabited open grassy portions of this area. (USFWS, 2011)

Dispersal/Migration**Motility/Mobility**

Adult: Low (inferred from USFWS, 2015)

Dispersal

Adult: Low (inferred from USFWS, 2015)

Dispersal/Migration Narrative

Adult: *Clarkia imbricata* plants would likely be unable to shift their range naturally because of their dependence on specific soil characters, climate, the presumably low dispersal-potential of the species, and natural and anthropogenic barriers to dispersal (agriculture and housing developments).

Population Information and Trends**Population Trends:**

Previous reports have described the population trend to be increasing and stable (USFWS 2011, 2016). However, recent data suggest the population has declined in the past decade. (USFWS, 2019)

Number of Populations:

1 (USFWS, 2019)

Population Size:

Variable; past surveys have noted from 60 to 8,700 plants (USFWS, 2019)

Additional Population-level Information:

The only known, extant population of Vine Hill clarkia exists at the Vine Hill Preserve (preserve) in Sonoma County, California. The preserve is owned and managed by CNPS volunteers (USFWS 2016; K. Symonds, in litt. 2018). Historically, there were as many as three locations where the plant existed in central Sonoma County. All known populations existed on Goldridge acidic sandy loam soils, in an area known as the Sonoma Barrens. Past surveys have documented as many as 8,700 plants and as few as 60 plants at the reserve, suggesting a high degree of population variation at the site, typical of annual plant species (USFWS 2016; S. Gordon, in litt. 2018). Previous reports have described the population trend to be increasing and stable (USFWS 2011, 2016). However, recent data suggest the population has declined in the past decade. Vine Hill clarkia continues to be located only within the 0.6 hectare (1.5 acre) Vine Hill Preserve (K. Symonds, pers. comm. 2018; S. Gordon, pers. comm. 2018). (USFWS, 2019)

Population Narrative:

Narrowly endemic to a small area in Sonoma County, California. Historically, four populations were known; currently, there is one natural population, with a total of about 5000 plants, and one planted population with < 400 plants (NatureServe, 2015). Based on monitoring by The Nature Conservancy and CNPS, in 1978, 60 plants were observed; from 1988 to 1993, the population fluctuated from about 200 to 300 plants; and, from 2007 to 2012, the population fluctuated from approximately 500 to 8,781 plants. In 2013, the population of *C. imbricata* at Vine Hill Preserve was estimated at 908 individuals (S. Gordon, personal communication 2013) and in 2015 was estimated at 270 plants (S. Gordon, personal communication 2015). The number of *C. imbricata* plants on the property to the east of the Vine Hill Preserve fluctuates from zero to 100 plants, depending on property maintenance activities. In 2010, the area occupied by *C. imbricata* on the Vine Hill Preserve was measured at 1,540 square meters (16,576 square feet), up from 1,467 square meters (15,791 square feet) in 2009. (USFWS, 2011; USFWS, 2015; NatureServe, 2015)

Threats and Stressors

Stressor: Land use conversion (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: At the time of listing in 1997, the most significant threat to the two remaining populations of *Clarkia imbricata* was extirpation through land use conversion to housing, vineyards and orchards. Land use conversion is now lesser threat given that of the two populations that existed at the time of listing, only one is known to remain and it is on the Vine Hill Preserve which is protected by the California Native Plant Society (CNPS). The second population (Sequoia Circle) was on private land with restricted access and plants have not been surveyed since 1997. The extant Vine Hill Preserve population is protected, monitored and

managed by CNPS, but the plants growing on the adjacent property are not protected. Thus habitat destruction, modification or curtailment due to land use conversion remains a threat, but a lesser one than at the time of listing. In 2011 land use changes on the adjacent parcel reduced the available habitat for *C. imbricata*. (USFWS, 2011)

Stressor: Shading and nonnative species (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Another mechanism for habitat destruction, modification or curtailment that is probably a greater threat than at the time of listing is succession of the grassland habitat that *Clarkia imbricata* requires. This threat has increased because there is now only a single known population that is restricted to the open, grassy area of the Vine Hill Preserve. The open area will decrease if the grassland is allowed to progress through successional stages into chaparral and forest. This will shade *C. imbricata* and enrich the soil with leaf litter which may encourage competing non-native species such as *Holcus lanatus*, a perennial plant that reseeds readily and can tolerate fire. Invasive species such as *Holcus lanatus* threaten *C. imbricata* through competition for space and resources. In areas where *H. lanatus* grows, *C. imbricata* is shaded and grows at a lower density. *H. lanatus* has increased in numbers over the last few years in an area of the Vine Hill Preserve that lies under trees growing on a neighboring property (S. Gordon, personal communication 2010). (USFWS, 2011)

Stressor: Over-collection (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: At the time of listing, the Vine Hill Preserve population of *Clarkia imbricata* was threatened by over-collection and damage associated with trespassing by recreational plant enthusiasts seeking not only the *C. imbricata* plants and seeds, but also *Arctostaphylos densiflora* and *Ceanothus foliosus* var. *vineatus*, ostensibly for the nursery trade. However at this time overcollecting is not thought to be a major threat, as no incidents have occurred within the last 10 years (P. Van Soelen, personal communication 2010). Therefore over collection remains a threat, but less so since 1997. (USFWS, 2011)

Stressor: Risk of extirpation due to small population sizes (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Risk of extinction through random events was listed as a threat in the 1997 listing rule. The small number of individuals in the single *Clarkia imbricata* population increases the threat of extinction of the species as a whole through stochastic demographic and environmental events. *C. imbricata* has been reduced to a single protected population with fluctuating numbers of individuals. Even with as many as 5,000-10,000 plants in an annual plant population, risk of extirpation due to small populations is a major threat because we do not know enough about population dynamics, and annual plant numbers can vary greatly between years. (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:**Consequence:**

Narrative: Global climate change was not included in the 1997 listing rule, but is a potential threat to *Clarkia imbricata*. Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999; Cayan et al. 2005; IPCC 2007). *C. imbricata* may be at risk with global climate change if it cannot disperse to favorable climate and conditions. (USFWS, 2011)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2011)

Exposure:**Response:****Consequence:**

Narrative: At the time of the listing, regulatory mechanisms thought to provide protection to *Clarkia imbricata* included: 1) listing under the Endangered Species Act; 2) the National Environmental Policy Act (NEPA); 3) listing under the California Endangered Species Act (CESA); 4) the California Environmental Quality Act (CEQA); and 5) the California Native Plant Protection Act (NPPA). In summary, the Act is the primary Federal law that provides protection for *Clarkia imbricata* since its listing as endangered in 1997. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act. Therefore, we continue to believe other laws and regulations have limited ability to protect the species in absence of the Federal Endangered Species Act. (USFWS, 2011)

Recovery**Reclassification Criteria:**

E/1. There are three separate locations with *C. imbricata*, each consisting of 2 acres or more, and each with a 10-year average of 4,000 plants or more. Due to the longterm persistence of the species at the Vine Hill Preserve (smaller than 2 acres) and the successful management of the site by CNPS, the Vine Hill Preserve may be counted as one of the three locations if it meets all other aspects of the downlisting criteria. For the purpose of meeting this criterion, a separate location is defined as a group of *C. imbricata* plants sufficiently separated from any other group of *C. imbricata* as to minimize the potential that a typical single stochastic event (e.g., fire or storm damage) would affect more than one location with *C. imbricata*. (USFWS, 2015)

E/2. Develop a management plan to control competing native and non-native vegetation. Competing native and non-native vegetation should be controlled at a level whereby years with less than 4,000 *C. imbricata* plants at each location counted towards recovery (as defined in delisting criterion E/1) cannot be attributable to competition with native and non-native vegetation. Also, there is a monetary commitment in place to continue control in perpetuity for all locations counted toward recovery (as defined in downlisting criterion E/1). (USFWS, 2015)

A/1. All populations of *C. imbricata* counted toward recovery, as defined in E/1, are protected from incompatible uses with a binding legal commitment from the landowner, and funding has been secured for the perpetual implementation of the management plans defined in E/2. (USFWS, 2015)

Delisting Criteria:

A/1. All populations of *C. imbricata* counted toward recovery are protected from incompatible uses with a binding legal commitment from the landowner, and funding has been secured for the perpetual implementation of the management plans. (USFWS, 2015)

E/1. There are five separate locations with *C. imbricata*, each consisting of 2 acres or more, and each with a ten year average of 4,000 plants or more. Due to the longterm persistence of the species at the Vine Hill Preserve and the successful management of the site by CNPS, the Vine Hill Preserve (smaller than 2 acres) may be counted as one of the five locations if it meets all other aspects of the delisting criteria. For the purpose of meeting this criterion, a separate location is defined as a group of *C. imbricata* plants sufficiently separated from any other group of *C. imbricata* as to minimize the potential that a single stochastic event (e.g., fire or storm damage) would affect more than one location with *C. imbricata*. (USFWS, 2015)

E/2. Competing native and non-native vegetation are controlled to a level whereby years with less than 4,000 *C. imbricata* plants at each location counted towards recovery (as defined in delisting criterion E/1) cannot be attributable to competition with native and non-native vegetation. Also, there is a monetary commitment in place to continue control in perpetuity for all locations counted toward recovery (as defined in delisting criterion E/1). (USFWS, 2015)

Recovery Actions:

- Establish additional populations of *Clarkia imbricata*. (USFWS, 2015)
- Monitor and manage competing native and non-native vegetation affecting *Clarkia imbricata*. (USFWS, 2015)
- Conduct research for the development of a population viability analysis, determine levels of genetic diversity and interbreeding coefficients, and model the rate at which genetic diversity can be expected to be lost to genetic drift. (USFWS, 2015)

Conservation Measures and Best Management Practices:

- Protect, manage, and increase the population where possible within its native range. If appropriate areas that are not within the native range are found, reintroduce *C. imbricata*. (USFWS, 2011)
- Establish at least two additional separate populations on protected land. (USFWS, 2011)
- Control of succession and nonnative plants where possible through hand removal of vegetation. (USFWS, 2011)
- Explore the use of a burn box to determine how fire affects *C. imbricata* seed bank and germination, in addition to nonnative species such as *Holcus lanatus* seed bank and germination. (USFWS, 2011)
- Gather information about life history and the ecosystem requirements of *Clarkia imbricata*. More specifically, gather information about how long the seed bank remains viable and how it responds to fire, germination requirements, and genetic diversity. (UFSWS, 2011)
- Create and implement a monitoring plan for *Clarkia imbricata*. Yearly plant counts are already conducted. Add estimation of percent cover of nonnative species and percent cover by shrubs and trees.
- Monitor land-use conversion in parcels adjacent to Vine Hill Preserve. If development occurs, attempt to rescue plants or seeds if possible. (USFWS, 2011)
- Control and monitor access to the Vine Hill Preserve to prevent and monitor trespassing. (USFWS, 2011)

- Pruning and managing the extent of Vine Hill Manzanita. Reports suggest the Vine Hill clarkia and Vine Hill manzanita coexisted naturally in the Sonoma Barrens prior to European settlement (USFWS 2016). Today, both plants only exist at the Vine Hill Preserve. In previous years, Vine Hill clarkia existed in the margins between individual Vine Hill manzanitas. Currently, the Vine Hill manzanita have grown to a point that they are shading and excluding the Vine Hill clarkia from these areas, limiting the number of individual clarkia which can grow at the site. We suggest pruning the Vine Hill manzanita to increase the amount of available habitat for the Vine Hill clarkia. This will require coordination with the California Department of Fish and Wildlife, as the Vine Hill manzanita is a state listed species. (USFWS, 2019)
- Continued seeding upslope. Vine Hill clarkia populations could be dispersal limited (S. Gordon, pers. comm. 2018). Upslope areas at the Vine Hill Preserve previously contained plants (S. Gordon, pers. comm. 2018); however, today the population has shifted spatially within the preserve to areas where its survival is threatened by competition with the Vine Hill manzanita (USFWS 2016). This threat would decrease if individual Vine Hill clarkia seeds were collected and distributed upslope habitat every few years. (USFWS, 2019)

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SPECIES ACCOUNT: *Clarkia speciosa ssp. immaculata* (Pismo clarkia)

Species Taxonomic and Listing Information

Listing Status: Endangered; 1/17/1995; California/Nevada (Region 8)

Physical Description

An annual herb, with branched stems, in the four o'clock family (Onagraceae). It is up to 50 cm (20 in) tall and has flowers 1.5 to 2.5 cm (0.5 to 1.0 in) wide that are white or cream colored at the base, streaking into pinkish or reddish-lavender at the tips. (USFWS, 2009)

Taxonomy

A member of the four o'clock family (Onagraceae), was first collected in Carpenter Canyon by Frank Harlan Lewis and Margaret Ensign Lewis in 1947. Their monograph on the genus *Clarkia* (Lewis and Lewis 1955) described the plant for the first time (USFWS, 1998). *Clarkia speciosa ssp. immaculata* differs from the more abundant *ssp. speciosa* in having somewhat larger flowers with a different petal-color pattern (lacking a red spot); genetic studies (Lewis and Lewis, Univ. Calif. Publ. Bot., 1955) showed "considerable" genetic differentiation between these two subspecies. (NatureServe, 2015)

Historical Range

See Current Range.

Current Range

Western San Luis Obispo County, California, ranging from San Luis Obispo south to the Nipomo Mesa area, an area approximately 20 kilometers (km) (13 miles (mi)) long by 10 km (7 mi) wide. (USFWS, 2009)

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Lifespan**

Adult: 1 year (USFWS, 1998)

Breeding Season

Adult: May through July, occasionally extending into September (USFW, 1998)

Reproduction Narrative

Adult: Pismo clarkia is an annual herb that typically flowers from May through July, occasionally extending into September. (USFWS, 1998)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest Edge, Forest/Woodland, Old field, Shrubland/chaparral, Woodland - Hardwood (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at elevations below 600 feet (USFWS, 1998)

Spatial Arrangements of the Population

Adult: Patches (USFWS, 2009)

Habitat Narrative

Adult: Pismo clarkia typically occurs in fine, dry, sandy soils, derived from ancient marine terraces, in grasslands or openings in chaparral and oak woodlands at elevations below 600 feet. Due to the patchy distribution of these openings, *C. speciosa* subsp. *immaculata* populations (and polygons within each population) are fragmented by nature. (USFWS, 1998; USFWS, 2009)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Not available

Number of Populations:

14 (USFWS, 2009)

Population Narrative:

Currently, there are 14 populations listed within CNDDDB that are extant or presumed to be extant. While more populations have been found in recent years, the overall status of this species is not improving. Development has adversely affected or threatens to adversely affect nine of the remaining 14 known populations and fragmentation due to development is a serious concern for the survival of the species as a whole. (USFWS, 2009)

Threats and Stressors

Stressor: Development and secondary impacts from development (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Residential development and other secondary impacts associated with urban development continue to be the greatest threat to the continued existence of *Clarkia speciosa* subsp. *immaculata*. Development has caused the loss of all or part of five known populations of this species since listing. Development has affected or continues to threaten nine additional populations in part or in whole (Roalman 2000, CNPS 2006, CNDDDB 2009). In addition to direct loss of plants and occupied sites, development eliminates adjacent suitable habitat that

otherwise would allow for natural population expansion and movement as suitable microhabitats shift in the landscape. Furthermore, it may eliminate habitat that supports populations of pollinators and seed dispersal vectors and habitat that contains a seedbank, in cases where there is no germination in a given year when surveys are conducted. (USFWS, 2009)

Stressor: Urban sprawl and development (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Urban sprawl and development leads to habitat loss and increased fragmentation and is the number one cause of imperilment to listed species, including *Clarkia speciosa* subsp. *immaculata*, in California (Doyle et al. 2001). Likewise, urban sprawl and development are directly linked to introduction of and competition from non-native species and outdoor recreation, the second and third leading cause in the decline of listed species, including *C. speciosa* subsp. *immaculata* (Alberts et al. 1993, Doyle et al. 2001). The fragmentation of habitat and populations due to development projects may pose the greatest threat to the recovery of the species. Commercial and residential development is rapidly increasing within areas in close proximity to existing and potential *C. speciosa* subsp. *immaculata* habitat (Draeger 2002), leading to a substantial increase in fragmentation of populations since listing. A large increase in the amount of development (e.g., residential, recreational, infrastructure) within this area has occurred between populations, which may have increased their isolation from each other (CNDDDB 2005; AirPhotoUSA Inc. 2000, 2003; USDA National Agricultural Image Program 2005; M. Elvin, Service Biologist, pers. obs. 2006). Additionally, numerous development projects have further fragmented individual populations by extirpating portions of them (CNDDDB 2005; AirPhotoUSA Inc. 2000, 2003; USDA National Agricultural Image Program 2005; L. Althouse, pers. comm. 2006). (USFWS, 2009)

Stressor: Habitat fragmentation (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Habitat fragmentation affects persistence of populations or species within habitat fragments (Wilcove et al. 1986, Noss et al. 1997). Fragmentation also may lead to a decrease in pollination and reduced reproductive success, due to decreased visitation from pollinators to small and/or isolated populations (Kearns and Inouye 1997). While fragmentation does not necessarily lead to extinction of a species within a habitat patch, small populations in small habitat patches have an increased likelihood of extinction and are increasingly affected by their surroundings (i.e., edge effects such as physical effects differing at the boundaries of a patch and the interior of a patch) (Noss and Cooperrider 1994). At what point in the fragmentation process biological integrity of this species declines dramatically is not known. (USFWS, 2009)

Stressor: Habitat degradation (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The CNDDDB indicates that many of the properties containing *Clarkia speciosa* subsp. *immaculata* populations have been proposed for development since listing (CNDDDB 2005), although many of these projects either have not occurred yet or have fallen through (L. Althouse

pers. comm. 2009; Google Earth 2009). We know of two instances where the translocation of *C. speciosa* subsp. *immaculata* populations (soil and seedbank) was attempted in an effort to mitigate for impacts to portions of the original populations due to development (EO 16 and 17). Plants survived during the monitoring and management phases of these projects, but after the monitoring and management ended, the sites became so degraded and the vegetation/habitat was altered to the point that suitable habitat for *C. speciosa* subsp. *immaculata* no longer exists at any of the sites. Plants have not been seen at these locations since 1998 and all of these sites (original donor populations and the recipient translocated populations) are now presumed to be extirpated (J. Dart, pers. comm. 2006; L. Althouse, pers. comm. 2006; M. Elvin, pers. obs. 2006; CNDDDB 2009). Therefore, all of the known translocation efforts for *C. speciosa* subsp. *immaculata* have failed and the translocation of populations of this species may not be a sufficient mitigation or conservation strategy. (USFWS, 2009)

Stressor: Non-native plants (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: *Cortaderia jubata* (pampas grass) and *Ehrharta calycina* (veldt grass) are nonnative plants adversely affecting many populations (CNDDDB 2005, 2009; L. Althouse pers. comm. 2009), and their invasions are most likely an indirect effect from nearby development and plants that escaped from landscaping. (USFWS, 2009)

Stressor: Roadside threats (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Threats and adverse effects from road grading, roadside traffic, and roadside maintenance (including mowing and herbicide spraying) have not caused the extirpation of any entire occurrence, but they continue to threaten the species as a whole. At least three occurrences are threatened by road maintenance activities (CNDDDB 2005, CNPS 2006, CNDDDB 2009). (USFWS, 2009)

Stressor: Cattle grazing (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: We noted that two of the four known extant occurrences (at that time) had been subject to grazing by livestock (Service 1994), but that *C. speciosa* subsp. *immaculata* might be able to sustain a certain amount of grazing by livestock (Dunn 1987). Although cattle grazing may adversely affect *Clarkia speciosa* subsp. *immaculata*, it may not necessarily be a threat to its survival under all conditions. If controlled and timed correctly, cattle grazing may provide some benefits to *C. speciosa* subsp. *immaculata* by reducing competition from other vegetation. Overgrazing, on the other hand, can be extremely detrimental to the species, particularly through trampling and alterations to the hydrology (Service 1997, 1998). While this plant may be able to withstand a small amount of grazing, grazing still appears to adversely affect it through the reduction of reproductive success due to loss of flowers and a correlated reduction in the production of seeds (Service 1998). Grazing has been reported as a potential threat at four occurrences (CNDDDB 2009). (USFWS, 2009)

Stressor: Stochastic events (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: *Clarkia speciosa* subsp. *immaculata* may be threatened with stochastic extinction due to the small number of individuals within populations and isolation of the remaining populations (Airphoto USA Inc. 2000, 2003; CNDDDB 2009). It is generally accepted that small populations have higher probabilities of extinction than larger populations because their low numbers make them susceptible to inbreeding, loss of genetic variation, high variability in age and sex ratios, demographic stochasticity, and random naturally occurring events such as wildfires, floods, droughts, or disease epidemics (Soulé 1987, Shaffer 1981, 1987; Meffe and Carroll 1997, Primack 1998). (USFWS, 2009)

Stressor: Isolation (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Another factor commonly understood to make populations vulnerable to stochastic events is isolation. Isolation often acts in concert with small population size to increase the probability of extinction. Isolated populations are more susceptible to long-term/permanent extirpation by accidental or natural catastrophes because the likelihood of recolonization following such events is negatively correlated with the extent of isolation (i.e., colonization is less likely as isolation increases) (Wilcox and Murphy 1985, Meffe and Carroll 1997). (USFWS, 2009)

Stressor: Isolation (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: In addition, wide fluctuations in numbers from year to year in annual plants, such as *Clarkia speciosa* subsp. *immaculata*, may reduce population viability if there is a series of poor seed production years (Menges 1991). The limited gene pool may depress reproductive vigor or a single human-caused or natural environmental disturbance (e.g., wildfire) could extirpate one or more populations of this species. Additionally, small populations are threatened by inbreeding depression and can have significantly lower germination rates than larger populations of the same species due to high levels of homozygosity (Menges 1991). (USFWS, 2009)

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Since the time of listing, we have identified climate change as a potential threat to the species. Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to

make accurate predictions regarding its effects to particular species at this time. *Clarkia speciosa* subsp. *immaculata* may be particularly threatened by climate change because its geographic distribution is so narrow and its current range is unlikely to overlap with regions that would be climatically suitable in the future (Levine et al. 2008). (USFWS, 2009)

Recovery

Reclassification Criteria:

1. Eight populations are on lands secured from human-induced threats with adequate surrounding habitat to permit natural population expansion and movement as suitable microhabitats shift in the landscape. (USFWS, 1998)
2. The eight protected populations represent the plant's entire range. (USFWS, 1998)
3. These populations must be large, stable or increasing (a minimum of 10 years of monitoring is needed because the population sizes fluctuate due to precipitation). (USFWS, 1998)
4. Management of these populations and associated lands in the future must be reasonably assured for the long term, and must be effective, as demonstrated by stable or increasing populations. (USFWS, 1998)

Delisting Criteria:

When the downlisting criteria have been met for a species, the species can be considered for delisting if:

- (1) Threats are reduced or eliminated so that occurrences are capable of persisting without significant human intervention or perpetual endowments are secured for management necessary to maintain the continued existence of the species; (USFWS, 2019)
- (2) An ex situ seedbank is established in a Center for Plant Conservation-affiliated botanic garden. While sufficient seedbank in the soil would typically provide a strategy for the taxon to persist through several years of short- or medium-term drought, it may not be sufficient to persist through long-term drought. Therefore, an ex situ seedbank would provide assurance that an occurrences could be reseeded, should long-term drought – or other stochastic events – make it necessary; (USFWS, 2019)
- (3) All existing occurrences are stable or increasing in the wild for at least 10 years. We expect above-ground occurrence size to fluctuate annually, based on response to amount and timing of rainfall. Therefore, a period of 10 years should be long enough to include most of the variability in rainfall that occurs in this region. Monitoring of occurrences should be undertaken and access to private properties that support the species should be pursued, which will provide a baseline for the status of these occurrences; these data should provide a basis for monitoring occurrence attributes and trends to determine the species trajectory over time. (USFWS, 2019)

Recovery Actions:

- Secure populations and habitat on unprotected lands. Methods for securing lands include in-fee purchase, gifts of easement or fee interest by the property owner, deed restrictions (provided restrictions cannot be changed privately without the knowledge of Federal, State

- and County agencies), acquisition of property rights (e.g., development rights) or permanent conservation easements. (USFWS, 1998)
- Manage secured lands to control or eliminate other known threats. Although habitat alteration through development is currently the most substantial and irreversible threat facing all of the species in this plan, the management of lands secured from development will remain a formidable task, made more so in those cases where the secured habitats are adjacent to high density residential and urban development. (USFWS, 1998)
 - Evaluate potential threats and conduct management-oriented research. Conduct habitat-oriented research for Morro Bay species. Conduct species-specific research. Evaluate research results and use in future management. (USFWS, 1998)
 - Determine population dynamics and effects of recovery efforts. Studies should be conducted to learn the number and size of successful self sustaining populations for the species to establish criteria for its reclassification. (USFWS, 1998)
 - Develop and implement an education/information program. The benefits of protecting native species and their habitats and maintaining native biological communities should be explained clearly to all concerned parties. (USFWS, 1998)
 - Reevaluate recovery criteria and revise recovery plan based on expanded knowledge from research, monitoring, and management. The scientific validity of the recovery criteria and recovery plan should be reviewed and revised as more information becomes available. The criterion of maintaining sufficient numbers of populations or conservation areas should be assessed, and the success or failure of management actions should be evaluated. (USFWS, 1998)
 - Recommendations for Actions from 2009 5-Year Review: Work with local partners to secure occupied sites that meet recovery criteria. Work with local partners (including the County of San Luis Obispo) to help development projects avoid impacts to *Clarkia speciosa* subsp. *immaculata*, considering the two attempted translocation projects for this species have failed, resulting in the presumed extirpation of both populations. Work with the County of San Luis Obispo to develop an improved system to track projects that might adversely affect listed and other sensitive species. Amend the recovery objectives and tasks to account for the increase in fragmentation and how it affects our ability to accomplish the recovery criteria. (USFWS, 2009)

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SPECIES ACCOUNT: *Clarkia springvillensis* (Springville clarkia)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/14/1998; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

An erect annual herb, up to about 1 m tall. Flowers (May-July) have lavender petals with a long narrow base and an expanded, diamond-shaped tip that has a darker, purplish basal spot. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Endemic to the foothills of the Sierra Nevada in a small area of Tulare County, California along the Tule River drainage. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: 1 year (USFWS, 2009)

Breeding Season

Adult: May to July (NatureServe, 2015)

Reproduction Narrative

Adult: *Clarkia springvillensis* is a narrowly distributed annual in the evening primrose family (Onagraceae) and blooms from May to July. (USFWS, 2009)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest Edge, Forest/Woodland, Woodland - Hardwood (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Prefers sunny open sites (USFWS, 2009)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 330 and 1,220 m (1,080 to 4,000 feet) (USFWS, 2009)

Spatial Arrangements of the Population

Adult: Colonies (USFWS, 2009)

Habitat Narrative

Adult: *Clarkia springvillensis* grows mostly on the uphill slope of roadbanks, on small decomposing granitic domes, and in sunny openings from elevations between 330 and 1,220 meters (1,080 to 4,000 feet) within the blue oak woodland community. *Clarkia springvillensis* is found on granitic soils at sunny sites. Population surveys revealed 18 colonies in 2002 and 23 colonies in 2003. (USFWS, 2009)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Declining (USFWS, 2009)

Resiliency:

Low (inferred from USFWS, 2009)

Representation:

Low (inferred from USFWS, 2009)

Redundancy:

Low (inferred from USFWS, 2009)

Number of Populations:

10 (NatureServe, 2015)

Population Narrative:

The California Department of Fish and Game (2001) characterized the species as a whole as declining in 1999. There are about 10 populations known extant (NatureServe, 2015). The population size of *Clarkia springvillensis* can vary enormously from one year to the next due to interactions between the soil seed bank and seasonal weather conditions. (USFWS, 2009)

Threats and Stressors

Stressor: Residential development (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Prior to listing, residential development affected *Clarkia springvillensis* at two sites. Element Occurrence 5 was damaged, but not destroyed, when an access road, building pad, and well were constructed in the midst of the *C. springvillensis* population (Ashford 1989) for a home that was never built. Mobile home development contributed to the extirpation of Element Occurrence 1. No mobile homes are currently located at that site, but road construction,

maintenance and improvement associated with the former residences are believed to be responsible for its disappearance (J. Stebbins, pers. comm. 2001, J. Stebbins in litt. 2002; CNDDDB 2009). (USFWS, 2009)

Stressor: Road maintenance (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Road maintenance and improvements have affected *Clarkia springvillensis* on steep banks near roadways to some extent (Stebbins 1991, J. Stebbins, in litt. 2002; CNDDDB 2009). Road maintenance is still a threat at five occurrences in *Clarkia springvillensis* habitat. The dirt along which it grows are maintained either by Tulare County, Pacific Gas and Electric, or Southern California Edison. Road maintenance includes activities such as mowing, grading, spraying herbicide, mechanically removing brush, and clearing culverts (USFS 1996), whereas road improvements are activities such as widening or straightening roads, or installing culverts (USFWS, 2009)

Stressor: Livestock grazing (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The apparent decline of *Clarkia springvillensis* is likely due to a complex combination of inappropriate livestock (J. Shevock, USFS, in litt. 1985; Stebbins 1991; Hansen 1992; USFS; 1996), competition from nonnative plants (McCue et al. 1996), and altered fire regimes (McCue et al. 1996; S. Carter, pers. comm. 2001, J. Stebbins, in litt. 2002). Inappropriate grazing practices that apparently contributed to the decline of *C. springvillensis* included (1) repeated consumption of the same plants in a single growing season; (2) grazing late in the season (May or later) so *C. springvillensis* plants did not have time to send up new shoots or set seed before dying back (McCue 1997; J. Stebbins, pers. comm. 2001); and (3) livestock spending long periods in one area, which caused direct trampling of plants, soil compaction, and surface disturbance (Hansen 1992). Concern over grazing peaked in the 1980s, and several occurrences were then fenced to exclude livestock (Stebbins 1991). (USFWS, 2009)

Stressor: Random demographic, environmental or genetic events (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The combination of small range and restricted habitat still renders *Clarkia springvillensis* susceptible to extirpation due to random events such as flood, drought, disease, or other factors (Shaffer 1981, 1987; Groom et al. 2006). Demographic events that may put small populations at risk involve random fluctuations in survival and reproduction of individuals (Shaffer 1981, 1987; Lande 1998; Groom et al. 2006). Small populations may also be subject to increased genetic drift and inbreeding (Menges 1991, Ellstrand and Elam 1993). Populations that are continually small in size are particularly susceptible to genetic changes due to drift. However, drift may also cause genetic changes with populations that occasionally fluctuate to small sizes. Increased homozygosity resulting from genetic drift and inbreeding in small populations may lead to a loss of fitness. In addition, reduced genetic variation in small populations may make any species less able to successfully adapt to future environmental changes (Ellstrand and Elam

1993). *Clarkia springvillensis* has small population size for at least five occurrences, therefore, it also is susceptible to extirpation due to demographic events, genetic drift, and inbreeding. (USFWS, 2009)

Stressor: Competition with nonnative plants (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Nonnative plants, especially *Bromus* grass species (brome), may have contributed to the decline of *Clarkia springvillensis* by competing directly for moisture and nutrients (J. Stebbins in litt. 2002). Dead stems of nonnative grasses create a build-up thatch that may have prevented *C. springvillensis* from becoming established in openings, thereby isolating populations (McCure et al. 1996; J. Stebbins, pers. comm. 2001). Prolonged grazing may have exacerbated these problems because soil disturbance favors some nonnative plants over native species (Hansen 1992). A related problem is that the stems and thatch of nonnative plants contribute to an increased fire frequency. Conversely, fire suppression activities may have inadvertently contributed to the decline of *Clarkia springvillensis* by allowing encroachment of shrubs and trees into the openings where it grows (McCue et al. 1996; S. Carter, pers. comm. 2001, J. Stebbins in litt. 2002). (USFWS, 2009)

Stressor: Global climate change (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Impacts to *Clarkia springvillensis* under predicted future climate change are unclear. A trend of warming in the mountains of western North America is expected to decrease the snowpack, hasten spring runoff, and reduce summer stream flows, and increased summer heat may increase the frequency and intensity of wildfires (IPCC 2007). While it appears reasonable to assume that the species may be affected, we lack sufficient certainty on knowing how and how soon climate change will affect the species, the extent of average temperature increases in California, or potential changes to the level of threat posed by drought and fire. (USFWS, 2009)

Recovery

Reclassification Criteria:

Reclassification criteria are not available.

Delisting Criteria:

Delisting criteria are not available.

Recovery Actions:

- Recovery actions are not available.

Conservation Measures and Best Management Practices:

- Complete and published the draft recovery plan, and approve a final recovery plan (USFWS, 2009)
- Establish reliable baseline data for monitoring plant occurrences. Monitor the status and trend of *Clarkia springvillensis* in order to estimate current population sizes, the number and distribution of

populations, the threats to each occurrence, and whether the species is stable, increasing, or declining. (USFWS, 2009)

- Work with the Forest Service, Bureau of Land Management, and California Department of Fish and Game to conduct research on a) the value of prescribed burning and mechanical brush removal; and b) study the effects of livestock grazing on *Clarkia springvillensis*. (USFWS, 2009)

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SPECIES ACCOUNT: *Clematis morefieldii* (Morefield's leather flower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/19/1992; Southeast Region (R4)

Physical Description

A perennial vine in the buttercup family (Ranunculaceae). This species is a member of the *Viornae* subsection of *Clematis*, distinguished by urnshaped flowers which occur singly, or in few-flowered groups, in leaf axils. Their primary flower stalks (peduncles) are subtended by leafy bracts. *Clematis morefieldii* is closely related to *C. viorna*, a more variable species. However, *C. morefieldii* is distinguished from this species by the dense white hairs on the shoot, the velvety lower leaf surfaces, and stouter, usually shorter (15 to 25 millimeters (mm) or 0.6 to 1.0 inch long) peduncles with sessile to nearly sessile bracts at the base (Kral 1987). *Clematis morefieldii* attains heights up to 5 meters (16 feet) and has compound leaves reaching lengths of 2 decimeters (8 inches). Leaves have 9 to 11 leaflets and the terminal 1 to 3 leaflets form tendrils. The flowers, which are present from May to July, are pinkish in color and 20 to 25 mm (0.8 to 1.0 inch) long. Fruits are clusters of hairy achenes. (USFWS, 1994)

Taxonomy

It was first collected by Morefield in the early 1980's from Round Top Mountain in Madison County, Alabama and later described by Kral (1987). This species is a member of the *Viornae* subsection of *Clematis*, which is noted for its narrow endemics (Kral 1987). *Clematis morefieldii* is closely related to *C. viorna*, a more variable species (USFWS, 1994).

Historical Range

Endemic to the southeastern United States, known from three states (Alabama, Georgia, and Tennessee). (USFWS, 2019)

Current Range

Endemic to the southeastern United States, known from three states (Alabama, Georgia, and Tennessee). (USFWS, 2019). In five counties in three states (Jackson and Madison counties, Alabama; Walker County, Georgia; and Franklin and Grundy counties, Tennessee). The species' known range spans fewer than 70 miles east to west and under 50 miles north to south. (USFWS, 2018)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 2018)

Breeding Season

Adult: May - July (USFWS, 2018)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 2018)

Other Reproductive Information

Adult: Crabtree (2011) observed bumblebees (*Bombus* sp.) visiting flowers of Morefield's leather flower. Preliminary data indicate that pollinated flowers are capable of producing abundant (15 or more per flower) achenes (a type of simple, dry fruit containing only one seed) (Crabtree 2014a). Preliminary data also indicate a moderately positive correlation with precipitation and fruiting in the field (Crabtree 2014a). Likewise, Paris et al. (2015, 2016) also noted increased flowering and fruiting in the rainiest year of their multiyear studies. However, lack of rainfall has also been associated with poor flower production (Emanuel 2000, Boyd and Paris 2013). (USFWS, 2018)

Reproduction Narrative

Adult: Crabtree (2011) noted reproductive activity at 11 of 18 Morefield's leather flower sites in Tennessee during 2009–2010 and further noted the presence of seedlings at most sites. However, follow-up surveys in 2013 failed to relocate mature plants resulting from these seedlings (Crabtree 2014a), but small plants were found where seedlings were previously located during follow-up monitoring surveys in 2018 at two sites (Crabtree pers. comm. 2018c). Crabtree (pers. comm. 2018c) suggested that surveying earlier in the year than previous surveys may have contributed to these discoveries and further suggested that seedlings and small plants may go dormant as precipitation decreases during summer's progression. Boyd and Paris (2013) likewise noted seedling recruitment in most of the populations in Alabama and Tennessee visited as part of their study. Interestingly, Crabtree (2011) noted repeatedly observing Morefield's leather flower seedlings along deer trails, suggesting that deer (*Odocoileus virginianus*) may be potential dispersal agents of the species' seeds, but recommended additional research to further understand this putative relationship. Additionally, the species' pollen has been imaged and

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Limestone bluffs, montane hardwood forests, riparian (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: ~800 - 1700 ft. elevation (USFWS, 2018)

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Habitat Narrative

Adult: Occurs in the Cumberland Plateau physiographic region in Madison County (Figure 1). It occurs in patches near seeps and springs in rocky limestone woods, typically at elevations of 800 to 1100 feet, on the south and southwest facing slopes of mountains (Weber 1991). Currently, it is known from a total of five sites with populations on Huntsville, Keel, and Monte Sano Mountains. Populations tend to occur on limestone of the Monteagle formation with a

sandstone cap (Weber 1991). Plants are rooted in basic clay-loam soils and are often found sprawling over shrubs and boulders or climbing understory shrubs and trees (Kral 1987). *Clematis morefieldii* occurs locally within an open to dense juniper-hardwoods community. (USFWS, 1994) Morefield's leather flower is found within an elevation gradient of approximately 700 to 1,700 feet above sea level (Cook 2018), but most sites are found between roughly 1,000 and 1,400 feet elevation. The species has remarkably high fidelity with the Plateau Escarpment Level IV ecoregion - which is found within the Southwestern Appalachians Level III ecoregion - with all known populations occurring within this ecoregion. A small portion of one population slightly crosses into the Eastern Highland Rim Level IV ecoregion (part of the Interior Highlands Level III ecoregion); however, this apparent ecoregional association may simply be an artifact of how the population and/or ecoregion were mapped rather than a true association. (USFWS, 2018)

Dispersal/Migration

Dependency on Other Individuals or Species for Dispersal

Adult: Unknown

Dispersal/Migration Narrative

Adult: Crabtree (2011) noted repeatedly observing Morefield's leather flower seedlings along deer trails, suggesting that deer (*Odocoileus virginianus*) may be potential dispersal agents of the species' seeds, but recommended additional research to further understand this putative relationship. (USFWS, 2018)

Population Information and Trends

Population Trends:

Uncertain (USFWS, 2018)

Species Trends:

Uncertain (USFWS, 2018)

Number of Populations:

32 extant; 2 extirpated (under a 1-km provisional population definition; see narrative) (USFWS, 2018)

Population Size:

Insufficient data available (USFWS, 2018)

Additional Population-level Information:

For this 5-year review, a provisional population definition of 1 kilometer (0.6 mile) is used to delimit individual populations, which is in line with both the Tennessee Natural Heritage Program's (TNHP 2018) and the Alabama Natural Heritage Program's (ANHP 2018) element occurrences. As such, individuals or groups of Morefield's leather flower that are separated by at least 1 kilometer from their nearest known neighbors are considered to be a distinct population. Under the 1-kilometer provisional population definition, there are 34 known populations of Morefield's leather flower across three states (Alabama, Florida, and Georgia), with 32 populations considered extant and 2 considered extirpated. With 20 extant populations

in two counties (Franklin – 18; Grundy – 2), Tennessee is home to nearly two-thirds of known populations (TNHP 2018). Six of Tennessee’s populations (Franklin – 5; Grundy – 1) have been discovered since 2010 (TNHP 2018). Alabama has 11 extant populations in 2 counties (Jackson – 2; Madison – 9; ANHP 2018). A previously unknown population was discovered in Walker County, Georgia in 2015 (GDNR 2018a), which represents an extension of the species’ known range into Georgia. No other occurrences from Georgia are known. (USFWS, 2018)

Population Narrative:

Current population size data are limited and no systematic population monitoring and survey protocols are known for Morefield’s leather flower. The only known monitoring program for the species occurs in Tennessee, which is funded by the Service’s U.S. Endangered Species Act (ESA) Section 6 cooperative grant program and is conducted by TNHP (cf. Bailey 2005, Crabtree 2011, 2014a). While population size data are available for 31 of the 32 extant populations (no population size data are available for Georgia’s only known population), only 20 populations have data available that were collected since the last 5-year review (i.e., 2010), 11 of which have data that are 5 or less years old. Available population data for the remaining 11 populations were collected between 1990 and 2009. Together, these data, ranging from 1 to 28 years old, indicate that the total population size of Morefield’s leather flower may be potentially as large as 16,000 individuals (Boyd and Paris 2013, Paris 2013, ANHP 2018, Cook pers. comm. 2018, TNHP 2018). Based on these latest available observations, individual population sizes range from 1 to over 7,000 individuals, but only 2 populations are greater than 1,000, whereas, 17 populations (over half of all extant populations) have fewer than 100 individuals and 11 have 20 or less. The lack of recent (i.e., less than 5 years old), systematic survey and monitoring data for many populations increases the uncertainty of our assessment of individual population sizes, the species’ total population size, and population trends. (USFWS, 2018)

Threats and Stressors

Stressor: Development (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Since its discovery, two populations of this species were destroyed or damaged by residential development in Alabama (Weber 1994, ANHP 2018). *Clematis morefieldii* continues to be threatened by habitat destruction from development, particularly for those sites located in the Huntsville area (Schotz 2007, Paris 2013). One of the largest populations in this area consists of pockets of plants on lots slated for development within the city limits. Long-term protection of these populations in the Huntsville vicinity population is precarious. Overall, development, particularly for residential purposes, has been identified as a significant threat to species associated with privately owned forested lands (Stein et al. 2010), such as Morefield’s leather flower. Development and associated land use changes on unprotected sites could negatively impact or destroy populations if precautions are not taken. Such development activities can also fragment populations (see Factor E). Within the southeastern United States, the urban footprint has been projected to more than double by 2060 compared with 2009 for the region and may more than triple within the Southwestern Appalachians ecoregion during the same period (Terando et al. 2014), thus putting further development pressure on Morefield’s leather flower and its habitats. However, the overall proportion of the landscape within the Southwestern Appalachians ecoregion projected to be urbanized during this time is expected to remain small

(less than 10%) (Terando et al. 2014). Likewise, Morefield's leather flower typically inhabits locations that are less suitable for urban development (sensu Baldwin et al. 2018), which likely ameliorates some of the threats posed by continued urban development. (USFWS, 2018)

Stressor: Small populations (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Over half (53%) of known extant populations (17 of 32) remain vulnerable due to their small numbers of plants, having fewer than 100 individuals, including 11 populations (34%) with no more than 20 individuals (Boyd and Paris 2013, Paris 2013, ANHP 2018, Cook pers. comm. 2018, TNHP 2018). Maintenance of genetic diversity within populations is the best protection against future environmental changes (Boyd et al. 2008). Those populations with small numbers of plants likely have limited genetic diversity, which makes their persistence into the future precarious (Ellstrand and Elam 1993, Matthies et al. 2004). The negative consequences of small populations are further exacerbated by habitat fragmentation. For example, habitat fragmentation from development and other activities can disrupt pollinators and consequent gene flow between populations, which may ultimately reduce viability of individual populations (Honnay and Jacquemyn 2007). Potential deleterious consequences (e.g., inbreeding, loss of genetic diversity, genetic drift) of fragmented populations increase as population sizes decrease and with increasing length of time that fragmented conditions remain in place (Young et al. 1996, Aguilar et al. 2008). (USFWS, 2018)

Stressor: Herbivory (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Herbivory of Morefield's leather flower plants is common (Paris et al. 2015, 2016) and continues to be of some concern. Insect infestation was thought to cause the decline of one population in Alabama (Weber 1994). Bailey (2005) observed mealybug infestation on numerous individuals at several locations in Tennessee and suggested that damage from these insects may inhibit reproductive capacity of plants. However, during surveys in following years mealy bugs were only observed at one population (Crabtree 2011), indicating the need for further investigation of this potential threat to the species throughout its range. Crabtree (2011) also noted extensive deer browsing at one site in Tennessee and suggested that large deer populations could potentially threaten the species at some sites. Similar deer browsing has also been noted more recently in Tennessee (Crabtree pers. comm. 2018b). Paris et al. (2015) found decreased flower bud damage and increased fruit production on Morefield's leather flower plants treated with insecticide, and further noted that both insect and vertebrate browsing damage was reduced on treated plants. Such observations indicate that insecticide application could successfully reduce herbivory in particularly vulnerable populations. (USFWS, 2018)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Alabama has no state laws affording specific protections to Morefield's leather flower or its habitat; however, Alabama Department of Conservation and Natural Resources (ADCNR)

has recently designated the species as a Plant of Conservation Concern in the State Wildlife Action Plan (SWAP; ADCNR 2016). However, this designation does not carry any legal protections. *Clematis morefieldii* is state listed as endangered by the Tennessee Department of Environment and Conservation (TDEC). The Tennessee Rare Plant Protection and Conservation Act of 1985 (T.C.A. 11-26-201) forbids persons from knowingly uprooting, digging, taking, removing, damaging, destroying, possessing, or otherwise disturbing for any purpose, any endangered species from private or public lands without the written permission of the landowner. Written permission from a landowner or manager before knowingly removing or destroying a state listed species (T.C.A. §§70-8-301–314). In addition, a state-issued scientific collecting permit is required before removing any state-listed species from TDEC lands (TDEC Rule 0400-02-02-.23) and a state-issued license is required to sell state-listed species in Tennessee (TDEC Rule 0400-06-02-.06). *Clematis morefieldii* is also identified as a species of Greatest Conservation Need in Tennessee's SWAP (Tennessee State Wildlife Action Plan Team 2015). As with Alabama's SWAP, such designation does not confer additional legal protection to the species, but may serve to help focus conservation efforts on this species and its habitats. In Georgia, the species is state protected as endangered (GDNR 2018b) under the Wildflower Preservation Act of 1973 (O.C.G.A. 12-6-170). This law authorizes rules for permitted collection, transport, sale, and listing of protected plants within the state. In addition, no protected plants may be collected without landowner approval and no transport within the state is allowed without a state-issued permit (Patrick et al. 1995). Furthermore, the Georgia Environmental Policy Act (GEPA) of 1991 (O.C.G.A. 12-16-1) requires that impacts to protected species be addressed for all projects on state-owned lands and for all projects undertaken by a municipality or county if funded half or more by state funds or by a state grant of more than \$250,000. The provisions of GEPA do not apply to actions of non-governmental entities. On private lands, the landowner has ultimate authority on what protection efforts, if any, occur with regard to protected plants (Patrick et al. 1995). Otherwise, protection is also afforded to the species under Sections 7 and 9 of the ESA throughout its range. (USFWS, 2018)

Stressor: Encroachment of exotic plants (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Encroachment of exotics, most notably Japanese honeysuckle (*Lonicera japonica*) and fragrant honeysuckle (*L. fragrantissima*) may pose problems for some populations, particularly those within the Huntsville city limits (Schotz 2007). Recently, the Alabama Plant Conservation Alliance and Georgia Plant Conservation Alliance—non-governmental plant conservation organizations—have begun to focus attention on Morefield's leather flower by including them as an organizational project or priority species, which will help provide additional attention to the conservation needs of this species, such as habitat management in the wild and ex situ (off-site) conservation in botanical gardens and arboretums (Thompson 2018, Ceska pers. comm. 2018). (USFWS, 2018)

Stressor: Rock mining (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Rock mining occurs on property adjacent to one population in Grundy County, Tennessee and is considered a potential threat to this population (Crabtree pers. comm. 2018b).

Mining activities have also been noted as potential threats to suitable habitat elsewhere in Tennessee (Bailey 2005). More recently, expansion of quarrying activities in Grundy and Franklin Counties, Tennessee has been proposed (Crabtree 2011), which may increase threats posed by these activities to the species and its habitat. In Franklin County, Tennessee State acquisition—via donation and purchase in 2016—of land formerly owned by a mining company has alleviated threats posed to Morefield's leather flower by continued mining activities on this land by incorporating this area in the State's conservation lands estate. (USFWS, 2018)

Stressor: Forestry practices (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Incompatible forestry practices and logging have also been noted to pose threats to a number of the Alabama sites (Schotz 2007, ANHP 2018) and at least one Tennessee site (Crabtree 2011). Schotz (2007) noted three sites in Alabama that were threatened by timber harvesting activities. Crabtree (2011) noted that tops from harvested trees were left on favorable habitat for Morefield's leather flower at one of the smallest Tennessee populations. Disturbance from logging activities may also promote the encroachment of exotic invasive species. (USFWS, 2018)

Stressor: Road construction (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: A Franklin County, Tennessee population located near a road is thought to have been extirpated when the road was widened (Crabtree pers. comm. 2010, TNHP 2018). However, shifting right-of-way maintenance from herbicide spraying to vegetation cutting has apparently benefitted Morefield's leather flower plants that were recently discovered along a highway in Franklin County, Tennessee (TNHP 2018). Roadside maintenance involving herbicide spraying or mowing at inappropriate times may threaten populations in Alabama and Tennessee that are located near roads. (USFWS, 2018)

Recovery

Reclassification Criteria:

1. At least ten (10) geographically distinct populations of sufficient size within the Plateau Escarpment ecoregion exhibit stable or increasing population trends over an appropriate time span, as evidenced by natural recruitment and multiple size classes. (USFWS, 2019)
2. These ten (10) populations are protected by a conservation mechanism. (USFWS, 2019)
3. Protected populations are managed to promote open canopies, integrity of native plant communities, and growth of Morefield's leather flower plants. (USFWS, 2019)

Delisting Criteria:

In addition to meeting downlisting criteria, Morefield's leather flower will be considered for delisting when the following criteria are met: (USFWS, 2019)

4. At least 10 additional geographically distinct populations of sufficient size within the Plateau Escarpment ecoregion exhibit stable or increasing population trends over an appropriate time span, as evidenced by natural recruitment and multiple size classes. (USFWS, 2019)

5. At least one population (as described in Criterion 1) protected by a conservation mechanism occurs in each of the five counties where the species is known to occur (Madison and Jackson Counties, Alabama; Walker County, Georgia; and Franklin and Grundy Counties, Tennessee). (USFWS, 2019)

Recovery Actions:

- Protect populations and habitat. Ensure protection of publicly-owned sites. Secure plants on private lands. (USFWS, 1994)
- Survey for new populations. Limited surveys have been conducted by Kral (1987), Weber (1991), and the author; however, a thorough systematic survey for new populations is needed. Suitable habitat should be identified through an analysis of habitat supporting extant populations. Current sites occur near seeps and springs at elevations of 800 to 1100 feet in Monteagle Limestone with overlying shales and sandstones. Particular attention should be focused on sites with *Cotinus obovatus*, which appears to be a principal indicator species for *Clematis morefieldii* habitat. Surveys should continue in north Alabama (Limestone, Madison, Morgan, Jackson Counties) and extend into Franklin and Marion Counties in Tennessee (Kral 1987). Possible sites which have good potential include the south/southwest faces of the plateau region between Huntsville (AL) and Carter Mountain (TN) in Monteagle limestone and Brindley Mountain in Morgan County, AL (Weber in liii. 1994). The location and protection of additional sites is essential for reclassification to threatened and future recovery. The location of other populations will perhaps yield important information on this species' habitat requirements. In addition, documentation of apparently suitable habitat, which lacks the plants, will be important to any future plans to establish additional populations. (USFWS, 1994)
- Gather baseline data on populations and habitat and conduct long-term monitoring. An understanding of this species' distribution within populations and its habitat needs is essential to determining limiting factors. (USFWS, 1994)
- Investigate potential management techniques. Weber (1991) reported reduced vigor for plants under extremely shaded conditions. Populations appear to have been enhanced at sites where the canopy was more open from a limited amount of selective logging. Test plots to evaluate this species' response to different light levels and competition will assist in determining appropriate management for this species. Information gathered from Task 3 will aid in determining management will be needed. (USFWS, 1994)
- Study species' biology and conduct life history studies. No research on this particular species' life history has been conducted. An understanding of this species' biology and life history is essential to identifying limiting factors and understanding the dynamics of the populations. Information gained will ensure that populations are appropriately protected and managed. (USFWS, 1994)
- Preserve genetic stock. This species is extremely vulnerable due to such few populations. Protection of the gene pool should be accomplished through seed bank storage and by maintaining material in cultivation. This will provide material for research, propagation, and horticultural interests. Such activities should be conducted under the guidance of the Center

- for Plant Conservation. Roles which could be played by local botanical gardens (Huntsville-Madison County Botanical Garden) in this task should also be explored. (USFWS, 1994)
- Establish additional populations, if found to be necessary. Establishment of additional populations should be considered only after extensive searches for new populations have been conducted and there has been ample time to assess the progress of management actions on existing populations. Establishment of new populations should be considered as a means of decreasing the vulnerability of this species, which is restricted to only a few sites. Established populations and their habitat will likely require active management and long-term monitoring to assess success of efforts. The number of populations to be established will be determined at the time the necessity of this task is assessed. (USFWS, 1994)
 - Develop public awareness program. Public support is an important part of recovering listed species. General information on this species and its conservation needs should be provided to landowners, governmental agencies, local parks, and nature centers, as well as the media. The recovery of this species will depend largely on the voluntary protection from private landowners and local governments. Education efforts will lead to a public more informed of the conservation needs of endangered species and possibly to the location of additional populations. (USFWS, 1994)
 - Recommendations for Future Actions from 2010 5-Year Review: Gather base-line data on all populations and initiate long-term monitoring on sites, particularly on the secure, protected sites. - Continue surveys in Alabama and adjacent Tennessee (survey reports in “V. References” below identify target areas for surveys). - Work to obtain protection for sites on privately-owned lands. - Investigate habitat parameters. - Develop protection and management plans for all sites as indicated by information acquired from habitat studies. - Evaluate significance of insect predation on populations. - Conduct species biology studies (i.e. reproductive biology etc.). - Implement all other tasks identified in the recovery plan, with exception of #7,(Establish additional populations) which is not likely needed in light of the discovery of new populations. - Revise recovery plan. (USFWS, 2010)

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SPECIES ACCOUNT: *Clematis socialis* (Alabama leather flower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/27/1986; Southeast Region (R4)

Physical Description

A member of the family Ranunculaceae. The most distinctive features are its rhizomatous habit and formation of dense clones with erect stems reaching 0.2-0.3 meters(in) or 7-12 inches (in.) in height. The leaves are variable from the base to the apex of the stem. The lowermost leaves are scalelike, oblong or triangular in shape and mostly under 1 centimeter (cm) (0.39 in.) long; median leaves are simple, mostly elliptic-linear in shape, 4-12 cm (1.6-4.7 in.) long, and 0.5-1.0 cm (0.20-0.39 in.) wide; upper leaves are 3 to 5 foliolate and shaped as in median leaves. The flowers are solitary at the tips of slender stems, urn to bell-shaped, 2-3 cm (0.79-1.18 in.) long, and blue-violet in color. The fruits are aggregates of achenes which are densely pubescent and 2.5-3.0 cm (0.98-1.18 in.) in length (Figure 1). *Clematis socialis*, a member of the *Viorna* section of *Clematis*, superficially resembles the more widespread *C. crispa* but is distinguished by its erect stems, rhizomatous nature, solitary flowers and lack of tendrils (Kral 1982, 1983). (USFWS, 1989)

Taxonomy

Described as a new species in 1982 by Dr. Robert Kral. (USFWS, 1989)

Historical Range

The Alabama leather flower was known from only two sites, one each in St. Clair and Cherokee counties, Alabama, at the time of listing in 1986. (USFWS, 2010)

Current Range

St. Clair County (3 populations) , Cherokee County (two populations), and Etowah County (1 population), Alabama. Floyd County, Georgia (two populations). (USFWS, 2017)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Clonal, sexual (USFWS, 2010)

Dependency on Other Individuals or Species

Adult: *Bombus pennsylvanicus* and *Anthophora ursina* (USFWS, 2010)

Breeding Season

Adult: March - June (USFWS, 2010)

Other Reproductive Information

Adult: Genetic sampling of populations in Alabama by Goertzen et al. (2011) revealed that individual genets (genetically distinct individuals) of Alabama leather flower can be quite large, spreading to at least 36 feet (ft.) (11 meters [m]) via underground rhizomes. The authors note that these genets may span greater distances than their sampling scheme detected. These data, coupled with earlier estimates that Alabama leather flower's rhizomes grow approximately 4 inches (10 centimeters [cm]) per year (Goertzen and Boyd 2007), indicate that the species is relatively long-lived and capable of living for at least 55 years. (USFWS, 2017)

Reproduction Narrative

Adult: Flowering occurs March to June. Fruit development begins in June; seeds mature by late July through early August and seeds have senesced by late August. Pollinators include queen bumblebee (*Bombus pennsylvanicus*), bee (*Anthophora ursina*); pollination not required for production of seeds, but seed production increases with pollination. *Anthophora* is a more productive pollinator than *Bombus* (EPA, 2016). Plants are believed to reproduce primarily by forking and spreading rhizomes which form dense clones (Kral 1982, Garrett 2004). Timmerman-Erskine and Boyd (1999) suggested that sexual reproduction in this species was limited by a combination of pollinator frequency, herbivory, low light levels, and post-maturation achene predation by mice. The level of genetic diversity in the Alabama leather flower is higher than average for rare species and surprising given that it is a narrow endemic with a clonal nature, thus suggesting that considerable sexual reproduction has likely occurred in these populations despite low observed seedling recruitment (Boyd et al. 1998, Goertzen and Boyd 2007) (USFWS, 2010).

Habitat Type

Adult: Terrestrial, palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Herbaceous wetland, riparian, forest, grassland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Periodic fires (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped, scattered (USFWS, 2010)

Environmental Specificity

Adult: Moderate (NatureServe, 2015)

Habitat Narrative

Adult: Silt and clay of alluvial, grass-sedge openings along a highway right-of-way, extending into the adjacent hardwood edge. Associated members of the grass-sedge community prior to logging included: *Scarpus lineatus*, *S. atrovireus*, *Fimbristylis puberula*, and *Rhynchospora caduca*; several andropogons, such as *A. gerardi* and *A. scoparius*; patches of *Allium* and *Sysyrinchium* were noted, in addition to violets and composites. The woodland overstory prior to logging (Kral, 1982) was composed of lowland oaks, hickories, white and green ash, sweet gum, black gum, persimmon, and red maple. The understory included flowering dogwood, swamp cornel, sassafras, buckthorn, elderberry, viburnums, honeysuckle, and blackberry. Many of these species have been documented as components of the climax vegetation usually

associated with southeastern loblolly pine forests. These forests experience natural fires approximately every ten years (Wright and Bailey, 1982). It has a moderate environmental specificity (NatureServe, 2015). Open grass-seed-rush prairie areas and adjoining hardwood swamp forests. Soil types are Conawauga and Firestone formations (developed from weather shale, are acidic, low fertility, and poor in organic material); Tupelo series with Dowellton series inclusions (calcareous flatwood communities growing on circum-neutral soils) (EPA, 2016). The Alabama leather flower is found occurring in tight patches or sparsely scattered (Goertzen and Boyd 2007). Though plants are found in sunny and shaded conditions, they are more vigorous in full or partial sunlight where plant competition is low (Emanuel 2000, 2002; Garrett 2004, 2005; Garrett and Schotz 2005; Sherbundy and Martin 2007) (USFWS, 2010).

Dispersal/Migration

Dependency on Other Individuals or Species for Dispersal

Adult: Unknown

Dispersal/Migration Narrative

Adult: Dispersal mechanisms are unknown.

Population Information and Trends

Population Trends:

Not available

Species Trends:

Stable (USFWS, 2017)

Number of Populations:

6 extant; 1 uncertain (USFWS, 2017)

Population Size:

Approximately 13,000 - 18,000 stems across extant populations (USFWS, 2017)

Additional Population-level Information:

Because of the clonal nature of Alabama leather flower, individual populations can be thought of in terms of both genetically distinct individuals (genets) and clones (ramets). Genets are often composed of numerous ramets (clonal stems). As such, population assessments using numbers of stems alone can easily overestimate the actual population in terms of genets (Tepedino 2012). With respect to Alabama leather flower clonality, as noted above, genets have been documented to be at least 36 ft. (11 m) long (Goertzen et al. 2011). It is unknown how large individual Alabama leather flower genets can grow or how many ramets a given genet may produce. Similarly, no known study has attempted to characterize the number of genets found in an entire population of Alabama leather flower, let alone all populations of the species. In addition, ramets from individual genets grow intermixed with each other (Service 1989), further complicating population estimates using aboveground stem counts. Given these challenges, stem counts/estimates can be considered to represent maximum ramet population sizes, but are likely to overestimate the actual genet population size. (USFWS, 2017)

Population Narrative:

Alabama leather flower's known range has expanded from two Alabama counties (St. Clair and Etowah) at the time of listing (see Service 1986) and completion of the recovery plan (see Service 1989). Currently, the species is known from eight natural populations—six extant, one extirpated, and one uncertain (likely extirpated)—in northeastern Alabama's Cherokee, Etowah, and St. Clair Counties and northwestern Georgia's Floyd County. The species' entire known range spans less than 90 miles (145 kilometers [km]), with individual populations typically separated by 30 or more miles (48 km) from their nearest neighbors. All known populations occur within the Valley and Ridge physiographic province. (USFWS, 2017)

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Habitat for this species has been reduced through development and conversion to agriculture and pine plantations. Logging operations have degraded the habitat at two sites in Alabama (ANHP data, Byrd 2016c). The use of heavy equipment has adversely impacted these sites by creating ruts and promoting erosion, and has destroyed several plants. In addition, soil disturbance has fostered invasion by exotic and weedy species, further reducing habitat integrity and species viability. One population, in Cherokee County, Alabama, has been repeatedly impacted by disking for row-crop agriculture and has recently been extirpated by conversion to a soybean field (Schotz pers. comm. 2014, Byrd 2016c). One subpopulation in St. Clair County, Alabama was damaged by silt fencing installation for road improvement work (Byrd 2016c). Road improvements (e.g., widening, repaving) could jeopardize the continued viability of plants in adjacent rights-of-way if such activities are not conducted in an appropriate manner and coordinated with the Service. Rutting by ATVs and mowing equipment also pose threats to plants in rights-of-way (Emanuel 2000, Byrd 2016c). Development, particularly for residential purposes, has been identified as a significant threat to at-risk species associated with privately owned forested lands (Stein et al. 2010), such as Alabama leather flower. Within the southeastern United States, the urban footprint has been projected to more than double by 2060 compared with 2009 (Terando et al. 2014), thus putting further development pressure on Alabama leather flower and its habitats. Development and associated land use changes on unprotected sites could negatively impact or destroy populations if precautions are not taken. (USFWS, 2017)

Stressor: Small, isolated populations (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: A number of the populations remain vulnerable due to the small number of plants and the limited area they occupy. Three of the populations occupy no more than an acre in area and one of these consists of only 2 plants occupying a 15 m² area (Martin 2008, 2009).

Stressor: Disease or predation (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Disease and predation are not known to threaten Alabama leather flower. Herbivore browsing damage has been observed in Georgia and fencing has been erected to deter herbivores around some plants (von Schmeling pers. comm. 2016). Accounts of such herbivore damage to Alabama leather flower are rare, indicating that this may be a localized rather than widespread phenomenon. One study identified a species of carpenter bee, *Xylocopa virginiana*, exhibiting nectar-robbing behavior on Alabama leather flower (Boyd and Wall 1998, Wall et al. 2003); however, the authors noted that given the apparently low visitation rates of this nectar-robbing bee, its effects on Alabama leather flower reproduction is likely small. It has also been suggested that deer mice (*Peromyscus* sp.) may be seed predators of Alabama leather flower (Timmerman-Erskine and Boyd 1999), which may potentially limit seedling recruitment. However, given the species' clonal nature (i.e., its ability to spread locally without seedling recruitment), it is unlikely that seed predation by deer mice alone presents a substantial threat to Alabama leather flower. Furthermore, as noted by Goertzen et al. (2011), Alabama leather flower's relatively high genetic diversity indicates that sufficient sexual reproduction is occurring within the species, despite low apparent seedling recruitment. (USFWS, 2017)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: No State laws in Alabama protect Alabama leather flower and its habitat. In Georgia, the species is State protected as endangered under the Wildflower Preservation Act of 1973, O.C.G.A. 12-6-170. This law authorizes rules for the collection, transport, sale, and listing of protected plants within the State. In addition, no protected plants may be collected without landowner approval and no transport within the state is allowed without a State-issued permit (Patrick et al. 1995). Otherwise, protections are afforded to this species under sections 7 and 9 of the ESA. Two populations are considered protected from outright habitat destruction or adverse habitat modification due to their protection on a TNC preserve (in Alabama) and on lands set aside as a state Natural Area by the State of Georgia (in Georgia). In Georgia, state-designated Natural Areas are managed by GDNr to conserve natural communities and rare species (GDNr 2017). In addition, part of one population has received some habitat protection and management by the City of Gadsden, Alabama.(USFWS, 2017)

Stressor: Inadequate/Incompatible Habitat Management (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Inadequate management—e.g., lack of mowing, prescribed fire, and/or hand clearing—remains a persistent concern for Alabama leather flower populations. At least one subpopulation in St. Clair County, Alabama has not been relocated, in part, due to growth of encroaching plants (Byrd 2016c), which has obscured plants and/or suppressed their growth. Plants at this site have not been observed since 2009 and it is unknown if they still exist. Three other subpopulations in St. Clair and Cherokee Counties are in need of management activities to reduce competing understory and woody vegetation (Wiggers 2014, Byrd 2016c). (USFWS, 2017)

Stressor: Competition from Encroaching Species (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Alabama leather flower is an apparently poor competitor, as it is most vigorous in open areas with little competing vegetation and open canopies. Indeed, low light levels have been associated with increased flower abortion (Timmerman-Erskine and Boyd 1999). The species also benefits from occasional, limited disturbance (such as periodic mowing or prescribed fire) which reduces encroachment of competing vegetation. However, Alabama leather flower can apparently remain dormant for some time as evidenced by its appearance in openings created in woods that were selectively logged (Service 1989). Even though the increased light initially benefited Alabama leather flower, it also stimulated more aggressive competing vegetation including the exotic Japanese honeysuckle (*Lonicera japonica*). All populations of Alabama leather flower need active management (e.g., thinning overstory trees, mowing, prescribed fire) due to shading and competition from more aggressive vegetation. (USFWS, 2017)

Stressor: Small Population Size and Small Number of Populations (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Attempts to locate additional Alabama leather flower populations since completion of the species' original Recovery Plan in 1989 (e.g., Boyd 1991, Boyd and Hilton 1992, Govus 1999, Ware 1999, Garrett and Schotz 2005) have had some success thus far, with eight natural populations now known for the species. Of these populations six are extant (ANHP data, GNHP data, Byrd 2016c, Byrd pers. comm. 2016a, b, Thompson 2016), one may have been extirpated (Schotz pers. comm. 2014, Byrd 2016c), and one has been extirpated (Schotz pers. comm. 2014). Only three populations are considered to be large (1,000+ stems), while two are of moderate size (400–500 stems) (GNHP data, Wiggers 2014, Byrd 2016c). Alabama leather flower's limited number of extant populations and relatively small local population sizes increase the species' vulnerability to anthropogenic and environmental perturbations. In addition, small population sizes increase the risks posed by inbreeding and genetic drift, which may limit the species' adaptive capacity and ability to cope with future stressors (Ellstrand and Elam 1993). However, the unexpectedly high level of genetic diversity maintained within Alabama leather flower populations studied thus far (Boyd et al. 1998, Goertzen and Boyd 2007, Goertzen et al. 2011), may limit some of the genetic threats posed by the species small number of populations and overall small population size. Attempts to augment existing and establish new populations have been made in Georgia, but these efforts have had limited success (GNHP data, CNC 2010, Hodges pers. comm. 2013, 2014, von Schmeling pers. comm. 2016). As such, the one known established population is not yet considered a viable population for recovery. (USFWS, 2017)

Stressor: Climate Change (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: The precise magnitude and impacts of climate change on the southeastern United States are uncertain, but models have projected that climate change in the region may include increased temperatures of 2 to 4°C (3.6 to 7.2°F) and reduced average annual precipitation by the end of the century (Joyce et al. 2011, Ingram et al. 2013). Specific effects of climate change on populations of Alabama leather flower are poorly understood; however, a variety of effects are possible. Climate change has the potential to affect distribution and abundance of plants by influencing seasonal weather patterns, frequency and timing of severe weather events, and

myriad plant physiological responses (Hawkins et al. 2008). Davenport (2007) suggested that Alabama leather flower may be negatively impacted by climate change within Alabama if available habitat becomes constricted under drier conditions. In addition, climate change may disrupt plant-pollinator interactions via phenological shifts in flowering and/or pollinator activity (Mommott et al. 2007, Hawkins et al. 2008), which may thereby reduce sexual reproduction of Alabama leather flower. Given that only two primary pollinators have been identified for Alabama leather flower, Wall et al. (2003) suggested that such asynchrony between flowering and pollinator activity may be particularly severe for this species. Given the variety and complexity of climate change's potential effects (cf. Hawkins et al. 2008, Walther 2010), more research is needed to assess its potential long-term impacts on Alabama leather flower populations and habitats. (USFWS, 2017)

Recovery

Reclassification Criteria:

When 10 geographically distinct, self-sustaining populations, occupying a minimum of one acre of habitat each, are known and protected from any foreseeable threats. (USFWS, 1989)

Delisting Criteria:

When 20 geographically distinct, self-sustaining populations, occupying a minimum of one acre of habitat each, are known and protected from any foreseeable threats. (USFWS, 1989)

Recovery Actions:

- 1. Protect and manage populations and habitat. The first step in the recovery process is to protect the populations and their habitat. Protection efforts, excluding Section 7 obligations, may include land donations, conservation easements, long-term conservation agreements, land acquisition or other methods. (USFWS, 1989)
- 2. Establish a monitoring program for protected sites. A monitoring program should be established on protected sites in order to track population trends and evaluate effectiveness of recovery efforts. (USFWS, 1989)
- 3. Study ecology and species' biology. An understanding of the ecology and species' biology of the Alabama leather flower is necessary in order to appropriately manage and protect this species. (USFWS, 1989)
- 4. Determine effective management for maintaining or increasing populations. Management needs of the Alabama leather flower are largely unknown; however, this species appears more vigorous in areas of partial or full sunlight with little competition. In order to maintain or expand populations, active management of its habitat, targeted at controlling competing vegetation, will probably be necessary. Management is further necessitated due to the disturbed nature of the present sites. (USFWS, 1989)
- 5. Preserve genetic stock. This species is extremely vulnerable due to such few populations. Protection of the gene pool should be accomplished through seed bank storage and by maintaining material in cultivation. Additionally, this will provide material for research, propagation, and horticultural interests to reduce pressure on wild populations and other recovery activities. Such activities should be conducted under the guidance of the Center for Plant Conservation which sponsors the establishment of garden populations of endangered plants at member botanical gardens. (USFWS, 1989)

- 6. Establish experimental population(s) within historic range. if deemed necessary. *Clematis socialis* is only known from two sites and only one is protected. If after extensive surveys, no new populations are located and secured, it may be necessary to establish additional ones in the wild to decrease this species vulnerability. (USFWS, 1989)
- Recommendations for Future Actions from 2017 5-Year Review: - Work with federal and state entities, non-governmental organizations, and private individuals to permanently protect and manage existing habitats and populations, including the development and implementation of management plans. - Conduct surveys to locate additional populations. - Conduct studies to determine the number and distribution of populations required to maintain the species' genetic diversity. - Conduct studies into the species' life history, biology, habitat, and ecology to inform future population searches, management, and potential population augmentation and (re)establishment efforts. - Investigate efficacy of habitat management techniques (e.g., fire). Update and improve monitoring and habitat management methods. - Develop and implement long-term demographic monitoring to track population trends and evaluate management efforts. - Expand ex situ conservation efforts to include plants from all known extant populations. - Update the species' recovery plan to reflect current knowledge (e.g., distribution, habitats) and needs (e.g., data/knowledge deficiencies, management).

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SPECIES ACCOUNT: *Clermontia drepanomorpha* (ʻOha wai)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Clermontia drepanomorpha, of the bellflower family (Campanulaceae), is a terrestrial oreophytic (not rooted in the soil), branching tree 2.5 to 7 m (8.2 to 23 ft) tall. The stalked leaves are 10 to 27 cm (4 to 11 in) long and 1.5 to 4.5 cm (0.6 to 1.8 in) wide. Two to four flowers, each with a stalk 2 to 3.5 cm (0.8 to 1.4 in) long, are positioned at the end of a main flower stalk 5 to 12 cm (2 to 5 in) long. The calyx (fused sepals) and corolla (fused petals) are similar in size and appearance, and each forms a slightly curved, five-lobed tube 4 to 5.5 cm (1.6 to 2.2 in) long and 1.5 to 2 cm (0.6 to 0.8 in) wide which is blackish purple. The berries are orange and 2 to 3 cm (0.8 to 1.2 in) in diameter. (USFWS, 1998)

Taxonomy

Clermontia drepanomorpha, a member of the bellflower family (Campanulaceae), was described by Joseph Rock (1913) from collections made in the Kohala Mountains in the early 1900s (USFWS 1996, 1998). The species has no known synonyms (Wagner et al. 1999; Lammers 1991), although hybrids between it and another species have been named (see below) (Lammers 1991). Lammers (1991) revised the genus *Clermontia* and treated *Clermontia drepanomorpha*, much as he (the author of the treatment) had in Wagner et al. (1999). Lammers (1995) studied the taxonomy and speciation patterns in *Clermontia* and included *Clermontia drepanomorpha* in Section *Clermontia*, Series *Kakeanae*. Based on cladistic studies, *C. drepanomorpha* was stated to be most closely related to *C. montis-loa* and *C. kohalae* (Lammers 1995). (USFWS, 2012)

Historical Range

Historically, *Clermontia drepanomorpha* was known only from the Kohala Mountains (Hawaii Heritage Program (HHP) 1993a1-1993a4; Rock 1913; Skottsberg 1944; Stemmermann and Jacobson 1987). (USFWS, 1998)

Current Range

Endemic to Kohala Mountains on the island of Hawaii. (NatureServe, 2015)

Critical Habitat Designated

Yes; 5/14/2003.

Legal Description

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Clermontia drepanomorpha* on the island of Hawaii.

Critical Habitat Designation

The critical habitat designation for *Clermontia drepanomorpha* includes one unit totaling 4,709 acres in Hawaii county, Hawaii. The unit is Hawaii 8—*Clermontia drepanomorpha*—a.

Hawaii 8—*Clermontia drepanomorpha*—a [1,906 ha (4,709 ac)]: This unit contains part of the Kohala Mountains, Opaeha summit, Puu O Umi, and Puu Pohoula. The western portion of the unit is in the Honokaa Nui watershed, the eastern portion is in the Waiohale/ Waipio watershed, and the southern portion in the Waikoloa/Waiula watershed. The northern portion contains the upper reaches of the Honopuu, Nakaa, Ohiauea, Waikoloa, and Waimanu watersheds. The unit lies completely within the Kohala Forest Reserve. This unit provides habitat for 6 populations of 300 mature, reproducing individuals of *C. drepanomorpha*; and is currently occupied by about 200 individuals. This unit is essential to the conservation of *C. drepanomorpha* because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. Although we do not believe enough habitat currently exists to reach the recovery goal of 8 to 10 populations for this island-endemic species, this unit is of an appropriate size such that each of the 6 potential recovery populations within the unit is geographically separated to a sufficient extent to be likely to avoid destruction of all of the populations by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Habitat features that are essential for this species include, but are not limited to, montane wet forests dominated by *Metrosideros polymorpha*, *Cheirodendron trigynum*, and *Cibotium glaucum*.

Special Management Considerations or Protections

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for this species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland, bogs (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 915 and 1,676 meters (USFWS, 2012)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 2012)

Habitat Narrative

Adult: Clermontia drepanomorpha grows in montane bogs in montane wet forests (Lammers 1991) between approximately 915 and 1,640 meters (3,002 and 5,381 feet) elevation. However, elevational estimates vary by source (e.g., Wagner et al. 1999 and Lammers 1991; USFWS 2002, 2003). At the time critical habitat was designated (USFWS 2003), the given range was between 1,106 and 1,676 meters [3,627 and 5,495 feet] elevation, which was based on the only known extant population at the time. Native plant species associated with Clermontia drepanomorpha include Carex alligata (no common name), Melicope clusiifolia (alani), Leptecophylla tameiameia (pukiawe), Astelia menziesiana (painiu), Rubus hawaiiensis (akala), Cyanea pilosa (haha), Sphagnum moss (unidentified to species), and species of Coprosma (pilo) (USFWS 1996, 2003; National Tropical Botanical Garden 2011). (USFWS, 2012)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Low (inferred from USFWS, 2012)

Redundancy:

Low (inferred from USFWS, 2012)

Number of Populations:

1 (USFWS, 2012)

Population Size:

~200 (USFWS, 2012)

Population Narrative:

When critical habitat was proposed, C. drepanomorpha was known from a single population comprising approximately 200 individuals (USFWS 2002, USFWS 2003). (USFWS, 2012)

Threats and Stressors

Stressor: Ditch road improvements and herbicide application (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: Threats to Hamakua Ditch Population include proposed ditch road improvements and herbicide application along ditch. Road or ditch modification may have eliminated some individuals along the Alakahī and Kawainui Streams headwaters several years ago (C. Corn, DOFAW, in lift. 1994). (USFWS, 1998; NatureServe, 2015)

Stressor: Rodent predation (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Rodent and slug predation or herbivory – Girdling of stems by rats (*Rattus* sp.) (USFWS 1996, 2003; Hawaii Biodiversity and Mapping Program 2010) remains a threat. (USFWS, 2012)

Stressor: Climate change (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2012)

Stressor: Small population size (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Low numbers – increased likelihood of stochastic extinction due to changes in demography, the environment, genetics, or other factors (USFWS 1996, 2003; Hawaii Biodiversity and Mapping Program 2010). (USFWS, 2012)

Stressor: Invasive plant species (USFWS, 1998; USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Established invasive plant species competition (USFWS 1996, 2003; Hawaii Biodiversity and Mapping Program 2010) including *Axonopus fissifolius* (common carpetgrass), *Juncus* spp. (no common name), *Polygonum punctatum* (dotted smartweed), *Setaria palmifolia* (palmgrass), and *Rubus rosifolius* (thimbleberry). (USFWS, 1998; USFWS, 2012)

Stressor: Over-collection (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Over-collection by collectors and researchers (N. Agorastos, pers. comm. 2011) is a possible threat. (USFWS, 2012)

Stressor: Habitat degradation by ungulates (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Ungulate degradation of habitat: disturbance by feral pigs (*Sus scrofa*) (USFWS 1996, 2003; Hawaii Biodiversity and Mapping Program 2010; National Tropical Botanical Garden 2011) and habitat degradation by cattle (*Bos taurus*) (N. Agorastos, pers. comm. 2011) are a continual threat. (USFWS, 2012)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on the Big Island and at least one other island where it now occurs or occurred historically, if it is not endemic to the Big Island. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on the Big Island and at least 1 other island where they now occur or occurred historically, if it is not endemic to the Big Island. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1998)

Recovery Actions:

- Construct fenced exclosures on State lands in the Kohala Mountains around the known populations, and initiate removal of feral ungulates and weeds from its habitat. (USFWS, 1998)
- Steps should be taken to control rats within and surrounding the exclosures. This should include the use of the currently approved Diphacinone bait blocks and ultimately amore broad-scale method such as aerial dispersal of rodenticide. (USFWS, 1998)

Conservation Measures and Best Management Practices:

- Collect cuttings or seed from tagged individuals, keeping close track of the maternal source for use in ex situ propagation. Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation and storage. (USFWS, 2012)
- Continue to reintroduce the species back into its known historical range. (USFWS, 2012)
- Maximize the genetic variation among individuals at each reintroduction site, based on microsatellite data and detailed information from crossing records. (USFWS, 2012)
- While surveying for new populations or reintroduced populations, determine which sites are least invaded by invasive introduced plant species and which appear to have the highest likelihood of maintaining new reintroductions. (USFWS, 2012)
- Construct ungulate-proof fenced enclosures around each population and monitor the fences for any signs of breaching. (USFWS, 2012)
- Protect all populations against disturbances from feral ungulates. (USFWS, 2012)
- Control invasive introduced plant species around all populations. (USFWS, 2012)
- Implement effective control methods for rodents. (USFWS, 2012)
- Develop and implement control methods for slugs. (USFWS, 2012)
- Monitor newly established reintroduced and wild populations for evidence of plant disease and insect predation. If threats are found implement effective control methods. (USFWS, 2012)
- Develop and implement effective measures to reduce the impact of collecting, drought, and hiking and trail maintenance. (USFWS, 2012)
- The historical range of the species should be resurveyed intensively, preferably in July, which coincides with the greatest number of historical records of the species being in flower. Determine if previously unknown populations exist and whether the species has reappeared at localities where it formerly was believed to have been extirpated. (USFWS, 2012)
- Study the reproductive biology of the species in the field to determine which (presumably) bird species pollinate the plant, and what species likely are involved with fruit dispersal. (USFWS, 2012)
- Tag and sample at least 50 individuals in the single extant population and carry out genetic studies using microsatellites or other appropriate genetic markers to determine the genetic variation within the population. Based on the results of microsatellite (or other appropriate genetic markers), consult with a population geneticist to devise a crossing plan that will maximize the amount of genetic variation in the progeny. (USFWS, 2012)
- Work with Hawaii Division of Forestry and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2012)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2012)

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SPECIES ACCOUNT: *Clermontia lindseyana* (‘Oha wai)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/04/1994; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Clermontia lindseyana Rock is a small, branched tree that grows 8.2 to 20 ft (2.56 m) tall (Lammers 1990). A perennial, the taxon is either terrestrial or epiphytic, living on the surface of other plants. Oblance-shaped leaves are 5-9 in (13-24 cm) long and 1.5-2.6 in (3.8-6.5 cm) wide. The upper surface is dark green while the lower is pale green or purplish and hairy. Leaf stalks are 12.8 in (2.5-7 cm) long and hairy. Two flowers arise from the tip of the main flower stalk which is 1-6 in (2.5-4 cm) long. The spreading sepals and petals are similar in shape, texture and size, 2.2-2.6 in (5.5-6.5 cm) long and 0.35-0.7 in (0.9-1.8 cm) wide, green or purplish on the outside and whitish on the inside. They are fused at the base into a hemispherical or ob-oval tube, which is 0.470.79 in (1.2-2 cm) long and 0.39-0.87in (1-2.2 cm) wide. Berries are 1-1.6 in (2.5-4cm) wide, almost round, and orange. (USFWS, 1996)

Taxonomy

In 1957, J.F. Rock made this taxon a variety of *Clermontia hawaiiensis* and named it *Clermontia hawaiiensis* (Hillebr.) Rock var. *grandis* Rock, based on incomplete specimens collected on the Big Island in the 1950s. Rock (1962) recounted that, at the time, he was unable to study the specimens at length, as he was preparing for a trip to Europe. After review, Rock renamed the taxon *Clermontia lindseyana*, in honor of Thomas Lindsey and his wife who first found it. At this time, he also described variety *livida* Rock. St. John (1987a) described the two new species *Clermontia albimontis* St. John and *C. viridis* St. John. However, Lammers (1990, 1991) concluded that these two species were within the range of *C. lindseyana*. Lammers recognized no subspecific taxa. (USFWS, 1996)

Historical Range

Historically *Clermontia lindseyana* was known on Maui from the southern slope of Haleakala and the eastern portion of the island. (USFWS, 1996)

Current Range

Current range: East Maui and Hawaii. (USFWS, 1996)

Critical Habitat Designated

Yes; 5/14/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Clermontia lindseyana* (‘Oha wai) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Hawaii (81 FR 17790-18110).

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Clermontia lindseyana* on the island of Hawaii (68 FR 39623 - 39722).

On May 14, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, for *Clermontia lindseyana* on the island of Maui, Hawaii.

Critical Habitat Designation

The critical habitat designation for *Clermontia lindseyana* includes one CHU in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Montane Mesic—Unit 1 (and) *Palmeria dolei*—Unit 18—Montane Mesic (and) *Pseudonestor xanthophrys*—Unit 18— Montane Mesic This area consists of 6,593 ac (2,668 ha) of State land, 707 ac (286 ha) of privately owned land, and 3,672 ac (1,486 ha) of federally owned land (Haleakala National Park), from Kealahou to Puualae, nearly circumscribing the summit of Haleakala on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Asplenium dielirectum*, *A. peruvianum* var. *insulare*, *Clermontia lindseyana*, *Cyanea horrida*, *C. obtusa*, *Cyrtandra ferripilosa*, *C. oxybapha*, *Diplazium molokaiense*, *Geranium arboreum*, *G. multiflorum*, *Huperzia mannii*, *Melicope adscendens*, and *Neraudia sericea*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 1 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Cyanea glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. mceldowneyi*, *Phyllostegia bracteata*, *P. mannii*, *Santalum haleakalae* var. *lanaiense*, *Wikstroemia villosa*, or *Zanthoxylum hawaiiense*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat designation for *Clermontia lindseyana* includes three critical habitat units totaling 10,459 acres in Hawaii county, Hawaii. The units are Hawaii 1—*Clermontia lindseyana*—a, Hawaii 2—*Clermontia lindseyana*—b, Hawaii 30—*Clermontia lindseyana*—c.

Hawaii 1—*Clermontia lindseyana*—a [1,377 ha (3,303 ac)]: This unit contains the upper portions of the Awehi, Hakalau, Honolili, and Kapue streams, and is in the Honolii, Kapue, Kolekole, and Wailuku watersheds. The unit, which lies completely within the Hakalau Unit of Hakalau Forest NWR; and provides habitat for 2 populations of 300 individuals of *C. lindseyana*; and is currently occupied by about 8 individuals. This unit provides the easternmost critical habitat within the species' historical range.

Hawaii 2—*Clermontia lindseyana*—b [1,262 ha (3,119 ac)]: This unit contains a portion of Nauhi Gulch, and the northern portion is in the Haakoa watershed, the southern portion in Umauma watershed, and the central portion in Waikaumalo watershed. The northern and southern portions of this unit lie partly in the Hakalau Forest NWR, and the central portion lies in the Hilo Forest Reserve. The unit provides habitat for 2 populations of 300 individuals of *C. lindseyana* and is currently occupied by 5 individuals.

Hawaii 30—*Clermontia lindseyana*— c [1,634 ha (4,037 ac)]: This unit, which contains no named natural features, lies just northeast of Puu Kipu. The northern portion of this unit lies in the Wailoa watershed and the southern portion is in the Kaahakini watershed. This unit is mostly within Olaa-Kilauea Partnership lands with a small portion of the northeast section lying in the upper Waiakea Forest Reserve. The unit provides habitat for 4 populations of 300 individuals of *C. lindseyana* and is currently occupied by 9 individuals. This unit provides the southernmost critical habitat within the species' historical range.

The critical habitat designation for *Clermontia lindseyana* includes two units totaling 587 acres on the island of Maui. The units are Maui 9—*Clermontia lindseyana*—a, b.

Maui 9—*Clermontia lindseyana*—a [177 ha (438 ac)]: This unit is critical habitat for *Clermontia lindseyana* and is 177 ha (438 ac) on State-owned land. The unit contains Manawainui Gulch. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *C. lindseyana* and is currently occupied by 330 plants. The habitat features contained in this unit that are essential for this species include, but are not limited to, *Acacia koa* mesic forest. This unit is essential to the conservation of the species because it supports an extant colony of this species. It is some distance away from the other critical habitat for this species, in order to avoid all populations important for the conservation of the species on the island from being destroyed by one naturally occurring catastrophic event.

Maui 9—*Clermontia lindseyana*—b [60 ha (149 ac)]: This unit is critical habitat for *Clermontia lindseyana* and is 60 ha (149 ac) on State-owned land (Kula Forest Reserve). The unit contains no named natural features. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *C. lindseyana* and is currently unoccupied. The habitat features contained in this unit that are essential for this species include, but are not limited to, *Acacia koa* mesic forest. This unit is essential to conservation of the species because it provides for one population within this multi-island species' historical range on Maui that is some distance away from the other critical habitat for this species, in order to avoid all populations important for the conservation of the species on the island from being destroyed by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Clermontia lindseyana* critical habitat consists of one component. Montane mesic (east Maui) (81 FR 17790-18110):

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: *Acacia*, *Ilex*, *Metrosideros*, *Myrsine*, *Nestegis*, *Nothocestrum*, *Pisonia*, *Pittosporum*, *Psychotria*, *Sophora*, *Zanthoxylum*. Subcanopy: *Alyxia*, *Charpentiera*, *Coprosma*, *Dodonaea*, *Kadua*, *Labordia*, *Leptecophylla*, *Phyllostegia*, *Vaccinium*. Understory: Ferns, *Carex*, *Peperomia*.

Features that are essential for this species include, but are not limited to, slightly open forest cover in wet and mesic *Metrosideros polymorpha*-*Acacia koa* forest, *M. polymorpha* forest, and mixed montane mesic *M. polymorpha*-*Acacia koa* forest.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed

plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkiei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for these species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Breeding Season

Adult: February to August (USFWS, 1996)

Reproduction Narrative

Adult: This species was observed in fruit from June to October, and in flower from February to August (HHP 1991a2, a3, a10). (USFWS, 1996)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Habitat Narrative

Adult: This species is found growing on the ground or on trees in wet and moist forests. The extant populations grow in mesic forest on the leeward slopes. On the Big Island, the habitat is montane mesic forest dominated by *Acacia koa* A. Gray (Fabaceae) (koa), and *Metrosideros polymorpha* Gaud. (Myrtaceae) (ohia), (Gagne and Cuddihy 1990, Lammers 1990, Lammers 1991, HHP 1991a1-a13, NTBG 1991a). Associated native taxa include the following native trees and shrubs: *Itex anomala* Hook. & Arnott (Aquifoliaceae), *Coprosma* J.R. Forster & G. Forster (Rubiaceae) (pilo), and *Myrsine* L. (Myrsinaceae) (kolea) (HHP 1991a2, 1991a5; NTBG 1991a; FernDuvall, Hawaii Division of Forestry and Wildlife, Maui District, pers. comm., 1992). (USFWS, 1996)

Dispersal/Migration***Population Information and Trends*****Population Trends:**

Not available.

Resiliency:

Low (inferred from USFWS, 2015)

Redundancy:

Low (inferred from USFWS, 2015)

Number of Populations:

4 or more (USFWS, 2010)

Population Size:

124 wild, 2,000 reintroduced (USFWS, 2015)

Population Narrative:

Because many current observations are not available it is difficult to estimate the number of extant populations or individuals. However, it seems likely that there are at least four or more populations remaining on Hawaii and Maui, and between 400 and 500 individuals total. Overall,

the numbers of individuals have decreased from the 400 to 500 individuals reported in the previous 5-year review, to approximately 124 wild individuals in 2015. This large decrease in the numbers of wild individuals is related to the lack of current information for four populations on Hawaii Island. Meanwhile, more than 2,000 individuals were reintroduced to Kipahoe Natural Area Reserve, Hawaii Volcanoes National Park and their Kahuku Unit, and Laupahoehoe Natural Area Reserve. (USFWS, 2010; USFWS, 2015)

Threats and Stressors

Stressor: Trampling and grazing by ungulates (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: The threats to *Clermontia lindseyana* include trampling and grazing by cattle (*Bos taurus*), trampling and browsing by goats (*Capra hircus*), and trampling and rooting by pigs (*Sus scrofa*) (Hawaii Biodiversity and Mapping Program 2009; National Tropical Botanical Garden 2008; Perlman 2009; USFWS 2003a, b). (USFWS, 2010)

Stressor: Invasive introduced plants (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Competition with the invasive introduced plant species *Pennisetum clandestinum* (Kikuyu grass) in Kulani, and *Ulex europaeus* (gorse) and *Juncus effusus* (Japanese mat rush) in Hakalau Forest Reserve are serious threats. Other introduced invasive plant species are *Rubus argutus* (prickly Florida blackberry), *Passiflora tarminiana* (banana poka), *Tibouchina herbacea* (glory bush), and *Ilex aquifolium* (English holly) (Maxfield 1998; Wood 2009). (USFWS, 2010)

Stressor: Predation by rats and slugs (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Consumption of berries, flowers, bark, and vegetation by black rats (*Rattus rattus*) is a threat to *Clermontia lindseyana* (Hawaii Biodiversity and Mapping Program 2009; USFWS 2003a, b). Predation by unidentified species of slugs (Perlman 2009) is also noted. (USFWS, 2010)

Stressor: Loss of pollinators and transport vectors (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Another threat factor is the loss of pollinators and loss of transport vectors for seed, and limited outcrossing due to both the scarcity and distances in distribution (K. Bio, pers. comm. 2009). (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to *Clermontia lindseyana*. However, current climate change models do not allow us to predict specifically what those effects, and their extent, would be for this species. (USFWS, 2010)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on the Big Island and at least one other island where it now occurs or occurred historically, if it is not endemic to the Big Island. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1996)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1996)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on the Big Island and at least 1 other island where they now occur or occurred historically, if it is not endemic to the Big Island. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 individuals per population for short-lived perennials. (USFWS, 1996)
3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1996)

Recovery Actions:

- Current populations of this species should be protected from ungulates wherever possible, and their habitat managed for deterrence of non-native plant invasions. (USFWS, 1996)

Conservation Measures and Best Management Practices:

- Survey geographical and historical range for a current assessment of the species' status. (USFWS, 2015)
- Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. (USFWS, 2015)
- Maintain existing fences and fence remaining populations to protect them from the impacts of feral ungulates. (USFWS, 2015)
- Eradicate invasive introduced plants within ungulate exclosures and maintain exclosures free of invasive plants. (USFWS, 2015)
- Control slugs (unidentified species) and rodents within the vicinity of all known *C. lindseyana* populations. (USFWS, 2015)

- Continue monitoring wild and reintroduced individuals. (USFWS, 2015)
- Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2015)
- Protect all occurrences against trampling, browsing, and disturbances from feral ungulates. (USFWS, 2010)
- Develop and implement methods of rat control for all populations. (USFWS, 2010)
- Monitor for slug depredation, and develop and implement control methods as needed. (USFWS, 2010)
- Weed all exclosures to inhibit invasive alien competitor plant species. (USFWS, 2010)
- Survey formerly identified locations for current status of populations, especially on Maui. (USFWS, 2010)
- Work with Hawaii Division of Forestry and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2010)

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

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SPECIES ACCOUNT: *Clermontia oblongifolia* ssp. *brevipes* (‘Oha wai)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/08/1992; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Clermontia oblongifolia ssp. *brevipes*, a member of the bellflower family, is a shrub or tree, which reaches a height of 2 to 7 m (6.6 to 23 ft). The leaves, on petioles (leafstalks) 1.8 to 3 cm (0.7 to 1.2 in) long, are lance-shaped; have thickened, rounded teeth; and reach a length of 7 to 11 cm (2.8 to 4.3 in) and a width of 2 to 5 cm (0.8 to 2 in). Two or sometimes three flowers are grouped together on a stalk 5 to 10 mm (0.2 to 0.4 in) long, each flower having a stalk 1 to 4.5 cm (0.4 to 1.8 in) long. The flower is 6 to 7.8 cm (2.4 to 3.1 in) long; the calyx (fused sepals) and corolla (fused petals) are similar in size and appearance, and each forms an arched tube, which is greenish-white or purplish on the outside and white or cream colored on the inside. The nearly spherical, orange fruit is a berry, 17 to 30 mm (0.7 to 1.2 in) long. (USFWS, 1998)

Taxonomy

Franz Elfried Wimmer (1943) described *Clermontia oblongifolia* f. *brevipes* based upon a specimen collected by Forbes on Molokai in 1912. The name of the form refers to the plant's short leaves, leaf stalks, and flower stalks. Lammers (1988) raised this taxon to the subspecific level when he published the new combination *C. oblongifolia* ssp. *brevipes*. (USFWS, 1998)

Historical Range

Historically no additional range. (NatureServe, 2015)

Current Range

Its current range is in Molokai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/18/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Clermontia oblongifolia* ssp. *brevipes* (‘Oha wai) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes ten detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Clermontia oblongifolia* ssp. *brevipes* includes ten CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Molokai—Lowland Mesic—Unit 1 (and) Palmeria dolei—Unit 37—Lowland Mesic (and) Pseudonestor xanthophrys—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waiianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Ctenitis squamigera*, *Cyanea dunbariae*, *C. mannii*, *C. profuga*, *Cyperus fauriei*, *Cyrtandra filipes*, *Gouania hillebrandii*, *Labordia triflora*, *Neraudia sericea*, *Santalum haleakalae* var. *lanaiense*, *Schiedea*

lydgatei, *S. sarmentosa*, *Silene alexandri*, *S. lanceolata*, *Spermolepis hawaiiensis*, and *Zanthoxylum hawaiiense*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Lowland Mesic—Unit 1 is not known to be occupied by *Asplenium dielirectum*, *Bonamia menziesii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea procera*, *C. solanacea*, *Diplazium molokaiense*, *Festuca molokaiensis*, *Flueggea neowawraea*, *Isodendron pyriformis*, *Kadua laxiflora*, *Melicope mucronulata*, *M. munroi*, *M. reflexa*, *Phyllostegia haliakalae*, *P. mannii*, *P. pilosa*, *Sesbania tomentosa*, *Stenogyne bifida*, or *Vigna o-wahuensis*, or the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 1 (and) *Palmeria dolei*—Unit 38—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 38—Lowland Wet This area consists of 2,195 ac (888 ha) of State land, and 754 ac (305 ha) of privately owned land (partly within The Nature Conservancy's Pelekunu Preserve), from Pelekunu Valley to Wailau Valley, in north-central Molokai. These units are occupied by the plant *Cyrtandra filipes*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Lowland Wet—Unit 1 is not known to be occupied by *Asplenium dielirectum*, *Bidens wiebkii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Lysimachia maxima*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 2 (and) *Palmeria dolei*—Unit 39—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 39—Lowland Wet This area consists of 1,356 ac (549 ha) of State land and 594 ac (241 ha) of privately owned land, from Kahanui to Pelekunu Valley, in north-central Molokai. These units are occupied by the plant *Lysimachia maxima*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Lowland Wet—Unit 2 is not known to be occupied by *Asplenium dielirectum*, *Bidens wiebkii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Cyrtandra filipes*, *Melicope*

reflexa, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 3 consists of 94 ac (38 ha) of State land, and 3,125 ac (1,265 ha) of privately owned land, from Waiahookalo gulch to Moaula stream and Puniuohua, on eastern Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Molokai—Lowland Wet—Unit 3 is not known to be occupied by *Asplenium dielerectum*, *Bidens wiebkei*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Cyrtandra filipes*, *Lysimachia maxima*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 1 (and) *Palmeria dolei*—Unit 40—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 40— Montane Wet This area consists of 1,545 ac (625 ha) of State land, and 1,851 ac (749 ha) of privately owned land, from the headwaters of Waialelia Stream and above Pelekunu Valley, eastward along the summit area to Mapulehu, in northcentral Molokai. These units are occupied by the plants *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. profuga*, *Phyllostegia hispida*, and *Pteris lidgatei*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Montane Wet—Unit 1 is not known to be occupied by *Adenophorus periens*, *Cyanea procera*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Melicope reflexa*, *Phyllostegia mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 41—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 41— Montane Wet This area consists of 871 ac (353 ha) of State land, and 39 ac (16 ha) of privately owned land, from Honukaupu to Olokui (between Pelekunu and Wailau valleys), in north-central Molokai. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species

identified as physical or biological features in the montane wet ecosystem (see Table 5). Although Molokai—Montane Wet—Unit 2 is not known to be occupied by *Adenophorus periens*, *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. procera*, *C. profuga*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Melicope reflexa*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Pteris lidgatei*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 3 consists of 77 ac (31 ha) of State land, and 726 ac (294 ha) of privately owned land, above the east rim of Wailau Valley on eastern Molokai. This unit is occupied by the plant *Melicope reflexa*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Montane Wet—Unit 3 is not known to be occupied by *Adenophorus periens*, *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. procera*, *C. profuga*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Pteris lidgatei*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Wet Cliff—Unit 1 (and) *Palmeria dolei*—Unit 43—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 43—Wet Cliff This area consists of 1,395 ac (565 ha) of State land, and 212 ac (86 ha) of privately owned land, and encircles the plateau between Pelekunu and Wailau valleys, in north-central Molokai. These units are occupied by the plants *Brighamia rockii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea munroi*, and *Hibiscus arnottianus* ssp. *immaculatus*, and include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Wet Cliff—Unit 1 is not known to be occupied by *Cyanea grimesiana* ssp. *grimesiana*, *Hesperomannia arborescens*, *Phyllostegia hispida*, *Pteris lidgatei*, or *Stenogyne bifida*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Wet Cliff—Unit 2 (and) *Palmeria dolei*—Unit 44—Wet Cliff (and) *Pseudonestor xanthophrys*—Unit 44— Wet Cliff This area consists of 462 ac (187 ha) of State land, and 806 ac (326 ha) of privately owned land (partly within The Nature Conservancy's Pelekunu Preserve), along the rim of Pelekunu Valley from Kipapa Ridge to Mapulehu, in central Molokai. These units are occupied by the plants *Clermontia oblongifolia* ssp. *brevipes* and *Phyllostegia hispida*, and include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Wet Cliff—Unit 2 is not known to be occupied by *Brighamia rockii*, *Canavalia molokaiensis*, *Cyanea grimesiana* ssp. *grimesiana*, *C. munroi*, *Hesperomannia arborescens*, *Hibiscus arnottianus* ssp. *immaculatus*, *Pteris lidgatei*, or *Stenogyne bifida*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Wet Cliff—Unit 3 consists of 1,137 ac (460 ha) of State land, and 225 ac (91 ha) of privately owned land, along the rim of Wailau Valley from Mapulehu to Kahiwa Gulch, in eastern Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Molokai—Wet Cliff—Unit 3 is not known to be occupied by *Brighamia rockii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea grimesiana* ssp. *grimesiana*, *C. munroi*, *Hesperomannia arborescens*, *Hibiscus arnottianus* ssp. *immaculatus*, *Phyllostegia hispida*, *Pteris lidgatei*, or *Stenogyne bifida*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Clermontia oblongifolia* ssp. *brevipes* critical habitat consists of four components. Lowland mesic (Molokai), Lowland wet (Molokai), Montane wet (Molokai) and Wet cliff (Molokai) (81 FR 17790-18110):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*,

Metrosideros, Myrsine, Pisonia, Psychotria. Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: Acacia, Charpentiera, Cheirodendron, Metrosideros. Subcanopy: Broussaisia, Cibotium, Eurya, Ilex, Myrsine. Understory: Ferns, Carex, Coprosma, Leptecophylla, Oreobolus, Rhynchospora, Vaccinium.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: Broussaisia, Cheirodendron, Leptecophylla, Metrosideros. Understory: Bryophytes, Ferns, Coprosma, Dubautia, Kadua, Peperomia.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's

tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylothea* ssp. *pentamera*, *B. campylothea* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (outcrossing) (USFWS, 2011)

Dependency on Other Individuals or Species

Adult: Pollination by birds (USFWS, 2011)

Reproduction Narrative

Adult: Clermontia flowers are protandrous (male parts maturing first), which indicates that they are primarily outcrossing between plants, although they may occasionally self-pollinate. Clermontia species are believed to have been pollinated by passerine birds (honeycreepers and honeyeaters). (USFWS, 2011)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 1,100 and 1,200 meters (USFWS, 1998)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1998)

Habitat Narrative

Adult: Growing on the ground in wet forests. This taxon typically grows in shallow soil on gulch slopes in wet ohia dominated forests at elevations between 1,100 and 1,200 meters (3,500 and 3,900 feet) (USFWS 1992). Associated plant species include Cheirodendron trigynum (olapa) (USFWS 1992). (USFWS, 1998; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: The seeds of Clermontia species are also believed to be spread by birds. (USFWS, 2011)

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2011)

Redundancy:

Very low (inferred from USFWS, 2011)

Number of Populations:

3 wild populations (USFWS, 2018)

Population Size:

90 wild individuals, 50 outplanted individuals (USFWS, 2018)

Population Narrative:

Currently, *C. oblongifolia* subsp. *brevipes* is found in a single population of 10 individuals on Uapa Ridge, East Molokai (A. Bakutis, Plant Extinction Prevention Program, pers. comm. 2009; Perlman 2009; Plant Extinction Prevention Program 2009). (USFWS, 2011); In 2011, *Clermontia oblongifolia* subsp. *brevipes* was known from one population of 11 individuals on Uapa ridge (Kapulei-Kamakou summit), with a possible second occurrence of an unknown number of individuals in an area nearby. Currently at Uapa ridge (Kapulei-Kamakou summit, above Kamalō) there are about nine plants (PEPP 2017). Further surveys of the nearby area, Kaholo a Pele, found 30 individuals (PEPP 2010, 2013, 2015). In addition, one more population of 50 individuals was discovered at Oloku'i (PEPP 2017). In summary, there are three wild populations totaling approximately 90 individuals. (USFWS, 2018)

Threats and Stressors

Stressor: Habitat degradation by pigs and goats (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Feral pigs (*Sus scrofa*) and goats are a threat to the habitat of *Clermontia oblongifolia* subsp. *brevipes*. (USFWS, 2011)

Stressor: Small population size (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: In addition to all of the other threats, species like *Clermontia oblongifolia* subsp. *brevipes* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding, and disease outbreaks. (USFWS, 2011)

Stressor: Predation (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Predation on the fruit or plant parts of *Clermontia oblongifolia* subsp. *brevipes* by feral pigs, goats, rats (*Rattus* spp.), and slugs (unidentified species) are threats (Perlman 2009; USFWS 1996). (USFWS, 2011)

Stressor: Climate change (USFWS, 2011; USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to this species (Listing Factors A and E). However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative

(PICCC) has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2011) The assessment by Fortini et al. (2013) was conducted for *Clermontia oblongifolia* at the species level, and concluded that this species is vulnerable to the impacts of climate change, with a vulnerability score of 0.329 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). (USFWS, 2018)

Stressor: Invasive plants (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: *Melinis minutiflora* (molasses grass) and other invasive introduced plant species also modify the habitat and compete with *C. oblongifolia* subsp. *brevipes* (Perlman 2009; Wood 2009). (USFWS, 2011)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Molokai and at least one other island where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Molokai and at least 1 other island where they now occur or occurred historically. (USFWS, 1998)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)
3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1998)

Recovery Actions:

- These actions include propagation and maintenance of genetic stock ex situ, and protection of remaining wild individuals from threats. (USFWS, 1998)
- Secondly, the plan proposes the delineation of management units to conserve not only these taxa, but their habitats as well. (USFWS, 1998)
- The next step in the recovery of these species is augmentation of small populations and re-establishment of new populations within the historical range of the species. (USFWS, 1998)

- A research program is also recommended to study the growth and reproductive viability of each taxon, determine the parameters of viable populations of each taxon, study the reproductive strategy and pollinators of each taxon, and study possible pests and diseases. (USFWS, 1998)
- Surveys and inventories—Continue to survey for additional populations and monitor known populations of *Clermontia oblongifolia* subsp. *brevipes* in areas of potentially suitable habitat. (USFWS, 1998)
- Ungulate monitoring and control—Construct and maintain fenced exclosures to protect individuals from the negative impacts of feral ungulates. Protect all occurrences against browsing and habitat disturbances from feral ungulates to prevent imminent extinction. (USFWS, 2018)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. Control invasive nonnative species that compete with the species around all populations. (USFWS, 2018)
- Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock. (USFWS, 2018)
- Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this subspecies. (USFWS, 2018)
- Predator and herbivore monitoring and control—Implement effective control methods for rodents and slugs in the vicinity of all populations. (USFWS, 2018)
- Alliance and partnership development—Continue to work with partners in planning and implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2018)
- Climate change adaptation strategy—Assess the modeled effects of climate change on this subspecies, and determine future landscape needed for the recovery of the subspecies. (USFWS, 2018)

Conservation Measures and Best Management Practices:

- Continue monitoring existing populations. (USFWS, 2011)
- Conduct surveys to determine the current status of the species. (USFWS, 2011)
- Collect seeds from each population for genetic storage and potentially for reintroduction. (USFWS, 2011)
- Fence all populations to provide protection from the negative impacts of feral ungulates. (USFWS, 2011)
- Control rats in the vicinity of all populations. (USFWS, 2011)
- Control invasive introduced plant species around all individuals. (USFWS, 2011)
- Develop and implement an effective control method for slugs. (USFWS, 2011)
- Propagate to augment the existing population. (USFWS, 2011)
- Establish additional populations within protected suitable habitat. (USFWS, 2011)
- Work with Hawaii Division of Forestry and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2011)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2011)

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SPECIES ACCOUNT: *Clermontia oblongifolia* ssp. *mauiensis* (‘Oha wai)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/15/1992; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Clermontia oblongifolia ssp. *mauiensis* is a shrub or tree in the bellflower family (Campanulaceae) 2-7 m (7-23 ft) tall with oblong to lance-shaped leaves (7-19 x 2-5 cm on leaf stalks (petioles) about 2-11 cm (0.8-4.3 in) long. The upper leaf surface is smooth and glossy dark green; the lower leaf surface is whitish green and maybe smooth or downy. The edges of the leaves have small, thickened, rounded teeth. Inflorescences occur on stalks 55 mm (0.2-1.8 in) long, bearing two or three flowers, each on an individual stalk 10-45 mm (0.4-1.8 in) long. The curved, smooth, tubular flowers are greenish-white or purplish on the outside and white or cream within, approximately 6-8 cm (2.4-3.2 in) long and 1-1.3 cm (0.4-0.5 in) wide with a near-hemispherical base. The lobes, except the top one, are erect or slightly spreading, and as long as the tube. Its berries are orange and nearly spherical, 17-30 mm (0.7-1.2 in) long. (USFWS, 1997)

Taxonomy

A recent review of the genus (Lammers in Wagner et al. 1990) recognized three subspecies of *Clermontia oblongifolia*. Of the three, only the ssp. *oblongifolia*, which is restricted to Oahu, is relatively common (Lammers in Wagner et al. 1990). Degener (1937) stated that the ssp. *oblongifolia* is one of the most common *Clermontia* species in the Koolau Mountains of Oahu, especially above Honolulu. The ssp. *brevipes* (F. Wimmer) Lammers, which is restricted to Molokai, was last collected more than 30 years ago and only twice in the past 60 years. The ssp. *mauiensis* (Rock) Lammers historically occurred on Lanai and Maui but is now apparently extirpated from Lanai. DNA analysis of these specimens and material from the West Maui *Clermontia oblongifolia* ssp. *mauiensis* indicates that *Clermontia oblongifolia* and its subspecies maybe hybrids of *Clermontia arborescens* and *Clermontia kakeana* (R. Palmer, personal communication 1997). (USFWS, 1997)

Historical Range

Historically, *Clermontia oblongifolia* ssp. *mauiensis* is known from Lanai and Maui (Lammers in Wagner et al. 1990). (USFWS, 1997)

Current Range

This subspecies is endemic to Maui and Lanai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 5/14/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Clermontia oblongifolia* ssp. *mauiensis* (‘Oha wai) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes seven detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Clermontia oblongifolia* ssp. *mauiensis* includes seven CHUs in Maui County, Hawaii with detailed unit information. There are also an unknown number of units on Lanai that contain this species (number of units is unknown because detailed unit descriptions for Lanai are not available) (81 FR 17790-18110).

Maui—Lowland Wet—Unit 1 (and) *Palmeria dolei*—Unit 2—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 2—Lowland Wet This area consists of 6,616 ac (2,677 ha) of State land, 7,425 ac (3,005 ha) of privately owned land, and 2,038 ac (825 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Kipahulu Valley on the northern and eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia samuelii*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *M. ovalis*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 1 is not known to be occupied by the plants *Clermontia oblongifolia* ssp. *mauiensis*, *C. peleana*, *Mucuna sloanei* var. *persericea*, *Phyllostegia haliakalae*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 2 (and) *Palmeria dolei*—Unit 3—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 3—Lowland Wet (and) *Newcombia cumingi*—Unit 1—Lowland Wet This area consists of 65 ac (26 ha) of State land at Moomoku, on the northwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. Although Maui—Lowland Wet—Unit 2 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendrion pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), or by the Newcomb's tree snail (*Newcombia cumingi*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 3 (and) *Palmeria dolei*—Unit 4—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 4—Lowland Wet This area consists of 1,247 ac (505 ha) of State land at

Honanana Gulch on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants *Bidens conjuncta*, *Cyanea asplenifolia*, and *Pteris lidgatei*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 3 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 5 (and) *Palmeria dolei*—Unit 6—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 6— Lowland Wet This area consists of 30 ac (12 ha) of State land at Iao Valley on the eastern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 5 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 8 (and) *Palmeria dolei*—Unit 9—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 9— Lowland Wet This area consists of 230 ac (93 ha) of State land at upper Ukumehame Gulch, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 8 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or

Wikstroemia villosa, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 1 (and) *Palmeria dolei*—Unit 10—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 10— Montane Wet This area consists of 1,313 ac (531 ha) of State land and 798 ac (323 ha) of privately owned land, at Haiku Uka on the northern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Cyanea duvalliorum*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *Phyllostegia pilosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 1 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 5 (and) *Palmeria dolei*—Unit 14—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 14— Montane Wet This area consists of 222 ac (90 ha) of State land, and 165 ac (67 ha) of federally owned land (Haleakala National Park), near Kaumakani on the eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units area occupied by the plant *Bidens campylotheca* ssp. *pentamera*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 5 is not currently occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small

numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Clermontia oblongifolia* ssp. *mauiensis* critical habitat consists of three components. Lowland mesic (Lanai and Molokai), Lowland wet (east Maui, west Maui and Lanai), Montane wet (east Maui) (81 FR 17790-18110):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*,

Schiedea jacobii, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkii*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*,

Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (outcrossing) (USFWS, 2011)

Dependency on Other Individuals or Species

Adult: Clermontia species are believed to have been pollinated by passerine birds (honeycreepers and honeyeaters). (USFWS, 2011)

Breeding Season

Adult: November to July (USFWS, 1997)

Reproduction Narrative

Adult: Clermontia flowers are protandrous (male parts maturing first), which indicates that they are primarily outcrossing between plants, although they may occasionally self-pollinate. Clermontia species are believed to have been pollinated by passerine birds (honeycreepers and honeyeaters). Clermontia oblongifolia ssp. mautensis is known to flower from November to July (Rock 1919). (USFWS, 1997; USFWS, 2011)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 850 and 900 meters (USFWS, 1997)

Habitat Narrative

Adult: This species grows on the ground in wet forests. Clermontia oblongifolia ssp. mautensis typically grows on the sides of ridges inohia-dominated montane wet forest at elevations between 850-900 meters (2,790-2,950 feet) (Hawaii Heritage Program [HHP] references; Rock 1913). Associated native species include Coprosma, Clermontia, Hedyotis, and Melicope (R.W. Hobdy, personal communication in USFWS 1992a). (USFWS, 1997; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Clermontia species are believed to have been pollinated by passerine birds (honeycreepers and honeyeaters). Their seed is believed to be spread by birds also. (USFWS, 2011)

Population Information and Trends

Population Trends:

Not available.

Resiliency:

Very low (inferred from USFWS, 2011)

Redundancy:

Very low (inferred from USFWS, 2011)

Number of Populations:

5 (USFWS, 2018)

Population Size:

< 31 (USFWS, 2018)

Population Narrative:

In 2009, 4 individuals of Clermontia oblongifolia subsp. mauiensis were observed along the pipeline of the Lower Waikamoi Ditch Trail and at Haipuena Gulch in East Maui (Perlman 2009). There is currently only one extant occurrence in West Maui. (USFWS, 2011); At the time of the last 5-year review in 2011, there were four individuals on east Maui at Haipua'ena, and no individuals had been observed on Lāna'i between Palea and Kamiki ridges since 1998. Currently, there is one individual on west Maui (the identity of which is uncertain) and fewer than 30 individuals total in four populations on east Maui (Oppenheimer 2018, in litt.). (USFWS, 2018)

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Threats to Clermontia oblongifolia subsp. mauiensis are deer (Axis axis) and pigs (Sus scrofa), which degrade habitat. (USFWS, 2011)

Stressor: Invasive plants (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plant species that compete with the taxon and degrade habitat include Ageratina adenophora (sticky snakeroot), Clidemia hirta (Koster's curse), Hedychium gardnerianum (Kahili ginger), Leptospermum scoparium (New Zealand tea tree), Morella faya (fire tree), Psidium cattleianum (strawberry guava), P. guajava (common guava), Rubus rosifolius

(thimbleberry), and *Tibouchina herbacea* (glorybush) (Oppenheimer 2009; Perlman 2009; Wood 2009). (USFWS, 2011)

Stressor: Predation (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Threats to *Clermontia oblongifolia* subsp. *mauiensis* also include predation by rats (*Rattus* spp.), deer, and slugs (various species) (Listing Factor C) (Perlman 2009; Wood 2009). Slugs show a particular affinity for feeding on plants in the Campanulaceae family (Joe 2006). (USFWS, 2011)

Stressor: Climate change (USFWS, 2011; USFWS, 2018))

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this subspecies. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai'i using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) was conducted for *Clermontia oblongifolia* at the species level, and concluded that this species is vulnerable to the impacts of climate change, with a vulnerability score of 0.329 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2018)

Stressor: Small population size (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: In addition to all of the other threats, species like *Clermontia oblongifolia* subsp. *mauiensis* that have few populations and low numbers of individuals are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding and disease outbreaks. (USFWS, 2011)

Stressor: Human development (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The extent of these natural processes on this single island endemic are exacerbated by anthropogenic threats, such as habitat loss for human development or predation by introduced species (USFWS 1997). (USFWS, 2011)

Stressor: Hybridization impacts (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: This subspecies may hybridize with the more common *Clermontia arborescens* or *C. kakeana* that could lead to loss of species diversity, local adaptations, and genetic representation. (USFWS, 2018)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1997)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)
2. Each population must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)
3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1997)

Recovery Actions:

- Complete taxonomic studies to determine subspecific status of the possible Koolau Forest Reserve *Clermontia oblongifolia* ssp. *mauiensis* population. (USFWS, 1997)
- Search for East Maui individuals of *Clermontia oblongifolia* ssp. *mauiensis*. (USFWS, 1997)
- Propagate and outplant in protected areas. (USFWS, 1997)
- Surveys and inventories—Continue surveys for additional populations of *Clermontia oblongifolia* subsp. *mauiensis* in areas of potentially suitable habitat. (USFWS, 2018)
- Hybridization impacts—Conduct genetic analysis to determine if the taxon is valid or a hybrid. Conduct pollen studies to evaluate pollen quality and viability, as pollen is often aborted in this subspecies. (USFWS, 2018)
- Climate change adaptation strategy—Assess the modeled effects of climate change on this subspecies, and determine future landscape needed for its recovery. (USFWS, 2018)

Conservation Measures and Best Management Practices:

- Pollen staining tests should be conducted, as pollen is often aborted and consequently staining is often (but not always) reduced in hybrids. (USFWS, 2011)
- Conduct genetic analysis to determine if the taxon is valid or a hybrid. (USFWS, 2011)

- Work with Hawaii Division of Forestry and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2011)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2011)

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

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SPECIES ACCOUNT: *Clermontia peleana* (‘Oha wai)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/04/1994; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Clermontia peleana Rock is an epiphytic shrub or tree that grows between 5-20 ft (1.5-6 m) tall (Lammers 1990). Alternate oblong to elliptic leaves with blades 3-8 in (8-20 cm) long and 1.2-2 in (3-5 cm) wide are attached to leaf stalks 1.2-2.4 in (3-6 cm) long. Single or paired flowers are attached to a flower stalk 1.2-1.8 in (3-4.5 cm) long and then to a main stalk 0.3-0.7 in (0.8-1.7 cm) long. The calyx and petals are fused into a tube (hypanthium) 0.4-0.6 in (1.0-1.5 cm) long and 0.4-0.6 in (1-1.5 cm) wide. The tip of the green calyx is 5-lobed and each lobe is triangular. The petals are fused 3/4 to 4/5 of their lengths above the hypanthium, and all are curved down, such that the flower appears 1-lipped. The black-purple or green-white petals measure 2.0-2.8 in (5-7 cm) long and 0.3-0.5 in (0.8-1.3 cm) wide. Anthers extend beyond the petals. Berries are orange and about 1.2 in (2.5-3.0 cm) long and wide. (USFWS, 1996)

Taxonomy

Clermontia peleana has been known by several other names including: *C. gaudichaudii* Hillebr. var. *singuliflora* Rock (Rock 1919a), *C. singuliflora* (Rock) Rock (Rock 1919a), *C. gaudichaudii* Hillebr. var. *barbata* Rock (Rock 1919a), *C. clermontioides* (Gaud.) A. Hellervar. *singuliflora* (Rock) Hochr. (Hochreutiner 1934), *C. clermontioides* (Gaud.) A. Hellervar. *mauiensis* Hochr. nom. illeg., and *C. clermontioides* (Gaud.) A. Hellervar. *barbata* (Rock) St. John (St. John 1973). Lammers (1991), in the most recent treatment, recognized two subspecies: *C.p. peleana*; and *C.p. singuliflora*. *C.p. singuliflora* is presumed extinct. Two subspecies are separated on the basis of flower color: *Clermontia peleana* subsp. *peleana* Rock is black-purple while *C. p. subsp. singuliflora*, presumed extinct, is green-white. (USFWS, 1996)

Historical Range

Clermontia peleana subsp. *peleana* is known only from the island of Hawaii, where it was found on the northeastern and southeastern slopes of Mauna Kea and from the eastern slopes of Mauna Loa (Lammers 1991). (USFWS, 1996)

Current Range

Its current range is in Eastern Hawaii. (NatureServe, 2015)

Critical Habitat Designated

Yes; 7/2/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Clermontia peleana* (‘Oha wai) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one detailed critical habitat unit (CHU), in Hawaii (81 FR 17790-18110).

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Clermontia peleana* on the island of Hawaii (68 FR 39623 - 39722).

Critical Habitat Designation

The critical habitat designation for *Clermontia peleana* includes one CHU in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Lowland Wet—Unit 1 (and) *Palmeria dolei*—Unit 2—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 2—Lowland Wet This area consists of 6,616 ac (2,677 ha) of State land, 7,425 ac (3,005 ha) of privately owned land, and 2,038 ac (825 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Kipahulu Valley on the northern and eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia samuelii*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *M. ovalis*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 1 is not known to be occupied by the plants *Clermontia oblongifolia* ssp. *mauiensis*, *C. peleana*, *Mucuna sloanei* var. *persericea*, *Phyllostegia haliakalae*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwiku* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat designation for *Clermontia peleana* includes three units totaling 38,664 acres in Hawaii County, Hawaii. The units are Hawaii 1—*Clermontia peleana*—a, Hawaii 3—*Clermontia peleana*—b, Hawaii 29—*Clermontia peleana*—c. Hawaii 1—*Clermontia peleana*—a, that currently is unoccupied, is essential to the conservation of the species because it supports habitat that is necessary for the establishment of additional populations in order to reach recovery goals. Each of the two occupied units is essential to the conservation of *C. peleana* because each supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. Each unit is geographically separated from other critical habitat for this multi-island species in order to reduce the likelihood of all recovery populations on the island being destroyed by one naturally occurring catastrophic event.

Hawaii 1—*Clermontia peleana*—a [4,704 ha (11,624 ac)]: This unit contains a portion of Honohina and Nauhi gulches, and Hakalau, Kapue, and Kolekole streams. The unit is bordered on the north by the Nanue watershed and on the south by the Honolii and Pahoehoe watersheds. It also contains portions of the Kapue, Kolekole, and Umauma watersheds. This unit lies mostly within Hakalau Forest NWR and is intersected by a small section of the Hilo Forest Reserve. This unit provides habitat for 3 populations of 300 individuals of *C. peleana* and is currently unoccupied.

Hawaii 3—*Clermontia peleana*—b [4,128 ha (10,126 ac)]: This unit contains a portion of Kaiwilalilahi, Haakoa, and Waikaumalo streams and is bordered on the northwest by the Kaawalii

and Laupahoehoe watersheds, in the south by the Waikāumalo watershed, and contains portions of the Haakoa, Kaiwilāhilahi, Kilau, Manowaiopae, Maulua, Ninole, Pahale, and Pohakupuka watersheds. This unit lies partly, in the northwest portion, in the Hilo Forest Reserve; in the central portion in Laupahoehoe NAR; and in the southern portion in the Hākalau Forest NWR. The unit provides habitat for 3 populations of 300 individuals of *C. peleana* and is currently occupied by 1 individual.

Hawaii 29—*Clermontia peleana*—c [6,830 ha (16,914 ac)]: This unit contains a portion of Waipahoehoe Gulch and a portion of the lava flows of 1881 and 1852, and the northern portion is in the Wailuku watershed, while the southern portion in the Wailoa watershed. The unit contains about half of the Waiākea 1942 Lava Flow NAR, the main part of the unit lying, in the south, in the Upper Waiākea Forest Reserve and in the north in the Hilo Forest Reserve. This unit provides habitat for 4 populations of 300 individuals of *C. lindseyana* and is currently occupied by 3 individuals.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Clermontia peleana* critical habitat consists of one component. Lowland wet (east Maui). Species-specific physical or biological features: observed epiphytic on ohia, koa, olapa (81 FR 17790-18110):

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Habitat features that are essential for this species included, but are not limited to, montane wet *Metrosideros*-*Cibotium* forest.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other

Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C.*

samuelii, Ctenitis squamigera, Cyanea asplenifolia, C. copelandii ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. magnicalyx, C. mannii, C. maritae, C. mceldowneyi, C. profuga, C. solanacea, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Dubautia plantaginea ssp. humilis, Geranium hanaense, G. multiflorum, Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for these species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: This species was observed in flower during June and November 1957 (HHP 1991b1, b7), and in fruit during November 1977 (HHP1991b3). (USFWS, 1996)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 1,800 and 3,800 feet (USFWS, 1996)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1996)

Habitat Narrative

Adult: *Clermontia peleana* is an epiphyte of montane wet forests on windward slopes of Mauna Kea and Mauna Loa. Rock (1913) commented that “the very handsome species” was associated with *Clermontia hawaiiensis* (Hillebr.) Rock, *Cheirodendron gaudichaudli* (DC.) Seem. [*C. trigynum* (Gaud.) A. Heller], *Cyrtandra* sp., and *Cibotium* sp. Currently, the taxon grows in rain forests dominated by *Acacia koa*, *Metrosideros polymorpha*, *Cibotium* subsp. and/or *Sadleria* spp. (tree ferns) at elevations between 1,800 and 3,800 ft. (530-1,600 m) (HELP 1991b1-1991b4, 1991b6, 1991b7; Lammers 1990, 1991). Other native species that grow in association with *Clermontia peleana* are *Melicope clusiifolia* (A. Gray) T. Hartley & B. Stone (kolokolo mokihana) and *Scaevola chamissoniana* Gaud. (naupaka kuahiwi) (HELP 1991b1). (USFWS, 1996)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Resiliency:

Low (inferred from USFWS, 2015)

Redundancy:

Low (inferred from USFWS, 2015)

Number of Populations:

6 (1 wild, 5 reintroduced) (USFWS, 2015)

Population Size:

6 wild, 3,155 reintroduced (USFWS, 2015)

Population Narrative:

In 2009, there were four wild mature and two wild immature individuals in a single population in Hilo Forest Reserve (Plant Extinction Prevention Program [PEPP] 2009). In 2015, five wild plants remained (J. VanDeMark, PEPP, pers. comm. 2014). There are five outplanted populations of *Clermontia peleana* ssp. *peleana* containing approximately 3,155 individuals at: Hakalau Forest National Wildlife Refuge (257 individuals), Hawaii Volcanoes National Park (144 individuals) and at the Kahuku Unit (320 individuals), Kulani Area (34 individuals), and Kilauea Forest (2,400 individuals) (PEPP 2009, 2010, 2011; Hawaii Volcanoes National Park 2010, 2011, 2014; Volcano Rare Plant Facility 2013). (USFWS, 2015)

Threats and Stressors

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Climate change destruction or degradation of habitat – Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *Clermontia peleana* is minimally vulnerable to the impacts of climate change. (USFWS, 2015)

Stressor: Habitat degradation and predation by feral pigs (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: The major threats to *Clermontia peleana* are habitat degradation and predation by feral pigs (*Sus scrota*) (Wood et al. 2002; Big Island Plant Extinction Prevention Program 2006; Hawaii Biodiversity and Mapping Program 2005; Lau 2007). (USFWS, 2008)

Stressor: Introduced plant species (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Another threat is competition from invasive introduced plant species, including *Setaria palmifolia* (palmgrass), *Tibouchina herbacea* (glorybush), *Psidium guajava* (common guava, kuawa), *Passiflora* spp., *Psidium cattleianum* (strawberry guava), and *Rubus ellipticus* (yellow Himalayan raspberry) (Wood et al. 2002; Big Island Plant Extinction Prevention Program 2006; Hawaii Biodiversity and Mapping Program 2005; Lau 2007). (USFWS, 2008)

Stressor: Predation (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Predation by slugs and rats is a current threat to *C. peleana* (Wood et al. 2002; Big Island Plant Extinction Prevention Program 2006; Hawaii Biodiversity and Mapping Program 2005; Lau 2007). (USFWS, 2008)

Stressor: Small population and restricted range (USFWS, 2008)

Exposure:

Response:

Consequence:

Narrative: Species like *Clermontia peleana* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes and disease outbreaks (Factor E). When considered on their own, the natural processes associated with being a single island endemic do not affect *C. peleana* to such a degree that it is threatened or endangered with extinction in the foreseeable future, but these natural processes can exacerbate the threat from anthropogenic factors, such as habitat loss for human development or predation by alien species (USFWS 1996). (USFWS, 2008)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on the Big Island and at least one other island where it now occurs or occurred historically, if it is not endemic to the Big Island. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1996)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1996)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on the Big Island and at least 1 other island where they now occur or occurred historically, if it is not endemic to the Big Island. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 individuals per population for short-lived perennials. (USFWS, 1996)
3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1996)

Recovery Actions:

- In order to prevent possible extinction of this taxon, maintenance of ex situ (at other than the plant's natural location, such as a nursery or arboretum) genetic stock is necessary. (USFWS, 1996)
- The eight known plants should be protected from ungulates, particularly pigs, via fencing or other means. (USFWS, 1996)
- Propagation and outplanting of ex situ stock will likely be needed in order to establish a sufficient number of plants for recovery within the taxon's four known locations, and a fifth population will need to be established. (USFWS, 1996)

Conservation Measures and Best Management Practices:

- Develop a plan for conserving the species' genetic diversity in ex situ collections and in reintroduced populations. (USFWS, 2008)
- Continue reintroducing individuals into protected suitable habitat. (USFWS, 2008)
- Collect fruit from any reintroduced individuals that set seed to add to the genetic diversity of the ex situ material. (USFWS, 2008)
- Search for new populations of *Clermontia peleana* ssp. *peleana*, and regularly visit the sites where the species formerly grew to search for any seedlings that might germinate at the sites from a seedbank. (USFWS, 2008)

- Study new or reintroduced *Clermontia peleana* ssp. *peleana* populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. (USFWS, 2008)
- Survey geographical and historical range for a current assessment of the species' status. (USFWS, 2015)
- Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. (USFWS, 2015)
- Maintain existing exclosures and monitor for potential incursions. (USFWS, 2015)
- Eradicate invasive introduced plants within ungulate exclosures and maintain exclosures free of invasive plants. (USFWS, 2015)
- Continue monitoring wild and reintroduced individuals. (USFWS, 2015)
- Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. (USFWS, 2015)
- Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2015)

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SPECIES ACCOUNT: *Clermontia pyrrularia* (ʻOha wai)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/04/1994; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Clermontia pyrrularia Hillebr. is a tree that grows to about 13 ft (3-4 m) tall (Lammers 1990). Narrowly elliptic leaf blades are 5.9-11 in (15-28 cm) long and 1-2 in (2.5-5 cm) wide, finely-toothed, alternate, dark green on the upper surface, and light green beneath. The leaf blades are attached to winged stalks 0.8-1.4 in (1.5-3.5 cm) long. Two, three, or sometimes five flowers are attached to a flower cluster stalk (inflorescence) 1.1-2.4 in (2.8-6 cm) long. Each flower is subtended (supported) by a flower stalk 0.3-0.8 in (0.8-2 cm) long. The calyx and petals are fused at the flower's base into a tube 0.4-0.7 in (1-1.8 cm) long and 0.7-4.7 in (0.8-12 cm) wide. The calyx is small and its lobes are triangular, 0.1-0.2 in (0.3-0.5 mm) long and 0.4-0.8 in (1-2 cm) wide. Petals, 1.6-1.8 in (4-4.5 cm) long, are fused into a tube 0.2-0.3 in (5-8 mm) wide, which is 2-lipped and curved. Five white or green-white petals are finely hairy, lobed and spreading. Berries, 0.7-1.1 in (1.8-2.8 mm) long and 0.6-0.9 in (1.5-2.4 cm) wide, are oboval or ob-pear-shaped and orange. (USFWS, 1996)

Historical Range

Clermontia pyrrularia is known only from the Big Island, where it occurred on the western and northeastern slope of Mauna Kea, the western slope of Mauna Loa and the saddle between the two (59 FR 10305, HHP 1991d1-d6). (USFWS, 1996)

Current Range

Its current range includes Hawaii. (NatureServe, 2015)

Critical Habitat Designated

Yes; 7/2/2003.

Legal Description

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Clermontia pyrrularia* on the island of Hawaii (68 FR 39623 - 39722).

Critical Habitat Designation

Critical habitat for *Clermontia pyrrularia* is designated in two units totaling 6,823 acres in Hawaii County, Hawaii. The two units provide habitat for combined total of six populations, each with 300 mature, reproducing individuals. The units are geographically separated. The units are Hawaii 1—*Clermontia pyrrularia*—a and Hawaii 2—*Clermontia pyrrularia*—b.

Hawaii 1—*Clermontia pyrrularia*—a [1,378 ha (3,405 ac)]: This unit contains Kaloaloa summit and portions of Hakalau, Honolii, and Kapue streams. It is bordered in the north by Kolekole watershed and in the south by Wailuku watershed, and it contains portions of the Kapue and Honolii watersheds. The unit lies completely within Hakalau Forest NWR; provides habitat for 3 populations of 300 individuals; and is currently unoccupied. This unit is essential to the

conservation of the species because it supports habitat that is necessary for the establishment of additional populations in order to reach recovery goals.

Hawaii 2—Clermontia pyralaria—b [1,383 ha (3,418 ac)]: This unit contains a portion of Nauhi Gulch and is bordered in the north by Kaawalii watershed; and in the south by Umauma watershed. It also contains portions of Haakoa, Kaiwilahilahi, and Waikaumalo watersheds. The unit lies partly in the Hilo Forest Reserve in the north and south-central portion of the unit and in Hakalau Forest NWR in the south and north-central portion of the unit. This unit provides habitat for 3 populations of 300 individuals of *C. pyralaria* and is currently occupied by 4 individuals. This unit is essential to the conservation of *C. pyralaria* because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable.

Primary Constituent Elements/Physical or Biological Features

Habitat features that are essential for this species include, but are not limited to, wet and mesic montane forest dominated by *Acacia koa* or *Metrosideros polymorpha*, and subalpine dry forest dominated by *Metrosideros polymorpha*; and montane wet *Metrosideros-Cibotium* forest.

Special Management Considerations or Protections

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for this species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: This species was observed in fruit and flower during December 1978 (HHP 1991b3) and November 1957 (HHP 1991b4). (USFWS, 1996)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 3,000 to 7,000 feet (USFWS, 1996)

Environmental Specificity

Adult: Narrow, with key requirements (USFWS, 1996; NatureServe, 2015)

Habitat Narrative

Adult: Moist and wet forests on old lava flows and old cinder cones. The habitat for *Clermontia pyralaria* is wet montane forest dominated by *Acacia koa* and/or *Metrosideros polymorpha*, and subalpine dry forest dominated by *M. polymorpha*, at elevations between 3,000 to 7,000 ft (910 and 2,130 m) (HHP 1991d1-d2, 59 FR 10305). Associated taxa are *Lythrum maritimum* Kunth (pukamole), *Rubus hawaiiensis* A. Gray (kala), and *Hedyotis* (HHP 1991d1-d2). (NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Very low (inferred from USFWS, 2007)

Redundancy:

Very low (inferred from USFWS, 2007)

Number of Populations:

1 (USFWS, 2007)

Population Size:

15 wild, 136 reintroduced (USFWS, 2007)

Population Narrative:

Currently, *C. pyralaria* is known from 1 natural population of 15 individuals in the Upper Piha GMA, and several outplanted populations at Hakalau National Wildlife Refuge (Hakalau NWR). Since 1992, 569 individuals of *C. pyralaria* have been outplanted in the Hakalau NWR, with 136 surviving as of 2003. (USFWS, 2007)

Threats and Stressors

Stressor: Habitat damage by feral ungulates (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: *Clermontia pyrrularia* is threatened by feral ungulates which damage habitat by rooting and trampling vegetation, and feed on its fruit (Jeffrey and Horiuchi 2005). As early as 1778, European explorers introduced livestock, which became feral, increased in number and range, and caused significant changes to the natural environment of Hawaii, especially to wet and mesic forests, and dry areas at high elevations. Feral pigs are currently present on the island of Hawaii, and inhabit both rain forests and grasslands. While rooting in the ground in search of the invertebrates and plant material they eat, feral pigs disturb and destroy vegetative cover, trample plants and seedlings, and threaten forest regeneration by damaging seeds and seedlings. They disturb soil and cause erosion, especially on slopes. Alien plant seeds are dispersed on their hooves and coats as well as through their digestive tracts, and the disturbed soil is fertilized by their feces, helping these plants to establish. Pigs are a primary vector causing the spread of many introduced plant species (Smith 1985; Scott et al. 1986; Tomich 1986; Cuddihy and Stone 1990; Wagner et al. 1999). Cattle (*Bos taurus*), the wild progenitor of which was native to Europe, northern Africa, and southwestern Asia, were introduced to the Hawaiian Islands in 1793. Large feral herds developed as a result of restrictions on killing cattle decreed by King Kamehameha I. While small cattle ranches were developed on Kauai, Oahu, and west Maui, very large ranches of tens of thousands of acres were created on east Maui and Hawaii. Much of the land used in these private enterprises was leased from the State or was privately owned and classified as Forest Reserve and/or Conservation District land. Cattle eat native vegetation, trample roots and seedlings, cause erosion, create disturbed areas into which alien plants invade, and spread seeds of alien plants in their feces and on their bodies. The forest in areas grazed by cattle becomes degraded to grassland pasture, and plant cover is reduced for many years following removal of cattle from an area. Several alien grasses and legumes purposely introduced for cattle forage have become noxious weeds (Tomich 1986; Cuddihy and Stone 1990). Cattle have been eliminated from the Upper Piha GMA, but feral pigs remain a threat to *C. pyrrularia* (L. Perry, Division of Forestry and Wildlife, pers. comm. 2006). All domestic cattle grazing was discontinued in the Hakalau Forest NWR between 1989 and 2001, and over 250 feral cattle and 1,000 feral pigs were removed from refuge lands. Eight feral ungulate management units have been completely fenced. The process of removing feral ungulates will continue in all currently fenced management units until eradication has been completed. Fencing and eradication will continue in other areas of the refuge as funding allows (Jeffrey and Horiuchi 2005). In June of 2005, Hakalau NWR received Congressional funding for fencing and feral ungulate removal (Jeffrey and Horiuchi 2005). (USFWS, 2007)

Stressor: Non-native plant species (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Nonnative plant species degrade habitat of and compete with *Clermontia pyrrularia*. At the time of listing the primary nonnative species impacting *C. pyrrularia* was *Passifloramollissima* (banana poka) (59 FR 10307). *Passiflora mollissima*, a vine native to the Andes of South America and first collected in Hawaii in 1926, is a serious pest in mesic forest on the islands of Hawaii, where it overgrows native trees (Wagner et al. 1999). It is distributed by feral pigs and other animals that feed on its fruit (Service 1996). Currently, the nonnative plant species *Rubus argutus* (prickly Florida blackberry), *Passiflora mollissima*, *Ehrharta stipoides* (meadow rice grass), and *Pennisetum clandestinum* (kikuyu grass), compete with *C. pyrrularia* for space, light, water, and

nutrients (Jeffrey and Horiuchi 2005). Weed control is ongoing at fenced areas of Hakalau NWR (Jeffrey and Horiuchi 2005). (USFWS, 2007)

Stressor: Predation (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: Predation on fruits and seeds by black rats (*Rattus rattus*) may limit the successful establishment of new plants (Service 1996) (Factor C). The black rat occurs on all the main Hawaiian Islands around human habitations, in cultivated fields, and in dry to wet forests. Rats are known to eat the fruit and strip the bark of some native plants, particularly fruits of plants in the African violet (*Gesneriaceae*) family with fleshy stems and fruits (Wagner et al. 1985; Tomich 1986; Cuddihy and Stone 1990; Jeffrey and Horiuchi 2005). (USFWS, 2007)

Stressor: Small population size (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: In addition to the above threats, species like *Clermontia pyralaria* that are endemic to single islands are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes and disease outbreaks. In the past, *C. pyralaria* was pollinated by nectar feeding birds, and its seeds were disseminated by fruit eating birds. Some of these bird species are now extinct, and others have been decimated by mosquito borne diseases, predation by introduced rats, cats and mongooses, competition from introduced birds, and habitat destruction by feral ungulates. As a result, little or no cross pollination takes place and seeds are no longer dispersed. A possible solution to this dilemma is to plant the bird pollinated and seed dispersed *C. pyralaria* in small areas at relatively high densities intermixed with common native food plants that fruit and flower synchronously with *C. pyralaria* (Jeffrey and Horiuchi 2005). Propagation and seed storage of *C. pyralaria* is conducted at Lyon Arboretum Seed Storage Facility, the Volcano Rare Plant Facility, Hakalau NWR, and at Lyon Arboretum's Micropropagation Facility (Service 2005). Since 1992, 569 individuals of *C. pyralaria* have been outplanted in the Hakalau NWR, with 136 surviving as of 2003. The outplanted individuals were propagated from seeds collected from the wild plants of *C. pyralaria* as well as from seeds collected from outplanted individuals that had matured and fruited (Jeffrey and Horiuchi 2005). (USFWS, 2007)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of *Clermontia pyralaria* should be documented on the Big Island where it now occurs or occurred historically. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population. (USFWS, 1996)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1996)

Delisting Criteria:

1. A total of 8 to 10 populations of *Clermontia pyrrularia* should be documented on the Big Island where it now occurs or occurred historically. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable, or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population. (USFWS, 1996)
3. Each population should persist at this level for a minimum of 5 consecutive years before delisting is considered. (USFWS, 1996)

Recovery Actions:

- The known remaining individuals should be protected from ungulates and encroachment of alien plants. (USFWS, 1996)
- In order to prevent possible extinction of this taxon, maintenance of ex situ genetic stock is necessary. (USFWS, 1996)
- Propagation and outplanting of ex situ stock will be needed in order to establish a sufficient number of populations and plants for recovery. (USFWS, 1996)
- Research into the taxons pollination vectors may be necessary. (USFWS, 1996)

Conservation Measures and Best Management Practices:

- Search for *Clermontia pyrrularia* throughout its historical range, particularly in leeward Mauna Loa, where no wild plants are known to be extant. (USFWS, 2007)
- Study *Clermontia pyrrularia* with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. (USFWS, 2007)
- Formulate a plan to maintain or increase genetic variability of *Clermontia pyrrularia*. (USFWS, 2007)

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SPECIES ACCOUNT: *Clermontia samuelii* (ʻOha wai)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/03/1999; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Clermontia samuelii, a short-lived perennial in the bellflower family (Campanulaceae), is a terrestrial shrub 1.2 to 5 m (4 to 16 ft) tall. The leaves are elliptical, sometimes broader at the tip, with blades 5 to 10 cm (2 to 4 in) long and 1.8 to 4.5 cm (0.7 to 1.8 in) wide. The upper surfaces of the leaves are dark green, often tinged purplish, and may be sparsely hairy. The lower surfaces of the leaves are pale green, and sparsely to densely hairy. The leaf margins are thickened, with shallow, ascending, rounded teeth. The tips and bases of the leaves are typically sharply pointed. The inflorescences (flowering clusters) bear two to five flowers on a main stem that is 4 to 18 mm (0.2 to 0.7 in) long. The stalk of each individual flower is 12 to 28 mm (0.5 to 1.1 in) long. The hypanthium (cup-like structure at the base of the flower) is widest on the top, 8 to 14 mm (0.3 to 0.6 in) long, and 5 to 10 mm (0.2 to 0.4 in) wide. The sepals and petals are similar in color (rose or greenish white to white), curved, and tubular. The flowers are 36 to 44 mm (1.4 to 2.2 in) wide. The lobes of the sepals and petals are erect, and extend 0.2 to 0.5 times beyond the tube. (USFWS, 2002)

Taxonomy

In the most recent treatment of this endemic Hawaiian genus, Lammers considers all four species to be synonymous with *C. samuelii*, and divides the species into two subspecies – ssp. *hanaensis* (including the synonyms *C. hanaensis* and *C. kipahuluensis*) and ssp. *samuelii* (including *C. gracilis* and *C. rosacea*) (Lammers 1988, 1999). *Clermontia samuelii* ssp. *hanaensis* is differentiated from *C. samuelii* ssp. *samuelii* by the greenish white to white flowers; longer, narrower leaves with the broadest point near the base of the leaves; and fewer hairs on the lower surface of the leaves. (USFWS, 2002)

Historical Range

Historically (prior to 1970), *Clermontia samuelii* has been reported from Haleakala, East Maui, and from Keanae Valley on the windward (northeastern) side to Manawainui on the more leeward (southeastern) side of Haleakala (Hawaii Natural Heritage Program Database 2001; Medeiros et al. 1998). (USFWS, 2002)

Current Range

Its current range includes the Hana District of East Maui. (NatureServe, 2015)

Critical Habitat Designated

Yes; 5/14/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Clermontia samuelii* (ʻOha wai) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for *Clermontia samuelii* includes six CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Lowland Wet—Unit 1 (and) *Palmeria dolei*—Unit 2—Lowland Wet (and) *Pseudonestor xanthophrys*—Unit 2— Lowland Wet This area consists of 6,616 ac (2,677 ha) of State land, 7,425 ac (3,005 ha) of privately owned land, and 2,038 ac (825 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Kipahulu Valley on the northern and eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *waihoi*ensis, *Clermontia samuelii*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakala*ensis, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *M. ovalis*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 1 is not known to be occupied by the plants *Clermontia oblongifolia* ssp. *mauiensis*, *C. peleana*, *Mucuna sloanei* var. *persericea*, *Phyllostegia haliakalae*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 1 (and) *Palmeria dolei*—Unit 10—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 10— Montane Wet This area consists of 1,313 ac (531 ha) of State land and 798 ac (323 ha) of privately owned land, at Haiku Uka on the northern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Cyanea duvalliorum*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *Phyllostegia pilosa*, and by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 1 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoi*ensis, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakala*ensis, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 2 (and) *Palmeria dolei*—Unit 11—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 11— Montane Wet This area consists of 4,075 ac (1,649 ha) of State land, 9,633 ac (3,898 ha) of privately owned land, and 875 ac (354 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Puukaukanu and upper Waihoi Valley, on the northern and northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Geranium hanaense*, *G. multiflorum*, and *Wikstroemia villosa*, and by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwiku* (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 2 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea glabra*, *C. maritae*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, and *Schiedea jacobii*, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 3 (and) *Palmeria dolei*—Unit 12—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 12— Montane Wet This area consists of 2,228 ac (902 ha) of federally owned land (Haleakala National Park) in Kipahulu Valley, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. maritae*, and *Melicope ovalis*, and by the forest bird, *kiwiku* (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 3 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea duvalliorum*, *C. glabra*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest bird, the *akohekohe* (*Palmeria dolei*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 4 (and) *Palmeria dolei*—Unit 13—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 13— Montane Wet This area consists of 180 ac (73 ha) of State land and

1,653 ac (669 ha) of federally owned land (Haleakala National Park), in Kaapahu Valley on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *Cyrtandra ferripilosa*, and *Huperzia mannii*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 4 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea duvalliorum*, *C. glabra*, *C. mceldowneyi*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 5 (and) *Palmeria dolei*—Unit 14—Montane Wet (and) *Pseudonestor xanthophrys*—Unit 14—Montane Wet This area consists of 222 ac (90 ha) of State land, and 165 ac (67 ha) of federally owned land (Haleakala National Park), near Kaumakani on the eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units area occupied by the plant *Bidens campylotheca* ssp. *pentamera*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 5 is not currently occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Clermontia samuelii* critical habitat consists of two components. Lowland wet (east Maui) and Montane wet (east Maui). Species- specific physical or biological features: bog margins (81 FR 17790-18110):

Ecosystem: Lowland Wet. Elevation: >75 in (>190 cm). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. Subcanopy: *Broussaia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyriformis*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the

critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Life History**Food/Nutrient Resources****Reproduction Narrative**

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 725 and 2,245 meters (USFWS, 2002)

Habitat Narrative

Adult: This species is often found in wet forest and bog margins. *Clermontia samuelii* is found at elevations between 725 and 2,245 meters (2,380 to 7,365 feet). *Clermontia samuelii* ssp. *hanaensis* is found in wet *Metrosideros polymorpha* (ohia) and *Metrosideros polymorpha*-*Dicranopteris linearis* (uluhe) forest (USFWS, 2002; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Low (inferred from USFWS, 2011)

Redundancy:

Low (inferred from USFWS, 2011)

Number of Populations:

<10 (NatureServe, 2015)

Population Size:

~300 wild individuals, > 10 outplanted individuals (USFWS, 2018)

Population Narrative:

Currently, there are 300 to 400 known individuals of *C. samuelii* (Bily et al. 2008). There are currently fewer than 10 occurrences. (USFWS, 2011; NatureServe, 2015); The 2011 five-year review combined data on populations of both subspecies to total 300 to 400 individuals, this included five new subpopulations of *C. samuelii* subsp. *hanaensis* at Kopiliula and Kawaipapa totaling 76 to 96 individuals, and one new subpopulation at Kawaipapa with an unknown number of individuals; and two new subpopulations of *C. samuelii* subsp. *samuelii* at Hanawī NAR and Haleakala National Park (HNP) totaling approximately 20 individuals. However, HNP estimated as many as 300 individuals in 2012 (HNP 2012). Currently, there are 10 subpopulations of *C. samuelii* subsp. *hanaensis* from Hanawī NAR and east to the Hāna Forest Reserve that total between 247 and 257 individuals. There are eight subpopulations of *C.*

samuelii subsp. samuelii from Hanawi NAR, east to the Hāna FR and into Haleakalā National Park totaling fewer than 50 individuals (Oppenheimer 2018, in litt.; TNC 2010). (USFWS, 2018)

Threats and Stressors

Stressor: Feral pigs (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The main threats to *Clermontia samuelii* subsp. hanaensis include feral pigs (*Sus scrofa*). (USFWS, 2011)

Stressor: Introduced plants (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: One main threat is competition with invasive introduced plant species including *Ageratina adenophora* (Maui pamakani), *Axonopus fissifolius* (narrow-leaved carpetgrass), *Clidemia hirta* (Koster's curse), *Tibouchina herbacea* (cane tibouchina), *Rubus rosifolius* (thimbleberry), *Prunella vulgaris* (selfheal), *Hedychium gardnerianum* (Kahili ginger), *H. coronarium* (white ginger), *Juncus* sp. (rush), *Holcus lanatus* (common velvet grass), *Miconia calvenscens* (miconia), *Paspalum conjugatum* (Hilo grass), *P. urvillei* (vasey grass), and *Rubus argutus* (blackberry) (Listing Factor A and E) (Bily et al. 2008; USFWS 2002; Wood 2009). (USFWS, 2011)

Stressor: Predation (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Unidentified slug species (USFWS 2002) and seed predation by rats (*Rattus* spp.) and mongoose (*Herpestes javanicus*) are threats to *Clermontia samuelii* (Bily et al. 2008; USFWS 2002; Wood 2009). (USFWS, 2011)

Stressor: Climate change (USFWS, 2011; USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai'i using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) was conducted at the species level and concluded that *Clermontia samuelii* is vulnerable to the impacts of climate change, with a vulnerability score of 0.444 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2018)

Stressor: Flooding destruction or degradation of habitat (USFWS, 2018)

Exposure:**Response:****Consequence:**

Narrative: Floods, including tree falls and erosion associated with them, can have a significant effect on small populations and are reported as a threat to both subspecies at Kawaipapa stream, Kahawaiapapa stream, and Helele'ike'ohā stream (NTBG 2013a, c-f, 2014b, d). (USFWS, 2018)

Stressor: Lack of adequate hunting regulations (USFWS, 2018)

Exposure:**Response:****Consequence:**

Narrative: The majority of the known individuals of both subspecies of *Clermontia samuelii* occur in a public hunting area. Nonnative feral ungulates pose a major ongoing threat to *C. samuelii* through destruction and modification of habitat, and through direct herbivory or predation. Public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations are at risk (Department of Land and Natural Resources (DLNR) 2010). (USFWS, 2018)

Recovery**Reclassification Criteria:**

1. A total of five to seven populations of each taxon should be documented on islands where they now occur or occurred historically. (USFWS, 2002)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with the following minimum numbers of mature individuals per population: 100 for long-lived perennials and 300 for short-lived perennials. (USFWS, 2002)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 2002)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on islands where they now occur or occurred historically. (USFWS, 2002)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with the following minimum numbers of mature individuals per population: 100 for longlived perennials and 300 for short-lived perennials. (USFWS, 2002)
3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 2002)

Recovery Actions:

- Construct exclosures to protect populations against feral ungulates. Exclosures should be constructed around known populations of *Clermontia samuelii* to reduce impacts from ungulates. (USFWS, 2002)

- To prevent extinction of this species, a program of propagation and maintenance of ex situ genetic stock should be developed and expanded, following the Center for Plant Conservation Guidelines (Falk and Holsinger 1991). (USFWS, 2002)
- A long-range management plan to control alien plant species such as *Miconia* and *Clidemia* in the Hana and Koolau forest reserves should be developed and implemented. (USFWS, 2002)
- Outplanting to enhance the remaining wild populations should begin after they have been protected from ungulates and weed control is under way. When adequate propagated material is available, new populations should be established within the historic range of *Clermontia samuelii* in areas free from the impacts of feral ungulates and alien plants. (USFWS, 2002)
- Ungulate monitoring and control—Continue to construct and maintain large-scale fenced exclosures to protect individuals from the negative impacts of feral ungulates. Protect all occurrences against browsing and habitat disturbances from feral ungulates. (USFWS, 2018)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. Control invasive nonnative species that compete with the species around all populations. (USFWS, 2018)
- Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. (USFWS, 2018)
- Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to both subspecies. (USFWS, 2018)
- Predator and herbivore monitoring and control—Implement effective control methods for rodents and slugs. (USFWS, 2018)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from floods. (USFWS, 2018)
- Climate change adaptation strategy—Assess the modeled effects of climate change on this species, and determine future landscape needed for the recovery of the species. (USFWS, 2018)
- Alliance and partnership development—Continue to work with partners in planning and implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2018)

Conservation Measures and Best Management Practices:

- Fence all populations to protect against negative impacts from ungulates. (USFWS, 2011)
- Control introduced invasive plant species in all populations. (USFWS, 2011)
- Collect seeds from all populations for propagation and genetic storage. (USFWS, 2011)
- Work with East Maui Watershed Partnership and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2011)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2011)

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SPECIES ACCOUNT: *Clitoria fragrans* (Pigeon wings)

Species Taxonomic and Listing Information

Listing Status: Threatened; 5/27/1993; Southeast Region (R4)

Physical Description

Pigeon wings is a 15 to 100 cm tall herbaceous plant. Plants have a thick horizontal root, which may grow to more than 2 m long, and bear one to several erect, purplish, wiry, very straight stems. The somewhat leathery leaves consist of three leaflets. Leaflets of the upper leaves are obtuse at the tip and narrower than those of lower leaves. (Fantz 1977). Pigeon wings produce flowers aboveground (chasmogamous flowers) and underground (cleistogamous flowers). Aboveground flowers usually occur in pairs, each corolla consisting of one 3.5 to 5 cm-long standard petal and a small white keel. The common name of this species refers to the petals of the aboveground flowers, which resemble wings. The seed pod (legume) is 5 to 8 cm long and extends from the calyx (Fantz 1979). (USFWS, 1999)

Taxonomy

Clitoria fragrans was described and named from a Highlands County specimen in 1926 (Small 1926). The name *C. pinetorum* was recognized but never published (Fantz 1977). The North American *Clitoria* species were moved to the genus *Martiusia* by Small (1933), but were later transferred back to the genus *Clitoria* by Fantz (1977). This herb's common name, pigeon wings, was derived because of its flowers' bird-like appearance (Fantz 1979). It is one of three species of the genus occurring in the southeastern United States. The others are the native butterfly pea (*C. mariana*) and a butterfly pea escaped from cultivation (*C. ternata*). (USFWS, 1999)

Historical Range

In Florida, along the Lake Wales Ridge, primarily in Highlands, Orange, and Polk counties; in central Osceola County; near Leesburg IN Lake County. (USFWS, 1999)

Current Range

In Florida, along the Lake Wales Ridge, primarily in Highlands, Orange, and Polk counties (USFWS, 1999)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated

Lifespan

Adult: > 5 years

Breeding Season

Adult: Chasmogamous flowers bloom from May to June.

Reproduction Narrative

Adult: Pigeon wings are long-lived (> 5 years) perennials. Flowers are pollinated by insects, while cleistogamous flowers are self-pollinating. Cross-fertilization of cleistogamous flowers is prevented, since the flowers do not open. Chasmogamous flowers bloom from May to June. Cleistogamous flowers occur later in the summer through late September. No information is available on the pollination vector, fertilization rate, seed production, or germination rates for this species.

Habitat Type

Adult: Xeric upland/sandhill and oak hickory scrub

Habitat Narrative

Adult: SUMMARY: Widely scattered in undisturbed clearings of xeric sandhill and scrub communities on well-drained upland soils. END SUMMARY. Suzanne Cooper of the Florida Natural Areas Inventory (unpublished FNAI data) reports that *C. fragrans* is more commonly found in the sandhill or sandhill/scrub ecotones than in the scrub proper, which is contrary to published reports. Sandhill typically occurs on rolling hills of yellowish sand with a longleaf pine/turkey oak overstory (bluejack and/or sand live oak may also be dominant) and a ground cover of numerous herbs dominated by wiregrass. The white sand scrub is generally found with an overstory of scattered pines (sand, slash or longleaf), a middle layer of scrub oaks, several ericaceous shrub species and saw palmetto, and a thin layer of many herbaceous or dwarf shrub species (Duever 1983). *Clitoria* is typically found in undisturbed clearings in the scrub but also occurs in very open scrub as well (Kral 1983). (NatureServe, 2015). Pigeon wings occurs in a range of xeric upland habitats on the Lake Wales, Winter Haven, and Bombing Range Ridges and on xeric upland sites west of Bombing Range Ridge within APAFR. On the southern third of the LWR (i.e., the part within Highlands County), it occurs primarily in sandhill and oak-hickory scrub (Menges et al. 2007b). On APAFR, it occurs primarily in sandhill and oak scrub (S. Orzell, APAFR, pers. comm. 2008). Pigeon wings is a soil generalist, occurring on a yellow, white, and gray sands (Menges et al. 2007b; S. Orzell, pers. comm. 2008).

Dispersal/Migration

Population Information and Trends

Number of Populations:

21 - 80 (NatureServe, 2015); 77 (USFWS, 2016)

Population Size:

1000 - 2500 individuals (NatureServe, 2015)

Population Narrative:

Requires undisturbed soils and fire. Doesn't seem to return quickly to abandoned farmland or neglected orange groves. Never abundant at a given site Fifty nine Element Occurrences recorded by FNAI as per July 1995 (Gary Knight, pers. comm., July 17, 1995) (NatureServe, 2015). Data on population trends are not available for pigeon wings because monitoring programs at most sites do not involve repeated censuses of populations within well defined areas. However,

the evidence that is available, usually based on short-term surveys of relatively few individuals, suggests substantial year to year fluctuations in aboveground population sizes. For example, annual monitoring of a small pigeon wings population (< 70 plants in all years surveyed) at ABS from 1992 to 2000 found annual survival rates ranging from 72 to 98 percent (C. Weekley, pers. comm. 2008). Over the nine years of the study, sexual reproduction was negligible and few seedlings were found (C. Weekley, pers. comm. 2008). The study also documented the presence of belowground dormancy in pigeon wings, with 14 percent of tagged plants re-appearing aboveground following a year or more in which they were absent. Stout et al. (2003) recorded an annual survival rate of 68% (28 of 43 plants) in one APAFR population tagged in 2002 and re-surveyed one year later. Weekley and Menges (2003) characterized pigeon wings as a moderate resprouter based on the percentage of tagged aboveground individuals present two years after a prescribed burn (48.4 percent). However, aboveground pigeon wings populations may fluctuate annually due to belowground dormancy (C. Weekley, pers. comm. 2008). Anecdotal evidence also indicates that dramatic increases in post-burn aboveground population sizes may be short lived (C. Weekley, pers. obs. 2008). Thus, population densities may increase post-fire and decline with time-since-fire. High percent flowering by postburn plants also suggests that they are more likely resprouts than seedling recruits (C. Weekley, pers. obs. 2008). The FNAI identifies 77 occurrences of pigeon wings. Fifty-four (70.1 percent) of the occurrences are on protected sites on the Lake Wales (45) or Winter Haven Ridges (1), or on the APAFR (8). Of the 24 occurrences outside protected areas, all but two are on the LWR (one each on the Winter Haven and Mount Dora Ridges). Since most of these occurrence records are more than 20 years old, it is not known how many of the unprotected sites remain. Pigeon wings is currently known from 18 managed areas on the LWR: A. D. Broussard Catfish Creek Preserve State Park, ABS, Crooked Lake Sandhill, Jack Creek, LWRSF (Arbuckle, Hesperides, and Walk-in-Water Tracts), Lake Wales Ridge National Wildlife Refuge (Carter Creek South, Flamingo Villas), LWRWEA (Carter Creek North, Holmes Avenue, Lake Placid Scrub, Mountain Lake Cutoff, Royce Ranch, Silver Lake, and Sunray/Hickory Lake Tracts), Seminole State Forest (Warea Tract), and Tiger Creek Preserve. It is also protected at Lake Griffin State Park on the Sumter Upland, LWRWEA (Lake Blue) on the Winter Haven Ridge, and at APAFR.

Threats and Stressors

Stressor: Predation

Exposure:

Response:

Consequence:

Narrative: Heavy vertebrate and invertebrate predation, including the destruction of entire seed crops or the complete removal of aboveground individuals, have been documented for pigeon wings (e.g., Stout and Lewis 2004; Lewis 2007; A. Faivre, pers. comm. 2008). Other likely invertebrate predators on pigeon wings include orthopterans and possibly seed predating coleopterans. Vertebrate herbivores probably include white-tailed deer (*Odocoileus virginianus*) and eastern cottontail rabbits (*Sylvilagus floridanus*). Herbivory may threaten the persistence of local populations. The impact on pigeon wings plants of partial or complete defoliation is unknown.

Stressor: Inadequate fire frequency/management

Exposure:

Response:

Consequence:

Narrative: Human development has disrupted the natural disturbance regime for pigeon wings. Because pigeon wings occurs in pyrogenic communities with a range of natural fire return intervals, we can infer that it can tolerate a range of fire frequencies and intensities. Some data (Weekley and Menges 2003, Lewis 2007) and anecdotal evidence (C. Weekley, pers. obs. 2008) suggest that aboveground populations decline with time-since-fire. Thus, inadequacies in existing prescribed fire programs or the use of mechanical methods such as mowing or gyro-tracking as a substitute or pre-treatment for fire may be adversely affecting the persistence of populations.

Stressor: Habitat destruction or modification

Exposure:

Response:

Consequence:

Narrative: Pigeon wings is protected in 18 managed areas on LWR and in three managed areas off LWR. However, almost one-third (24 of 77) of the FNAI EORs are on unprotected sites. It is not known how many of these sites remain. Although unprotected populations at Avon Park Lakes were targeted for acquisition (Turner et al. 2006), the site is quickly being converted to residential development and the population will almost certainly be lost. Surveys of other unprotected FNAI EORs will be required to determine if they are still extant. (USFWS, 2008)

Stressor: Human development

Exposure:

Response:

Consequence:

Narrative: Human development has disrupted the natural disturbance regime for pigeon wings. Because pigeon wings occurs in fire dependent communities with a range of natural fire return intervals, we can infer that it can tolerate a range of fire frequencies and intensities. Some data (Weekley and Menges 2003, Lewis 2007) and anecdotal evidence (C. Weekley, pers. obs. 2008) suggest that aboveground populations decline as the time-since-fire interval increases. Thus, inadequacies in existing prescribed fire programs or the use of mechanical methods such as mowing or gyro-tracking as a substitute or pretreatment for fire may be adversely affecting the persistence of populations. Observations by B. Blihovde at Lake Wales Ridge NWR suggest pigeon wings thrive in and around mechanically treated fire breaks. Data being generated by ABS's PDEP project aims to provide answers to some of these questions. In the meantime, development of science-based guidelines for the management of pigeon wings is precluded for lack of data.

Recovery**Reclassification Criteria:**

Not relevant. (USFWS, 1999)

Delisting Criteria:

1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to ensure 95 percent probability of persistence for 100 years (USFWS, 1999)

2. When these sites, within the historic range of *C. fragrans*, are adequately protected from habitat loss, degradation, and fragmentation (USFWS, 1999)
3. When these sites are managed to maintain the ecotone between xeric oak scrub and high pine that supports *C. fragrans* (USFWS, 1999)
4. When monitoring programs demonstrate that populations of *C. fragrans* on these sites support the appropriate numbers of self-sustaining populations, and those populations are stable throughout the historic range of the species. (USFWS, 1999)

Recovery Actions:

- Determine current distribution of *C. fragrans*. Some portions of *C. fragrans*'s range have been well surveyed, yet a total distribution has not been ascertained for this species. A thorough survey is needed to determine the distribution for this species. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Conduct research on life history characteristics of *C. fragrans*. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species, more specific biological information is needed. (USFWS, 1999)
- Monitor populations of *C. fragrans*. Develop monitoring protocol to assess population trends for *C. fragrans*. Develop a quantitative description of the population structure of *C. fragrans*. (USFWS, 1999)
- Provide public information about *C. fragrans*. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Care is needed, though, to avoid revealing specific locality information about where *C. fragrans* is found. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of *C. fragrans* and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- Habitat-level Recovery Actions. Prevent degradation of existing habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

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SPECIES ACCOUNT: *Colubrina oppositifolia* (Kauila)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/04/1994; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Colubrina oppositifolia is a tree approximately 16-40 ft (5-13 m) tall, with extremely hard red wood (Wagner et al. 1990). Opposite, oval-shaped leaf blades are 2.4-4.7 in (6-12 cm) long and 1.2-2.8 in (3-7 cm) wide. Leaf blades are thin, dull green on the upper surface, and olive green beneath. Two kinds of glands occur on the lower surface: small black glands near the margin and small glandular projections in the axil of the leaf vein. Leaf stalks are 0.6-1.2 in (1.4-3 cm) long. Lance-shaped stipules are fused at the base of each pair of leaves. Ten to 12 flowers are arranged on a flower cluster stalk 0.1-0.3 in (3-8 mm) long. Each flower is subtended by a flower stalk 0.07-0.1 in (2-3 cm) long, which increases in length as the fruit matures. Five sepals are triangular and about 0.06-0.08 in (1.5-2 mm) long. Five green-yellow petals are about 0.06 in (1.5 mm) long. Emits are brown, almost round, about 0.3-0.4 in (8-11 mm) long, and explosively split apart, discharging oval or oblong, black, shiny, hump-back seeds, 0.2-0.3 in (6-8 mm) long and 0.1-0.2 in (4-5 mm) in diameter. (USFWS, 1996)

Historical Range

Historic populations are known from the central and southern Waianae mountains on Oahu, and from the Kohala mountains; western, southwestern, and southern slopes of Mauna Loa; and northern slopes of Hualalai on the Big Island. (USFWS, 1996)

Current Range

Colubrina oppositifolia is known from Waianae Mountains of Oahu, Hawaii, and Maui. (NatureServe, 2015)

Critical Habitat Designated

Yes; 5/14/2003.

Legal Description

On March 18, 2003 (Revised March 30, 2016), the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Colubrina oppositifolia* (Kauila) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Colubrina oppositifolia* (Kauila) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Colubrina oppositifolia* (77 FR 57648-57862). The critical habitat designation includes three critical habitat units, which encompass approximately 5,884 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Colubrina oppositifolia* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Colubrina oppositifolia* on the island of Hawaii (68 FR 39623 - 39722).

Critical Habitat Designation

The critical habitat designation for *Colubrina oppositifolia* includes six CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Lowland Dry—Unit 1 consists of 11,465 ac (4,640 ha) of State land, 2,069 ac (837 ha) of federally owned land, and 3 ac (1 ha) of privately owned land, from Kanaio to Kahualau Gulch on the southern slopes of east Maui. This unit is occupied by the plants *Bonamia menziesii*, *Cenchrus agrimonioides*, *Flueggea neowawraea*, *Melicope adscendens*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 1 is not known to be occupied by *Alectryon macrococcus*, *Bidens micrantha* ssp. *kalealaha*, *Canavalia pubescens*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Sesbania tomentosa*, *Solanum incompletum*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 2 consists of 1,851 ac (749 ha) of State land at Keokea on the southern slopes of east Maui. This unit is occupied by the plants *Bonamia menziesii*, *Canavalia pubescens*, and *Hibiscus brackenridgei*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 2 is not known to be occupied by *Alectryon macrococcus*, *Bidens micrantha* ssp. *kalealaha*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 3 consists of 188 ac (76 ha) of privately owned land, at Keauhou on the southern slopes of east Maui. This unit is occupied by the plant *Canavalia pubescens*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the

conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 3 is not known to be occupied by *Bidens micrantha* ssp. *kalealaha*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 4 consists of 1,266 ac (512 ha) of State land (including the Department of Land and Natural Resources) at Ahihi-Kinohiwa Natural Area Reserve on the southern slopes of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Maui—Lowland Dry—Unit 4 is not currently occupied by *Bidens micrantha* ssp. *kalealaha*, *Bonamia menziesii*, *Canavalia pubescens*, *Cenchrus agrimonioides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Mesic—Unit 2 consists of 1,034 ac (419 ha) of State land, and 113 ac (46 ha) of privately owned land, from Honokohau to Launiupoko on the western slopes of west Maui. This unit is occupied by the plants *Ctenitis squamigera*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, and *Zanthoxylum hawaiiense*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Mesic—Unit 2 is not known to be occupied by *Asplenium dielirectum*, *Bidens campylotheca* ssp. *pentamera*, or *Colubrina oppositifolia*, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within its historical range. Due to its small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could approach recovery.

Maui—Lowland Mesic—Unit 3 (and) *Palmeria dolei*—Unit 1—Lowland Mesic (and) *Pseudonestor xanthophrys*—Unit 1—Lowland Mesic This area consists of 477 ac (193 ha) of State land at Ukumehame on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5).

Although Maui—Lowland Mesic—Unit 3 is not currently occupied by the plants *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Zanthoxylum hawaiiense*, or by the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat designation for *Colubrina oppositifolia* includes three critical habitat units, covering one ecosystem type, which encompasses approximately 5,884 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

The critical habitat designation for *Colubrina oppositifolia* includes two units totaling 11, 453 acres in Hawaii County, Hawaii. The units are Hawaii 10—*Colubrina oppositifolia*—a and Hawaii 18—*Colubrina oppositifolia*—b. Each unit is currently occupied, and each provides habitat to support two populations with 100 mature, reproducing individuals of *C. oppositifolia*. Each unit is essential to the conservation of *C. oppositifolia* because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population (the present population within “Hawaii 18— *Colubrina oppositifolia*—b” is currently considered nonviable). The units are geographically separated from other critical habitat for this multi-island species in order to reduce the likelihood of all recovery populations being destroyed by one naturally occurring catastrophic event.

Hawaii 10—*Colubrina oppositifolia*— a [1,918 ha (4,740 ac)]: This unit contains no named natural features and lies completely within the Kiholo watershed. It is currently occupied by several hundred individuals of *C. oppositifolia*.

Hawaii 18—*Colubrina oppositifolia*— b [2,703 ha (6,713 ac)]: This unit contains no named natural features and lies almost completely within the Kauna watershed, with a small portion lying in the Kiilae watershed on the southwestern side of the unit. This unit is currently occupied by 10 to 50 individuals, and is currently considered nonviable. This unit provides the southernmost critical habitat within the species’ historical range.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Colubrina oppositifolia* critical habitat consists of two components. Lowland dry (east Maui) and Lowland mesic (west Maui) (81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: Diospyros, Myoporum, Pleomele, Santalum. Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Sicyos.

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Colubrina oppositifolia* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Colubrina oppositifolia* occurs within the indicated ecosystem in the Waianae Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (E) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Features that are essential for this species include, but are not limited to, lowland dry and mesic forests dominated by *Diospyros sandwicensis* or *Metrosideros polymorpha*.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (*Abutilon eremitopetalum*, *Cyanea gibsonii*, *Kadua cordata* ssp. *remyi*, *Labordia tinifolia* var. *lanaiensis*, *Pleomele fernaldii*, *Portulaca sclerocarpa*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Viola lanaiensis*) and two tree snails (*Partulina semicarinata* and *P. variabilis*). The 125 species for which we are designating critical habitat include 108 plant and animal species

that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (*Adenophorus periens*, *Clermontia peleana*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyperus trachysanthos*, *Eugenia koolauensis*, *Gouania vitifolia*, *Isodendron pyrifolium*, *Kadua coriacea*, *Nototrichium humile*, and *Solanum incompletum*), 6 plant species that may not be currently extant in the wild (*Acaena exigua*, *Cyanea glabra*, *Phyllostegia bracteata*, *P. haliakalae*, *Schiedea jacobii*, and *Tetramolopium capillare*), and 1 plant species, *Kokia cookei*, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic—Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses *Andropogon virginicus* (broomsedge), *Cenchrus* spp. (sandbur, buffelgrass), and *Melinis minutiflora* (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; Maui Wet Cliff—Units 6 and 7; and Molokai Montane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., *Adenophorus periens*, *Alectryon macrococcus*, *Asplenium peruvianum* var. *insulare*,

Bidens campylotheca ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *B. conjuncta*, *B. wiebkkei*, *Bonamia menziesii*, *Clermontia oblongifolia* ssp. *brevipes*, *C. oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. magnicalyx*, *C. mannii*, *C. maritae*, *C. mceldowneyi*, *C. profuga*, *C. solanacea*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Dubautia plantaginea* ssp. *humilis*, *Geranium hanaense*, *G. multiflorum*, *Hesperomannia arborescens*, *Huperzia mannii*, *Kadua laxiflora*, *Lysimachia lydgatei*, *L. maxima*, *Melicope balloui*, *M. ovalis*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Schiedea laui*, *Stenogyne bifida*, *S. kauaulaensis*, *Wikstroemia villosa*, and *Zanthoxylum hawaiiense*) found on steep slopes and cliffs, or in narrow gulches.

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Colubrina oppositifolia* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for these species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (NatureServe, 2015)

Reproduction Narrative

Adult: This species was observed in fruit and flower during September 1929 (HHP 1991e8) and June 1968 (HHP 1991e12), and in flower during December 1947 (HHP 1991e4) and January 1984 (HHP 1991e9). Seed production in *Colubrina oppositifolia* is very low for trees in South Kona on

Hawaii Island, but the cause is unclear (Nick Agorastos, Department of Land and Natural Resources, pers. comm. 2009). (USFWS, 1996; USFWS, 2011)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1996)

Habitat Narrative

Adult: This species is found in dry and moist forests on Gulch slopes on the older islands and old forested lava flows on the island of Hawaii. Habitats of *Colubrina oppositifolia* are lowland dry and mesic forests. The dominant species of these forests is *Diospyros sandwicensis*. Individuals are found at elevations between 800 and 3,000 ft (240-910 in), sometimes on a'a lava flows and associated with *Canthium odoratum* (G. Forster) Seem. (alahe'e) and *Reynoldsia sandwicensis* A Gray (ohe) (HHP 1991e3, 1991e8, 1991e15, 1991e16, NTBG 1991b). (USFWS, 1996; NatureServe, 2015)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends**Population Trends:**

Not available.

Resiliency:

Medium (inferred from USFWS, 2015)

Redundancy:

Medium (inferred from USFWS, 2015)

Number of Populations:

10-13 (USFWS, 2015)

Population Size:

1,500-2,000 (USFWS, 2015)

Population Narrative:

There are around seven populations containing at least 54 mature wild individuals and 44 reintroduced immature individuals of *Colubrina oppositifolia* on Oahu (PEPP 2011, 2012, 2014) and one population containing two wild mature individuals on Maui (PEPP 2011). There are approximately two to five populations containing 1,190 to 1,209 wild individuals and 400

reintroduced individuals are known from the island of Hawaii (DLNR 2013, 2014a, 2015a, 2015b; J. Wagner, pers. comm. 2015). (USFWS, 2015)

Threats and Stressors

Stressor: Ungulates (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: On West Maui, feral pig (*Sus scrofa*) activity is light and under management by the West Maui Mountains Watershed Partnership Program. On Oahu, threats include feral ungulates including pigs and goats (*Capra hircus*). (USFWS, 2011)

Stressor: Invasive introduced plants (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Invasive introduced plants which alter the habitat and compete with *C. oppositifolia* are *Aleurites moluccana* (candlenut), *Melinis minutiflora* (molasses grass), *Schinus terebinthifolius* (Christmasberry), *Psidium cattleianum* (strawberry guava), *P. guajava* (common guava), *Lantana camara* (lantana), *Juniperus bermudiana* (Bermuda juniper), and *Grevillea robusta* (silk oak) (Hawaii Biodiversity and Mapping Program 2009; H. Oppenheimer, pers. comm. 2009). *Colubrina oppositifolia* occurs on the island of Hawaii in habitat degraded by invasive introduced plant species including *Pennisetum setaceum* (fountain grass), *Grevillea robusta*, *Urochloa maxima* (Guinea grass), *Sigesbeckia orientalis* (small yellow crown-beard), *Leucaena leucocephala* (haole koa), *Schinus terebinthifolius*, *Lantana camara*, *Bidens pilosa* (Spanish needle), *B. alba* (beggartick), *Senecio madagascariensis* (fireweed), *Lophospermum erubescens* (larger roving sailor), and *Asclepias physocarpa* (balloon plant) (N. Agorastos, pers. comm. 2009; M. Donoho, pers. comm. 2009; Hawaii Biodiversity and Mapping Program 2009; National Tropical Botanical Garden 2010b; Perlman 2009; Wood 2009). On Oahu, threats include invasive introduced plant species which degrade the habitat and compete for resources, including *Adiantum hispidulum* (rough maidenhair fern), *Ageratina riparia* (spreading mist flower), *Aleurites moluccana*, *Blechnum appendiculatum* (no common name), *Clidemia hirta* (Koster's curse), *Grevillea robusta*, *Oplismenus hirtellus* (basketgrass), *Psidium cattleianum*, *Schinus terebinthifolius*, *Syzygium cumini* (Java plum), and *Toona ciliata* (cedar) (Hawaii Biodiversity and Mapping Program 2009; Perlman 2009; Wood 2009). (USFWS, 2011)

Stressor: Predation (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: *Colubrina oppositifolia* on all islands have suffered severe damage from the black twig borer (*Xylosandrus compactus*) (Hawaii Biodiversity and Mapping Program 2009; H. Oppenheimer, pers. comm. 2009). On Oahu, direct damage to the species from rats (*Rattus* spp.), slugs (unidentified species), pigs, and goats has been reported (Perlman 2009). On the island of Hawaii, threats include grazing by domestic livestock, feral ungulates, and rats (N. Agorastos, pers. comm. 2009; M. Donoho, pers. comm. 2009). (USFWS, 2011)

Stressor: Fire (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: On West Maui, threats to *Colubrina oppositifolia* are fire and erosion. On Hawaii Island, *Pennisetum setaceum* increases the threat from fire (Cabin et al. 2004). (USFWS, 2011)

Stressor: Drought and land conversion (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: On Oahu, threats to *Colubrina oppositifolia* include drought and conversion of land to agriculture (Hawaii Biodiversity and Mapping Program 2009; Perlman 2009; Wood 2009). (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2011)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of each taxon should be documented on the Big Island and at least one other island where it now occurs or occurred historically, if it is not endemic to the Big Island. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1996)
3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1996)

Delisting Criteria:

1. A total of 8 to 10 populations of each taxon should be documented on the Big Island and at least 1 other island where they now occur or occurred historically, if it is not endemic to the Big Island. (USFWS, 1996)
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived

perennials, and a minimum of 300 individuals per population for short-lived perennials. (USFWS, 1996)

3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1996)

Recovery Actions:

- Protecting habitat from ungulates and controlling aggressive alien plant taxa such as lantana, fountain grass and Christmasberry are necessary for recovery of the species, as is reducing the threat of fire. (USFWS, 1996)
- Control of the black twig borer, and research necessary to accomplish this, should be undertaken to stem the species' demise. Steps should be taken to ensure that populations remain viable on each of the islands on which the species presently occurs. (USFWS, 1996)

Conservation Measures and Best Management Practices:

- Fence to exclude ungulates from known populations. (USFWS, 2011)
- Eradicate invasive introduced plants, particularly *Pennisetum setaceum*, from known populations. (USFWS, 2011)
- Collect material for genetic storage and propagation for reintroduction from all existing populations. (USFWS, 2011)
- Continue efforts to register an effective control method for black twig borer. (USFWS, 2011)
- Control rats in the vicinity of these populations. (USFWS, 2011)
- Develop and implement methods to control slugs. (USFWS, 2011)
- Work with Hawaii Division of Forestry and Wildlife, West Maui Mountains Watershed Partnership Program, and Hawaii State Parks to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2011)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2011)
- Survey geographical and historical range for a current assessment of the species' status. (USFWS, 2015)
- Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. (USFWS, 2015)
- Maintain existing exclosures and monitor for potential incursions. (USFWS, 2015)
- Eradicate invasive introduced plants within ungulate exclosures and maintain exclosures free of invasive plants. (USFWS, 2015)
- Continue monitoring wild and outplanted individuals. (USFWS, 2015)
- Develop and implement a fire management plan at the existing exclosures. (USFWS, 2015)
- Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2015)

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SPECIES ACCOUNT: *Conradina brevifolia* (Short-leaved rosemary)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/11/1993; Southeast Region (R4)

Physical Description

The short-leaved rosemary (*Conradina brevifolia*) is a shortlived, erect, woody, perennial shrub that reaches about 1 m in height (Kral 1983). It is very similar to the relatively widespread, and quite variable *C. canescens* of the Florida panhandle, Alabama, and Mississippi, and it is similar to the endangered *C. glabra* of the Apalachicola bluffs (Gray 1965, FWS 1994). As its name implies, *C. brevifolia*'s alternate leaves are shorter than *C. canescens*. The larger leaves on well-developed flowering branches are 6.0 to 8.2 mm long, and mostly shorter than the internodes, whereas *C. canescens*' leaves are 7 to 20 mm long and are mostly longer than the internodes. *C. brevifolia* also tends to have more flowers per axil than *C. canescens*: one to six per axil versus one to three in *C. canescens*. (USFWS, 1999)

Taxonomy

The short-leaved rosemary is one of five shrubby mints in the interior central Florida scrub. The others are *Calamintha ashei*, *Dicerandra frutescens*, *D. christmanii*, and a *Dicerandra* population whose taxonomic status is unresolved. *C. brevifolia* was described as a new species by Shinnars (1962). Taxonomic reviews of *Conradina* have upheld *C. brevifolia*'s treatment as a distinct species (Gray 1965, Wunderlin et al. 1980, Kral 1983, Kral and McCartney 1991). However, Wunderlin (1982) and DeLaney and Wunderlin (1989) included *C. brevifolia* in *C. canescens*, without noting *C. brevifolia* as a synonym. Gray (1965) showed that *C. brevifolia*, like *C. glabra*, is morphologically not strongly differentiated from, and is less variable than, *C. canescens*. (USFWS, 1999)

Historical Range

Not Available

Current Range

Lake Wales Ridge in Polk and Highlands counties, Florida (USFWS, 1999)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual

Reproduction Narrative

Adult: We have no species-specific data on the reproductive biology of *C. brevifolia*. In fire-dependent scrub habitat, most plants respond to fire by sprouting while a few recruit from seed that is stored in the sand (Johnson and Abrahamson 1990). Anecdotal information suggests that

C. brevifolia does not persist when burned, clipped, or defoliated (FWS 1996). If this is true, sprouting and other forms of asexual reproduction are unlikely. (USFWS, 2019)

Habitat Type

Adult: white sands/scrub

Environmental Specificity

Adult: Very narrow to narrow. (Natureserve, 2015)

Habitat Narrative

Adult: Conradina brevifolia inhabits white sand scrub with a scattered overstory of sand pine (Pinus clausa), interspersed with evergreen scrub oaks (Quercus spp.). C. brevifolia is usually found interspersed in clearings with other small shrubs and herbs (FWS 1992). Like all other xeric scrub communities, oak scrub is a fire-dependent vegetative complex that persists when burned at intervals of 10 to 20 years. In the slower-growing oak scrub of Florida's ridges, including Highlands and Polk counties, fire frequencies of 15 to 20 years are sufficient to maintain the vegetative diversity of the scrub habitats. (USFWS, 1999)

Dispersal/Migration***Population Information and Trends*****Number of Populations:**

6 - 80 (NatureServe, 2015)

Population Size:

1000 - 2500 individuals (NatureServe, 2015)

Population Narrative:

The FNAI 2015 Element Tracking Summary (FNAI 2015), identifies 28 occurrences, 15 of which are on 7 different managed areas that are presumed or known to be extant. The other 13 occurrences were located on private lands. This represents roughly a 20 percent decline from the last 5-year status review, which reported 35 known occurrences (Service 2008c). The current status of occurrences and trends of short-leaved rosemary on private lands is unknown. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat destruction or modification

Exposure:

Response:

Consequence:

Narrative: This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and

landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 million persons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

Stressor: Lack of adequate fire management

Exposure:

Response:

Consequence:

Narrative: Fire is necessary to maintain the scrub habitats upon which this species depends. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time (Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species. (USFWS, 2019)

Stressor: Limited geographic range

Exposure:

Response:

Consequence:

Narrative: This species occurs within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

Recovery

Reclassification Criteria:

1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations required to ensure 20 to 90 percent probability of persistence for 100 years (USFWS, 1999)
2. When these populations, within the historic range of *C. brevifolia*, are adequately protected from further habitat loss, degradation, and fire suppression (USFWS, 1999)
3. When these sites are managed to maintain sand pine scrub (USFWS, 1999)
4. When monitoring demonstrates that these sites support sufficient population sizes, are distributed throughout the historic range, and are sexually or vegetatively reproducing at sufficient rates to maintain the population (USFWS, 1999)

Delisting Criteria:

1. At least 20 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)
2. Populations (as defined in criterion 1) in rosemary and yellow sand scrub habitats are distributed across the known range of the species. (USFWS, 2019)
3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

Recovery Actions:

- Determine current distribution of *C. brevifolia*. Some portions of *C. brevifolia*'s range have been well surveyed yet a total distribution has not been ascertained for this species. A thorough survey is needed to determine the distribution for this species. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection. (USFWS, 1999)
- Conduct research on life history characteristics of *C. brevifolia*. Little is known of the basic biology and ecology of this species. To effectively recover this species more specific biological information is needed. (USFWS, 1999)
- Monitor populations of *C. brevifolia*. Develop monitoring protocol to assess population trends for *C. brevifolia*. Develop a quantitative description of the population structure of *C. brevifolia*. (USFWS, 1999)
- Conduct research on life history characteristics of *C. brevifolia*. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit, since the recovery of *C. brevifolia* and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)

- Habitat-Level Actions: Prevent degradation of existing habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

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SPECIES ACCOUNT: *Conradina etonia* (Etonia rosemary)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/11/1993; Southeast Region (R4)

Physical Description

A perennial, aromatic shrub, reaching 1.5 m tall, with slender, arching branches. Leaves are 1.5-3 centimeters long with rolled margins. Both sides of the leaves are hairy; mid-rib and veins are strongly raised on the lower surface. Flowers appear in clusters of 3-7 bent flowers, lavender in color, the lip marked with streaks and dots. (NatureServe, 2015)

Taxonomy

Conradina etonia could be the best marked species in a genus whose species differ mostly in very fine characters (Kral and McCartney, 1991). (NatureServe, 2015)

Historical Range

It is known from only two sites near Etonia Creek, northeast of Florahome, Putnam County, Florida (USFWS, 1994).

Current Range

Occurs at six sites near Etonia Creek, northeast of Florahome, Putnam County, northeastern Florida. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Spring - fall (EPA, 2016)

Key Resources Needed for Breeding

Adult: Insect pollinators (EPA, 2016)

Reproduction Narrative

Adult: Flowering occurs from early spring to late fall. Pollination occurs via insects (EPA, 2016).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest, savanna, shrubland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Periodic fire (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Excessive shade (inferred from NatureServe, 2015)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Habitat Narrative

Adult: Florida scrub vegetation with sand pine, shrubby evergreen oaks; in openings, edges, and disturbed areas. It is most abundant in natural or artificial clearings, appears to respond to disturbance such as fire (A91KRA01). It may be shaded out by mature scrub (NatureServe, 2015).

Dispersal/Migration**Dependency on Other Individuals or Species for Dispersal**

Adult: Unknown (EPA, 2016)

Dispersal/Migration Narrative

Adult: Dispersal mechanisms are unknown (EPA, 2016).

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Species Trends:

Increasing (USFWS, 2007)

Resiliency:

Very low (inferred from NatureServe, 2015; see current range/distribution)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low to moderate (inferred from USFWS, 2007)

Number of Populations:

8 (USFWS, 2007)

Population Size:

1000 - 2500 individuals (NatureServe, 2015)

Adaptability:

Low (inferred from NatureServe, 2015)

Population Narrative:

This has a limited geographic distribution and small population sizes. In 2005 there were at least 2276 plants (Jenkins, A.M.). The long term population trend is unknown (NatureServe, 2015). The species status is improving; the most recent surveys indicate an increase in the number of plants. There are a total of 8 populations (USFWS, 2007).

Threats and Stressors

Stressor: Habitat loss and degradation (Factor A)

Exposure:

Response:

Consequence:

Narrative: Development has and continues to be the primary threat to *C. etonia*. In 1991, there were only two known populations; both on what were then private lands (USFWS 1994). These private lands were platted and planned for development. In 1993, the State of Florida purchased much of these lands as the Etoniah Creek State Forest (ECSF), and surveys found additional populations of *C. etonia* in areas that are now protected. Within ECSF, there is still a large population located mostly on privately owned lots (Garden Drive/Blossom Street population). ECSF has purchased several of these lots and plans to continue to acquire additional property as funds become available. (USFWS, 2019)

Stressor: Hurricanes (USFWS, 2007)

Exposure:

Response:

Consequence:

Narrative: In 2004, hurricanes impacted populations at ECSF and DCSP by blowing over sand pines and crushing plants in areas occupied by *C. etonia*. At DCSP, four of the historic sites of *C. etonia* could not be located since the area was covered with downed sand pines (Herring 2004). ECSF also had areas where the presence of downed sand pines made it difficult to access known sites of *C. etonia*. During the 2004 surveys at ECSF, it was determined that the number of plants did decrease after the hurricanes. However, since then surveys at ECSF and DCSP have shown an increase in the number of plants. The increase in plants is most likely due to more intensive surveys of additional areas at ECSF and DCSP. (USFWS, 2019)

Recovery

Reclassification Criteria:

1. When five (5) wild populations are under protection and management (USFWS, 1994).

Delisting Criteria:

1. In addition to the five (5) populations identified in the downlisting criteria, at least five (5) additional populations are established or discovered that exhibit stable or increasing trends as evidenced by natural recruitment, and multiple age classes. (USFWS, 2019)
2. All ten (10) populations are located on lands protected via a conservation mechanism. (addresses Factors A and D). (USFWS, 2019)

3. Threats (e.g. inadequate management, invasive species) have been reduced and/or managed to a degree that *Etonia rosemary* will remain viable for the foreseeable future (addresses Factors A and D) (USFWS, 2019)

Recovery Actions:

- Protect and monitor natural populations (USFWS, 1994).
- Survey for additional populations along Etonia Creek, in Putnam County, and potential areas of scrub habitat (USFWS, 1994).
- Continue propagation at several locations to prevent extinction of the species due to disease or other disaster at any one propagation site (USFWS, 1994).
- Determine habitat requirements, life history characteristics, and requirements for reproduction (USFWS, 1994).
- Locate potential (re)introduction sites on protected lands, including public land, highway rights-of-way, and conservation easements on private land (USFWS, 1994).
- (Re)introduce plants to protected sites using plants under cultivation and/or plants from natural sites (USFWS, 1994).

Conservation Measures and Best Management Practices:

- Revise the current recovery plan to include updated objective and measurable recovery criteria, as well as updated information on the species distribution and biology. (USFWS, 2019)
- Provide funding and technical support for further research on: (a) The effects of prescribed burning and other management tools (e.g., thinning sand pines or mechanical clearing to reduce the understory) on *C. etonia*. Continue working with public land managers to increase the management on their sites. (b) The role pollinators play in the life history of *C. etonia*. Additional life history information may also be needed. (c) The genetics of the different populations to determine how different they are based on geographic distribution. Genetics could also tell us if inbreeding depression is occurring in some of the smaller populations. This information will help us determine what constitutes a stable population. (USFWS, 2019)
- Acquire additional private lands within ECSF that currently contain *C. etonia* (USFWS, 2019).
- Work with the Service's partners for Fish and Wildlife program staff to encourage private landowners to protect this species on their lands (USFWS, 2019).
- Conduct additional surveys on public lands adjacent to ECSF and DCSP (such as along the Crescent City Ridge) to look for suitable habitat and new populations of *C. etonia*. Continue annual surveys of populations at ECSF and DCSP (USFWS, 2019).
- Consider reintroduction and monitoring on adjacent publicly owned lands with suitable habitat. Conduct research into whether *C. etonia* will hybridize with other more common *Conradina* species, which could equate to loss of genetic variability of *C. etonia*. Reintroduction of *C. etonia* could help to increase the number of geographically distinct, self-sustaining populations on protected sites and augment populations where needed (USFWS, 2019).

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SPECIES ACCOUNT: *Conradina glabra* (Apalachicola rosemary)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/11/1993; Southeast Region (R4)

Physical Description

Conradina glabra is a much-branched shrub up to 2 meters tall. The branches of *C. glabra* are spreading or upright. The leaves are evergreen, opposite, with additional leaves in short shoots in the axils giving the appearance of fascicles. The leaves are needle-like, “very similar to the needles of fir” (Kral 1983, p. 949). The leaves are hairless on the upper surface—the only species of *Conradina* for which this is the case. *Conradina glabra* flowers from March to June and then intermittently until frost (Kral 1983). The flowers are usually in groups of two or three. The calyx and corolla are two-lipped. The corolla is 1.5 to 2.0 centimeters (0.5 to 0.75 inches) long from its base to the tip of its longest lobe, with a slender corolla tube that is straight for about 5 millimeters (mm) long, then bends sharply downward to form a funnel-shaped throat 5 mm long, then widens out into upper and lower lips. The outside of the tube and throat are white, with the lobes and lips lavender blue at the tips. The lower lip of the corolla is three-lobed, with a band of purple dots extending along its inner side. The four stamens are paired. Many flowers are male sterile. (USFWS, 1994)

Taxonomy

Conradina glabra was named as a distinct species by Shinnars (1962), a treatment that was upheld by Gray (1965) and Kral and McCartney (1991). The plant had first been collected in 1931, and Small (1933, p. 1167) mentioned the specimen without assigning a name. (USFWS, 1994)

Historical Range

Historical extent and abundance of this species is unknown because the silviculture industry destroyed large areas of this species' sandhill habitat during the 1950's, and the species was not described until 1962. We can assume that the species was once more widespread within the sandhill habitat in Liberty County, Florida. (USFWS, 2017)

Current Range

Conradina glabra is restricted to approximately 1000 to 1470 ha in northern Liberty County, Florida, west of Tallahassee near the Apalachicola River. (USFWS, 2017)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, asexual (NatureServe, 2015)

Breeding Season

Adult: March - first frost (NatureServe, 2015)

Key Resources Needed for Breeding

Adult: Insect pollinators (EPA, 2016)

Reproduction Narrative

Adult: The flower is strongly protandrous the pollen being shed 24 or more hours before the stigma becomes receptive. One population displayed some degree of male sterility. The anthers of some flowers being grossly malformed and were functionally unisexual. Some anthers were well formed but the pollen was aborted. *C. glabra* is the only species of this genus known to have this feature. Flowering occurs mainly from March to June and then intermittently until frost (Kral, 1983). The flower is strongly protandrous - its pollen being shed 24 or more hours prior to its stigma becoming receptive. Gray (1965) discovered one population near Torreya State Park that had 29 of 100 examined individuals displaying some degree of male sterility. These flowers had grossly malformed stamens and were thus functionally unisexual. The anthers were usually completely abortive; sometimes the filaments were flattened and petaloid, becoming white and variously spotted with purple. A less bizarre condition was found in flowers with normal appearing anthers having aborted pollen grains. *C. glabra* is the only species of this genus known to show this anomalous feature. Wilson Baker (personal communication) said it might possibly spread by rhizomes and Kral (1983) wrote that it "often is a clonal shrub." No definite reports on its reproduction were found. Reproduction can be achieved sexually, asexually, or through vegetative spread (NatureServe, 2015). Bees, butterflies, wasps, beetles and flies have been observed visiting the flowers (EPA, 2016).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Longleaf pine forest, field, steephead (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: 15 - 40 year fire intervals (USFWS, 2009)

Geographic or Habitat Restraints or Barriers

Adult: Heavy shade (EPA, 2016)

Environmental Specificity

Adult: Very narrow to narrow (NatureServe, 2015)

Habitat Narrative

Adult: Formerly occurred in the grassy understory of the upland longleaf pine-wiregrass vegetation, as well as steephead edges. Currently found on dry, sandy, well-drained soils of road edges, in planted pine plantations and along their cleared edges, and along the edges of ravines. In Florida, Apalachicola rosemary is a rare plant found only in two very limited areas. It occurs in flat sandy areas (characterized by longleaf pine and turkey or bluejack oak) that are deeply dissected by steep sided, moist ravines (Gray, 1965). Kral (1983) wrote that it was and is an understory plant in open woodlands of pine and oaks or in small clearings therein. Wilson Baker (personal communication) suggested that *Conradina* may have naturally grown in the ecotone

between the sandhills and the densely forested ravines; it spread into the sandhills only after their disturbance by the establishment of pine plantations in the late 1950's. It is presently found on road edges, in planted pine plantations and along their cleared edges, and along the edges of the ravines (Baker, personal communication). He wrote on the herbarium sheet (examined by the author at the UF (FLAS) herbarium that plants were on the periphery of the clearing with some very close to *Chamaecyparis* and others in the adjacent pineland. The environmental specificity is very narrow to narrow, as it appears to require open areas, without a heavy overhead canopy, on steepheads (NatureServe, 2015). It prefers sunny or lightly shaded areas (EPA, 2016). Florida rosemary (*Ceratiola ericoides*) requires longer fire cycles (15–40 year intervals) to maximize soil seed bank (Quintana-Ascencio et al. 2003) (USFWS, 2009).

Dispersal/Migration

Dependency on Other Individuals or Species for Dispersal

Adult: Unknown (EPA, 2016)

Dispersal/Migration Narrative

Adult: dispersal mechanisms are unknown (EPA, 2016).

Population Information and Trends

Population Trends:

30 - 50% decline (NatureServe, 2015)

Species Trends:

Stable (USFWS, 2017)

Number of Populations:

1 (USFWS, 2017)

Population Size:

Unknown (USFWS, 2017)

Additional Population-level Information:

The only population on public land is found at the SCT, Torreya State Park. This area was prepared by a bulldozer scraping topsoil and remaining vegetation into linear berms called windrows, planted in slash pine (with 500-700 stems per acre of sand pine), and then logged in the late 1980s (Spector and Bente 2009). Despite this severe alteration of habitat, SCT contains the majority of *C. glabra*. The estimated number of plants (or ramets, see recovery action 2.1) in 2009 for 102 ha was about 89,815 (Spector 2009); current and projected counts are underway (R. Pruner, Florida State Parks, 8/4/2017, pers. comm.). At present, about 15-20% of the core known habitat within the park remains to be surveyed (R. Pruner, Florida State Parks, 8/4/2017, pers. comm.). Data are collected on an ongoing basis, allowing for trend analysis as well as assessing the effects of restoration, particularly the effects of aggressive fire. (USFWS, 2017)

Population Narrative:

This plant, based on best available information, is only known from one population found on approximately 1000 ha of xeric sandhills, a small geographic range in northern Liberty County.

Several locations occur on privately owned silvicultural land and rights-of-way (ROW) with unknown number of estimated plants. Two of the reintroduced populations at the Nature Conservancy's ABRP have > 600 individuals, but a third has fewer than 75 (A. Winn, FL State Univ., 2009, pers. comm.). According to managers of Torreya State Park, Liberty County, FL (8/4/2017, pers. comm. to V. Negrón-Ortiz), the species status over the short-term appears stable, but uncertain over the long-term. Short-term trends in plant numbers over the past years indicate a high reduction of adults in mowed plots and an increase of small (<5cm) plants vs. an increase of adults in non-mowed areas. (USFWS, 2017)

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Habitat modification remains the main threat to date for this species as a result of silviculture practices. The entire range was altered by site preparation (e.g. bulldozing of topsoil into linear berms called windrows, and possible herbicide application) and conversion to pine plantations in the 1950s (Spector and Bente 2009). A large extent of Liberty County was logged mainly for longleaf pine, and many acres were converted to slash pine. The uplands on the SCT were managed for timber for several decades. The St. Joe Timberland Company harvested planted slash pine in 1987, followed by sand pine plantation. Although *C. glabra* has been seen growing at the edges and sporadically within pine plantation, plant density is low compared to more open areas. Therefore, shading, due to increases in canopy cover from natural longleaf pine forests to managed pine plantations, is a threat to this species and should be evaluated. (USFWS, 2017)

Stressor: Inappropriate fire management (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Longleaf pine has not been introduced to the ongoing Florida Park Service forest management restoration treatments (restoration zone 2), at SCT. Introduction of longleaf pine may result in hotter fires due to needle accumulation. Also, ongoing conversations are considering a planting density of 400+ longleaf pine trees per acre to control woody species such as oak, potentially allowing for hotter fires (R. Pruner, Florida State Parks, 8/4/2017, pers. comm.). This should be closely monitored because *C. glabra* is also a woody species. Therefore, the use of a too frequent fire return interval and intensity could be a threat to the species. (USFWS, 2017)

Stressor: Herbicides (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The Recovery Plan mentioned that the use of the herbicide (hexazinone, Velpar) is a threat when it is used in timber regeneration areas. According to M. Ludlow (Department of Environmental Protection; 2009, pers. comm. to Negrón-Ortiz), spot application of Garlon 4 (a less toxic herbicide) is used to treat exotic shrubs or trees at TSP. In addition, there are almost no

woody exotics in the area where *C. glabra* occurs. Therefore, herbicide use is currently considered a minor threat. (USFWS, 2017)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Section 7(b)(4) and 7(b)(2) of the Act generally do not apply to listed plants species. However, limited protection of listed plants from take is provided to the extent that the Act prohibits the removal and reduction to possession of federally listed threatened and endangered plants or the malicious damage of such plants on areas under federal jurisdiction, or the destruction of endangered plants on nonfederal areas in violation of state law or regulations or in the course of any violation of a state criminal trespass law. *Conradina glabra* is protected under Florida State Law, chapter 85-426, which includes preventions of taking, transport, and the sale of the plants listed under the State Law. The rule Chap. 5B-40, Florida Administrative Code, contains the "Regulated Plant Index" (5B-40.0055) and lists endangered, threatened, and commercially exploited plant species for Florida; defines the categories; lists instances where permits may be issued; and describes penalties for violations (<http://www.virtualherbarium.org/EPAC>). Several sites containing *C. glabra* occur on private timberland and highway and utility right of way (ROWs). While the Act requires federal agencies to carry out programs for the conservation of endangered and threatened species, no such programs are stipulated for non-federal landowners. Neither section of the Act provides protection for plants on non-federal lands as long as the activity is permissible under state/local laws. The State requires permission of private landowners for collecting of state-listed plants from their property. At present, we have not been able to comment on state park management practices, and the Service doesn't have a legal mechanism to regulate management on state lands. The next revision of the park management plan will likely start around 2020 and finalized in 2022, and the Service should be able to attend public meetings and request a copy of the draft plan for commenting (R. Pruner, Florida State Parks, 9/25/2017, pers. comm.). Right of way maintenance activities are not always reviewed for threatened and endangered species impact. However, if there is an activity (e.g., construction, mowing, or maintenance projects) affecting federally listed species on state highway ROWs, then the Service can recommend consultation to the Florida Department of Transportation (FDOT) under the Act because FDOT recently assumed NEPA authority and is considered a federal agency for consultation purposes. The FDOT routinely consults with the Service on all major road construction activities. Currently, these protections are inadequate for this plant and its habitat. (USFWS, 2017)

Stressor: Climate change (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: According to the Intergovernmental Panel on Climate Change Report (IPCC 2013), warming of the earth's climate is "unequivocal," as is evident from observations of increases in average global air and ocean temperatures, widespread melting of snow and ice, and rising sea level. Scientific evidence indicates a rapid and abrupt climate change, rather than the gradual changes that were previously forecasted (IPCC Report 2007), posing a significant challenge for fish, wildlife, and plant conservation. Highly specialized or endemic species, such as *C. glabra*, are likely to be most susceptible to the stresses of changing climate. Species that are already rare

may become rarer. This may be even more pronounced for those species with restricted ranges, with poor dispersal ability, requiring long generation times, possessing susceptibility to extreme conditions (such as flood or drought), exhibiting extreme habitat/niche specialization, or requiring symbiotic relationships (Hawkins et al. 2008). Using the NOAA Sea Level Rise (SLR) and Coastal Flooding Impacts Viewer (<https://coast.noaa.gov/slr/>), the projections indicated no potential impact to *C. glabra* population in Liberty County by intrusion of saltwater. Heatwave intensities and drought events, however, have strengthened in parts of the United States including the southeast (Mazdiyasni and AghaKouchak 2014) and Florida (Gao et al. 2012), and are becoming more likely to overlap. Heatwaves can make xeric areas such as sandhills even drier, and if these concurrently occur with drought events, represent a growing threat to *C. glabra* survival. Thus, it is recommended to avoid or postpone prescribed-fire during extreme drought and heatwave conditions. (USFWS, 2017)

Stressor: Forestry and Development (USFWS, 2017)

Exposure:

Response:

Consequence:

Narrative: Most of the remaining population of *C. glabra* is now protected under ownership by the State of Florida and managed by the Florida Park Service. The private land east of SCT where *C. glabra* likely occurred has been recently cut. In addition, herbicide was applied to the entire tract, limiting the likelihood of *C. glabra* persistence in the treated area (M. Maples, Florida State Parks, 9/12/2017, pers. comm.). There are other properties adjacent to SCT that have not been surveyed, but likely contain this species. Given the ownership of these surrounding properties, it is probable that they will continue to be utilized as pine plantations or converted to residential and/or commercial development in the near future. Therefore, conversion to pine plantations and residential or commercial developments are threats. (USFWS, 2017)

Recovery

Reclassification Criteria:

1. The Sweetwater Creek Tract population is assessed as resilient (addresses Factor A). Resilient: naturally reproducing, stable or increasing in number, and actively and appropriately managed. (USFWS, 2019)
2. Five additional populations are: 1) discovered or reintroduced within the historic range of the species, and 2) under long-term protection. These populations must be resilient (addresses Factors A and D). (USFWS, 2019)

Delisting Criteria:

1. Threat reduction and management activities (e.g., compatible silviculture practices, fire return interval and intensity, and restoration) have been implemented to a degree that the long-term resiliency of all six *C. glabra* populations and habitat is demonstrated over multiple prescribed burn cycles (addresses Factors A and D). (USFWS, 2019)

Recovery Actions:

- 1. Protect existing populations. Encourage conservation of existing populations on private lands. Conduct annual mapping and monitoring of all known populations of *C. glabra*. Manage rights-of-way. Acquire habitat. (USFWS, 1994).

- 2. Conduct population biology studies. Study the effects of prescribed fire and forest management practices. Conduct life history studies. Survey for *Conradina glabra* outside its current range (USFWS, 1994).
- 3. Conduct genetic studies. Research is needed to determine genetic variability within reintroduced populations. This research will ensure that reintroduced populations have genetic variability similar to natural populations to withstand drought, diseases, etc. (USFWS, 1994)
- 4. Propagate *Conradina glabra* and reintroduce and/or augment populations within its historic range. Establishment of the artificial population on ABRP shows that *C. glabra* can be propagated and introduced rather easily. If necessary, additional reintroductions could take place on protected sites within the historic range of the plant. (USFWS, 1994)
- An in-depth *C. glabra* inventory across the species' historic sites and on new locations is conducted where appropriate habitat exists (addresses Factor A and redundancy). (USFWS, 2019)
- The effects of prescribed fire and forest management practices on long-term persistence of *C. glabra* (survival, growth and reproduction) in the sandhill community is assessed and a standardized monitoring technique is in place (addresses Factor D and resiliency). (USFWS, 2019)
- The contribution of sexual reproduction and clonal propagation to population maintenance is assessed via research related to (1) in-situ soil seed bank, seed viability, and seedling recruitment (in-situ seed germination, seedling survival and growth), and (2) genetic composition and clonality (addresses Factors A, D, and E, and resiliency; it will inform representation). (USFWS, 2019)
- A living collection of viable germplasm³ is maintained at botanical gardens and other Service approved facilities for research, recovery, and public outreach (addresses Factor E, and representation). (USFWS, 2019)

Conservation Measures and Best Management Practices:

- 1. Conduct population surveys using a consistent, statistically valid, repeatable survey method. Once population numbers are known and an inventory has been conducted to find new populations throughout appropriate sandhill habitat, consistent surveys would allow for the analysis of long-term trends for this species. This information would help to determine when the species is stable and may be considered for reclassification. This information would also help to inform conservation managers of appropriate management techniques, and whether restoration of the pine plantation back to sandhill is assisting in the recovery of the species. - Continue and complete ongoing surveys throughout the present distribution. - Continue regular monitoring of marked individuals (e.g., the total number of individuals, number of flowering vs. non-flowering plants, and whether seedling recruitment is occurring). (USFWS, 2017)
- 2. Conduct an inventory of sites where appropriate habitat exists. This action can include the use of aerials and species distribution modeling methods to initially determine potential sites, with subsequent field inventory of the site using a consistent, statistically valid, repeatable inventory method. If new populations are discovered, protection should be sought. (USFWS, 2017)
- 3. Identify appropriate soil types and other environmental conditions within the *C. glabra* range and adjacent areas as well as other sandhill areas within the Florida panhandle. This action can include the use of aerials and species distribution modeling methods to initially determine potential habitat associations. (USFWS, 2017)

- 4. An ex-situ plant collection should be actively pursued and implemented. Studies on the viability of seeds, germination, and seedling establishment, in addition to whether the *C. glabra* spread by rhizomes and a persistent seed bank is present should be addressed. (USFWS, 2017)
- 5. Continue the restoration of and subsequent management of *C. glabra*'s habitat. This is crucial for the long-term population stability (Park Service staff, 2017, pers. comm.) given that the global population of *C. glabra* is only found at the TSP. - Determine the fire regime (intensity) and monitor the effect of this event on *C. glabra* density, fecundity, and size structure. (USFWS, 2017)
- 6. Avoid or postpone prescribed-fire during extreme drought and heatwave conditions. (USFWS, 2017)
- 7. Evaluate the benefits and risks of translocation, augmentation, and reintroduction strategies under the combined pressures of habitat fragmentation and climate change. (USFWS, 2017)
- 8. Assess the occurrence of vegetative reproduction (i.e., clonality) using genetic markers and determine the conservation implications. (USFWS, 2017)
- 9. Develop a stand-alone plan for managing listed plants at the TSP and integrate it to the restoration protocol and the Torreya State Park Unit Management Plan. - Evaluate the reference (remnant) site and determine the relevance and utility in informing restoration. (USFWS, 2017)
- 10. Seek partnership with private landowners to help better understand the present distribution of *C. glabra*. (USFWS, 2017)
- 11. Acquire the following properties adjacent to SCT: Candence Bank (3 parcels), Holland Ware, and R Dell Phillips. (USFWS, 2017)
- 12. The recovery plan should be updated to define objective measurable recovery criteria. A few key points to consider when addressing this action are: current population resiliency, effects of management and restoration efforts (particularly the effects of aggressive fire), and seedling recruitment. (USFWS, 2017)

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SPECIES ACCOUNT: *Conradina verticillata* (Cumberland rosemary)

Species Taxonomic and Listing Information

Listing Status: Threatened; 12/30/1991; Southeast Region (R4)

Physical Description

Cumberland rosemary, an evergreen perennial shrub in the mint family, is most noted for its aromatic leaves, which smell like the culinary herb rosemary, and for its abundant pink to purple flowers. A full technical description can be found in Gray (1965), but a few characteristics from Kral (1983), Patrick and Wofford (1981), and Roulston (1994) are presented and will aid in field identification. Inflorescence: Flowers on short-stalked, linear-bracted, axillary cymes from most or all upper nodes; the cyme stalks hispidulous; the bracts covered with long-spreading gland-tipped hairs. Flowers: They are 1 to 2 centimeters (cm) long; lavender, purple, or rarely white, usually with dark spots leading down the throat; two-lipped, the upper lip with two lobes, the lower with three; floral tube strongly bent, giving the flower an s-shape in profile; borne in small clusters in the axils of the present year's leaves from early May until early June. Calyx: Bilabiate, five-toothed, persistent, 7 to 9 millimeters (mm) long, glandular-pubescent and/or sparsely puberulent to appressed pubescent. Stems: Four-sided; woody but lax, often decumbent; seldom growing more than 1 foot tall before falling over, rooting at the nodes, and putting up more stems. Leaves: Entire, needlelike, opposite with additional pairs clustered in the axils appearing whorled, somewhat fleshy, with strongly revolute margins, 1 to 3 cm long, resin dotted, aromatic. Seeds: Up to four per calyx, dry, dark brown, spherical, 1 mm in diameter; loose in calyx but usually not falling out before calyx falls off plant. No other plants are likely to be mistaken for it when it is in flower. Without flowers, however, it resembles *Aster linariifolius*, *Hypericum densiflorum*, and *Pycnanthemum tenuiflorum*, which also have needlelike leaves and grow in the same habitat but do not have the distinctive rosemary aroma. (USFWS, 1996)

Taxonomy

Conradina is a genus of six allopatric species confined to the Southeastern United States (Shiners 1962, Gray 1965, Kral and McCartney 1991) (USFWS, 1996).

Historical Range

This species is known from five counties in north-central Tennessee and one county in southeastern Kentucky (USFWS, 1996).

Current Range

Tennessee: Cumberland, Fentress, Morgan, Scott, and White Counties; Kentucky: McCreary County. These occurrence are along nine major streams of the Cumberland Plateau--Big South Fork River, New River, Clear Fork River, White Oak Creek, Caney Fork River, Obed River, Daddys Creek, Clear Creek, and Emory River. (USFWS, 2018)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources**Reproductive Strategy**

Adult: Asexual, sexual (NatureServe, 2015)

Dependency on Other Individuals or Species

Adult: Bumblebees and honeybees (EPA, 2016)

Breeding Season

Adult: May - June (EPA, 2016)

Key Resources Needed for Breeding

Adult: Insect pollinators (EPA, 2016)

Reproduction Narrative

Adult: Flowering occurs from May to June, with fruiting in mid June. Pollination is primarily by bees, especially bumblebees and honeybees, although it attracts many different types of insects (EPA, 2016). Less than 10 percent of the seeds are fully developed and fertile. Germination takes about 2 weeks (USFWS, 1996). *C. verticillata* reproduces sexually and asexually. Due to low seed viability, a majority of reproduction is the result of asexual reproduction via fragmentation (NatureServe, 2015).

Habitat Type

Adult: Wetland (EPA, 2016)

Habitat Vegetation or Surface Water Classification

Adult: Riparian, flood plain, sand bar (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Seasonal flooding (NatureServe, 2015); full to moderate sunlight (USFWS, 1996)

Geographic or Habitat Restraints or Barriers

Adult: Excessive vegetation/shading (inferred from EPA, 2016); saturated soil (USFWS, 1996)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 1996); colonial (NatureServe, 2015)

Habitat Narrative

Adult: Cumberland rosemary is found on rocky river bars composed of unsorted boulders, cobbles, gravel and sand, with the largest populations occurring in open, 8 washed-out areas near the centers of these bars. The essential habitat requirements of this species are: open to barely shaded sites; moderately deep, sandy, well-drained soils with no visible organic matter; periodic forceful flooding to maintain openness; topographic features to enhance sand deposition; and, perhaps, periods of inundation of at least two weeks to induce rooting at the lower nodes (Patrick and Wofford 1981). (USFWS, 2018)

Dispersal/Migration

Dependency on Other Individuals or Species for Dispersal

Adult: Unknown (EPA, 2016)

Dispersal/Migration Narrative

Adult: Dispersal mechanisms are unknown (EPA, 2016). Dispersal seems to be mainly through fragmentation during winter storms (USFWS, 1996).

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Unknown (USFWS, 2011)

Number of Populations:

66 extant occurrence (USFWS, 2018)

Population Size:

Unknown (USFWS, 2018); < 4,000 (NatureServe, 2015)

Population Narrative:

There currently are 66 extant occurrences; though, it is likely many others also are extant but lack current observation data to verify their persistence. While most extant sites are located on conservation lands, few are actively managed to improve habitat conditions and promote population growth of Cumberland rosemary occurrences. Data are lacking from most sites for generating reliable estimates of the species abundance, either in terms of individual clumps or genetically distinct plants. However, viability ranks assigned by Kentucky and Tennessee NHPs indicate that fewer than 100 clumps are present at 90 percent of extant occurrences. Available monitoring data suggest general trends in each of the major watersheds where the species occurs, at least among monitored sites, including declines at a majority of occurrences in the Big South Fork and Caney Fork watersheds and increases or stability at a majority of sites monitored in the Obed-Emory. (USFWS, 2018)

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2011)

Exposure:

Response:

Consequence:

Narrative: The potential exists that small ponds and reservoirs constructed in upper reaches of watersheds have altered hydrologic and geomorphologic processes necessary to maintain suitable conditions for the species on the cobble bars where it occurs. White (pers. comm. 2010) reported that encroachment of woody species, both native and exotic, onto cobble bar habitats led to the decline of at least three Cumberland rosemary occurrences in Kentucky, and suggested that either drought or altered hydrology could be factors contributing to these declines. Impacts associated with hiking and equestrian trails at Big Island in BSFNRR and impacts from vehicular and camping activity at the Lilly Bridge site in ONWSR may be a threat (USFWS, 2011).

Recovery**Reclassification Criteria:**

Not applicable.

Delisting Criteria:

There are 25 protected and managed colonies with 50 genetically distinct individuals per colony on the five major rivers (five colonies on each river) where it occurs (USFWS, 1996).

Recovery Actions:

- Protect existing colonies and habitat. Only three populations with 91 colonies are known to exist, with the majority in north-central Tennessee and a few in adjacent Kentucky. The largest colonies in each population need immediate protection. A total of 76 colonies are located on land managed by the National Park Service, and 15 sites are located on privately owned land. Only five colonies are known to have more than 100 clumps of plants. Protection of five colonies in each of the five major rivers in which Cumberland rosemary occurs is considered to be essential to the recovery of the species and to prevent its irreversible decline. (USFWS, 1996)
- Search for new populations within the known range and in other watersheds. The search for new populations is necessary within both the known range and other watersheds. This information will be useful in making management decisions and for determining the genetic variability of the species. The most intensive searches for Cumberland rosemary in Tennessee were conducted in 1979 and 1980 (Patrick and Wofford 1981, Patrick 1979, Schmalzer and DeSelm 1982). These searches were restricted to the five major rivers within the known range of the species. Only a few new colonies have been found since 1980 (see Appendix). Suitable habitat north of and between the known Kentucky population has been thoroughly searched; no new colonies were located (White 1994). Searches should be conducted in other watersheds in Tennessee's northern Cumberland Plateau. Because of the restricted riparian habitat, access by canoe is the most efficient method of surveying for new colonies. Searches in the BSFNRR and the 16 ONWSR should continue in order to ensure that all federally owned colonies are adequately managed and protected. (USFWS, 1996)
- Conduct studies of the species' biology. Additional information on the biology of *C. verticillata* is important and necessary for developing and implementing management guidelines. (USFWS, 1996).
- Maintain and expand cultivated sources for the species. Vegetative material should be preserved for the purpose of establishing new populations if natural populations were to be eliminated. (USFWS, 1996).
- Develop materials to inform the public about the status of the species and the recovery plan objectives. Public support for the conservation of Cumberland rosemary could play an important part in encouraging conservation efforts. In order to ensure that the taking threat is not increased, information materials should not identify specific plant locations. (USFWS, 1996).
- Annually assess the success of recovery efforts for the species. The review of new information, evaluation of ongoing actions, and redirection of recovery efforts, if necessary,

are essential for assuring that full recovery is achieved as quickly and efficiently as possible. (USFWS, 1996)

Conservation Measures and Best Management Practices:

- Work with NPS, TDEC, and KSNPC to reconcile data concerning extant and historic locations, abundance at extant locations, and threats (USFWS, 2011).
- Continue efforts to control invasive, exotic plants at occurrences on NPS lands at BSFNRR and expand these efforts, as needed, to ONWSR (USFWS, 2011).
- Continue long-term monitoring begun by TDEC. Expand monitoring effort to occurrences in Kentucky. Review monitoring protocols and revise, if warranted, to provide a more repeatable system for tracking changes in distribution and abundance. Incorporate threats assessment into monitoring program (USFWS, 2011).
- Use data from NPS Cobble Bar Monitoring program to track threats to Cumberland rosemary at BSFNRR and ONWSR (USFWS, 2011).
- Continue implementation of Recovery Plan for Cumberland rosemary (USFWS, 2011).
- Conduct a population genetics study to assess the level of genetic variation found in the species and how that variation is distributed among watersheds and sites within watersheds; assess inbreeding risk for watersheds and occurrences; and evaluate the relationship between number of clumps/plants (ramets) 30 observed at sites and the number of genetically distinct individuals (genets) they represent. This information should be used to evaluate abundance at site and watershed levels and determine whether population augmentation should occur in some watersheds/sites to facilitate gene flow and increase the number of compatible mates. (USFWS, 2018)
- Coordinate monitoring efforts between KSNPC, TDEC, and NPS-APHN to avoid duplication and ensure monitoring is conducted at standardized times of year, using consistent methodology. Monitoring programs should also be designed to document threats observed at Cumberland rosemary sites, including assessing impacts of recreational activities in sites with known threats, and should attempt to document seedling recruitment into populations. (USFWS, 2018)
- The Service's (2016) programmatic BO for streams crossings on trails at BISO included a nondiscretionary requirement that NPS coordinate with the Service to devise a monitoring plan for Cumberland rosemary that includes formally designated trail crossings and other significant sites where this plant occurs in proximity to trails in BISO. While NPS conducts monitoring at 18 sites in BISO and OBRI, there has been little coordination with the Service on the monitoring program. Some NPS monitoring sites for Cumberland rosemary are located along trails, but we do not currently know which sites, nor do we know if data are collected regarding evidence of impacts related to recreational use of trails or nearby areas. The NPS staff at BISO, OBRI, and APHN, should coordinate with the Service to evaluate whether the current NPS monitoring program includes a representative set of sites for assessing effects of recreational uses on and near trails and to establish routine coordination and reporting procedures. (USFWS, 2018)
- Evaluate data and reports from the NPS-APHN (Murdock et al. 2013) long-term cobble bar monitoring program, to increase understanding of cobble bar geomorphology and dynamics in relation to vegetation structure and composition, as well as responses of Cumberland rosemary to changes in these habitats over time. We are not currently aware of any publicly available data or reports that have been produced from this monitoring program. (USFWS, 2018)
- There is a need to reconcile NPS data on observations of Cumberland rosemary at OBRI and BISO with data in NHP databases. Nearly one-third (~30 percent) of all known EOs are considered historical, because there are no observations recorded for them in NHP databases since prior to

1998. The greatest number of these historical occurrences are located in the Big South Fork watershed, where NPS-APHN conduct cobble bar monitoring and other biological surveys and potentially have collected data on Cumberland rosemary occurrences (both previously known and not yet documented). While some data have been provided to Tennessee's NHP program, there is a need to ensure that NPS observation data for Cumberland rosemary and other listed species are routinely shared with NHP programs. (USFWS, 2018)

- Once NPS and NHP data are reconciled, data should be reviewed and sites prioritized for surveys where recent observation data are lacking. Current data are needed to verify persistence of many EOs and to estimate abundance for evaluating the species' status with respect to recovery criteria. (USFWS, 2018)
- Surveys for new occurrences should be conducted and negative data stored in a collective database. (USFWS, 2018)
- Prioritize and increase efforts to control invasive species and assess whether additional management is needed on highest priority sites. Document areas where invasive species control and other habitat management occurs. (USFWS, 2018)
- Additional seed banking and testing of seed viability are needed to provide adequate ex situ resources for conservation of the species. (USFWS, 2018)

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SPECIES ACCOUNT: *Consolea corallicola* (Florida semaphore Cactus)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/25/2013; Southeast Region (R4) (USFWS, 2015)

Physical Description

Consolea corallicola is a tree-like cactus; mature plants grow 2 meters (m) (6 feet (ft)) tall with an erect main trunk, which is elliptical or oval in cross section and armed with spines. The flowers are bright red and 1.3 to 1.9 cm (0.50 to 0.75 in) wide, and the fruits are yellow, egg-shaped, and 2.5 to 5.1 cm (1 to 2 in) long (USFWS, 2013)

Taxonomy

John Kunkel Small discovered and described *Consolea corallicola* (Family: Cactaceae) in 1930. While some authors still place this species in the genus *Opuntia*, genetic studies by Gordon and Kubisiak (1998) confirmed that the Florida plants are a genetically distinct species. Recent taxonomic treatments accept the genus *Consolea* and apply the name *C. corallicola* to the Florida species. Synonyms include *Opuntia corallicola* (Small) Werdermann. (USFWS, 2013)

Historical Range

Consolea corallicola was known historically from three islands of the Florida Keys in Monroe County: Key Largo, Big Pine Key, and Little Torch Key, and from Swan Key, a small island in Biscayne Bay in Miami-Dade County. (USFWS, 2013)

Current Range

The current range of *Consolea corallicola* includes two naturally occurring populations, one on Swan Key in Biscayne National Park (BNP), Miami-Dade County, and one at the Nature Conservancy's (TNC) Torchwood Hammock Preserve on Little Torch Key, a small island in the Florida Keys, Monroe County (Bradley and Gann 1999, p. 77; Bradley and Woodmansee 2002, p. 810) (USFWS, 2013).

Critical Habitat Designated

Yes; 2/22/2016.

Legal Description

On January 22, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective February 22, 2016) for *Consolea corallicola* (Florida semaphore Cactus) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four critical habitat units (CHUs), in Florida (81 FR 3866-3925).

Critical Habitat Designation

The critical habitat designation for *Consolea corallicola* includes four CHUs in Miami-Dade and Monroe Counties, Florida, all of which was occupied by the species at the time of listing. The critical habitat includes lands under Federal (28 percent), State (58 percent), county (1 percent), and private or other (13 percent) ownership. This species critical habitat encompasses approximately 4,411 acres (ac) (1,785 hectares (ha)). General descriptions are presented below. Maps depicting the CH units are available in the Final Rule (81 FR 3866-3925).

Unit FSC1: Swan Key—Biscayne National Park, Miami-Dade County, Florida: Unit FSC1 consists of 37 ac (15 ha) in Miami-Dade County. This unit is composed entirely of lands in Federal ownership, 100 percent of which are located on Swan Key within Biscayne National Park. The unit includes all upland rockland hammock habitat on Swan Key, most of which is located on the eastern side of Swan Key, surrounded by the island's mangrove fringe. A second, smaller area is located on the island's elongate western half and is also surrounded by mangroves.

Unit FSC2: Key Largo, Monroe County, Florida: Unit FSC2 consists of 3,434 ac (1,389 ha) in Monroe County. This unit is composed of Federal lands within Crocodile Lake National Wildlife Refuge (NWR) (702 ac (284 ha)); State lands within Dagny Johnson Botanical State Park, John Pennekamp Coral Reef State Park, and the Florida Keys Wildlife and Environmental Area (2,331 ac (943 ha)); lands owned by Monroe County (17 ac (7 ha)); and parcels in private or other ownership (384 ac (155 ha)). This unit extends from near the northern tip of Key Largo, along the length of Key Largo, beginning at the south shore of Ocean Reef Harbor near South Marina Drive and the intersection of County Road (CR) 905 and Clubhouse Road on the west side of CR 905, and between CR 905 and Old State Road 905, then extending to the shoreline south of South Harbor Drive. The unit then continues on both sides of CR 905 through the Crocodile Lake NWR, Dagny Start Printed Page 3889 Johnson Key Largo Hammock Botanical State Park, and John Pennekamp Coral Reef State Park. The unit then terminates near the junction of U.S. 1 and CR 905 and Garden Cove Drive. The unit resumes on the east side of U.S. 1 from South Andros Road to Key Largo Elementary; then from the intersection of Taylor Drive and Pamela Street to Avenue A, then from Sound Drive to the intersection of Old Road and Valencia Road, then resumes on the east side of U.S. 1 from Hibiscus Lane and Ocean Drive. The unit continues south near the Port Largo Airport from Poisonwood Road to Bo Peep Boulevard. The unit resumes on the west side of U.S. 1 from the intersection of South Drive and Meridian Avenue to Casa Court Drive. The unit then continues on the west side of U.S. 1 from the point on the coast directly west of Peace Avenue south to Caribbean Avenue. The unit also includes a portion of the barrier island (El Radabob Key) in Largo Sound located directly east of Avenue A, extending south to a point directly east of Mahogany Drive.

Unit FSC3: Big Pine Key, Monroe County, Florida: Unit FSC3 consists of 772 ac (313 ha) in Monroe County. This unit is composed of Federal land within the National Key Deer Refuge (NKDR) (508 ac (205 ha)), State land managed as part of the NKDR (172 ac (70 ha)), lands owned by Monroe County (11 ac (5 ha)), and parcels in private or other ownership (81 ac (33 ha)). This unit extends from near the northern tip of Big Pine Key along the eastern shore to the vicinity of Hellenga Drive and Watson Road; from Gulf Boulevard south to West Shore Drive; Big Pine Avenue and Elma Avenues on the east, Coral and Yacht Club Road, and U.S. 1 on the north, and Industrial Avenue on the east from the southeastern tip of Big Pine Key to Avenue A.

Unit FSC4: Little Torch Key, Monroe County, Florida: Unit FSC4 consists of 168 ac (68 ha) in Monroe County. This unit is composed of State lands (47 ac (19 ha)), lands owned by Monroe County (10 ac (4 ha)), and parcels in private and other ownership (111 ac (45 ha)). This unit extends along State Highway 4A, from Coral Shores Road, south to County Road, resuming at Linda Street and extending south to the Overseas Highway. South of the Overseas Highway, the unit includes areas west of Kings Cove Road, and an area comprising the southern tip of Little Torch Key that includes portions of the John J. Pescatello Torchwood Hammock Preserve.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Consolea corallicola* critical habitat consists of the following components (81 FR 3866-3925):

- (i) Areas of upland habitats consisting of coastal berm, rockland hammocks, and buttonwood forest. (A) Coastal berm habitat that contains: (1) Open to semi-open canopy, subcanopy, and understory; and (2) Substrate of coarse, calcareous, and storm-deposited sediment. (B) Rockland hammock habitat that contains: (1) Canopy gaps and edges with an open to semi-open canopy, subcanopy, and understory; and (2) Substrate with a thin layer of highly organic soil covering limestone or organic matter that accumulates on top of the limestone. (C) Buttonwood forest habitat that contains: (1) Open to semi-open canopy and understory; and (2) Substrate with calcareous marl muds, calcareous sands, or limestone rock.
- (ii) A plant community of predominately native vegetation with no invasive, nonnative animal or plant species or such species in quantities low enough to have minimal effect on survival of *Consolea corallicola*.
- (iii) A disturbance regime, due to the effects of strong winds or saltwater inundation from storm surge or infrequent tidal inundation, that creates canopy openings in coastal berm, rockland hammocks, and buttonwood forest.
- (iv) Habitats that are connected and of sufficient size to sustain viable populations in coastal berm, rockland hammocks, and buttonwood forest.
- (v) Habitats that provide populations of the generalist pollinators that visit the flowers of *Consolea corallicola*.

Special Management Considerations or Protections

Special management considerations or protection are necessary throughout the critical habitat units to avoid further degradation or destruction of the habitat that provides those features essential to the species' conservation. The primary threats to the physical or biological features that *Consolea corallicola* depends on include: (1) Habitat destruction and modification by development and sea level rise; (2) Competition with nonnative, invasive plant and animal species; (3) Wildfire; and (4) Hurricanes and storm surge. Some of these threats can be addressed by special management considerations or protection, while others (e.g., sea level rise, hurricanes, storm surge) are beyond the control of landowners and managers. However, even when landowners or land managers may not be able to control all the threats, they may be able to address the results of the threats.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Vegetative (NatureServe, 2015)

Reproduction Narrative

Adult: The breeding system is complex, with one population being effectively male-only, while the other is reproducing. Sexual reproduction has not been observed. The Little Torch Key population consists of eight individual plants none of which seem to have produced viable fruit (Williams, pers. comm., 1989). The flowers tend to drop off shortly after peak bloom is reached and these blooms occasionally take root beneath the parent plant (Avery, 1963; Williams, pers. comm., 1989). This type of vegetative reproduction is also mentioned by Small (1930) who suggests that the lack of proper ovary development is a result of not having been pollinated. In this same report, however, Small does mention that fruits have been observed and he describes the seeds from them. It is possible that the pollinators of the plant were present when the plant was better represented in the wild, but when the plants were extirpated the pollinators may have been effectively eliminated from the area. Species specific pollinators are not common in the Cactaceae, but they do occur (Grant and Hurd, 1979). It is also possible that the presence of a diversity of pollinators in past years was affecting more frequent pollination than now occurs. Research in this area is critical if anything more than clones are to be preserved (NatureServe, 2015).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Hardwood hammocks, mangrove hammock (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Moderate sunlight (USFWS, 2013)

Geographic or Habitat Restraints or Barriers

Adult: High elevations (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Habitat Narrative

Adult: Small (1930) reported that in Florida the plants occur on bare rocks with only a slight covering of humus in hardwood hammocks near sea level. Substrate material in this area of the Keys is almost entirely Key Largo limestone with some sand. The single remaining Florida population occurs in a transitional zone between mangrove and hardwood hammock habitats (Williams, pers. comm., 1989), and the most common associate species include: *Sporobolus virginicus* (L.) Kunth., *Conocarpus erectus* L., *Maytenus phyllanthoides* Benth., *Manilkara bahamensis* (Baker) Lam. & Meeuse, *Hippomane mancinella* L., *Opuntia stricta* var. *dillenii* (Ker-Gawl.) L. Bens. Both mature extant populations of this species occur at or near mean sea level. The environmental specificity is narrow, as it currently occurs in a narrow ecotone near sea level between salt tolerant communities (salt marsh/mangrove) and hammock (fire-intolerant) communities (NatureServe, 2015). It seems to prefer areas where canopy cover and sun exposure are moderate (Grahl and Bradley 2005, p. 4) (USFWS, 2013).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available.

Population Information and Trends

Population Trends:

50 - 70% decline (NatureServe, 2015)

Species Trends:

Relatively stable (NatureServe, 2015)

Number of Populations:

6 (USFWS, 2013)

Population Size:

< 1,000 (USFWS, 2013)

Adaptability:

Low (inferred from NatureServe, 2015)

Population Narrative:

This species is unlikely to ever have been very common, but there is evidence (herbaria) that it was once more common than it currently is (extinct populations on Big Pine Key, Key Largo), with one natural, one apparently non-natural, and one recently planted population remaining. Both mature extant populations of this species occur at or near mean sea level. Intrinsic vulnerability is the most likely dominant long-term threat. This species has experienced a long-term decline of 50-70%. This plant is clonal and several small 'pups' are associated with larger, older 'trunked' individuals. Population size depends on what is considered an individual. Genetic studies suggest that there are few genetic individuals in one population (<5). The other population has 570 plants with trunks, up to 200 more without trunks, with a genetic analysis funded as of 15 Mar 03. The population now extant on Little Torch Key, in all probability, originated from wild stock of the Keys population and thus is of the same gene pool. Currently, the trend is most likely stable to a slight decline (NatureServe, 2015). Of six extant populations, one wild population and three reintroduced populations are small. The naturally occurring populations account for fewer than 1,000 plants (USFWS, 2013).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Destruction and modification of habitat from development throughout the species' range continue to be a threat to *Consolea corallicola*. Unoccupied suitable habitat throughout the species' former range is under intense development pressure. At one State-owned site where a reintroduction was attempted, all of the plants were accidentally destroyed by the expansion of a trail (USFWS, 2013).

Stressor: Fungal pathogen (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: A fungal pathogen, *Fusarium oxysporum*, can infect *Consolea corallicola*, causing crown rot, a disease in which plants rot near their base (Slapcinsky et al. 2006, p. 2; Stiling 2010, p. 191). Cacti in the Florida Keys populations that are affected by this disease have also tested positive for a fungus, *Phomopsis* sp. (Slapcinsky et al. 2006, p. 3). This disease was largely responsible for the high mortality rates in some reintroduced populations in the Florida Keys (Stiling 2010, p. 193). At present, crown rot does not appear to be affecting the population at BNP (USFWS, 2013).

Stressor: Predation (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: Predation by the moth *Cactoblastis cactorum* (Lepidoptera: Pyralidae) is considered a significant threat to *Consolea corallicola* (Stiling et al. 2000, pp. 2, 6; Gann et al. 2002, p. 481; Wright and Maschinski 2004, p. 4; Grahl and Bradley 2005, pp. 2, 7; Slapcinsky et al. 2006, pp. 2–4). Native to South America, *Cactoblastis cactorum* was introduced to Australia in 1925, as a biological control agent for nonnative species of *Opuntia*. Adult moths deposit eggs on the branches of host species. When these eggs hatch, larvae then burrow into the cacti and feed on the inner tissue of the plant's stems. The larvae then pupate, and the cycle repeats. To date, *C. cactorum* has not been observed in BNP (McDonough 2010a, pers. comm.). Even if the moth has not yet reached the BNP, it likely will, based on its rapid spread in the Caribbean and Florida. This threat has the potential to cause steep declines in populations of *Consolea corallicola* if they become infested. No satisfactory method of large-scale control is known at this time (Habeck et al. 2009, p. 2). Potential impacts to *C. corallicola* at the population level as a result of predation by *C. cactorum* are severe. Predation by the Cuban garden snail (*Zachrysia provisoria*) has been observed at one *Consolea corallicola* reintroduction site (Duquesnel 2008, pers. comm.). The population-level impact of the Cuban garden snail is not known (USFWS, 2013).

Stressor: Fire (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: Wildfire, whether naturally ignited or caused by unauthorized burning, such as bonfires, is a threat to *Consolea corallicola*. In general, these plants do not survive fires, making this a severe threat to remaining populations and occupied sites (USFWS, 2013).

Stressor: Nonnative plant species (USFWS, 2013)

Exposure:**Response:****Consequence:**

Narrative: *Schinus terebinthifolius* can dramatically change the structure of rockland hammocks, coastal berms, and shell mounds, making habitat conditions unsuitable for *Consolea corallicola*, which prefers moderate to full sun exposure. *Colubrina asiatica* is also present in BNP in areas supporting *Consolea corallicola* (McDonough 2010b, pers. comm.). Other invasive plant species that are a threat to *Consolea corallicola* include *Scaevola taccada* (beach naupaka), *Neyraudia*

reynaudiana (Burma reed), Cupaniopsis anacardioides (carrotwood), Thespesia populnea (Portia tree), Manilkara zapota (sapodilla), Hibiscus tiliaceus (hau), and Hylocereus undated (night blooming cactus) (FNAI 2010f, p. 4; Bradley et al. 2004, p. 13; McDonough 2010b, pers. comm.) (USFWS, 2013).

Stressor: Vandalism (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: For *Consolea corallicola*, vandalism has been documented twice. In 1990, branches were cut off plants at one site, but instead of being taken (as would be the case for poaching), the cut stems were left at the base of plants. In 2003, vegetative recruits and pads were damaged by unauthorized removal of protective cages from plants (Slapcinsky et al. 2006, p. 3). Due to their historic significance and possible presence of artifacts, shell mounds are susceptible to vandalism by artifact hunters. Despite regulations that protect these sites on State lands (Florida Statute 267.13), there is a long history of artifact hunters conducting unauthorized excavation of shell mounds in Florida (USFWS, 2013).

Stressor: Sea level rise (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: Suitable habitat such as coastal rock barrens on Key Largo have been inundated with saltwater during spring and fall high tides over the past 5 to 10 years; these extreme events killed planted *Consolea corallicola* at one location (Duquesnel 2011a, pers. comm.). In the future, sea level rise could cause increases in flooding frequency or duration, prolonged or complete inundation of plants, and loss of suitable habitat. A 1.8-m (5.9-ft) sea level rise would completely inundate Little Torch Key and severely reduce the area of habitat remaining on Swan Key, including all areas currently supporting *C. corallicola*. In 2100, the nearest upland habitats from Little Torch Key may be as far as 100 miles north in peninsular Florida, or 100 miles south in Cuba. On Swan Key, the species may be able to disperse to the remaining higher ground, and the location could continue to support a population given a 1.8-m (5.9-ft) sea level rise.

Stressor: Small population size (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: The two natural populations of *Consolea corallicola* are spread across 193 km (120 mi) between Biscayne Bay and Big Pine Key. One of the two remaining natural populations of *C. corallicola* consists of fewer than 20 adult plants (see table 2). Threats exacerbated by small population size include hurricanes, storm surges, and poaching. Populations can also be impacted by demographic stochasticity, where populations are skewed toward either male or female individuals by chance. This may be the case with *C. corallicola*, in which the two remaining populations do not contain any female plants. While the species may continue to reproduce indefinitely by clonal means, populations may not be viable over the long term due to a lack of genetic mixing and thus the potential to adapt to environmental changes (USFWS, 2013).

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan.

Delisting Criteria:

Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- The Nature Conservancy purchased Torchwood Hammock Preserve on Little Torch Key in 1988, to protect what was at the time the only known remaining population of *Consolea corallicola* (USFWS, 2013).
- The comprehensive conservation plan (CCP) for the Lower Florida Keys National Wildlife Refuges (National Key Deer Refuge, Key West National Wildlife Refuge, and Great White Heron National Wildlife Refuge) and Crocodile Lake National Wildlife Refuge promote the enhancement of wildlife populations by maintaining and enhancing a diversity and abundance of habitats for native plants and animals, especially imperiled species that are only found in the Florida Keys. This CCP provides specifically for maintaining and expanding populations of candidate plant species including *Consolea corallicola* (USFWS, 2013).
- *Cactoblastis* moth (*Cactoblastis cactorum*) monitoring and hand removal efforts are underway at BNP and Torchwood Hammock Preserve in an effort to protect *Consolea corallicola*. No satisfactory method of large-scale control for the *Cactoblastis* moth is known at this time. The USDA Agricultural Research Service's Center for Medical, Agricultural, and Veterinary Entomology in Tallahassee, Florida, is developing containment methods including the use of female sex pheromone wing traps and irradiation techniques to control the spread of the *Cactoblastis* moth. These techniques have not yet been approved for widespread use (USDA 2006, p. 9) (USFWS, 2013).
- Reintroductions of *Consolea corallicola* have been implemented at several locations on State lands in the Florida Keys, but these have been largely unsuccessful due to *Cactoblastis* moth predation, crown rot, and burial of small plants by leaf litter (USFWS, 2013).
- Fairchild Tropical Botanic Garden (FTBG) has 11 collections of *Consolea corallicola*, representing both wild populations, each of which is represented by at least one living specimen of at FTBG, for a total of 17 living specimens. Key West Botanical Garden (KWBG) has one collection of *Consolea corallicola* represented by several living specimens (Maschinski 2013b, pers. comm.) (USFWS, 2013).
- The Service; NPS; State of Florida; Sarasota, Charlotte, Lee, Miami-Dade, and Monroe Counties; and several local governments conduct nonnative species control efforts on sites that support *Consolea corallicola* (USFWS, 2013).

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USFWS. 2015. Environmental Conservation Online System (ECOS) – Species Profile.
<http://ecos.fws.gov/speciesProfile/>. Accessed April 2016

USFWS 2013. Determination of Endangered Status for *Chromolaena frustrata* (Cape Sable Thoroughwort), *Consolea corallicola* (Florida Semaphore Cactus), and *Harrisia aboriginum* (Aboriginal Prickly-Apple)

Final Rule. 78 FR 63795 - 63821 (October 24, 2013).

U.S. Fish and Wildlife Service. 2016. Designation of Critical Habitat for *Consolea corallicola* (Florida Semaphore Cactus) and *Harrisia aboriginum* (Aboriginal Prickly-Apple). Final Rule. 81 FR 3866-3925 (January 22, 2016).

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Determination of Endangered Status for *Chromolaena frustrata* (Cape Sable Thoroughwort), *Consolea corallicola* (Florida Semaphore Cactus), and *Harrisia aboriginum* (Aboriginal Prickly-Apple)

Final Rule. 78 Federal Register 206. October 24, 2013. Pages 63795 - 63821.

USFWS. 2013. Endangered and Threatened Wildlife and Plants

SPECIES ACCOUNT: *Cordia bellonis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 1/10/1997; Southeast Region (R4) (USFWS, 2015)

Physical Description

An arching to erect shrub of about 1 to 2 meters (3.3 to 6.6 feet) high with very slender twigs with short hairs. The leaves are alternate, oblong to oblong lanceolate, 2 to 6 centimeters (0.8 to 2.4 inches) long, usually 2.5 to 3 times longer than wide. The corolla is white with 4 subcylindric lobes. The fruit is a pointed drupe, 5 millimeters (0.2 inches) in length (Proctor 1991). The white axillary flowers are unisexual and the plants are either male or female (dioecious) (Breckon and Kolterman 1993). The flowers have a thin, reduced corolla that is adnate at its apex to the apical rim of the calyx. Breckon and Kolterman (1993) specified that all other species of the genus apparently have bisexual flowers. The plants remain dense and shrubby in open, exposed habitats, but in closed vegetation the branches become divaricating and form obtuse angles that hook the plant into the surrounding trees, forming a clambering, rigidly branched liana (Breckon and Kolterman 1993). (USFWS, 1999)

Taxonomy

Cordia L. is a genus of about 250 or more species of trees and shrubs of tropical and subtropical regions (Breckon and Kolterman 1993). *Cordia bellonis* was described by Urban (1899). Britton and Wilson (1925) described this species as a member of *Varronia* (USFWS, 1999).

Historical Range

See current range/distribution.

Current Range

It is known from only three public forests: Maricao, Susua, and Rio Abajo in Puerto Rico (USFWS, 1999). The scrambling growth form and plants that have reached the canopy make the species difficult to detect. (USFWS, 2017).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, asexual (USFWS, 1999)

Breeding Season

Adult: October - January (EPA, 2016). In general, the flowering period of *C. bellonis* occurs during the rainy season. The fructification period was recorded from the end of the rainy season and continues until the dry season (September-February). Immature fruits were synchronic from October to December and mature fruits from November to January. Observations made on female individuals indicate that fruits in *C. bellonis* plants mature

unequally. Female plants were seen with mature and immature fruits at the same time, and all fruits were single seeded. No evidence of fructification was observed in any male individuals (Sánchez-Cuervo 2006). (USFWS, 2017).

Key Resources Needed for Breeding

Adult: Insect pollinators (EPA, 2016)

Other Reproductive Information

Adult: According to Sánchez-Cuervo (2006), recruitment does not occur every year. She noted that no recruitment occurred in February 2004 in known localities compared to 2005. The recruitment period occurred during the short dry season and the beginning of the rainy season. According to her observations, recruitment occurs in one or two months around the fructification period (February) suggesting a short latency period. (USFWS, 2017). Sánchez-Cuervo (2006) also conducted diurnal and nocturnal observations during the flowering period from August to November 2004 in 3 females and 6 males to document the presence of floral visitors or pollinators. She documented 4 species of insects visiting the flowers. The most frequent visitor was a moth from the Noctuidae family (Lepidoptera), and the second most abundant species of visitor was the honey bee (*Apis mellifera* L. (Hymenoptera:Apidae). Other two species from the Syrphidae (fly) and Pompilidae (wasp) families were also recorded. Sánchez-Cuervo (2006) also collected some specimens of the visitors to determine the presence of pollen in their bodies. Since no pollen from *C. bellonis* was detected on any insect part, it was not possible to determine the presence of a “true” pollinator for the species. These visitors caused no harm to the floral parts and there was no preference to visit either male or female plants. (USFWS, 2017). Sánchez-Cuervo (2006) conducted diurnal and nocturnal observations in Maricao during the fructification period of November 2005 to determine the potential seed dispersal agents for *C. bellonis*. Her observations indicated that the majority of the fruits matured in the plant until the pericarpus (wall of the ripened fruit) was colonized or invaded by fungus and fell directly on the floor. The majority of seedlings observed were found under the canopy of female plants. According to Sánchez-Cuervo (2006), seed dispersal could be carried out by birds because of the pericarpus morphology and color of the fruit. (USFWS, 2017). Data to obtain information on average monthly growth was collected by Sánchez-Cuervo (2006) from 40 seedlings which germinated approximately in February and March 2005 after the previous fructification season (September 2004-February 2005). Seedlings grew an average of 0.46 cm from April to May and presented an average height of 3.23 cm at the beginning of the observation period (April 2005). The highest growth rate (0.83) and an average height (5.44 cm) were recorded in October, during the rainy season. Data from material germinated at the tree nursery of the Cabo Rojo National Wildlife Refuge indicated that individuals may develop into reproductive plants in less than 2 years if maintained under nursery conditions (O. Monsegur, Service, 2012, pers. obs.). (USFWS, 2017). Observations made indicate that this species do not form seed banks possibly due to soil depth (low profile). Soil type may also influence the establishment of seed banks under *C. bellonis* plants. Seed producers were found in serpentine soils and Nipe and Rosario soil series. These soils are characterized by their clay-like and sticky texture, which can make the seed emergence to the soil surface difficult. However, seedbank formation may not be discarded as it has been documented for other related species such as *V. rupicola*, and this may represent a strategy to colonize areas or colonize gaps when conditions are favorable. (USFWS, 2017).

Reproduction Narrative

Adult: Produces flowers and fruit at least from October through January. Honeybees and other insects have been observed visiting flowers (EPA, 2016). The species of *Cordia* typically have perfect (bisexual) flowers, and some species exhibit heterostyly; meaning that some plants produce flowers with short styles and long stamens, while other plants produce flowers with long styles and short stamens (Breckon and Kolterman 1993). These authors established that this condition favors outcrossing. Breckon and Kolterman (1993) reported asexual reproduction in the wild, some stems creep along the ground or under the leaf litter, and some of these were observed producing roots. Breckon and Kolterman (1996) grew 26 plants from seeds collected in Maricao; the sex ratio estimated for the cultivated plants was 7 females to 4 males (USFWS, 1999).

Habitat Type

Adult: Terrestrial (EPA, 2016)

Habitat Vegetation or Surface Water Classification

Adult: Subtropical wet forest, subtropical moist forest, and subtropical lower montane wet forest (EPA, 2016)

Geographic or Habitat Restraints or Barriers

Adult: ~752 - 2681 ft. elevation (EPA, 2016)

Environmental Specificity

Adult: Moderate (inferred from EPA, 2016)

Habitat Narrative

Adult: It is found at road edges, river margins, and steep slopes in Maricao and Susua. In Rio Abajo, it is found along sunny banks along dirt roads, growing in thickets of vegetation, and in open saddles between limestone hills. Life zones include: subtropical wet forest, subtropical moist forest, and subtropical lower montane wet forest. Topography is The area has serpentine outcrops interspersed with Nipe and Rosario clay soils (derived from serpentine). Occurs between 752 to 817 ft. (Susa); 1442 to 2681 ft. (Maricao) (EPA, 2016).

Dispersal/Migration**Dependency on Other Individuals or Species for Dispersal**

Adult: Unknown (EPA, 2016)

Dispersal/Migration Narrative

Adult: Dispersal mechanisms are unknown (EPA, 2016).

Population Information and Trends**Population Trends:**

Not available

Resiliency:

Low (inferred from USFWS, 1999; see current range/distribution)

Redundancy:

Low (inferred from USFWS, 1999; see current range/distribution)

Population Size:

~81 (USFWS, 1999). As of 2017: ~275 (USFWS, 2017).

Additional Population-level Information:

Approximately 226 individuals of *C. bellonis* were reported by Sánchez-Cuervo (2006) from the Maricao (192), Río Abajo (34) and Susúa (0) Commonwealth Forest. However, initial surveys under an ongoing project between the Service, PRDNER and the Royal Botanical Garden (KEW) to determine the population status of *C. bellonis* (Coop. Agreement F15AC01225) shows that as of the day of this review there are at least 275 detected individuals within the Maricao (255) and Río Abajo Commonwealth Forest (20), with further surveys planned along the northern karst and the Susúa Commonwealth Forest (Hamilton 2017). Some individuals are at sites of reintroduction. (USFWS, 2017). According to Sanchez-Cuervo (2006), the species may be extirpated from the Susua Commonwealth Forest, and some historical locations in the Rio Abajo and Maricao Commonwealth forests were not located during the research. In addition, the distribution of the species in Puerto Rico has expanded to privately owned lands within the municipality of Maricao, and in the municipalities of Ciales and Utuado (Hamilton 2017). (USFWS, 2019).

Population Narrative:

Only 81 individuals of *Cordia bellonis* are known to occur in the wild (USFWS, 1999).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 1999).

Exposure:

Response:

Consequence:

Narrative: Destruction and modification of the habitat are considered to be the most significant factors affecting the numbers and distribution of *Cordia bellonis*. In Maricao, the species is found at 17 localities in three areas, with a total of 87 individuals. Thirty-four of these individuals were eliminated due to clearing along the roadside and the reconstruction of Road 362. Half of the localities consist of isolated individuals. Because the majority of these individuals occur along both sides of two public roads, maintenance of road sides, as well as fires and vandalism, may result in the loss of these individuals. In Susua, a small population of only 5 individuals was found in 1992. The species was previously unknown from this area. This small population may be affected by certain forest management practices. Ninety-five individuals were located along the construction route for a highway (which is now completed) and were removed for possible future transplantation. Of the remaining 23 individuals, 13 have been found in an area designated for compensation (mitigation) for the highway and 10 are found in highway rights-of-way. The species is also known from a private landholding where extraction of fill material for the construction of the road will likely result in the loss of these plants (USFWS, 1999). Activities along Road PR-120 in Maricao Commonwealth Forest continue to be a threat to the species. (USFWS, 2019).

Stressor: Other natural and manmade factors (USFWS, 2019).

Exposure:**Response:****Consequence:**

Narrative: Human-induced fires, river flooding, landslides, hurricanes. (USFWS, 2019).

Recovery**Reclassification Criteria:**

Not available

Delisting Criteria:

1. A management plan that considers the protection and recovery of the species has been prepared and implemented for the Maricao, Susua and Rio Abajo Commonwealth Forests (USFWS, 1999).

2. New populations (the number of which should be determined following the appropriate studies) capable of self perpetuation have been established within protected areas. One of these populations should be established using the 111 individuals already located at the Cambalache greenhouse (USFWS, 1999).

Amended criteria in 2019: 1) Existing three (3) main populations at Rio Abajo, Maricao and Susua Commonwealth forests show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factor A and E). (USFWS, 2019).

Amended criteria in 2019: 2) Existing three (3) populations on privately-owned lands in Maricao, Ciales and Utuado are protected via a conservation mechanism, and show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factor A and E). (USFWS, 2019).

Amended criteria in 2019: 3) Threat reduction and management activities have been implemented to a degree the species will remain viable into the foreseeable future (addresses Factor E). (USFWS, 2019).

Recovery Actions:

- Educate the public on conservation values and regulations (USFWS, 1999).
- Search for additional populations and potential habitat suitable for reintroduction efforts (USFWS, 1999).
- Conduct research on the life history of the species and evaluate propagation techniques (USFWS, 1999).
- Conduct propagation and enhance existing populations and establish new ones on protected lands (USFWS, 1999).
- Annually assess the overall success of the recovery program and recommend actions (USFWS, 1999).
- Protect the existing populations and its habitat through the development and implementation of a management plan for the Maricao, Susua and Rio Abajo Commonwealth Forests (USFWS, 1999).
- Monitor known populations (USFWS, 1999).

- Enforce existing Commonwealth and Federal endangered species regulations (USFWS, 1999).
- Reintroduce transplanted individuals (USFWS, 1999).
- 2017 Recommended actions: a. The PRDNER and the Service should develop a comprehensive survey program to inventory areas with potential habitat for *C. bellonis* in Río Abajo, Susúa and Maricao Commonwealth Forests. (USFWS, 2017).
- 2017 - b. Studies should be conducted to determine the patterns of genetic variation within and among populations in order to develop a plan to preserve the species genetic variability. (USFWS, 2017).
- 2017 - c. Development of a habitat suitability model for the species (USFWS, 2017).
- 2017 - d. Development of management plans or establishment of management practices in areas where the species occur to avoid and/or minimize impacts by road or trails maintenance activities. (USFWS, 2017).

Conservation Measures and Best Management Practices:

- Conservation measures provided to federally listed species include recognition, recovery actions, requirements for Federal protection, and prohibitions against certain practices. Recognition through listing encourages and results in conservation actions by Federal, State, and private groups and individuals. The Endangered Species Act provides for possible land acquisition in cooperation with the States and requires that recovery actions be carried out for all listed species. Section 7(a) of the Act, as amended, requires Federal agencies to evaluate their actions with respect to any species that is listed as federally endangered or threatened. If a Federal action may affect a listed species or its critical habitat, the responsible Federal agency must enter into formal consultation with the Fish and Wildlife Service (USFWS, 1999).
- Studies of the distribution, abundance, population size and structure, and reproductive biology of *Cordia bellonis* have been ongoing since 1993. These studies have provided information on the threats to the species. Preliminary results from these studies have been incorporated into this recovery plan (USFWS, 1999).

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USFWS. 2019. Recovery Plan for *Cordia bellonis*, Amendment 1. USFWS, Atlanta, Georgia. 5 pp.

SPECIES ACCOUNT: *Cordylanthus maritimus* ssp. *maritimus* (Salt marsh bird's-beak)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/29/1978; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

A hemiparasitic annual herb, 1-3 dm tall, with grayish-green, herbage, often tinged with purple. Specimens are branched and may be up to 16 inches (40 centimeters) tall with numerous flowers arranged on flower stalks termed spikes. The flowers of some *C. maritimus* taxa have showy pale pink pouches with darker purple lips on purplish-green plants. The hairiness of the foliage and stems is variable, and most plants have visible salt-encrusted glandular hairs. *Chloropyron maritimus* ssp. *maritimus* may occur as short, erect, scarcely branched plants, or as plants with a profusion of spreading or ascending branches. (USFWS, 2013; NatureServe, 2015)

Taxonomy

At the time *Chloropyron maritimus* ssp. *maritimus* was listed (as *Cordylanthus maritimus* ssp. *maritimus*), the genus *Cordylanthus* was placed in the Scrophulariaceae (figwort family). However, based on molecular systematic studies using DNA sequences of three plastid genes, Olmstead et al. (2001) transferred the hemiparasitic group Castillejiinae, including *Cordylanthus*, to the Orobanchaceae. Though the taxon continues to be called *Cordylanthus maritimus* ssp. *maritimus* on the Federal List of Threatened and Endangered Wildlife and Plants (List) pursuant to the Endangered Species Act (Act) (16 U.S.C. 1531 et seq.), here we use the currently accepted name, *Chloropyron maritimus* ssp. *maritimus*. The species is divided into northern and southern coastal subspecies, and an inland subspecies. *Chloropyron maritimus* ssp. *maritimus*, the southern California coastal subspecies, is distinguished from the northern ssp. *palustris*, mainly by geographic distribution in that it occurs from Morro Bay south through southern California. It is also distinguished by branching patterns, growth habit, narrower and more acute leaves, and variations in seed size and floral traits (Chuang and Heckard 1973, 1993). The three intergrading subspecies have distinct ecological and geographical distributions. *Chloropyron maritimus* ssp. *canescens* (hoary salt marsh bird's-beak) is a widely distributed, but uncommon, plant of inland saline/alkaline wetlands of the Great Basin; *Chloropyron maritimus* ssp. *maritimus* (salt marsh bird's-beak), an endangered tidal marsh plant limited to few populations in southern California and Baja California, Mexico; and *Chloropyron maritimus* ssp. *palustre* (Point Reyes bird's-beak), a similar rare tidal marsh plant from San Francisco Bay to Oregon. (USFWS, 2013)

Historical Range

Historically, *C. maritimus* ssp. *maritimus* was widespread near the upper edges of coastal tidal marshes from Morro Bay in San Luis Obispo County to San Diego County and northern Baja California. (USFWS, 2013)

Current Range

Chloropyron maritimus subsp. *maritimus* is currently known to persist in seven coastal salt marshes: San Diego County at Tijuana Estuary (separated into Border Field State Park and

Tijuana Slough NWR), Naval Radar Receiving Facility (NRRF), and Sweetwater Marsh Unit of San Diego Bay NWR; Orange County at Upper Newport Bay (State) Ecological Reserve; Ventura County at Naval Base Ventura County, Point Mugu; Santa Barbara County at Carpinteria Salt Marsh; San Luis Obispo County at Morro Bay. (USFWS, 2009)

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (NatureServe, 2015)

Dependency on Other Individuals or Species

Adult: Bees are thought to be the principal pollinators of ssp. maritimum at other locations (Parsons and Zedler 1997).

Breeding Season

Adult: May to October (USFWS, 2009)

Reproduction Narrative

Adult: Chloropyron maritimum subsp. maritimum is a taxon of annual plants in the Orobanchaceae (broom rape family). The flowering period is between May and October (Munz 1974, p. 801; Naval Base Ventura County Point Mugu 2003, p. 1). Each flower may produce 10-40 seeds with an average of 15 to 20 seeds per capsule (Chuang and Heckard 1993, p. 1029). (USFWS, 2009)

Habitat Type

Adult: Estuarine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Herbaceous wetland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Requires water salinities between 5 to 33 parts per thousand and less than 12 parts per thousand for germination (USFWS, 2013)

Geographic or Habitat Restraints or Barriers

Adult: Requires periodic tidal inundation; prefers brackish to tidal marsh with low vegetative cover (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Patchy (USFWS, 2009)

Environmental Specificity

Adult: Narrow/specialist

Habitat Narrative

Adult: Plants have naturally patchy distributions in sites subject to only higher tidal influxes in coastal salt marshes. (USFWS, 2009). The range of salinity associated with growth of ssp. maritimum is 5 to 33 parts per thousand, but pulses of freshwater from flooding or rainfall are probably necessary for germination (Parsons and Zedler 1997). Salinity at the time of germination usually cannot exceed 12 parts per thousand (Newman 1981). Populations generally occur in areas with low salinity in the spring and low vegetative cover (Newman 1981, Dunn 1981). *Cordylanthus maritimus* ssp. maritimus roots form haustoria to obtain water and nutrients through the roots of other host plants. *Chloropyron maritimum* ssp. maritimum can grow without host plants (Chuang and Heckard 1971), but hemiparasitism may permit them to flourish in the hot, dry, higher soil-salinity conditions of summer (Vanderwier and Newman 1984). (USFWS, 2013; USFWS, 2009)

Dispersal/Migration**Dispersal**

Adult: High (USFWS, 2013)

Dependency on Other Individuals or Species for Dispersal

Adult: Animals, especially birds (USFWS, 2013)

Dispersal/Migration Narrative

Adult: Physical factors such as currents, tides, wave action, and sheet erosion are among the ways seeds are moved around within and between marshes. The seeds of *C. maritimum* ssp. maritimum have a honeycombed surface that traps air bubbles and makes them highly buoyant. They have been shown to float for up to 50 days and floatation may be the primary local dispersal mechanism for *C. maritimum* ssp. maritimum (Newman 1981). Animals, especially birds, may carry the seeds on their feet, or in their fur, feathers, or digestive systems (U.S. Fish and Wildlife Service 1985a). (USFWS, 2013)

Population Information and Trends**Population Trends:**

Decline of >30% (NatureServe, 2015)

Resiliency:

Low (inferred from USFWS, 2013)

Representation:

Low (inferred from USFWS, 2013)

Redundancy:

Low (inferred from USFWS, 2013)

Number of Populations:

37 (USFWS, 2009)

Population Size:

30,000 (highly variable) (NatureServe, 2015)

Population Narrative:

C. maritimus var. *maritimus* is rare, while the typical form is fairly common. (B. Csuti) *C. maritimus* var. *maritimus* plants can number 30,000 in good years at San Quintin Bay in Baja California (S. Vanderplank pers. comm. 2009). The CNDDDB currently recognizes 37 separate element occurrences (EOs) for this plant (CNDDDB 2008), although short-term trends suggest a greater than 30% decline. (USFWS, 2009; USFWS, 2013; NatureServe, 2015)

Threats and Stressors

Stressor: Habitat loss (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Historically, *Chloropyron maritimum* subsp. *maritimum* occurred in many more salt marshes than it did at the time of listing. Many of these salt marsh areas were either filled in for development (e.g. Artesia and Long Beach in Los Angeles County) or cleared for marinas (e.g. Mesmer near Santa Monica in Los Angeles County). Diversion of fresh water from the salt marsh areas may also have led to the habitat becoming unsuitable to sustain *C. maritimum* subsp. *maritimum* populations. (USFWS, 2009)

Stressor: Off-highway vehicles (OHVs) (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Impacts from off-highway vehicles have been reported for some occurrences of *Chloropyron maritimum* subsp. *maritimum* (CNDDDB 2008). These occurrences are in San Diego County in an area of the Tijuana Slough NWR in the Tijuana Estuary where OHV activity is controlled by the Refuge managers; in Orange County at Upper Newport Bay where OHV activity is controlled by managers of the Upper Newport Bay State Ecological Reserve; in Ventura County at Ormond Beach where OHV activity is controlled to a degree by the Coastal Conservancy and The Nature Conservancy's Conservation Easement, and at the Ventura County Naval Base Point Mugu (CNDDDB 2008). Potential impacts from OHVs are currently minimal and management measures are in place to minimize these impacts. (USFWS, 2009)

Stressor: Hydrological changes (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Modification for natural tidal flow in Point Mugu Lagoon in Ventura County, noted as a threat in the listing rule, was completed in about 1980. As a result, a portion of the populations at the occurrence were destroyed, but most remained. Since listing, increased tidal flow at one site in the Carpinteria Marsh in 1984 reportedly created wetter conditions (CNDDDB 2008, EO 17). However, there are no subsequent reports on the precise location of the site or condition of plants in the area and occurrences in the area are presumed to be extant (CNDDDB 2008). Hydrological alterations to promote populations of endangered birds (e.g., light-footed clapper

rail) have taken place at historical occurrence sites of *Chloropyron maritimum* subsp. *maritimum*, though the impact on plant populations is unknown. (USFWS, 2009)

Stressor: Global climate change (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: According to the Intergovernmental Panel on Climate Change (IPCC) there has been a general but measured increase in global average temperatures since the turn of the century (IPCC WG I 2007, p. 6). This translates to the fact that the average temperature of the ocean has also risen. The same is true for global average sea level (IPCC WG I 2007, p. 6). The total rise in sea level during the 20th century is estimated to be about 0.56 feet (0.17 meters). This means that the tidal flows will encroach further into all coastal marshes including those that support *C. m. subsp. maritimum*. The impact on distribution of associated vegetation and host plants is unknown. Although the degree of sensitivity *Chloropyron maritimum* subsp. *maritimum* to incremental changes in sea level is unknown, ultimately, it is likely that the full extent and distribution of populations will be affected and likely move inland or up the elevational gradient. The populations could potentially migrate inland in step with changes in the estuarine hydrology as long as the physiography of the site allowed. The physiography of each occurrence differs, which in turn dictates whether or not *C. maritimum* subsp. *maritimum* can naturally migrate to other suitable sites. The potential for adjacent habitats to become suitable for *C. maritimum* subsp. *maritimum* as the inundation regime changes also likely varies from occurrence to occurrence. Habitat for *C. maritimum* subsp. *maritimum* at generally broad open estuaries such as Tijuana Estuary in San Diego County and Point Mugu in Ventura County would persist more readily than that at Newport Bay in Orange County where the adjacent bluffs could preclude inland migration of the habitat. Sea level rise poses a significant rangewide threat to all extant occurrences of *C. maritimum* subsp. *maritimum* and coastal marsh areas under consideration for restoration and/or enhancement. (USFWS, 2009)

Stressor: Storm drain runoff (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Since listing, erosion from storm drain runoff is listed as a threat to occurrences in Upper Newport Bay in Orange County (CNBBB 2008). This runoff is generated by neighborhoods on the bluffs above the bay. Projections of precipitation as less snow and more rain (CEC 2006, p. 31) mean that there would likely be more runoff than is currently experienced. The amount and timing of runoff impacts coastal salt marsh habitat and any changes due to climate change likely result in changes to the condition and distribution of suitable habitat for *Chloropyron maritimum* subsp. *maritimum*. (USFWS, 2009)

Stressor: Herbivory (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Since listing, herbivory by the microlepidopteran, salt marsh snout moth (*Lipographis fenestrella*) has been documented (Parsons and Zedler 1997, p. 259). This is listed in CNDDB as insect damage for a few of the occurrences (Appendix 1). The larvae of the moth consume

capsules and even unfertilized ovaries, however, a large number of capsules escape attack (Parsons and Zedler 1997, p. 259). These authors report that although there was more damage between mid-May and mid-June there was no correlation with environmental variables. The extent and impact of herbivory to populations of *Chloropyron maritimum* subsp. *maritimum* is unknown. (USFWS, 2009)

Stressor: Trampling (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Since listing, new threats from trampling have been reported for occurrences at the Naval Radar Receiving Station (NRRF), San Diego County, Upper Newport Bay Ecological Reserve, Orange County, and at the south end of Morro Bay, San Luis Obispo County (Appendix 1). The extent and persistence of the threats from trampling is unknown. (USFWS, 2009)

Stressor: Nonnative plants (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Since listing nonnative plants (e.g. *Limonium* spp. (sea-lavender) and *Carpobrotus* spp. (sea-fig)) have been noted as a new threat to *Chloropyron maritimum* subsp. *maritimum* at occurrences in Santa Barbara County (e.g., Carpinteria) (CNDDDB 2008) and San Luis Obispo County (e.g., Morro Bay) (CNDDDB 2008). No specific impacts were provided, thus the nature and magnitude of this threat cannot be assessed at this time. These invasive plants may alter movement and availability of fresh water or otherwise preclude germination and growth of the *Chloropyron maritimum* subsp. *maritimum* and/or its hosts. (USFWS, 2009)

Recovery

Reclassification Criteria:

1. Fifteen acres [6 hectares] of secured and protected high marsh habitat at appropriate elevations is required at a minimum of eight marshes for a period of at least five consecutive years. (USFWS, 2009)

Delisting Criteria:

1. Twenty acres [8 hectares] of secured, protected, and managed high marsh habitat at appropriate elevations is required at each of the 12 major marshes within the historical range of the plant for a period of ten consecutive years. (USFWS, 2009)

Recovery Actions:

- Conservation easements or fee-title purchase from willing sellers should be sought to place remaining undeveloped shoreline under protective ownership. (USFWS, 2013)
- Many of the threats facing the subspecies are aggravated by its small population size and limited range-wide distribution; therefore, population augmentation and initiation of new subpopulations in suitable unoccupied habitat at Morro Bay should be planned and implemented to reduce the risk of regional extinction. (USFWS, 2013)
- Morro Bay populations of *Chloropyron maritimum* ssp. *maritimum* are sensitive to trampling and disturbance and should be protected, by use of fencing, against recreational pressures

from nearby residential areas and from park visitors. Access and trails should be routed away from sensitive habitat. Boat haulouts near populations of *C. maritimum* ssp. *maritimum* must be curtailed. Dredge disposal should be managed to minimize the risk of sand movement burying subpopulations of the species. (USFWS, 2013)

- Shoreline stands of *Carpobrotus edulis* (iceplant) should be eradicated and replaced with native marsh-upland ecotone vegetation. Other non-native plants should be controlled to prevent crowding, shading, or other impacts to the salt marsh bird's-beak and its habitat. (USFWS, 2013)
- Populations of *Chloropyron maritimum* ssp. *maritimum* should be monitored annually for distribution, abundance, and reproductive output. (USFWS, 2013)
- Continuing and new threats should be identified and reported. Disturbances and sand dune movement should be monitored, and measures to address impacts—as well as to evaluate the success of these measures—should be developed. (USFWS, 2013)
- Management plans that address protective and population augmentation actions for *Chloropyron maritimum* ssp. *maritimum* should be developed and implemented for lands in public or conservation ownership. (USFWS, 2013)

Conservation Measures and Best Management Practices:

- Resurvey historical and extant occurrences, especially inland salt marsh habitats, to detect presence and local distribution of plants. There is some potential for the inland occurrences to have persisted. (USFWS, 2009)
- Develop a threats-based recovery plan to guide conservation actions for the species. Incorporate SLAMM assessments of sea level change. (USFWS, 2009)
- Determine the distribution of genetic diversity at extant occurrences. This will assist us in identifying pollinators and pollen sources should pollen transfer among occurrences prove necessary. As part of this effort, verify the subspecific relationships of the occurrences in Morro Bay. (USFWS, 2009)
- Prepare site specific monitoring protocols to determine, if possible, fine-scale habitat requirements and species fidelity to those habitat requirements. This will allow us to discriminate between lack of seed dispersal and unsuitable habitat as explanations for discontinuities in plant distributions. (USFWS, 2009)
- Establish site and species monitoring protocols, based on those developed by VFWO at Point Mugu, to identify potential impacts of sea level changes associated with climate change. This will help detection of species responses to long term changes in sea level and associated vegetation. (USFWS, 2009)
- Work with partners to help conserve *Chloropyron maritimum* subsp. *maritimum*. Identify opportunities through the Service's Partners for Fish and Wildlife and Coastal Programs to seek habitat restoration and enhancement opportunities. (USFWS, 2009)

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SPECIES ACCOUNT: *Cordylanthus mollis* ssp. *mollis* (Soft bird's-beak)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/20/1997; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

Chloropyron molle ssp. *molle* is an erect annual herb in the Orobanchaceae (broomrape) family. Mature plants range from approximately 10 to 40 cm (4 to 16 in) tall. Stems and leaves are gray-green, often purple-tinged, and covered with very fine hairs bearing glands as well as longer soft non-glandular hairs. Leaves and stems are sparsely to heavily covered with crystals of salt exuded from leaf glands. Leaves are typically 1.0 to 2.5 cm (less than 0.5 to 1.5 in long, oblong, and may be entire or pinnately lobed 3 to 7 lobes). The tubular flowers are pale cream to yellowish at the tip, and crowded together in spikes 5.0 to 15.0 cm (2 to 6 in long). The fruit is a capsule, approximately 8 mm (0.3 inch) long (Ruygt 1994). (USFWS, 2013)

Taxonomy

At the time *Chloropyron molle* ssp. *molle* was listed (as *Cordylanthus mollis* ssp. *mollis*), the genus *Cordylanthus* was placed in the Scrophulariaceae (figwort family). However, based on molecular systematic studies using DNA sequences of three plastid genes, Olmstead et al. (2001) transferred the hemiparasitic group Castillejiinae, including *Cordylanthus*, to the Orobanchaceae, thereby placing it in the genus *Chloropyron*. The species *Cordylanthus mollis* was split into two subspecies by Chuang and Heckard (1973), based on geographic variation in spike length, branching pattern, corolla hair density, seed size, and hair stiffness. *Chloropyron mollis* ssp. *hispidus* is distinguished from ssp. *molle* by its pronounced bristly stem and leaf hairs, and its growth habit of branching strongly from the base of the plant. The flowers of ssp. *hispidus* are sparsely hairy, not densely tomentose (woolly) as in ssp. *mollis*. Within its range, *Chloropyron molle* ssp. *molle* can be distinguished from two other taxa in the Scrophulariaceae that occur in brackish tidal marshes: *Chloropyron maritimum* ssp. *palustre* and *Castilleja ambigua*. When in flower, *C. maritimum* ssp. *palustre* is readily distinguished from *C. molle* by its rose-purple and pinkish-white flowers, and the presence of four fully developed stamens (not two plus two vestigial stamens, as in *C. molle*). The inner bracts of *C. maritimum* ssp. *palustre* are notched, not lobed, while the bracts of *C. mollis* are pinnately lobed. *C. ambigua* flowers in spring (variably late March to May) before *C. molle*. The bracts and leaves of *C. ambigua* are palmately cleft, not pinnately lobed as in *C. molle*. Although, typical *C. ambigua* ssp. *ambigua* has white and yellow flowers like *C. molle*, the Point Pinole population of ssp. *ambigua* and other historical San Francisco Bay populations have flowers that mature and senesce with a purplish tinge (P. Baye unpubl. data 1997-2000), as do the white-tipped bracts (Chuang and Heckard 1993). In contrast, the bracts of *C. molle* are gray-green or a blend of gray-green and dull dark purplish highlights, and its flowers are creamy yellow or yellowish-green and lack an open beak tip that allows the stigma to protrude (Chuang and Heckard 1993). (USFWS, 2013)

Historical Range

Endemic to California, reported from Contra Costa, Marin, Napa, Solano, Sonoma, Sacramento, and Del Norte counties. (NatureServe, 2015)

Current Range

The species is currently restricted to widely scattered populations in Napa, Solano, and Contra Costa Counties, from Point Pinole and Fagan Slough marsh through the Carquinez Strait to Suisun Bay. (USFWS, 2009)

Critical Habitat Designated

Yes; 4/12/2007.

Legal Description

On April 12, 2007, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Cordylanthus mollis* ssp. *mollis* (Soft bird's-beak) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes five critical habitat units (CHUs), in California (72 FR 18518-18553).

Critical Habitat Designation

The critical habitat designation for *Cordylanthus mollis* ssp. *mollis* includes five CHUs in Contra Costa, Napa, and Solano Counties, California. This species critical habitat encompasses approximately 2,276 acres (ac) (921 hectares (ha)) (72 FR 18518-18553).

Unit 1: Fagan Slough Marsh (Napa County): Unit 1 consists of approximately 384 ac (156 ha) located adjacent to the Napa River to the west, Napa County Airport to the east, Fagan Slough to the south, and Steamboat Slough to the north. This unit consists of 297 ac (120 ha) of Stateowned land (Fagan Slough Ecological Reserve), which is managed by the CDFG, 6 ac (2 ha) of county-owned land, 9 ac (4 ha) of land owned by the City of Napa, and 72 ac (29 ha) of privately owned land. *Cordylanthus mollis* ssp. *mollis* occupied the unit at the time of listing as identified in the final listing rule (62 FR 61916; November 20, 1997) and contains the features essential to the conservation of *C. mollis* ssp. *mollis*. The unit receives tidal inundations regularly (NWI 2005) from the abovementioned tidal sloughs and the Napa River.

Unit 2: Hill Slough Marsh (Solano County): Unit 2 for *Cordylanthus mollis* ssp. *mollis* consists of approximately 525 ac (213 ha) located north of Potrero Hills between Grizzly Island Road and Highway 12. The unit consists of approximately 440 ac (178 ha) of Stateowned land (Hill Slough Wildlife Area), which is managed by the CDFG, and 85 ac (35 ha) of privately owned land. *Cordylanthus mollis* ssp. *mollis* occupied the unit at the time of listing as identified in the final listing rule (62 FR 61916; November 20, 1997) and contains the features essential to the conservation of *C. mollis* ssp. *mollis*. The unit receives tidal inundations irregularly (not daily) (NWI 2005) from Hill Slough and a flood control channel along the western unit boundary.

Unit 3: Point Pinole Shoreline (Contra Costa County): Unit 3 consists of approximately 22 ac (9 ha) located along the Contra Costa shoreline in San Pablo Bay just east of Point Pinole. This unit consists of 13 ac (5 ha) of County-owned land (Point Pinole Regional Shoreline Park), which is managed by the East Bay Regional Park District, and 9 ac (4 ha) of Stateowned land. *Cordylanthus mollis* ssp. *mollis* occupied the unit at the time of listing as identified in the final listing rule (62 FR 61916; November 20, 1997) and contains the features essential to the conservation of *C. mollis* ssp. *mollis*. The unit receives tidal inundations on a regular basis (NWI 2005) from natural and artificial (dredged) tidal channels within the unit. Additional special management considerations or protections beyond those discussed above may be required to minimize the impact of industrial or commercial encroachment from the south that could increase stormwater and wastewater runoff into the unit.

Unit 4: Rush Ranch/Grizzly Island Wildlife Area (Solano County): Unit 4 for *Cordylanthus mollis* ssp. *mollis* consists of approximately 1,181 ac (477 ha) located adjacent to Suisun Slough to the west, Cutoff and Montezuma Sloughs to the south, and Potrero Hills to the North. This unit consists of 231 ac (93 ha) of State-owned land (Joice Island portion of the Grizzly Island Wildlife Area), which is managed by the CDFG, and 950 ac (384 ha) of land owned and managed by the Solano Land Trust (local non-profit public land trust). *Cordylanthus mollis* ssp. *mollis* occupied the unit at the time of listing as identified in the final listing rule (62 FR 61916; November 20, 1997) and contains the features essential to the conservation of *C. mollis* ssp. *mollis*. The unit receives tidal inundations regularly (at least once daily) (NWI 2005) from the above-mentioned tidal sloughs).

Unit 5: Southampton Marsh (Solano County): Unit 5 consists of approximately 164 ac (66 ha) of State-owned land managed by the California Department of Parks and Recreation (CDPR) as a wetland natural preserve (CDPR 1991, p. 44). The unit is located in the Benicia State Recreational Area along Interstate Highway 780 and just northwest of the City of Benicia. *Cordylanthus mollis* ssp. *mollis* occupied the unit at the time of listing as identified in the final listing rule (62 FR 61916; November 20, 1997) and contains the features essential to the conservation of *C. mollis* ssp. *mollis*. The unit receives tidal inundations on a regular-to-irregular basis (NWI 2005) from natural and artificial (dredged) tidal channels within the unit. Additional special management considerations or protection of the PCEs beyond those discussed above may be required to minimize the impact of residential encroachment from the north that could increase stormwater and wastewater runoff into the unit.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Cordylanthus mollis* ssp. *mollis* critical habitat consists of three components (72 FR 18518-18553):

- (i) Persistent emergent, intertidal, estuarine wetland at or above the mean high-water line (as extended directly across any intersecting channels);
- (ii) Open channels that periodically contain moving water with ocean-derived salts in excess of 0.5 percent; and
- (iii) Gaps in surrounding vegetation to allow for seed germination and growth.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the areas determined to be occupied at the time of listing and that contain the PCEs may require special management considerations or protection. Most of the PCEs and the known occurrences of *Cirsium hydrophilum* var. *hydrophilum* and *Cordylanthus mollis* ssp. *mollis* are threatened by: (1) tidal wetland conversions to diked, managed, or muted tidal marshes; (2) changes to channel water salinity and tidal regimes; (3) mosquito abatement activities; (4) marsh invasions by nonnative plants; (5) plant-eating insects; (6) urban, industrial, and agricultural encroachment; (7) impacts from livestock overgrazing; (8) feral pigs (*Sus scrofa*); and (9) impacts from unauthorized foot and off-road vehicle traffic. These combined threats result in the loss and fragmentation of suitable habitat for *C. hydrophilum* var. *hydrophilum* and *C. mollis* ssp. *mollis*, which could significantly affect their

long-term survival. Individually, these threats may require special management considerations or protection as addressed under the critical habitat unit descriptions below.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Sexual (NatureServe, 2015)

Lifespan

Adult: 1 year (USFWS, 2009)

Breeding Season

Adult: July to September (NatureServe, 2015)

Reproduction Narrative

Adult: *Cordylanthus mollis* ssp. *mollis* is a hemiparasitic annual herb in the Orobanchaceae (broomrape) family with flowers that bloom from July to September. The number of seeds produced per plant ranged from 91 to 790, depending on year and microhabitat (Futrell in litt. 2013). *C. mollis* ssp. *mollis* can hybridize with *C. mollis* ssp. *hispidus* indicating sexual reproduction (USFWS, 2009; USFWS, 2013)

Habitat Type

Adult: Estuarine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Tidal flat/shore (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Prefers higher soil salinity and hydroperiods (USFWS, 2013)

Geographic or Habitat Restraints or Barriers

Adult: Found in high marsh near limits of tidal action (USFWS, 2009)

Spatial Arrangements of the Population

Adult: Colonies (USFWS, 2013)

Dependency on Other Individuals or Species for Habitat

Adult: As a hemiparasitic plant, seedling survival in *Cordylanthus mollis* ssp. *mollis* is critically dependent on establishing an early connection with a suitable host plant. (USFWS, 2009)

Habitat Narrative

Adult: *Cordylanthus mollis* ssp. *mollis* is found predominantly in the high marsh (upper reaches) of salt grass-pickleweed marshes at or near the limits of tidal action (Stromberg and Villasenor 1986) and is associated with *Salicornia virginica* (pickleweed), *Distichlis spicata* (salt grass), *Jaumea carnosa* (fleshy jaumea), *Frankenia salina* (alkali heath), and *Troglochin maritima* (arrow-grass) (Stromberg and Villasenor 1986). Seedling survival in *Cordylanthus mollis* ssp. *mollis* is

critically dependent on establishing a connection with a suitable host plant. Typical host plants include *Distichlis spicata* (salt grass) and *Salicornia virginica* (pickleweed) (Grewell et. al. 2003, Grewell 2004). Most known *Cordylanthus mollis* ssp. *mollis* occurrences are found in regularly flooded and permanently saturated habitats within mixed halophytic plant communities, that is, communities where plants are adapted to live and reproduce in salt or brackish water (NWI 2005) with extended tidal hydroperiods and somewhat higher soil salinity (Grewell 2004). (USFWS, 2009; USFWS, 2013)

Dispersal/Migration

Dispersal

Adult: Moderate (USFWS, 2009)

Dispersal/Migration Narrative

Adult: Seeds may disperse short distances from parent plants by tidal inundations or animals (Grewell et al. 2003), but successful long-distance dispersal by these or other means has not been documented. Repeated surveys indicate that most dispersal occurs over short distances (Ruygt 1994) on the order of 10 meters [11 yds] or less (Grewell et al. 2003). (USFWS, 2009)

Population Information and Trends

Population Trends:

Not available

Resiliency:

Low (inferred from USFWS, 2009)

Representation:

Low (inferred from USFWS, 2009)

Redundancy:

Low (inferred from USFWS, 2009)

Number of Populations:

11 (USFWS, 2009)

Population Narrative:

Although no recent comprehensive status surveys have been conducted, the latest information indicates that 11 extant populations of *Cordylanthus mollis* ssp. *mollis* are currently distributed within 50 percent of the historical range and that a large percentage of the remaining plants are in Solano County (Grewell et. al. 2003). In the final listing rule, it was reported that the number of individuals within the populations varied from 1 to 150,000 plants and that most sites varied between 1,000 and 6,000 plants (CNDDB 1996). (USFWS, 2009)

Threats and Stressors

Stressor: Altered tidal regimes (USFWS, 2009)

Exposure:

Response:**Consequence:**

Narrative: Since listing, continuation of altered tidal regimes still occurs in much of the potential habitat and represents both the most significant historical and current threat to *Cordylanthus mollis* ssp. *mollis* and its habitat. With respect to effects to *C. mollis* ssp. *mollis*, alteration of tidal regime includes muting of tidal flows, increases in freshwater runoff, or decreases in freshwater inflows such as diversion of freshwater for agricultural and municipal uses, that increase salinity. (USFWS, 2009)

Stressor: Habitat loss (USFWS, 2009)

Exposure:**Response:****Consequence:**

Narrative: *Cordylanthus mollis* ssp. *mollis* habitat in the San Francisco estuary has dwindled over the last 200 years, San Pablo Bay and Suisun Bay having experienced 70 and 79 percent reductions in tidal marsh, respectively (Goals Project 1999). Historically, a large portion of tidal marshes in San Pablo Bay were diked and managed for agricultural production and livestock grazing (discussed further under Factor E), whereas, in Suisun Bay, most historical tidal marshes were diked and managed for waterfowl, though cattle grazing also occurred. These historical reductions of habitat have affected the extent and composition of tidal marsh communities. As a result, many native halophytic (salt-tolerant) plants are exceedingly rare in tidal marshes within the estuary (Goals Project 1999). (USFWS, 2009)

Stressor: Muting tidal flows (USFWS, 2009)

Exposure:**Response:****Consequence:**

Narrative: Some *Cordylanthus mollis* ssp. *mollis* occurrences exist in muted tidal marshes around the perimeter of high tidal areas near Hill Slough and Fagan Slough marshes, where they were once completely diked and managed. The occurrences of *C. mollis* ssp. *mollis* populations in muted marshes, though, may likely be a result of dormant seed banks and associated marsh conditions that still promote their establishment. These populations face the risk of extirpation if the levee fails or is unmaintained in the future. Also, future land use and management activities that further mute tidal flows in these marshes may rapidly alter marsh conditions to further restrict or exclude the subspecies from the local plant community (Goals Project 1999). Muting of tidal flows is known to have extirpated *Cordylanthus mollis* ssp. *mollis* in at least one instance. Mitigation for the expansion of the Potrero Hills Landfill, initiated in 2002, involved extending tidal flows into a mitigation area to support vernal pool species, thereby reducing, and in some cases eliminating, tidal flows from the Hill Slough area which supported *C. mollis* ssp. *mollis*. Continuous hydrologic recorders in place at the site since 2001 to support local restoration research documented the change in hydrology that resulted in negative impacts to *C. mollis* ssp. *mollis*. (USFWS, 2009)

Stressor: Freshwater inflow (USFWS, 2009)

Exposure:**Response:****Consequence:**

Narrative: Changes to freshwater inflow have also modified the habitat for this species. For example, at BSRA, increased freshwater runoff from nearby urban development has replaced halophytic communities (including species such as *Salicornia virginica* (pickleweed) with freshwater emergent marsh communities not appropriate as host plants (Grewell, pers comm. 2007). (USFWS, 2009)

Stressor: Agriculture and municipal uses (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Agricultural and municipal uses have diverted much historical annual inflow of freshwater from the Suisun Marsh and Delta, creating a more saline environment. In addition, artificially variable soil salinities may threaten *Cordylanthus mollis* ssp. *mollis* by reducing the distribution and abundance of its host plants. (USFWS, 2009)

Stressor: Sea level rise (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Sea level rise, such as that potentially associated with global climate change, and anticipated associated flood control responses, though not discussed in the listing rule, may impose significant long-term threats to conservation of *Cordylanthus mollis* ssp. *mollis*. Conservation of high marsh zones in the face of sea level rise requires landward migration of the marsh profile on broad, sloping plains (Field et al. 1999, Baye 2006). Many alluvial terraces and valleys adjacent to the estuary are bordered by steep levees or are already converted to intensive agriculture, residential, or commercial development. In Suisun and northern San Pablo Bay, however, some undeveloped grazing land remains. Conflicting needs for flood protection, agriculture, and marsh transgression could effectively compress tidal marsh zones to a point at which they could cease to support *C. mollis* ssp. *mollis* habitat (Grewell 2006). Land use planning and economic pressures that favor conversion of “underdeveloped” grazing lands contribute to the loss of potential transgressive high marsh habitat for long-term viability of the species (Baye 2006). (USFWS, 2009)

Stressor: Mosquito abatement (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Mosquito abatement activities noted in the final listing rule continue to threaten *Cordylanthus mollis* ssp. *mollis* populations, though to a lesser degree than the above threats. Specifically, ditch cleaning and dredging along first order channels for mosquito abatement purposes alter the natural hydrology of the habitat and chemical spraying of vegetation threatens the species as well. Off-road vehicle traffic associated with mosquito control (discussed under Factor A) continues to threaten *Cordylanthus mollis* ssp. *mollis* populations in most known locations (Grewell 2005; CNDDDB 2006). Foot traffic in Suisun Marsh at the time of listing was believed to contribute to habitat degradation via trampling. Foot traffic remains a threat today, specifically via excessive recreational and research access (Grewell, pers. comm. 2007). (USFWS, 2009)

Stressor: Seed predation (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Intense seed predation by insects was reportedly observed at Joice Island and Hill Slough within the Suisun Marsh in Solano County (U.S. Fish and Wildlife Service 1997). Insect predation reportedly was responsible for decline in one of the largest populations of *Cordylanthus mollis* ssp. *mollis*. Since the time of listing, much light has been shed on the specifics of *C. mollis* ssp. *mollis* seed predation which still poses a threat to populations in Suisun Marsh. *Cordylanthus mollis* ssp. *mollis* seed production can be significantly influenced by pre-dispersal seed predation from moth larvae (*Saphenista* spp., Tortricidae and salt marsh snout moth, *Lipographis fenestrella*, Pyralidae) (Ruygt 1994; Grewell et al. 2003). Areas with muted tidal regimes can support the subspecies (CDWR 1999), but increased tidal muting can constitute a threat to *C. mollis* ssp. *mollis* by increasing the prevalence of unsuitable host plants, and by changing the balance of seed production to seed predation maintained between the plant and seed-eating moths, such as various *Saphenista* species (Grewell 2004; Grewell 2006). The moth larvae burrow in the sediment during part of their life cycle, so reduced tidal flooding may improve their survivorship. Under full tidal regimes, the interaction between the rare Lepidopteran moth (*Cordylanthus mollis* specialist) and its rare plant host appears to be in balance (Grewell et al. 2003; Grewell 2004). (USFWS, 2009)

Stressor: Non-native plants (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Aside from the alteration of natural tidal cycles, the most significant threat to the species is that from invasion of non-native plants, especially winter annuals, which are inappropriate host plants. Since the time of listing, the threat posed by nonnative plant competitors and winter annuals as inappropriate host plants has become more defined. *Lepidium latifolium* (perennial pepperweed) and *Spartina patens* (salt-meadow cord grass) are two non-native species endangering native tidal marsh ecosystems in the range of *Cordylanthus mollis* ssp. *mollis* (Grewell 2005). Both plants are highly invasive, however *L. latifolium* is thought to be a more significant threat due to its proximity to *C. mollis* ssp. *mollis* occurrences, especially in Suisun Marsh. *Lepidium latifolium* is also of particular concern because it forms large monospecific patches that displace native marsh vegetation. L.C. Lee and Associates (2003) observed that one of the five most dominant associates of *C. mollis* ssp. *mollis* at Rush Ranch, based on canopy coverage in sample plots, was *L. latifolium*. *Lepidium latifolium* is a highly invasive non-native plant that forms monospecific stands that are very difficult to remove. *Spartina patens* also exists in the general vicinity of *Cordylanthus mollis* ssp. *mollis* habitat. It presents a more minor threat to *C. mollis* ssp. *mollis* because it is not known to exist along the high marsh edge. However, it does present a threat to the high marsh plant community in general in that the species displaces native habitat essential for a fully functioning ecosystem. (USFWS, 2009)

Stressor: Inappropriate host plants (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: High levels of premature mortality were found to be correlated with the presence of non-native winter annual grasses in the immediate vicinity of *C. mollis* ssp. *mollis* seedlings (Grewell et al. 2003). Non-native winter annuals such as *Hainardia cylindrica* (bargrass) and *Polypogon monspeliensis* (annual rabbitsfoot grass) or native winter annuals such as *Juncus bufonius* (toad rush) are not suitable hosts since they typically die before *C. mollis* ssp. *mollis* can flower and produce seeds (Grewell et al. 2003, 2004). The prevalence of inappropriate plant hosts is correlated with muted tidal regimes (Grewell et al. 2003, 2004). (USFWS, 2009)

Stressor: Chronic pollution (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Oil spills and chronic pollution from point and non-point sources are unavoidable occurrences that continue to occur in or near habitat for *Cordylanthus mollis* ssp. *mollis* (U.S. Fish and Wildlife Service 2007). In particular, because of their location, Point Pinole and BSRA populations are the most threatened by oil spills and pollution (U.S. Fish and Wildlife Service 2006). (USFWS, 2009)

Stressor: Cattle grazing and feral hogs (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Cattle grazing still occurs and introduced feral hogs (*Sus scrofa*) roam *Cordylanthus mollis* ssp. *mollis* habitat in some locations (Grewell et al. 2003). Cattle and feral hogs can degrade habitat for the species by trampling and can also damage the plant itself by crushing fragile underground connections (haustoria) to host plants. These connections are critical to the hemiparasitic life history of *C. mollis* ssp. *mollis*. In fact, the Rush Ranch population described in the final listing rule was extirpated due to trampling by cattle around 1999 (Grewell, in litt. 2008). Populations at Hill Slough and Rush Ranch (the reintroduced population) are currently subject to rooting, wallowing, trampling, and grazing impacts from livestock and feral hogs that could result in damage or loss to *C. mollis* ssp. *mollis* populations or soil disturbance and compaction leading to a disruption in natural marsh ecosystem processes (U.S. Fish and Wildlife Service 2006). (USFWS, 2009)

Stressor: Random events (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Since the time of listing, the distribution of the species within its range has not increased and the habitat of the species remains restricted due to fragmentation and historic conversion to other uses. The resulting small populations are still highly susceptible to extinction due to random natural and human-made events, such as pest outbreaks, extended drought, fire, oil spills, genetic or demographic problems or a combination of these events. (USFWS, 2009)

Stressor: Hybridization (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: No new information exists regarding the threat of hybridization with *Cordylanthus mollis* ssp. *hispidus*, so we must assume the threat is still present. Also, though a permitted reintroduction effort involving seed harvesting and planting has been conducted (Grewell et. al. 2003), no new information exists regarding the threat of unpermitted seed harvesting and planting. We must also assume this threat still persists. (USFWS, 2009)

Recovery

Reclassification Criteria:

1. The minimum area inhabited annually by the species in the Suisun Bay Area Recovery Unit must be 3,000 acres and the minimum area inhabited annually by the species around San Pablo Bay Recovery Unit must be 1,000 acres, over a period of five years. (USFWS, 2013)
2. A minimum of 5,000 acres of suitable habitat in the Suisun Bay Area and San Pablo Bay Recovery Units must be permanently preserved and under protective management. (USFWS, 2013)
3. Reduction in extant *Lepidium latifolium* populations in tidal areas (in and downgradient of the high marsh-upland ecotone) to less than ten percent cover for five years. (USFWS, 2013)
4. There must be less than ten percent total cover of other non-native, invasive perennial or non-native winter annual grass species (other than *Lepidium latifolium*), including, but not limited to, *Apium graveolens* (celery), *Cotula coronopifolia* (brass-buttons), *Juncus gerardi* (black-grass rush), *Spartina patens* (salt-meadow cordgrass), *Polypogon monspeliensis* (annual beard grass), *Hainardia cylindrical* (barbgrass), *Parapholis incurva* (sicklegrass), *Crypsis schoenoides* (swamp grass), and *Lepidium latifolium* within 50 feet of extant *C. molle* ssp. *molle* populations. (USFWS, 2013)
5. Natural tidal range must be restored at Hill Slough and the ponded area at Rush Ranch to return periodic tidal flooding. (USFWS, 2013)
6. At least nine populations must occur in the Suisun Bay Area Recovery Unit and at least four populations must occur around San Pablo Bay Recovery Unit. (USFWS, 2013)
7. Over five years of monitoring, each population must have a mean of at least 3,000 individuals. (USFWS, 2013)
8. The entire species must not fall below 500 individuals for two consecutive years over a period of five years. (USFWS, 2013)
9. There must be an average of more than 10 seed capsules produced per plant, resulting in an average of more than 15 mature seeds per plant. (USFWS, 2013)

Delisting Criteria:

1. The minimum area inhabited annually by the species in the Suisun Bay Area Recovery Unit must be 6,000 acres and the minimum area inhabited annually by the species around San Pablo Bay Recovery Unit must be 2,500 acres over a period of eight years. (USFWS, 2013)

2. A minimum of 9,000 acres in the Suisun Bay Area Recovery Unit or around San Pablo Bay Recovery Unit must be permanently preserved and under protective management. (USFWS, 2013)
3. All conditions under downlisting criterion A/3 have been met. In addition, a plan must be developed and implemented for early detection and control of *Lepidium latifolium* following any future increase beyond ten percent cover in tidal areas (in and down-gradient of the high marsh-upland ecotone). Also, a funding source must be secured to fund such actions in perpetuity. (USFWS, 2013)
4. All conditions under downlisting criterion number 4 must have been met. (USFWS, 2013)
5. All conditions under downlisting criterion number 5 must have been met. (USFWS, 2013)
6. Trampling damage by grazed cattle and feral pigs to *C. molle* ssp. *molle* and its haustorial connections to host plants must have been eliminated at all populations for eight years. (USFWS, 2013)
7. Reliable propagation and reintroduction methods must be developed and available. (USFWS, 2013)
8. Pre-dispersal seed predation on *C. molle* ssp. *molle* from moth larvae (*Saphenista* spp., Tortricidae and salt marsh snout moth, *Lipographis fenestrella*, Pyralidae) must, on average, fall below 15 percent. (USFWS, 2013)
9. At least ten separate populations must occur in the Suisun Bay Area Recovery Unit and at least eight separate populations must occur around San Pablo Bay Recovery Unit. (USFWS, 2013)
10. Over eight years of monitoring, each population must have a mean of at least 3,000 individuals; or if the species is widespread and abundant and is not divisible into separate populations, there must be a mean of at least 300,000 individuals in the Suisun Bay Area Recovery Unit and at least 300,000 individuals around San Pablo Bay Recovery Unit over a period of eight years. (USFWS, 2013)
11. The entire species must not fall below 1,000 individuals for two consecutive years over a period of eight years. (USFWS, 2013)
12. There must be an average of more than 10 seed capsules produced per plant, resulting in an average of more than 15 mature seeds per plant. (USFWS, 2013)
13. Seed banking of all extant populations and representative genetic diversity (per commonly accepted seed banking protocols) must be complete. (USFWS, 2013)
14. To minimize impacts sustained after oil spills occurring at or near populations, the San Francisco Bay and Delta Area section of the Sector San Francisco-Area Contingency Plan must be revised to place high priority on the emergency protection of *C. molle* ssp. *molle*. (USFWS, 2013)

15. High marsh/upland transition lands must be preserved or created as part of new marsh restoration efforts and managed to provide opportunity for landward migration of species in response to sea level rise. (USFWS, 2013)

Recovery Actions:

- Non-native plant control should target *Lepidium latifolium* at Hill Slough, Rush Ranch, BSRA, and other population locations. (USFWS, 2013)
- Adaptive management for and monitoring of ground-nesting and other native bees, particularly near *C. molle* ssp. *molle* populations, is needed. Protection of predatory wasps that feed on moth larvae infesting *C. molle* ssp. *molle* inflorescences should reduce losses of reproductive output to seed-eaters. (USFWS, 2013)
- Management of grazing should aim to reduce trampling and breaking of haustorial connections to host plants due to disturbance. (USFWS, 2013)
- Controls should be erected and maintained to prevent illicit off-road vehicle use in habitat of *C. molle* ssp. *molle*. (USFWS, 2013)
- Where urban runoff has displaced former tidal marsh habitat at BSRA with freshwater emergent marsh, solutions should be identified to direct the runoff away from sensitive habitat. (USFWS, 2013)
- Natural tidal range should be maintained or restored, since their resulting effects on vegetation and soil chemistry are important to the persistence of *C. molle* ssp. *molle*. (USFWS, 2013)
- Seed banking is recommended for *C. molle* ssp. *molle*, including banking from different population areas. (USFWS, 2013)
- In addition to monitoring needed for appropriate management and tracking of progress toward recovery, it is recommended that field surveys be conducted for additional, as-yet undiscovered populations of *C. molle* ssp. *molle*. (USFWS, 2013)
- Given the importance of a host plant community comprised of a matrix of native perennials, information on host plants within *C. molle* ssp. *molle* population patches should also be gathered. (USFWS, 2013)
- Research is needed on many aspects of life history and conservation of *C. molle* ssp. *molle*. (USFWS, 2013)
- Over the longer term, restoration of suitable tidal marsh habitat and introduction/reintroduction of *C. molle* ssp. *molle* within its historic range will advance recovery of the species. (USFWS, 2013)

Conservation Measures and Best Management Practices:

- A recovery plan for *Cordylanthus mollis* ssp. *mollis* should be developed which describes recovery strategies and specific tasks necessary for recovery of the species. A draft recovery plan for this species and five other listed tidal marsh species is currently in development at SFWO. (USFWS, 2009)
- Control of non-native competitor species and non-native winter annual species should be conducted at all appropriate sites. *Lepidium latifolium* should be targeted at Hill Slough Wildlife Area, Rush Ranch, BSRA, and other population locations where it presents a threat and *Spartina patens* (salt-meadow cord grass) should be targeted at BSRA. Nonnative winter annuals that invade upper tidal marsh habitats at the known locations should be controlled to increase survival of *Cordylanthus mollis* ssp. *mollis* seedlings (Grewell et al. 2003). Initially, surveys for these invasive plants should occur at each site in order to document the extent of spread and prioritize treatment efforts. (USFWS, 2009)

- Natural tidal cycles of San Pablo and Suisun Bays should be maintained or restored to the extent possible because middle to high marsh areas with periodic tidal flooding provide appropriate hydrology and help retain the healthy extent and composition of tidal marsh communities, including *Cordylanthus mollis* ssp. *mollis*. Additionally, natural tidal regimes encourage low abundance of damaging non-native winter annuals and seed predators. (USFWS, 2009)
- Surveys should be conducted within potential *Cordylanthus mollis* ssp. *mollis* habitat as well as at known population centers to identify potential new occurrences as well as to provide an updated species status with which to make management decisions. (USFWS, 2009)
- Management of *Cordylanthus mollis* ssp. *mollis* habitat should involve reducing trampling and breaking of haustorial connections to host plants by grazed cattle and feral hogs. Removal of cattle and feral hogs or other protection of the populations from grazing should occur at Hill Slough and Rush Ranch populations, as well as other locations where trampling presents a threat to *C. mollis* ssp. *mollis*. A regional-scale feral hog eradication effort should be coordinated with CDFG to decrease that species' impact on habitat for sensitive plants. (USFWS, 2009)

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SPECIES ACCOUNT: *Cordylanthus palmatus* (Palmate-bracted bird's beak)

Species Taxonomic and Listing Information

Listing Status: Endangered; 07/01/1986; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

An annual herb in the broomrape family (Orobanchaceae) (Olmstead et al. 2001). The plants are 4-12 inches tall and highly branched. The stems and leaves are grayish green and sometimes are covered with salt crystals excreted by glandular hairs. Small pale whitish flowers, up to 1-inch long, are arranged in dense clusters (spikes) and are densely surrounded by herbaceous leaf-like bracts. The petals are divided into two lips. The upper one is shaped like a bird's-beak, leading to the common name of the genus. (USFWS, 2009)

Taxonomy

Tank et al. (2009) moved four species of *Cordylanthus* (*maritimus*, *mollis*, *palmatus*, and *tecopensis*) to *Chloropyron*. (NatureServe, 2015)

Historical Range

Historically, the species is known from scattered locations in the Sacramento and San Joaquin Valleys (Bittman 1985, 1986; Center for Conservation Biology 1991, 1992, 1993, 1994) (USFWS, 2009)

Current Range

The species ranges from the northern Sacramento Valley south to the San Joaquin Valley. (USFWS, 2009)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: 1 year (USFWS, 2009)

Dependency on Other Individuals or Species

Adult: Bumblebees (*Bombus californicus*, *B. occidentalis*, and *B. vosnesenskii*) were the primary pollinators of palmate-bracted bird's-beak at the Springtown Alkali Sink in 1993. (USFWS, 1998)

Breeding Season

Adult: May to October (USFWS, 1998)

Key Resources Needed for Breeding

Adult: Seasonal overland flooding may disperse seeds and promote seed germination by diluting the saline soils (Coats et al. 1993).

Reproduction Narrative

Adult: Palmate-bracted bird's-beak is an annual herb in the broomrape family (Orobanchaceae) (Olmstead et al. 2001). This species flowers from May until October (Skinner and Pavlik 1994). Both self- and cross-pollination can contribute to seed-set (Center for Conservation Biology 1993j, and individual plants can produce up to 1,000 seeds in a single growing season (Center for Conservation Biology 1991). Seasonal overland flooding may disperse seeds and promote seed germination by diluting the saline soils (Coats et al. 1993). Bumblebees (*Bombus californicus*, *B. occidentalis*, and *B. vosnesenskii*) were the primary pollinators of palmate-bracted bird's-beak at the Springtown Alkali Sink in 1993. (USFWS, 1998; USFWS, 2009)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Grassland/herbaceous, Shrubland/chaparral (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Seasonal flooding (USFWS, 1998)

Geographic or Habitat Restraints or Barriers

Adult: Restricted to elevations of less than 155 m (500 feet) (USFWS, 1998)

Spatial Arrangements of the Population

Adult: Small and isolated patches (USFWS, 2009)

Habitat Narrative

Adult: Palmate-bracted bird's-beak is restricted to seasonally-flooded, saline-alkali soils in lowland plains and basins at elevations of less than 155 meters (500 feet). It occurs in a mosaic pattern of small and isolated patches. Within these areas, palmate-bracted bird's-beak grows primarily along the edges of channels and drainages, with a few individuals scattered in seasonally-wet depressions, alkali scalds (barren areas with a surface crust of salts), and grassy areas. Suitability of microhabitats for palmate-bracted bird's beak depends primarily on soil pH and to a lesser extent on soil layering, salinity, and moisture. This species occurs on neutral to alkaline soils pH 7.2 to 9.5) under natural conditions (Coats et al. 1993, Center for Conservation Biology 1993, 1994). (USFWS, 1998; USFWS, 2009)

Dispersal/Migration**Dispersal**

Adult: Moderate (inferred from USFWS, 2009)

Dispersal/Migration Narrative

Adult: The pattern of genetic variation within palmate-bracted bird's-beak populations support the hypothesis that the historical frequency and extent of seed dispersal by overland flooding

has influenced population genetic structure. In brief: (1) sites that are more-frequently flooded or that have more extensive floods (leading to enhanced seed dispersal). (USFWS, 2009)

Population Information and Trends

Population Trends:

Declining (USFWS, 2009)

Resiliency:

Low (inferred from USFWS, 2009)

Representation:

Low (inferred from USFWS, 2009)

Redundancy:

Low (inferred from USFWS, 2009)

Number of Populations:

8 (USFWS, 2009)

Population Narrative:

The palmate-bracted bird's-beak has declined significantly over the past century. Several palmate-bracted bird's-beak species experts have suggested that (a) except, perhaps, for Sacramento National Wildlife Refuge Complex there are fewer palmate-bracted bird's-beak today than when the species was originally listed and (b) population trends are down. Of the eight known occurrences (up to 10 populations reported historically), five are located on public lands and are protected from development. The constrained dispersal abilities of *C. palmatus* can limit its ability to withstand changes in climate. (USFWS, 2009)

Threats and Stressors

Stressor: Urban sprawl (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Urban sprawl and associated human activities have also been identified as the leading cause of species imperilment – including the palmate bracted bird's-beak -- in the State (National Wildlife Federation 2001). Sprawl (low density, automobile dependent development into natural areas outside of cities and towns) results in habitat loss, habitat degradation (including the disruption of natural processes, wildfire suppression, noise pollution, and high-impact outdoor recreation), habitat fragmentation (including blocking wildlife movement and edge effect), and loss of species diversity (including an increase in exotic species and changing ecosystem dynamics). (USFWS, 2009)

Stressor: Habitat loss (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: These widespread and ongoing threats include: the conversion of native habitat into irrigated agricultural fields (e.g., palmate-bracted bird's-beak sites at Woodland, Sacramento Valley, San Joaquin Valley); installation of pipelines and transmissions lines (Woodland); drainage facilities (Springtown residential development); gas and water pipelines (Springtown); and off-road vehicle use (Springtown). (USFWS, 2009)

Stressor: Cattle grazing (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: At the time of listing, cattle grazing was identified as a major factor (Service 1986:23767). Cattle grazing has undoubtedly altered the plant species composition of the areas occupied by the palmate-bracted bird's-beak, but the specific effects and mechanisms were not indicated. Existing grazing levels, at that time, did not appear to threaten those areas still supporting the palmate-bracted bird's-beak. Cattle grazing as a management tool, it now appears, can be beneficial as well as harmful to the palmate-bracted bird's-beak. Grazing can enhance the conservation status of the palmate-bracted bird's-beak through the removal of invasive non-native plants that compete with the palmate-bracted bird's-beak for resources or displace host plants (Wingo-Tussing et al., 2005; Wingo-Tussing 2006). (USFWS, 2009)

Stressor: Invasive non-native plants (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Invasive non-native plant species are a potential threat to palmate-bracted bird's-beak and associated native host plants at Colusa NWR and Delevan NWR (Wight 2000; Wingo-Tussing et al. 2005; WingoTussing 2006). Populations of the annual ryegrass (*Lolium multiflorum*), tall wheatgrass (*Elytrigia pontica* ssp. *pontica*), broad-leaved pepperweed (*Lepidium latifolium*), and fleshy-leaved Russian-thistle (*Salsola soda*) have been increasing in habitat occupied by palmate-bracted bird's-beak, and associated (host) plants such as Great Valley gum plant (*Grindelia camporum* var. *camporum*), pappose spikeweed (*Hemizonia parryi* spp. *rudis*), alkali heath (*Frankenia salina*), and saltgrass (*Distichlis spicata*; host plant). These plants compete with the palmate bracted bird's-beak for resources (e.g., space, water, and nutrients) and can displace host plants. (USFWS, 2009)

Stressor: Accidental flooding (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Accidental flooding of palmate-bracted bird's-beak during the dry period (June to September) from rice field run-off has also impacted one palmate bracted bird's beak patch at Colusa NWR (J. Silveira, in litt., 2006). Extensive and unseasonal flooding can kill palmate-bracted bird's-beak plants, as well as allow other plants to invade after the waters recede. Deep flooding that persists over several weeks can kill individual plants. (USFWS, 2009)

Stressor: Decline of pollinators (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Another widespread threat to palmate-bracted bird's-beak is the loss of pollinators through the spraying of malathion and other pesticides. Bees are important pollinators of the palmate-bracted bird's-beak in California (SaulGershenz et al., 2004). Malathion application to bees and the vegetation where they occur may be a specific threat to the genetic diversity of palmate-bracted bird's-beak by reducing pollination. The effects of malathion application are extremely local given that bees typically range only about 300-400 meters (about 980-1300 feet) from the nest to a flower (Kroodsma 1975; Keasar et al., 1996; Capaldi et al., 2000; Kwak 2002). (USFWS, 2009)

Stressor: Pesticides (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: The Sacramento/Yolo Mosquito Vector Control District (Undated) also has an ongoing program to control the West Nile virus through the aerial application of pyrethroids and other insecticides that may affect palmate-bracted bird's-beak pollinators. It is not clear if sites with palmate-bracted bird's-beak are being sprayed or if palmate-bracted bird's-beak pollinators are being affected.

Stressor: Climate change (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Due to the highly restricted range of palmate-bracted bird's beak, climate change in the Central Valley could have a particularly negative effect on the species. As stated previously, the palmate-bracted bird's-beak is restricted to the Sacramento Valley and the San Joaquin Valley under a unique set of geographic (flat) and climatic (hot and dry) conditions (Figures 1-3). The range of palmate-bracted bird's-beak is restricted by soil type (alkaline-saline). Some climate change models predict for California an overall warming of 1.7 degrees Centigrade – 5.8 degrees by 2100 (Cayan et al. 2006), but they vary in their predictions for precipitation. VanRheenen et al. (2004) predict a decrease in precipitation in the San Joaquin Valley. Changes in annual precipitation have a large effect on the abundance of palmate-bracted bird's-beak, as typical of desert annuals (Germano et al. 2005; Warrick 2006). (USFWS, 2009)

Stressor: Ozone (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: Another potential threat to palmate-bracted bird's-beak is ozone due to photochemical smog. Numerous studies have documented the negative effects of ozone on plants, such as pronounced foliar injury and growth reduction (e.g., Miller 1992; Grantz and Yang 1996; Bytnerowicz 2002), but no studies have been performed specifically on palmate-bracted bird's-beak. The California Air Resources Board (2006) reported for southern portions of the San Joaquin Valley as many as 26 days per year above the national 1-hour ozone standard and as many as 116 days per year above the national 8-hour ozone standard during the period 2002 - 2005. (USFWS, 2009)

Stressor: Excessive dust (USFWS, 2009)

Exposure:

Response:

Consequence:

Narrative: An additional potential threat to the palmate-bracted bird's-beak is excessive dust. Dust may affect photosynthesis, respiration, and transpiration, as well as allow the penetration of phytotoxic gaseous pollutants (Farmer 1993). No research, however, has analyzed the effects of dust specifically on palmate-bracted bird's-beak. From 1996 – 2005, Bakersfield – in the southern portion of the San Joaquin Valley – on average surpassed the State of California 24-hour PM10 (particulate matter with an aerodynamic diameter of 10 microns or less) standard 170 days per year and surpassed the national 24-hour PM2.5 (particulate matter with an aerodynamic diameter of 2.5 microns or less) standard 16 days per year (California Air Resources Board 2006). In 2005, the primary sources of particulate matter (PM10 and PM2.5) in Kern County, for example, were farming operations, road dust, and fugitive windblown dust (California Air Resources Board 2006). (USFWS, 2009)

Recovery

Reclassification Criteria:

1. Protection of occupied habitat A) 95 percent of occupied habitat on public lands is secured and protected, and B) 75 percent or more of the population at Springtown Alkali Sink and 75 percent or more of the occupied area and upland habitat for pollinators within 300 meters (984 feet) of the population margins is secured and protected, and C) Two or more populations are secured and protected in the San Joaquin Valley. (USFWS, 2009)
2. A management plan that includes the survival of palmate-bracted bird's-beak as an objective has been approved and implemented for all protected areas identified as important to continued survival. (USFWS, 2009)
3. The populations are stable or increasing through a precipitation cycle. (USFWS, 2009)

Delisting Criteria:

1. Eight or more distinct populations, including two or more in the San Joaquin Valley are secured and protected. (USFWS, 2009)
2. 95 percent or more of the occupied habitat [under Service ownership] of Colusa National Wildlife Refuge, Delevan National Wildlife Refuge, and Sacramento National Wildlife Refuge is secured and protected. (USFWS, 2009)
3. 95 percent or more of the occupied habitat [under CDFG ownership] of the Alkali Sink Ecological Reserve-Mendota Wildlife Area (San Joaquin Valley) is secured and protected. (USFWS, 2009)
4. 260 hectares (640 acres) or more of any occupied habitat [under any ownership] elsewhere in the San Joaquin Valley, including western Madera County, is secured and protected. (USFWS, 2009)

5. 90 percent or more of the plants and occupied habitat [under ownership by City of Livermore, Federal Communications Commission, or private] of the Springtown Alkali Sink is secured and protected. (USFWS, 2009)

6. Two or more distinct populations each about 260 hectares (640 acres) [under any ownership] in the Sacramento Valley are protected. (USFWS, 2009)

7. A management plan has been approved and implemented for all protected areas identified as important to the continued survival of the species. (USFWS, 2009)

8. There is no decline after downlisting. If the population is declining, then the Service should determine the cause and reverse the trend. (USFWS, 2009)

Recovery Actions:

- Recovery actions are not available.

Conservation Measures and Best Management Practices:

- Protection of palmate-bracted bird's-beak habitat on private lands. One of the most important goals for the conservation of this species is the protection of occupied palmate-bracted bird's-beak habitat primarily at three sites. (USFWS, 2009)
- General and applied ecological research of palmate-bracted bird's-beak. Little is known about the basic biology of this species or how it responds to management practices (C. Feldheim, in litt., 2007). (USFWS, 2009)
- Over the next 5 years, genetic variation at the remaining sites should be characterized and synthesized with existing knowledge. The genetic variation at all sites should then be compared leading to a ranking of sites to guide conservation efforts according to the nature and extent of differences, as well as the importance of rare or unique alleles. A seed collection, based on the site rankings, should also be completed. (USFWS, 2009)
- Natural resource managers should consider the negative impacts of invasive nonnative species in order to enhance conservation and restoration programs for the palmate-bracted bird's-beak. Controlled grazing (see Wingo-Tussing et al. 2005; Wingo-Tussing 2006) and controlled burns (see Wight 2000) may enhance the conservation status of the palmate-bracted bird's-beak. (USFWS, 2009)
- The continued survival of the palmate-bracted bird's-beak depends on many demographic factors. The natural variation of these factors, though, is poorly understood (Fleishman et al., 1994, 1996). An outline for future actions that incorporates demographic monitoring of the several populations and minimum levels of demographic parameters maintained should be established. (USFWS, 2009)
- The scientific name should formally be changed in the Code of Federal Regulations from *Cordylanthus palmatus* to *Chloropyron palmatum*.

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